Households' Responses to Policy in Labor and Credit Markets
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Abstract
Household Debt and Monetary Policy: Revealing the Cash-Flow Channel We examine the effect of monetary policy on spending when households hold debt linked to short-term rates, such as adjustable-rate mortgages (ARMs). Using registry-based data, which is broadly representative of Swedish households, we find substantial heterogeneity in consumption responses to changes in monetary policy. We find that consumption responds more strongly to changes in interest rates for households with high debt than for households with little or no debt. Moreover, households with ARMs appear to be more interest-rate sensitive than households with fixed-rate mortgages. Our results are consistent with hand-to-mouth behavior and an important transmission of monetary policy through the cash-flow channel.

Should I Stay or Must I Go? Temporary Refugee Protection and Labor-Market Outcomes We study a Danish reform in 2002 that lowered the ex-ante probability of refugees receiving permanent residency by prolonging the time period before they were eligible to apply for such residency. Adherence to the new rules was entirely determined by the date of the asylum application and the reform was implemented retroactively. We formulate a simple search and matching model to derive predictions that can be tested using our data. Using registry based data on individuals in Denmark, we then study the effects on educational and labor-market outcomes and find that the reform significantly increased the enrollment in formal education, especially for females and low-skilled individuals. In terms of employment and earnings, the coefficients are in general negative but insignificant. Other outcomes of interest are also studied.

Risk-sharing and Entrepreneurship We study the role of risk-sharing in facilitating innovation. Studying entrepreneurship and innovation entails modelling an occupational choice and an effort choice. Risk-sharing may increase the number of individuals who become entrepreneurs by limiting the downside risk. The effort of entrepreneurs may, however, be hampered by high risk-sharing if this limits the returns faced by successful entrepreneurs relative to unsuccessful entrepreneurs. We construct a theoretical model where risk-sharing may be private or public, i.e., provided through the welfare state by means of taxation. We show that the level of risk-sharing matters for the characteristics of entrepreneurs. Moreover, high taxes, which imply high equilibrium benefits paid out to entrepreneurs, encourage entrepreneurship but discourage effort.

Portfolio and Housing Decisions in the Presence of Intergenerational Links There is ample support for the idea that parents matter for the housing market choices of their children. Despite this, our understanding of the effects of these intergenerational links remains limited. I set up a partial equilibrium overlapping generations model with intergenerational links and study housing and portfolio decisions. I use the model to characterize individual behavior, as well as behavioral responses to a change in borrowing conditions. In steady state, the main determinant of both children's and parents' behavior is parental wealth and stricter borrowing conditions have a limited effect. During a transition with positive house price growth, however, the difference between parents who are homeowners and renters (and between their children) is amplified and stricter borrowing conditions have a stronger impact on behavior.

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HOUSEHOLDS' RESPONSES TO POLICY IN LABOR AND CREDIT MARKETS

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results do not seem to be driven by selection, since the reform had no significant effect on the share of refugees that stayed in Denmark in the long run.

Risk-sharing and Entrepreneurship In this paper, we study the role of risk-sharing in facilitating innovation. Studying entrepreneurship and innovation entails modelling an occupational choice and an effort choice. Risk-sharing may increase the number of individuals who become entrepreneurs by limiting the downside risk. The effort of entrepreneurs may, however, be hampered by high risk-sharing if this limits the returns faced by successful entrepreneurs relative to unsuccessful entrepreneurs. We construct a theoretical model where risk-sharing may be private or public, i.e., provided through the welfare state by means of taxation. We show that the level of risk-sharing matters for the characteristics of entrepreneurs. Moreover, high taxes, which imply high equilibrium benefits paid out to unsuccessful entrepreneurs, encourage entrepreneurship but discourage effort.

Portfolio and Housing Decisions in the Presence of Intergenerational Links There is ample support for the idea that parents matter for the housing market choices of their children. Despite this, our understanding of the mechanisms and effects of these intergenerational links, and how they interact with policy, remains limited. In this paper, I set up a partial equilibrium overlapping generations model with intergenerational linkages and study housing and portfolio decisions. There is predetermined heterogeneity in parents’ housing tenure status, in that parents can be either renters or homeowners, whereas children choose their housing tenure status. I use the model to characterize individual behavior, as well as behavioral responses to a change in borrowing conditions. In steady state, the main determinant of both children’s and parents’ behavior is parental wealth and stricter borrowing conditions have a limited effect. During a transition with positive house price growth, however, the difference between parents who are homeowners and renters, and between their children, is amplified, and stricter borrowing conditions have a stronger impact on behavior.
Till Gabriel och min familj.
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'Drops mic'

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### Contents

**Introduction**

1 Household Debt and Monetary Policy  
   1.1 Introduction .................................. 7  
   1.2 Theoretical Motivation .......................... 14  
   1.3 Data and Summary Statistics  .................... 18  
   1.4 Empirical Framework  .......................... 25  
   1.5 Results ........................................ 27  
   1.6 Conclusion ...................................... 33  
   References .......................................... 35  
   1.A Details on the Model  .......................... 51  
   1.B Details on the Data  ............................ 58  

2 Should I Stay or Must I Go?  61  
   2.1 Introduction ..................................... 61  
   2.2 Institutional Settings  .......................... 70  
   2.3 Theoretical Framework .......................... 74  
   2.4 Empirical Strategy ................................ 85  
   2.5 Results .......................................... 95  
   2.6 Sensitivity Analysis  .............................. 100  
   2.7 Other Outcomes .................................. 105  
   2.8 Conclusion ....................................... 109  
   References .......................................... 111  
   2.9 Figures and Tables  .............................. 115
CONTENTS

2.A The Danish Asylum Process .......................... 137
2.B Other Reform Components .......................... 139
2.C Model Details ...................................... 141
2.D Details on the Data .................................. 144

3 Risk-sharing and Entrepreneurship .................. 145
3.1 Introduction ....................................... 145
3.2 Empirical Motivation ................................ 152
3.3 A Model of Occupational and Effort Choice ......... 167
3.4 Analysis of the Model ................................ 178
3.5 Discussion ......................................... 190
3.6 Conclusion ......................................... 193
References .............................................. 194
3.A Model Appendix ..................................... 198
3.B Additional Tables .................................... 205

4 Portfolio and Housing Decisions ...................... 207
4.1 Introduction ....................................... 207
4.2 Parents and Housing: An Empirical Overview ....... 216
4.3 Theoretical Model ................................... 224
4.4 Analysis of the Model ................................ 236
4.5 Discussion ......................................... 270
4.6 Conclusion ......................................... 274
References .............................................. 276
4.A Additional Figures ................................... 283
4.B Model Details ....................................... 284
4.C Computational Method .............................. 291

Sammanfattning (Swedish Summary) .................... 293
Introduction

This thesis consists of four self-contained papers that study households’ responses to policy in different settings. Chapters 1 and 4 study household behavior in relation to credit markets, while Chapters 2 and 3 study individuals in the labor market. The order of the chapters is chronological so that Chapter 1 is the paper I started working on first, and so on.

There is a large literature investigating the effects of monetary policy on the real economy and on households. The standard theoretical channel through which monetary policy can affect households is that a change in interest rates makes forward looking households alter their relative consumption between the present and the future. However, empirically, the support for this mechanism is mixed and modifications, as well as other potential channels, have been suggested. In Chapter 1, Household Debt and Monetary Policy: Revealing the Cash-Flow Channel, jointly written with Martin Flodén, Jósef Sigurdsson, and Roine Vestman, we study an alternative, more direct, channel. When a household holds debt (often a mortgage) with adjustable interest rates, a change in the monetary policy rate will affect the household’s cash flow. In this sense, there is a direct link between changes in monetary policy and the household’s disposable income. We call this channel the cash-flow channel and study if households update their consumption in response to changes in monetary policy, through this specific channel, and how they do so. Here, we build on a literature that highlights the importance of
accounting for households' balance sheet positions. In particular, a prediction for our setting is that the cash-flow channel will have a differential impact on households depending on how indebted they are.

We use Swedish administrative panel data to study the cash-flow channel. Swedish data is optimal for this type of analysis for many reasons. Swedish household debt is relatively high and adjustable interest rates are common (and considered to be a standard product). The register data also features detailed and high-quality information on households, including balance sheets, income, and demographics. This data is crucial for our exercise, since a general difficulty in studying consumption responses is the lack of high-quality consumption data. We overcome this problem by using an imputed consumption measure, based on the notion that the budget constraint serves as an accounting identity for a household in a given year.

Using this measure, we find substantial differences in how households respond to a change in the monetary policy rate. Our results imply that households that are more indebted, or have adjustable rates, react more to monetary policy changes. Furthermore, on a more general note, our results indicate that monetary policy is more potent in economic environments where households are highly indebted and hold loans with adjustable interest rates and that its impact is affected by the distribution of debt.

In Chapter 2, Should I Stay or Must I Go? Temporary Refugee Protection and Labor-Market Outcomes, jointly written with Birthe Larsen and Elisabet Olme, I turn to analyze risk, or uncertainty, in connection to labor markets and consider the risk that refugees face of being deported from their host countries. Over the last couple of years, Europe has seen large inflows of asylum seekers and, as a result, several countries have implemented stricter immigration policies. One such policy is the shift from permanent to temporary residence permits, which affects the probability of being allowed to stay in the host country in the long run.

We study this type of policy in the Danish context, using a reform
that was implemented in 2002. This reform increased the period with temporary permits (before refugees were eligible to apply for permanent residency), lowering the ex-ante probability of asylum holders being granted permanent residency. We primarily study the effects on human capital investment decisions and labor-market outcomes. The reform was implemented retroactively, allowing for a discontinuity in time design. For our empirical research design we exploit this discontinuity together with high-quality registry data.

Ex ante, the impact of the reform on individuals' decisions is unclear. In particular, we may think that the effects are likely to differ across individuals, depending on characteristics, such as how close they are to the labor market or on their education level upon arrival. In order to better understand the mechanisms at work, we therefore set up a theoretical search and matching model with heterogeneity in skill levels. From this framework, we derive predictions that can be compared to our empirical findings. Empirically, we find that the reform had significant positive effects on the enrollment in education and that, in line with the hypothesis that there is heterogeneity in responses, this effect was strongest for women and for individuals with less than university education at arrival. For the full sample, we find no statistically significant effects on labor-market outcomes, such as having a job (or being self-employed), or on income.

Exploring the mechanisms further, we turn to a related strand of literature that studies the effects of legalization (of illegal immigrants) on criminal activity. Using the administrative data, we study the impact of this reform on the share of individuals that are convicted of a crime. Our results show a reduction in criminal activity following the implementation of the reform. Although anecdotal evidence from the time points to increased stress among refugees, we do not find that the reform had any effect on the number of times individuals seek formal healthcare. It is possible that increased uncertainty about the time horizon in Denmark could deter individuals from having children or make them postpone forming a family. We find a small negative effect on childbearing, offer-
ing some support for this hypothesis.

Another area where risk may matter for individual behavior is for the occupational choice. In Chapter 3, *Risk-Sharing and Entrepreneurship*, jointly written with Paula Roth, we ask what the role of risk-sharing is in facilitating innovation through entrepreneurship, when individuals are risk averse. There exists a large literature on the relationship between inequality and growth and on the role of innovation for growth. One strand of this literature has argued that in order to incentivize innovation, it is necessary to tolerate inequality and to restrict the degree of public risk-sharing.\footnote{By public risk-sharing we mean insurance provided by the welfare state.} Another part of the literature, however, has argued that risk-sharing can increase the number of individuals who become entrepreneurs, by limiting downside risk and, because of this, that risk-sharing is crucial for promoting entrepreneurship.

We show that, in terms of innovation rankings and other measures of innovative activities, it is not obvious that there is a simple policy recommendation for the optimal degree of risk-sharing. We find countries with both high and low levels of public risk-sharing among the top innovators. Using cross-country data we establish some general patterns that are used as a motivation for a simple model. We argue that, in order to study entrepreneurs and innovation theoretically, it is crucial to account for both the occupational choice and the effort choice. Thus, we need to consider the extensive margin, i.e., the choice of whether or not to become an entrepreneur, as well as the intensive margin, i.e., the choice of how hard to work. To motivate entrepreneurs to work hard, the relative return for successful, compared to unsuccessful, entrepreneurs needs to be high enough. This puts restrictions on how much risk-sharing is feasible. At the same time, in order for individuals to choose entrepreneurship in the first place, the expected value of doing so must exceed that of being a worker. For this purpose, a higher degree of risk-sharing can increase the number of individuals that become entrepreneurs by limiting the downside risk. The presence of private insurance, in addition to that provided...
by the welfare state, implies that the characteristics of entrepreneurs, in terms of economic resources, may vary depending on the level of public risk-sharing.

Taking these components into account, we solve a static model for individuals with different levels of (exogenous) profits, wages, and assets. The solution from this model shows that when tax rates (and in equilibrium also benefits, i.e., public risk sharing), are higher, the share of individuals who choose to become entrepreneurs goes up. At the same time, however, this also implies a smaller share of entrepreneurs exerting effort, since the value of exerting effort goes down when risk-sharing increases. We also find that overall (utilitarian) welfare is maximized for an in-between level of the tax rate (20-30 percent). Finally, we also investigate how the characteristics of entrepreneurs vary across different tax rates. This is particularly relevant if we want to think about the pool of entrepreneurs, i.e., which types of individuals choose to be entrepreneurs, and how this pool depends on the level of public risk-sharing.

In Chapter 4, *Portfolio and Housing Decisions in the Presence of Intergenerational Links*, I turn to the question of how parents may affect their children’s housing market outcomes. It is well understood that parents’ economic resources matter for the general prospects of children. However, we still have a limited understanding of the mechanisms through which intergenerational links matter and how they may react to policy changes. Importantly, when it comes to the housing market, there are several ways in which parents may influence the behavior of their children. Furthermore, more recently, concerns about how the presence of family finance affects who can access the housing market and who is affected by stricter borrowing conditions have been raised both in the media and by policy makers, highlighting that we need a better understanding of these mechanisms.

In this paper I study the role of intergenerational interactions in connection to the housing market and assess the importance of accounting for two specific (financial) intergenerational links: inter-vivos transfers and bequests. The paper is intended to be a first step in characterizing
individual behavior in the presence of these types of intergenerational links. I first provide a summary of the empirical evidence on the importance of parents for the housing market outcomes of children, finding that: (i) family finance is used to alleviate borrowing constraints, (ii) transfers increase the likelihood of becoming a homeowner, and (iii) the extent to which family finance is used depends on policy. I then study individual behavior in a partial equilibrium overlapping generations model with intergenerational links. I focus on financial links, motivated by one-sided altruism, directed from the parent to the child and study portfolio and housing decisions. In the model, parents are either renters or homeowners, whereas children need to decide on their optimal housing tenure status.

The results from the model highlight the importance of parents’ economic resources for their children’s housing market outcomes. Since, by construction, parents have different housing tenure statuses, they naturally differ in their required housing expenses as well as in the bequests that they can leave to their children. In steady state, parents who are renters and those who are homeowners transfer very similar amounts of the inter-vivos transfer, but there is a compositional difference for the bequests. At the cutoff, in terms of parents’ wealth, where children choose to become homeowners, there is a small shift in the portfolio composition - resources are directed slightly more towards parents’ savings rather than to inter-vivos transfers. In a transition period, when house price growth is positive, the difference between parents who are renters and those who are homeowners, and between their respective children, is amplified. Furthermore, parents, in general, put more weight on the inter-vivos transfer, as compared to savings.

In steady state, stricter borrowing conditions (exemplified through lower maximum loan-to-value ratios), have a limited impact on optimal behavior and the biggest effect is a reduction in debt, particularly for children. At high house price growth rates, parents are, however, inclined to take on more debt in response to stricter borrowing conditions, in line with a slight shift in debt from the young to the old generation.
Chapter 1

Household Debt and Monetary Policy: Revealing the Cash-Flow Channel∗

1.1 Introduction

A fundamental question in macroeconomics is how monetary policy affects the real economy. The primary transmission mechanism in standard macroeconomic models is the interest-rate channel. According to this mechanism, forward-looking households change the slope of their consumption profiles when interest rates change. The empirical support for

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CHAPTER 1. HOUSEHOLD DEBT AND MONETARY POLICY

this mechanism is, however, mixed.\footnote{Attanasio and Weber (2010) and Jappelli and Pistaferri (2010) survey the empirical support for the consumption theories that underpin the interest-rate channel.} Monetary policy indeed appears to have effects on the real economy that are both stronger and of a different character than predicted by the interest-rate channel. This suggests that monetary policy does not only operate through the interest-rate channel, but that there are also other important transmission mechanisms at work.\footnote{Boivin et al. (2011) discuss different transmission mechanisms that have been suggested in the literature, and the (often weak) empirical support for these mechanisms.}

One such mechanism is the \textit{cash-flow channel}.\footnote{This terminology has previously been used by, for example, Cloyne et al. (2016) whereas Berben et al. (2004) and Di Maggio et al. (2014) refer to the same channel as the “income channel”. However, Boivin et al. (2011) do not mention this channel in their survey.} According to this mechanism, monetary policy has a direct effect on household spending through households’ cash flows and disposable incomes. A tightening of monetary policy raises the interest-rate expenses for households with adjustable-rate mortgages and therefore has a negative impact on the disposable income of such households. If households are forward-looking and have good access to financial markets, such variations in cash flows need not result in tangible consumption responses. But if households are myopic, liquidity-constrained, or for some other reason unable or unwilling to increase debt in response to temporarily lower disposable income, monetary policy will affect consumption also through the cash-flow channel.

In this paper, we investigate this cash-flow channel empirically using household data. A typical problem when trying to estimate the impact of monetary policy is that changes in monetary policy are endogenous to the economic development. Therefore, it is difficult to identify the causality from monetary policy to economic outcomes. This problem is mitigated with the household data that we use. All households are affected by the same monetary policy, but the impact varies from household to household if the cash-flow channel is important because households have a differ-
1.1. **INTRODUCTION**

Exposure to interest-rate changes depending on the composition of their balance sheets and mortgage contracts. In particular, we examine how monetary policy affects consumption choices for households with a large debt relative to households with less debt, and for households with adjustable-rate mortgages (ARMs) relative to households with fixed-rate mortgages (FRMs).

Our study builds on data on Swedish households between 2002 and 2007. For three reasons, Sweden is the perfect laboratory for examining the cash-flow channel. The first reason is that household debt is high and adjustable-rate mortgages are common in Sweden. Throughout our sample period, ARMs accounted for 30 to 40 percent of the aggregate value of outstanding mortgages. These ARMs often have an interest fixation period of only three months.\(^4\) The second reason is that ARM is a standard product on the Swedish mortgage market. That is, it is not targeted to particular household groups. Therefore, it is unlikely that our results are contaminated by selection into different types of loan portfolios depending on household characteristics or spending behavior.\(^5\) In support of this, we note that households that we identify as having ARMs in our sample are almost economically identical to households which we identify as having FRMs.\(^6\) The final reason to focus on Sweden is data availability. A common challenge in previous studies on the impact of monetary policy on consumption is the lack of data sets that feature both a high quality measure of consumption and data on households’ wealth and balance sheets that are representative for the population. We overcome this problem by using administrative panel data based on tax reports, which

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\(^4\) According to Statistics Sweden’s Financial Markets Statistics, the fraction of mortgages that had an interest-rate fixation period of one year or shorter at origination varied between 42 and 58 percent in 2003 to 2007. See also Figures 2 and 3 and Holmberg et al. (2015).

\(^5\) A possible concern is otherwise that households may select into ARM or FRM based on household-specific characteristics that are correlated with macroeconomic developments (see, e.g., Campbell and Cocco (2003) and Campbell and Cocco (2015) for theoretical arguments, and Badarinza et al. (2018) for empirical evidence).

\(^6\) Moreover, Holmberg et al. (2015) do not find that the probability that a Swedish household defaults on its mortgage correlates with the choice of interest-rate fixation.
allows us to impute a measure of consumption, as in Koijen et al. (2015), as well as providing us with detailed information on all earnings, income, assets, and debt positions.

Our main finding is that consumption responds more strongly to changes in interest rates for households with high debt than for households with little or no debt. If the monetary policy rate increases by one percentage point, a household with debt equal to one year’s disposable income reduces its consumption by 0.15-0.26 percentage points relative to a similar household with no debt. The transmission of monetary policy to household consumption can be divided into two steps: first the transmission to interest rates faced by households, then the transmission from household rates to consumption. When focusing on the second step, we estimate responses in the range 0.28-0.39. That is, a household with debt equal to one year’s disposable income reduces consumption by 0.28-0.39 percent relative to a similar household with no debt. The latter range of estimates can also be interpreted as the marginal propensity to consume (MPC) out of an interest-rate induced increase in cash flow. Our data set does not allow us to directly identify which households that have ARMs or FRMs. Instead we use the correlation between each household’s interest rate and the monetary policy rate as a proxy for the contract type. Based on that approach, we find some evidence that households with ARMs respond more strongly to monetary policy than households with FRMs.

We argue that our findings are consistent with widespread hand-to-mouth behavior. The distribution of liquid assets in our sample provides further support for this interpretation. Only 22 percent of homeowners’ net worth are in liquid assets whereas 78 percent are tied to illiquid assets. Moreover, there is a strong negative correlation between debt and liquid assets; whereas the average homeowner has liquid assets corresponding to eight months of disposable income, homeowners with a high debt-to-income ratio have less than three months worth of liquid assets. Combined with the high prevalence of ARMs, this increases the likelihood that changes in interest rates quickly affect consumption choices.
Our paper contributes, in particular, to the recent and still expanding empirical literature on the relation between household debt, mortgage markets, and the transmission of monetary policy. Most similar to our study are the papers by Cloyne et al. (2016) and La Cava et al. (2016). Cloyne et al. (2016) study the response of expenditure and income to monetary policy in the United Kingdom and the United States.\footnote{Like in Sweden, ARMs make up a large share of mortgages in the United Kingdom, whereas FRMs are more prevalent in the United States.} In the absence of detailed balance sheet information, they use housing tenure status as a proxy for debt positions, finding that the consumption response to a temporary cut in interest rates depends on households' balance sheets. They argue, however, that the general equilibrium effect of monetary policy on income is quantitatively more important than the direct effect of cash flows. In contrast to Cloyne et al. (2016), we are able to study responses across the distribution of debt positions even among households with the same housing tenure status, and thus shed further light on the mechanisms at work. La Cava et al. (2016) explore the cash-flow channel in Australia using the large decline in interest rates early on in the financial crisis. They find that (durable) consumption responds more strongly to changes in cash flows for borrowers than savers, in particular for borrowers that hold debt with variable rates.

Di Maggio et al. (2017) study a group of U.S. households with mortgages that face interest rates that are held fixed for five years before being automatically adjusted. They exploit the staggering of such contracts to estimate consumption responses to changes in interest rates. The authors find strong responses in consumption to a change in interest expenses. At the reset date, monthly interest payments drop by about a half, causing a substantial increase in car purchases (the authors' main measure of consumption). In addition, they find that the consumption response is stronger for households with high debt (relative to house values) and low income. These findings thus indicate that cash flows matter for consumption decisions, and that the importance of cash-flow effects varies between different household groups. An important difference be-
between their study and ours is that we use a comprehensive expense-based measure of consumption rather than car purchases.

Calza et al. (2013) document that the transmission of monetary policy shocks to residential investment and house prices is stronger in countries with more flexible and developed mortgage markets, and that responses in consumption are stronger in countries where there is a higher prevalence of ARMs. Mian et al. (2013) explore regional differences in house price falls in the United States during the recent financial crisis and find a strong correlation between the fall in housing wealth and consumption. They also find that housing wealth had a larger impact on consumption in regions with poor and more levered households. Using detailed U.S. household data, Baker (2017) finds that the consumption elasticity of income as a result of credit constraints is significantly higher for households with high debt. Using Danish administrative data, Andersen et al. (2016) study if household leverage prior to the financial crisis amplified the reduction in household spending during the crisis. They find a negative correlation between pre-crisis debt growth and consumption growth during the crisis but no relation between high debt at the time of the crisis and a spending decline over the course of the crisis. Our findings are broadly in line with these papers, although our focus is slightly different. We thus provide further support for the importance of household debt and the mortgage market for the transmission of monetary policy.

The long period with extraordinarily expansionary monetary policy after the outbreak of the financial crisis has resulted in a discussion about the distributional impact of monetary policy (see for example Bullard, 2014, Mersch, 2014, Bernanke, 2015). Although we do not directly focus on this question, our findings highlight that the impact of monetary policy varies across households. Recent empirical papers that more directly study the distributional implications of monetary policy include Sterk.

8The paper by Andersen et al. (2016) is relevant for our study also because they use a similar data set and, like us, impute consumption from changes in households’ balance sheets.
1.1. INTRODUCTION

and Tenreyro (2015) and Casiraghi et al. (2018).\footnote{See Garriga et al. (2017) and Auclert (2017) for theoretical contributions.}

Lastly, our study is related to a series of papers studying household consumption responses to shocks to unearned income and fiscal stimulus programs. Shapiro and Slemrod (2003), Johnson et al. (2006), Agarwal et al. (2007), Shapiro and Slemrod (2009), and Parker et al. (2013) study the effect of 2001 and 2008 economic stimulus payments in the US on consumer spending.\footnote{For studies on the consumption responses to other sources of shocks to disposable income, see, e.g., Stephens (2008), Kueng (2018), Hsieh (2003) and Agarwal and Qian (2014).} In all cases, the authors find a considerable consumption response to these income shocks, and the response is stronger for those that are more likely to be liquidity constrained. These papers study consumption responses to changes in disposable income induced by fiscal policy. Our paper can be viewed as a monetary-policy analogue to that literature.

The remainder of this paper proceeds as follows. In the next section, we provide a theoretical motivation for our empirical framework. This is done by identifying how the consumption behavior behind the cash-flow channel differs from the standard consumer theory behind the interest-rate channel. Section 1.3 then provides details on the data set we use and our measure of consumption and presents some summary statistics. The empirical strategy is discussed in Section 1.4. We present our results in Section 1.5. Section 1.6 concludes the paper.
1.2 Theoretical Motivation

To motivate our empirical framework, we briefly consider models of consumer behavior. A natural starting point for studying consumption and savings decisions is the life cycle/permanent income model. Consumers then have concave preferences which induce a consumption smoothing motive. Another implication is that unconstrained households that are forward-looking and maximize expected utility only react to unanticipated income changes. In the most extreme setup, where markets are complete and allow households to fully insure against idiosyncratic risks, the consumption growth rate will be identical for all households. To see this, note that in this setting, the first-order conditions for household optimization reduce to:

\[ \Delta \log c_{i,t} = \lambda_t, \]  

(1.1)

where \( \Delta \log c_{i,t} \) is the difference in log consumption for household \( i \) from period \( t - 1 \) to \( t \), and where \( \lambda_t \) captures anticipated and unanticipated macroeconomic developments that are common to all households.\(^{11}\)

A somewhat more general specification that does not rely on full insurance between households would also imply that household reactions are homogeneous across households in response to interest-rate changes that are either anticipated or temporary. An unanticipated persistent shock may, however, result in heterogeneous consumption responses if markets are not complete. For example, a surprisingly high return on savings would induce old, wealth-rich households with a short remaining planning horizon to raise the consumption more than younger or less wealthy households in a life-cycle setting. But for typical interest-rate shocks, most households have a sufficiently long remaining planning horizon for such heterogeneity to be of minor importance in these models.

According to these theories, a change in monetary policy will be captured by the term \( \lambda_t \) and will therefore have an identical impact on

\(^{11}\)Although not explicitly captured in this specification, preference shifters, such as age or household composition, may then still generate a variation in consumption growth between households.
consumption growth for all households. But it is well-established that there is little empirical support for a strict interpretation of the life cycle and permanent income theories. For example, it has been found that consumption, in violation of these theories, often responds to predictable household-specific income changes. One suggested remedy to explain such behavior is to introduce borrowing constraints. Carroll and Kimball (1990) is an early theoretical contribution showing that the average marginal propensity to consume increases in the presence of borrowing constraints and uncertainty. Campbell and Mankiw (1990) introduce "rule-of-thumb" consumers as another potential explanation for the excess sensitivity of consumption. Furthermore, Krusell and Smith (1998) show that if individuals have different subjective discount rates, rule-of-thumb behavior arises endogenously for a share of consumers (those with high discount rates).

If binding borrowing constraints or hand-to-mouth behavior due to other factors are prevalent in the economy, interest-rate changes will affect consumption growth more for some households than for others. In particular, changes in disposable income will then feed directly into changes in consumption. To motivate an empirical specification that allows for such cash-flow effects, consider a household with net financial assets $a_t$, where “net” indicates the value of financial assets exposed to the short-term interest rate minus the balance of the household’s ARM. Notice that for the typical mortgage holder, gross financial assets are small relative to the value of the mortgage. For such households (the majority of ARM holders) $a_t$ is essentially equal to the negative of the mortgage principal. Being aware of the fact that some ARM holders are financially rich, we will nonetheless let $d_t$ denote either gross or net debt and refer to $\frac{d_t}{y_t}$ as the debt-to-income ratio. The intertemporal budget constraint reads $c_t - d_{t+1} = y_t + d_t(1 + r_t)$ where $y_t$ is labor income and $d_t(1 + r_t)$ is debt service.\(^\text{12}\)

By definition, hand-to-mouth (HTM) households maintain net finan-

\(^{12}\)For ease of notation, household subscripts $i$ are suppressed.
cial assets constant. Hence consumption obeys:

\[ c_t = y_t - r_t \cdot d_t. \]  
(1.2)

In other words, if measured as a marginal propensity to consume, the response of a hand-to-mouth household to a change to the short-term interest rate is equal to one. Such a response may be irrational but it also occurs if the household is borrowing constrained. To obtain a measure of the elasticity in the response, we write equation (1.2) as a log-linear approximation:

\[ \Delta \log c_t \approx \theta \cdot \Delta \log y_t - \theta \cdot \frac{d}{y} \cdot \Delta r_t, \]  
(1.3)

where \( \theta \) is the inverse of the household's (steady state) consumption to income ratio and \( \frac{d}{y} \) the (steady state) debt-to-income ratio.\(^{13}\) If households hold no or little financial assets that respond to short-term interest rate changes, this equation shows that the percentage consumption response to interest-rate changes is proportional to the household’s debt-to-income ratio. For example, in response to an interest-rate increase, an HTM household with a debt-to-income ratio of 3 will reduce consumption (in percentage terms) by twice as much as an HTM household with a debt-to-income ratio of 1.5. Note also that the response of HTM households does not depend on when information about the interest-rate change arrives. Their consumption responds when their cash flow changes, irrespective of whether the change was anticipated or not.

This simple framework suggests that the consumption response of HTM households differs from that of optimizing households in response to changes in interest rates. Optimizing households respond to new information about the future interest rate. HTM households, on the other hand, only respond when their cash flows change. If markets are complete, all optimizing households respond similarly to new information. HTM households respond differently depending on how their household-

\(^{13}\)Appendix 1.A.1 provides a derivation of the approximation.
specific cash flows are affected. If markets are not complete, optimizing households may also display heterogeneous consumption responses to changes in their cash flows. However, this heterogeneity is typically of minor importance since these households are forward-looking and allocate the consumption response across their planning horizon.\textsuperscript{14}

\textsuperscript{14}Consider a (temporary) shock to the interest rate. An optimizing household in its final period responds as an HTM household with the same financial portfolio. The consumption of an optimizing household with $T$ periods remaining is roughly $\frac{T}{T}$ times that of an HTM household.
1.3 Data and Summary Statistics

1.3.1 Data description

The main data set we use is the Swedish registry-based panel data set LINDA (Longitudinal INdividual DAta for Sweden). This data set is representative for the Swedish population, covering a random sample of 300,000 households and their members. Since in Sweden, as in other Scandinavian countries, each tax payer has a unique social security number, we are able to construct a panel using several sources of administrative data. Our sample period covers 2000-2007. During this period, Sweden levied a wealth tax which meant that taxpayers were required to provide the tax authority with comprehensive information on all taxable wealth, in addition to information on earnings and income.\textsuperscript{15} The tax registers therefore include information about all taxable income and transfers, tax payments, liabilities and taxable wealth, including the value of real estate (i.e., houses, apartments and cabins), cash holdings on bank accounts, bonds, stocks, and mutual funds.\textsuperscript{16}

Market values of single-family houses and cabins are assessed by Statistics Sweden. They are a function of a long list of characteristics of the property and updated yearly using a price index which is constructed from transactions in a given municipality in each year. Market values of apartments (shares in co-op associations) are also assessed by Statistics Sweden but with more noise. Values of financial assets are detailed and, for instance, each household reports each and every listed stock or mutual fund it holds in its tax filings (see Calvet et al., 2007). The data set contains information on total household debt which is the debt measure we use in the empirical analysis. The data set also contains information about annual interest expenses on that debt. Finally, the data set includes residential location for each household and various

\textsuperscript{15}Most of this information was submitted automatically to the tax authority by employers, banks, and public authorities and registers.

\textsuperscript{16}For further details on the data set used in the current paper, see Koijen et al. (2015), and for a detailed account of the data collection process for LINDA, see Edin and Fredriksson (2000).
1.3. DATA AND SUMMARY STATISTICS

demographic variables.

The unit of analysis is the household, meaning that individual data has been aggregated to the level of the household using marital status, residential location, and parent-child linkages (household identifiers are constructed by Statistics Sweden based on this information). Household characteristics, such as age and education, represent a household head, which we take as the oldest individual in the household unless more than one individual is of that same age, in which case we choose the oldest male.

1.3.2 Sampling restrictions

Our household level panel data set is outstanding in that it contains detailed information about the households’ balance sheets at an annual frequency. Nevertheless, we impose a few restrictions on our sample, most of which are related to the construction of the consumption measure where we follow Koijen et al. (2015). First, we require households to be present for two consecutive years. Second, we drop households that transact in real estate or apartments because such events require additional careful adjustments that rely on additional non-registry-based data (see the Appendix of Sodini et al. (2017)). In addition, we exclude observations with outliers in disposable income, the debt-to-income ratio, or the consumption measure. All in all, our sample corresponds to approximately 25 percent of the LINDA households in 2002-2007. Appendix 1.B (Table 1.8) reports incremental changes to the sample as restrictions are imposed.

1.3.3 Imputing consumption

We use this detailed data set to impute a measure of consumption expenses based on the approach in Koijen et al. (2015). This is a vital part of our exercise since the main outcome of interest is spending.

\[17\] Browning and Leth-Petersen (2003) were the first to impute consumption expenses from Danish registry-based data.
A common way of describing a given household $i$’s budget constraint in year $t$ is as follows:

$$c_{i,t} = y_{i,t} + \Delta d_{i,t} - r^d_{i,t}d_{i,t-1} - \Delta a_{i,t} + r^a_{i,t}a_{i,t-1}.$$ (1.4)

That is, consumption, $c$, is constrained by disposable income, $y$, the change in outstanding debt, $\Delta d$, interest payments, $r^d$, savings, $\Delta a$, and their returns $r^a$. Based on the notion that the budget constraint can serve as an accounting identity in a given year, it can be used to impute a measure of consumption as total income net of change in wealth from previous period. This is possible since all terms on the right-hand side of equation (1.4) are observable in our data. Mapping equation (1.4) into the detailed structure of our data gives the identity:

$$c_{i,t} = y_{i,t} + \Delta d_{i,t} - r^d_{i,t}d_{i,t-1} - \Delta b_{i,t} - \Delta v_{i,t} - \Delta h_{i,t} - \Delta \psi_{i,t} - \omega_{i,t},$$ (1.5)

where the household’s disposable income, $y$, includes labor income, transfers and benefits (all net of taxes), and financial income, $\Delta d$ is the change in debt, $r^d$ are interest payments, $\Delta b$ is the change in deposits on bank accounts, $\Delta v$ is active re-balancing of mutual funds, stocks, and bonds, $\Delta h$ is the change in housing wealth (due to buying/selling), $\Delta \psi$ are changes in capital insurance accounts, and $\omega$ are contributions to private pension savings.

Equation (1.5) is identical to the imputation method of Koijen et al. (2015), who show that the correlation between the imputed measure and a survey-based measure of consumption exceeds 0.5 at the household level.\(^{18}\)

\(^{18}\)Relative to Koijen et al. (2015), one refinement has been made which concerns bank accounts. Bank account deposits are only reported if certain criteria are met and those changed in 2006. In 2000-2005, a deposit in a bank account was reported in the Swedish tax records if the earned interest from that account exceeded SEK 100, while in 2006 and 2007 the deposit was only reported if the balance on the account exceeded SEK 10,000. Overall, the new rule implies an improvement in accuracy. However, to avoid over-stating savings between 2005 and 2006, we artificially implement the reporting rule of 2000-2005 also on the latter period when imputing consumption.
1.3.4 The Swedish mortgage market

Our proposed transmission channel for monetary policy relies on a high prevalence of adjustable-rate mortgages (ARMs). Figure 1.1 shows the division of fixed-rate periods of new mortgages in Sweden during the relevant period. ARMs are defined as mortgages with a fixed-rate period of three months or shorter. It is clear that a nontrivial share, approximately fifty percent, of new mortgages had adjustable rates during the period. Figure 1.2 reports the division of fixed-rate periods in the stock of outstanding mortgages. The value-weighted share of ARMs increases from 30 to 40 percent during the time period of interest. Taken together, these aggregate statistics suggest that the cash-flow channel may be an important transmission mechanism. Another important aspect of Swedish mortgage contracts is that the borrower bears the cost of refinancing. If the borrower wishes to switch from an FRM to an ARM at a time when interest rates are low, the borrower must compensate the bank for the loss. Letting households bear these costs inhibits consumer mobility in the mortgage market. For us, this is helpful since we can only infer the mortgage type indirectly, as outlined below.

1.3.5 Household interest rates and correlation with the repo rate

In some of our empirical specifications, we try to identify differences in responses for households with adjustable- rather than fixed-rate mortgages. A problem in doing so is that we do not observe debt contract details in our data. In particular, we cannot directly see in our data if a household has chosen an adjustable- or fixed-rate mortgage, nor can we directly observe the interest rate that the household pays on its debt. Instead we calculate the household-specific interest rate from information on interest paid and the size of the household’s debt. For each household we then calculate the correlation between its household-specific interest rate and the monetary-policy rate. We use that correlation as a proxy for the impact of changes in the monetary policy rate on that particu-
lar household, or to identify the household as having an adjustable- or fixed-rate mortgage.

More precisely, we first calculate the interest rate \( r_{d_{i,t}} \) for household \( i \) in year \( t \) as total interest expenses divided by average debt (from \( t \) and \( t - 1 \))

\[
r_{d_{i,t}} = \frac{\text{interest payment}_{i,t}}{0.5 \cdot \text{debt}_{i,t} + 0.5 \cdot \text{debt}_{i,t-1}}. \tag{1.6}
\]

Based on this definition, we construct value-weighted and equally weighted household interest rates in our sample. Figure 1.3 illustrates the fluctuation of these variables along with the fluctuation of the repo rate and an aggregate household interest rate reported by Statistics Sweden. The U-shaped pattern of all rates highlights the high prevalence of ARMs. The value weighted household interest rate almost perfectly tracks the repo rate with some lag. It also tracks the Statistics Sweden’s reported rate well. The equally weighted measure also tracks the fluctuation well, but the level is too high, indicating that small credits carry a higher interest.

We then calculate the correlation between household-specific interest rates, \( r_{d_{i,t}} \), and the repo rate, \( r_t \), as:

\[
\text{corr}_i = \text{correlation} \left( r_t, r_{d_{i,t}} \right). \tag{1.7}
\]

We use this measure later on to proxy for whether a household holds an ARM or an FRM.\textsuperscript{19} Appendix 1.B (Figure 1.6) reports the cross-sectional distribution of household interest rates and correlations with the repo rate. The median correlation is 0.61, consistent with a high prevalence of ARMs.

\textsuperscript{19}The low numbers of observations used to calculate household correlations can raise concerns about measurement error. A misclassification would, however, result in an attenuation bias as the differential responses would be muted.
1.3.6 Summary statistics

We report summary statistics for the main variables in our data set in Table 1.1. Homeowners are more resourceful than renters along essentially any dimension. For instance, they are more educated and have higher incomes. Adult equivalent disposable income differs by 29 kSEK and adult equivalent consumption by 19 kSEK. Homeowners have more liquid assets than renters, 168 kSEK compared to 69 kSEK. However, most of their wealth is tied to illiquid assets. The average loan-to-value ratio is 0.45 and 78 percent of net worth are tied to illiquid assets.

Figure 1.4 provides a simple graphical illustration of why it is sensible to hypothesize that homeowners with a high DTI are more sensitive to interest-rate changes than are less indebted homeowners. The top panels display the mean and median asset and debt balances in relation to disposable income for three groups: renters, homeowners with a debt-to-income ratio of less than 3, and homeowners with a debt-to-income ratio greater than 3. The group of homeowners with a high debt-to-income ratio comprises 13.2 percent of all homeowners. Whereas illiquid assets are relatively evenly distributed among homeowners—the mean is 4 for homeowners, and 6 for the high DTI group—liquid assets are distributed differently. The average homeowner has liquid assets worth approximately 8 months of disposable income. In contrast, the most highly indebted group has less than 4 months of disposable income. In other words, there is a strong negative correlation between illiquid and liquid assets and between debt and liquid assets. Combined with a high prevalence of ARMs, this increases the likelihood of hand-to-mouth behavior.

The bottom panels of Figure 1.4 display a cross-sectional variation in interest expenses relative to disposable income and consumption. Homeowners with a high DTI ratio (i.e., greater than 3) spend on average 0.15 years of their disposable income on interest expenses. A doubling of the interest rate that homeowners face would thus imply that the median homeowner in the high DTI category would deplete the liquid assets within one year, unless they adjust their income or consumption. These
households are wealthy in terms of illiquid wealth but hold very little liquid wealth. Thus, these households are likely to have a large propensity to consume out of changes in transitory income and to not react strongly to news about future income changes. These empirical patterns support our hypothesis of the sensitivity of indebted households to changes in interest expenses. Our statistics are related to Kaplan et al. (2014) who argue that it is important to consider the liquidity of households' assets and emphasize the significant population share of "wealthy-hand-to-mouth" households.
1.4 Empirical Framework

Our empirical strategy builds on the insights from the theory presented in Section 1.2. In particular, it is motivated by the interaction between hand-to-mouth behavior and the DTI ratio as given by equation (1.3). This cash-flow effect of monetary policy is likely to be detectable for households with a high DTI ratio as a large share of mortgages have adjustable rates and as high DTI households have little liquid assets. In order to test this hypothesis, our main regression specification is:

\[
\Delta \log c_{i,t} = \beta_0 + \beta_1 DTI_{i,t-2} + \beta_2 \Delta r_t \times DTI_{i,t-2} \\
+ \beta_3 \Delta r_t \times X_{1i,t} + \beta_4 X_{2i,t} + \delta_t + \phi_i + \epsilon_{i,t},
\]  

(1.8)

where \( \Delta r_t \) is the change in the repo rate and \( DTI_{i,t-2} \) is the household's DTI ratio. We lag the DTI ratio by one year so that it is predetermined with respect to \( c_{i,t-1} \). The coefficient of main interest is \( \beta_2 \). It captures systematic variation in consumption growth due to differences in DTI in response to a change in the interest rate. In most of our specification, we use changes in the repo rate, denoted by \( \Delta r_t \), but we also consider changes in the aggregate household interest rate, denoted by \( \Delta i_t \). If all households optimize, we would expect to estimate \( \beta_2 = 0 \). If all households instead obey equation (1.3), we would expect to estimate that \( \beta_2 \) equals the average income to consumption ratio (\( \theta \)). In sum, the regression specification given by (1.8) is intended to capture the implications from Section 1.2. The coefficients \( \delta_t \) denote year fixed effects.

\footnote{Note that throughout our analysis, we prefer to use the change in an aggregate interest rate, \( \Delta r_t \), with no subindex \( i \), i.e., we do not use a household-specific interest rate as defined by (1.6). We mainly use the repo rate but also consider an aggregate household interest rate provided by Statistics Sweden (for all loans to households). By omitting household-specific interest rates, we avoid any bias that would arise if unobserved idiosyncratic events, e.g., negative news about future income, affect both the household’s consumption path and the household’s credit worthiness.}

\footnote{One caveat is that, given the data at hand, we are not able to observe if households adjust their amortization in response to interest-rate changes. Such a strategic response would be absorbed into the estimated cash-flow effect. For constrained
and capture common effects of aggregate shocks, including intertemporal responses to consumption of optimizing households. In some specifications we include household fixed effects, $\phi_i$, to capture any time-invariant cross-sectional heterogeneity. In $\Delta r_t \times X_{1,i,t}$ we include an interaction between $\Delta r_t$ and dummy variables for being young (below 40), old ($\geq 60$) and having children to account for characteristics that may interact with interest rate sensitivity. We always include a set of control variables denoted by $X_{2,i,t}$ which consists of factors influencing preferences for consumption. In this vector, we include a fourth-order polynomial in age, number of children and the change in number of children.

We emphasize the implications of including year and household fixed effects in our empirical model. The year fixed effects account for the overall aggregate effect of monetary policy on household spending. The household fixed effects account for time-invariant individual differences in consumption growth. In other words, the coefficient $\beta_2$ captures responses less the aggregate effect. Our specification thus makes an inference about heterogeneous or relative responses to monetary policy rather than the aggregate effect per se.

A potential problem when including household fixed effects in the specification is that we have a short time dimension in our data set. This is not a major obstacle since much of the identification comes from the cross-sectional variation. However, we choose not to include $DTI_{i,t-2}$ as an explanatory variable in the fixed-effects regressions because there is a particular risk of bias in the estimates of $\beta_1$.22

households who consume all their disposable income, a decrease in the short interest rate implies increased consumption possibilities which could be highly valued. Therefore, we expect any strategic amortization adjustment to come from less constrained households, making the differential effect biased towards zero.

22The problem with $DTI_{i,t-2}$ is that it is supposed to proxy for $DTI_{i,t-1}$. But with household fixed effects, we would only exploit the within variation in $DTI_{i,t}$. A high value of $DTI_{i,t-2}$ then means that $DTI_{i,t-2}$ is high relative to its value in the other time periods, and thus that it is likely that $DTI_{i,t-1}$ and $DTI_{i,t}$ are low. We would then obtain biased estimates of $\beta_1$. However, it is not likely that a similar bias would affect estimates of $\beta_2$, the parameter in which we are most interested.
1.5 Results

This section presents our main empirical findings.

1.5.1 Response to changes in the repo rate

Table 1.2 reports estimates based on the specification in equation (1.8), using changes in the repo rate. Column (1) reports a coefficient $\beta_2$ of $-0.26$ based on an OLS specification with year fixed effects. The interpretation is that the average household (with a DTI of 0.88) responds by 0.23 ($0.88 \times 0.26$) percentage points more than a household with no debt to a one-percentage point change in the repo rate.

Column (2) extends the specification so that it differentiates between renters and homeowners. The estimated $\beta_2$ then falls somewhat to 0.15. However, we estimate a stronger response to interest-rate changes for homeowners than for renters. Because homeowners on average have more debt than renters (DTI of 1.27 for homeowners and 0.33 for renters), it is possible that some of the effect of debt is instead captured by the ownership status. Column (3) reports estimates based on homeowners only. The heterogeneous response for homeowners with different DTI ratios is almost as large as in the greater population. Importantly, this means that the DTI ratio matters even within the group of homeowners. This is consistent with our discussion about the importance of the liquidity of assets.

Columns (4)-(6) report estimates from specifications that include household fixed effects. These estimates are very similar to those in columns (1)-(3), suggesting that unobserved time-invariant heterogeneity is not a major factor for our findings.\(^{23}\)

The results also some shed light on demographic differences in

\(^{23}\)As noted in the previous section, we do not use $DTI_{i,t-2}$ as an explanatory variable in regressions where we include household fixed effects because of a risk of biased estimates when $T$ is small. If we include $DTI_{i,t-2}$ in the regressions anyway, the estimates of $\beta_2$ increase in absolute value to between -0.29 and -0.35 (remaining highly significant), and the estimates of $\beta_1$ are between 0.04 and 0.05 and highly significant.
consumption responses to monetary policy. Conditional on a given DTI ratio, old households respond more strongly (more negatively) than younger and middle aged households. This finding is consistent with old households having shorter remaining planning horizons and therefore behaving more as hand-to-mouth households even if they are optimizing and forward-looking. However, the magnitude of our estimated response for the old households appears somewhat large for a strict interpretation along these lines. This finding differs from Wong (2018), who finds younger cohorts’ consumption to be more sensitive to monetary policy, as responses are concentrated among households taking out new loans or refinancing, which, in turn, are mainly younger households. Since our empirical specification looks within DTI groups, these findings are not directly comparable. The prevalence of ARMs in Sweden may also contribute to the difference. We also find that households that have children appear to reduce their consumption less than households without children when the interest rate increases.24

We conclude that there are strong indications that the cash-flow channel is present in the data. That is, the elasticity of consumption responses to changes in the repo rate depends importantly on the household’s debt-to-income ratio.

1.5.2 Response to changes in the aggregate household interest rate

Table 1.3 reports households’ consumption responses to changes in the average interest rate faced by households instead of changes to the repo rate. By focusing on this interest rate, we ignore the first step in the transmission of monetary policy.25 Thus, we can better identify the impact of cash flows on household consumption behavior. The downside is

---

24 Recall that all these estimates are in relative terms since we include year fixed effects. It is thus not clear from our estimates if households on average increase or reduce consumption when the interest rate is raised.

25 However, the two interest rates follow each other closely as seen in Figure 1.3. A regression of the average household rate on the repo rate results in an estimated coefficient of 0.95 on the repo rate.
that we get one step further from identifying the impact of monetary policy on household behavior.

Columns (1)-(3) in Table 1.3 report estimates of $\beta_2$ between $-0.28$ and $-0.39$ based on OLS estimation. Compared to using the repo rate, the estimated coefficients are roughly fifty percent greater. That the estimated coefficients are greater than the coefficient reported in Table 1.2 is consistent with the interest rate here having a more direct impact on household cash flows. Columns (4)-(6) report panel estimates with household fixed effects. The results are still similar to those in Table 1.2 but $\beta_2$ is now estimated in the interval $-0.59$ to $-0.62$, thus indicating a substantially stronger response to the average household rate than to the repo rate.

Because the interest rate faced by households has a direct impact on household cash flows, the results here can be translated into a (relative) marginal propensity to consume (MPC) out of changes in cash flows. Average consumption is 241 kSEK and average debt is 284 kSEK implying an MPC in the interval 0.24 to 0.50.\footnote{A one percentage point higher interest rate then reduces household cash flows by $0.01 \times 284 = 2.84$ kSEK. The average reduction in consumption is in the interval $0.28 \times 241 = 0.7$ to $0.62 \times 241 = 1.4$ kSEK.}

We conclude that using the average household interest rate rather than the repo rate reinforces our result that the cash-flow channel is strong. In the remaining analysis, we do, however, use the repo rate since it has a tight link to monetary policy.

1.5.3 The role of the net debt-to-income ratio

Depending on how households use their liquid assets to smooth consumption, the relevant metric on which to sort households is either the debt-to-income ratio or the debt-to-income ratio minus the liquid assets-to-income ratio. We name the latter metric households’ net debt-to-income ratio and use it to replace the debt-to-income ratio in the baseline regression specification. Table 1.4 reports the estimates. Column (1) reports a coefficient $\beta_2$ of $-0.07$ which indicates substantially smaller differences
in relative responses. It is indicative that households may compartmentalize debt and liquid assets and hence, do not use liquid assets to buffer changes in interest-rate expenses. In column (2), we find no evidence that the responses differ along the net debt-to-income ratio other than by average differences between renters and homeowners (which nevertheless are substantial). Column (3) is consistent with the findings in column (2). Estimates based on fixed effects (columns (4) to (6)) are consistent with the OLS estimates.

1.5.4 Proxies for type of mortgage contract

Although we do not observe the details of a household’s mortgage contract, we can use our correlation measure defined by equation (1.7) as a proxy for the mortgage type. We either use a dummy variable for a correlation greater than the median (0.61) to proxy for an ARM contract, or directly interact the correlation measure with the repo rate. Appendix 1.B (Table 1.9) reports differences between households with FRMs and ARMs based on our proxy. While there are statistically significant differences between the two groups, the differences are economically small. Households with ARMs earn a 3.6 percent higher disposable income than households with FRMs and their consumption differs by 4.3 percent. Households with ARMs and FRMs also have essentially equal liquid assets. One of the greater differences is their debt-to-income ratios, but at 11 percentage points, the difference is nevertheless economically small. This is consistent with the conventional Swedish view that ARMs is not an exotic mortgage product.

Table 1.5 presents estimates based on these proxies for the sample of households for which the correlation measure could be computed. Column (1) indicates a weaker relationship between the debt-to-income ratio and the response in consumption than in previous specifications. However, at the same time, it indicates a strong difference in the response between households with ARMs and FRMs. A household with an ARM responds by cutting consumption 0.53 percentage points more in response
to a one percentage-point-increase in the repo rate. Evaluated at the mean, this corresponds to approximately SEK 1,600 more.\textsuperscript{27} At a mean debt-to-income ratio of 1.57, this in turn corresponds to an MPC of 0.32 for households with ARMs relative to households with FRMs. No further difference between ARMs with different debt-to-income ratios can be detected.

Using the continuous correlation measure itself in column (2) yields estimates consistent with column (1). There is a substantial difference in response for a household with a perfect correlation compared to household with an interest rate that is not correlated with the monetary policy rate. Furthermore, households with a high-debt-to-income and a high correlation respond more strongly than households with a high debt-to-income ratio and a low correlation.

Moving to fixed effect estimates in columns (3) to (4), it is evident that our proxies are too crude and time invariant to allow for precise inference. While the signs of estimates related to the ARM dummy variable remain correct, they are no longer statistically significant. That said, the correlation measure interacted with debt-to-income remains significant (column (4)). The main take-away is that consumption responses to monetary policy are much stronger among households with ARMs as compared to other households.

\textbf{1.5.5 Non-linearities}

Finally, we explore whether households with low income or little wealth are particularly sensitive to changes in interest rates. Such households could be more likely than others to be liquidity constrained and display hand-to-mouth behavior. The results are reported in Table 1.6. In column (1) we focus on households with low income, identified as adult-equivalent disposable income in the lowest quartile. They respond by an additional 0.37 percentage points for each percentage point change in

\textsuperscript{27}This number comes from the significant response from column (1) for the interaction between having an ARM and the change in the interest rate, times average consumption for households with ARMs.
the repo rate, but they do not appear to respond more strongly when they hold more debt. In column (2) we focus on highly indebted households, identified as households with a debt-to-income ratio above 3. We do not find any evidence of non-linear behavior for that group. In column (3) we instead use the loan-to-value (LTV) ratio to identify highly indebted households. More precisely, we identify high LTV as the households having loans that exceed 85 percent of their house value. We find no evidence that households with an LTV ratio above 0.85 respond differently. Finally, there is also no evidence that households with a low assets-to-income ratio behave differently (column (4)).

\footnote{The estimated coefficient on Lowincome $\times \Delta \times DTI_{t-2}$ is positive (rather than negative as expected) but only significant at the 10 percent level.}
1.6 Conclusion

This paper studies a transmission mechanism of monetary policy that operates through interest-rate changes on households’ debt. We study this channel for monetary policy using an administrative panel data set for a large sample of Swedish households. The data set contains both detailed information about the balance sheet of households and their consumption. In Sweden during the years of our analysis (2002 to 2007), 30 to 40 percent of the aggregate value of mortgages were adjustable rates. Importantly, ARMs is a standard, non-exotic, form of mortgage contract in Sweden.

We find strong heterogeneity in the consumption responses to changes in monetary policy. In particular, households with more debt respond more strongly to changes in interest rates. We also find some evidence that households with adjustable-rate mortgages respond more strongly than households with fixed-rate mortgages. These findings are consistent with hand-to-mouth behavior, something that is further supported by the wealth distribution in our data set, where many households have little liquid wealth but adjustable-rate mortgages.

Our results highlight the importance of a cash-flow channel in the transmission of monetary policy. More precisely, our results indicate that monetary policy is more potent in economic environments where households are highly indebted, face restricted access to credit, and hold loans with interest rates that respond directly to variations in short interest rates. Monetary policy then has a stronger effect on real economic activity than in other environments since households respond to monetary policy-induced interest rate changes by a larger magnitude than predicted by conventional estimates of the intertemporal elasticity of substitution.

It is in order to emphasize the limitations of our study and the interpretability of our results. Our focus is only on the cash-flow effect of changes in interest rates, but not on the effect that monetary policy may have on the supply of credit. This may be an important channel,
particularly at times when central banks make large changes to their policy rates. Specifically, we are unable to characterize the general equilibrium effect of the cash-flow channel on aggregate consumption in the economy. Another channel that we have abstracted from, but believe to be important, is that monetary policy may have heterogeneous effects on household consumption by affecting the distribution of wealth in the economy. Studying such implications remains as interesting but challenging tasks for future research.
References


CHAPTER 1. HOUSEHOLD DEBT AND MONETARY POLICY


REFERENCES


# Chapter 1. Household Debt and Monetary Policy

## Table 1.1: Summary statistics

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Notes: Values are in 1,000 Swedish Krona or in percent (averages). Values in parenthesis are (s.d.). "a.e." refers to adult equivalent. The scaling factor follows OECD, assigning a weight of 1 to the first household member, 0.7 to each additional adult and 0.5 to each child. Age and education refer to the household head.

*) There are fewer observations for the interest rate and for the correlation measure (e.g., 192,569 in column (1)). For the loan-to-value ratio the mean for percentile 99 and below is reported.
Table 1.2: Consumption Responses to Changes in the Repo Rate

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Notes: All specifications include year fixed effects, a fourth polynomial in age, the number of children and the change in number of children. DTI denotes the ratio of debt-to-income. $\Delta r_t$ is the year-on-year change in the repo (monetary policy) interest rate, set by the Central Bank’s monetary policy committee. Columns (1)–(3) report results from the OLS estimation, columns (4)–(6) use fixed effects. In columns (3) and (6), the estimation is restricted to homeowners. Young is a dummy defined as $< 40$ and old as $\geq 60$. Have children is a dummy for having children. Standard errors in parenthesis are clustered at the household level. *, ** and *** denotes significance at the 10 percent, 5 percent and 1 percent level, respectively.
### Table 1.3: Consumption Responses to Changes in the Aggregate Household Rate

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<td>All</td>
<td>All</td>
<td>Home own.</td>
<td>All</td>
<td>All</td>
<td>Home own.</td>
</tr>
<tr>
<td>Household FE</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Unique households</td>
<td>64,158</td>
<td>64,158</td>
<td>37,547</td>
<td>64,158</td>
<td>64,158</td>
<td>37,547</td>
</tr>
</tbody>
</table>

**Notes:** All specifications include year fixed effects, a fourth polynomial in age, the number of children and the change in number of children. $\text{DTI}$ denotes the ratio of debt-to-income. $\Delta i_t$ is the year-on-year change in the average household interest rate (Statistics Sweden). Columns (1)–(3) report results from the OLS estimation, columns (4)–(6) use fixed effects. In columns (3) and (6), the estimation is restricted to homeowners. Young is a dummy defined as $< 40$ and old as $\geq 60$. Have children is a dummy for having children. Standard errors in parenthesis are clustered at the household level.

*, ** and *** denotes significance at the 10 percent, 5 percent and 1 percent level, respectively.
### Table 1.4: Consumption Responses: Net debt-to-income

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net DTI$_{t-2}$ × Δr$_t$</td>
<td>-0.07**</td>
<td>-0.04</td>
<td>-0.04</td>
<td>-0.10***</td>
<td>-0.08**</td>
<td>-0.07</td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
<td>(0.03)</td>
<td>(0.04)</td>
<td>(0.04)</td>
<td>(0.04)</td>
<td>(0.05)</td>
</tr>
<tr>
<td>Net DTI$_{t-2}$ Homeowner</td>
<td>0.00***</td>
<td>0.00***</td>
<td>0.00***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Homeowner Homeowner × Δr$_t$</td>
<td>-0.00***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Young × Δr$_t$</td>
<td>0.21</td>
<td>0.13</td>
<td>0.00</td>
<td>-0.46**</td>
<td>-0.50***</td>
<td>-0.72***</td>
</tr>
<tr>
<td></td>
<td>(0.13)</td>
<td>(0.13)</td>
<td>(0.19)</td>
<td>(0.18)</td>
<td>(0.18)</td>
<td>(0.26)</td>
</tr>
<tr>
<td>Old × Δr$_t$</td>
<td>-1.11***</td>
<td>-1.04***</td>
<td>-0.93***</td>
<td>-1.10***</td>
<td>-1.04***</td>
<td>-0.92***</td>
</tr>
<tr>
<td></td>
<td>(0.12)</td>
<td>(0.12)</td>
<td>(0.19)</td>
<td>(0.16)</td>
<td>(0.16)</td>
<td>(0.24)</td>
</tr>
<tr>
<td>Have children × Δr$_t$</td>
<td>0.38***</td>
<td>0.53***</td>
<td>0.47***</td>
<td>0.42***</td>
<td>0.52***</td>
<td>0.46**</td>
</tr>
<tr>
<td></td>
<td>(0.12)</td>
<td>(0.12)</td>
<td>(0.18)</td>
<td>(0.14)</td>
<td>(0.15)</td>
<td>(0.21)</td>
</tr>
<tr>
<td>Mean DTI</td>
<td>0.88</td>
<td>0.88</td>
<td>1.27</td>
<td>0.88</td>
<td>0.88</td>
<td>1.27</td>
</tr>
</tbody>
</table>

**Notes:** All specifications include year fixed effects, a fourth polynomial in age, the number of children and the change in number of children. netDTI denotes the ratio of debt-to-income minus the ratio of liquid assets-to-income. Δr$_t$ is the year-on-year change in the repo (monetary policy) interest rate, set by the Central Bank’s monetary policy committee. Columns (1)–(3) report results from the OLS estimation, columns (4)–(6) use fixed effects. In columns (3) and (6), the estimation is restricted to homeowners. Young is a dummy defined as < 40 and old as ≥ 60. Have children is a dummy for having children. Standard errors in parenthesis are clustered at the household level.

*, ** and *** denotes significance at the 10 percent, 5 percent and 1 percent level, respectively.
### Table 1.5: Consumption Responses: Proxies for ARM

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{DTI}_{t-2} \times \Delta r_t$</td>
<td>-0.15*</td>
<td>-0.13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.09)</td>
<td>(0.11)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\text{DTI}_{t-2}$</td>
<td>0.01***</td>
<td>0.01***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.00)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\text{ARM} \times \text{DTI}_{t-2} \times \Delta r_t$</td>
<td>-0.13</td>
<td>-0.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.13)</td>
<td>(0.15)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\text{ARM} \times \Delta r_t$</td>
<td>-0.53**</td>
<td>-0.35</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.24)</td>
<td>(0.28)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corr $\times \text{DTI}_{t-2} \times \Delta r_t$</td>
<td>-0.35***</td>
<td>-0.44***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.10)</td>
<td>(0.12)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corr $\times \Delta r_t$</td>
<td>-0.34*</td>
<td>-0.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.19)</td>
<td>(0.23)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Young $\times \Delta r_t$</td>
<td>0.01</td>
<td>-0.01</td>
<td>-0.77***</td>
<td>-0.78***</td>
</tr>
<tr>
<td></td>
<td>(0.19)</td>
<td>(0.19)</td>
<td>(0.27)</td>
<td>(0.27)</td>
</tr>
<tr>
<td>Old $\times \Delta r_t$</td>
<td>-0.85***</td>
<td>-0.84***</td>
<td>-0.98***</td>
<td>-0.97***</td>
</tr>
<tr>
<td></td>
<td>(0.21)</td>
<td>(0.21)</td>
<td>(0.28)</td>
<td>(0.28)</td>
</tr>
<tr>
<td>Have children $\times \Delta r_t$</td>
<td>0.55***</td>
<td>0.54***</td>
<td>0.58***</td>
<td>0.58***</td>
</tr>
<tr>
<td></td>
<td>(0.18)</td>
<td>(0.18)</td>
<td>(0.22)</td>
<td>(0.22)</td>
</tr>
<tr>
<td>Mean DTI</td>
<td>1.52</td>
<td>1.52</td>
<td>1.52</td>
<td>1.52</td>
</tr>
</tbody>
</table>

| Household FE  | No      | No      | Yes     | Yes     |
| Unique households | 31,552 | 31,552 |      |      |

**Notes:** All specifications include year fixed effects, a fourth polynomial in age, the number of children and the change in number of children. DTI denotes the ratio of debt-to-income. $\Delta r_t$ is the year-on-year change in the repo (monetary policy) interest rate, set by the Central Bank’s monetary policy committee. Corr is the correlation between the household interest rate and the repo rate. ARM is a dummy equal to one if the correlation is above the median (0.61). Young is a dummy defined as $< 40$ and old as $\geq 60$. Have children is a dummy for having children. Standard errors in parentheses are clustered at the household level.

*, ** and *** denotes significance at the 10 percent, 5 percent and 1 percent level, respectively.
Table 1.6: Consumption Responses: Other factors

<table>
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<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$DTI_{t-2} \times \Delta r_t$</td>
<td>-0.32***</td>
<td>-0.32***</td>
<td>-0.19***</td>
<td>-0.26***</td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
<td>(0.07)</td>
<td>(0.06)</td>
<td>(0.07)</td>
</tr>
<tr>
<td>$DTI_{t-2}$</td>
<td>0.00***</td>
<td>0.00***</td>
<td>0.00***</td>
<td>0.00***</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>Young $\times \Delta r_t$</td>
<td>0.24*</td>
<td>0.22*</td>
<td>0.25*</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td>(0.13)</td>
<td>(0.13)</td>
<td>(0.13)</td>
<td>(0.13)</td>
</tr>
<tr>
<td>Old $\times \Delta r_t$</td>
<td>-1.09***</td>
<td>-1.15***</td>
<td>-1.13***</td>
<td>-1.10***</td>
</tr>
<tr>
<td></td>
<td>(0.13)</td>
<td>(0.12)</td>
<td>(0.12)</td>
<td>(0.12)</td>
</tr>
<tr>
<td>Have children $\times \Delta r_t$</td>
<td>0.59***</td>
<td>0.55***</td>
<td>0.57***</td>
<td>0.55***</td>
</tr>
<tr>
<td></td>
<td>(0.13)</td>
<td>(0.12)</td>
<td>(0.12)</td>
<td>(0.12)</td>
</tr>
<tr>
<td>Low income $\times \Delta r_t \times DTI_{t-2}$</td>
<td>0.19*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.11)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low income $\times \Delta r_t$</td>
<td>-0.37***</td>
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<tr>
<td></td>
<td>(0.12)</td>
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<tr>
<td>High DTI $\times \Delta r_t \times DTI_{t-2}$</td>
<td></td>
<td>0.12</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>(0.25)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High DTI $\times \Delta r_t$</td>
<td></td>
<td>-0.12</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>(1.00)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High LTV $\times \Delta r_t \times DTI_{t-2}$</td>
<td></td>
<td></td>
<td>-0.12</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.14)</td>
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<tr>
<td>High LTV $\times \Delta r_t$</td>
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<td></td>
<td></td>
<td>(0.31)</td>
<td></td>
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<tr>
<td>Low ATI $\times \Delta r_t \times DTI_{t-2}$</td>
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<td></td>
<td>-0.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.09)</td>
</tr>
<tr>
<td>Low ATI $\times \Delta r_t$</td>
<td></td>
<td></td>
<td></td>
<td>0.22*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.11)</td>
</tr>
<tr>
<td>Mean DTI</td>
<td>0.88</td>
<td>0.88</td>
<td>0.88</td>
<td>0.88</td>
</tr>
<tr>
<td>Sample</td>
<td>All</td>
<td>All</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td>Household FE</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Observations</td>
<td>265,675</td>
<td>265,675</td>
<td>265,675</td>
<td>265,675</td>
</tr>
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</table>

Notes: All specifications include year fixed effects, a fourth polynomial in age, the number of children and the change in number of children. $DTI$ denotes the ratio of debt-to-income. $\Delta r_t$ is the year-on-year change in the repo (monetary policy) interest rate, set by the Central Bank’s monetary policy committee. Young is a dummy defined as $< 40$ and old as $\geq 60$. Have children is a dummy for having children. The following variables are dummies. Low income is defined as belonging to the lowest disposable income quarter, adjusted for household size. High DTI, High LTV and Low ATI are defined using predetermined values (lagged by two years). High DTI is homeowners with a DTI above 3. High LTV is households with an LTV above 85 percent. Low ATI is households’ assets-to-income that are lower than one month’s disposable income. Standard errors in parenthesis are clustered at the household level.

*, ** and *** denotes significance at the 10 percent, 5 percent and 1 percent level, respectively.
Figure 1.1: Share of mortgage issuances by duration of interest rate fixation.

Note: Variable mortgage rate is defined as 3 months or shorter. The data source is Figure A18 in Sveriges Riksbank (2012).
Figure 1.2: Shares of the mortgage stock by duration of interest rate fixation

Note: Variable mortgage rate is defined as 3 months or shorter. The data source is Figure A30 in Sveriges Riksbank (2015).
**Figure 1.3: The repo rate and household interest rates**

Note: The figure displays the repo rate, the average household interest rate (dashed lines) in our sample, both equally weighted (ev) and value weighted (vw), and an aggregate household interest rate from Statistics Sweden (dotted line).
Figure 1.4: Assets, debt, and interest expenses

Note: The figure displays renters’ and homeowners’ assets, debt, and interest expenses normalized by disposable income. The second and third category report homeowners with a debt-to-income ratio of less than 3 and greater than 3, respectively. The last category is referred to as “high DTI” homeowners. 9.2 percent of all homeowners belong to this category. The left-hand panels display means and the right-hand panels display medians within each group.
Figure 1.5: The repo rate and relative consumption growth

Note: The left-hand panel depicts relative consumption growth measured as the median consumption growth among homeowners with a high debt-to-income ratio minus the median consumption growth of homeowners with a high debt-to-income ratio and an interest rate correlation above the median. The right-hand panel depicts the same difference evaluated at the mean.
Appendices

1.A  Details on the Model

1.A.1  Derivation of the log-linear expression for hand-to-mouth behavior

Let us again consider $a_t$, net financial assets. Starting from equation (1.2) we then want to approximate:

$$\log (c_t) = \log (y_t + r_t \cdot a_t).$$  \hspace{1cm} (1.9)

We use a first-order Taylor approximation of the form $f(x) = f(x^*) + (x - x^*)f' (x^*)$. The left-hand side in (1.9) is then approximated by:

$$\log (c_t) = \log (c^*) + (c_t - c^*) \frac{1}{c^*},$$ \hspace{1cm} (1.10)

while the right-hand side is approximated by (remember that we assume that net financial assets are kept constant):

$$\log (y_t + r_t \cdot a_t) = \log (y^* + r^* \cdot a^*) + \left[ (y_t + r_t \cdot a_t) - (y^* + r^* \cdot a^*) \right] \frac{1}{y^* + r^* \cdot a^*}.$$ \hspace{1cm} (1.11)

Now, use $y^* + r^* \cdot a^* = c^*$ to simplify (1.11):

$$\log (y_t + r_t \cdot a_t) = \log (c^*) + \left[ (y_t + r_t \cdot a_t) - (y^* + r^* \cdot a^*) \right] \frac{1}{c^*}$$

$$= \log (c^*) + \frac{y_t - y^*}{c^*} + \frac{(r_t - r^*)a^*}{c^*}$$

$$= \log (c^*) + \frac{y_t - y^*}{c^*} + \frac{y^* a^*}{c^*} \frac{1}{y^*} (r_t - r^*)$$

$$= \log (c^*) + \theta \frac{y_t - y^*}{y^*} + \theta \frac{a^*}{y^*} (r_t - r^*).$$ \hspace{1cm} (1.12)

Substitute (1.10) and (1.12) into (1.9) to obtain:
CHAPTER 1. HOUSEHOLD DEBT AND MONETARY POLICY

\[
\frac{(c_t - c^*)}{c^*} = \theta \frac{y_t - y^*}{y^*} + \theta \frac{a^*}{y^*} (r_t - r^*). \tag{1.13}
\]

Finally use the approximation \( \frac{e^x - e^y}{x - y} \approx \log(x) - \log(y) \) to obtain:

\[
\Delta \log(c_t) = \theta \Delta \log(y_t) + \theta \frac{a^*}{y^*} \Delta r_t. \tag{1.14}
\]

1.A.2 Optimizing households – Alternative timing assumptions

The optimizing household’s problem is as follows. We ignore uncertainty in returns and labor income and only consider the effects of unanticipated shocks to the short-term interest rate. Optimizing households solve:

\[
\max \ E_0 \sum_{t=0}^{T_i-1} \beta^t u \left( c_t^i \right), \tag{1.15}
\]

subject to the budget constraint:

\[
\sum_{t=0}^{T_i-1} R_t^{-1} (c_t^i - y_t^i) = (1 + r_0) a_0^i, \tag{1.16}
\]

where \( R_0 = 1 \) and \( R_t = (1 + r_t) R_{t-1} \) for \( t \geq 1 \), and where \( \beta \) denotes the discount factor and the utility function is \( u(c) = \frac{c^{1-\sigma}}{(1-\sigma)} \).

The solution to this problem is characterized by the Euler equation which determines consumption growth:

\[
\frac{c_{t+1}^i}{c_t^i} = [\beta (1 + r_{t+1})]^{\sigma}, \tag{1.17}
\]

and

\[
c_0^i = \frac{Y^i + (1 + r_0) a_0^i}{\sum_{t=0}^{T_i-1} R_t^{-1} \beta^{\sigma t}}. \tag{1.18}
\]

which determines the level of consumption. \( Y^i \) is the present value of the household’s income stream. The Euler equation demonstrates that the
percentage consumption response to anticipated interest rate movements is identical for all optimizing households in the economy. However, there is some heterogeneity in response to unanticipated interest-rate changes when households have different levels of wealth and/or remaining life-spans.

We refer to the solution given by (1.17) and (1.18) for a given constant interest rate as the steady state. For these households, the response, measured as an elasticity, to a change in the interest rate is:

\[ \Delta \log c_t \approx \sigma \cdot \Delta r_t. \]  

(1.19)

Below we analyze scenarios when a household has chosen \( c_0 \) in steady state and then learns at the beginning of period 1 that either \( r_2 \) has changed or that \( r_1 \) has changed. In the first case, the household chooses \( c_1 \) so that the relation between \( c_1 \) and \( c_2 \) remains consistent with the Euler equation. The level of \( c_1 \) (and consumption in periods thereafter) in relation to the initial steady-state consumption (\( c_0 \)) is however also affected – exactly how depends on the household’s initial (net) wealth. In the second case, all forward-looking interest rates are unaffected. The household does therefore not want to reoptimize the slope of its consumption path. But the surprise in the return on savings between period 0 and 1 has consequences for the household’s available resources at the beginning of period 1. This wealth or cash-flow effect thus affects the relation between \( c_0 \) and all future consumption levels.

**Timing assumption 1: new information about the future interest rate**

We first explore the assumption that the household has chosen \( c_0 \) according to (1.18), but that, at the beginning of period \( t = 1 \), it learns that the interest rate will be \( \tilde{r}_2 \) instead of the anticipated \( r_2 \). The household will then reoptimize at the beginning of period \( t = 1 \), resulting in:

\[ \Delta \log c_1 \approx \alpha + \gamma \left( \tilde{r}_2 - r_2 \right). \]  

(1.20)
CHAPTER 1. HOUSEHOLD DEBT AND MONETARY POLICY

where \( \Delta \log c^i_1 \) denotes the deviation in \( c_1 \) away from steady state and \( \alpha \) is a term common to all households, where:

\[
\gamma \approx \frac{T^i - 2}{T^i - 1} \left( \frac{T^i}{T^i + a^i/y^i} + \sigma - 1 \right),
\]

and where the last approximation builds on the assumption that there is little discounting, that the interest rate is close to zero, and that the household has a flat income profile. In this forward-looking scenario, there are three effects that determine the response: a substitution effect, an income effect, and a cash-flow effect. Notice that apart from accounting for a finite horizon, equation (1.20) is essentially equal to the negative of equation (1.19). The difference in signs appears because equation (1.19) considers changes to \( \log(c_2) - \log(c_1) \) in response to a change in \( r_2 \).

Timing assumption 2: new information about the realized interest rate

We also explore the assumption that the household has chosen \( c_0 \) according to (1.18), but that the interest rate turns out to be \( \hat{r}_1 \) instead of the anticipated \( r_1 \). The household will then reoptimize at the beginning of period \( t = 1 \), resulting in:

\[
\Delta \log c^i_1 \approx \alpha + \delta^i \frac{a^i}{y^i} (\hat{r}_1 - r_1),
\]

where \( \alpha \) is, again, a term common to all households. The individual-specific factor \( \delta \) in this expression can be approximated as:

\[
\delta^i \approx \frac{1}{T^i + a^i/y^i},
\]

if there is little discounting, the interest rate is close to zero, and if the household has a flat income profile over the life cycle. The fact that future interest rates remain at steady state shuts down the substitution effect. Nonetheless, the response of typical optimizers is an order of magnitude
smaller than for hand-to-mouth households (provided that $T^i \gg |a^i/y^i|$).

1.A.3 Quantitative analysis

We report model estimates based on a simple model simulation. We set $\beta = 0.98$, $y = 1$, and let $T$ be uniformly distributed between 10 and 50 years. Debt-to-income, the negative of $\frac{a^i}{y^i}$, is uniformly distributed between 0 and 5. The experiment is that the interest rate increases for one period from 0.02 to 0.03.

We estimate the regression:

$$\Delta \log c_i = \beta_0 + \beta_1 DTI_i \times \Delta r_i + \varepsilon_i, \quad (1.24)$$

where subscript $t = 1$ has been omitted. Columns (1) to (3) of Table 1.7 report estimates for optimizers that behave as in Section 1.A.2. The EIS ($\sigma$) varies between 0.5 (column 1), 1.0 (column 2), and 1.5 (column 3). This parameter determines the common response of all households and is identified by the intercept in each regression. The estimate on $\Delta r_i \times DTI_i$ indicates that the percentage response in consumption growth is amplified by 0.071 for each unit of additional debt-to-income.

The mean response is estimated to be $-0.179\%$. Whether optimizers can adjust period-0 consumption (columns 1 to 3), or not (column 4) does not matter much for the response. Column 5 focuses on a sample of households that display hand-to-mouth behavior as given by equation (1.2). The estimate in this sample is 16 times larger than the estimate of column (2). The response is essentially proportional to the debt-to-income ratio. Finally, column (6) reports estimates if optimizers and hand-to-mouth households are mixed 50-50, simply by combining the samples of columns 2 and 5. At $-0.607$, the estimate in the combined sample is equal to the average of the two estimates. The mean response is $-1.53\%$ and the response amplitude varies by 0.607 percent for each unit of debt-to-income.
Table 1.7: Model Estimates for ARM Holders

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$DTI_i \times \Delta r$</td>
<td>-0.071***</td>
<td>-0.071***</td>
<td>-0.071***</td>
<td>-0.076***</td>
<td>-1.143***</td>
<td>-0.607***</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.002)</td>
<td>(0.001)</td>
<td>(0.012)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.005***</td>
<td>-0.009***</td>
<td>-0.014***</td>
<td>-0.004***</td>
<td>0.0013***</td>
<td>-0.0065***</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>Observations</td>
<td>2,100</td>
<td>2,100</td>
<td>2,100</td>
<td>2,100</td>
<td>2,100</td>
<td>4,200</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.536</td>
<td>0.580</td>
<td>0.622</td>
<td>0.457</td>
<td>0.999</td>
<td>0.450</td>
</tr>
<tr>
<td>Share of optimizers</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>0.0</td>
<td>0.5</td>
</tr>
<tr>
<td>Share of HTMs</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>1.0</td>
<td>0.5</td>
</tr>
<tr>
<td>EIS of optimizers ($\sigma$)</td>
<td>0.5</td>
<td>1.0</td>
<td>1.5</td>
<td>1.0</td>
<td>—</td>
<td>1.0</td>
</tr>
<tr>
<td>Flexible current consumption</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Mean DTI</td>
<td>2.525</td>
<td>2.525</td>
<td>2.525</td>
<td>2.525</td>
<td>2.525</td>
<td>2.525</td>
</tr>
<tr>
<td>Average Response</td>
<td>-0.179</td>
<td>-0.179</td>
<td>-0.179</td>
<td>-0.192</td>
<td>-2.886</td>
<td>-1.333</td>
</tr>
</tbody>
</table>

Notes: The sample is based on a parameterization where $y = 1$, $\beta = 0.98$, households whose heads are aged between 30 and 70 years ($T$ uniformly distributed between 10 and 50), and debt-to-income uniformly distributed between 0 and 5 ($DTI_i$ is the negative of $\frac{a_i}{y_i}$). The experiment involves a one-year increase in the interest rate from 0.02 to 0.03. Flexible current consumption denotes whether optimizers follow equation (1.22), in which case it is fixed, or equation (1.20), in which case it is flexible.

* , ** and *** denotes significance at the 10 percent, 5 percent and 1 percent level, respectively.
1.A.4 Extension of model to FRMs

It is straightforward to extend the simple model to include an FRM. The most simple form of FRM would involve a non-amortizing mortgage with a fixed interest rate, i.e., independent of the experiment above, that is paid back in full at time $T$. In the above setting, the response of a household that holds such a mortgage to a temporary one-period change to the short-term interest rate would be miniscule.
CHAPTER 1. HOUSEHOLD DEBT AND MONETARY POLICY

1.B Details on the Data

Figure 1.6: Household interest rates and correlations with the repo rate

Note: The left-hand panel displays the cross-sectional distribution of correlations between the repo rate and the household interest rate. The right-hand panel displays the cross-sectional distribution of household interest rates.
### Table 1.8: Sample restrictions

<table>
<thead>
<tr>
<th>Type of restriction</th>
<th>Observations</th>
<th>Unique households</th>
</tr>
</thead>
<tbody>
<tr>
<td>0. Full sample (household heads)</td>
<td>2,434,359</td>
<td>412,968</td>
</tr>
<tr>
<td>1. Match with consumption data</td>
<td>1,800,100</td>
<td>394,504</td>
</tr>
<tr>
<td>2. Drop year 2000</td>
<td>1,784,261</td>
<td>329,000</td>
</tr>
<tr>
<td>3. Excl. unstable households over time (includes dropping 2001)</td>
<td>1,666,434</td>
<td>255,014</td>
</tr>
<tr>
<td>4. Excl. households who change official address or transact real estate</td>
<td>830,902</td>
<td>231,955</td>
</tr>
<tr>
<td>5. Excl. self-employed</td>
<td>708,691</td>
<td>223,913</td>
</tr>
<tr>
<td>6. Excl. households who hold derivatives</td>
<td>787,968</td>
<td>222,105</td>
</tr>
<tr>
<td>7. Excl. households who hold securities with missing ISINs, or mutual funds or stocks with missing prices or returns</td>
<td>603,380</td>
<td>183,909</td>
</tr>
<tr>
<td>8. Excl. households with missing disposable income in $t$, $t-1$ or $t-2$</td>
<td>603,314</td>
<td>183,900</td>
</tr>
<tr>
<td>9. Excl. households with missing interest rate (unless debt is zero in $t$ and $t-1$)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10. Excl. households with missing change in number of adults</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>11. Excl. households with missing DTI in $t-2$</td>
<td>509,011</td>
<td>160,949</td>
</tr>
<tr>
<td>12. Excl. households that change housing tenure status</td>
<td>534,927</td>
<td>165,915</td>
</tr>
<tr>
<td>13. Excl. households where the number of adults changes</td>
<td>524,035</td>
<td>164,280</td>
</tr>
<tr>
<td>14. Excl. households where the household head is younger than 18</td>
<td>509,011</td>
<td>160,949</td>
</tr>
<tr>
<td>15. Excl. households with negative consumption in $t$ or $t-1$</td>
<td>485,082</td>
<td>156,082</td>
</tr>
<tr>
<td>16. Excl. households with missing consumption growth</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>17. Excl. households with negative disposable income in $t$, $t-1$ or $t-2$</td>
<td>484,557</td>
<td>156,470</td>
</tr>
<tr>
<td>18. Excl. lowest 1 percentile of disposable income in $t-1$ and $t-2$</td>
<td>474,057</td>
<td>153,006</td>
</tr>
<tr>
<td>19. Excl. if the interest is higher than 20 percent for indebted households</td>
<td>461,922</td>
<td>151,409</td>
</tr>
<tr>
<td>20. Excl. if consumption growth is higher (lower than +/− 50 percent)</td>
<td>378,483</td>
<td>137,533</td>
</tr>
<tr>
<td>21. Excl. if DTI in $t-2$ is negative or higher than 10</td>
<td>378,222</td>
<td>137,298</td>
</tr>
<tr>
<td>22. Excl. households that are not in the sample at least 3 years</td>
<td>366,301</td>
<td>64,322</td>
</tr>
<tr>
<td>23. Excl. indebted homeowners with no correlation measure</td>
<td>366,301</td>
<td>64,322</td>
</tr>
<tr>
<td>24. For the balanced sample required in sample for 2002-2007</td>
<td>615,426</td>
<td>11,253</td>
</tr>
</tbody>
</table>
### Table 1.9: Summary statistics and balance by mortgage type

<table>
<thead>
<tr>
<th></th>
<th>FRM (1)</th>
<th>ARM (2)</th>
<th>ARM - FRM (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Socio demographics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disposable income</td>
<td>324</td>
<td>339</td>
<td>11,821**</td>
</tr>
<tr>
<td></td>
<td>(140)</td>
<td>(147)</td>
<td>(1,588)</td>
</tr>
<tr>
<td>Disposable income a.e.</td>
<td>164</td>
<td>167</td>
<td>2,936**</td>
</tr>
<tr>
<td></td>
<td>(56)</td>
<td>(59)</td>
<td>(0.020)</td>
</tr>
<tr>
<td>Age</td>
<td>50</td>
<td>50</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>(13)</td>
<td>(13)</td>
<td>(0.153)</td>
</tr>
<tr>
<td>Household size</td>
<td>2.82</td>
<td>2.89</td>
<td>0.069**</td>
</tr>
<tr>
<td></td>
<td>(1.48)</td>
<td>1.49</td>
<td>(0.017)</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; High school (share)</td>
<td>11.08</td>
<td>10.04</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(56)</td>
<td>(59)</td>
<td>(0.620)</td>
</tr>
<tr>
<td>High school (share)</td>
<td>58.18</td>
<td>56.36</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(28)</td>
<td>(28)</td>
<td>(0.180)</td>
</tr>
<tr>
<td>&gt; High school (share)</td>
<td>30.74</td>
<td>33.63</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(13)</td>
<td>(13)</td>
<td>(0.180)</td>
</tr>
<tr>
<td><strong>Consumption measure</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumption</td>
<td>301</td>
<td>314</td>
<td>12,787**</td>
</tr>
<tr>
<td></td>
<td>(139)</td>
<td>(149)</td>
<td>(1,501)</td>
</tr>
<tr>
<td>Consumption a.e.</td>
<td>152</td>
<td>156</td>
<td>3,315**</td>
</tr>
<tr>
<td></td>
<td>(58)</td>
<td>(61)</td>
<td>(0.582)</td>
</tr>
<tr>
<td><strong>Balance sheet items</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Debt</td>
<td>500</td>
<td>556</td>
<td>55,576**</td>
</tr>
<tr>
<td></td>
<td>(471)</td>
<td>(500)</td>
<td>(3,358)</td>
</tr>
<tr>
<td>Debt-to-income</td>
<td>1.46</td>
<td>1.57</td>
<td>0.115**</td>
</tr>
<tr>
<td></td>
<td>(1.14)</td>
<td>1.16</td>
<td>(0.013)</td>
</tr>
<tr>
<td>Interest rate</td>
<td>5.38</td>
<td>5.04</td>
<td>-0.334**</td>
</tr>
<tr>
<td></td>
<td>(2.40)</td>
<td>(1.89)</td>
<td>(0.020)</td>
</tr>
<tr>
<td>Correlation measure</td>
<td>0.09</td>
<td>0.83</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(0.43)</td>
<td>(0.11)</td>
<td>-</td>
</tr>
<tr>
<td>Interest share</td>
<td>7.37</td>
<td>7.47</td>
<td>0.001*</td>
</tr>
<tr>
<td></td>
<td>(5.79)</td>
<td>(5.43)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Liquid assets</td>
<td>1.120</td>
<td>1.239</td>
<td>99,430**</td>
</tr>
<tr>
<td></td>
<td>(0.344)</td>
<td>(0.906)</td>
<td>(10.453)</td>
</tr>
<tr>
<td>Liquid assets-to-income</td>
<td>0.43</td>
<td>0.42</td>
<td>-0.003</td>
</tr>
<tr>
<td></td>
<td>(0.74)</td>
<td>(0.71)</td>
<td>(0.005)</td>
</tr>
<tr>
<td>Loan-to-Value*</td>
<td>0.52</td>
<td>0.55</td>
<td>0.022**</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.005)</td>
</tr>
<tr>
<td>Observations</td>
<td>64,704</td>
<td>64,702</td>
<td>129,406</td>
</tr>
<tr>
<td>Unique households</td>
<td>15,695</td>
<td>15,857</td>
<td>31,552</td>
</tr>
</tbody>
</table>

**Notes:** Columns (1) and (2) report summary statistics by groups of homeowners with a different duration of debt, where High (Low) represents groups with a correlation of household interest rates with the repo rate above (below) the median among homeowners. Values are in 1,000 Swedish Krona or in percent (averages). Values in parenthesis are (s.d.). Column (3) reports regression coefficients from single variable regressions on an indicator of having a highly variable interest rate. Standard errors, reported in parenthesis below, are clustered at the household level. *) For the loan-to-value ratio the mean for percentile 99 and below is reported. See Table 1.1 for further details.
Chapter 2

Should I Stay or Must I Go? Temporary Refugee Protection and Labor-Market Outcomes*

2.1 Introduction

Recent developments around the world have led to a large inflow of asylum seekers to Europe. In response to the increased numbers of asylum seekers, many European countries have implemented stricter immigration policies. The motivation has been to reduce immigration and/or

*This paper has been jointly written with Birthe Larsen and Elisabet Olme. We are grateful for helpful discussions with Niklas Blomqvist, Jonas Cederlöf, Matz Dahlberg, Peter Fredriksson, John Hassler, David Jinkins, Per Krusell, Jaakko Meriläinen, Elin Molin, Arash Nekoei, Peter Nilsson, Gritt Ølykke, Per Pettersson-Lidbom, Miikka Rokkanen, Anna Seim, David Seim, Jósef Sigurdsson, Björn Tyrefors Hinnerich, Jonas Vlachos, Eskil Wadensjö, and seminar participants at the Migration and Demographics conference in Nürnberg, the Institute for Housing and Urban Research (Uppsala University), the National Institute of Economic Research, Research Institute of Industrial Economics, Swedish Public Employment Service, and Stockholm University. This research benefited from financial support from Handelsbanken’s Research Foundations. Financial support from Stiftelsen Söderströms Donationsfond is gratefully acknowledged by Elisabet Olme and Matilda Kilström. All errors are our own.
improve the integration of immigrants granted residency. One such policy is the shift from permanent to temporary residence permits for refugees.\footnote{For example, in July 2016, Sweden introduced a temporary law shifting from permanent to temporary residence permits and limiting possibilities of family reunification. Among several other changes to the refugee policy, in December 2014 Australia reintroduced temporary protection visas - which cannot be promoted to permanent status - for those who arrive without a valid visa.} While several countries have, or are about to, implement such reforms, we lack empirical evidence on their effects on refugees’ integration in society in general and in labor markets in particular.

A priori, it is possible to think that a shift to temporary permits could have both positive and negative effects on integration in society and in the labor market. The public debate has been centered around the relative strengths of these effects. On the one hand, the expected return to investment in country-specific human capital falls if the probability of receiving permanent residency falls. There can also be a cost in the form of increased stress from a lower probability of being granted permanent residency. On the other hand, actions that lead to labor-market attachment during the time with temporary residency are incentivized when they increase the probability for permanent residency. This could strengthen the incentives for labor-market investments in the host country and improve integration.

The net effect of a shift from permanent to temporary residence permits for refugees is therefore an empirical question in much need of attention. Specifically, we want to address what the effects are of changes in the probability of being granted permanent residency. Furthermore, while immigrants’ entrance into the labor market is relatively well studied, less attention has been given to the specific challenges of those given refuge in a new country. In fact, we know very little about the integration process of refugees and their labor-market prospects. In a recent paper, Fasani et al. (2018) show that refugees perform worse in the labor market than other immigrants across Europe, and Dustmann et al. (2017a) highlight the indecisiveness about the duration and permanence of the stay in the host country as one of the primary reasons for the
poor labor-market integration. This calls for more research focusing on refugee immigration to Europe, with a focus on refugees’ labor-market outcomes in connection with the expected duration in the host country.

In this paper, we study the effects of a Danish reform, implemented in 2002 as part of a reform package, that changed the eligibility requirements for permanent residency, thereby lowering the ex-ante probability of being granted a permanent residence permit. This was done by increasing the length of the time period a refugee would have had to have been a legal resident (on a temporary residence permit) in Denmark before being eligible to apply for permanent residency. During the time with temporary status, a residence permit could be withdrawn if the grounds for protection were no longer valid, and if the individual did not have the right to stay on other grounds, such as having a solid labor-market attachment. The fact that the spell under a temporary residency was implemented retroactively allows us to distinguish the effect of this part of the reform from other aspects of the reform package. The change applied to individuals who lodged their first asylum application on or after February 28, 2002. This meant that refugees who applied for asylum from February 28 2002 onwards faced a longer time period with temporary status, during which they risked losing the grounds for protection, before they could apply for permanent residency. All else equal, the ex-ante probability of receiving permanent residency in Denmark on the grounds of asylum was thus higher prior to the reform.\(^2\)

To understand the mechanisms at work, we set up a theoretical search and matching model, with the objective of deriving predictions that can

\(^2\)However, this does not mean that the reform necessarily changed whether an individual got to stay in Denmark or not. In fact, we show that around 90 percent of the individuals (in both the control and the treatment group) are still in Denmark twelve years after their first arrival. The individual could (1) have had asylum reasons throughout the time period with a temporary permit, or (2) established a labor-market attachment which could be used as grounds for prolonged temporary residency. Although a refugee had no control over the development in her home country, or the Danish authorities’ assessment of whether the grounds for asylum were still valid, she could affect her attachment to the labor market and thus affect the probability of staying in Denmark.
be compared to our empirical findings. The model focuses on labor-market outcomes and features heterogeneity in terms of productivity and a human capital investment decision. We use the model to study education and labor-market outcomes under different assumptions about a policy change similar to the reform. Empirically, we then use a Regression Discontinuity in Time framework to study the impact of the reform. Register data allows us to track individuals granted asylum, and a large set of their outcomes, over time. Thus, we are able to empirically dig more deeply into the mechanisms at work and to consider the impact of the reform on different subgroups of refugees. We are interested in the behavioral responses to this reform component, and our focus is on outcomes that are relevant for integration and/or the assessment of grounds for prolonged residency that the individual could affect herself. Our main outcomes are therefore in terms of educational investments and status in the labor market. Labor-market attachment can, in itself, be viewed as a measure of integration, whereas education can be considered as an investment in integration. We study the full sample as well as sample splits based on gender and skill level.

Our results suggest that lowering the ex-ante probability of receiving permanent residency increased the enrollment in education by 17 percentage points at the cutoff point. Enrollment is measured as the share that is ever enrolled in education, excluding Danish courses, during the first twelve years of residency in Denmark. We also show that enrollment rates are higher for the treatment group throughout the sample period by plotting enrollment rates over time. The increase in enrollment is mainly driven by females and low-skilled individuals, defined as individuals who lack a university education. The effect for females is an increase of around 21–27 percentage points at the cutoff. We interpret the positive effect on enrollment in education as an increased investment in human capital and integration. To understand the impact of this increase, we consider several other educational outcomes. We find no significant effects on enrolling in labor-market training or adult education, or on the propensity to complete an education, or the number
of years in education. In terms of labor-market outcomes, we focus on the share of individuals that are ever employed (or self-employed) during the first twelve years in Denmark, and on their earnings measured three and seven years after arrival. We do not estimate any significant effects on labor-market outcomes, but the coefficients are negative. The same holds true when we look at earnings conditional on employment. There is no change in the number of times individuals change jobs, but for high-skilled individuals we do find a weakly significant, negative effect on the highest skill level ever achieved on a job. One potential explanation for this could be that high-skilled workers accept jobs for which they are over-qualified, or that employers are reluctant to invest in high-skilled workers with a more uncertain future in Denmark. The empirical findings on education are in line with the implications from our theoretical model where low-skilled individuals are, ex ante, more negatively affected by the reform. In the model, this is true regardless of whether they are employed or unemployed.

There are other outcomes of interest in this context. We study whether the reform had any effect on criminal activity, health, or fertility. Engaging in criminal activity could be seen as an alternative to entering the labor market, but criminal activities also make it harder to obtain permanent residency post-reform. Increased uncertainty from a lower probability of permanent residency may also have a direct effect on individual health which, in turn, could affect future labor-market outcomes. In terms of fertility, the reform and the implied increase in uncertainty may have affected the willingness to bring children into the world. Finally, we are interested in asylum holders’ duration in Denmark, for two reasons. First, the reform could have affected the willingness and ability to stay in Denmark as the prerequisites to stay changed, which in itself is an interesting outcome. Second, if the fraction staying in Denmark changed, the results on other outcomes may be driven by this selection rather than by behavioral responses among those staying in Denmark. We find a negative effect on conviction rates for property crimes during the first twelve years in
Denmark of around 10 percentage points. This decrease is concentrated among males. We find no significant differences between the two groups in terms of health, fertility, or the share that is still in Denmark twelve years after their first asylum application. The latter finding suggests that any effects we pick up are unlikely to be due to an indirect effect - operating through selection - that would occur if some group was more likely than another to stay in Denmark.

**Related literature** There is, to our knowledge, no other paper that specifically studies the long-run effects on refugees of a prolonged temporary status. Changes to immigration policy are particularly difficult to evaluate due to difficulties in finding a valid comparison group. Previously, some studies have compared different types of immigrants to assess the importance of, for example, the time horizon in the host country. As different types of immigrants may differ in important ways, we would preferably like to study the effects within one specific group of immigrants. At the same time, even when looking at one type of immigrants (for example refugees) there may be substantial heterogeneity. It is well known that the characteristics of refugees from a given country can change over time. All of this implies that estimating the effects of changes to the probability of being granted permanent residency is challenging.

There are related studies that consider the difference between temporary and permanent migration spells in other contexts. For example, Chen et al. (2016) study the selection into temporary or permanent migration. Temporary, short-term, migration is typically a response to fluctuations in the local labor market, while long-term migration is more stable. They show that long-term migrants are more strongly positively selected and relate this to higher returns to matching. Adda et al. (2016) estimate a dynamic model of return migration and human capital accumulation. They simulate the effects of uncertainty about the permanence of an individual’s stay in the host country and find reduced investments in human capital and decreased lifetime earnings because of a short-
ened pay-off period. These papers do not explicitly consider refugees, a
group that is fundamentally different from other types of migrants in
that they are forced to leave their home country. This implies that while
other migrants have the option to return to their home country, refugees
may not. Cortes (2004) recognizes the importance of this distinction and
focuses on the heterogeneity between refugees and economic immigrants
in terms of their time horizons. Assuming that refugees cannot return to
their country of origin, and thus face a longer time horizon, they have
stronger incentives to invest in country-specific human capital. Her study
is related to, and theoretically builds on, Duleep and Regets (1999) and
their model of human capital accumulation. Furthermore, Orrenius and
Zavodny (2015) study the effects on labor-market outcomes of granting
specific groups of immigrants a temporary protected status (TPS) in
the United States, and show that, in general, it appears that even hav-
ing a temporary permit - compared to an illegal status - improves the
labor-market opportunities for immigrants. In Cortes (2004) and Orre-
nius and Zavodny (2015), a distinction is made between immigrants with
different time horizons (refugees vs. economic immigrants) and between
immigrants with a different legal status. One benefit of our setup is that
we can look at the importance of the time horizon and status in the host
country within one group of immigrants, refugees. Arguably, refugees are
likely to be different in many ways compared to, for example, economic
immigrants, and, since they constitute a more marginalized group in re-
lation to the labor market, it is particularly important to understand the
effects of changing the conditions they face.

Several papers study immigration and crime and how policy matters
in this context. In a recent paper, Pinotti (2017) uses a regression dis-
continuity design to show that immigrant legalization reduces the crime
rates among immigrants in Italy. The proposed mechanism is that legal-
ization increases the opportunity cost of crime by improving access to the
regular labor market. Mastrobuoni and Pinotti (2015) find a reduction in
crime following the European Union enlargement. Baker (2015) also finds
a negative effect on crime of legalization of undocumented immigrants in
the United States. Lozano and Sørensen (2011) study the effect of legalization on earnings among Mexican immigrants in the United States and find an increase in occupational wages. They interpret their findings as support of immigrants finding better jobs following legalization. Cascio and Lewis (2017) also study the effect of legal status in the US context, exploiting the Immigration Reform and Control Act of 1986, and find an increase in EITC transfers but no effects on food stamp transfers. Fasani (2018) finds small and non-persistent reductions in crime following a wave of amnesty programs in Italy. Furthermore, Fasani (2015) highlights the importance of policy design in shaping effects of legalization on crime. Considering a different type of outcome, Dustmann et al. (2017b) study the consumption effects of legalization. They show that undocumented immigrants consume less than documented immigrants, and argue that this is because of lower income. More closely related to the outcomes studied in this paper, Devillanova et al. (2017) study employment effects of legalization following an amnesty program in Italy and find positive effects of prospective legal status on employment probability. Legalization policies are clearly important, but they are conceptually different from policies involving permanent versus temporary residence permits. It is not necessarily the case that findings from the legalization literature translate into other types of policy changes, such as the one we study.

Another closely related paper in terms of the type of policy studied is Blomqvist et al. (2018). They study the short-run effects, over a one-year horizon, of restricting the access to permanent residency in Sweden and find some evidence of a higher probability of enrolling in basic Swedish education. Finally, Mansouri et al. (2010) provide a comparative study of temporary permit regimes in Denmark, Germany and Australia. Through interviews with NGOs, they conclude that introducing temporary residence permits, or prolonging the temporary status, increased the uncertainty for refugees and suggest that integration has been made more difficult as a result. A key advantage of our study is that we are able to quantify the response to prolonged temporary status and
that we can study the mechanisms through which refugees were affected.

There are several relevant papers using Danish data to study immigrants’ outcomes. Clausen et al. (2009) analyze the effects on labor-market integration for immigrants from Danish active labor-market programs (ALMPs). They find mixed effects depending on the type of program, but in general positive effects from language training and participation in wage subsidy programs.\textsuperscript{3} Other aspects of the 2002 reform package in Denmark have also been studied. There were several aspects to the general reform package; notably limiting the access to the welfare state and to family reunification. Huynh et al. (2007) study the employment effects of limiting access to the welfare state, finding positive employment effects from reduced benefits. The authors exploit the discontinuity that arises from the fact that only those granted asylum after July 1, 2002 were subject to the new benefit rules. Similarly, Rosholm and Vejlin (2010) analyze the effects of lowering the benefits on both job finding and job separation rates. Rather than using a regression discontinuity approach, they implement a mixed proportional hazard model. In line with the evidence from Huynh et al. (2007), the authors find small positive effects on the job finding rate. In this paper, we instead study another part of the reform package to shed some light on the effects of a lower ex-ante probability of receiving a permanent residence status.

The paper is organized as follows. Section 2.2 describes the Danish institutional settings and the reform that we are studying. Section 2.3 presents the theoretical framework. Section 2.4 describes the empirical strategy and the data. In Section 2.5 we present our main results. Robustness checks are performed in Section 2.6. Section 2.7 presents results on other outcomes. Section 2.8 concludes the paper.

\textsuperscript{3}See Sarvimäki and Hämäläinen (2016) for a paper on ALMP in Finland. They find positive effects on earnings following compliant participation.
2.2 Institutional Settings

Denmark has seen the number of asylum applicants vary a great deal over the years. 2001 marked a peak in the number of asylum seekers, and between 2001 and 2002, the number of asylum seekers was cut in half from 12,512 to 6,068, with most of the asylum seekers arriving from Afghanistan, Iraq, and the Former Republic of Yugoslavia. This is the time period of immediate interest to us, and as we will explain in Section 2.2.1, it is a time of substantial change in terms of asylum policies.

The process of applying for asylum in Denmark is governed by the Aliens Act and decisions are made by the Danish Immigration Service (DIS), while appeals are handled by the Refugee Appeals Board. The process of applying for asylum in Denmark and the different types of permits are described in more detail in Appendix 2.A.

2.2.1 The 2002 reform package

On November 27, 2001, a new minority center-right-wing coalition government was appointed in Denmark. This shift of government reflected a shift in the public opinion on immigration (see, for example, Mansouri et al. (2010)). The new government introduced a number of legislative changes regarding asylum and immigration policies that were passed by the Danish parliament as amendments to the Aliens Act and the Integration Act. We will study the effects of a reform component that changed the criteria for eligibility for permanent residency in Denmark (henceforth referred to as the reform). This change was part of a suggestion for a new Bill to amend the Danish Integration Act, presented by the new government in February 2002 (Ersbøll and Gravesen, 2010). The Bill was passed by the Danish parliament (Folketinget) on June 6 2002.

---

4 Individuals granted asylum for humanitarian reasons are an exception and in these cases, the Ministry for Foreigners, Integration and Housing (in 2002, the Ministry for Integration) makes the decision. If an asylum seeker’s application is rejected, he/she can still be given asylum for humanitarian reasons.

5 Discussions began in January when a new aliens policy was introduced, and this gave rise to the suggested Bill amending the Integration Act in February. The Bill
The explicit aim of this reform package was to limit the number of asylum seekers in Denmark, while honoring international obligations, and to speed up the integration process (The Danish Immigration Service, 2003).

Both before and after the reform, individuals given asylum were initially granted a temporary residence permit if protection was deemed necessary. While under temporary status, the residence permit could be discontinued if the grounds for residency were no longer valid. Generally, temporary protection would be sustained if the need for protection was intact and there were no legal reasons to withdraw it. Refugees could also be allowed to sustain their temporary residence permits based on labor-market attachments, even if there was no longer any need for protection. After a certain time period as a resident in Denmark, a refugee (above 18 years old) would be eligible to apply for permanent residency.

The main change implied by the reform was the change in how long a refugee would have had to have been on a temporary residence permit before being considered for permanent residence status. Prior to the reform, three years were sufficient, whereas after the reform a refugee would have to wait for seven years before being allowed to apply for a permanent residence permit. This change implied that individuals subject to the new rules would have to live with temporary protection for a longer time period, facing the risk of having their permit discontinued. Once eligible to apply for permanent residency, refugees would be granted permanent residence if the need for protection remained or if they had a labor-market attachment (given the fulfillment of some supplementary conditions), unless there were legal reasons to withdraw the

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6Paragraph 11 in the Aliens Act.

7Formally, the reform implied that if the refugee had held a legal permit on basis of paragraphs 7–9 of the Aliens Act for at least seven years, counting from the date of approval of the temporary permit, he/she was eligible to apply for permanent residency. Paragraphs 7–9 included permits for all categories of refugees that we consider, and, in particular, paragraph 9 included specific permits based on labor-market attachment.
residence permit. Prior to the reform, these conditions included completing an integration program and having limited public debt. Under the new rules, in addition to completing the integration course, asylum seekers would now have to pass a language test and hold no overdue public debt. In addition, while a criminal record used to lead to a longer waiting time, a serious criminal record would prevent permanent residency altogether post-reform (Ersbøll and Gravesen, 2010). Obtaining permanent residency was thus made more difficult by the reform.

In addition to the changes in the requirements for being eligible to apply for permanent residency, the 2002 reform package also entailed lower benefit levels, made family reunification more difficult, abolished the de facto status and the possibility to apply for asylum at Danish embassies abroad. We are able to isolate the effect of changes to the eligibility for permanent residency from other parts of the reform package as this was the only component introduced retroactively and it applied to all individuals who lodged their asylum application on or after February 28, 2002 (the date when the new Bill was proposed). The other components of the reform package took effect after the Bill had been passed, on July 1, 2002. For more details about the other components of the reform, see Appendix 2.B.

Another potentially important reform came in 2003, allowing immigrants that had lodged their applications on or after February 28, 2002 to apply for permanent residency already after five years if they were "well integrated", i.e., if they had a strong labor-market attachment and had not relied on social welfare. Furthermore, in case of an exceptionally successful integration, it was possible to receive a permanent permit already after three years of legal residency (Ersbøll and Gravesen, 2010). In terms of our analysis, this implies that the integration motive was made stronger.\footnote{This was an addition to paragraph 11 in the Aliens Act, entered into force as Act no. 425 of June 10 2003, and the formal requirement implies that the applicant should have lived legally in Denmark for at least five years and have been self-supporting with a solid labor-market attachment for the last three years.}

\footnote{During 2002, there were some other important changes to decision practices for}
The key takeaway from the policy change introduced by Act no. 365 of June 6 2002, for our analysis, is that it implied a lower ex-ante probability of being granted permanent residency based on asylum reasons. At the same time, permanent residency could be obtained through labor-market attachment and a potential effect of the reform is therefore that this option became more important. In terms of such incentives, we believe that different groups of refugees may have been differentially affected. In particular, since not all groups are likely to face the same labor-market prospects, the option of securing residency through labor-market attachment will be more realistic for some groups than others. The types of heterogeneity on which we will focus in the empirical analysis are gender and skill levels.

specific refugee groups. These are unrelated to the policy changes studied in this paper, but they are relevant to highlight since they affected the approval rates for specific nationalities. In particular, changes applied to asylum seekers from Afghanistan, Iraq and Kosovo, for whom, following a reassessment of the security situations, the requirements for asylum were made stricter.
2.3 Theoretical Framework

Changes to the probability of being granted permanent residency in Denmark could affect labor-market and education investments in the host country in two opposite directions. On the one hand, an ex ante lower probability of permanent residency based on asylum reasons could increase the incentives to qualify for permanent residency based on labor-market attachment, and thus increase investments in country-specific human capital, for example by acquiring an education. If so, we would expect to see positive effects on educational and/or labor-market outcomes. On the other hand, with a lower probability of staying in the long run, the expected payoff to country-specific investments is lower. The lower probability could, in this case, deter asylum seekers and we would expect to see negative effects on educational and/or labor-market outcomes. A key argument in favor of temporary protection is the idea that it has positive effects on integration. This claim is, however, clearly subject to verification because of these potentially counteracting effects. To shed some light on the mechanisms at work, we set up a search and matching model using the framework laid out in Diamond (1984) and Mortensen and Pissarides (1994), modified to include a choice of whether or not to invest in human capital.\footnote{For studies on investments in host country-specific human capital, see for example Chiswick (1978), Cortes (2004), and Duleep and Regets (1999).}

The theoretical model aims at providing testable predictions and to facilitate the interpretation of our empirical results. The model is intentionally kept as simple as possible to focus on the key questions of interest. In particular, we focus on steady-state analysis. Given the one-time policy changes undertaken in Denmark, it would be relevant to also solve for transitional dynamics, whereby job-finding rates would change over time until they reach a new steady state. We conjecture that the transition dynamics in this model are rather fast, but an examination of this conjecture is left for future research. We thus solve the steady-state model to obtain endogenous expressions for wages, labor-market
conditions and the decision of whether or not to invest in education. Performing comparative statics then allows us to study the response of these variables to a policy change similar to the Danish reform of 2002.

2.3.1 A search and matching model with human capital investments

In our model, individuals are either educated or uneducated. Educated workers are considered high-skill, indexed $H$, and uneducated workers are considered low-skill, indexed $L$. The different skill levels $S$, with $S \in \{H, L\}$, correspond to productivity levels $y^H > y^L$.\footnote{See Bennett et al. (2015) for a model where firms supply jobs for both immigrants and natives.} We make the simplifying assumption that there are separate markets for high- and low-skilled workers. We further assume that refugees may be in a temporary or a permanent state, corresponding to residency $R$, with $R \in \{T, P\}$. Therefore, we have four different markets in total corresponding to the different combinations of $S$ and $R$.

The type of productivity we have in mind is host-country specific and we assume that the value of being in the host country is larger than the value of being in the home country, as this is consistent with the asylum seeker fleeing the home country. Therefore, we can disregard the home country in the model. As refugee seekers may lose temporary residency – something which became, ex ante, even more likely following the reform of 2002 – we allow for an exogenous probability of being deported from the host country. Increasing this parameter and examining the impact on employment and education is a key objective of the model. If the individual is deported, she gets nothing. Firms supply $v^S_R$ vacancies and the unemployment rates are given by $u^S_R$. The matching function is given by $M^S_R = (v^S_R)^{\alpha}(u^S_R)^{1-\alpha}$, where $M^S_R$ is the number of matches in residency state $R$ and for skill level $S$, and $\alpha \in (0, 1)$ is the match elasticity with respect to vacancies. The transition rate for an unemployed refugee worker of skill level $S$ into employment in residency state
R is then given by \( f^S_R(\theta^S_R) = (\theta^S_R)^\alpha \), where \( \theta^S_R = v^S_R/u^S_R \) is labor-market tightness. Firms’ transition rates are given by \( q^S_R(\theta^S_R) = (\theta^S_R)^{\alpha - 1} \). We turn to the value functions of workers and firms. Let \( U^S_T \) and \( E^S_T \) denote the expected present values of unemployment and employment in the temporary state. The value functions are then given by:

\[
rU^S_T = f^S_T(E^S_T - U^S_T) + \rho_U^S(U^S_P - U^S_T) - \Gamma(S)c(e) - (a + d_U)U^S_T, \tag{2.1}
\]

\[
rE^S_T = w^S_T + \sigma(U^S_T - E^S_T) + \rho_E^S(E^S_P - E^S_T) - \Gamma(S)c(e) - (a + d_E)E^S_T, \tag{2.2}
\]

where \( r \) is the exogenous discount rate, \( \rho_U^S \) and \( \rho_E^S \) are the probabilities of moving from the temporary to the permanent state as unemployed and employed, respectively, \( \Gamma(S) \) is an indicator variable which takes the value of one if the worker acquires and maintains education and zero otherwise, \( c(e) \) is the cost of acquiring education, \( a \) is the exogenous transition rate out of the labor force, \( d_U \) and \( d_E \) are the probabilities of being deported while unemployed or employed, and \( w^S_T \) is the sectoral wage (i.e., the wage for a given skill level and residency status). The value function for an unemployed individual in the temporary residency state, \( rU^S_T \), then consists of the sum of the expected value of transitioning into employment, into permanent unemployment minus the loss from being deported (or exiting the labor force), and the cost of investing in education (if the individual chooses to do so). For an employed individual in the temporary state, the value function, \( rE^S_T \), instead consists of the wage in the current period, the expected value of losing the job and transitioning into unemployment and the expected value of becoming employed in the permanent sector, minus the loss from the risk of exiting the labor force or being deported, and the cost of investing in education (if that applies).

We assume that individual workers, indexed \( i \), have different abilities,
2.3. THEORETICAL FRAMEWORK

e_i$, and therefore face different costs of obtaining education, \( c(e_i) \). The variable \( e_i \) is assumed to be uniformly distributed, \( e_i \in [0, 1] \), and the costs are decreasing in ability at a decreasing rate, \( c'(e_i) < 0 \) and \( c''(e_i) > 0 \). Furthermore, in order to guarantee a non-trivial solution where some, but not all, individuals choose to acquire an education, we assume that the individual with the highest ability faces a very low cost of education, \( c(1) = 0 \), and the individual with the lowest ability faces a very high cost of education, i.e., \( \lim_{e_i \to 0} c(e_i) = \infty \). Hence, \( \Gamma(H) = 1 \) and \( \Gamma(L) = 0 \).\(^{13}\)

For the permanent state, the values of unemployment and employment are instead determined by:

\[
\begin{align*}
    rU_P^S &= f_P^S(E_P^S - U_P^S) - \Gamma(S)c(e) - aU_P^S, \quad (2.3) \\
    rE_P^S &= w_P^S + \sigma(U_P^S - E_P^S) - \Gamma(S)c(e) - aE_P^S, \quad (2.4)
\end{align*}
\]

where \( w_P^S \) is the wage in the permanent state for skill group \( S \). The difference as compared to the temporary residence state is that individuals no longer face the risk of being deported, and they do not need to take into account the probability of transitioning to the permanent state. From the firm's perspective, we let \( J_T^S \) and \( V_T^S \) represent the expected present value of an occupied job and a vacant job in the transitory state. The value functions for a job paying the wage \( w_T^S \) and a vacant job are then:

\[
\begin{align*}
    rJ_T^S &= y^S - w_T^S + \sigma(V_T^S - J_T^S) + \rho_E^S(J_T^P - J_T^S) - (a + d_E)J_T^S, \quad (2.5) \\
    rV_T^S &= q_T^S(J_T^S - V_T^S) - k, \quad (2.6)
\end{align*}
\]

where \( k \) are hiring costs. The value of a filled position is then equal to the

\(^{13}\) We assume that the educational switching does not occur in steady state. The assumption that the education cost is borne every period is a simplifying assumption and is not important for the results.
productivity gain minus the wage paid, plus the expected value of that job instead turning into a vacancy or a permanent position, minus the risk of the worker exiting the labor force or being deported. The value of a vacancy is given by the probability of that vacancy turning into a filled position minus hiring costs. For firms in the permanent state we instead have:

\[ rJ_S^P = y_S^P - w_P^S + \sigma(V_P^S - J_P^S) - aJ_P^S, \]  
\[ rV_S^P = q_P^S(J_P^S - V_P^S) - k. \]  

(2.7)  

(2.8)

The difference now is that firms no longer risk losing their workers because of deportation (and they do not need to take into account transition into the permanent state). Free entry implies \( V_S^R = 0 \) and we can therefore rewrite equations (2.6) and (2.8) as:

\[ \frac{k}{q_R^S} = J_R^S. \]  

Wages

Wages are determined in Nash Bargaining where workers and firms have equal bargaining power.\(^{15}\) Wages are then determined by the maximization problem:

\[ \max_{w_R^S} \left( E_R^S - U_R^S \right)^{0.5} \left( J_R^S - V_R^S \right)^{0.5}, \]  

(2.9)

\(^{14}\)To see this, simply use equations (2.6) and (2.8) together with the free entry condition to set:

\[ 0 = q_T(J_T^S - 0) - k \quad \rightarrow \quad J_T^S = \frac{k}{q_T^S}, \]  

\[ 0 = q_P(J_P^S - 0) - k \quad \rightarrow \quad J_P^S = \frac{k}{q_P^S}. \]

\(^{15}\)Note that we consider a labor market consisting only of refugees. We believe that refugees in general face different labor-market conditions than natives, and that this might be reflected in the wage setting process. To simplify the analysis, however, we assume equal bargaining powers in the labor market that refugees face.
2.3. THEORETICAL FRAMEWORK

with the first-order condition \( E_R^S - U_R^S = J_R^S - V_R^S \). For the permanent state, we use equations (2.1)-(2.6) and assume free entry. Furthermore, in the baseline case, we assume that the risk of being deported is the same for individuals who are employed and unemployed, i.e., \( d_E = d_U = d \). Then, we can look at the impact of a change in the deportation rate in Section 2.3.1. We make the simplifying assumption that \( \rho_E^H = \rho_U^H \). The rationale behind this is that despite the general increase in the number of years before an immigrant could apply for permanent residency, some special conditions were in place for workers. Hence, since they empirically have a higher unemployment rate, uneducated workers were worse off than educated workers, in particular if they happened to be unemployed.

We arrive at the following expression for wages in the permanent state:

\[
w_P^S = 0.5(y^S + k\theta_P^S). \tag{2.10}
\]

From this expression, we see that wages are increasing in labor-market tightness and in productivity. For the transitory state, we arrive at a slightly more complicated expression for wages:

\[
w_T^S = 0.5 \left( y^S + \frac{r + a + d + \rho_E^S k\theta_T^S - (\rho_E^S - \rho_U^S)}{r + a + d + \rho_U^S} \frac{r + a + d}{r + a + d + \rho_U^S} k\theta_P^S \right), \tag{2.11}
\]

which is also increasing in productivity.\(^{17}\)

\(^{16}\)This follows from:

\[
\left( E_R^S - U_R^S \right)^{0.5} \left( J_R^S - V_R^S \right)^{0.5} \left[ 0.5 \frac{1}{E_R^S - U_R^S} \frac{dE_R^S}{dw_R} + 0.5 \frac{1}{J_R^S - V_R^S} \frac{dJ_R^S}{dw_R} \right] = 0,
\]

\[
\left( E_R^S - U_R^S \right)^{0.5} \left( J_R^S - V_R^S \right)^{0.5} \left[ 0.5 \frac{1}{E_R^S - U_R^S} \cdot 1 + 0.5 \frac{1}{J_R^S - V_R^S} \cdot (-1) \right] = 0.
\]

\(^{17}\)For educated workers, as we assume \( \rho_E^H = \rho_U^H \), we can simplify to obtain:

\[
w_T^H = 0.5(y^H + k\theta_T^H). \tag{2.12}
\]
CHAPTER 2. SHOULD I STAY OR MUST I GO?

Labor-market tightness

Next, we turn to labor-market tightness, \( \theta^S_R \), which is defined as vacancies relative to the unemployment rate. Here, we derive expressions for the transitory and permanent state in reduced form, i.e., we solve for expressions in terms of exogenous parameters and the endogenous labor-market tightness. For the temporary state, we use equations (2.5)-(2.6) and assume free entry, i.e., \( \frac{k}{q^S_R} = J^S_R \), to arrive at the following expression (in terms of \( \theta^L_T \) and exogenous parameters) for uneducated workers:

\[
(r + a + \sigma + \rho^L_E + d)2k(\theta^L_T)^{1-\alpha} = \left( \frac{r + a + \sigma + \rho^L_E}{r + a + \sigma} \right) y^L - \frac{r + a + d + \rho^L_E}{r + a + d + \rho^L_U} k \theta^L_T + \left( \frac{\rho^L_E - \rho^L_U}{r + a} \right) \frac{r + a + d}{r + a + d + \rho^L_U} - \frac{\rho^L_E}{r + a + \sigma} \theta^L_P,
\]

(2.13)

and for educated workers:

\[
(r + a + \sigma + \rho^H_E + d)2k(\theta^H_P)^{1-\alpha} = \left( \frac{r + a + \sigma + \rho^H_E}{r + a + \sigma} \right) y^H - \frac{\rho^H_E}{r + a + \sigma} k \theta^H_P.
\]

(2.14)

For the permanent state, we instead obtain:

\[
(r + a + \sigma)2k(\theta^S_P)^{1-\alpha} = y^S - k \theta^S_P.
\]

(2.15)

We can show that the labor-market tightness facing workers with temporary status is lower than the labor-market tightness facing workers with permanent status, \( \theta^S_T < \theta^S_P \). This is then consistent with a higher employment rate for permanent workers than temporary permit workers. The reason is that the firm supplying vacancies to temporary permit workers faces a lower duration of a potential match and therefore supplies fewer vacancies for a given pool of unemployed job seekers. In Appendix 18The details are available upon request.
2.3. THEORETICAL FRAMEWORK

We show that labor-market tightness, $\theta_{ST}^S$, increases in $\rho_{SE}^S$ and decreases in $\rho_{SU}^S$. Furthermore, wages, $w_{ST}^S$, are increasing in $\rho_{SU}^S$ whereas the effect of a change in $\rho_{SE}^S$ on wages is indeterminate.$^{19}$

Education

We now turn to the human capital investment decision: whether or not to invest in education. For simplicity, we consider workers with a temporary status, which is the main state of interest in the empirical part of the paper. When a worker makes this decision, she compares the value of unemployment as an educated worker, bearing the associated costs of education, to the value of unemployment as an uneducated worker. The marginal worker has the ability level, $\hat{e}$, which makes her indifferent between acquiring higher education and remaining an uneducated worker. We write the condition determining the ability level of the marginal worker as:

$$rU_T^H(\hat{e}) = rU_T^L. \quad (2.16)$$

Workers proceed to higher education if the expected income gains from education exceed the cost of education.$^{20}$ We rewrite equation (2.1) and subtract this expression from equation (2.3), and use the free entry condition to arrive at the following rewritten expression for (2.16):

$$\left\{ \left( r + a \right) \theta_T^H + \rho_{UT}^H \theta_P^H - \frac{r + a + d + \rho_{UT}^S}{r + a + d + \rho_{UT}^L} \left( (r + a) \theta_T^L + \rho_{UT}^L \theta_P^L \right) \right\} \frac{k}{r + a + \rho_{UT}^L} = c(\hat{e}). \quad (2.17)$$

$^{19}$We also note that labor-market tightness decreases when the deportation rate, $d$, increases. The same is true for wages. The intuition behind this result is that a higher deportation rate decreases the value of a match, and therefore worsens the labor-market conditions (and decreases the labor-market tightness). The same intuition applies to wages.

$^{20}$Note that this cost can be a monetary or a time cost. Here we think of it as a monetary cost.
Condition (2.17) determines $\hat{e}$ as a function of exogenous parameters and the endogenous variables, $\theta^S_T$ and $\theta^S_P$ for $S \in \{H, L\}$. Workers with ability level $e_i$ below the threshold level, $e_i \leq \hat{e}$, choose not to invest in education, whereas workers with $e_i > \hat{e}$ choose to go to school. Hence, $\hat{e}$ and $(1 - \hat{e})$ constitute the uneducated and educated labor forces, respectively. The right-hand side of equation (2.17) is the expected income gain of investing in education. This gain needs to be positive in order for at least some workers to proceed to higher education. The fact that productivity is higher for educated workers means that there is an educational wage premium which, in turn, provides incentives for higher education as well as a higher probability of getting a job.

**Impact of a policy change**

Finally, we turn to the impact of a policy change on employment and education. We will consider three different cases, all consistent with the law change and giving us testable predictions to take to the data. As mentioned above, despite the general increase in the number of years before an immigrant could apply for permanent residency, some special conditions applied to workers. Hence, uneducated workers were worse off than educated workers as they have a lower probability of obtaining employment than educated workers. In the first case, we therefore assume that the likelihood of obtaining permanent residency decreases for uneducated and unemployed individuals only, so that $d\rho_{LU}^L < 0$. In the second case, we consider the impact of a decrease in the likelihood of obtaining a permanent permit for employed uneducated workers, $d\rho_{LU}^E < 0$. Finally, to capture a related implication of the law change, namely that the probability of also losing a temporary permit increased, we consider an increase in the deportation risk, $dd_E = dd_U = dd > 0$.

**Case 1.** If $d\rho_{LU}^L < 0$, the likelihood of obtaining permanent residency decreases only for the unemployed, uneducated individuals. In this case, education increases. There are two counteracting forces at play. First, the relative value of being educated (and unemployed) increases as the value
of being uneducated and unemployed decreases. This increases the value of obtaining an education. Second, there is an increase in the labor-market tightness for the uneducated workers because their wages fall, which increases employment (they will be more eager to have a job when the value of being unemployed falls). This effect tends to reduce the number of individuals that acquire an education. The former effect dominates the latter, implying that more individuals invest in education.

Case 2. If $d \rho^E_L < 0$, the likelihood of obtaining a permanent residency for employed uneducated workers diminishes. A lower probability of permanent residency reduces labor-market tightness, and thus employment, for this group of workers. This is because the match between a worker and a firm will last for a shorter period of time. The negative impact on labor-market tightness dominates (the effect on wages is indeterminate) and the incentives to acquire an education become stronger, which increases education.

Case 3. Finally, if $\rho^S_E = \rho^S_U$, for $S \in \{H, L\}$, we can look at the impact of $dd > 0$, i.e., an increase in the deportation rate. The value of unemployment falls when the probability of losing a temporary permit increases equally for both educated and uneducated workers. Fewer vacancies are supplied and the labor-market tightness falls for both skill groups, which reduces employment. The impact will be stronger for educated workers because of their higher productivity and thus fewer individuals acquire an education.

As pointed out above, our analysis abstracts from the fact that the intensity of the effects may differ across time. In our empirical design, we are interested in changes to behavior that occur over time. Specifically, we look at outcomes over time after approval and compare individuals

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21As shown in, for example, the literature on effects of unemployment insurance (UI) on unemployment duration, where duration dependence can be expected to matter. See for example Nekoei and Weber (2017) where extended UI benefits are found to lengthen unemployment, but also improve matching (measured in terms of wages). Rosholm and Toomet (2005) is an example allowing for discouragement.
facing different spells under temporary protection. Dynamic effects will therefore be informally discussed further in Section 2.5.
2.4 Empirical Strategy

In this section, we describe our data sources and the empirical strategy used for the analysis.

2.4.1 Data

Our main data set is register data collected by Statistics Denmark. For the purpose of this study, we combine two sources of Danish micro data. First, from Statistics Denmark we have register data on a broad set of outcomes for all immigrants in Denmark 1997-2015. This data set includes all immigrants who were registered as living in Denmark on January 1 in any of the years 1997 to 2015, which means that we can follow the individuals in our sample up until twelve years after their initial application for asylum was approved. Second, using unique register data from the Danish Immigration Service we observe, for each individual, the type of residence permit held as well as dates of application and approval. Using individual identifiers, this data can be linked to our main data set and enables us to define relevant treatment and control groups, as discussed in more detail in Section 2.4.2. Our main variables of interest include educational investments and labor-market outcomes. We study enrollment defined as the share of individuals that, at some point during the twelve years of data that we observe, enroll in general education or in education at the university level.\textsuperscript{22} In terms of labor-market outcomes, we focus on employment status and labor earnings (including earnings from self-employment). Employment status is defined as the share of individuals that are registered as employed (or self-employed) at some point during the twelve years that we observe, whereas earnings are measured after three and seven years of residency in Denmark in our benchmark (in our sensitivity analysis, we also consider earnings in each individual year in the sample).\textsuperscript{23}

From the register data, we also collect information on demographic\textsuperscript{22}The data comes from the educational registers UDDA and VEUV.\textsuperscript{23}The data comes from the INK and RAS registers.
characteristics, specifically age, gender, nationality, marital status, and the number of children in the household, to be used as control variables in the analysis.\footnote{These variables are from the population register (BEF). To determine marital status on arrival, we assume that if the date of the first change in marital status is missing, the change must have happened before arriving in Denmark (or it would have been recorded). Children at arrival is defined by considering all children born before the application year and associated with the first family identifier available in the registers after the first asylum application.} In addition, from the educational registers, we impute two different measures of skill level at arrival. First, we use the highest level of education completed before arrival in Denmark (primary/secondary or higher).\footnote{Primary/secondary education includes early childhood education and primary education as well as lower and upper secondary education. Higher education captures university studies (short cycle tertiary, bachelor, master and doctoral).} Second, we use the entry level of Danish language courses (1, 2, or 3), because the entry level is determined by the individual’s skill level.\footnote{Level 1 is for students with no or limited educational background, or those who are considered to have limited learning abilities because of trauma, level 2 is for students with some (normal) educational background and level 3 is for students with higher education (who often speak several languages).} These measures of initial skill level are used both as control variables and to split the sample in order to study heterogeneous effects.\footnote{All information on education comes from the two registers UDDA and VEUV.}

Sample restrictions We remove individuals lacking information on application date, and those who applied for asylum before November 1, 2001 or after June 30, 2002. Without information on the application date, we are not able to identify our relevant control and treatment groups. Figure 2.1 shows a timeline of the period of interest and the way we split our sample into a control and a treatment group. Our control group is defined as individuals applying for asylum between November 1, 2001 and February 27, 2002, while the treatment group includes individuals applying between February 28 and June 30, 2002. The sample split is chosen to ensure that nothing else is happening that would affect those applying prior to and post the cutoff differentially. As described in Section 2.2.1, there were several components to the 2002 reform, apart from
2.4. EMPIRICAL STRATEGY

the prolonged waiting time for permanent residency. To avoid confounding effects from these other components, which mainly relied on the date of approval, we also restrict our sample to individuals whose applications were approved after July 1, 2002. The reason for this restriction is that we want to compare asylum holders who only differ in terms of which rules regarding permanent residency they are subject to, and not in any other dimensions. The reform included changes to, for example, the benefit structure. Due to long processing times, this restriction on the approval date does not reduce our sample to any considerable extent. Figure 2.2 shows the fraction of individuals in 2001 and 2002 whose applications were approved post July 1, 2002, by month of application. We also exclude individuals lodging their application from abroad.28 Throughout the paper, the unit of analysis is the individual. Finally, because we are interested in educational and labor-market outcomes, we focus on individuals who are between the age of 16–60 at the time of application.

Figure 2.1: Overview of the time period of interest

28 This means dropping three individuals that would otherwise have been included in the control group.
Figure 2.2: Fraction granted asylum post July 1, 2002, by month of application 2001-2002

2.4.2 Identification

The implementation of the reform implies that refugees who applied for asylum prior to February 28, 2002 (henceforth referred to as the cutoff) were able to apply for permanent residency three years after approval, whereas those who applied after the cutoff had to wait for seven years. The fact that this reform was implemented retroactively gives rise to a Regression Discontinuity in Time setting with no possibility of manipulation around the cutoff. The decision about the reform was taken on June 6, 2002 and took effect on July 1, 2002 - but the part of the reform that we are studying applied retroactively to everyone who applied from February 28, 2002 onwards. This means that neither immigrants nor the decision makers at the DIS could have perfectly manipulated the date of application in order to achieve a certain treatment. Intuitively, individuals who applied just before the cutoff should therefore be comparable to individuals who applied just after the cutoff.

Looking at aggregate statistics from The Danish Immigration Service (2003) in Figure 2.3, we conclude that there is no major change in the number of lodged asylum applications in Denmark from February to March 2002. In our data, we observe only individuals whose asylum applications were subsequently approved. Figure 2.4 shows the number of
approved applications by month of application and type of asylum during 2002. Once more, we see no notable change in the number of approvals around the cutoff. As we observe the actual date of application, we also present a histogram of the number of granted asylum applications using the week of application in Figure 2.5.\textsuperscript{29} The absence of a spike in the density of applications made just before the cutoff is in line with our intuition as the reform was implemented retroactively, leaving no room for manipulation.\textsuperscript{30}

\textit{Figure 2.3: Asylum applications lodged in Denmark, by month of application 2001-2002}

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{asylum_applications_lodged.png}
\caption{Asylum applications lodged in Denmark, by month of application 2001-2002}
\end{figure}

\textit{Data source:} The Danish Immigration Service (2003).

\textsuperscript{29}We aggregate to the weekly level to comply with the micro data policy of Statistics Denmark.

\textsuperscript{30}In Table 2.6, we present the results from a formal test of manipulation at the cutoff using the Stata package \texttt{rddensity}. We implement this test for a linear and a quadratic specification. For the linear specification, we obtain a p-value of 0.121 while the quadratic specification results in a p-value of 0.935.
Figure 2.4: Number of approved applications, by normalized month of application and type of asylum 2001-2002

Data source: UDLST.

Figure 2.5: Density of running variable
Approved applications lodged November 2001 to June 2002

Notes: Week 17 excluded, due to too few observations (n < 5), to comply with the rules of Statistics Denmark.

In the regression discontinuity framework, treatment effects are identified by estimating the magnitude of the discontinuity at the cutoff. While the
sharp cutoff implied by the reform intuitively lends itself to the regression discontinuity approach, ideally one would want to compare individuals on each side close to the cutoff. As Denmark approves a relatively small number of asylum seekers, we have to use a relatively broad bandwidth of four months on each side of the cutoff (119 days between November 2001 to June 2002). This leads the attention to the inherent trade off between precision and bias in the regression discontinuity framework. Extending the bandwidth around the cutoff increases the precision, but also the risk of introducing a bias. As our running variable is the date of application, we have to estimate treatment effects parametrically in order to avoid confounding time-varying effects. The regression equation is specified as:

\[ Y_i = \alpha + \beta T_i + h(x_i) + T_i h(x_i) + Z_i + \epsilon_i, \]  

(2.18)

where \( Y_i \) is the outcome of individual \( i \), \( x_i \) is the normalized date of application such that February 28, 2002, is set to zero and \( h(\cdot) \) is a continuous function of the date of application, \( T_i \) is an indicator for treatment status with \( T_i = 0 \) if \( x_i < 0 \) and \( T_i = 1 \) otherwise, and \( \epsilon_i \) is the error term. We include an interaction between \( h(x_i) \) and the treatment indicator \( T_i \), to allow for different trends over time on each side of the cutoff. \( \beta \) is the coefficient of interest measuring the effect of being subject to the new rules on permanent residency. In our main specification, \( h(\cdot) \) is specified as a linear function. In Section 2.6, we vary the order of this polynomial to test the robustness of our results. Furthermore, all specifications are estimated with and without a vector of predetermined individual characteristics, \( Z_i \), to increase efficiency and confirm that covariates do not affect the point estimates.\(^\text{31}\)

For the graphical representation (Figures 2.9–2.10), we plot the mean

\(^\text{31}\)Although it has been standard practice in regression discontinuity designs to cluster on the running variable, we choose to follow Kolesár and Rothe (2016) and abstain from clustering using only robust standard errors. We have repeated all estimations for the full sample with clustering on the running variable and find that not clustering is the more conservative approach for all outcomes. Results from estimations where standard errors are clustered are available upon request.
of each outcome for evenly spaced bins of the running variable. For each plot, we fit a global linear polynomial, $h$, to approximate the population CEF, using a uniform kernel and evenly spaced bins.\footnote{These plots are produced using the Stata package \texttt{rdplot}; for more details, see Sebastian Calonico and Titunik (2014). Graphs using a quadratic polynomial for our main outcomes are available upon request.} For all plots, we use the full bandwidth of 119 days and we do not include covariates. We also present similar graphs of predetermined characteristics to substantiate the continuity assumption underlying the regression discontinuity framework; see Figures 2.6–2.8 in Section 2.9. In terms of predetermined characteristics, we study demographic characteristics and educational background. For demographic characteristics, we look at the fraction of males, household characteristics and average age, as well as nationality. For educational background, we investigate both a self-reported measure of the highest level of education achieved and the level of Danish studies to which the individual is assigned. The reason we consider these characteristics is that they are predetermined variables that we believe may impact how individuals are affected by the reform. We find significant discontinuities in terms of nationalities. There is a positive jump for the category other nationalities (of 0.175) and a negative jump for Afghans (-0.128).\footnote{Other nationalities is defined as a dummy equal to one if the individual is not from one of the most common countries of origin: Afghanistan, Former Yugoslavia, Iraq, or Somalia.} There is a marginally significant discontinuity in the share of males (0.136). We also estimate labor earnings one year after approval by regressing labor earnings on predetermined characteristics. Then, we estimate the regression discontinuity using the predicted values for earnings and do not find any discontinuities in this variable.

Table 2.1 compares means of predetermined characteristics for the control and treatment group as well as their normalized difference.\footnote{See Imbens and Woolridge (2009) for a motivation for using the normalized difference. The measure is defined as: 
\[ nd = \frac{\bar{x}_t - \bar{x}_c}{\sqrt{(s^2_{t} + s^2_{c})/2}} \]}

\[ nd = \frac{\bar{x}_t - \bar{x}_c}{\sqrt{(s^2_{t} + s^2_{c})/2}} \]
The normalized difference gives us a scale-invariant measure of the magnitude of the difference between groups. We consider differences above 0.25 to indicate sizable differences. We note that the groups are generally well balanced over the whole 8 month period that defines our sample of interest. Once more, the biggest differences arise in terms of nationalities: there are more Iraqis in the control group and more individuals from the category other nationalities in the treatment group. In addition, there are fewer males in the treatment group. Apart from these variables, the two groups seem balanced. However, as a small sample size is challenging in a regression discontinuity framework, we complement our analysis by looking at differences in average outcomes over time, by treatment status.

### Table 2.1: Comparison of means (bw 119 days)

<table>
<thead>
<tr>
<th>demographic characteristics</th>
<th>(1) Control</th>
<th>(2) Treatment</th>
<th>(4)=(1) Normalised difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>0.54</td>
<td>0.43</td>
<td>-0.22</td>
</tr>
<tr>
<td>(0.50)</td>
<td>(0.50)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of children</td>
<td>1.71</td>
<td>1.57</td>
<td>-0.15</td>
</tr>
<tr>
<td>(1.99)</td>
<td>(2.03)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partner</td>
<td>0.51</td>
<td>0.56</td>
<td>0.05</td>
</tr>
<tr>
<td>(0.50)</td>
<td>(0.50)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age at application</td>
<td>31.00</td>
<td>31.47</td>
<td>0.47</td>
</tr>
<tr>
<td>(9.10)</td>
<td>(9.72)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Danish 1</td>
<td>0.21</td>
<td>0.24</td>
<td>0.07</td>
</tr>
<tr>
<td>(0.41)</td>
<td>(0.43)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Danish 2</td>
<td>0.40</td>
<td>0.36</td>
<td>-0.08</td>
</tr>
<tr>
<td>(0.40)</td>
<td>(0.48)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Danish 3</td>
<td>0.27</td>
<td>0.27</td>
<td>0.00</td>
</tr>
<tr>
<td>(0.45)</td>
<td>(0.45)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary or secondary</td>
<td>0.45</td>
<td>0.47</td>
<td>0.02</td>
</tr>
<tr>
<td>(0.50)</td>
<td>(0.50)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Higher</td>
<td>0.24</td>
<td>0.22</td>
<td>-0.05</td>
</tr>
<tr>
<td>(0.43)</td>
<td>(0.42)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country of origin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Afghanistan</td>
<td>0.34</td>
<td>0.30</td>
<td>-0.09</td>
</tr>
<tr>
<td>(0.48)</td>
<td>(0.46)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iraq</td>
<td>0.19</td>
<td>0.10</td>
<td>-0.20</td>
</tr>
<tr>
<td>(0.39)</td>
<td>(0.39)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Former Yugoslavia</td>
<td>0.10</td>
<td>-0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>(0.31)</td>
<td>(0.36)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Somalia</td>
<td>0.17</td>
<td>0.13</td>
<td>-0.04</td>
</tr>
<tr>
<td>(0.37)</td>
<td>(0.33)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>0.19</td>
<td>0.32</td>
<td>0.23</td>
</tr>
<tr>
<td>(0.40)</td>
<td>(0.47)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: Values in parenthesis are (s.d.). Demographic characteristics are measured at application. Danish 1 - Danish 3 indicate the level of Danish courses assigned at approval, whereas primary or secondary and higher education indicates the level of education acquired prior to applying for asylum in Denmark. The normalized difference is defined as $$\frac{\hat{x}_t - \hat{x}_c}{\sqrt{sd_t^2 + sd_c^2}/2}$$. 


Heterogeneous effects To capture potential heterogeneity in response to the reform, we split the sample by (i) level of education at arrival (below/above university level, henceforth referred to as low/high skilled) and (ii) gender (males/females). The reform may have had a different impact on different groups of refugees since differences in access to the labor market could determine how much they were able to affect their probability of being granted residency based on labor-market attachment. These aforementioned sample splits can capture important differences in terms of labor-market access. Related to our theoretical model, we believe that these groups may also differ in their cost of acquiring education in the host country. Other potentially interesting sample splits would be to look at age groups and country of origin, but splitting the sample along these dimensions is not feasible due to the sample size and the distribution of these variables. For the subgroup analysis, we split the sample by subgroup and estimate equation 2.18.

\footnote{We check the overlap between these groups and note the following. Around 47 percent of the females are classified as low skilled, and around 22 percent as high skilled. Among males the division is similar with 43 percent of the men classified as low skilled and 26 percent classified as high skilled. For around 30 percent of both males and females we do not observe skill level at arrival. The correlation between gender and skill level is 0.07.}
2.5 Results

This section presents and discusses our empirical findings. We present both graphical evidence and estimates from the regression analysis. The graphical evidence is based on the estimated discontinuity at the cutoff date. For these figures, we always use a bandwidth of 119 days on each side of the cutoff and we do not include any covariates. For the regression analysis, we present results with and without covariates for the benchmark bandwidth of 119 days.

2.5.1 Educational outcomes

Human capital investments can be viewed as part of the integration process. Table 2.2 shows our estimated results for the full sample as well as for the subgroups based on gender and skill level. First, we look at enrollment in formal education. This variable measures the share of individuals that, at some point during the twelve years we observe in our data, enroll in any type of formal education (primary, secondary or university). Columns (1) and (2) show the estimated coefficients with and without covariates for the full sample. We estimate an increase of around 17 percentage points at the cutoff. The effect is significant at the 5 percent level when controls are excluded and at the 1 percent level in the specifications including controls. Panel (a) in Figure 2.9 confirms this picture and we observe a clear jump at the threshold. Turning to the subgroups analyzed in columns 3-10, we see that the effect is driven by females and, to a lesser degree, low-skilled individuals. For females, the estimated effect is an increase of 22 percentage points at the cutoff, significant at the 5 percent level for the specification with covariates (the effect is slightly stronger when covariates are excluded). Next, we estimate the effect on enrollment at the university level. This variable measures the share of individuals that enroll in university education at some point in time during the twelve years that we observe. The estimated coefficient is positive at around 6 percentage points but not significant (for the low skilled, the estimated coefficient is around 11 percentage points and significant at
the 10 percent level). Panel (a) of Figure 2.11 shows the evolution of enrollment rates over time. Here we look at the share of individuals that are enrolled in education in a specific year (through a fitted quadratic polynomial with 95 percent confidence intervals). This shows that the treatment group does have overall higher enrollment rates over time for general education. Finally, in panel (a) in Figure 2.21, we look at the estimated effect at the cutoff for enrollment in education in each year after arrival, separately. We note that the effect, if anything, appears to grow stronger over time.

We interpret the positive effect on enrollment in education as an increased investment in human capital and integration. However, for the integration to be successful, it is relevant to assess what enrollment results in. Therefore, we also consider different types of education that might be particularly relevant for access to the labor market (adult education and labor-market training), the propensity to complete an education, and the number of years in education (throughout, we exclude Danish courses which are mandatory for both groups). We do not find any significant effects on any of these variables. For females, who show the largest increase in the propensity to be enrolled in education, we find support for a higher propensity to be classified as a student in the long run (measured seven years after approval). This implies that women are more likely to be students as compared to working or being unemployed and could indicate that females substitute work for education in order to boost their human capital. Alternatively, females could be having a harder time gaining access to the labor market and enroll in education by necessity rather than choice.

Our findings for enrollment are in line with the hypotheses in Case 1 and Case 2 from our theoretical model, i.e., that the change in the ex-ante probability of obtaining a permanent residence permit was especially

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36 We also test for the difference in means between the control and treatment group. There is a marginally significant difference between the two groups for enrollment in general education, with higher enrollment rates for the treatment group.
37 The results are available upon request.
pronounced for low skill individuals or those further away from the labor market. We believe that females are, if anything, likely to be less attached to the labor market than males. Thus, our findings, with strong effects among females and the low skilled, are in line with the theoretical model. If the only change implied by the reform had been an increase in the deportation rate, as in Case 3, we would instead have expected a decrease in enrollment. We now turn to direct measures of labor-market outcomes.

2.5.2 Labor-market outcomes

Labor-market outcomes are direct measures of attachment to the labor market which makes them highly important. Furthermore, in the previous section, we did not find any significant effects of the reform on human capital investments for males. This could be because they instead find jobs to a greater extent, which makes it important to look at labor-market outcomes also for subgroups. We consider whether an individual was ever employed (including self-employment) in Denmark and look at labor earnings after three and seven years of residency. Employment is defined as the share of individuals (in the treatment and control group) that are ever employed or self-employed during the twelve years following their initial approval of asylum. Table 2.3 shows the estimated regression results for the full sample and our four subgroups. In addition, panels (c)-(e) in Figure 2.9 show the graphical presentation of our results. For the full sample, we do not find any significant effects on employment or earnings. When we look at earnings conditional on employment, we find a marginally significant negative effect when including controls (these results are available upon request). All coefficients are negative but imprecisely estimated. The graphical evidence also reveals a small decrease, but there are no indications of a sizable and significant negative effect. Turning to the subgroups, the picture is very similar to the results for the full sample. However, females (and to some extent the high skilled) exhibit a significant decrease in earnings. This is consistent with more females being enrolled in education. For males, who were not more likely
to enroll in education, there is no significant effect on any of the labor-market outcomes. Figure 2.12 confirms this picture looking graphically at employment and earnings for each year and in Figure 2.21 we estimate the coefficients for each of the different years after arrival. The conclusions remain. If anything, there are signs of a more negative impact on earnings in later years. To try to understand the potential mechanisms, Figure 2.13 looks at the fitted quadratic polynomial over time for earnings conditional on employment in the different subgroups (since the subgroups are small already before conditioning on employment, we do not estimate regressions for this outcome variable). We note a difference in that earnings for women who are employed appear to be very similar in both groups, whereas there is a divergence for the high-skilled individuals with the control group experiencing stronger earnings over time. Interestingly, the divergence between the control and the treatment group appears 3–5 years after approval for this subgroup. This is around the time when individuals in the control group are eligible to apply for permanent residency status and is in line with high-skilled individuals in the treatment group accepting jobs with lower earnings compared to the control group. This could be a sign of weaker bargaining power of the individuals in the treatment group or that employers are more reluctant to invest in individuals whose future in the country (and thus also in the firm) is more uncertain. This is consistent with Case 3 in our model, where employment falls for both educational groups.

We also look at the highest skill level ever achieved in the labor market during the years we observe (more details on skill level in Appendix 2.D.1) and the number of times an individual changes workplaces. We find no difference in the number of times individuals change workplaces during the twelve years we observe them in Denmark but they generally appear to do so at a decreasing rate over time (which is consistent with a more stable labor-market attachment). For high-skilled individuals, we estimate a weakly significant negative effect on the highest skill level achieved on a job. This could imply that the high skilled accept jobs for which they are potentially over-qualified. We conclude that the increased
enrollment in education does not seem to have translated into improved labor-market outcomes at any time horizon.\textsuperscript{38}

The labor-market outcomes can be related to our theoretical model as follows. Cases 1 and 2 had the same implications for investments in education but differed in the impact on labor-market tightness and therefore employment. The empirical evidence is consistent with the relative reduction in the probability of obtaining permanent residency for employed versus unemployed workers being such that the counteracting effects cancel out. Females, however, display reduced earnings which is more in line with Case 1, i.e., that unemployed and uneducated individuals were most negatively affected, as we think of females as further away from the labor market. However, we do not find any evidence of divergence in earnings conditional on employment when we look at earnings dynamics graphically. This is, in turn, consistent with Case 3 in the theoretical model and in line with the reform having a negative impact on refugees in general, because of the perceived risk of losing a match, and on individuals further away from the labor market in particular.

\textsuperscript{38}The results are available upon request.
2.6 Sensitivity Analysis

In this section, we perform a sensitivity analysis to assess the robustness of our results. In particular, we consider standard tests for the validity of our regression discontinuity approach. Furthermore, we investigate the importance of calendar effects.

2.6.1 Placebo tests

A standard test in this type of design is to test for placebo effects by estimating the same model, but varying the location of the cutoff. Discontinuities at other cutoff points (where nothing happened) may suggest that discontinuities at the real cutoff are not due to the reform. We split the main sample into the control and treatment group separately. Then, following Imbens and Lemieux (2008), we test for discontinuities in our outcome variables at the median date of application in each of the two groups. The advantage of splitting the sample into the control and treatment group is that we avoid fitting a regression function over a point where we expect a discontinuity to occur. We could test for discontinuities at other points within each of these sub-samples, but using the median gives us more power to detect potential discontinuities. Tables 2.7–2.9 present the results from this placebo analysis. For most variables, we do not find any significant discontinuities at the placebo cutoff. For employment, we estimate a significant (at the 10 percent level) discontinuity when covariates are included. In addition, for a few other variables, when we include the other outcomes discussed in more detail in Section 2.7, we detect a significant jump at the placebo cutoff. This is the case for the share registered in Denmark, the number of births and hospital visits for the treatment group. Given the narrow bandwidth we have to implement for this test and the lower number of observations we end up with, it is not surprising that we detect a few discontinuities as we are not able to estimate the time trend and control function as well.
2.6. SENSITIVITY ANALYSIS

2.6.2 Choice of bandwidth

Given that the placebo test detected a few discontinuities at other values of the running variable than the true cutoff point, we want to assess the robustness of our results in greater detail. More specifically, we carefully investigate the sensitivity of our results to changes in the bandwidth. Our main results, presented in Tables 2.2-2.3, are estimated using a bandwidth of 119 days around the cutoff point. We cannot extend the bandwidth further without including individuals in the treatment group that were also subject to, for example, the change in benefit levels. For this reason, our sensitivity analysis is restricted to analyzing the effects when decreasing the bandwidth.

For both predetermined characteristics and outcome variables, we present coefficients and confidence intervals from estimating the regression discontinuity equation using bandwidths starting at 21 days and then increasing the bandwidth by two days at a time until reaching 119 days (our benchmark bandwidth). Figures 2.15-2.17 present the results from this analysis for predetermined characteristics. Although confidence intervals suggest that even for smaller bandwidths, the coefficients are in general not significantly different from zero and the coefficients become much more stable at broader bandwidths. This analysis corroborates our choice of using a bandwidth of 119 days. Figures 2.18-2.20 present the same type of analysis for our outcome variables, and confirm our interpretation of the results. At broader bandwidths, the coefficients become insensitive to bandwidth changes.

Many papers that use the regression discontinuity approach choose to use optimal bandwidth selection, a data-driven approach to select how many observations on each side of the cutoff should be used in the estimation. We have chosen to instead use the broadest bandwidth possible to isolate the effect of this reform, i.e., use as many observations as possible without including individuals that were also subject to other components of the 2002 reform. This gives us the bandwidth of 119 days. However, we also estimate regressions for our main outcomes using the
optimal bandwidth. Using the optimal bandwidth selection, about 100 observations are used in estimations compared to the sample size of 635 when using the 119 days bandwidth. In general, coefficients estimated with the optimal bandwidth are in line with, or larger in magnitude, than our preferred specification. The exception is enrollment, where the magnitude is smaller and non-significant when controls are excluded (although including controls increases the magnitude and the estimate is significant at the 10 percent level) when using the optimal bandwidth. In light of the low number of observations used in these estimations, the 119 days bandwidth remains our preferred choice.\footnote{Results using optimal bandwidth selection are available upon request.}

2.6.3 Assumptions on the regression specification

We also replicate all our main results using a quadratic polynomial, rather than the linear function for $h(\cdot)$ of Section 2.5. The main reason to include higher-order polynomials is to capture non-linearities in the underlying data. However, in our case, using a higher order polynomial often appears to lead to overfitting and, thus, overestimation of the effect. Using the linear specification is therefore the more conservative choice for most outcomes. However, the results for enrollment are sensitive to the inclusion of a second-order polynomial. The estimated effect is smaller in magnitude and imprecisely estimated. Looking at the graphical evidence in Figure 2.9 (a), the linear fit seems more appropriate. The linear case therefore remains our preferred specification.

The benchmark estimations employ a uniform kernel, but we have estimated all the results for the full sample using a triangular kernel as well. The motivation for using a triangular kernel is that it gives more weight to observations close to the cutoff, but given the low number of observations in our sample, the uniform kernel remains our preferred choice. In general, the coefficients using a triangular kernel are in line with, or even larger in magnitude than, our preferred specification. For enrollment, the effect is slightly weaker at 13–15 percentage points. In

\footnote{Results using optimal bandwidth selection are available upon request.}
addition, a few other outcomes become significant.\textsuperscript{40}

\subsection{Calendar effects}

Our treatment group arrives in Denmark later than the control group by definition. One potential concern is therefore that any observed effects depend on this difference rather than on the reform itself. For example, calendar effects could potentially affect our results if the state of the labor market differs between the points in time when the control and the treatment group receive their asylum approvals.\textsuperscript{41} In 2002, asylum seekers were not allowed to work until their applications were approved, which means that we need to consider the difference in approval rates between treatment and control. We note that the distribution of approval dates for the treatment and control groups are quite similar, suggesting that there are no substantial differences in when our control and treatment groups are allowed to enter the labor market.\textsuperscript{42}

Because the approval dates of the two groups look rather similar (see Figure 2.23), it is possible that the processing times instead differ. We note that the control group had a somewhat longer processing time, implying that these individuals spent more time in the asylum center awaiting their decision. If we believe that the time in processing matters, for example because of discouragement from a lack of meaningful activities or because a longer time spent in Denmark gave the control group an advantage before entering the labor market, this could be of relevance. The differences are, however, not so large that we believe they are likely to impact the results.\textsuperscript{43} Furthermore, Figure 2.6 shows that there is no discontinuity in the processing time at the cutoff.

\textsuperscript{40}Results using a quadratic polynomial and a triangular kernel are available upon request.

\textsuperscript{41}Another concern could be if we think that asylum seekers arriving between November and February are inherently different compared to asylum seekers arriving in the spring. We can control for potential differences in observed characteristics but are not able to control for differences in unobserved characteristics.

\textsuperscript{42}Results are available upon request.

\textsuperscript{43}Results are available upon request.
The appointment of a new government, on November 27, 2001, was, however, clearly associated with stricter immigration policies to come. Discussions of these policies started formally in January–February 2002 and there was media coverage on the intentions to implement measures aimed at reducing immigration. This means that immigrants could have been aware of the intention to reform Danish asylum policies. Still, they would not have been able to foresee the exact timing of the reform.
2.7 Other Outcomes

We have focused on outcomes related to the labor market and human-capital investments. These variables are most directly related to the reform we are studying. However, there are several other ways in which the lower ex-ante probability of permanent residency (through a longer time period with temporary residency) may have affected individual behavior. In addition to educational investments and labor-market outcomes, we therefore also explore if the reform affected crime rates, health, family composition, and the duration in Denmark. These outcomes are of interest to understand the full impact of the reform.

Access to criminal registers allows us to observe whether individuals have been convicted of any crime, as well as property crimes separately, during their time in Denmark. Our measure of criminal activity captures the share of individuals that have ever been convicted during the twelve years that we observe.\textsuperscript{44} This variable is included to consider potential outside options to the regular labor market, as well as potential deterring effects of the prolonged temporary status. We also assess the impact of the reform on health outcomes. In particular, we consider the number of hospital/doctor visits over the twelve-year period that we observe.\textsuperscript{45} This adds a dimension to the analysis as an individual’s health status may affect both her current and future labor-market prospects. Furthermore, there is anecdotal evidence that the reform imposed stress on refugees. This makes health itself a relevant outcome if we want to consider the direct impact on refugees’ welfare and, more generally, potential costs to society of the reform. Finally, we consider the effects on fertility behavior by studying the number of births during the first twelve years in Denmark.\textsuperscript{46} The intuition here is that increased uncertainty about the future in Denmark could have discouraged individuals from having children.

\textsuperscript{44}From the KRAF register, we access information on charges and convictions.
\textsuperscript{45}This variable is created using data from the LPRPOP register on health care utilization and diagnoses.
\textsuperscript{46}We use an indicator equal to one if the number of children in a family increases from one year to the other as a measure of a birth.
CHAPTER 2. SHOULD I STAY OR MUST I GO?

2.7.1 Duration in Denmark

First, however, we study if the reform had an impact on whether asylum holders actually stayed in Denmark during the twelve years that we can observe them in the data. Individuals in the treatment group faced the risk of losing their residence status for a longer time before they were eligible to apply for permanent residency. This could lead to more individuals leaving Denmark, because their asylum claim was no longer valid and they did not qualify for residency based on labor-market attachment. Further, asylum holders may have left Denmark by choice, due to the change in regulations. This highlights the importance of looking at how long these individuals stay in Denmark, since any effects on other outcome variables could potentially be driven by selection effects of individuals having to, or choosing to, leave Denmark. Estimation results in Table 2.4 show that there is no significant difference between the control and treatment group in the share that is still registered in Denmark in 2015. This is true for the full sample as well as the different subgroups, confirmed graphically in panel (e) of Figure 2.10, and it facilitates the interpretation of our other results. It is unlikely that any effects are driven by selection in either the control or treatment group.47

2.7.2 Crime

A change in the permit structure could have affected crime rates as the opportunity cost of criminal activity may have changed. The reform we study could also have had a more direct effect on crime rates, since a criminal record reflected negatively on applications for prolonged residency, implying that a longer time period with temporary residency in combination with these stricter rules may have deterred individuals from committing crimes. In addition, the reform may have impacted the immigrant’s view of the host country and affected her willingness to comply

47In Figure 2.22 we present regression discontinuity estimates of the share still in Denmark for each individual year up until twelve years after application. These results confirm that there is no significant difference in the share staying in Denmark. In Table 2.5 we also confirm that the groups are still relatively well balanced in 2015.
2.7. OTHER OUTCOMES

with its norms and laws.

We study the impact on convictions in general as well as on property crime specifically. This variable measures the share of individuals that are ever convicted of any crime (for the general case) or of a property crime. Table 2.4 presents regression estimates for the full sample and our subgroups. For the full sample, we note a negative but non-significant coefficient of between 6 and 12 percentage points. If we instead look at property crime rates, we note a significant (at the 5 percent level including controls) decrease of around 12 percentage points. This effect is mainly driven by a reduction of around 25 percentage points for males (significant at the 1 percent level).\footnote{There is also a statistically significant difference in means between the two groups, with lower rates for the treatment group.}

The negative jump is confirmed in panels (a) and (b) in Figure 2.10 as well as in panels (a) and (b) in Figure 2.14, showing the crime rates in the control and treatment group for the different years over time. Panels (a) and (b) in Figure 2.22 show that there is no clear trend in the estimated coefficients over time.

2.7.3 Fertility behavior and health

Finally, we study the impact on fertility behavior and health. The lower ex-ante probability of getting permanent residency in Denmark may have induced asylum holders to delay having children. A reason for this could have been to achieve a more stable situation before starting a family.\footnote{This is in line with the model outlined by Ranjan (1999). He suggests that the irreversible aspect associated with childbearing, together with the ability to postpone, lead people to postpone childbearing when there is uncertainty about future income. The analogue to our context is straightforward, uncertainty about the future in Denmark may have lead asylum holders to postpone childbearing. Gustafsson (2005) emphasizes that changes in fertility behavior do not need to be driven by a change in expected family sizes, but be due to a changed timing of family formation. Postponing having children pays off, because women who have children later earn more, all else equal. This could play a role in our context, where the prolonged temporary period of the treatment group may have increased the value of labor-market attachment as an alternative way of receiving residency.}

Our variable of interest is the total number of times that individuals have
children during the years we observe.

In Table 2.4, the coefficients on the number of children born in the full sample are negative, but the effect is non-significant. For females, we estimate a significant (at the 5 percent level) decrease in the number of new births, with a coefficient of around -0.7. Panel (c) in Figure 2.10 confirms this picture for the discontinuity estimation, and panel (c) in Figure 2.14 shows no clear graphical differences over time. Figure 2.22 shows that there is not a very clear pattern if we look at the estimated effect at different years after arrival. If anything, there is a small upward trend in the coefficient in the later years.

Finally, anecdotal evidence suggests that the reform created a more stressful situation for asylum holders due to increased uncertainty about their future in Denmark. We explore this by studying the effect on the total number of visits to health care centers and hospitals (during the twelve years we observe). The results suggest no significant impact of the reform. This is true also looking at the long run and at the estimated impact at different time horizons.
2.8 Conclusion

We study the effects of lowering the ex-ante probability of receiving permanent residency status on refugees' outcomes. We exploit a Danish reform in 2002 that prolonged the time period that a refugee was required to have been a legal resident before being eligible to apply for a permanent residence permit. In light of recent asylum policy changes in Europe and elsewhere, this is a question that has assumed center stage in the policy debate. However, there is very little evidence on how such reforms affect the integration of refugees and their labor-market prospects. While proponents of temporary protection regimes often argue that stronger incentives to qualify for residency based on labor-market attachment will speed up the process of entering the labor market, we find no evidence of positive effects on labor-market outcomes. There is no difference between the employment rates of individuals in our control and treatment groups. Similarly, there is no evidence of increased earnings. The estimated coefficient is negative but not significantly different from zero. Opponents to temporary protection argue that worsening the prospects of staying in the new host country may deter country-specific human capital investments since the expected payoff of doing so is discounted at a higher rate. We find evidence of the opposite and document large and significant effects on education enrollment rates, driven by females and low-skilled workers. The findings on investments in education are in line with the predictions of the theoretical model, specifically the case when the ex-ante probability of obtaining permanent residency is more negatively affected for low-skilled individuals, which in the empirical analysis corresponds to individuals further from the labor market.

We want to emphasize some limitations of our study. While the reform studied in this paper is in many ways ideal for studying the effect of prolonged temporary status, the setting also offers some challenges. Our sample size is limited for two reasons: (1) we only study outcomes of individuals that are actually given asylum and (2) we need to restrict the time interval to four months before and after the reform to avoid con-
founding policy changes. This means that we need to be careful when interpreting our results. Furthermore, the external validity of our results depends on the institutional setting. First, the composition of refugees is clearly time dependent and depends on many things outside the control of the policy maker. Second, temporary protection schemes may be designed in many different ways, making them more or less comparable to the reform we are studying in this paper. Therefore, it is important to compare our results to the findings of future studies of temporary permits studied in other settings. Finally, we focus on a variety of outcomes that we argue to be particularly relevant but have abstracted from many others. For example, the role of intra-household relationships may be important in order to understand heterogeneous responses of females and males. Exploring other outcomes and assessing potential mechanisms at work remain interesting tasks for future research.
References


REFERENCES


2.9 Figures and Tables

Figure 2.6: General (predetermined) characteristics

(a) Male

(b) No. of children at application

(c) Partner at application

(d) Age at application

(e) Processing time

(f) Predicted wage

Notes: The graphs are generated using evenly spaced bins, a linear polynomial (order 1), and a uniform kernel.
Figure 2.7: Danish language courses and education level (predetermined)

Notes: The graphs are generated using evenly spaced bins, a linear polynomial (order 1), and a uniform kernel.
Figure 2.8: Country of origin

Notes: The graphs are generated using evenly spaced bins, a linear polynomial (order 1), and a uniform kernel.
CHAPTER 2. SHOULD I STAY OR MUST I GO?

**Figure 2.9: Education and labor-market outcomes**

(a) *Enrollment in education*  

(b) *Enrollment in university education*  

(c) *Employed*  

(d) *Earnings 3Y*  

(e) *Earnings 7Y*  

Notes: The graphs are generated using evenly spaced bins, a linear polynomial (order 1), and a uniform kernel. Enrollment is a dummy variable equal to one if the individual at some point is enrolled in general education. Enrollment in university education is the corresponding variable for university education. Employed is a dummy equal to one if the individual was ever employed in Denmark. Earnings is total labor earnings from employment and/or self-employment after three and seven years, respectively.
Figure 2.10: Crime, fertility behavior, and health outcomes

Notes: The graphs are generated using evenly spaced bins, a linear polynomial (order 1), and a uniform kernel. Registered in Denmark 2015 is a dummy equal to one if the individual is registered in Denmark in the year 2015. Criminal conviction is a dummy equal to one if ever convicted of any crime. Property crime is equal to one if ever convicted of a property crime. Giving birth is the number of times a family has more children. Hospital visits is the number of doctor/hospital visits.
CHAPTER 2. SHOULD I STAY OR MUST I GO?

**Figure 2.11: Education outcomes over time**

(a) Enrollment in education

(b) Enrollment in university education

Notes: The graphs show a quadratic polynomial and 95 percent confidence intervals.

**Figure 2.12: Labor-market outcomes over time**

(a) Employed

(b) Earnings

Notes: The graphs show a quadratic polynomial and 95 percent confidence intervals.
Figure 2.13: (Heterogeneous) Earnings conditional on employment over time

Notes: The graphs show a quadratic polynomial and 95 percent confidence intervals.
Figure 2.14: Crime, fertility behavior, and health over time

(a) Criminal conviction

(b) Property crime

(c) Giving birth

(d) Hospital visits

(e) Fraction still living in Denmark

Notes: The graphs show a quadratic polynomial and 95 percent confidence intervals.
2.9. FIGURES AND TABLES

Figure 2.15: General (predetermined) characteristics, RD coefficients by bandwidth

(a) Male

(b) No. of children at application

(c) Partner at application

(d) Age at application

(e) Processing time
Figure 2.16: Danish language courses and education level (predetermined), RD coefficients by bandwidth

(a) Danish 1

(b) Danish 2

(c) Danish 3

(d) Primary and secondary

(e) Higher
Figure 2.17: Country of origin, RD coefficients by bandwidth

(a) Afghanistan

(b) Iraq

(c) Former Yugoslavia

(d) Somalia

(e) Other nationalities
Figure 2.18: Education outcomes, RD coefficients by bandwidth

(a) Enrollment in education

(b) Enrollment in university education

Figure 2.19: Labor-market outcomes, RD coefficients by bandwidth

(a) Employed

(b) Earnings 3Y

(c) Earnings 7Y
Figure 2.20: Crime, fertility behavior, and health, RD coefficients by bandwidth

(a) Criminal conviction

(b) Property crime

(c) Giving birth

(d) Hospital visits

(e) Registered in Denmark, 2015
Figure 2.21: Education and labor-market outcomes, RD coefficients over time

(a) Enrollment in education

(b) Employed

(c) Earnings
Figure 2.22: Crime, fertility behavior, and health, RD coefficients over time

(a) Criminal conviction

(b) Property crime

(c) Giving birth

(d) Hospital visits

(e) Registered in Denmark, 2015
Figure 2.23: Approval rates for lodged applications, November 2001 – June 2002

Data source: Statistics Denmark.
### Table 2.2: Education outcomes

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<th>Female</th>
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<th>Low skill</th>
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Notes: Regressions are estimated for the different groups using a polynomial of order 1 and a uniform kernel. High skilled is defined as having a university education, while low skilled have primary or secondary education upon arrival in Denmark. Covariates include age at application, gender, partner, number of children, education level and dummies for the most common nationalities (Afghanistan, former Yugoslavia, Iraq, and Somalia). Enrollment is a dummy variable equal to one if the individual at some point is enrolled in general education. Enrollment university is the corresponding variable for university education. *, ** and *** denote significance levels at the 10 percent, 5 percent and 1 percent levels, respectively.
### Table 2.3: Labor-market outcomes

<table>
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<th>Outcome</th>
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<th>Female</th>
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**Notes:** Regressions are estimated for the different groups using a polynomial of order 1 and a uniform kernel. High skilled is defined as having a university education, while low skilled have primary or secondary education upon arrival in Denmark. Covariates include age at application, gender, partner, number of children, education level and province for the most common nationalities (Afghanistan, Former Yugoslavia, Iraq, and Somalia). Employed is a dummy equal to one if the individual was ever employed in Denmark. Earnings in total labor earnings from employment and/or self-employment after three and seven years. *, ** and *** denote significance levels at the 10 percent, 5 percent and 1 percent levels, respectively.
Table 2.4: Crime, fertility behavior, and health

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</tbody>
</table>

Notes: Regressions are estimated for the different groups using a polynomial of order 1 and a uniform kernel. High skilled is defined as having a university education, while low skilled have primary or secondary education upon arrival in Denmark. Covariates include age at application, gender, partner, number of children, education level and duration for the most common nationalities (Afghanistan, former Yugoslavia, Iran, and Somalia). In Denmark 2015 is a dummy equal to one if the individual is registered in Denmark in the year 2015. Criminal conviction is a dummy equal to one if ever convicted of any crime. Property crime is equal to one if ever convicted of a property crime. Giving birth is the number of times a family has more children. Hospital visits is the number of doctor/hospital visits. *, ** and *** denote significance levels at the 10 percent, 5 percent and 1 percent levels, respectively.
Table 2.5: Comparison of means for individuals residing in Denmark 2015 (bw 119 days)

<table>
<thead>
<tr>
<th></th>
<th>(1) Control</th>
<th>(2) Treatment</th>
<th>Normalized difference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographic characteris</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>0.51</td>
<td>0.43</td>
<td>-0.16</td>
</tr>
<tr>
<td>(0.50)</td>
<td>(0.50)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of children</td>
<td>1.78</td>
<td>1.66</td>
<td>-0.06</td>
</tr>
<tr>
<td>(1.91)</td>
<td>(2.05)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partner</td>
<td>0.53</td>
<td>0.57</td>
<td>0.08</td>
</tr>
<tr>
<td>(0.50)</td>
<td>(0.50)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>30.02</td>
<td>31.05</td>
<td>0.08</td>
</tr>
<tr>
<td>(0.15)</td>
<td>(0.15)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Danish 1</td>
<td>0.23</td>
<td>0.25</td>
<td>0.05</td>
</tr>
<tr>
<td>(0.42)</td>
<td>(0.43)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Danish 2</td>
<td>0.40</td>
<td>0.36</td>
<td>-0.04</td>
</tr>
<tr>
<td>(0.40)</td>
<td>(0.40)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Danish 3</td>
<td>0.26</td>
<td>0.28</td>
<td>0.04</td>
</tr>
<tr>
<td>(0.44)</td>
<td>(0.44)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary or secondary</td>
<td>0.48</td>
<td>0.47</td>
<td>-0.02</td>
</tr>
<tr>
<td>(0.50)</td>
<td>(0.50)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Higher</td>
<td>0.25</td>
<td>0.25</td>
<td>0.00</td>
</tr>
<tr>
<td>(0.42)</td>
<td>(0.42)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Country of origin</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Afghanistan</td>
<td>0.37</td>
<td>0.33</td>
<td>-0.08</td>
</tr>
<tr>
<td>(0.48)</td>
<td>(0.47)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iraq</td>
<td>0.19</td>
<td>0.10</td>
<td>-0.09</td>
</tr>
<tr>
<td>(0.30)</td>
<td>(0.30)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Former Yugoslavia</td>
<td>0.10</td>
<td>0.16</td>
<td>0.18</td>
</tr>
<tr>
<td>(0.30)</td>
<td>(0.37)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Somalia</td>
<td>0.13</td>
<td>0.10</td>
<td>-0.09</td>
</tr>
<tr>
<td>(0.34)</td>
<td>(0.30)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>0.21</td>
<td>0.31</td>
<td>0.23</td>
</tr>
<tr>
<td>(0.41)</td>
<td>(0.47)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Values in parenthesis are (s.d.). This table shows the means and normalized difference for individuals in our sample that were still residing in Denmark in 2015. Demographic characteristics are measured at application, Danish 1 - Danish 3 indicate the level of Danish courses assigned at approval, whereas primary or secondary and higher education indicates the level of education acquired prior to applying for asylum in Denmark. The normalized difference is defined as $\frac{t - c}{\sqrt{s^2_t + s^2_c} / 2}$. 


<table>
<thead>
<tr>
<th>Table 2.6: Regression discontinuity density test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outcome</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>(1)</td>
</tr>
<tr>
<td>p-value</td>
</tr>
</tbody>
</table>

Notes: The test is implemented using the `rddensity` command in Stata, using the robust bias-corrected estimates. Reported values are p-values from this test.

<table>
<thead>
<tr>
<th>Table 2.7: Placebo test: Education outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outcome</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>(1)</td>
</tr>
<tr>
<td>Enrollment</td>
</tr>
<tr>
<td>(0.187)</td>
</tr>
<tr>
<td>Enrollment university</td>
</tr>
<tr>
<td>(0.114)</td>
</tr>
</tbody>
</table>

Notes: Regressions are estimated for the full sample using a polynomial of order 1 and a uniform kernel. Covariates include age, gender, partner, number of children, education level (all measured at application) and dummies for the most common nationalities (Afghanistan, Former Yugoslavia, Iraq, and Somalia). We split the sample into two halves at the cutoff. Then we run the regression on each sample using the median as the cutoff.

<table>
<thead>
<tr>
<th>Table 2.8: Placebo test: Labor-market outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outcome</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>(1)</td>
</tr>
<tr>
<td>Employed</td>
</tr>
<tr>
<td>(0.221)</td>
</tr>
<tr>
<td>Earnings 3Y</td>
</tr>
<tr>
<td>(78,314)</td>
</tr>
<tr>
<td>Earnings 7Y</td>
</tr>
<tr>
<td>(85,291)</td>
</tr>
</tbody>
</table>

Notes: Regressions are estimated for the full sample using a polynomial of order 1 and a uniform kernel. Covariates include age, gender, partner, number of children, education level (all measured at application) and dummies for the most common nationalities (Afghanistan, Former Yugoslavia, Iraq, and Somalia). We split the sample into two halves at the cutoff. Then we run the regression on each sample using the median as the cutoff.
### Table 2.9: Placebo test: Crime, fertility behavior, and health

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Left of the cutoff</th>
<th>Right of the cutoff</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Crime</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Criminal conviction</td>
<td>-0.214</td>
<td>-0.209</td>
</tr>
<tr>
<td></td>
<td>(0.200)</td>
<td>(0.194)</td>
</tr>
<tr>
<td>Property crime</td>
<td>-0.144</td>
<td>-0.064</td>
</tr>
<tr>
<td></td>
<td>(0.168)</td>
<td>(0.147)</td>
</tr>
<tr>
<td>Fertility behavior</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Giving birth</td>
<td>-0.575</td>
<td>-0.395</td>
</tr>
<tr>
<td></td>
<td>(0.687)</td>
<td>(0.669)</td>
</tr>
<tr>
<td>Health status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital visits</td>
<td>-2.654</td>
<td>-5.605</td>
</tr>
<tr>
<td></td>
<td>(7.311)</td>
<td>(5.629)</td>
</tr>
</tbody>
</table>

**Notes:** Regressions are estimated for the full sample using a polynomial of order 1 and a uniform kernel. Covariates include age, gender, partner, number of children, education level (all measured at application) and dummies for the most common nationalities (Afghanistan, Former Yugoslavia, Iraq, and Somalia). We split the sample into two halves at the cutoff. Then we run the regression on each sample using the median as the cutoff.
2.A. THE DANISH ASYLUM PROCESS

Appendices

2.A The Danish Asylum Process

The process of applying for asylum in Denmark is governed by the Aliens Act from 1983, to which several changes have been made over the years. This section will briefly describe the Danish asylum system in effect around 2002 and builds upon information in The Danish Immigration Service (2003). An asylum seeker arriving in Denmark under these conditions should report to the police once at the border. The application is filed either at a local police station or at the center in Sandholm. First, the Danish Immigration Service (DIS) will confirm that Denmark is responsible for processing the asylum application. Asylum seekers that are not rejected at the border will be sent to a registration center and, once identity and travel routes to Denmark have been established, to one of several accommodation centers in the country. During the time when the application for asylum is processed, accommodation and financial support for the asylum seeker are provided by the DIS.\(^5\) Most asylum seekers will be accommodated at a residence center until the final decision has been made, but after six months from the application date, the asylum seeker is allowed to find own housing until the claim has been processed (but they are not allowed to buy property). During the time when the application is processed, the asylum seeker is not allowed to accept any paid work. Voluntary activities are provided, and there are also some compulsory activities.

The asylum application is handled by the DIS, which is the first instance of decision and they will determine if the asylum application falls under the provisions of the Geneva Convention or the Danish Aliens Act. The assessment is made using information provided by the asylum seeker as well as information collected by the DIS on the asylum seeker’s country of origin. Convention refugee status is regulated by the UN 1951 refugee

\(^{5}\)In cooperation with the Danish Red Cross, the Danish Emergency Management unit and the municipalities of Hansthom and Brovst.
Asylum seekers who do not directly qualify as refugees according to the definition of the Refugee Convention but who risk the death penalty or being subjected to torture or inhuman or degrading treatment or punishment in case of return to his or her country of origin get protection status. This category extends the refugee status beyond the UN refugee convention, to individuals with "asylum reasons similar to those in the convention". Prior to the reform in 2002 this would fall under the de facto refugee status in the Danish Aliens Act. As part of the reform, a new Status B was introduced with much stricter criteria to get protection status. There are two different procedures, the normal procedure and the manifestly unfounded procedure.\footnote{The manifestly unfounded procedure is applied when it is clear that the application cannot be approved. In this case, there is no possibility to appeal, and the applicant has to leave Denmark immediately. However, it is required that the Danish Refugee Council (an NGO) agrees with the DIS's assessment. If the Danish Refugee Council uses its veto, the case will instead be processed under the normal procedure.} If an application is rejected by the DIS under the normal procedure, it is automatically appealed to the Refugee Appeals Board\footnote{An independent body with representatives from the government and the Danish Bar and Law Society.} (whose decision is final), in order to speed up the process. If the application is rejected, the individual can still obtain a residence permit for humanitarian reasons or for other exceptional reasons (in which case decisions are made by the Ministry of Integration, later the Ministry for Foreigners, Integration and Housing), although very few individuals are considered for these types of residence permits. These decisions are final, and cannot be appealed. If granted asylum for humanitarian reasons, one can only stay in the country for as long as those reasons still exist. What constitutes humanitarian reasons has varied over time and, for example, used to include families with small children from countries at war and individuals suffering the effects of torture. Nowadays, it is only granted to individuals with life-threatening illness who cannot get treatment in their own country. Once recognized as a refugee, social benefits are given on the same conditions as for Danish citizens. According to the 1999 integration plan, the DIS required...
that the refugee resided in a specific municipality during a three-year integration program. Refugees would be assigned a municipality based on a quota system designed to achieve even distribution, with considerations to circumstances related to the municipality and the refugee. The integration program consisted of Danish culture courses, language classes, and vocational training. After three years (prior to the reform), permanent residence permits were conditioned on the performance in the integration program.

2.B Other Reform Components

We briefly describe the other components of the reform package below:

1. Access to the Danish welfare state was limited. Following the reform, individuals were required to have been a resident in Denmark for seven out of the eight most recent years to get the standard level of benefits. For others, benefits were lowered by 35 percent. This part of the reform also applied to native Danes who had lived abroad. The change applied to all asylum seekers who got their applications granted after July 1, 2002.

2. Family reunification of refugees was discouraged in several ways. First, by disallowing reunification for spouses under the age of 24 (both spouses had to be 24 years of age or older). In addition, if a Danish citizen wanted to sponsor a spouse, the couple had to prove that their “ties” were stronger to Denmark than to the country of the non-Danish spouse. Further, a Danish citizen could no longer sponsor a parent aged 60 years or older. This change applied to applications for family reunion lodged after July 1, 2002.

3. The de facto refugee status was abolished. This status previously implied that an individual could get asylum even if the criteria of the UN Geneva Convention from 1951 were not satisfied. This was no longer possible. Instead, a new status B was introduced with a
more narrow scope. This change applied to all refugees who lodged their applications after July 1, 2002.

4. Prior to the reform, it was possible to apply for asylum in Denmark at a Danish embassy or consulate abroad. This possibility was abolished by the reform. The possibility to lodge an application abroad was removed as of July 1, 2002.

We define our control and treatment groups to make sure these other changes do not interfere with the component of interest for this study.

\[53\text{During the first six months of 2002, 354 individuals lodged their asylum applications from abroad. In 2001 that number was 1,933 with a vast majority of the applications (1,669) coming from the embassy in Afghanistan (The Danish Immigration Service, 2003).}\]
2.C  Model Details

2.C.1 Derivatives

To study the impact on \( \theta^E_T \) of changing \( \rho^E_L \) and \( \rho^U_L \), we evaluate the expression in equation (2.13) around \( \rho^E_L = \rho^U_L \):

\[
\begin{align*}
\frac{d\theta^L_T}{d\rho^E_L} &= \left( \frac{r+a+\sigma+d}{r+a+\rho^E_L+d} \left( \frac{y^E-k\theta^E_L}{r+a+\sigma} - \frac{y^E-k\theta^E_L}{r+a+\sigma+d} \right) + \frac{r+a+d}{r+a+d+\rho^E_L} \right) \frac{1}{k(\theta^E_L)^{-\alpha}} > 0 \\
\frac{d\theta^L_T}{d\rho^U_L} &= -\left( \frac{1}{r+a+\rho^E_L+d} \right) \frac{1}{(r+a+\rho^E_L+d)}(1-\alpha)(\theta^E_L)^{-\alpha} + k < 0.
\end{align*}
\]

The impact on labor-market tightness of a change in \( \rho^E_L \) is positive, whereas the impact of a change in \( \rho^U_L \) is negative. Next we look at the impact of changes to \( \rho^E_L \) and \( \rho^U_L \) on wages in the transitory state, \( w_T^E \).

We obtain:

\[
\begin{align*}
\frac{dw_T^E}{d\rho^E_L} &= -0.5 \left( \frac{\theta^L_T}{(r+a+\rho^E_L+d} \right) \frac{\theta^E_L k - \theta^E_L k}{r+a+d+\rho^E_L} \\
&\quad - \frac{r+a+\sigma+d}{r+a+\rho^E_L+d} \left( \frac{y^E-k\theta^E_L}{r+a+\sigma} - \frac{y^E-k\theta^E_L}{r+a+\sigma+d} \right) + \frac{\theta^E_L k(\theta^E_L)^{\alpha}-k\theta^E_L}{r+a+d+\rho^E_L} \\
&\quad \frac{(r+a+\sigma+\rho^E_L+d)(1-\alpha)(\theta^E_L)^{-\alpha} + 1} > 0,
\end{align*}
\]

\[
\frac{dw_T^E}{d\rho^U_L} = 0.5k \left( \frac{\theta^L_T}{(r+a+\rho^E_L+d} \right) \frac{\theta^E_L k - \theta^E_L k}{r+a+d+\rho^E_L} \\
&\quad \times \frac{1}{(r+a+\rho^E_L+d)(1-\alpha)(\theta^E_L)^{-\alpha} + 1} > 0.
\]

This means that the impact on wages of a change in \( \rho^E_L \) is indeterminate, whereas the effect of a change in \( \rho^U_L \) is positive. Finally, we look at the impact of an increase in \( d_E = d_U = d \) (for skill group \( S \)):

\[
\frac{d\theta^S_T}{dd} = -2k(\theta^S_T)^{1-\alpha} \quad \frac{\theta^S_L}{(r+a+\sigma+\rho^E_L+d)(1-\alpha)(\theta^E_L)^{-\alpha} + k} < 0.
\]
CHAPTER 2. SHOULD I STAY OR MUST I GO?

We see that the labor-market tightness decreases as the deportation risk increases, implying that labor-market conditions deteriorate.

2.C.2 Impact of policy

Case 1: In the first case we consider a reduction in the likelihood of obtaining permanent residency only for unemployed low skill workers, $d\rho_L^U < 0$ (around $\rho_H^E = \rho_L^E = \rho_H^U = \rho_L^U$). We then find that:

$$
\frac{d\hat{e}}{d\rho_L^U} = \left\{ \frac{1}{r + a + d + \rho_L^U} \left[ \theta_T^L - \frac{(r + a + d)\theta_T^L}{r + a} \right] - \frac{d\theta_T^L}{d\rho_L^U} \right\} \frac{k(r + a)}{r + a + \rho_H^U} \frac{1}{c'(\hat{e})} > 0.
$$

Noting that $c'(\hat{e}) < 0$, we find that there is a positive relationship between $\hat{e}$ and $\rho_L^U$. Since the policy change implied a decrease in $\rho_L^U$, we conclude that the impact of the policy is a decrease in $\hat{e}$ and thus an increase in the share of individuals that acquire education (remember that $\hat{e}$ is the share of uneducated individuals).

Case 2: In the second case we consider a reduction in the likelihood of obtaining permanent residency only for employed low skill workers, $d\rho_L^E < 0$ (around $\rho_H^E = \rho_L^E$). We then find that:

$$
\frac{d\hat{e}}{d\rho_L^E} = -\frac{(r + a)k}{r + a + \rho_L^E} \frac{d\theta_T^L}{d\rho_L^E} \frac{1}{c'(\hat{e})} > 0.
$$

There is a positive relationship between the share of uneducated individuals and the probability of permanent residency. This means that a decrease in $\rho_L^E$ will increase the investments in education.

Case 3: Finally, in the third case, we consider an increase in the deportation risk, $d_E = d_U = d$ (when $\rho_P^S = \rho_E^S$). We find that:
\[
\dot{e} = \left( \frac{d\theta^H_L}{dd} - \frac{d\theta^L_L}{dd} \right) \frac{(r + a)k}{r + a + \rho^H_L c'(\hat{e})} \cdot \frac{1}{r + a + \rho^H_L c'(\hat{e})} > 0.
\]

This implies that when the deportation risk increases, fewer individuals invest in education.
2. D  Details on the Data

2. D.1  Mapping from DISCO codes to skill levels

We use the Danish version of the International Standard Classifications of Occupations (DISCO) to map working functions, that we observe in the data, into different skill levels. We define skill level by picking one occupation per year and person. If a person has more than one job, we take the job with the highest skill level. If there is more than one job with the same skill level, we pick the most common job within that skill level. Finally, if a person has two jobs from different occupations that have the same skill level in a given year, we pick the occupation with the highest ranking according to the DISCO code. If a person has an equal number of jobs in two occupations with the same skill level and one of the occupations is in the armed forces, we pick the civilian occupation as the main occupation. This variable is used to see if there is a change in average skill level over time.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Skill level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Managers</td>
<td>$3 + 4^a$</td>
</tr>
<tr>
<td>2</td>
<td>Professionals</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Technicians and Associate Professionals</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Clerical Support Workers</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>Services and Sales Workers</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>Skilled Agricultural, Forestry and Fishery Workers</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>Craft and Related Trades Workers</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>Plant and Machine Operators and Assemblers</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>Elementary Occupations</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>Armed Forces Occupations</td>
<td>$1, 2 + 4^b$</td>
</tr>
</tbody>
</table>

$^a$Level 3 for managers in Hospitality, Retail and Service. Other managers have skill level 4.

$^b$Military officers are level 4, other occupations are at level 1. Non-commissioned Officers count as skill level 2.
Chapter 3

Risk-sharing and Entrepreneurship

3.1 Introduction

Innovation is commonly held as an important determinant of economic growth. An extensive research effort has consequently been devoted to understanding which policies and institutions that promote innovation. In terms of policies, the importance of risk-sharing for entrepreneurship-driven innovation has been widely debated. Proponents of a strong welfare state argue that a high degree of public risk-sharing may be conducive to entrepreneurship by affecting occupational choice. Others instead argue that it is important to promote the effort of entrepreneurs by limiting risk-sharing and allowing for more inequality.\(^1\)

\(^*\)This paper has been jointly written with Paula Roth. We are grateful for helpful discussions with Timo Boppart, Georg Graetz, John Hassler, Per Krusell, Anna Seim, Jósef Sigurdsson, Daniel Waldenström, and seminar participants at the Research Institute of Industrial Economics, SUDSWEC, and Stockholm University. This research benefited from financial support from Handelsbanken’s Research Foundations. All errors are our own.

\(^1\)For previous research speaking for a system that tolerates and encourages inequality, where the returns to successful innovators are high, see for example Hall and Soskice (2001) and Okun (1975).
Acemoglu et al. (2017) argue that countries with high inequality provide greater economic benefits of innovation, incentivizing entrepreneurs to exert more effort.² Since entrepreneurs drive the technological frontier in their model, this is key for economic growth. In their setting, a country like Sweden, with low inequality and a generous welfare system, will be less innovative and instead free-ride on the innovations made by other countries. However, country rankings based on various innovation measures suggest that there is no simple policy recommendation with regard to the optimal degree of risk-sharing. For example, among the top innovator countries in 2017, according to the Global Innovation Index, we find two Anglo-Saxon economies; the United States and the United Kingdom, as well as the Nordic countries; Sweden, Finland and Denmark. Importantly, these two groups of countries differ in that the Anglo-Saxon countries are characterized by higher inequality and less public risk-sharing than the Nordic ones. We argue that in the choice between venturing into entrepreneurship and working in a less risky environment, risk-sharing can play an important role. Moreover, risk-sharing can be both public, i.e., provided by the welfare state, and private, i.e., stemming from private asset holdings. If these two types of risk-sharing are substitutes, an individual’s own economic resources may therefore matter more for occupational choice in the absence of public risk-sharing.

The contribution of this paper is twofold. First, we combine cross-country data with results from previous empirical studies to establish a set of key stylized facts. Second, we construct a model of risk-sharing and entrepreneurship that is consistent with these facts. In the first, empirical part, we study a sample of OECD countries between 2005 and 2015. We consider several measures of innovation: patents, self-employment by opportunity and innovation indices. We look at unconditional correlations for countries that can be classified according to their degree of risk-sharing, and find that: (1) public risk-sharing is negatively related

²In their theoretical setting, all agents are entrepreneurs, and inequality is therefore interpreted as inequality among entrepreneurs, specifically, rather than among all individuals.
3.1. INTRODUCTION

Inequality, (2) public risk-sharing is positively related to innovation, and (3) inequality is negatively related to innovation. We find that the United States appears to be an outlier in several dimensions with relatively high levels of both inequality and innovation. We argue that one potential explanation for this finding is greater private risk-sharing in the United States as compared to, for example, Sweden. Private risk-sharing, in terms of holding financial assets or intergenerational transfers, can be seen as an alternative to the public risk-sharing provided by the welfare state. In addition, we document differences in hours worked between Americans and Europeans, as well as in their optimism.

Based on the empirical findings we set up a theoretical framework to study the role of risk-sharing. This is done in a simple model of occupational and effort choice, inspired by the set-up of the individual's problem in, for example, Acemoglu et al. (2017) and Garcia-Penalosa and Wen (2008). The model is first used to study comparative statics, and then solved for a distribution of individuals characterized by given initial levels of wages, profits and assets, that are exogenous. In terms of comparative statics, we identify thresholds for public risk-sharing that determine whether individuals choose to become entrepreneurs, and, conditional on being entrepreneurs, whether they choose to exert effort. The threshold in terms of public risk-sharing, above which individuals choose to become entrepreneurs, is higher if wages or taxes on profits are high. Intuitively, if the outside option of being a worker is made more attractive, individuals require more public risk-sharing to choose the uncertain path of entrepreneurship. Conversely, the threshold is low if the returns to being an entrepreneur are high, if the probability of success is high, or, for a given level of effort, if the initial assets are substantial, as these provide a form of private risk-sharing.

When individuals choose whether or not to exert effort, the threshold in terms of public risk-sharing, below which individuals exert effort, is high if the returns to being an entrepreneur are high or if the level of initial assets is low. Intuitively, if the initial assets are limited, individuals will work hard, at higher levels of the public benefit, to increase
their probability of success. In the quantitative evaluation, we find that a larger degree of risk-sharing through taxation, which in equilibrium implies higher benefits paid out to unsuccessful entrepreneurs, increases the number of entrepreneurs. At the same time, high taxes lower the share of entrepreneurs who exert effort. We also show that the level of public risk-sharing matters for which individuals choose to become entrepreneurs. The model is solved under different assumptions about the joint multivariate distribution of wages, assets and profits. Specifically, we consider different correlation structures between the three variables. For all specifications, as taxes, and hence equilibrium benefits, increase, the average entrepreneur faces lower profits but higher wages. Whether or not average entrepreneurial wealth increases or decreases as taxes increase crucially depends on the correlation structure imposed. Note that entrepreneurial wealth is equal to initial assets among those who choose entrepreneurship and that it is excluding profits. When initial assets and profits are substantially more correlated than initial assets and wages, average entrepreneurial wealth decreases as the tax rate is raised. This is also the case if individuals only have access to their initial assets as unsuccessful entrepreneurs, i.e., if the initial assets are exclusively used for private risk-sharing.

This paper is mainly related to three strands of the literature. First, we aim at contributing to the understanding of the relationship between risk-sharing and growth through entrepreneurship-driven innovation. We provide an alternative hypothesis to the one whereby inequality, which is negatively correlated with risk-sharing, promotes growth. Acemoglu et al. (2017) distinguish between cutthroat and cuddly capitalism. They argue that so-called cutthroat economies, such as the United States, are more likely to be at the forefront of innovation, compared to cuddly countries such as the Scandinavian ones. This hypothesis is linked to the classification of market economies made by Hall and Soskice (2001), who distinguish coordinated market economies (CME) from liberal market economies (LME). The countries classified as CME in their work are Austria, Belgium, Denmark, Finland, Germany, Japan, the Nether-
lands, Norway, Sweden and Switzerland, while the LME countries are Australia, Canada, the United Kingdom, Ireland, New Zealand and the United States. CME countries, such as Sweden, are characterized by relatively low inequality and high social insurance, while LME countries such as the United States, on the other hand, exhibit higher inequality and a low degree of public risk-sharing. Theoretically, this literature suggests that both types of countries can exhibit high growth but their degree of innovation will differ. LME countries are more likely to focus on radical innovation, with a significant impact, while CME countries have an advantage in incremental innovation that improves existing products or services. The empirical support for this argument is mixed.\footnote{Taylor (2004) finds no evidence supporting this claim, while Akkermans et al. (2009) find that it only holds under specific assumptions.} In general, the empirical evidence on the relationship between inequality and growth is inconclusive. For example, Persson and Tabellini (1994), Alesina and Rodrik (1994) and Perotti (1996) find a negative relationship between inequality and growth, while Barro (2000) finds some positive relation, and Banerjee and Duflo (2000) highlight a nonlinear relationship. Neves et al. (2016) perform a meta-study of published papers estimating the relationship between inequality and growth (the final sample includes 28 papers published between 1994 and 2014). They find that the average impact of inequality on growth is not significant, but among the results there is a high degree of heterogeneity in both the sign and the magnitude of the effect. Part of their result is explained by the presence of a publication bias, but the heterogeneity can also be explained by other factors. The most important finding is that the negative effect of inequality on growth is more pronounced in less developed countries as compared to rich countries. They conclude that the mechanism through which inequality influences growth operates differently under different circumstances. These results motivate further research where these mechanisms are studied separately. Recently, Akrigit et al. (2017) have shown that there is a u-shaped relationship between top income inequality and innovation in the United States. There is still a need to better understand...
stand the channels that relate inequality to growth. We contribute to this literature first, by presenting broader measures of innovation across the two groups of countries mentioned above and showing that highly innovative countries are found among both CME and LME countries, and, second, by offering an alternative hypothesis to why the two groups can be innovative in quite similar ways.

Second, our paper is related to the strand of literature on downside insurance and entrepreneurship. Kihlstrom and Laffont (1979) highlight the inherited risk associated with entrepreneurship, and show that more risk-averse agents prefer to be workers rather than entrepreneurs. More recently, there is a growing literature on policies that limit the downside risk connected to entrepreneurship. Hombert et al. (2018) evaluate the effect of introducing a generous downside insurance for unemployed individuals starting their own businesses in France, and find that such a policy increases the number of entrepreneurs. In a related study, Bird (2001) finds that a higher degree of redistribution is positively related to measures of risk, implying that an extensive welfare state may induce risk-taking. Gottlieb et al. (2016) use a natural experiment in Canada to evaluate the importance of career considerations for entrepreneurship. They find that increased downside-insurance opportunities, in the form of job-protected leave entitlements, increase the entrepreneurship among those entitled.4 Theoretically, our paper is also related to Garcia-Penalosa and Wen (2008) and Gaillarda and Kankanamge (2018), who provide a theoretical foundation for the importance of downside insurance in occupational choice when agents are risk averse. In the framework by Gaillarda and Kankanamge (2018), agents can also exert effort at work or in order to find a business idea. We differ from these papers

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4See, for example, Parker and Robson (2004) and Koellinger and Minniti (2009) for studies that find a negative relationship between replacement rates and self-employment. A crucial determinant for the relationship between replacement rates and self-employment appears to be whether benefits are available for self-employed and employed individuals alike. See also Kreiner et al. (2015) for an analysis of the distortionary effects of taxation. Their analysis, however, does not explicitly consider entrepreneurs or the presence of an insurance motive.
by considering both private and public risk-sharing in an encompassing framework, as well as allowing for both an occupational choice and an effort choice, where the latter is on the "job" and specific for entrepreneurs.

Finally, our paper is related to models of occupational choice and wealth inequality comprising Banerjee and Newman (1993), Quadrini (2000) and Cagetti and De Nardi (2006).\(^5\) The last paper departs from the observation that "most rich people are entrepreneurs" (p. 839), and models occupational choice in the presence of borrowing constraints, where inherited wealth can be used as collateral for entrepreneurs. Cagetti and De Nardi (2006) focus on how saving behavior affects wealth accumulation and wealth inequality, whereas we focus more directly on how the distribution of initial assets affects occupational choice. In another study, Celik (2018) models how parental background affects the probability of becoming an inventor, by affecting early investments in education and credentialing. In Section 3.2, we further discuss the empirical evidence on the importance of parental background for entrepreneurship, but in the theoretical model we only indirectly account for parental background by considering its implicit relation to initial assets.

The rest of the paper is organized as follows. Section 3.2 combines cross-country data and previous empirical findings on innovation, inequality and risk-sharing, to identify a set of stylized facts that motivate our theoretical framework. In Section 3.3, we present a simple model of occupational and effort choice. The model is solved and the results are presented and analyzed in Section 3.4. Section 3.5 provides a brief discussion and Section 3.6 concludes the paper.

\(^5\)See also De Nardi (2004) for a joint analysis of social insurance and intergenerational links to analyze wealth accumulation.
3.2 Empirical Motivation

3.2.1 Country-level data

In this section we combine cross-country data and estimates from previous research to establish key stylized facts. We focus on the relationship between: (i) risk-sharing and innovation, (ii) inequality and innovation, and (iii) risk-sharing and inequality. We use data for OECD countries and focus on countries that can be characterized as CME or LME countries. We also look more closely at evidence from the United States and Sweden. We first consider several measures of innovative activity to document which countries are the most innovative. Then, we move on to consider country characteristics related to risk-sharing and inequality.

**Innovation** The type of innovative activity we have in mind is entrepreneurial rather than intrapreneurial, i.e., we are interested in individuals who start their own firms rather than individuals who are employed, and we think of individuals who choose to forgo a secure income for a riskier outcome. This means that we are not only interested in patents and R&D, but rather in all types of activities that can be classified as entrepreneurial. Henrekson and Stenkula (2016) define entrepreneurship as consisting of three parts; (i) to discover and create new economic opportunities, (ii) to introduce ideas in the market under uncertainty, and (iii) to create value. This is also, broadly speaking, the definition we have in mind for this paper. We do not have cross-country data measuring entrepreneurial activity per se. Instead we combine three different types of measures of innovative activity to cover our definition of entrepreneurship.

First, we look at patent applications, filed under the Patent Cooperation Treaty (PCT), per 1000 inhabitants.\(^6\) Figure 3.1 shows the evolution of filed patents between 1995–2015. In panel (b) we note that the United States appears to be somewhat of an outlier with more patents than the

\(^6\)Data on population and patents come from the OECD, and we look at total patents filed under the PCT by the inventor's country of residence.
other countries in the LME group while, in panel (a), most CME groups outperform the OECD average. There are several available measures of patents, and we evaluate two other measures to ensure that there are no large differences as compared to our conclusions. Furthermore, Table 3.1 gives us a snapshot of the top ten countries in terms of patents by industry (biotechnology, IT, medical technology, pharmaceuticals and nanotechnology) in the year 2013 (the latest year available). We find both the United States and Sweden in the top ten in the first four categories, and the United States in the top ten in the fifth category, along with both CME and LME countries. We conclude that, in terms of patents, both coordinated and liberal market economies are found among the most innovative countries.

**Table 3.1: Top ten countries in patents by industry, 2013**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Biotechnology</th>
<th>ICT</th>
<th>Medical Technology</th>
<th>Pharmaceuticals</th>
<th>Nanotechnology</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Denmark</td>
<td>Sweden</td>
<td>Iceland</td>
<td>Switzerland</td>
<td>Switzerland</td>
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<tr>
<td>2</td>
<td>Switzerland</td>
<td>Finland</td>
<td>Israel</td>
<td>Denmark</td>
<td>South Korea</td>
</tr>
<tr>
<td>3</td>
<td>Israel</td>
<td>Japan</td>
<td>Netherlands</td>
<td>Israel</td>
<td>France</td>
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<tr>
<td>4</td>
<td>United States</td>
<td>Israel</td>
<td>Switzerland</td>
<td>United States</td>
<td>Iceland</td>
</tr>
<tr>
<td>5</td>
<td>Netherlands</td>
<td>South Korea</td>
<td>Denmark</td>
<td>South Korea</td>
<td>United States</td>
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<td>Finland</td>
<td>United States</td>
<td>United States</td>
<td>Belgium</td>
<td>United Kingdom</td>
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<tr>
<td>7</td>
<td>South Korea</td>
<td>Switzerland</td>
<td>Japan</td>
<td>Netherlands</td>
<td>Denmark</td>
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<tr>
<td>8</td>
<td>Sweden</td>
<td>Netherlands</td>
<td>Sweden</td>
<td>Sweden</td>
<td>Belgium</td>
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<tr>
<td>9</td>
<td>Japan</td>
<td>Germany</td>
<td>New Zealand</td>
<td>Norway</td>
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</tr>
<tr>
<td>10</td>
<td>Belgium</td>
<td>Denmark</td>
<td>Ireland</td>
<td>Slovenia</td>
<td>Netherlands</td>
</tr>
</tbody>
</table>

Source: OECD Statistics. Measured in terms of patents per capita.

Patents have been used in many studies as a proxy for innovation and therefore serve as a natural starting point (for recent examples, see Bell et al. (2017), Aghion et al. (2018) and Celik (2018)). At the same time, there are clear drawbacks to using patents as a measure of innovation, since they only measure a narrowly defined type of innovation. Innovation in the form of patents is often carried out in large firms by intrapreneurs. We instead want to focus on innovation that is entrepreneurial, i.e., innovation carried out by individuals. Furthermore, agents can fulfill all three

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7 The other measures we use are patents granted by the European Patent Office (EPO) and patents granted by the United States Patent and Trademark Office. These measures give similar results, and the main difference is that the United States have more granted patents by the USPTO than by the EPO, compared to EU countries, which is not surprising.
Figure 3.1: Innovation measures: patent applications

(a) Patent applications under PCT (CME)

(b) Patent applications under PCT (LME)

(c) Patent applications under PCT (Sweden and the United States)

criteria of entrepreneurship above without being able to file for a patent. Therefore, we turn to a second broader measure of innovation defined by the Global Innovation Index. In Table 3.2 we present the Global Innovation Index rankings from the last five years. We note that, using this broad innovation measure, both Sweden and the United States are in the

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For example, someone could choose to import and sell a foreign product that was not previously sold in the home market. The importer could not patent this product, but would still fulfill all three criteria for entrepreneurship.

This index is designed to capture both input characteristics that facilitate innovation and output measures of innovative activity. The input channels, for example institutions, include human capital and research, infrastructure as well as market and business sophistication. Output measures include knowledge, technology and creative output.
top ten for all years, together with other CME and LME countries. In fact, Sweden has been ranked above the United States for five consecutive years, suggesting that countries with low inequality and a generous welfare system are also able to promote innovation. Table 3.3 shows a similar picture using the Global Entrepreneurship and Development Index, although the United States is ranked higher in this index. We also consider the Economist Intelligence Unit's innovation indices in Table 3.4 (EIU, 2009). We look at three index measures from the EIU to compare innovation across countries; the innovation performance index, the innovation environment index and the innovation enablers index. These indices show a similar picture. Finally, we consider survey evidence from the Global Entrepreneurship Monitor, which classifies self-employment as being driven either by necessity or opportunity. Self-employment by opportunity is defined as driven by improvement, with increased income or independence as the main motivation, and it is thus close to our definition of entrepreneurship. Sometimes, total self-employment is used as a measure of entrepreneurship in the literature. The reason why we do not use this measure is that individuals can become self-employed for many different reasons.\(^{10}\) Figure 3.2 shows the percent of self-employed individuals who are self-employed by opportunity (as an average over the years 2005 to 2015). We see that both types of countries, LME and CME, are found above the OECD average, and that Sweden and the United States both have a relatively high share of self-employment by opportunity. From the motivational index calculated by the Global Entrepreneurship Monitor (the share of opportunity driven entrepreneurs divided by the share motivated by necessity), we note that Sweden does, on average, score higher than the United States, with an index of 8.14 on average between the years 2011 and 2016, as compared to an index of 4.07 for the United States. The OECD average is slightly lower than the

\(^{10}\)Individuals who become self-employed out of necessity do not fulfill the above mentioned criteria for entrepreneurship and should not be associated with innovation. One can also show that, across countries, total self-employment is, in fact, negatively related with many other proxies for innovation, and has a u-shaped relationship with GDP per capita.
United States average at 3.74 (Table 3.6 in Appendix 3.B). We move on to consider the relationship between risk-sharing and innovation.

**Table 3.2: Top ten countries in the Global Innovation Index**

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<td>Germany</td>
<td>Denmark</td>
<td>Hong Kong</td>
<td>Ireland</td>
</tr>
</tbody>
</table>

Source: Global Innovation Index.

**Table 3.3: Top ten countries in the Global Entrepreneurship and Development Index**

<table>
<thead>
<tr>
<th>Rank</th>
<th>2018</th>
<th>2017</th>
<th>2016</th>
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</thead>
<tbody>
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<td>France</td>
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</tbody>
</table>

Source: Global Entrepreneurship and Development Index.

**Table 3.4: Top ten countries in the EIU’s Innovation performance indices, 2004-2008**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Innovation performance</th>
<th>Innovation environment</th>
<th>Innovation enablers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>Denmark</td>
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<tr>
<td>2</td>
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<td>4</td>
<td>United States</td>
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<td>Switzerland</td>
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<td>Denmark</td>
<td>Canada</td>
<td>Israel</td>
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</tbody>
</table>

Source: Economist Intelligence Unit.
3.2. EMPIRICAL MOTIVATION

Figure 3.2: Percent of self-employed motivated by opportunity, 2005-2015

Public risk-sharing  The degree of public risk-sharing in an economy can be measured in different ways. Here we consider average replacement rates as a proxy for the type of unemployment insurance that is available for failed entrepreneurs.\(^{11}\)

\(^{11}\)We use OECD data from 2005 to 2015 (the results are very similar if we use the time period 1995–2015 for variables with available data). We plot average values and focus on countries classified as CME or LME. We also perform the analysis for the full OECD sample with similar results (the results are available upon request). Net replacement rates are defined as the five-year average of the net unemployment benefit (including social assistance and cash housing assistance) for two earnings levels and three family situations (OECD Wages and Benefits, 2015). In addition to different replacement rates, countries differ in terms of how much access a self-employed person has to unemployment insurance. In Sweden, self-employed individuals have access to the same unemployment benefits as those who are employed, under the condition that they do not actively manage their business while receiving benefits. In the United States, fewer entrepreneurs are in general eligible for unemployment benefits. If you run your business as a sole proprietorship (which is the default choice for American entrepreneurs according to the Small Business Administration) you are not eligible for any unemployment insurance. If you register your firm as a corporation and hire yourself as an employee, you will, in most states, be eligible for the same unemployment benefits as an employed individual. The benefit is funded by payroll taxes. See Hasler and Rodriguez-Mora (1999) for an analysis of the political determination of unemployment insurance, departing from observed differences between Europe and the United States.
In Figure 3.3, we show the (unconditional) relationship between replacement rates and innovation. We note that replacement rates are positively correlated with patents per capita and self-employment by opportunity, our two measures of innovation. For both measures of innovation the United States appears to be an outlier, showing that it is possible to achieve high innovation rates without high public risk-sharing and a generous welfare system. The individual replacement rate generally depends on several factors, such as the family composition and their income level. The many factors behind the level of individual replacement rates make conclusions from these data potentially ambiguous. To substantiate our understanding of the role of risk-sharing we also consider four other types of measures: social expenditures, private expenditures on health care, income taxes (since taxes can be indicative of the degree of risk-sharing), and public expenditures on education and childcare. These results paint a very similar picture - there is a positive relationship between our measure of risk-sharing and innovation - and are available upon request.

Figure 3.3: Innovation and replacement rates (average across 2005-2015)

(a) Patents  (b) Self-employment by opportunity

Before turning to an analysis of the relationship between innovation and

\footnote{Hassler et al. (2007) discuss a negative correlation between inequality and mobility in relation to public spending on education.}

\footnote{Note that for these measures, Ireland is no longer an outlier in the LME group.}
3.2. EMPIRICAL MOTIVATION

inequality, we briefly look at the relationship between public risk-sharing and inequality. We use the Gini coefficient for income as our measure of inequality within a country.\(^{14}\) Figure 3.4 shows that there is a negative relationship between our measure of risk-sharing and the Gini coefficient. This confirms our intuition behind the split between CME and LME countries.\(^{15}\)

**Figure 3.4: Inequality and replacement rates (average across 2005-2015)**

(a) Replacement rates

![Graph showing the relationship between Gini coefficient and replacement rates.

Inequality and private risk-sharing** Inequality has been suggested as a driving force for innovation because of its implications for incentives and effort. Another way in which inequality may matter for innovation, in addition to providing incentives, is through selection to the pool of entrepreneurs. As we discuss below, individuals with more resources are often more likely to become entrepreneurs or inventors. This could, among other things, be because financial assets can act as a type of private risk-sharing in case of failure, implying that inequality can matter

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\(^{14}\)There are several measures of inequality available and we have chosen to use the measure provided by the Standardized World Income Inequality Database. We utilize the measure of net Gini, which uses the equivalized (square root scale) household disposable (post-tax, post-transfer) income, using Luxembourg Income Study data as the standard, to measure the Gini coefficient. See Solt (2016) for more information about the database.

\(^{15}\)Note that Sweden and the United States are much more similar in terms of the Gini coefficient for wealth. We argue that there still is a substantial difference in the amount of public versus private risk-sharing between these two countries.
for which individuals are able to choose entrepreneurship.

**Figure 3.5: Innovation and inequality (average across 2005-2015)**

(a) Patents

(b) Self-employment by opportunity

In panel (a) of Figure 3.5 we show the unconditional relationship between inequality and patents per capita. We see that there is a clear division between the LME and CME countries, where LME countries have a higher Gini coefficient. The United States appears to be somewhat of an outlier with more patents and more inequality as compared to the other LME countries. Turning to panel (b), we instead look at self-employment by opportunity and inequality and see a very similar pattern. Again, the United States is an outlier with higher inequality than the rest of the other high-innovation countries. These unconditional correlations suggest that inequality is negatively associated with innovation, but that some high-inequality countries are still quite innovative. As mentioned above, private risk-sharing, in the form of savings or parental transfers, might facilitate entrepreneurship and innovation in an environment with high inequality. There are differences also in terms of parental transfers. For example, average bequests and inter-vivos transfers are larger in the United States than in Sweden. The difference is even larger when we only look at bequests and transfers received by self-employed individuals.  

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16 There are, of course, clear limitations to studying unconditional correlations at the country level. At the state level within the United States, see Akerlind et al. (2017) who find that broad measures of income inequality are negatively related to innovation.

17 Laitner and Ohlsson (2001) show that the average inherited amount, conditional
3.2. EMPIRICAL MOTIVATION

It is possible that family background is more important in countries with a larger reliance on private risk-sharing (and with lower public risk-sharing). Bell et al. (2017) look at patents and family background in the United States and find that having wealthy parents increases the probability of being an inventor. More specifically, children of parents in the top 1 percent of the income distribution are ten times more likely to become inventors than children of parents in the bottom half of the distribution and individuals with parents in the top 5 percent of the income distribution are 3.5 times more likely to become inventors than the mean. In a similar study on Finnish data, Aghion et al. (2018) also find that the relationship between parent income and innovation is positive. Comparing the estimates in Aghion et al. (2018) to the ones from Bell et al. (2017), the former study finds that having parents in the top 5 percent increases the probability of becoming an inventor 2.4 times, as compared to the mean. More importantly, in Finland, this gap is almost fully explained by other factors such as parental education and individual ability (IQ). In the United States, ability explains less than one third of the innovation gap. Using historic data, Akcigit et al. (2017) show that, in the United States, parental income matters for the probability of becoming an inventor, and that one potential mechanism is through access to own
education. Furthermore, survey evidence from the International Social Survey Program shows that Americans believe that family background (parental income and education) is more important to become successful than do Swedes. Overall, we argue that parental background, and more importantly parental transfers, are likely to be a more important determinant of entrepreneurship in countries like the United States, compared to countries like Sweden, and that this can have important implications for innovation and entrepreneurship. In Section 3.2.2, we discuss examples of how parental background may be more important in the United States as compared to Sweden.

**Effort**  Many factors matter for innovation. One factor, which we have not discussed so far, is that individual entrepreneurs can affect their own probability of success through effort, and that their propensity to do so may depend on the level of public risk-sharing. Many entrepreneurs work more hours than the average employee. This appears to be the case both in countries such as the United States and in Sweden. However, recent literature has highlighted large differences in the general hours worked across countries and, in particular, that Europeans work fewer hours than Americans in the aggregate. For a recent contribution, Bick et al. (2018) utilize data from national labor force surveys to document differences in working hours. They find that Scandinavians work on average 14 percent less hours as compared to Americans, and that the main explanation for this, in Scandinavia and Western Europe, is less weekly hours worked. Their data include both employees and self-employed individuals, but the authors argue that the results are robust to defining self-employment as a separate sector. One potential explanation for the difference in hours is differences in policy, and in particular taxes (see, for example, Olovsson (2009)). Lindbeck and Nyberg (2006) offer a complementary perspective arguing that a generous social insurance appears to weaken parents’ incentives to instill norms on work effort in their children. These findings

---

19 See the International Social Survey Program on Social Inequality conducted in 2009.
indicate that we should see more individuals choosing to exert effort in a low risk-sharing economy, compared to in an economy with a generous downside insurance.

Next we consider anecdotal evidence on the importance of family background for American and Swedish entrepreneurs, before moving on to the theoretical framework.
CHAPTER 3. RISK-SHARING AND ENTREPRENEURSHIP

3.2.2 Anecdotal evidence on the breeding ground for unicorns

Some researchers have argued that the United States can never apply the Nordic model. Because if they did, the world economy would slow down. [...] Stockholm is only second to Silicon Valley in the number of newly created billion-dollar companies (unicorns) per million residents, 6.3 compared with 7.3, in the whole world. [...] Social safety nets, free and high-quality education and free health care create ideal conditions for as many people as possible to have the opportunity to realize their ambitions [...]. Therein lies the key to Sweden performing well above what would be expected of our size in so many areas. We are the land of opportunity.

Sebastian Siemiatkowski, Founder and CEO of Klarna, DN Debatt, June 2015 [authors’ translation].

The above quote summarizes the idea, brought forward by proponents of high public risk-sharing, that a generous welfare system may help entrepreneurs realize their dream regardless of their background. The man behind that quote, Sebastian Siemiatkowski, is a successful entrepreneur himself, with first-hand experience of this "land of opportunity". His parents came to Sweden from Poland and, as he has discussed in numerous interviews, he did not grow up in a privileged environment. His father was partly unemployed and worked as a taxi driver, while his mother was on disability pension. Still, the co-founder of the Swedish unicorn Klarna studied at the Stockholm School of Economics, a prestigious school where he also met his future business partners.

Both Sweden and the United States have innovation clusters that are comparable in terms of start-ups per capita, Stockholm and Silicon Valley, but anecdotal evidence suggests that they are inhabited by entrepreneurs from different types of backgrounds. In this part of the paper, we look at a sample of companies classified as "unicorns" in the United States and Sweden, respectively, and compare their founders’

\[20\] In 2015, Stockholm was second to Silicon Valley in terms of startups per capita, see Telegraph, June 2015.
3.2. EMPIRICAL MOTIVATION

While the United States is the home of the majority of unicorns (in 2017), Sweden is known for its high share of unicorns in proportion to its population. Klarna, the company co-founded by Sebastian Siemiatkowski, is valued at around the same as unicorns in the top 30-40s in the United States, and Spotify was ranked just after the 10th highest valued unicorn in the United States. Looking at the characteristics of the founders, several of the Swedish entrepreneurs come from non-privileged backgrounds. Two of the most famous ones, Daniel Ek, founder of Spotify, and Markus Persson, founder of Mojang, have no university degrees and grew up far from the privileged academic environment of many of their American counterparts. Out of the Swedish entrepreneurs, 70 percent have a university degree, while the corresponding number for the United States is 87 percent. Out of the American entrepreneurs, 28 percent went to schools that are ranked top ten in the world (34 percent went to schools that are top ten in the United States). In the Swedish sample, one person (6.7 percent of the sample) went to a top school in terms of international rankings. Furthermore, many of the American entrepreneurs on the list come from academic and/or wealthy backgrounds, based on information on their parents’ occupations and on their early schooling (from magazine interviews, blogs, podcasts etc.). There are, of course, exceptions, but it is also rare to find interviews with these entrepreneurs that, in any way, mention hardship or financial struggles when growing up. Among the American entrepreneurs we find names such as, for example, Joshua Kushner, son of a real estate magnate and brother of Jared Kushner, and (South Africa-born) Elon Musk. As already mentioned, the notion that

\(^{21}\)Information was gathered in January 2018 from Crunchbase Unicorn Leaderboards. A unicorn company is a startup firm valued above 1 billion USD. The companies we compare are the top 50 unicorns in the United States (as of January 2018) and Spotify, Mojang, Klarna, King, LeoVegas and Skype for Sweden. Note that Mojang, King and Skype are no longer considered to be unicorns since they have been acquired by other companies. Moreover, as of April 2018, Spotify is no longer a unicorn because of its initial public offering, but the valuation is based on data from January 2018. Details of the comparison are available upon request.

\(^{22}\)Naturally, it should be noted that many of the top ten universities are located in the United States.
entrepreneurship and innovation in the United States are more accessible if you come from a wealthy background has also been put forward in a more rigorous manner in recent papers by, for example, Akcigit et al. (2017), Bell et al. (2017) and Celik (2018). We want to use the anecdotal evidence from this section to simply highlight differences in the background of entrepreneurs in the United States and Sweden.

3.2.3 Summary of empirical findings

Our innovation indicators show that both CME and LME countries are represented in the group of top innovators. Cross-country data suggest that there is a positive relationship between risk-sharing and innovation (with innovation measured both as patents and as self-employment by opportunity). At the same time, inequality is negatively related to innovation. In this analysis of aggregate data, the United States is an outlier with low public risk-sharing, high inequality and high scores on all of our innovation measures. One possible explanation that can reconcile the relevance of public risk-sharing and the performance of countries like the United States is that they are able to compensate for the lack of public risk-sharing with high private insurance, in the form of, for example, savings and parental transfers, and high effort. Parental transfers are higher in the United States than in Sweden, which is at the other end of the spectrum when it comes to inequality and public risk-sharing, and survey evidence indicates that parental background is likely to matter more in the United States than in Sweden. Furthermore, the anecdotal evidence is in line with a difference in backgrounds between American and Swedish entrepreneurs. We also find support for the notion that American entrepreneurs work longer hours than their Swedish counterparts. Next, we incorporate the ideas suggested by the findings presented above in a simple model of occupational and effort choice.
3.3  A Model of Occupational and Effort Choice

To study the importance of risk-sharing for entrepreneurship, we develop a simple static model of occupational choice, where entrepreneurs also choose their optimal effort level, knowing their levels of assets, wages and potential profits. We think of entrepreneurship as a risky activity. With some probability, entrepreneurs are successful and make profits, but there is also a risk of failing. Unsuccessful entrepreneurs are assumed to only receive some level of insurance benefits as a result of risk-sharing. This downside insurance can either be public or private. Public insurance comprises the benefits that the government provides for entrepreneurs without income. We think of private insurance, on the other hand, as coming from the family or from private savings. Insurance from the family can stem from intergenerational ties, but here we simply assume that private insurance corresponds to holding some level of initial assets. A stronger public welfare system then means that agents are, all else equal, less reliant on private insurance. Downside insurance matters for risk averse agents, i.e., the income you get in the worst state of the world matters for whether or not you are willing to forgo a certain income. All else equal, since entrepreneurship is a risky activity, a stronger safety net through downside insurance makes risk averse agents more prone to become entrepreneurs. Compared to the literature that purely focuses on the importance of high powered incentives, i.e., sufficiently high returns for successful relative to unsuccessful entrepreneurs, we add the relevance of downside risk and risk-sharing, both public and private, when there is an occupational choice and agents are risk averse. Finally, in reality, effort may clearly affect returns, for example by affecting the probability of success. When this is the case, the return to putting in effort clearly matters. This motivates the inclusion of an effort choice.
Economic environment. The model is static, and agents work, consume and then die.\textsuperscript{23} Agents are characterized by a combination of assets, $a$, wages, $w$, and entrepreneurial profits, $\pi$ (all exogenous). We call this combination a type $t$, where $t = (a, w, \pi)$, and types are distributed according to a function $F(t)$. Agents choose whether to be entrepreneurs, denoted $E$, or workers, denoted $W$. Entrepreneurship is risky while working provides a secure income. This occupational decision, broadly inspired by the set-up in Garcia-Penalosa and Wen (2008), described in detail in Section 3.3.2, is the first decision they make.\textsuperscript{24} Then, conditional on choosing entrepreneurship, they also make an effort choice, described in Section 3.3.1. We solve the effort choice and the occupational choice by backward induction. That is, when the agent makes her occupational choice, she assumes the optimal level of effort.

We follow Acemoglu et al. (2017) in the specification of the agent’s effort choice.\textsuperscript{25} Exerting effort is costly, but it increases the probability of success. To simplify this, we specify this as a discrete choice between either exerting effort or not exerting any effort at all. Specifically, entrepreneurs choose between the two effort levels $e = 1$ and $e = 0$. Let $p_1$ denote the probability of success when exerting effort and $p_0$ the probability without effort, with $1 \geq p_1 > p_0 \geq 0$. Specifically,

$$p(e) = \begin{cases} p_1 & \text{if } e = 1, \\ p_0 & \text{if } e = 0. \end{cases} \quad (3.1)$$

Choosing to exert effort thus implies a higher probability of success, but

\textsuperscript{23}It is straightforward to incorporate the mechanisms studied in this paper in a model of endogenous growth. However, this static model captures the main aspects of interest.

\textsuperscript{24}In their setting, skilled individuals choose between working in manufacturing or entrepreneurship.

\textsuperscript{25}Specifically, we use the same utility function and condition to determine when it is optimal to exert effort. They also look at a discrete choice (effort/no effort). Acemoglu et al. (2017) embed the effort choice of entrepreneurs in a model of endogenous technological change with knowledge spillovers. They include the effort choice as a moral hazard problem with a social planner that ultimately decides on the reward structure. The reward structure implies either perfect or imperfect consumption insurance.
it comes at a cost $\eta(e)$. The individual has a total time endowment of 1, and there is an effort cost in terms of foregone leisure time. For the agent who does not exert effort, there is no cost:

$$\eta(e) = \begin{cases} 
\eta(1) > 0 & \text{if } e = 1, \\
\eta(0) = 0 & \text{if } e = 0.
\end{cases} \quad (3.2)$$

Agents value consumption and leisure. We specify utility for entrepreneurs, $U_E$, as a CRRA function of consumption and effort. Specifically, consumption is scaled by available leisure time. The utility of workers, $U_W$, is a CRRA function of consumption only, since workers do not make an effort choice.

$$U_E(c_E, e) = \begin{cases} 
\left(\frac{(c_E[1-\eta(1)])^{1-\theta}}{1-\theta}\right) & \text{if } e = 1, \\
\left(\frac{(c_E[1-\eta(0)])^{1-\theta}}{1-\theta}\right) & \text{if } e = 0,
\end{cases} \quad U_W(c) = \frac{c_W^{1-\theta}}{1-\theta}.$$ 

$\theta > 1$ is the coefficient of relative risk aversion. Note that, because there are no means of saving in the model, agents simply consume their income $y_E$ or $y_W$.

We take tax rates as given. We solve for the level of downside insurance, which we call the benefit $b$, by imposing that the government runs a balanced budget (see details in Section 3.3.3).

### 3.3.1 Effort choice

The total income of a successful entrepreneur is given by $(1 - \tau)\pi + a$, where $\tau$ is the tax rate faced by entrepreneurs, $\pi$ are entrepreneurial profits, and $a$ are initial asset holdings. For an unsuccessful entrepreneur, income is instead $(1 - \tau)b + a$, where $b$ are benefits. To determine when it is optimal to exert effort, we compare the expected utility from putting in effort and the expected utility from not putting in effort, and set up an incentive compatibility constraint. This constraint says that in order
to exert effort, the expected utility of doing so must be at least as large as the expected utility of not exerting effort. The left- and right-hand side below show expected utility for \( e = 1 \) and \( e = 0 \), respectively:

\[
\frac{1}{1-\theta} \left\{ p_1 \left[ (1-\tau)\pi + a \right]^{1-\theta} + (1-p_1) \left[ (1-\tau)b + a \right]^{1-\theta} \right\} \left[ 1 - \eta(1) \right]^{1-\theta} \\
\geq \frac{1}{1-\theta} \left\{ p_0 \left[ (1-\tau)\pi + a \right]^{1-\theta} + (1-p_0) \left[ (1-\tau)b + a \right]^{1-\theta} \right\} \left[ 1 - \eta(0) \right]^{1-\theta}.
\]

(3.3)

Because \( \eta(0) = 0 \), this is equal to:

\[
\frac{1}{1-\theta} \left\{ p_1 \left[ (1-\tau)\pi + a \right]^{1-\theta} + (1-p_1) \left[ (1-\tau)b + a \right]^{1-\theta} \right\} \left[ 1 - \eta(1) \right]^{1-\theta} \\
\geq \frac{1}{1-\theta} \left\{ p_0 \left[ (1-\tau)\pi + a \right]^{1-\theta} + (1-p_0) \left[ (1-\tau)b + a \right]^{1-\theta} \right\},
\]

(3.4)

which after some algebra boils down to the following condition for the relative return of a successful and an unsuccessful entrepreneur:26

\[
\frac{(1-\tau)\pi + a}{(1-\tau)b + a} \geq \left( \frac{1-p_0 - (1-p_1)(1-\eta(1))^{1-\theta}}{p_1(1-\eta(1))^{1-\theta} - p_0} \right)^{1-\theta} \]

(3.5)

\[
\equiv A.
\]

Specifically, we collect terms to rewrite this expression as:

\[
\frac{1}{1-\theta} \left\{ p_1 \left[ (1-\eta(1))^{1-\theta} - p_0 \right] \left[ (1-\tau)\pi + a \right]^{1-\theta} \\
\geq \frac{1}{1-\theta} \left\{ 1-p_0 - (1-p_1)(1-\eta(1))^{1-\theta} \right\} \left[ (1-\tau)b + a \right]^{1-\theta} \\
\Rightarrow \frac{1}{1-\theta} \left( \frac{(1-\tau)\pi + a}{(1-\tau)b + a} \right)^{1-\theta} \geq \frac{1}{1-\theta} \left( \frac{1-p_0 - (1-p_1)(1-\eta(1))^{1-\theta}}{p_1(1-\eta(1))^{1-\theta} - p_0} \right).
\]
3.3. A MODEL OF OCCUPATIONAL AND EFFORT CHOICE

The expression denoted $A$ determines the incentives required to ensure effort. In our calibration - see Section 4.4.1 - this expression is larger than one, which means that, in order for an individual to choose to exert effort, according to the incentive compatibility constraint, the returns to successful entrepreneurs need to be higher than the returns to unsuccessful entrepreneurs. This is in line with the cutthroat economy from the model in Acemoglu et al. (2017), with imperfect consumption insurance to incentivize effort. To ensure an effort motive, we follow Acemoglu et al. (2017) and use the assumption:

**Assumption 1.**

$$\min \left\{ p_1 (1 - \eta(1))^{1-\theta} - p_0, 1 - p_0 - (1 - p_1) (1 - \eta(1))^{1-\theta} \right\} > 0. \tag{3.6}$$

This assumption ensures that the right-hand side in equation (3.5) is larger than one. An individual will then exert effort if the returns to doing so are large enough, i.e., if $(1 - \tau)\pi + a > 1$. In our calibration, this condition is fulfilled, but Assumption 1 is important for our comparative statics results. Based on the incentive compatibility constraint, we define a threshold for the effort choice:

**Proposition 3.1.** There exists a threshold $\bar{E}$ consistent with the incentive compatibility constraint in equation (3.4) that defines the cutoff in terms of net of taxes benefits $(1 - \tau)b$ below which agents choose to exert effort as entrepreneurs:

$$(1 - \tau)b \leq \bar{E} = \frac{(1 - \tau)\pi + a}{A} - a. \tag{3.7}$$


**Lemma 3.1.** Under Assumption 1, the threshold $\bar{E}$ is increasing in $\pi$ and decreasing in $a$ and $\tau$.

See Appendix 3.A.1 for details. The threshold in equation (3.7) defines the level of (net of taxes) benefits below which agents choose to exert effort. If the benefits are too high, nobody has incentives to exert effort,
because they know they will be covered if they fail, and the payoff to putting in effort is then too small. What Lemma 3.1 tells us is that this threshold is higher if the returns to being an entrepreneur increase, which means that agents choose to exert effort at higher levels of the benefit when the profits go up. This is the case if the profits increase or if the tax rate faced by entrepreneurs, $\tau$, decreases. Moreover, agents exert effort at higher levels of the benefits for lower levels of the private asset $a$. This is in line with our intuition, because assets can be considered a type of private insurance.

To summarize, the solution to the effort choice is given by:

$$e(\Omega) \equiv \begin{cases} 1 & \text{if LHS of equation (3.4) } \geq \text{ RHS of equation (3.4)}, \\ 0 & \text{if LHS of equation (3.4) } < \text{ RHS of equation (3.4)}, \end{cases}$$

(3.8)

with $\Omega = (b, \tau, \eta(1), \eta(0), \theta, t)$. Note that while $t$ is defined as $t = \{a, w, \pi\}$, the effort choice does not depend on wages, $w$. The agent then makes her occupational choice taking this optimal effort level into account.

3.3.2 Occupational choice

The occupational choice is between becoming an entrepreneur, $E$, and being a worker, $W$. Entrepreneurship is risky. In what follows, to simplify the notation, define $p(e(\Omega)) \equiv \hat{p}(\Omega)$, where $e(\Omega)$ is the optimal effort level according to equation (3.8). With probability $\hat{p}(\Omega)$ agents succeed and make entrepreneurial profits $\pi$. The probability of success is thus a function of the effort choice, as defined in equation (3.1).

The total income of a worker, $y_W$, is given by $(1 - \tau_w)w + a$, where $\tau_w$ is the tax faced by workers and $w$ is the wage. For an entrepreneur, income, $y_E$, is $(1 - \tau)\pi + a$ with probability $\hat{p}(\Omega)$, and $(1 - \tau)b + a$ with probability $1 - \hat{p}(\Omega)$. We compare the expected utility that agents get if they choose to be entrepreneurs to the utility from being workers
(remember that agents consume all of their income). Just like for the probability of success, the cost also depends on effort choice through the cost function $\eta(e)$. For simplicity, define $\eta(e(\Omega)) \equiv \hat{\eta}(\Omega)$, where $e(\Omega)$ again is the optimal effort level according to equation (3.8). The cost function is defined in equation (3.2).

Agents choose between being entrepreneurs and workers to maximize the expected utility. We set up the incentive compatibility constraint for this choice. For an agent to choose entrepreneurship, we require that the expected utility from choosing to be an entrepreneur is at least as high as that from choosing to be a worker:

$$
\frac{1}{1 - \theta} \left\{ \hat{p}(\Omega) \left[ (1 - \tau) \pi + a \right]^{1-\theta} + (1 - \hat{p}(\Omega)) \left[ (1 - \tau) b + a \right]^{1-\theta} \right\} \left[ 1 - \hat{\eta}(\Omega) \right]^{1-\theta} \\
\geq \frac{1}{1 - \theta} \left[ (1 - \tau_w) w + a \right]^{1-\theta},
$$

(3.9)

where we can write the left-hand side as $E[U^E(y_E, e(\Omega))]$ and the right-hand side as $U^W(y_W)$. The option that gives the highest value according to

$$
E[U(y)] = \max \left\{ E[U^E(y_E, e(\Omega))], U^W(y_W) \right\}
$$

(3.10)

determines the occupational choice. Next, we solve for a threshold value of net of taxes benefits, $\hat{T}$, for agents to choose entrepreneurship:

**Proposition 3.2.** There exists a threshold $\hat{T}$ consistent with the incentive compatibility constraint in equation (3.9) that defines the cutoff for public insurance above which agents choose to become entrepreneurs:

$$(1 - \tau)b \geq \hat{T} = \left\{ \frac{1}{1 - \hat{p}(\Omega)} \cdot \frac{1}{[1 - \hat{\eta}(\Omega)]^{1-\theta}} \cdot \left[ (1 - \tau_w) w + a \right]^{1-\theta} - \frac{\hat{p}(\Omega)}{1 - \hat{p}(\Omega)} \cdot \left[ \hat{p}(\Omega) \right]^{1-\theta} \right\}^{1-\theta} - a.
$$

(3.11)
CHAPTER 3. RISK-SHARING AND ENTREPRENEURSHIP

See Proof 3.A.2 in Appendix 3.A.2 for details. In order to derive comparative-statics properties for how primitives affect $\bar{T}$, it is useful to define $\kappa$ as follows:

$$\kappa = \frac{1}{1 - \hat{p}(\Omega)} \cdot \frac{1}{[1 - \hat{\eta}(\Omega)]^{1-\theta}} \cdot \left[(1 - \tau)w + a\right]^{1-\theta} \cdot \left[(1 - \tau)\pi + a\right]^{1-\theta}$$

Next, we show comparative statics results conditional on the assumption that $\kappa > 0$. This is the case if the following conditions are satisfied:

**Assumption 2.**

$$\frac{1}{[1 - \eta(1)]^{1-\theta}} \cdot \left[(1 - \tau)w + a\right]^{1-\theta} > p_1 \cdot \left[(1 - \tau)\pi + a\right]^{1-\theta}$$

$$\left[(1 - \tau)w + a\right]^{1-\theta} > p_0 \cdot \left[(1 - \tau)\pi + a\right]^{1-\theta}$$

$$\theta > 1.$$

Lemma 3.2 summarizes the comparative statics for this expression:

**Lemma 3.2.** Consider parameter values such that Assumption 2 is satisfied. Then the threshold $\bar{T}$ increases in $w$ and decreases in $\tau_w$.

Comparative statics for $\pi$, $\tau$, and $a$ require some more thought. A change in any of these variables can also have an impact on the effort choice, and thus on the effective probability of success $p(e)$. For example, the threshold $\bar{T}$ decreases in $\pi$. If the agent’s optimal effort choice goes from $e = 0$ to $e = 1$, because of the increase in profits, then the effect on $\bar{T}$ is reinforced because of the increase in the probability of success. An increase in $\tau$, on the other hand, increases the threshold $\bar{T}$. If effort also goes down, the effect on $\bar{T}$ is reinforced as the probability of success is diminished. Finally, higher initial assets lower the threshold as long as they do not push the agent from $e = 1$ to $e = 0$, because the threshold for effort decreases in assets. If the optimal effort level changes, this
counteracts the effect on the occupational choice threshold. See Appendix 3.A.2 for a verbal proof.

The threshold for the occupational choice, in equation (3.11), gives us the level of (net of taxes) benefits above which agents choose to become entrepreneurs. If the benefits are too low, agents will choose the safe option of being workers instead. If the return to successful entrepreneurs increases, this threshold decreases and more agents choose entrepreneurship. The opposite is true at higher incomes from being a worker or higher tax rates facing entrepreneurs. Furthermore, if the probability of success is high, agents accept less risk-sharing and the threshold is lower.

Finally, a higher level of initial assets has an ambiguous effect on the occupational threshold, since the level of initial assets can also affect the effort choice. However, if the effort choice is unchanged, a higher level of initial assets imply a lower threshold, and then agents choose entrepreneurship at lower levels of the benefits. This implies that private risk-sharing, in that case, can function as a substitute for public risk-sharing.

The solution to the problem in equation (3.10) is an indicator function:

$$O(\tau, \tau_w, b, \theta, t) = \begin{cases} 
1 & \text{if } E, \\
0 & \text{if } W. 
\end{cases}$$

### 3.3.3 The government budget and taxation

Here we specify the type of public risk-sharing available in the model and how the benefit level, $b$, is determined. We model public risk-sharing as benefits from the government, i.e., the financial support received by unsuccessful entrepreneurs. To simplify, we assume that the tax rate is the same for wages, profits and the benefit, i.e., $\tau_w = \tau$. To highlight that wages and profits vary with the type $t$, we here denote wages $w_t$.
and profits \( \pi_t \). The government operates a balanced budget, which means that expenditures need to equal revenue. Remember that we defined \( p(e(\Omega)) \equiv \tilde{p}(\Omega) \). Expenditures are then defined as:

\[
E = \int b[1 - \tilde{p}(\Omega)] O(\tau, b, \theta, t) F(t) dt \\
= b \int [1 - \tilde{p}(\Omega)] O(\tau, b, \theta, t) F(t) dt,
\]

i.e., as the integral over types \( t \), where \( b \) are benefits paid out to unsuccessful entrepreneurs (which do not vary with type \( t \)), \( 1 - \tilde{p}(\Omega) \) is the share of entrepreneurs who are not successful, as a function of the optimal effort choice, \( O(\tau, b, \theta, t) \) is the indicator function from the occupational choice, i.e., it is one if the agent is an entrepreneur and zero if the agent is a worker, and \( F(t) \) is the distribution over types \( t \). Revenues are given by:

\[
R = \int \tau \pi_t \tilde{p}(\Omega) O(\tau, b, \theta, t) F(t) dt \\
+ \int \tau b \[1 - \tilde{p}(\Omega)] O(\tau, b, \theta, t) F(t) dt \\
+ \int \tau w_t \[1 - O(\tau, b, \theta, t)] F(t) dt \\
= \tau \int \pi_t \tilde{p}(\Omega) O(\tau, b, \theta, t) F(t) dt \\
+ \tau b \int [1 - \tilde{p}(\Omega)] O(\tau, b, \theta, t) F(t) dt \\
+ \tau \int w_t [1 - O(\tau, b, \theta, t)] F(t) dt,
\]

where \( 1 - O(\tau, b, \theta, t) \) is equal to one if the agent is a worker. A balanced budget requires that expenditures equal revenues:
3.3. A MODEL OF OCCUPATIONAL AND EFFORT CHOICE

\( b \int [1 - \hat{p}(\Omega)] O(\tau, b, \theta, t) F(t) dt = \tau \int \pi_t \hat{p}(\Omega) O(\tau, b, \theta, t) F(t) dt \)
\( + \tau b \int [1 - \hat{p}(\Omega)] O(\tau, b, \theta, t) F(t) dt \)
\( + \tau \int w_t [1 - O(\tau, b, \theta, t)] F(t) dt. \)

(3.12)

We solve for \( b \), the benefit that an individual entrepreneur can expect in case of failure, as:

\[ b = \frac{\tau \int \pi_t \hat{p}(\Omega) O(\tau, b, \theta, t) F(t) dt + \tau \int w_t [1 - O(\tau, b, \theta, t)] F(t) dt}{(1 - \tau) \int [1 - \hat{p}(\Omega)] O(\tau, b, \theta, t) F(t) dt}. \]

(3.13)

3.3.4 Equilibrium definition

Given a population distributed according to the function \( F(t) \), an equilibrium of this model is defined by:

1. The effort level of an agent is determined by equation (3.8).
2. The occupational choice of an agent is defined by \( O(\tau, b, \theta, t) \), which solves equation (3.10).
3. The government runs a balanced budget in line with equation (3.12).
3.4 Analysis of the Model

We now turn to a quantitative evaluation of the model. Here we solve the model for different levels of taxes, which in turn result in different benefit levels. To study the importance of public risk-sharing, we look at the share of agents who choose to become entrepreneurs and the share of entrepreneurs who exert effort. Furthermore, we analyze the composition of entrepreneurs in terms of assets (private risk-sharing), wages, and profits.

3.4.1 Calibration

Agents are characterized by their type $t$, i.e., some level of wages $w$, profits $\pi$, and initial assets $a$. For the calibration of $F(t)$, we first assume that the marginal distributions for these three variables are log-normal and choose parameters from data for the United States. We select $\mu_w$ from the log of median earnings and $\sigma_w$ to match the income Gini in the United States. For initial assets, we use information on net wealth in the United States. The positive part of the net wealth distribution is fairly well represented by a log-normal distribution. Thus, we choose parameter values from the net wealth distribution and assume a log-normal distribution. We select the parameter $\mu_a$ from the log of median net wealth in the United States. We calibrate $\sigma_a$ to match the net wealth Gini coefficient. We find the values for $\sigma_a$ and $\sigma_w$ by iterating on the standard deviations until we match the respective Gini coefficients.\(^{27}\)

For the wage and net wealth distributions, we choose parameters from the data as described above, but we also need to specify the distribution for profits. In our baseline case, we assume that the $\mu$-parameter for profits is the same as for wages, i.e., that $\mu_w = \mu_\pi$, but that the profits have a higher $\sigma$-parameter: $\sigma_w < \sigma_\pi$.

We simulate 250,000 values of $w$, $\pi$, and $a$, which gives us a sam-

\(^{27}\)We select values for median earnings and median net wealth from Rios-Rull and Kuhn (2016). We match Gini coefficients of 0.38 for earnings (Cagetti and De Nardi, 2006), and 0.83 for net wealth (Cowell et al., 2017).
ple of 250,000 individuals, or types. Specifically, we construct the three distributions by first drawing three marginal normal distributions with a specified correlation structure: \( \rho \). In the next step we transform the marginal distributions into log-normal variables that are related through the co-variance matrix. This step gives us three log-normally distributed variables with an updated correlation matrix \( \tilde{\rho} \), where \( \tilde{\rho} \) is not identical to \( \rho \) (we report \( \tilde{\rho} \) for each specification below). We vary the correlations between wages and assets, \( \rho_{w,a} \), between profits and assets, \( \rho_{\pi,a} \), and between profits and wages, \( \rho_{\pi,w} \). Specifically, we use the correlation structures \( \varrho^1 = \{ \rho^1_{w,a} = 0.21, \rho^1_{\pi,a} = 0.46, \rho^1_{\pi,w} = 0.06 \} \), \( \varrho^2 = \{ \rho^2_{w,a} = 0.05, \rho^2_{\pi,a} = 0.46, \rho^2_{\pi,w} = 0.07 \} \) and \( \varrho^3 = \{ \rho^3_{w,a} = 0.05, \rho^3_{\pi,a} = 0.06, \rho^3_{\pi,w} = 0.23 \} \). This implies that using \( \varrho^1 \), the correlation between assets and wages, and assets and profits, respectively, is more similar as compared to the correlation under \( \varrho^2 \), although the correlation with profits is still higher. The correlation between profits and wages is much lower in both cases. We base the correlation structure loosely on the information in Rios-Rull and Kuhn (2016), with a lower correlation between business income and wage income. Finally, in \( \varrho^3 \) the correlation between assets and the two other variables is weaker, while we instead choose a higher correlation between wages and profits. We remove individuals in the top 99 percent of the asset distribution, and solve the model for this distribution.\(^{28}\)

Finally, the parameters that remain to be specified are \( \theta \), \( p_1 \) and \( p_0 \), and \( c \). We set \( \theta \), the coefficient of relative risk aversion, to 1.5 following Cagetti and De Nardi (2006). In our baseline model, we set \( p_1 = 0.9 \) and \( p_0 = 0.1 \), which implies that there is a much higher probability of success if the individual entrepreneur chooses to exert effort. In the baseline calibration, we assume that the cost of effort, \( c \), is \( 1/20 \), implying that the utility of entrepreneurs who exert effort is scaled by 0.95.

\(^{28}\)We also solve the model including all individuals and the results are qualitatively very similar. The interpretation and illustration are somewhat easier without the outliers in terms of initial assets.
3.4.2 Solving the model

We solve the model for 20 different values of the tax rate $\tau \in \{0.05, \ldots, 0.95\}$. For each value of $\tau$, we iterate on possible values for the benefit $b$ to solve equation (3.13). This is carried out to find the value of $b$ that balances the government budget, so that total expenditures equal total revenues. To find total expenditures and total revenues, we need to know the number of agents who choose to be entrepreneurs and workers, respectively, given a benefit level $b$. For this purpose, we first solve the effort choice and the occupational choice for the 250,000 individuals for a given level of $b$. Then, knowing the probability of success $p(e)$, as a function of the optimal effort choice, we calculate total revenues and expenditures. We update the guess of $b$ until the government budget is balanced.

3.4.3 Results

We solve the model for the three correlation structures $\rho^1-\rho^3$ (rows (1)-(3) in Figure 3.6) and plot the results over different levels of the tax rate $\tau \in \{0.05, \ldots, 0.95\}$. From the occupational choice, we calculate the share of individuals who choose to become entrepreneurs for different levels of the tax rate $\tau$. Out of these entrepreneurs, we also calculate the share who exert effort and present their average characteristics. Column (1) of Figure 3.6 presents the first results (share of entrepreneurs and effort) for different levels of the tax rate $\tau$. Column (2) then shows the different types of risk-sharing: the equilibrium level of benefit expenditures, along with the average entrepreneurial wealth, i.e., average initial assets among the individuals who choose to become entrepreneurs. In column (3) we show average wages and profits of entrepreneurs and in column (4) we look at the total utility of workers and entrepreneurs.

Here we present our main findings. We first present the results that are most robust (Findings 1-5), and then discuss the results that are more sensitive to the exact specification, before we briefly discuss the implications for welfare.
Finding 1: The share of entrepreneurs increases with higher taxes. For all three correlation structures, the share of individuals who choose to be entrepreneurs increases with the tax rate (column (1) in Figure 3.6). Higher taxes imply higher benefits that make more individuals willing to choose the risky profession of being entrepreneurs. Because taxes are only used to finance benefits to unsuccessful entrepreneurs, the incentives to be a worker are also weak at high tax rates.

Finding 2: The share exerting effort decreases with higher taxes. Finding 1 established that the share of entrepreneurs increases with higher taxes. At the same time, however, at higher tax rates, a lower share of entrepreneurs optimally exert effort (column (1) in Figure 3.6). This is true for all three correlation structures and because higher taxes, and benefits, reduce the difference between returns of successful and unsuccessful entrepreneurs. This lowers the incentives to exert effort.

Finding 3: Average profits decrease with higher taxes. As more individuals choose to be entrepreneurs at higher tax rates (and higher benefits), the average profit among entrepreneurs decreases (column (3) in Figure 3.6). At low tax rates (corresponding to low benefits), only individuals with high profits choose to become entrepreneurs. As taxes go up, individuals with lower profits also find it worthwhile to be entrepreneurs.

Finding 4: Average wages increase with higher taxes. The opposite intuition compared to profits applies to average wages among entrepreneurs (column (3) in Figure 3.6). At low tax rates, only individuals with low wages choose to be entrepreneurs. For those with higher wages, the opportunity cost is too high. As taxes go up (along with benefits), the value of being an entrepreneur goes up and individuals with higher
wages now find it more attractive to be entrepreneurs.  

Finding 5: Benefits for unsuccessful entrepreneurs increase with higher taxes. Independent of the correlation structure, the benefits increase as the tax rate goes up (column (2) in Figure 3.6). Higher tax rates can fund higher benefits paid out to unsuccessful entrepreneurs. The equilibrium benefit level is determined by solving the government’s balanced budget, given individuals’ effort and occupational choices.

Finding 6: The relationship between average entrepreneurial wealth and the tax rate depends on the correlation structure. Column (2) in Figure 3.6 shows that the relationship between tax rates and average entrepreneurial wealth depends on the correlation structure. Remember that entrepreneurial wealth is equal to initial assets among those who choose entrepreneurship and that it is excluding profits. When the correlations $\rho_{w,a}$ and $\rho_{x,a}$ are more similar, in row (1), average entrepreneurial wealth displays a u-shape over the different tax rates. Average entrepreneurial wealth decreases until the tax rates are around 30 percent, and then increases with higher taxes. Because there is a positive correlation between initial assets and wages (although smaller than between initial assets and profits), it is not surprising that, as wages on average increase, average entrepreneurial wealth also goes up. Turning to the second row, where the correlation between initial assets and profits is much higher than between initial assets and wages, the pattern for average entrepreneurial wealth is different. Here, we instead see a decline in average entrepreneurial wealth over the different levels of taxes. This is in line with the average profits falling at the same time, as the correlation between profits and initial assets is relatively high. If, on the other hand, as in the third row, the correlation between initial assets and profits is low (very similar to the correlation between wages and initial assets), we see a small

\[29\] Also the incentive to be a worker is weaker because of high tax rates and no access to benefits.
increase in average entrepreneurial wealth as the tax rate increases.\footnote{In the main specification of the model, individuals have access to their initial assets in all states of the world, i.e., regardless if they are workers or successful/ unsuccessful entrepreneurs. We also solve the model using the correlation structure $\varrho^i$, where $\rho_{w,a}$ is similar to $\rho_{\pi,a}$, assuming that individuals only get access to their initial assets if they are unsuccessful entrepreneurs. In that case, average entrepreneurial wealth steadily declines as the tax rates increase. The results are available upon request.}

Finally, in Column (4) in Figure 3.6, we consider welfare in the form of total utility across the different tax rates.\footnote{We define total utility, at a given tax rate $\tau$, as the sum of the utility of workers and entrepreneurs:}

$$U(\tau) = \sum_{i=1}^{N_W} U_W^i(y_W, \tau) + \sum_{i=1}^{N_E} E[U^E_i(y_E, e(\Omega), \tau)]$$

(3.14)

where $N_W$ and $N_E$ are the number of workers and entrepreneurs, respectively.

\footnote{In row (3), however, the increase is so small, compared to the decrease after the peak, that it is not visible in the graph.}

\footnote{Thus, there are no positive externalities from a high share of entrepreneurs, such as, for example, increased consumption possibilities for workers through entrepreneurship-driven innovation.}
everyone, including those with very low profits, to become entrepreneurs. In our simple model, this will occur when tax rates are very high, because there are no longer any incentives to be a worker. In addition, the incentives to exert effort are very low and this is clearly not in line with the innovative entrepreneurship we have in mind. Using total utility as a metric to assess the optimal level of entrepreneurship, we conclude that a tax rate of around 20-30 percent is feasible.

Figure 3.6: Entrepreneurs and their characteristics

(a) \( \varphi^1 \): Share and effort
(b) \( \varphi^1 \): Benefits and assets
(c) \( \varphi^1 \): Wages and profits
(d) \( \varphi^1 \): Total utility

(e) \( \varphi^2 \): Share and effort
(f) \( \varphi^2 \): Benefits and assets
(g) \( \varphi^2 \): Wages and profits
(h) \( \varphi^2 \): Total utility

(i) \( \varphi^3 \): Share and effort
(j) \( \varphi^3 \): Benefits and assets
(k) \( \varphi^3 \): Wages and profits
(l) \( \varphi^3 \): Total utility

In Figure 3.7, we also show the distribution of entrepreneurs across wages, profits and assets (in 1000 USD) for three different tax rates in columns (1)-(3). Each row represents a specific correlation structure \( \varphi^1 - \varphi^3 \). We note a similar picture as in Figure 3.6, and it is clear that the number of entrepreneurs increases at higher tax rates. For low levels of
3.4. ANALYSIS OF THE MODEL

$\tau$, mainly those with low wages choose to become entrepreneurs. Then, as the tax rates increase, individuals with higher wages also choose to become entrepreneurs. In row (1), we also note that at low levels of the wage, mainly those with low assets choose to become entrepreneurs. Note that even though the correlation between assets and wages is lower compared to that between assets and profits, it is still positive, thereby explaining this pattern. We note that as the correlation with wages goes down (in rows (2) and (3)), there are entrepreneurs at lower levels of the wage for given levels of assets.\textsuperscript{34}

Finally, in Figure 3.8, we consider the distribution of entrepreneurs who choose to exert effort for the three levels of tax rates and the three correlation structures. First of all, it is clear that as the tax rate increases, fewer entrepreneurs exert effort. In addition, for all three correlation structures, most of the entrepreneurs who choose to exert effort at higher tax rates have low levels of assets.

\textbf{Sensitivity} We run the model for some other specifications to study individual behavior in more detail. Specifically we consider: (i) the same standard deviation of profits and wages, $\sigma_\pi = \sigma_w$, (ii) a higher cost of effort, $c = 1/10$, (iii) a smaller difference in the probability of success with/without effort, $p_1 = 0.6$ and $p_0 = 0.4$, and (iv) a larger coefficient of relative risk aversion, $\theta = 2$. For all these specifications, we use the baseline correlation structure $\rho^1$.$\textsuperscript{35}$

In specification (i), the correlation structure with these standard deviations is somewhat different compared to the baseline and implies that $\rho_{\pi,w}$ and $\rho_{a,w}$ are very similar (at 0.21). In this scenario, we obtain a very similar behavior for the share of entrepreneurs, the share exerting effort

\textsuperscript{34}We can relate the distribution of entrepreneurs to the distribution of workers (Appendix 3.A.3). Here we can see that wages are overall much larger compared to among entrepreneurs, while the profits are lower. It is clear that the number of individuals who choose to be workers decreases as taxes increase, and that most of the workers are concentrated at lower profits and assets. When the correlation between assets and profits is substantially higher (row (2) in Figure 3.9), it is even clearer that only individuals with lower assets and profits choose to be workers.

\textsuperscript{35}The results are available upon request.
(at the lowest tax rate everyone is exerting effort), average wages and profits, total utility, and benefits. Average assets are, however, strictly increasing over tax rates. Note that in this specification, being an entrepreneur is still risky because of the risk of failure, but the returns are now much less dispersed. For case (ii), with a higher cost of effort, the share of entrepreneurs and the share exerting effort are, not surprisingly, lower than in the baseline specification. In (iii), where effort has a much more limited effect on the probability of success, very few individuals exert effort, even at low levels of the tax rate. In this specification, total utility declines at a faster rate. In addition, average assets decline from
a much higher level, and benefits increase much faster at high tax rates. At this point, all or almost all individuals are entrepreneurs and their average profits are higher as compared to the baseline case, meaning they can finance higher benefits. Finally, in specification (iv), when the coefficient of relative risk aversion is higher, the results are very similar to those in the baseline case.

3.4.4 Summary of results

The exercise in this paper is clearly simple, but it sheds light on some important mechanisms. Evaluating the model, we find that the share of
entrepreneurs increases when tax rates, and equilibrium benefits paid out to unsuccessful entrepreneurs, increase. In addition, higher tax rates affect the average characteristics of individuals who choose entrepreneurship. Specifically, average wages increase, and average profits decrease, as the tax rate goes up. Average assets, however, do not always change monotonically with the tax rate, and the exact relationship depends on the correlation structure imposed.

At the same time as the share of entrepreneurs increases with higher taxes, fewer entrepreneurs choose to exert effort. This is in line with the incentive motive in Acemoglu et al. (2017), as our calibration ensures that less than perfect consumption insurance is a prerequisite to motivate entrepreneurs to exert effort. Lower effort implies a lower probability of success. If innovation were modelled as a product of the effective number of entrepreneurs, i.e., the number of entrepreneurs times their probability of success, this would, for a given number of entrepreneurs, dampen the innovative output. The high number of entrepreneurs at high tax rates, on the other hand, is in line with the literature that highlights the importance of insuring downside risk to ensure that individuals choose to become entrepreneurs; see, for example, Garcia-Penalosa and Wen (2008) and Gaillarda and Kankanamge (2018). Garcia-Penalosa and Wen (2008) find a higher growth rate with redistributive policies in a model with Schumpeterian growth, operating through the endogenous occupational choice. Gaillarda and Kankanamge (2018) highlight that ability and wealth are key determinants in the occupational choice in their model and that the type of policy implemented to encourage entrepreneurship has important effects for the pool of entrepreneurs. To relate back to the impact on innovation, if the technology for innovation is again defined by the product of the number of entrepreneurs times their probability of success, then, all else equal, an increase in the number of entrepreneurs also has a positive effect on growth.

The total impact from higher tax rates depends on the response along

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36 Specifically, they find that insurance results in a pool of richer and more high-skilled entrepreneurs that also last longer.
both margins: the extensive margin, through the occupational choice, and
the intensive margin, through the effort choice. In our baseline calibration,
where effort has a large impact on the probability of success, the
highest value for effective entrepreneurs is reached already at tax rates
of around 20 percent. However, this crucially depends on the large dif-
erence in probabilities between entrepreneurs who exert effort and those
who do not ($p_1 = 0.9$ and $p_0 = 0.1$). In this paper we argue, based on
total utility, that a tax rate of around 20–30 percent is feasible. Going
forward, it would be interesting to more carefully study the optimal mix
between incentives and downside insurance with a focus on the optimal
level of entrepreneurship.
3.5 Discussion

Here we discuss some assumptions and abstractions we have made. First we discuss how we model the individual’s decision, and then briefly how our set-up can relate to a framework with growth that is sustained by entrepreneurship and innovation.

In this paper we focus on the importance of risk-sharing for entrepreneurship and innovation. However, there are clearly other factors that matter for innovation and for incentives to become an entrepreneur, that are likely to differ across countries. In Section 3.2 we discussed a few specific factors, with a focus on differences in effort and family background, that appear to differ between entrepreneurs in the United States and Sweden (and that we implicitly incorporate in our framework). Here we briefly discuss some other potential factors that we have abstracted from in our analysis. Expectations and perceptions are likely to matter for both the occupational choice and the effort choice, possibly beyond what is motivated by rational forward-looking. For example, if the potential entrepreneur is very (and possibly too) optimistic about her chances of success, it is more likely that she will actually choose to become an entrepreneur. This implies that the perceived probability of success matters. The Global Entrepreneurship Monitor surveys individuals across different countries about these types of expectations (see Table 3.6 in Appendix 3.B). The survey evidence shows that American entrepreneurs are more confident in terms of perceived capability, fear of failure, and job creation as compared to Swedish entrepreneurs, which probably does affect both their effort and the occupational choice. In our setting, all these factors boil down to the probability of success.

It is hard to assess whether this optimism is rational or not. One way of squaring it with rationality is to consider heterogeneity in the probability of success. This would create a selection mechanism whereby the degree of optimism is endogenous and can be compared to the data. In the sensitivity part of the results, we show that if effort has a smaller effect on the probability of success, fewer individuals optimally exert
effort. We also abstract from differences in preferences that may motivate also the very wealthy to work hard. For example, a dynamic setting could incorporate a motive to stay wealthy.

Another simplification we make is to only consider two effort levels. This makes the model more tractable, but it would be possible to extend this choice to more levels, with the corresponding cost and probability functions.

We take wages, profits and initial assets as exogenously given and, although in Section 3.4 we use data to inform our parameter values, we abstract from the formation of these variables. For future work, it can be interesting to model heterogeneity in ability and endogenous human capital formation. Both these types of extensions would allow a richer analysis of the pool of entrepreneurs. Ability can affect returns from both entrepreneurship and employment as well as the probability of success. In our simple set-up, we implicitly assume that wages and profits are determined by ability, but future work could look to more explicitly incorporate differences in ability, which in turn could enable a discussion of efficiency and the optimal level of entrepreneurship. The discussion of how growth itself affects individual choice is also interesting.\(^{37}\)

Furthermore, while the main focus of our empirical discussion revolves around entrepreneurship rather than self-employment, the evaluation of the model does not clearly distinguish between self-employment by opportunity and necessity. In future work, it would be interesting to consider implications from incorporating the individual's decision into an endogenous growth framework, where economic growth is driven by the

\(^{37}\)See also, for example, Hassler and Rodriguez-Mora (2000) for an analysis of how technological change affects the return to innate ability in the presence of an occupational choice. They explicitly consider the importance of the individual's background for this choice, in a setting where also parents are either entrepreneurs or workers, and have interesting implications for the type of innovation, depending on individual ability, where a high-growth environment rewards initial ability (rather than social background) and great innovations. See also Bell et al. (2017) for a discussion of how childhood exposure to innovation affects the likelihood of becoming an inventor later in life, and how increased exposure for under-represented groups can alleviate the problem of 'lost Einsteins'.

share of successful entrepreneurs, i.e., the number of entrepreneurs times their probability of success (as a function of effort). If no entrepreneurs exert effort, then it does not matter how many individuals that choose entrepreneurship. But for a given level of effort, a larger number of entrepreneurs still increases growth. In general, incorporating the individual’s decision into an endogenous growth framework would enable a better comparison with, for example, Acemoglu et al. (2017). Compared to their paper, we zoom in on the individual’s problem and add the dimension of an occupational choice, but, at the same time, we abstract from the innovation process and from interconnectedness between different countries (with different welfare systems). This is done to focus on this specific part and to study the impact of different welfare systems on individuals’ choices and behavior in the aggregate. Since we do not specifically model the technology for innovation, we do, however, also stay silent on the type of innovation carried out in different countries.

Another way of studying the optimal level of entrepreneurship and redistribution is to allow tax rates to differ between entrepreneurs and workers. In our evaluation of the model, we assume a common tax rate, for simplicity, but if one allows different tax rates and effort choice for both workers and entrepreneurs, the optimal taxation problem would become quite rich and very interesting to study.
3.6 Conclusion

This paper studies the role of risk-sharing for entrepreneurship and innovation. Using country-level data we present stylized facts, in terms of unconditional correlations, on the relationship between risk-sharing and innovation, risk-sharing and inequality and, finally, between inequality and innovation. We find a positive relationship between risk-sharing and innovation, measured both as patents and self-employment by opportunity. Inequality, on the other hand, is negatively related to innovation. We also build a simple model with two decision margins, an occupational choice and an effort choice, along which we think that risk-sharing matters. This allows us to evaluate the role of private and public risk-sharing. We use the model framework to perform comparative statics and to numerically evaluate the effect of higher taxes on entrepreneurship. In terms of comparative statics we find that, for a given effort level, if entrepreneurship is made more attractive relative to being a worker, individuals become entrepreneurs at lower levels of the public insurance. This is the case if the returns to entrepreneurs increase, or the returns from working decrease. Higher initial asset holdings, all else equal, also imply a lower threshold to become an entrepreneur, as these holdings provide a form of private risk-sharing. Entrepreneurs also choose whether to exert effort or not and there is a threshold in terms of the public insurance below which it is optimal for them to do so. This threshold is higher if the returns to entrepreneurs are high, or if the level of initial assets is low. The quantitative evaluation highlights 6 findings. When taxes increase: (1) the share of entrepreneurs increases, (2) the share of entrepreneurs exerting effort decreases, (3) average profits decrease, (4) average wages increase, (5) benefits for unsuccessful entrepreneurs increase, (6) and average entrepreneurial wealth (excluding profits) depends on the correlation structure between initial assets, wages, and profits. Our exercise, although simple in nature, highlights some important mechanisms and suggests that there can be several ways to promote innovation, including both public and private risk-sharing.
References


REFERENCES


Appendices

3.A  Model Appendix

3.A.1  Effort choice

Here we show details for Proposition 3.1 and Lemma 3.1. First, Proof 3.A.1 shows how we solve for the threshold $E$.

Proof. For threshold $E$ in Proposition 3.1, consider equation (3.5) and solve for $(1 - \tau)b$:

\[
\frac{(1 - \tau)\pi + a}{(1 - \tau)b + a} \geq \left( \frac{1 - p_0 - (1 - p_1)(1 - \eta(1))^{1-\theta}}{p_1(1 - \eta(1))^{1-\theta} - p_0} \right)^{\frac{1}{1-\theta}} = \left( 1 + \frac{1 - [1 - \eta(1)]^{1-\theta}}{p_1[1 - \eta(1)]^{1-\theta} - p_0} \right)^{\frac{1}{1-\theta}} = A.
\]

\[
\frac{(1 - \tau)\pi + a}{(1 - \tau)b + a} \geq A
\]

\[
\Longrightarrow (1 - \tau)b \leq \frac{(1 - \tau)\pi + a}{A} - a. \tag{3.15}
\]

Define the threshold $E$ as the cutoff value in equation (3.15) below which agents’ incentive compatibility constraint is satisfied:

\[
(1 - \tau)b \leq E = \frac{(1 - \tau)\pi + a}{A} - a. \tag{3.16}
\]

Comparative statics for $E$  Here we show the comparative statics described in Lemma 3.1. We see that the threshold $E$ increases in $\pi$, and decreases in $a$ and $\tau$. \hfill $\blacksquare$
3.A. MODEL APPENDIX

\[
\begin{align*}
\frac{\partial \bar{E}}{\partial \pi} &= \frac{1 - \tau \pi}{A} > 0, \\
\frac{\partial \bar{E}}{\partial a} &= \frac{1}{A} - 1 < 0.
\end{align*}
\]

(3.17)

(3.18)

To examine the impact of taxes we define:

\[
b \leq \hat{E} = \frac{(1 - \tau)\pi + a}{(1 - \tau)A} - \frac{a}{1 - \tau},
\]

(3.19)

and the derivative is then:

\[
\frac{\partial \hat{E}}{\partial \tau} = \frac{a(1 - A)}{(1 - \tau)^2 A} < 0.
\]

(3.20)

3.A.2 Occupational choice

Here we show details for Proposition 3.2 and Lemma 3.2. First, Proof 3.A.2 shows how we solve for the threshold \( \bar{T} \).

\textit{Proof.} For threshold \( \bar{T} \) in Proposition 3.2, consider equation (3.9) and solve for \((1 - \tau)b\):

\[
\frac{1}{1 - \theta} \left\{ p(e) [(1 - \tau)\pi + a]^{1 - \theta} + (1 - p(e)) [(1 - \tau)b + a]^{1 - \theta} \right\} [1 - \eta(e)]^{1 - \theta}
\]

\[
\geq \frac{1}{1 - \theta} [(1 - \tau_w)w + a]^{1 - \theta}
\]

\[
\Rightarrow (1 - \tau)b \geq \left\{ \frac{1}{1 - p(e)} \cdot \frac{1}{[1 - c(e)]^{1 - \theta}} \cdot [(1 - \tau_w)w + a]^{1 - \theta} - \frac{p(e)}{1 - p(e)} \cdot [(1 - \tau)\pi + a]^{1 - \theta} \right\} \frac{1}{\tau \pi} - a.
\]

(3.21)
Define the threshold $\bar{T}$ as the cutoff value in equation (3.21) above which agents’ incentive compatibility constraint is satisfied:

$$(1 - \tau)b \geq \bar{T} = \left\{ \frac{1}{1 - p(e)} \cdot \frac{1}{[1 - \eta(e)]^{1-\theta}} \cdot [(1 - \tau_w)w + a]^{1-\theta} - \frac{p(e)}{1-p(e)} \cdot [(1 - \tau)\pi + a]^{1-\theta} \right\} \frac{1}{1-\theta}.$$ \hspace{1cm} (3.22)

In the following, we will first derive comparative statics relating changes in primitives like $\pi$ to changes in $\bar{T}$, taking effort choice as given. We then factor in how these primitives affect effort choice at the very end.

**Comparative statics for $\bar{T}$ for given effort choice** Here we show the comparative statics described in Lemma 3.2. Remember that $\kappa$, now for a given effort choice, is defined as:

$$\kappa = \left\{ \frac{1}{1 - p(e)} \cdot \frac{1}{[1 - \eta(e)]^{1-\theta}} \cdot [(1 - \tau_w)w + a]^{1-\theta} - \frac{p(e)}{1-p(e)} \cdot [(1 - \tau)\pi + a]^{1-\theta} \right\} \frac{1}{1-\theta}.$$ \hspace{1cm} (3.22)

We show comparative static results conditional on $\kappa > 0$, i.e., under the conditions in Assumption 2. The threshold $\bar{T}$ decreases in $\pi$ and $\tau_w$, and it increases in $w$. 
\[ \frac{\partial T}{\partial \pi} = -\kappa \cdot [(1 - \tau_w)\pi + a]^{-\theta} \cdot \frac{p(e)(1 - \tau_w)}{1 - p(e)} < 0, \] (3.23)
\[ \frac{\partial T}{\partial w} = \kappa \cdot [(1 - \tau_w)w + a]^{-\theta} \cdot \frac{(1 - \tau_w)}{1 - p(e)} \cdot \frac{1}{[1 - \eta(e)]^{1-\theta}} > 0, \] (3.24)
\[ \frac{\partial T}{\partial \tau_w} = -\kappa \cdot [(1 - \tau_w)w + a]^{-\theta} \cdot \frac{w}{1 - p(e)} \cdot \frac{1}{[1 - \eta(e)]^{1-\theta}} < 0. \] (3.25)

For initial assets, \( a \), and the probability of success, \( p(e) \), the following comparative statics hold under additional, plausible, conditions specified below:

\[ \frac{\partial T}{\partial p(e)} = \frac{1}{1 - \theta} \cdot \kappa \cdot \frac{1}{(1 - p(e))^2} \cdot \left\{ \frac{1}{[1 - \eta(e)]^{1-\theta}} [(1 - \tau_w)w + a]^{1-\theta} \right\} 
- \left\{ [(1 - \tau)\pi + a]^{1-\theta} \right\} < 0, \] (3.26)
\[ \frac{\partial T}{\partial a} = \kappa \cdot \frac{1}{1 - p(e)} \left\{ \frac{1}{[1 - \eta(e)]^{1-\theta}} [(1 - \tau_w)w + a]^{-\theta} - p(e) [(1 - \tau)\pi + a]^{-\theta} \right\} 
- 1 < 0. \] (3.27)

The sign for \( p(e) \) in equation (3.26) is conditional on the expression inside the outer brackets being larger than zero (since \( \theta > 1 \) and, thus, the first term \( \frac{1}{1 - \theta} \) is negative). The first term in the bracket is multiplied with a factor between zero and one (the denominator is larger than one, when \( e = 1 \), or equal to one, when \( e = 0 \)). As long as the return from being a successful entrepreneur is sufficiently high relative to the return from being a worker, the derivative is therefore negative. Specifically, we require that:

\[ \frac{1}{[1 - \eta(e)]^{1-\theta}} [(1 - \tau_w)w + a]^{1-\theta} > [(1 - \tau)\pi + a]^{1-\theta}. \]

The sign for \( a \) in equation (3.27) is conditional on \( \theta > 1 \), as well as \((1 - \tau_w)w + a\) and \((1 - \tau)\pi + a\) being larger than one. To see this, rewrite
equation (3.27), including the explicit expression for $\kappa$, to show that:

$$
\kappa \cdot \frac{1}{1 - p(e)} \left\{ \frac{1}{[1 - \eta(e)]^{1-\theta}} \left[ (1 - \tau_w)w + a \right]^{1-\theta} - p(e) \left[ (1 - \tau)\pi + a \right]^{1-\theta} \right\} < 1
$$

$$
\left\{ \frac{1}{[1 - \eta(e)]^{1-\theta}} \left[ (1 - \tau_w)w + a \right]^{1-\theta} - p(e) \left[ (1 - \tau)\pi + a \right]^{1-\theta} \right\} < \frac{1}{\kappa \cdot \frac{1}{1 - p(e)}}
$$

$$
\Rightarrow \left\{ \frac{1}{[1 - \eta(e)]^{1-\theta}} \left[ (1 - \tau_w)w + a \right]^{1-\theta} - p(e) \left[ (1 - \tau)\pi + a \right]^{1-\theta} \right\} < [1 - p(e)]^{1-\theta} \left( \frac{1}{[1 - \eta(e)]^{1-\theta}} \cdot \left[ (1 - \tau_w)w + a \right]^{1-\theta} - p(e) \left[ (1 - \tau)\pi + a \right]^{1-\theta} \right)^{\frac{\theta}{\theta - 1}}
$$

Because $[1 - p(e)]^{1-\theta} > 1$, and $\frac{\theta}{\theta - 1} > 1$, we only require that total returns for a successful entrepreneur and a worker, respectively, are both larger than one. As long as this holds, the expression on the left-hand side is smaller than the expression on the right-hand side.

Finally, to examine the impact of taxes we define a threshold $\bar{T}$ in terms of gross benefits:

$$
b \geq \bar{T} = \frac{1}{(1 - \tau)} \left\{ \frac{1}{1 - p(e)} \cdot \frac{1}{[1 - \eta(e)]^{1-\theta}} \cdot \left[ (1 - \tau_w)w + a \right]^{1-\theta} - \frac{p(e)}{1 - p(e)} \cdot \left[ (1 - \tau)\pi + a \right]^{1-\theta} \right\}^{-\frac{1}{\theta - 1}} - \frac{a}{(1 - \tau)},
$$

The derivative is then:

$$
\frac{\partial \bar{T}}{\partial \tau} = \frac{\kappa \cdot [(1 - \tau)\pi + a]^{-\theta} \cdot (\pi) \cdot p(e) \cdot (1 - \tau) + \kappa^2}{(1 - \tau)^2} > 0. \quad (3.28)
$$

**Comparative statics for $\bar{T}$ taking effort choice into account** For the threshold $\bar{T}$, equation (3.23) showed that high profits imply a low threshold to become an entrepreneur. However, if profits increase, we know from Lemma 3.1 and equation (3.17) that agents exert effort at
higher levels of the benefit. If this change shifts the agent from $e = 0$ to $e = 1$, it increases the probability of success. An increase in $p(e)$ then implies a lower threshold for the occupational choice. Thus, if the increase in profits also pushes the agent to exert effort, the probability of success increases, and the threshold for the occupational choice is lowered even more.

The threshold $\bar{T}$ instead increases in $\tau$ - see equation (3.28) - the tax rate faced by entrepreneurs. We know that agents only exert effort at lower levels of the benefit for higher tax rates; see equation (3.20). Thus, if an increase in taxes implies lower effort, then the probability of success goes down, reinforcing the increase in the threshold for the occupational choice.

For assets, $a$, the derivative for the threshold $\bar{T}$ is also negative, see equation (3.27). Because higher initial assets lower the incentives to exert effort - see equation (3.18) - this is, however, only true for agents whose effort choice is not affected. If the effort choice is affected and the probability of success is reduced, this counteracts the decrease in the occupational threshold.
3.4.3 Model output

Figure 3.9: The distribution of workers

(a) \( g^1: \tau_1 = 0.10 \)  
(b) \( g^1: \tau_2 = 0.48 \)  
(c) \( g^1: \tau_3 = 0.95 \)

(d) \( g^2: \tau_1 = 0.10 \)  
(e) \( g^2: \tau_2 = 0.48 \)  
(f) \( g^2: \tau_3 = 0.95 \)

(g) \( g^3: \tau_1 = 0.10 \)  
(h) \( g^3: \tau_2 = 0.48 \)  
(i) \( g^3: \tau_3 = 0.95 \)
3.B Additional Tables

3.B.1 Private risk-sharing: transfers and inheritance

Table 3.5 presents data on recipients of inheritance, transfers and gifts based on survey data from the United States and Sweden. The data for the United States come from the Survey of Consumer Finances (SCF), and the Swedish data are from the Survey of Health, Age and Retirement in Europe (SHARE). We use the 2016 wave for SCF and the 2015 wave for SHARE. Both surveys include similar questions on inheritance and transfers, which we use to compare inheritance rates for both countries.

Table 3.5: Inheritance and transfers in the United States and Sweden

<table>
<thead>
<tr>
<th></th>
<th>United States</th>
<th>Sweden</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ever received inheritance, transfer or gift &gt; 5000 euro* (%)</td>
<td>0.20</td>
<td>0.09</td>
</tr>
<tr>
<td>Self-employed: ever received inheritance, transfer or gift &gt; 5000 euro* (%)</td>
<td>0.31</td>
<td>0.09</td>
</tr>
<tr>
<td>Received this inheritance, transfer or gift from parents (%)</td>
<td>0.75</td>
<td>0.65</td>
</tr>
</tbody>
</table>

Source: SCF, SHARE. *6128 USD in 2016.
### 3.B.2 Entrepreneurship indicators

**Table 3.6: Global Entrepreneurship Monitor, country averages 2011-2016**

| Country   | Perceived opportunities | Perceived capabilities | Motivation | Innovation | High job creation | Fear of failure |
|-----------|-------------------------|------------------------|------------|------------|------------------|----------------
| Australia | 47.43                   | 46.09                  | 4.38       | 32.82      | 27.08            | 41.74          |
| Austria   | 45.28                   | 49.28                  | 3.31       | 34.62      | 11.59            | 35.08          |
| Belgium   | 36.79                   | 35.45                  | 3.99       | 39.61      | 16.78            | 43.19          |
| Canada    | 56.26                   | 50.30                  | 4.00       | 36.14      | 23.43            | 37.56          |
| Denmark   | 50.24                   | 33.02                  | 3.07       | 48.29      | 22.58            | 40.26          |
| Finland   | 50.61                   | 35.48                  | 4.73       | 24.89      | 10.73            | 35.26          |
| France    | 36.01                   | 36.89                  | 2.84       | 27.07      | 20.80            | 40.06          |
| Germany   | 32.49                   | 45.45                  | 1.00       | 37.26      | 32.51            | 38.14          |
| Japan     | 6.91                    | 11.95                  | 2.94       | 20.80      | 30.82            | 49.61          |
| Netherlands| 43.63                  | 42.88                  | 5.80       | 26.21      | 25.03            | 34.71          |
| Norway    | 65.51                   | 32.02                  | 13.36      | 19.03      | 14.07            | 37.32          |
| Portugal  | 70.10                   | 37.76                  | 8.14       | 30.35      | 16.12            | 36.25          |
| Sweden    | 81.21                   | 42.88                  | 5.84       | 33.55      | 16.42            | 30.85          |
| United Kingdom | 37.75              | 45.28                  | 2.98       | 32.40      | 23.20            | 35.01          |
| United States | 46.94              | 55.23                  | 4.07       | 35.28      | 30.72            | 31.16          |

OECD average 36.32 42.27 3.74 25.72 21.35 39.75

Source: Global Entrepreneurship Monitor. See GEM data for more information on these indicators.
4.1 Introduction

Despite a widespread belief that parents’ economic resources matter for the prospects of their children, our understanding of the effects of intergenerational links, and the mechanisms through which these links matter, remains limited. This paper represents a step towards assessing the importance of intergenerational links, acknowledging that parents can make both inter-vivos transfers and leave bequests to their children. In general, this type of intra-family finance may affect decision making related to, for example, occupational choice and human capital investments.\(^1\) Here

\(^{1}\)See, for example, Celik (2018) for a study on the importance of parental background for inventors, and Amromin et al. (2017) for an analysis of the rise in student loans, following the housing crisis in the United States that resulted in lower equity values for parents.
I focus on one particular area where these types of transfers are known to matter empirically: the housing market.

In the presence of intergenerational links, whether or not young individuals become homeowners may not only depend on their own economic resources, but also on the resources of their parents, through what I call the *parental channel*. This is also the case for the amount of housing services that they consume. Empirically, this connection can have implications for wealth inequality, since real estate is an important part of many households’ portfolios. Housing is typically both the most important asset and the largest liability on households’ balance sheets, making housing decisions one of the most important investment decisions that individuals make. Thus, if house prices are growing and if rich parents can facilitate their children’s entering the housing market, or increase the amount of housing services consumed, the intergenerational transmission of wealth is amplified. Furthermore, transfers associated with housing purchases are often large and therefore constitute an important part of lifetime intergenerational transfers. Therefore, the dynamics of family interactions in this context are key to understanding wealth inequality in general, and wealth inequality through the acquisition of housing in particular. I add to a large empirical literature on intergenerational transfers and housing by modelling these family linkages in a dynamic setting.\(^2\)

In addition to the benefits from housing services per se, and the (potential) increase in the house value, there are several advantages to being a homeowner. For example, owning a house is in many countries associated with access to collateral value and, in some cases, to subsidies on borrowing. However, despite the benefits associated with homeownership, some individuals rent. This can be because they do not choose to own, or because they do not have access to the housing market. In

\(^2\)See, for example, Engelhardt and Mayer (1998), Guiso and Jappelli (1991) and Bellettini et al. (2017) for studies on family finance in connection to the housing market. These, and other important examples in this field, will be further discussed in Section 4.2.
4.1. INTRODUCTION

particular, in the presence of borrowing constraints, young generations may find it especially difficult to enter the housing market, and this is where parents can play a role. Parents may influence children's housing investments by helping them with the down payment, by co-signing a mortgage to help them acquire a home in the first place, or, on the intensive margin, by enabling them to purchase larger homes. Furthermore, they can leave (the net value of) their own estate to their children as inheritance.

The role of parents, in the context of the housing market, is likely to depend on policy, and the importance of intergenerational links may be affected by changed conditions in, or related to, the housing market. For example, if down-payment requirements are raised, the distribution of homeowners and homeowners that can afford a particular amount of housing services will be shifted to those who are not (intergenerationally) constrained. This type of macroprudential measure, on the demand side, is typically introduced to limit indebtedness. Because the presence of the parental channel can affect borrowing decisions, it is important to take intergenerational links into account to understand the effectiveness of such a policy. Furthermore, in the presence of borrowing constraints, the timing of transfers matters, and it is therefore key to consider both inter-vivos transfers and bequests. If young individuals are more likely to be constrained by borrowing limits, then an increase in loan-to-value (LTV) requirements will mechanically have a dampening direct effect on their indebtedness. However, once we allow for intergenerational links, the effect also depends on the response of parents. If transfers are used to alleviate borrowing constraints, the scope of the parental channel is increased and the effect of the policy may, in turn, be dampened.\textsuperscript{3} To analyze the feasibility of these different types of policies, it is important

\textsuperscript{3}Other examples of policies that are used empirically, and where intergenerational links may be particularly important to consider, are loan-to-income requirements and amortization requirements tied to LTV ratios. In addition, tax policies can also affect the scope of the parental channel as changes to gift and bequest taxes will change the cost of making transfers across generations. See, for example, McGarry (2000) for an analysis of the timing of intergenerational transfers and estate taxes.
to also understand their welfare implications and, to this end, a micro-founded model of behavioral responses is needed. This paper is a first step at characterizing individual behavior in the presence of intergenerational links to be able to study how intergenerational decision-making affects both individual behavior and aggregate variables in a more realistic setting in the future.

In this first step, to study the importance of the parental channel in the housing market, I unite empirical observations from the previous literature and a model that can begin to address behavioral responses. I first establish some stylized facts from the empirical literature, before I turn to an analysis of the model. The main motivation for a theoretical exploration of this phenomenon is that, going forward, a realistic model of intergenerational behavior may shed some new light on policies deemed to be suitable in the previous literature. The point of departure is in terms of the minimum requirements for a model that is able to address behavioral responses and that can be used to discipline how to look at data going forward. While my model initially abstracts from several features required to make such a policy analysis, I build a framework that can be used to study family interactions, and which can be extended to include, for example, richer housing market structures and more realistic income profiles, as well as uncertainty. I set up a partial equilibrium overlapping generations (OLG) model and study how the housing tenure and portfolio choices of young individuals depend on their parents’ resources and tenure status. Key features of my setting include: (1) an intergenerational structure with one-sided altruism, where parents have the possibility to make transfers – both inter-vivos transfers and bequests – to their children; and (2) a housing tenure choice for young individuals. In a second step, I apply the model to analyze how a demand-side oriented macroprudential policy affects the scope of this parental channel and ultimately housing outcomes and portfolio decisions. Specifically, I consider the impact of stricter down-payment requirements.

The results from the model highlight the role of parental resources and parents’ housing tenure status in determining individual behavior.
4.1. INTRODUCTION

and portfolio composition. The intergenerational links, through altruistic preferences of the parent, and the resulting transfers of means, add a consideration for the parent in addition to her own portfolio choice. Because of differences in tenure statuses, parents, by construction, differ both in their required expenses today and in the bequests they leave for their children in the future. Parents thus have to make trade-offs, both intratemporally, between themselves and their children in the current period, and intertemporally, between the two time periods. The steady-state solution, with constant house prices, is used as a benchmark to assess the basic features of the model, before turning to an analysis of price changes and stricter borrowing conditions. In steady state, the main determinant of children’s behavior is parental wealth, not parental housing tenure status. Thus, the parental channel matters for the tenure decision, and for portfolio decisions, through its effect on children’s cash on hand. For comparison, if there is no scope for parents to make transfers, all children are equal, and their behavior is independent of the wealth of their parents. In the presence of the parental channel, however, children with the same (exogenous) labor income face different financial support from their parents, depending on how rich their parents are. In this sense, the parental channel introduces inequality among children with the same labor income. Turning to the explicit links that represent the parental channel, parents who are homeowners transfer similar amounts to their children, in terms of the inter-vivos transfer, as compared to parents who are renters. There is a subtle increase in parental savings, especially for parents who are homeowners, at levels of cash on hand above the threshold where their children optimally choose to become homeowners rather than to be renting, and, around that same level of cash on hand, inter-vivos transfers plateau somewhat. At lower levels of cash on hand, parents who are renters save more in the financial asset. When house price growth is positive, parents, in general, put some more weight on the inter-vivos transfer, whereas the threshold, in terms of parents’ cash on hand, for positive financial savings is higher. In this scenario, the housing tenure status of parents matters more for behavior (although the
hospitation that the parental channel is likely to be particularly im-

Turning to indebtedness, richer parents (who are homeowners) choose lower levels of leverage, whereas children do not decrease their leverage as they get richer. In steady state, when house prices are constant, the impact of stricter borrowing conditions (through an increase in down-payment requirements) on optimal behavior is limited for both parents and children. The biggest impact is a reduction in debt, particularly for the children, i.e., a mechanical dampening effect on indebtedness as mentioned earlier, and a slight increase in inter-vivos transfers. If the house price growth is high, on the other hand, parents shift more resources from financial savings towards inter-vivos transfers, in response to stricter borrowing conditions. In addition, parents who are homeowners also increase their own leverage, shifting some debt from the young to the old generation (although this increase is smaller than the decrease in debt among their children who choose the highest leverage allowed), implying that the scope of the parental channel is affected by this change in policy, and that stricter borrowing conditions may, in fact, increase the indebtedness among parents connected to borrowing constrained children (although parents still choose low levels of leverage). This is in line with the perception that the parental channel is likely to be particularly im-
4.1. **INTRODUCTION**

Important in a context with rising house prices. Because stricter borrowing conditions do not affect the housing tenure decision in the model, they do not affect access to the housing market. Stricter borrowing conditions do, however, (somewhat) affect affordability when house price growth is the highest, as children now need to have richer parents in order to upgrade their housing services. In addition, because of lower bequests, the stricter borrowing conditions do, in fact, weaken the relationship between parents’ cash on hand and the future cash on hand of their own children, especially at the top of the parents’ wealth distribution.

**Related literature** This paper is related to the literature on family economics and the relevance of, and the motivation for, transfers within the family. In terms of the motivation for making transfers, different suggestions have been made. For example, Cox (1987) finds support for an exchange motive while Cox (1990) finds support for inter-vivos transfers being directed towards liquidity constrained agents. Guiso and Jappelli (1991) use Italian survey data and find support for transfers being used to alleviate borrowing constraints. Clearly distinguishing between the role of inter-vivos transfers and bequests, Gale and Scholz (1994) constitute an early example arguing that it is crucial to understand their relative importance for wealth accumulation. McGarry (1999), in turn, models differences between inter-vivos transfers and bequests, arising from the type of income risk (of the child) that the parent is concerned with.\(^4\) Recently, Luo (2017) documents the role of inter-vivos transfers in the United States. She argues that inter-vivos transfers are voluntary, and negatively related to the recipient’s income, while bequests are largely accidental. The particular role for inter-vivos transfers observed empirically motivates the explicit modelling of such transfers. For example, Nishiyama (2002) documents that accounting for these types of inter-generational transfers is important for matching the wealth distribution in the United States. My paper is also related to papers on the dynamic

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\(^4\)In McGarry (2016), this analysis is extended so that it can assess dynamic aspects of intergenerational transfers.
modelling of families. To allow for imperfect altruism in an otherwise standard consumption-savings problem (with income risk), Barczyk and Kredler (2014) model intergenerational links in a continuous-time setting. In terms of the theoretical framework, Boar (2018) is a more closely related paper. Motivated by the empirical evidence on dynamic precautionary savings, i.e., that parents save to be able to transfer means to their children in case of an income loss, she builds an overlapping generations model with imperfect altruism. My paper is inspired by her framework of strategic intra-family interactions, adding a housing dimension, while abstracting from other features that are incorporated in her setting. In this paper, I focus on the role of parents, through their ability to make financial transfers, in connection to the housing market. There are other ways in which families may matter for the housing situation of young individuals. For example, Kaplan (2012) builds a structural model where children can choose to co-reside with their parents, showing that this can be an important insurance mechanism against labor market risk.\footnote{For quantitative papers with other types of, implicit or explicit, intergenerational links, see, for example, Favilukis et al. (2017) for a quantitative general equilibrium model with bequest heterogeneity (to generate a realistic wealth distribution). DeNardi (2004) also highlights the importance of voluntary bequests for generating wealth inequality, as observed empirically. Previous papers, such as Glover et al. (2017), have considered intergenerational redistribution across generations of young and old agents.}

Second, my paper is also related to the literature on housing and household finance. Housing is generally an important part of individuals’ portfolio decisions and has several distinct characteristics. Typically, housing is assumed to yield utility as well as serve as a storage of value and, in the case of collateral constraints, provide individuals with collateral value. Attanasio et al. (2012) model the demand for housing over the life cycle, taking into account that individuals choose their housing tenure status as well as the type of housing (in their case houses or apartments). My paper also includes a housing tenure choice but, instead of different types of housing,
individuals choose the quantity of housing services. The topic of housing is closely related to the literature on the effects of macroprudential policy aimed at the demand side. In particular, following years of expansionary monetary policy, macroprudential policies have been used to target housing- and asset markets (see, for example, Kuttner and Shim (2016) for an overview of policies related to the housing market). Tighter borrowing conditions through, for example, higher down-payment requirements are examples of such policies. Chiuri and Jappelli (2003) analyze cross-country differences in owner occupancy rates and down-payment requirements across OECD countries. They argue that borrowing conditions, exemplified by down-payment ratios, are important determinants of the distribution of homeowners. This is especially true for young households who have not had much time to accumulate wealth for the down payment. Alpanda et al. (2014) find that, in a DSGE model, stricter down-payment requirements are effective in reducing household indebtedness. Akinci and Olmstead-Rumsey (2017) also highlight the effectiveness of LTV and debt-service-to-income (DSTI) restrictions. In this paper, I argue that, to understand the mechanisms through which a change in borrowing conditions affects households, it is important to take into account links between members within a family, i.e., across generations. In doing so, I seek to contribute to our understanding of the mechanisms through which LTV requirements impact the economy.

The remainder of the paper is organized as follows. Section 4.2 describes the empirical evidence on the parental channel. Section 4.3 outlines the theoretical framework, Section 4.4 presents the numerical analysis and the results. Section 4.5 provides a discussion of the model, and Section 4.6 concludes the paper.

\footnote{See also Greenwald (2018).}
4.2 Parents and Housing: An Empirical Overview

The mechanisms discussed and modelled in this paper are motivated by empirical findings on the relationship between parents and children in connection to the housing market. In particular, the empirical overview in this section serves as a motivation for the importance of considering the parental channel through explicit intergenerational links. The papers mentioned in this overview document evidence on, or explore theoretically, the types of channels in which I am interested. The theoretical model, described in Section 4.3, is developed with implications from these studies in mind. This section also documents that the importance of family finance has changed over time, and suggests that this can be due to changes in policy and/or changes in (perceived) housing price growth.

4.2.1 The parental channel in the literature

In general, economic resources matter for the decision to become a homeowner and, for prospective homeowners, they also influence financing decisions. These economic resources may, in addition to being self-made, include support from parents or other relatives. There is a broad literature on intergenerational links in connection to the housing market. Engelhardt and Mayer (1998) and Guiso and Jappelli (1991) are two examples that find support for family finance being used to alleviate borrowing constraints. Engelhardt and Mayer (1998) also conclude that family transfers increase housing consumption, and are consistent with a strategic behavior aimed at obtaining more favorable mortgage terms. Brueckner (1986) and Haurin et al. (1997) further highlight the role of borrowing constraints for the housing tenure choice, especially for young people. More recently, Barrett et al. (2015) suggest that inter-vivos transfers and bequests are relevant for the housing tenure decisions of young individuals in Australia. Bellettini et al. (2013) and Bellettini et al. (2017)
study inter-vivos transfers in connection to the Italian housing market. Specifically, they exploit a policy change to examine the relationship between inter-vivos housing transfers and taxes. Using a Barro-type model (Barro, 1974) with a stylized housing sector to derive testable predictions, they find that first reducing, and then abolishing, the inter-vivos real estate and bequest tax yields a 5 percent increase in house prices and a 60 percent increase in intergenerational donations. They also estimate the degree of intergenerational altruism to be in the range of 0.2–0.3 in the Italian case. Blickle and Brown (2016) use a panel of Swiss households and find that wealth transfers increase the propensity to become a homeowner by 15–20 percentage points. The authors highlight that this relationship is strongest for young households who are more likely to face binding borrowing constraints. They find no effect for the propensity of homeowners to trade up in terms of housing, which implies that the effect is driven by the extensive margin. Cirman (2008) empirically investigates the role of intergenerational transfers in the case of Slovenia. Using survey data, she finds that intergenerational transfers depend on credit market conditions and are used as an alternative source of financing when borrowing conditions are stricter. In a study using Danish register data, Kölodziejczyk and Leth-Petersen (2013) do, however, not find that transfers of liquid funds from parents to children are important around the time of the children’s first home purchases. They highlight the role of relatively low down-payment requirements in Denmark as a potential explanation for this finding. In the French context, Spilerman and Wolff (2012) consider several mechanisms through which parental transfers can have an impact on the housing market outcomes of their children. They find that transfers both contribute to the homeownership rate and to the value of the children’s acquired homes. Duffy and Roche (2007) show that in Ireland, one in three first-time buyers use family finance, and that transfers are more likely to go to liquidity-constrained individuals. In addition, recipients of transfers purchase more expensive homes and add more to the down payment. Furthermore, the authors set up a two-period model with quadratic utility, allowing for non-negative
transfers and loans. In Mulder and Smits (2013), the authors discuss intergenerational ties in the Netherlands, where parents who are homeowners are more likely to provide financial transfers to their children, as compared to renters.\footnote{See also Aratani (2011) and Henretta (1984).} I explicitly consider the behavior of parents who are homeowners and renters separately, to study potential differences depending on housing tenure status. In another recent empirical paper, Begley (2017) studies the importance of family support for the transition to homeownership in the United States, and how this varied across the housing cycle between 2003-2011. In particular, she finds that family support was more important during the housing bust, when credit conditions were tighter, suggesting that family finance is used to alleviate borrowing constraints.\footnote{See, for example, Arthur et al. (2016) for an analysis of the contribution of stricter borrowing conditions to the decrease in homeownership rates.}

4.2.2 The importance of the parental channel is changing over time

The empirical importance of the parental channel is thus likely to depend on the institutional and cultural context, as well as on house price developments, and will therefore (likely) change over time in response to changes in these variables. There is a perception in many countries that the parental channel is becoming more important, and this view is visible in the media as well as among policy makers. In the United Kingdom, for example, it was reported that "Bank of mum and dad’ making housing market more unfair, study finds" (The Guardian, March 27 2017), and that "Number of first-time buyers helped by parents is symptom of intergenerational inequality and ‘broken housing market’" (The Guardian, May 2 2017). In the Australian setting, additional implications have been discussed as "It seems the bank of mum and dad is recycling large amounts of housing wealth to the next generation through intergenerational transfers; and it is an increasingly important pillar supporting educational, housing and business opportunities" (ABC, March
4.2. PARENTS AND HOUSING: AN EMPIRICAL OVERVIEW 219

As housing tenure, historically, has been an important determinant of life-time wealth, policy makers have expressed concerns about housing affordability, and about a stronger transmission of intergenerational wealth creating barriers to intra-generational mobility. A recent report by the Social Mobility Commission analyzes the development of family support in the United Kingdom (Udagawa and Sanderson, 2017), and highlights the connection to housing markets. Their main finding is that homeownership is falling among the young, and that young borrowers are increasingly relying on family finance to access the housing market. Typically, this help comes in the form of parental gifts or loans, and around one third of first-time buyers receive this type of assistance. The second most common source is inherited wealth. Turning to the intensive margin, Udaga and Sanderson (2017) find that parental help aimed at upgrading is less common, but that around 12 percent of the existing homeowners have benefited from either gifts or loans for this purpose. The report also highlights the importance of inter-vivos transfers for the timing of the house purchase. Individuals who receive gifts or loans can become homeowners earlier, and at lower income levels, as compared to those who do not, while there is no such difference for those who exploit inherited wealth. Furthermore, they point out that there is geographical heterogeneity. Looking at homeownership rates for different age groups over time, they also find that, while homeownership is (mostly) increasing over time for all groups, younger generations lag behind older cohorts.9 In the Norwegian context, a report from Norges Bank (2017) shows that the role of parents has increased over time in the sense that parents’ economic positions have become somewhat more important. Furthermore, they show that financial transfers from parents to children have become substantially more important as a predictor of the children’s homeownership between the years 2005 and 2014.

This picture appears to be largely in line with the Swedish case, as shown in, for example, Enström Öst (2011). Enström Öst (2011) high-

9 Similarly, Arundel (2017) points out an increase in intra- and intergenerational inequality on the UK housing market.
lights that parental background matters for the transition into homeownership, and that parents’ homeownership has become a more important determinant for children’s housing market status. Furthermore, in Sweden, parent co-signing is considered important for loan eligibility (Boutredningen, 2007). A parent who co-signs a mortgage is jointly responsible for repaying the debt. This is an arrangement which can be used to secure a mortgage if the child is not considered creditworthy on her own. Furthermore, many young borrowers rely on their parents to secure the money required for a down payment (European Commission, 2014). Survey evidence from the Swedish bank SBAB (Bo & Låna, 2016) shows that more than half of all young borrowers rely on assistance, typically in the form of co-signing, or help with the down payment, in order to buy a home. As shown in Figure 4.1, the share of buyers in need of assistance to be able to become homeowners has fluctuated over time, depending on business-cycle conditions and credit market regulations. In particular, the share of first-time buyers in need of assistance has increased after 2010, following a combination of house price increases, the aftermath of the financial crisis, and stricter borrowing conditions. Now, the share of first-time buyers that need both a co-signer and help with the down payment is the highest during the observed time period, at 8 percent across all ages. The share of young buyers needing assistance is higher, with 60 percent indicating that they needed some type of assistance from family. A survey by the Swedish bank Nordea shows that among 18–29 year old individuals, 50 percent would need financial help from their parents in order to be able move within the next year (Gabrielsson, 2015). Another survey shows that 61 percent of the parents asked were willing to help their children, in some way, to finance their first home (Länsförsäkringar, 2015).

In Eng Larsson et al. (2018a), we use unique loan level data on debt to study the composition of mortgage holders. The data comes from
the eight largest banks in Sweden and covers the time period 2010–2016. We show that the number of mortgage holders between ages 31–40 has decreased over this time period. Over the same time period, the population in this age group has increased. We interpret this reduction in the share of mortgage holders as a potential sign that the threshold into the mortgage market has increased, and that one reason may be the introduction of the mortgage cap in October 2010.

In a follow-up memo, we further show that the share of young mortgage holders (between ages 18–35) that rely on parental help, in the form of co-signing, has increased over the same time period (Eng Larsson et al., 2018b). This share is highest among the youngest

\[^{10}\text{Co-signing is one particular form of parental help and it is one of the most common methods together with assistance with the down payment (note that the analysis in Norges Bank (2017), instead, looks directly at financial transfers). We do not observe any direct links between parents and children in the data. The way we infer that a co-signer is a parent is the following. If a co-signer on a shared mortgage, with a young mortgage holder in the relevant age group, is not registered at the same address and there is an age difference of at least 20 years, we infer that the co-signer is a parent.}\]
mortgage holders (ages 18–25), but the increase is notable for all age groups (18–25, 26–30, 31–35). In general, there is an initial increase, followed by a relatively flat share, which then, for the two youngest groups, increases again at the end of the sample period.\textsuperscript{11} Together with the observation that the share of mortgage holders below the age of 40 has decreased, we consider this observation to be further support for the idea that the threshold into the housing market has gone up. Finally, we find that parents who are identified as co-signers do, on average, have higher debt-to-income levels, as compared to individuals who are not parent co-signers. Among children, the debt pattern depends on how debt is allocated for the analysis (between the mortgage holders). In all cases, the level of unsecured debt is lower among children with parent co-signers, but considering the full value of the mortgage, they are more indebted.\textsuperscript{12}

The empirical overview in this section is used as a motivation for the importance of considering the parental channel through explicit intergenerational links. The section also documents that the importance of family finance has changed over time. To summarize, the empirical evidence reveals that: (i) family finance is used to alleviate borrowing constraints, (ii) transfers increase the likelihood of becoming a homeowner, (iii) the extent to which family finance is used depends on policy, and (iv) the importance of family finance has changed over time.\textsuperscript{13} In the

\textsuperscript{11}Our data is measured in July every year between 2010 and 2016. During these years two important policy changes were implemented. On October 1 in 2010, the Swedish Financial Supervisory Authority (Swedish FSA) decreased the maximum LTV limit to 0.85. On June 1 2016, stricter amortization requirements, tied to the LTV ratio, were introduced. Since we observe individuals in July in any given year, we may start to see the impact of stricter amortization rules in 2016, and we see the (potential) impact of the stricter LTV requirement in the data point for 2011. At this time, the share of the youngest mortgage holders that rely on co-signers increases more compared to the time period 2012-2015.

\textsuperscript{12}If debt is allocated between the parent who co-signs and the child, these children are instead less indebted on average.

\textsuperscript{13}It is, of course, hard to prove why the importance of family finance has changed over time but changes in policy and in (perceived) house price growth are two reasonable candidates.
next section, I develop a model that is constructed with these implications in mind, and that is used to study behavioral responses to stricter borrowing conditions. Going forward, the implications from this section will also be important to discipline which model features are important for a more realistic theoretical framework.
4.3 Theoretical Model

In this section, I set up a theoretical model to study behavior in the presence of the parental channel. The point of departure for this framework is in terms of the minimum requirements for a model that is able to address the relevance of the parental channel and to study the behavioral responses to a change in borrowing conditions. The foundation is a model with intergenerational links that includes housing and portfolio decisions. The model is partial equilibrium, and I take labor income, interest rates, and house prices as given. To assume that the former two prices are exogenous to the analysis is probably not a serious omission, as these are influenced by many factors outside the housing market. As for housing prices, it would obviously be an important addition to include their endogenous determination here. However, it is rather challenging to explain the observed movements in housing prices based on standard fundamentals (see, for example, Kaplan et al., 2017) and hence, I decided to focus on households’ decisions only in the present project. I thus see a more complete treatment of the housing market as an interesting and important next step that I hope to pursue in my future research.

There are young and old agents in the model, henceforth referred to as individuals. Young individuals (children) choose between being renters or homeowners, I call this the housing tenure decision, whereas old individuals (parents) have a predetermined tenure status. The intergenerational link consists of a one-sided altruistic link from parents to children, and of the ability of parents to make both inter-vivos transfers and leave bequests. I study the model in steady state (this is the baseline case), with constant house prices, as well as during an exogenous transition from positive house price growth to steady state.

The model is calibrated and solved to study individual behavior and reactions to changed borrowing conditions. I consider the baseline solution to be a benchmark for the rest of the analysis.
4.3. THEORETICAL MODEL

4.3.1 Setting

The theoretical framework is an overlapping generations model where individuals live for two periods: as children, indexed \( C \), and as parents, indexed \( P \). They are children in the first period and parents in the second. The two periods are intended to illustrate the economically (most) active periods of life, and can, for reference, be considered to correspond to an actual age of 20–50 for the child, and to 50–80 for the parent.\(^{14}\)

Each parent has one child and they overlap for one period. I thus abstract from fertility decisions and from population growth to focus on the intergenerational transfer decision.\(^{15}\)

Empirically, we observe both inter-vivos transfers and bequests. In the model, parents are therefore allowed to make inter-vivos transfers while they are alive, denoted \( g \), and to leave bequests in the form of savings, and the net value of their real estate (if they are homeowners), when they die. The bequest is received by the child at the beginning of the next period, as part of cash-on-hand when the child becomes a parent himself. The transfer, \( g \), instead enters the child’s cash on hand in the current period, along with the child’s (exogenous) labor income.

Altruism is one-sided and directed from the parent to the child.\(^{16}\)

This implies that a parent, in addition to caring about her own utility from consumption and housing services, also cares about the discounted utility flow of her child. A child, on the other hand, simply receives a utility flow from his own consumption and from his own housing services.

I assume that both parents and children choose their amounts of

\(^{14}\)Note that this setup is a simplification of a multiperiod model, where generations overlap in more periods. I choose this structure to highlight the mechanisms of interest, while allowing for both inter-vivos transfers and bequests.

\(^{15}\)See Cooke et al. (2017) for a joint analysis of bequests and fertility, arguing that fertility differences between rich and poor households amplify the role of bequests for wealth inequality.

\(^{16}\)I argue that this assumption is reasonable in the context of this paper. However, it does limit the generality of the model to other cultural contexts. See, for example, Yukutakea et al. (2015) for a model with an exchange motive for transfers in the Japanese context, and Almås et al. (2016) for a study of savings and bequests in China.
housing services. The housing tenure choice, on the other hand, is restricted in that I only allow children to choose between being renters or homeowners, whereas parents' housing tenure status is predetermined. For my analysis, this means that there is a predetermined heterogeneity among young individuals in terms of their parents' housing tenure status, and therefore also in terms of parental resources. Since parental resources affect the ability to make intergenerational transfers, this difference may impact children's own economic resources, in terms of cash on hand and future bequests, and their ability to become homeowners.

The strategic interactions between parents and children are inspired by the setup in Boar (2018). I restrict the timing of the decision making to only allow for a specific type of sequential interaction, described in detail in Section 4.3.3. In my case, because parents and children only overlap in one period and because parents can commit, intratemporally, to a portfolio choice (including the level of the bequest), there is no scope for the child to exploit the parent.\footnote{\textsuperscript{17}The setup with strategic interactions, i.e., where the policy of a parent depends on that of her child, typically leads to what is known as the Samaritan's dilemma, with the child exploiting the altruism of his parent. To limit the scope of this channel, it is, for example, possible to restrict parents to only make transfers to their children if the children would otherwise be constrained (see, for example, Boar, 2018). See Luo (2017) for a setup without strategic interactions between generations, using warm-glow transfer motives to avoid the Samaritan's dilemma.}

For both parents and children, cash on hand partly consists of labor income. I assume an exogenous labor income, denoted $y^C$ for the child, indexed $C$, and $y^P$ for the parent, indexed $P$, respectively, to remove the aspect of uncertainty and income risk. To simplify further, I only consider one level of labor income, i.e., there is no heterogeneity in terms of earnings.\footnote{\textsuperscript{18}The model can be extended with more income levels.}

There are three types of assets in the model: houses $h$, deposit savings $a$, and mortgages $m$. Housing services, $h$, give utility, and owned housing can be used as collateral for borrowing. Housing is further different as compared to other asset types because it is nontradable: in order to consume housing services, individuals need to be homeowners or pay
rent for these services. For homeowners, the value of the non-depreciated part of housing (housing depreciates at the rate $\delta$ between two periods $t$ and $t + 1$) is also carried forward as part of the cash on hand in the next period. Because I assume that there are no trading frictions, the only way in which the housing choice from a previous period affects current wealth is through the contribution to cash on hand. The housing tenure choice gives the child a housing status as owner, indexed $O$, or renter, indexed $R$, and this status is maintained for both periods (i.e., for the rest of his life). Similarly as in, for example, Kiyotaki et al. (2011), renting is associated with lower utility. Specifically, housing services for homeowners are multiplied by a scalar, $\mu > 1$, in the utility function. All individuals can save in the deposit, $a \geq 0$, that pays a risk-free rate, $r_{t+1} = R_{t+1} - 1$, between time $t$ and $t + 1$. Homeowners can finance part of their housing purchase through collateralized borrowing, $m$, and this is the only type of borrowing that is allowed in the model, i.e., for renters $m$ is constrained to be zero. Buying a home is subject to a minimum collateral requirement given by the constraint:

$$m \leq \theta_{ltv} ph,$$

(4.1)

where $\theta_{ltv}$ is the LTV ratio, and $p$ is the house price (per housing unit).\textsuperscript{19} This implies that in order to enter the housing market, a prospective buyer needs to have at least a fraction $1 - \theta_{ltv}$ of the house value for the down payment. The constraint is only binding when individuals change their housing stock or their mortgage. However, in the model, this follows mechanically from the fact that there is only one period debt, i.e., all homeowners refinance when they go from being a child to becoming a parent.\textsuperscript{20} Homeowners can use increases in their equity, through house

\textsuperscript{19}See, for example, Iacoviello et al. (2016) for an example where the underlying reason for a borrowing constraint of the type used here is an enforcement problem.

\textsuperscript{20}This implies that the collateral constraint applies in every period, otherwise it would only be used when individuals refinance actively. This is to capture the fact that, in reality, mortgage restrictions apply to new loans or increases in existing loans. See Ortalo-Magné and Rady (2006) for an alternative setup with a housing ladder which implies that individuals trade up over the life cycle.
price increases (or previous amortizations), as collateral for new mortgages. In reality, this is of particular relevance for the parental channel, because mortgages can allow parents to capitalize on their house value gains, as a potential source of funding for, for example, the inter-vivos transfers to their children.

Below I specify the preferences of children and parents, as well as the prices in the model, before turning to the recursive formulation of the model.

Preferences  Children receive a utility flow from their own consumption of the consumption good, $c$, and from housing services, $h$.\footnote{To be more precise, they receive utility from housing services $s$. However, to simplify, I assume a linear housing technology such that $s = h$. See Davis and Ortalo-Magné (2011) for support on the Cobb-Douglas functional form.} I assume a CRRA utility function with a Cobb Douglas aggregator of $c$ and $h$:

$$u(c^c, h^c) = \left[ (c^c)^\gamma (h^c)^{1-\gamma} \right]^{1-\sigma},$$

(4.2)

where $\sigma > 0$ is the coefficient of risk aversion, and $\gamma \in (0, 1)$ is the weight on the consumption good in the bundle of $c$ and $h$. Parents derive utility from their own consumption of the consumption good and from housing services, as well as from the (discounted) utility of their offspring, similarly as in Barro (1974). More specifically, parents place a weight $\alpha$ on the utility of their children. The felicity function is additive and of the type:

$$v(c^p, h^p, c^c, h^c) = \left[ (c^p)^\gamma (h^p)^{1-\gamma} \right]^{1-\sigma} + \alpha \left[ (c^c)^\gamma (h^c)^{1-\gamma} \right]^{1-\sigma},$$

(4.3)

where $\alpha$ is the altruistic parameter, i.e., the weight that the parent puts on the utility of her child. This is the felicity function for the current period utility. In Section 4.3.2, I extend this formulation to include the continuation value, since parents also care about their children’s future,
and then the same alpha is applied to the future terms as well. As a consequence, since the parents’ children care about the children that they will have, alpha takes the role of a discount factor as we obtain a weight $\alpha^k$ for generations $k$ from today.

**Prices** The price of the consumption good is normalized to one. House prices are exogenous and denoted $p$, and rental prices are denoted $q$. I assume that rental prices, i.e., the expenditure on rented housing services, are linked to the price of owned housing. Specifically, I assume that they are simply equal to a fraction $\kappa$ of house prices: $q = \kappa p$. For the purpose of this paper, I focus on the case where house prices are either constant (steady state) or grow exogenously for three periods (transition period) and then become constant. The case with constant house prices is useful in order to focus on housing as a source of utility, and a storage of value, as compared to the case when housing can also be viewed as an investment.\(^{22}\)

\(^{22}\)See Óscar Arce and López-Salido (2011) for an example where the presence of investors gives rise to a possible housing bubble.
CHAPTER 4. PORTFOLIO AND HOUSING DECISIONS

4.3.2 Recursive formulation

For the recursive formulation, in the baseline case, all variables are constant. Therefore, there are no time indices. To further simplify the notation, I do not use indices for parents and children separately unless it is necessary for clarity. Appendix 4.B.1 shows first-order conditions for parents, and Appendix 4.B.1 shows the corresponding first-order conditions for children.

Decision problem of the parent

Homeowner’s problem A parent who is a homeowner, indexed $P,O$, solves the following optimization problem:

$$V_{P,O}(x) = \max_{\{c,a,g,h,m\}} u(c, \mu h) + \alpha V_C(y_C + g, y_P + b)$$

subject to

$$x = c + a + g + \tau(g) + ph - m,$$
$$b = Ra + p(1 - \delta)h - R^m m,$$
$$m \leq \theta^{ltv} ph,$$
$$a \geq 0,$$
$$g \geq 0.$$

$V_{P,O}(x)$ is the value function of a parent who buys her house. The state variable, $x$, is own cash on hand in the current period. Note that my definition of cash on hand includes all available economic resources in a given period. The parent chooses consumption $c$, savings $a$, the inter-vivos transfers $g$, housing $h$, and the mortgage $m$. She does this subject to the budget constraint, the borrowing constraint for the mortgage, and the non-negativity constraints on savings and on the transfer. The parent derives instant utility, $u$, from consumption $c$ and from housing services $\mu h$. She also gets utility, discounted by the

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$^{23}$See Appendix 4.B.2 for the corresponding notation in the transition period with time-varying policy and value functions.
4.3. THEORETICAL MODEL

altruistic parameter $\alpha$, from the value function of her child, $V^C$. The child’s value function is affected by the parent’s choice of $g$, today, and by bequests, $b$, for the next period. This is because cash on hand of the child in the next period, i.e., when becoming a parent, is given by savings and real estate from young age, the exogenous (and constant) income $y^P$ and the bequest, $b$. The bequest, in turn, consists of financial savings and, for the parent who is a homeowner, the net value of the parent’s real estate. There is a cost to making inter-vivos transfers, $\tau(g)$, i.e., parents need to spend more on the transfer than what their children actually receive.\footnote{This cost can, for example, represent mental costs or transaction costs to access liquid funds. In the limiting case when this cost goes to zero, parents will, for the baseline calibration in this model, be indifferent between transferring funds as inter-vivos or bequests.} Solving the problem gives decision rules for the choice variables as functions of the state variable $x$: $f_{c,P,O}^P(x)$, $f_{a,P,O}^P(x)$, $f_{g,P,O}^P(x)$, $f_{h,P,O}^P(x)$, and $f_{m,P,O}^P(x)$.

**Renter’s problem** A parent who is a renter, indexed $P, R$, solves the following optimization problem:

$$V^{P,R}(x) = \max_{\{c, a, g, h\}} \quad u(c, h) + \alpha V^C(y^C + g, y^P + b)$$

s.t. \quad $x = c + a + g + \tau(g) + qh,$

$\quad b = Ra,$

$\quad a \geq 0,$

$\quad g \geq 0.$

$V^{P,R}(x)$ is the value function of a parent who rents her house. The state variable is the same as for the homeowner, i.e., own cash on hand in the current period, $x$. The parent chooses consumption $c$, savings $a$, the inter-vivos transfers $g$, and housing $h$. She does this subject to the budget constraint, and the non-negativity constraints on savings and
on the transfer. Once more, $b$ is the bequest left by the parent to the child, which the child will receive in the next period, and $\tau(g)$ is the cost for making inter-vivos transfers. The bequest only consists of returns to savings, as the renter does not own any housing. Instant utility comes from the consumption good $c$ and from housing services $h$. Solving the optimization problem, I obtain decision rules for the choice variables: $f_c^{P,R}(x)$, $f_a^{P,R}(x)$, $f_g^{P,R}(x)$, and $f_h^{P,R}(x)$.

Decision problem of the child

**Homeowner’s problem** A child who buys a house chooses consumption $c$, savings $a$, housing services $h$, and the size of the mortgage $m$. He solves the following optimization problem:

$$V^{C,O}(x, y^P + b) = \max_{\{c, a, h, m\}} u(c, \mu h) + \beta V^{P,O}(x')$$

s.t. $x = c + ph + a - m$, 
$m \leq \theta lv ph$, 
$a \geq 0$, 
$x' = Ra + p(1 - \delta)h - R^m m + y^P + b$,

$V^{C,O}(x, y^P + b)$ is the value function of a child who buys a house. It consists of the instant utility from consumption of the consumption good $c$ and from housing services $\mu h$, as well as the discounted continuation value. The relevant state variables for the child are cash on hand today, $x$, and the given part of cash on hand for tomorrow, $y^P + b$, i.e., the sum of future labor income and the bequest. The amount received when old, $y^P + b$, is a separate state variable because if the borrowing constraint binds, this amount cannot simply be added, in present value, to current wealth (it cannot be borrowed against). The child solves the maximization problem subject to the budget constraint, the borrowing constraint for the mortgage, and the non-negativity constraint on savings, as well
as the law of motion for cash on hand in the next period which, apart from the exogenous income and the bequest, also includes his own savings and the net value (after the mortgage is paid off) of his house. The solution to this problem gives decision rules for the child: $f^{C,O}_c(x, y^P + b)$, $f^{C,O}_a(x, y^P + b)$, $f^{C,O}_h(x, y^P + b)$, and $f^{C,O}_m(x, y^P + b)$.

**Renter’s problem** A child who is a renter chooses consumption $c$, savings $a$, and housing services $h$:

$$V^{C,R}(x, y^P + b) = \max_{\{c, a, h\}} u(c, h) + \beta V^{P,R}_{t+1}(x')$$

s.t.

- $x = c + qh + a$,
- $a \geq 0$,
- $x' = Ra + y^P + b$.

$V^{C,R}(x, y^P + b)$ is the value function of a child who rents a house. It consists of the instant utility from consumption of the consumption good $c$ and from housing services $h$, as well as the discounted continuation value. The relevant state variables are the same as for the homeowner. The child solves the maximization problem subject to the budget constraint, the non-negativity constraint on savings, and the law of motion for cash on hand in the next period which, apart from the given income and bequest, now only includes his own savings. The child who is a renter has decision rules $f^{C,R}_c(x, y^P + b)$, $f^{C,R}_a(x, y^P + b)$, and $f^{C,R}_h(x, y^P + b)$.

**Housing tenure choice** To determine whether to be a homeowner or a renter, the child compares the value functions for the two different cases and picks the one associated with the highest value:
\[ V^C(x, y^P + b) = \max \{ V^{C,O}(x, y^P + b), V^{C,R}(x, y^P + b) \}. \quad (4.4) \]

### 4.3.3 Solution concept

To solve the model, I use the same timing assumption as in Boar (2018). This implies that in the first stage, parents optimize and then, in the second stage, children optimize given their parents’ actions. The motivation for such a timing structure is that parents can typically not force children to follow, for example, specific consumption rules. The biggest impact they have on their children’s behavior is through the type of transfer to which they commit. When solving this problem for a parent-child pair, I therefore first find the optimal response for the child, i.e., his decision rules, and then let the parent optimize, taking these decision rules into account. The solution method is described in more detail in Appendix 4.C.

**Endogenous objects of interest, constant prices** Children are heterogeneous in terms of their parents’ housing tenure status. But the only way in which this matters for the children’s behavior is through potential differences in their own cash on hand today, because of potential differences in the amount of inter-vivos transfers, and through the future bequests. The model is partial equilibrium and I assume that all prices, i.e., the interest rate, housing prices, rental and consumption good prices, and earnings, are given exogenously. Furthermore, in steady state all prices are constant. The relevant endogenous objects of interest are then:

1. a set of value functions \( \{ V^{C}(x^C, y^P + b), V^{P,R}(x^P), V^{P,O}(x^P) \} \),
2. a set of associated policy functions
4.3. THEORETICAL MODEL

\{f_{C,R}^C(x^C, y^P + b), f_{a}^{C,R}(x^C, y^P + b), f_{h}^{C,R}(x^C, y^P + b)\} for the case when the child is a renter,

\{f_{C,O}^C(x^C, y^P + b), f_{a}^{C,O}(x^C, y^P + b), f_{h}^{C,O}(x^C, y^P + b), f_{m}^{C,O}(x^C, y^P + b)\} if the child is a homeowner,

\{f_{P,R}^P(x^P), f_{a}^{P,R}(x^P), f_{g}^{P,R}(x^P), f_{h}^{P,R}(x^P)\} if the parent is a renter, and

\{f_{P,O}^P(x^P), f_{a}^{P,O}(x^P), f_{g}^{P,O}(x^P), f_{h}^{P,O}(x^P), f_{m}^{P,O}(x^P)\} if the parent is a homeowner,

and a set of (exogenous) prices \((1, p, q)\) such that, given prices, value functions solve the recursive problems of households and the optimal solutions are given by the policy functions for the two housing tenure statuses and the two stages of life.

Endogenous objects of interest, changing prices    During the transition period, house prices grow exogenously. The transition takes place over three stages, where the last is the steady state. I specify a vector of house price growth rates between the first and the last stage. Letting \(T\) denote the steady state, the growth rate between stages \(T - 2\) and \(T - 1\), and between \(T - 1\) and \(T\), is positive. In the final stage, \(T\), prices are constant.

To solve for the decision rules and the value functions along this transition path, I proceed backwards from the steady state (defined in the above paragraph). I start with \(T - 1\) and solve the decision problems, taking the steady-state solution as given. Specifically, in stage \(T - 1\), the continuation value is given by the solution from stage \(T\). For the first stage, \(T - 2\), the procedure is the same, i.e., the solution from the second stage, \(T - 1\), enters as the continuation value in the value function for \(T - 1\). From this exercise, I get a set of policy and value functions, indexed by their respective stage, where the solution for the last stage is known from the steady state.
4.4 Analysis of the Model

Here, I first describe the parameters used to solve the model numerically. Then, I study the portfolio and housing decisions of young and old individuals, and the housing tenure choice of young individuals. Finally, I analyze the effect of an increase in the down-payment requirements on individual behavior.

4.4.1 Parameter values

Table 4.4.1 shows all the parameters used for the benchmark model. Some parameters are stated in terms of annual values and, since one model period corresponds to 30 years, some of them have to be adjusted for this. Parameters that have such a time dimension are denoted by ($\ast$). Children enter the model at the age of 20 and become parents at the age of 51. Parents live until the age of 80 when they die with certainty. Most parameters are set exogenously to values found in previous studies or based on data. When possible I use parameter values based on Swedish data. I discuss the calibration in detail below.
### Table 4.1: Parameter values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length of time period</strong></td>
<td>$T$</td>
<td>30 years</td>
</tr>
<tr>
<td><strong>Preferences</strong></td>
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<td></td>
</tr>
<tr>
<td>Risk aversion</td>
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<td>Discount factor ($\star$)</td>
<td>$\beta$</td>
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<td>altruism parameter</td>
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<td>Ownership benefit</td>
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<td>Weight of housing services</td>
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<td><strong>Financial markets</strong></td>
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<td></td>
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<td>Risk free rate ($\star$)</td>
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<td>Mortgage rate ($\star$)</td>
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<td>Maximum LTV</td>
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<td><strong>Housing</strong></td>
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<td></td>
</tr>
<tr>
<td>(Adjusted) house price growth ($\star$)</td>
<td>$\Delta p$</td>
<td>0, {0.036, 0.018, 0}</td>
</tr>
<tr>
<td>House size (owner)</td>
<td>$h^O$</td>
<td>{1, 2, 5, 7, 5, 10}</td>
</tr>
<tr>
<td>House price</td>
<td>$p$</td>
<td>2.1017</td>
</tr>
<tr>
<td>House size (renter)</td>
<td>$h^R$</td>
<td>{1, 2, 5, 7, 5}</td>
</tr>
<tr>
<td>Rental price to house price ratio</td>
<td>$\kappa$</td>
<td>{1, 2, 5, 7, 5}</td>
</tr>
<tr>
<td>Depreciation rate ($\star$)</td>
<td>$\delta^h$</td>
<td>0.011</td>
</tr>
<tr>
<td><strong>Adjustment cost for inter vivos transfers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjustment cost function</td>
<td>$\tau(g)$</td>
<td>$\eta g^2$</td>
</tr>
<tr>
<td>Cost parameter</td>
<td>$\eta$</td>
<td>0.05</td>
</tr>
<tr>
<td><strong>Income</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child income</td>
<td>$y^C$</td>
<td>2</td>
</tr>
<tr>
<td>Parent income</td>
<td>$y^P$</td>
<td>3</td>
</tr>
</tbody>
</table>
Preference parameters I use a standard value of 2 for the risk aversion parameter in the CRRA utility function. Because I assume a Cobb-Douglas aggregator of consumption and housing services, $\gamma$, the weight on the consumption good in the utility function also constitutes the expenditure share of the consumption good. I choose $\gamma = 0.8$ based on the average expenditure share on housing from Statistics Sweden (2017b) (and in line with values in Piazzesi and Schneider, 2016). The discount factor $\beta$ is set to 0.974. There exists a range of estimates for the altruistic parameter $\alpha$ in the previous literature. I choose $\alpha = 0.5$ for the baseline value, which is in the range of estimates previously found. Finally, $\mu$ is a key parameter for my analysis. It is the scalar used to amplify utility from owned, as compared to rented, housing services. I use a relatively high value of 1.5 to make it reasonably attractive to own housing, given relatively cheap rental prices.\footnote{One reason for this is because in Sweden, for example, rentals are typically difficult to acquire, making owned housing a de facto preferred option for many.}

Other parameters I specify the cost for making inter-vivos transfers to be a quadratic adjustment cost. Remember that this cost is included in the parent’s decision problem to obtain interior solutions when choosing between the inter-vivos transfer and the bequest.\footnote{In the limiting case when this cost goes to zero, there is indeterminacy.} The parameter $\eta$ is a small number (0.05 in the baseline specification). For the risk free (deposit) rate, I use the average real rate on Swedish 2-year government bonds for the years 1988–2016, resulting in $r = 0.027$. I use an average of the (real) flexible mortgage rate from the main banks in Sweden for the same time period, implying an interest spread of 0.015 ($r^m = 0.042$). For the baseline model, I use the stipulated LTV ratio of 0.85 (Swedish FSA, 2016). For the income parameters, $y^c$ and $y^p$, I use a value of 2 for children and 3 for parents in the baseline specification. These values are particularly important in relation to the grid sizes for other variables and to the cost of housing.\footnote{Taking an average of, for example, median income within the age groups 20–50 and 51–80 over the years 2010–2015, income is rather similar (Statistics Sweden,
4.4. ANALYSIS OF THE MODEL

The maximum rental house size available is smaller than the minimum owned house size, but other than that, the two grids overlap. The lowest grid point for owned housing is chosen so that $p \times h$ corresponds to roughly double the exogenous labor income for parents (in line with Hull, 2017). For the rental price to house price ratio, $\kappa$, there exists a range of different estimates. A common range is between 5 and 10 percent (Piazzesi and Schneider, 2016). For the baseline, I choose $\kappa = 0.10$, i.e., 10 percent. The depreciation rate for owned housing is from Wilhelmsson (2008), and I choose the annual depreciation rate (which is then compounded to account for the length of a time period).

The baseline specification looks at the steady state with constant house prices, but for the transition period with positive house price growth, I start from a relatively high house price growth rate, and then go to the average real house price (annual) growth rate for the time period 1985–2016, 3.8 percent, before ending up in the steady state with zero house price growth. Because house prices are the only prices that evolve in the model over time, I subtract real wage growth (1.7 percent on average) over the same time period from the positive house price growths to arrive at $\Delta p / p = \{0.038, 0.018, 0\}$. The initial price level, which in combination with the growth rates determines the steady-state price level, is set to 0.402. This implies that in steady state, the house price is equal to 2.1017.

The baseline parameter values ensure that in steady state, rental expenditure relative to income ($y$) is in a reasonable range. Furthermore, the value of housing relative to total cash on hand decreases in parental wealth (in line with, for example, Bach et al., 2017), and debt-to-income is highest for the young individuals (in line with life-cycle patterns as in, for example, Eng Larsson et al., 2018a).

2017b). I choose a lower parameter for children to focus on the case when individuals accumulate more over their lifetime (and start off economically weaker). It would be possible to extend the model to allow for heterogeneity in children’s income for a given level of parental wealth, for a more realistic setting.
4.4.2 Baseline results

Here I present the main findings. I first characterize individual behavior in steady state, and then discuss an exogenous transition to steady state from positive house price growth, for the baseline specification. I specify an exogenous vector of house price growth starting at 3.8 percent and ending at zero growth. The transition takes place in three steps, where the third step is the steady state, and I use backwards induction to solve for the transition period. Finally, I also apply the model to analyze the impact of stricter borrowing conditions in the form of higher loan-to-value requirements.

Specifically, I look at housing and portfolio choices of parents and children. For children I study behavior conditional on their parents’ wealth. I retrieve the decision rules in the following way. First, I solve the child’s problem for all levels of the two state variables, own cash on hand and the bequest. Then, I solve the parent’s problem, taking the child’s optimal behavior into account, for renters and homeowners, respectively. For each level of parental cash on hand, which in turn is the parent’s only state variable, this results in a realized level of the child’s cash on hand and of the bequest, i.e., the optimal intergenerational transfers. Because the child’s state variables are determined by the parent’s actions, I can then construct an indicator for whether it is optimal for the child to be a homeowner or a renter at a given level of parental wealth. Knowing the optimal housing status for the child, I then choose the appropriate decision rule for different levels of parental wealth.\textsuperscript{28}

I graphically present policy functions and value functions for parents who can be homeowners (Owner) or renters (Renter). Policy and value functions are plotted over the different levels of cash on hand, and I keep the cash on hand grids for parents who are homeowners and renters the same. For children I plot the policy and value functions against parental cash on hand, and distinguish between children of homeowners (Parent

\textsuperscript{28}For each level of parental cash on hand, I can also look at the decision rules for the child’s realized cash on hand, where realized cash on hand is simply the exogenous income, $y^c$, plus the optimal inter-vivos transfer from the parent, $g^p$.}
owner) and of renters (Parent renter). An indicator function highlights when children themselves choose either housing tenure status.

**Steady state**

In steady state, house prices are constant, and the model is solved using the baseline calibration. I summarize the key insights from the model in terms of observations below. Note that there is a discrete change in homeowner parents’ consumption and savings. This change, discussed in more detail below, corresponds to the level of cash on hand where these parents upgrade their amount of housing services. Overall, decision rules are smooth, but the discretized state space (with a limited number of nodes) implies that a change in one variable can lead to a discrete change in another.

**Figure 4.2: Policy functions for parents**

(a) Consumption  
(b) Savings  
(c) Value function  
(d) Transfer  
(e) Housing  
(f) Mortgage

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29 The same is true for renters. However, the rental price is much lower, making these changes less pronounced.
Observation 1.1: In general, parents’ consumption, savings and inter-vivōs transfers increase in cash-on-hand. Unsurprisingly, in general, richer parents spend more on their own consumption, and on transfers to their children, both in terms of savings (i.e., the financial part of bequests) and in terms of inter-vivos. The reason is simply that they can afford more when they are richer: consumption of different kinds (both for the parent and the child) are normal goods, given the preferences assumed (this comes from the time additivity of the utility function $u$). The poorest parents, however, do not spend anything on savings. Instead there is a threshold, in terms of parental wealth, above which financial savings are positive. Finally, a parent’s own consumption is always higher than transfers to the child.

Observation 1.2: Parents who are renters consume, transfer and save (in the financial asset) as much, or more, as compared to owners. The main difference between parents who are homeowners and renters, in terms of consumption and transfers
to children, is that parents who are renters save and consume at least as much as parents who are homeowners. In terms of the inter-vivos transfers, comparing the richest renters and the richest homeowners, parents who are renters transfer slightly more to their children.

From Figure 4.2, panel (a) it is clear that parents who are renters consume at least as much as owners, and at higher levels of cash on hand they always consume more. As soon as they afford more than the smallest amount of housing, parents who are homeowners spend less on consumption of the consumption good and more on housing services. This explains the difference in consumption between them and parents who are renters. Furthermore, parents save in the deposit when they are above a threshold level of cash on hand (panel (b)), and this threshold is somewhat higher for parents who are homeowners. The reason why homeowners save less in the financial asset is that they also leave the net value of their real estate as part of the bequest. The richest homeowners, however, save as much as renters, implying that their total bequests are higher than that of renters. We note that for homeowners, there is one discrete change in the level of savings and consumption, corresponding to the level of cash on hand where they upgrade their amount of housing services, i.e., their housing size (panel (e)). Because consumption of both the consumption good and housing services enters the utility function, however, the value function is still smooth (panel (c)). Renters also have small changes in consumption, but, because of the relatively low price of rental housing services, these changes are much smaller. Panel (d) shows the inter-vivos transfers, which are increasing in cash-on-hand. Renters and homeowners spend very similar amounts on these transfers to their children, although at the highest levels of cash on hand, renter parents transfer somewhat more. At these levels of parental cash on hand, however, parents of homeowners instead leave larger bequests. In general, the amount of inter-vivos

\[30\text{We can also see that, apart from at low levels of parental wealth, parents who are homeowners fare as well as, or somewhat better, than parents who are renters, in terms of the value function.}\]
transfers is increasing in cash on hand until it plateaus somewhat around a cash on hand level around 30, before increasing slightly again after cash on hand levels of around 40. As we will see in panel (f) in Figure 4.3, the level where the inter-vivos transfers plateau is the level in terms of parental wealth where children choose to become homeowners. At this cutoff, parents put somewhat more weight on transfers for the future, and this is also the level of parental cash on hand where the financial savings of homeowners approach that of renters. Thus, parents of children who have entered the (owned) housing market direct more resources to intergenerational transfers for the future.

Observation 2.1: Parents upgrade their housing size with higher cash on hand. Housing is available in discrete sizes and thus, since parents consume more housing services at higher levels of cash on hand, the decision rule for housing is a step function, increasing in parental wealth.

Observation 2.2: Renters can consume more housing services (at a lower cost as compared to owning). For a given level of cash on hand, renters consume more housing services than homeowners. This is because the relative price of renting, compared to owning, is low.\(^{31}\) At the same time, homeowners derive more utility from any given level of housing services, and the non-depreciated value of housing, minus debt service if they have a mortgage, enters into their bequest that contributes to their children’s future cash on hand.

In Figure 4.2, panel (e), we note that parents who are renters upgrade their amount of housing services at lower levels of cash on hand as compared to owners. Once they have reached the maximum house size, they

\(^{31}\)This relative cost is determined by the parameter \(\kappa\), which is calibrated to be in the range of previous estimates. This cost may, however, be even higher in reality (because of, for example, non-functioning rental markets), and at higher levels of \(\kappa\), owned housing is more attractive.
stay at that level. Homeowners upgrade their housing size once they become richer, but, in the steady state, they never reach the largest housing size. Naturally, renters only pay a fraction $\kappa$ of the house price in any period, whereas homeowners must pay at least a fraction $1 - \theta^{LTV}$ of the house value. In the numerical solution, individuals choose leverage (the LTV ratio) rather than the mortgage directly, but in panel (f) it is clear that, in steady state, the parents’ mortgages are very low, and only positive for parents with the lowest levels of cash on hand.\footnote{Mortgages are simply calculated from: $m = LTV \times ph.$}

**Observation 3:** Based on Observations 1.2 and 2.2, parental tenure status matters more for the form of bequest than for the inter-vivos transfers. Because parents who are renters can only leave financial bequests, they save at least as much as homeowners at every level of cash on hand. Homeowners, on the other hand, also leave the net value of their real estate as a bequest, and therefore save less, apart from at the highest level of cash on hand. Looking at the value of total bequests, the housing tenure status does not make any big difference; the main difference is instead in terms of the type of asset. At the highest levels of parental wealth, homeowners bequeath somewhat more because they save as much as renters and also hold real estate but no debt.

Turning to the children’s policy functions and value functions (Figure 4.3), note that the decision rules for consumption and the value functions are not completely smooth. In particular, at stages corresponding to upgrades in housing services, there are small downward changes. Note also that the children’s value functions are smooth in their own levels of cash on hand, for different levels of the bequest. However, because their \textit{de facto} cash on hand is not completely smooth in parental cash on hand, the de facto value functions show these small irregularities.
Observation 4.1: Children’s consumption increases in parental cash on hand, whereas savings are always zero. Parents’ tenure status has virtually no impact on children’s consumption or savings. Figure 4.3 shows that children do not save at all using deposits (panel(b)), but instead consume more (panel (a)) the richer are their parents (and thus the higher is their own cash on hand). There are no clear differences between children of renters and homeowners. The reason for this is that inter-vivos transfers are very similar for parents who are homeowners and for parents who are renters. Furthermore, the level of bequests is also very similar. The only difference is that at the highest levels of parental cash on hand, renters transfer slightly more in terms of the inter-vivos gift, whereas homeowners bequeath somewhat more. At this point, all children are homeowners and the timing of intergenerational transfers does not affect their behavior in connection to the housing market. In line with this, panel (c) also shows that there is no clear difference in the value functions of children of homeowners or renters (apart from at the lowest levels of parental cash on hand).

Observation 4.2: Children increase the amount of housing services until they become homeowners. Once homeowners, they increase their leverage ratio with parental cash on hand. Children of renters have a slightly lower leverage. The amount of housing services increases in steps while children are still renters. When they become homeowners, they can no longer afford the same housing size and therefore downgrade.

From panel (e) in Figure 4.3, we see that housing consumption follows a step-wise pattern, where the amount of housing services first increases and then decreases. This is because there is a kink in the children’s housing tenure status (see the indicator function in panel (d)). We see that children of homeowners and children of renters become homeowners themselves at the same level of parental wealth. Below the threshold above which the child becomes a homeowner, he instead rents housing.
Immediately upon becoming an owner, he cannot buy as much housing services (because of the higher price) even when he is fully leveraged. After the transition to become a buyer, the child maintains a constant amount of housing services. To sum up, children above a certain level of parental wealth choose to become homeowners. Then, they cannot afford to upgrade the amount of housing services, however. The mortgage pattern in panel (f) shows that children have positive and almost constant mortgages when they are homeowners. Once homeowners, children increase their leverage slightly with parental wealth, and children of homeowners quickly reach the maximum LTV ratio, whereas children of renters have a slightly lower leverage. Remember that parents who are renters transfer somewhat more in terms of the inter-vivos at the highest levels of parental cash on hand, implying that their children have somewhat higher own cash on hand. Parents who are homeowners, on the other hand, leave somewhat larger bequests.

Observation 5: The main determinant of children’s behavior in steady state is parental wealth, not housing tenure status. To conclude, in steady state, what mainly matters for the children’s choice between renting and owning, and for the choice of housing size

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33 In general, when the gain to (cost of) being a homeowner increases (decreases), children become homeowners at lower levels of parental wealth. This is, for example, the case if the spread between the deposit rate and the mortgage rate decreases (then parents also increase their leverage ratio somewhat), or if the depreciation rate decreases. A higher cost of making inter-vivos transfers, η, does not necessarily make individuals postpone becoming homeowners, but it increases the level of bequests, both for parents who are homeowners and for parents who are renters, and makes children choose the maximum leverage at all levels of parental wealth. Furthermore, a lower relative cost of rented housing services, i.e., a decrease in κ, can make children choose to remain renters at all levels of their parents’ cash on hand. A lower altruistic parameter decreases the amount of resources transferred from parents to children in the form of inter-vivos. This also implies that the relationship between cash on hand over two generations becomes weaker and that the children of rich parents end up with less cash on hand when they become parents themselves, as compared to in the baseline case. A lower relative utility gain from owned housing, μ, of 1.1 instead of 1.5, makes children choose to be renters at all levels of parental wealth. Furthermore, in that case, parents who are homeowners bequeath less to their children.

34 Note that as long as the children are renters, they do not have access to any borrowing, and therefore debt is zero.
and leverage, is mainly parental cash on hand, whereas parental housing tenure status only has a marginal impact for leverage. For consumption and savings, the housing tenure status of parents is not important in determining behavior in steady state.

**Transition period with positive house price growth**

For this section, I assume an exogenous transition over three periods, where the last period is the steady state, going from a house price growth of 3.8 percent, to 1.8 percent and, finally, zero percent in steady state. In Figures 4.4–4.7, each row represents a specific policy or value function, whereas columns correspond to different levels of house price growth rates.

Note that, also during the transition, there are discrete changes in homeowner parents’ consumption, inter-vivos transfers, and savings, corresponding to upgrades in terms of housing services. Furthermore, in the intermediate stage, homeowner parents’ savings drop to zero around a cash on hand of 20. At this cutoff, they also upgrade their housing services, thus maintaining a smooth value of the total bequest they leave to their children. Finally, the policy function for mortgages also shows discrete changes, corresponding to upgrades in terms of housing services.

**Observation 6.1:** For parents, across all transition stages, the consumption of renters is at least as high as the consumption of homeowners. Row (1) of Figure 4.4 shows that the difference between homeowners and renters is more pronounced when the house price growth is higher. At all stages, homeowners get more utility from their housing services. When the house price is relatively low, and housing increases in value over time, homeowners therefore consume more housing services and less of the consumption good. Furthermore, there are fewer discrete changes in the consumption of homeowners when house price growth is high or zero, as compared to the intermediate stage. In the first case, because of the relatively low price of housing, homeown-
ers quickly upgrade to the largest housing size, whereas in steady state, homeowners can only afford to upgrade once. At the intermediate house price growth rate, the decision rule for owner-occupied housing is also a step function, with more discrete changes, which increases in parental cash on hand. In row (3) we note that parents who are homeowners are better off, measured by the value function, when the house price growth is positive, but that this difference becomes less pronounced as house price growth slows down. This is due to the fact that when house prices
are low and house price growth is high, they can consume large amounts of housing services themselves, and they can also leave larger bequests as compared to parents who are renters. Finally, their children are better off compared to children of renters. At each level of parental wealth, they consume at least as much, in terms of both the consumption good and the housing services, as children of renters. Their parents leave larger bequests, implying that they can take on more debt and still maintain a high level of cash on hand for the next period.
4.4. ANALYSIS OF THE MODEL

Figure 4.6: Policy functions for children (1)

(a) Consumption, $\frac{\Delta p}{p} = 0.038$

(b) Consumption, $\frac{\Delta p}{p} = 0.018$

(c) Consumption, $\frac{\Delta p}{p} = 0$

(d) Savings, $\frac{\Delta p}{p} = 0.038$

(e) Savings, $\frac{\Delta p}{p} = 0.018$

(f) Savings, $\frac{\Delta p}{p} = 0$

(g) Value function, $\frac{\Delta p}{p} = 0.038$

(h) Value function, $\frac{\Delta p}{p} = 0.018$

(i) Value function, $\frac{\Delta p}{p} = 0$

Observation 6.2: For parents, the difference between homeowners and renters in terms of savings is larger when house price growth is higher. Row (2) of Figure 4.4 highlights that: (a) the savings of homeowners are smaller when house price growth is positive, (b) the threshold for positive savings is higher at higher house price growth rates and, (c) the difference in savings between homeowners and renters is overall the largest when house price growth is the highest. When house price growth slows down, parents who are homeowners save more in the
financial asset since housing becomes a relatively less attractive asset. However, at high house price growth rates, homeowners prefer to save using housing rather than the deposit. This is because, in addition to the gain from increases in house values over time, they derive utility from consumption of the housing services.

Observation 6.3: Parents transfer relatively similar amounts of the inter-vivos transfer in all three stages. Row (1) of Figure 4.5 shows that transfers increase in parents’ cash on hand. There is a slight
difference between homeowners and renters in the amount of inter-vivos transfers at the highest house price growth rate, where renters transfer somewhat more at lower levels of cash on hand, whereas the opposite is true for wealthier parents. The wealthy homeowner parents already consume the maximum amount of housing services, they have zero leverage and they save in the financial asset. The increase in inter-vivos transfers enables their children to increase their own housing services at a slightly lower level of parental wealth as compared to children of renters. Among the richest parents in steady state, those who are renters transfer slightly more compared to parents who are homeowners. In steady state, the richest homeowner parents instead bequeath more to their children. At these high levels of parental cash on hand, children of both homeowners and renters choose to own housing, and neither can afford to upgrade the amount of housing services.

Observation 6.4: Homeowners increase the amount of housing services with cash on hand for all stages of the transition. Row (2) in Figure 4.5 shows that parents who are homeowners increase the amount of housing services in steps. In general, when house price growth is higher, parents consume more housing. Note that, while house prices are growing, the current house price is also lower as compared to in the steady state. When house price growth is the highest, all renters consume the maximum amount of (rented) housing. At the intermediate stage, and in steady state, housing is a step function which increases in parental cash on hand. Homeowners display this step function in all three stages, and upgrade housing services as they become richer.

Observation 6.5: Finally, the LTV ratios of parents who are homeowners are higher when house price growth is higher, and this corresponds to higher levels of the mortgage. Homeowners’ mortgages are shown in row (3) of Figure 4.5. Remember that renters are not allowed to borrow. Mortgages are still very low, but at higher levels of the house price growth rate, homeowner parents are more
leveraged and mortgages are higher. Compared to the steady state, they choose higher leverage, but because house prices are rather low, they do not need to take on more debt than this to afford the maximum amount of housing services. Generally, at higher levels of cash on hand, the leverage quickly goes to zero. However, in the case when house price growth is the highest, the leverage goes up at levels of cash on hand where parent homeowners upgrade their amount of housing services. Because of this pattern, mortgages are not monotonically decreasing in cash on hand. Mortgages are overall more attractive in the high house price growth rate environment. Because debt is denominated in the current price level, a high house price growth rate means that the net value of housing increases, thus lowering the perceived cost of borrowing.

Similarly to the steady state, children’s policy and value functions (Figures 4.6–4.7) are not entirely smooth along the transition path. Once more, changes in the optimal level of housing services translate into, more or less pronounced, changes in these variables. Furthermore, mortgages are closely related to upgrades in the children’s own housing services, as well as to the bequests from their parents (see discussion below).

**Observation 7.1:** Children consume slightly more of the consumption good when house price growth is lower. Row (1) of Figure 4.6 shows that consumption follows a similar pattern across parental cash on hand for all three levels of house price growth. There are small downward jumps in consumption at the point when there is an upgrade in the amount of housing services. In row (3), we see that children of homeowners fare better in terms of the value function when house prices grow the fastest (as discussed under Observation 6.1).

**Observation 7.2:** Children never save in the financial asset, independent of the house price growth rate. See row (2) of Figure 4.6.
Observation 7.3: When house price growth is positive, children always prefer to be homeowners. In steady state the tenure choice depends on parental cash on hand. See row (1) of Figure 4.7. On the transition path towards steady state, children can afford to be homeowners and know that owned housing increases in value over time. Because owned housing services also give a utility premium, it is the preferred housing tenure choice. In steady state, the investment component is absent and the only use of housing is for utility, and as a storage of value. In this case, owned housing is preferred when parental wealth (and thus own cash on hand) is high enough.

Observation 7.4: Housing services are constant or increasing in parents’ cash on hand for a given tenure status. When house price growth is higher, the amount of housing services demanded is also higher. When house price growth is the highest, children upgrade their amount of housing services more frequently and to higher levels. Children of homeowners upgrade at slightly lower levels of parental wealth. For the intermediate house price growth rate, children only upgrade once and there is no difference between children of homeowners and renters. Steady state is the only scenario where there is first an increase and then, as children become owners, a decrease in the amount of housing services demanded, since the transition from renting to homeownership implies a drop in housing consumption (row (2) in Figure 4.7). Remember that owned housing is more expensive and thus, children cannot afford to maintain the same amount of housing services that they had as renters.

Observation 7.5: Overall, children of homeowners have at least as high LTV ratios as compared to children of renters. In steady state, children who are homeowners are close to fully leveraged (children of renters have somewhat lower LTV ratios). When house price growth is positive, leverage depends on the parents’ tenure status to a greater extent. Row (3) of Figure 4.7
shows mortgages for different levels of the house price growth rate. In steady state, children of both homeowners and renters choose an almost constant, slightly increasing, LTV ratio when they become homeowners. Since they choose the same amount of housing services, their mortgage patterns are very similar, although the level is slightly lower for children of renters. When house price growth is the highest, children of homeowners keep their LTV ratio at the maximum until reaching a level of parental cash on hand of around 10. Here, they first increase leverage in response to an increase in their own housing services. However, around this level of parental cash on hand, the total value of their parents’ bequests plateaus (up until this point, bequests have been increasing), and children therefore soon cut down on their own leverage. They do so up until the point when parents increase the level of bequests, through the value of their real estate, when children again increase the LTV ratio to the maximum. Note that their future cash on hand depends both on the bequest and their own actions, and that this explains why larger bequests allow the children to take on more debt (and thus lower the net value of their own real estate). Children of renters, on the other hand, start at the maximum LTV ratio but quickly decrease their optimal leverage, apart from when they upgrade their own amount of housing services. When their parents start saving in the financial asset (implying that the bequests of these children are positive), children once more take on more leverage. In general, children of renters are more inclined to decrease their leverage at a constant housing size. At the intermediate house price growth rate, the amount of housing services is lower, automatically dampening the level of mortgages. In terms of leverage, the pattern is similar as in the case with the highest house price growth, in that children start at the highest LTV ratio possible. Then, however, both children of renters and homeowners decrease their leverage at higher levels of parental cash on hand. Children of homeowners allow for some increase again, as the value of their parents’ estates increases (parents upgrade housing and decrease leverage). When children are sufficiently rich in terms of bequests, at high enough levels of parental cash on hand, they once more
increase the LTV ratio, maintaining a constant level of the mortgage. Here, children of homeowners choose the maximum LTV ratio, whereas children of renters again choose to be somewhat less leveraged.

Summary

The steady-state solution highlights that when house prices are constant, parental cash on hand is the main determinant for children’s behavior, not parental tenure status. In particular, going back to the introduction and to the idea that parents matter for the housing market outcomes of their children, we see that (i) there is a threshold in terms of parental wealth above which children choose to be homeowners, and (ii) children of richer parents can, while they are renters, consume more housing services. This implies that the wealth of parents matters for the housing market outcomes of their children. Why does tenure status not matter more? In terms of parental tenure status, children of parents who are homeowners and children of parents who are renters do, in fact, behave very similarly. The reason for this is that both types of parents transfer similar amounts of the inter-vivos transfer and that total bequests are very similar (although the asset composition is different). Furthermore, in steady state, parents who are homeowners are very reluctant to take on debt. They are still able to afford some housing, and the cost of borrowing is simply too high relative to the gain from obtaining more housing services (when house prices are constant). Therefore, they consume less housing services compared to renters, but they are able to bequeath at least as much because they do not hold any debt (apart from at very low levels of parental wealth) and they save in the financial asset. The results from the transition period do, however, highlight some differences based on parental tenure status. Parents who are homeowners now shift their consumption towards housing services and away from financial savings. They are now also willing to take on more leverage, although their debt is still very low. For children, the main differences arise in relation to their leverage and, to some extent, in relation to their consumption of
housing services. Overall, for children of homeowners, the fact that house prices are growing implies that the values of their parents’ real estates are growing. This translates into larger bequests, and there is a larger difference between the bequests from parents who are homeowners and parents who are renters. The combination of slightly lower inter-vivos transfers from parents who are homeowners (for parental cash on hand levels below 25) and higher bequests makes their children take on more debt as compared to children of renters. As in the steady-state solution, children of richer parents consume more housing services.

The main determinant of consumption of housing services and the children’s own housing tenure choice is still parental wealth. This is not in line with the discussion in Section 4.2 about the importance of parents’ housing tenure for children’s outcomes. What is the reason for this result? In reality, parents with different tenure statuses typically differ in more dimensions than in terms of required housing expenditures and in the types of bequests. In particular, homeowners are typically wealthier than renters. In this simple theoretical setting, I have abstracted from differences in wealth to focus on the difference in tenure status for a given level of wealth, but a more serious treatment of the differences between homeowners and renters may remedy this feature. Furthermore, while it is comforting that parents choose a higher leverage when house prices are increasing (as compared to the steady state), empirically we observe that individuals corresponding to the "parent generation" take on more debt than observed in the model.\footnote{\ For example, in Sweden, as documented in Eng Larsson et al. (2018a), the indebtedness of older generations has been increasing over the last couple of years.} Borrowing conditions and perceptions of house price growth rates are likely to be important for behavior in connection to the housing market (and for portfolio choices), but so is one’s own housing situation. In the model, parents are forced to choose the amount of housing services at the same time as they decide on transfers to their children. This substantially simplifies the analysis since housing does not need to be included as a separate state variable (it only matters through its impact on cash on hand), but empirically,
parents often transfer funds without adjusting their own housing stock simultaneously. Adjusting the model to include housing as a state variable, with transaction costs to changing the housing stock, may also be important for better matching the patterns observed empirically.

4.4.3 An increase in the down-payment requirements

In this section, I lower the maximum LTV ratio allowed to 0.5 (compared to 0.85 in the baseline case) in order to study the impact of stricter borrowing conditions. This means that homeowners need a larger down payment for any given house size. Here I summarize the main conclusions from a comparison with the baseline specification in Section 4.4.2. Note that, also in this case, there are some discrete changes to policy and value functions. The same intuition as in the baseline case applies to these non-monotone functions.

Observation 8.1: Stricter borrowing conditions do not notably affect optimal decisions in steady state. The biggest impact is a decrease in children’s mortgages (because of lower leverage). Column (3) in Figures 4.8–4.9 and Figures 4.10–4.11 shows this for parents and children. Inter-vivos transfers as well as financial savings from the parents increase somewhat more linearly as compared to the baseline case. Because children’s leverage goes down (to the new borrowing limit), they rely more on the inter-vivos transfer. There is no longer a clear plateau for inter-vivos transfers; instead transfers simply increase with parents’ cash on hand.

Observation 8.2: When house price growth is positive, parental savings are lower and inter-vivos transfers are at least as large as in the baseline case. See row (2) in Figure 4.8 and row (1) in Figure 4.9. In particular, when house price growth is the highest, less resources go into financial savings that enter into the bequest in the following period, and instead more resources are directed to the inter-vivos
transfers that can be used in the current period. Because children are constrained by the borrowing limit, and because owned housing services are more attractive in the environment with high house price growth rates, there is this shift in the timing of intergenerational resources.

Observation 8.3: For the highest house price growth rate, parents who are homeowners upgrade their own housing at higher levels of cash on hand as compared to the baseline case. See row
4.4. ANALYSIS OF THE MODEL

Figure 4.9: Policy functions for parents, $LTV \downarrow (2)$

(a) Transfer, $\frac{\Delta p}{p} = 0.038$
(b) Transfer, $\frac{\Delta p}{p} = 0.018$
(c) Transfer, $\frac{\Delta p}{p} = 0$

(d) Housing, $\frac{\Delta p}{p} = 0.038$
(e) Housing, $\frac{\Delta p}{p} = 0.018$
(f) Housing, $\frac{\Delta p}{p} = 0$

(g) Mortgage, $\frac{\Delta p}{p} = 0.038$
(h) Mortgage, $\frac{\Delta p}{p} = 0.018$
(i) Mortgage, $\frac{\Delta p}{p} = 0$

(2) in Figure 4.9. For the lower house price growth rate, there is no notable difference compared to the baseline case. When house price growth rates are high, parents still upgrade their amount of housing services when they get richer. However, even though parents are not constrained themselves by the borrowing limit, they are affected through the links to their children, who are constrained. Homeowner parents increase their inter-vivos transfer (discussed in Observation 8.2) and instead slightly delay their own housing upgrade, i.e., they need to be richer to upgrade in terms of housing.
Observation 8.4: For the highest house price growth rate, there is also a slight increase in parents’ mortgages at intermediate levels of cash on hand. Children, on the other hand, lower their mortgages. See row (3) in Figure 4.9. This is because now, in the presence of the stricter borrowing conditions, parents only choose to lower their LTV ratio at higher levels of cash on hand compared to the baseline case (even though they start at a somewhat lower level of leverage). The slight increase in leverage also means that they avoid the
4.4. ANALYSIS OF THE MODEL

**Figure 4.11: Policy functions for children, LTV ↓ (2)**

(a) Indicator, $\frac{\Delta p}{p} = 0.038$

(b) Indicator, $\frac{\Delta p}{p} = 0.018$

(c) Indicator, $\frac{\Delta p}{p} = 0$

(d) Housing, $\frac{\Delta p}{p} = 0.038$

(e) Housing, $\frac{\Delta p}{p} = 0.018$

(f) Housing, $\frac{\Delta p}{p} = 0$

(g) Mortgage, $\frac{\Delta p}{p} = 0.038$

(h) Mortgage, $\frac{\Delta p}{p} = 0.018$

(i) Mortgage, $\frac{\Delta p}{p} = 0$

decrease in inter-vivos transfers, around the same level of cash on hand where they upgraded their housing before the change.

For the highest house price growth rate, the LTV pattern for children of renters is similar before and after the change in borrowing conditions (although the level is lower), following a rough u-shape, while children of homeowners keep their LTV ratio almost constant for all levels of parental cash on hand. Their bequests are more smoothly increasing (although at a slightly lower level) now that their parents are more leveraged.
at levels of cash on hand where they previously had very low LTV ratios.

Because the motivation for stricter borrowing conditions is typically to reduce indebtedness, whether or not individuals are borrowing constrained before the policy change is crucial for understanding the policy response. There are different possible scenarios which depend on the calibration and the relative costs and gains from being a homeowner and from holding debt. If parents, and not children, are borrowing constrained before a change to stricter borrowing conditions, their children will have to increase their own indebtedness.\textsuperscript{36} On the other hand, if parents are not constrained, they might instead increase their own indebtedness to transfer more resources to their children (depending on the cost and benefit from doing so). Another option is that parents, even though they are not constrained to start with, choose not to increase their own leverage. This happens if borrowing is too costly, relative to the gain from obtaining more housing, or if the altruistic link is weak. In this case, if children were constrained already before the stricter borrowing conditions, the indebtedness will clearly go down. It is also clear that the ability to make inter-vivos transfers, and to save in the form of financial bequests, matters for the impact of policy. If there is no possibility to make inter-vivos transfers, an increase in down-payment requirements can make it impossible for children to become homeowners.

Summary of the main conclusions from the policy experiment

The main conclusions from this policy experiment are the following. (i) In steady state, stricter borrowing conditions have a limited impact. The main effect from higher down-payment requirements is that children lower their leverage, and that parents somewhat increase their inter-vivos transfers. (ii) During the transition period, stricter borrowing conditions make parents shift more resources from financial savings and towards inter-vivos transfers. (iii) Furthermore, when house price growth is high,\textsuperscript{36} See Cox (1990) for an analysis where links to other constrained individuals help explain the presence of liquidity constraints.
parents take on more debt in response to higher down-payment requirements. Because children decrease their mortgages, this implies a (small) shift of debt from the young to the old generation. This implies that the parental channel is mostly relevant to consider when house prices are growing.

4.4.4 Aggregation over the transition period

Observations 1.1–8.4 above discuss individual behavior over different levels of cash on hand. Here, I look specifically at behavior over the transition period, by aggregating individuals into groups based on the parents’ cash on hand. The groups are created taking into account that individuals are not uniformly distributed across cash on hand. I specify five groups and take the midpoint in each group to be a representative individual for that specific group. I interpolate to retrieve the decision rule for the individual closest to the midpoint.\textsuperscript{37,38} Using the decision rules for these representatives, I then take the average, across the five groups, for each stage during the transition period. Figure 4.12 shows aggregated policy functions for parents, and Figure 4.13 shows aggregated behavior for children.

Figure 4.12 makes it clear that differences between parents who are renters and homeowners, in terms of consumptions, savings and the inter-vivos transfers, grow smaller over the transition period. Furthermore, apart from at the highest house price growth rate, parents who are renters generally consume more housing compared to homeowners. Note that when the loan-to-value requirement increases, through a decrease in the maximum LTV ratio from 0.85 to 0.5, savings are somewhat lower.

\textsuperscript{37}Specifically, based on the information on the income distribution in Rios-Rull and Kuhn (2016), I normalize their values to the range of the grid used for parental cash on hand. This distribution is skewed and consists mainly of non-negative values. I use the 20th, 40th, 60th, 80th and 99th percentile to define five groups with equal weights. The midpoints used are then \{3.55, 4.65, 6.00, 8.25, 29.85\}.

\textsuperscript{38}Using equal weights for the five groups (i) very poor $x^p \in (3, 5)$, (ii) poor $x^p \in (6, 10)$, (iii) middle $x^p \in (11, 20)$, (iv) rich $x^p \in (21, 40)$, and (v) very rich $x^p \in (41, 50)$, results in a similar picture.
when house price growth is the highest, whereas inter-vivos transfers are higher (see Appendix 4.A where this fact is documented). For children, in Figure 4.13, consumption and savings are flat across the transition periods. Housing is the highest at the first stage of the transition, and it decreases as house price growth slows down, and then picks up in steady state. This is because, in steady state, not all children are homeowners, and as renters they can afford more housing. The main difference in response to higher down-payment requirements is a decrease in the level of mortgages (as can be seen in Appendix 4.A).

**Figure 4.12: Aggregated policy functions for parents**

(a) Consumption  
(b) Savings  
(c) Transfer  
(d) Housing  
(e) Mortgage

**Figure 4.13: Aggregated policy functions for children**

(a) Consumption  
(b) Savings  
(c) Housing  
(d) Mortgage
4.4. ANALYSIS OF THE MODEL

Gini index

Finally, I also compute Gini coefficients for the different stages (period 1–3 in the table, where period 3 is the steady state) along the transition, both for the baseline case and with the stricter borrowing conditions. This is carried out separately for parents who are renters and owners and for children of renters and owners. In order to compute the Gini coefficients I construct weights for 100 equally spaced points on the cash on hand grid (which ranges from 3 to 50). The weights are constructed using the density from a truncated lognormal distribution in order to capture the fact that empirical distributions for wealth (or earnings) are fairly well represented by such a distribution. I use parameters $\mu = \log(12.5)$ and $\sigma = 0.9$. The density function is plotted in Appendix 4.A. I interpolate to match the points on this grid to the decision rules and use the density function to weigh them in the calculation of the Gini coefficients.

Table 4.2 shows Gini coefficients for parents’ savings (remember that children never save using the deposit), housing for children, housing for parents in the baseline case, and for the inter-vivos transfers. I present coefficients for the three stages of the transition period (stage 3 is the steady state). It is clear that savings are more unequally distributed than housing services or the inter-vivos transfers. Furthermore, there are some differences between parents with the two different tenure statuses. Among parents who are renters, savings are less unequally distributed than among parents who are homeowners. This is in line with the higher threshold for financial savings, in terms of parental wealth, that we could see for homeowners in previous sections. Housing is more unequally distributed among parents who are homeowners (remember that more renters can afford the maximum rental), whereas the difference among children is smaller. In the stage with the highest house price growth rate, inequality in terms of savings and inter-vivos transfers is greater than in the other stages.

In Table 4.3, I summarize the impact of stricter borrowing conditions
on the Gini coefficients. Just as in Section 4.4.4, I lower the maximum LTV ratio allowed to 0.5 (compared to 0.85 in the baseline case). To study the impact of the increase in down-payment requirements, I deduct the corresponding Gini coefficient from the model with higher down-payment requirements from the baseline values in Table 4.2. In terms of savings, the impact differs slightly between parents who are homeowners and parents who are renters. For homeowners, inequality increases somewhat in the case with the highest house price growth rate, but in the other stages inequality is instead reduced slightly. For renters, inequality is reduced when house price growth is positive and unaffected in steady state. There is a connection between the development for savings and for inter-vivos transfers. When inequality for savings increases, inequality in terms of the inter-vivos transfers is instead reduced and vice versa. The impact for children’s and parents’ housing is more limited. When house price growth is the highest, inequality in terms of children’s housing services is reduced (both for children of renters and for children of homeowners), but otherwise there is no impact from stricter down-payment requirements. For parents who are homeowners, inequality increases in the stage with the highest house price growth rate.
### Table 4.2: Gini coefficients

<table>
<thead>
<tr>
<th>Parents who are homeowners</th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Stage</td>
<td>Savings</td>
<td>Children’s housing</td>
<td>Parents’ housing</td>
<td>Inter-vivos transfers</td>
</tr>
<tr>
<td>1</td>
<td>0.9006</td>
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<td>0.2778</td>
<td>0.4356</td>
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<tr>
<td>2</td>
<td>0.7802</td>
<td>0.2005</td>
<td>0.3476</td>
<td>0.3633</td>
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<td>3</td>
<td>0.6379</td>
<td>0.2505</td>
<td>0.1903</td>
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<table>
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<th>Parents who are renters</th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage</td>
<td>Savings</td>
<td>Children’s housing</td>
<td>Parents’ housing</td>
<td>Inter-vivos transfers</td>
</tr>
<tr>
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<td>0.2297</td>
<td>0.0000</td>
<td>0.3183</td>
</tr>
<tr>
<td>2</td>
<td>0.6273</td>
<td>0.2005</td>
<td>0.0312</td>
<td>0.3416</td>
</tr>
<tr>
<td>3</td>
<td>0.5651</td>
<td>0.2505</td>
<td>0.1316</td>
<td>0.3779</td>
</tr>
</tbody>
</table>

### Table 4.3: The effect on Gini coefficients of stricter borrowing conditions

<table>
<thead>
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<th>Parents who are homeowners</th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage</td>
<td>Savings</td>
<td>Children’s housing</td>
<td>Parents’ housing</td>
<td>Inter-vivos transfers</td>
</tr>
<tr>
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<td>-0.0103</td>
<td>0.0072</td>
<td>-0.0151</td>
<td>0.0326</td>
</tr>
<tr>
<td>2</td>
<td>0.0130</td>
<td>0.0000</td>
<td>0.0000</td>
<td>-0.0101</td>
</tr>
<tr>
<td>3</td>
<td>0.0123</td>
<td>0.0000</td>
<td>0.0000</td>
<td>-0.0115</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parents who are renters</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage</td>
<td>Savings</td>
<td>Children’s housing</td>
<td>Parents’ housing</td>
<td>Inter-vivos transfers</td>
</tr>
<tr>
<td>1</td>
<td>0.0223</td>
<td>0.0448</td>
<td>0.0000</td>
<td>-0.0193</td>
</tr>
<tr>
<td>2</td>
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<td>0.0000</td>
<td>0.0000</td>
<td>-0.0035</td>
</tr>
<tr>
<td>3</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
</tbody>
</table>
4.5 Discussion

The model is admittedly stylized, in order to highlight the effects of family interactions on individual behavior in the presence of intergenerational links. I make several simplifying assumptions to focus on the key mechanisms of interest. Here I discuss some implications of the modelling choices and some suggestions for how to make the theoretical framework more realistic going forward.

First, the two stages of life only consist of two time periods. Realistically, in addition to the overlapping generations framework, it could be interesting to add a proper life-cycle structure, where individuals have richer earnings dynamics and also face retirement. In general, there is a trade-off between short and long time periods. Short time periods can be useful to assure quantitatively interesting results, but, at the same time, longer time periods are reasonable when the overlapping period is the stage of interest. Using only two periods clearly makes the model more tractable, at the expense of allowing for more detail, but it also serves a purpose of avoiding some issues related to the parent-child interactions. Because individuals only overlap for one period, parents can intratemporally commit to a specific portfolio choice (including the level of the inter-vivos transfer and the bequest), and there is no scope for the child to exploit the parent’s altruism. Second, the model environment is completely deterministic. A natural extension would be to add income uncertainty and, potentially, uncertainty about future house price developments. The current setup, however, without uncertainty, enables me to disentangle behavior stemming from the intergenerational altruistic link from other motives such as insurance. Third, in the baseline model, there is no heterogeneity in children’s income, yet this is something which is likely to matter for transfers. In general, parents transfer more (income) to poorer children. Children, on the other hand, rely less on their parents, the richer they are in terms of the exogenous income component. In general, heterogeneity in children’s income will affect the behavior of children at given levels of parents’ cash on hand, but I choose to only
look at one income level in this first step to focus on the importance of parental wealth. Fourth, the housing market is overall stylized. There is a flexible supply of housing at the given housing price, and no frictions on the rental market. This is in stark contrast to real world housing markets. The fact that the model is a partial equilibrium with given house prices, and price-to-rent ratios, also means that the numerical solution depends on the calibration. I consider the baseline specification to be the benchmark, and then study behavioral responses to policy changes, but endogenous prices would remove some degrees of freedom in the calibration. Finally, in this paper, I analyze the effects of a policy change, without an explicit motive for a policy maker. I choose to model the borrowing constraint as an LTV constraint, because (i) it is commonly used by policy makers in different economies, and (ii) it is a borrowing constraint that naturally arises when the lender faces an enforcement problem and there is a risk of default. I choose these simplifications as a natural starting point for an analysis of individual behavior.

Going forward, other types of policy experiments are interesting candidates for future work. Furthermore, it will be interesting to extend the model to allow for more features and, consequently, more interesting dynamics. Some potential extensions were discussed in Section 4.4.2. For example, a more serious treatment of the differences between parents who are renters and parents who are homeowners, as observed empirically, would likely make the parental tenure status more important for children’s outcomes. Related to the housing status, in the current setup, housing only matters through its impact on cash on hand. If instead, parents had the option of maintaining or adjusting the amount of housing services and there was an adjustment cost to changing the housing

\[39\] Decreasing $\kappa$, the relative price of rentals compared to owned housing, in order to make the rental market somewhat more accessible, makes both types of children choose to be renters in steady state. This is also true at lower levels of parental cash on hand for intermediate house price growth.

\[40\] From a macroprudential perspective, it is thus a constraint which can be manipulated to strengthen the sustainability of the financial system and limit household indebtedness.
size, this could make the model more realistic. Empirically, parents who are homeowners can use built-up equity to help finance their children’s housing and, importantly, in order to do so, they do not necessarily need to adjust their own housing. In particular, if an increase in the existing mortgage is less costly than buying additional housing units, parents may be more inclined to take on debt to help their children. The assumptions regarding the housing market are also important for the results. As mentioned above, the assumption of flexible housing at an exogenous price is a simplification and not a realistic feature. As a starting point, a less attractive rental market, which may be more restricted in quality/size, or more expensive, in combination with more pronounced differences between parents who are renters and parents who are homeowners, could both affect the housing tenure choice of children, in general, and the differences between children of renters and children of homeowners. Another feature of the current specification is that parents choose very low levels of the mortgage. Lowering the depreciation rate or the interest rate spread does increase mortgages, implying that it could be relevant to make borrowing more attractive (or less costly) than in the current setting. Finally, allowing for heterogeneity in children’s incomes, preferably along with some correlation with their parents’ wealth, could also be important for generating more realistic features. The analysis in this paper should thus be seen as a first step towards studying individual behavior in the presence of the parental channel, as the current setup focuses on a very narrow type of heterogeneity, while abstracting from other dimensions. Related to income, allowing for positive growth in the exogenous labor income would also be relevant going forward. House price growth rates are adjusted to account for a difference in growth rates between house prices and wages (see the comment in Section 4.4.1), but in the current version, house prices are still very cheap in the scenario with high house price growth. If income was also growing over time, this could affect both access to the housing market and the propensity to take on debt.

Using data on the correlation across generations, i.e., between par-
ents and children, for various variables of interest, it would be possible to compare implications from the model to what we observe empirically in the data. For example, some variables of interest could be the correlations between parents and children in terms of housing tenure statuses, housing spending, or indebtedness. In addition, an encompassing data set that includes measures of transfers, both inter-vivos and more long term transfers, would enable a comparison with empirical responses to policy changes such as increased down-payment requirements.
4.6 Conclusion

Empirical evidence suggests that family finance matters for the housing market outcomes of children in many countries. In this paper, I develop an overlapping generations model in partial equilibrium, with intergenerational links and imperfect altruism, to study housing and portfolio choices in the presence of a parental channel. The results, at this stage, are rather descriptive, and the paper is intended to be a first step in characterizing individual behavior in the presence of this parental channel. It is part of a larger research agenda that aims at understanding, for example, how intergenerational decision-making affects aggregate variables.

The numerical results from the model highlight the role of parental resources and housing tenure status in determining individual behavior and portfolio composition. I show that parents who are homeowners transfer similar, or lower, amounts of the inter-vivos gift to their children, compared to parents who are renters. In steady state, parental resources constitute the main determinant of children’s behavior and not their housing status. At the point where children choose homeownership, parents shift some of their resources from inter-vivos transfers to financial savings. When house price growth is positive, the difference between parents who are homeowners and renters, both in terms of their own behavior and in terms of their children’s behavior, is amplified. Finally, stricter down-payment requirements have a limited effect in steady state. When house price growth rates are high, however, the parental channel appears to be more important, in line with the empirical picture. Stricter borrowing conditions can, in fact, make parents take on more debt, as compared to the baseline case, shifting some debt from the young to the old generation. Parents are unconstrained both before and after the increase in down-payment requirements and can therefore increase their own leverage to maintain the level of the inter-vivos transfer when they increase their consumption of housing services. In addition, parents, in general, shift some resources to inter-vivos transfers (rather than to financial sav-
ings). Finally, when house prices are growing the most, stricter borrowing conditions have a small effect on the amount of housing attainable for homeowners. However, the housing tenure choice is unaffected because children receive more inter-vivos support and because house prices are relatively low.
References


4. A. ADDITIONAL FIGURES

Appendices

4. A. Additional Figures

Figure 4.14: Probability density function

Figure 4.15: Aggregated policy functions for parents, LTV ↓

(a) Consumption    (b) Savings    (c) Transfer    (d) Housing

(e) Mortgage
4.B Model Details

4.B.1 First-order conditions

Here I show first-order conditions for the different choice variables, for parents and children, respectively.

First-order conditions for the parent

Homeowner’s problem

\[
V^{P,O}(x) = \max_{\{c,a,h,g,m\}} u(c, \mu h) + \alpha V^C(y^C + g, y^P + b) \\
\text{s.t.} \quad x = c + a + g + \tau(g) + ph - m, \\
b = Ra + p(1 - \delta)h - R^m m, \\
m \leq \theta^{ltv} ph, \\
a \geq 0, \\
g \geq 0.
\]

The first-order condition, in equation (4.5), with respect to savings, \(a\), says that the individual will choose savings to equalize the marginal loss in utility - from foregone consumption in the current period - to the discounted marginal gain in utility in the next period, through the increase in cash-on-hand from asset returns, plus the shadow value of the constraint on savings. Parents discount the future value of savings also by the altruistic parameter.
4.B. MODEL DETAILS

\[ u'_1(c, \mu h) = \alpha V^C(y^C + g, y^P + b) \frac{\partial b}{\partial a} + \lambda_a, \quad (4.5) \]

where \( u'_1 \) denotes the derivative with respect to the first argument. The first-order conditions for housing, \( h \), and mortgages, \( m \), are:

\[ pu'_1(c, \mu h) = u'_2(c, \mu h) + \alpha V^C(y^C + g, y^P + b) \frac{\partial b}{\partial h} + \lambda_m \theta^{l_{tv}} p, \quad (4.6) \]

\[ u'_1(c, \mu h) = \alpha V^C(y^C + g, y^P + b) \frac{\partial b}{\partial m} + \lambda_m. \quad (4.7) \]

For housing, in equation (4.6), the left-hand side is the loss of utility from giving up consumption goods to buy housing. The right-hand side is the gain from a unit of housing: the instant utility and the discounted future value from acquiring housing today, as well as the increase in collateral value from an additional unit of housing times the shadow value of the borrowing constraint (this term is zero if the individual is unconstrained). The first-order condition for the mortgage, in equation (4.7), weighs the benefits from increased consumption possibilities today, against the future cost in terms of the repayment, as well as the shadow cost of the constraint (this term is zero if the borrowing constraint is not binding). Finally, the parent also chooses an optimal level for the transfer:

\[ u'_1(c, \mu h)(1 + \tau'(g)) = \alpha V^C(y^C + g, y^P + b) + \lambda_g, \quad (4.8) \]

where the parent equalizes the marginal loss of foregone consumption to the marginal increase in utility from giving her child more consumption possibilities.
CHAPTER 4. PORTFOLIO AND HOUSING DECISIONS

Renter’s problem

\[ V^{P,R}(x) = \max_{\{c,a,h,g\}} \left\{ u(c, h) + \alpha V^{C}(y^C + g, y^P + b) \right\} \]
\[ \text{s.t.} \quad x = c + a + g + \tau(g) + qh - m, \]
\[ b = Ra, \]
\[ a \geq 0, \]
\[ g \geq 0. \]

A parent who is a renter chooses \( c, a, h \) and \( g \). The first-order conditions for savings, \( a \), and inter-vivos transfers, \( g \), are unchanged, as compared to equations (4.5) and (4.8) for the parent who is a homeowner. The first-order condition for housing, \( h \), however, is different, since there is no longer a continuation value, or a collateral value from purchasing housing. Now, it is simply a trade-off between the consumption good and housing services, and the marginal utility of housing, relative to consumption, is equal to its relative price:

\[ qu'_1(c, h) = u'_2(c, h). \] (4.9)

First-order conditions for the child

Homeowner’s problem

\[ V^{C,O}(x, y^P + b) = \max_{\{c,a,h,m\}} \left\{ u(c, \mu h) + \beta V^{P,O}_{t+1}(x') \right\} \]
\[ \text{s.t.} \quad x = c + ph + a - m, \]
\[ m \leq \theta_{lv} \mu ph, \]
\[ a \geq 0, \]
\[ x' = Ra + p(1 - \delta)h - R^m m + y^P + b. \]

The first-order condition for savings, \( a \), is:
4.B. MODEL DETAILS

\[ u'_1(c, \mu h) = \beta V^{P,O}(x') \frac{\partial x'}{\partial a} + \lambda_a. \]  \hfill (4.10)

For housing, \( h \), the first-order condition is:

\[ pu'_1(c, \mu h) = u'_2(c, \mu h) + \beta V^{P,O}(x') \frac{\partial x'}{h} + \lambda_m \theta \tau v_p, \]  \hfill (4.11)

and, finally, for the mortgage, \( m \), it is:

\[ u'_1(c, \mu h) = \beta V^{P,O}(x') \frac{\partial x'}{\partial m} + \lambda_m. \]  \hfill (4.12)

The intuition behind these conditions is similar to that of the parents who are homeowners.

**Renter’s problem**

\[
V^{C,R}(x, y^P + b) = \max_{\{c, a, h\}} \ u(c, h) + \beta V^{P,R}(x') \\
\text{s.t.} \quad x = c + qh + a, \\
\quad a \geq 0, \\
\quad x' = Ra + y^P + b.
\]

The first-order condition with respect to savings, \( a \), is the same as for the homeowner. In terms of housing, the first-order condition is the same as for the parent:

\[ qu'_1(c, h) = u'_2(c, h). \]  \hfill (4.13)
4.B.2 Recursive formulation for the transition period

Here I show the recursive formulation for the case when there is a positive house price growth and, thus, time-varying decision rules and value functions.

**Decision problem of the parent**

### **Homeowner’s problem**

A parent who is a homeowner, indexed $P,O$, solves the following optimization problem:

$$V_{t}^{P,O}(x) = \max_{\{c,a,g,h,m\}} \left\{ u(c, \mu h) + \alpha V_{t}^{C}(y^{C} + g, y^{P} + b) \right\}$$

subject to:

\begin{align*}
  x &= c + a + g + \tau(g) + p_{t}h - m, \\
  b &= Ra + p_{t+1}(1 - \delta)h - R^{m}m, \\
  m &\leq \theta^{ltv}p_{t}h, \\
  a &\geq 0, \\
  g &\geq 0.
\end{align*}

$V_{t}^{P,O}(x)$ is the value function of a parent who buys her house. Solving this problem gives decision rules for the choice variables: $f_{c,t}^{P,O}(x)$, $f_{a,t}^{P,O}(x)$, $f_{g,t}^{P,O}(x)$, $f_{h,t}^{P,O}(x)$, and $f_{m,t}^{P,O}(x)$.

### **Renter’s problem**

A parent who is a renter, indexed $P,R$, solves the following optimization problem:
4.B. MODEL DETAILS

\[ V_{t}^{P,R}(x) = \max_{\{c,a,g,h\}} \ u(c, h) + \alpha V_{t}^{C}(y^{C} + g, y^{P} + b) \]
\[ \text{s.t. } x = c + a + g + \tau(g) + q_{t}h, \]
\[ b = Ra, \]
\[ a \geq 0, \]
\[ g \geq 0. \]

\( V_{t}^{P,R}(x) \) is the value function of a parent who rents her house. Solving this problem gives decision rules for the choice variables: \( f_{c,t}^{P,R}(x) \), \( f_{a,t}^{P,R}(x) \), \( f_{g,t}^{P,R}(x) \), and \( f_{h,t}^{P,R}(x) \).

Decision problem of the child

**Homeowner’s problem** A child who buys a house chooses consumption \( c \), savings \( a \), housing services \( h \), as well the size of the mortgage \( m \), and solves the following optimization problem:

\[ V_{t}^{C,O}(x, y^{P} + b) = \max_{\{c,a,h,m\}} u(c, p_{t}h) + \beta V_{t+1}^{P,O}(x') \]
\[ \text{s.t. } x = c + p_{t}h + a - m, \]
\[ m \leq \theta^{lt}p_{t}h, \]
\[ a \geq 0, \]
\[ x' = Ra + p_{t+1}(1-\delta)h - R^{m}m + y^{P} + b, \]

\( V_{t}^{C,O}(x, y^{P} + b) \) is the value function of a child who buys a house. The child has decision rules: \( f_{c,t}^{C,O}(x, y^{P} + b) \), \( f_{a,t}^{C,O}(x, y^{P} + b) \), \( f_{h,t}^{C,O}(x, y^{P} + b) \), and \( f_{m,t}^{C,O}(x, y^{P} + b) \).

**Renter’s problem** A child who is a renter chooses consumption \( c \), savings \( a \), and housing services \( h \):
CHAPTER 4. PORTFOLIO AND HOUSING DECISIONS

\[ V_{t}^{C,R}(x, y^P + b) = \max_{\{c, a, h\}} u(c, h) + \beta V_{t+1}^{P,R}(x') \]

\[
\text{s.t. } x = c + q_h h + a, \\
\quad a \geq 0, \\
\quad x' = Ra + y^P + b,
\]

\( V_{t}^{C,R}(x, y^P + b) \) is the value function of a child who rents a house. The child who is a renter has decision rules: \( f_{c,t}^{C,R}(x, y^P + b) \), \( f_{a,t}^{C,R}(x, y^P + b) \), and \( f_{h,t}^{C,R}(x, y^P + b) \).

**Housing tenure choice** To determine whether to be a homeowner or a renter, the child compares the value functions for the two different cases and picks the one associated with the highest value:

\[ V_{t}^{C}(x, y^P + b) = \max \{ V_{t}^{C,O}(x, y^P + b), V_{t}^{C,R}(x, y^P + b) \}. \]
4.C Computational Method

The model is solved (in Matlab) using value function iteration and grid search. I treat parental housing status as predetermined and solve the child’s problem for two cases: (1) the parent is a renter, and (2) the parent is a homeowner. For the child, I compare the value function for being a renter, to that of being a homeowner, and the housing status is determined by the maximum of these two alternatives. In the next period, when the child is a parent, he maintains the housing status.

For computational reasons, I define the state space in terms of leverage (LTV) instead of mortgages. For given house prices, $p$, and housing quantity, $h$, the mortgage can be backed out from: $m = LTV \times ph$. Grids for bequests, cash on hand, savings and transfers are unequally spaced, with a larger number of grid points at lower levels. This corresponds to a larger number of grid points where there is more curvature in policy and value functions. The grid for LTV is equally spaced, however.

4.C.1 Pseudo algorithm

1. Set up grids for cash on hand, savings, transfers, LTV, housing and the bequest. Housing is only available in discrete sizes. Note that income realizations (both for the child and the parent) are simply scalars. The number of grid points in each grid is given by: $n^X$, $n^A$, $n^G$, $n^{LTV}$, $n^H$, and $n^B$. The parent’s state space for the value function is simply given by $n^X_P$ nodes, while the state space for the child’s value function has $n^X_C \times n^B$ nodes, where subscripts $P$ and $C$ denote the parent and the child.

2. For a parent, with housing status $S^P \in \{R, O\}$, initialize the parent’s value function $V^P_0(x^P)$ for all $x^P = 1, ..., n^X_P$.

3. Update the initial guess to $V^P_1(x^P)$ by solving the intergenerational problem in two steps:
(a) For each value of $x^C$ and $b$, solve the child’s problem for the case of being a renter and for being a homeowner separately:

i. For the homeowner, solve the child’s problem to get policy functions: $f_{c}^{C,O}(x^C, y^P + b)$, $f_{a}^{C,O}(x^C, y^P + b)$, $f_{h}^{C,O}(x^C, y^P + b)$, and $f_{m}^{C,O}(x^C, y^P + b)$, as well as the value function $V^{C,O}(x^C, y^P + b)$.

ii. For the renter, solve the child’s problem to get policy functions: $f_{c}^{C,R}(x^C, y^P + b)$, $f_{a}^{C,R}(x^C, y^P + b)$, and $f_{h}^{C,R}(x^C, y^P + b)$, as well as the value function $V^{C,R}(x^C, y^P + b)$.

iii. Define the value function of the child as $V^C(x^C, y^P + b) = \max \{V^{C,O}(x^C, y^P + b), V^{C,R}(x^C, y^P + b)\}$.

(b) Next, solve the parent’s problem given her housing status $S^P$, to maximize the value function, taking the child’s optimal value function into account. Interpolate to match the grid for $b$. This gives policy functions: $f_{c}^{P,O}(x^P)$, $f_{a}^{P,O}(x^P)$, $f_{h}^{P,O}(x^P)$, $f_{m}^{P,O}(x^P)$, and $f_{g}^{P,O}(x^P)$ for the homeowner, and $f_{c}^{P,R}(x^P)$, $f_{a}^{P,R}(x^P)$, $f_{h}^{P,R}(x^P)$, and $f_{g}^{P,R}(x^P)$ for the renter, as well as the value functions $V^{P,O}(x^P)$ and $V^{P,R}(x^P)$.

i. For this purpose, define updated cash on hand for the child, based on possible transfer choices (since $x^C = y^C + g$). Interpolate over the child’s value function to get updated behavior, for current parental cash on hand levels. Use these values in the parent’s value function.

4. Iterate until $V^P_0$ and $V^P_1$ are sufficiently close.

5. Separately for the case when the parent is a renter and a homeowner, determine the child’s de facto housing status and policy functions, based on the realized, for given transfers and bequests (corresponding to different levels of the parent’s cash on hand), value functions of the child.
Sammanfattning

Min avhandling består av fyra fristående uppsatser som handlar om hur hushåll reagerar på policy i olika sammanhang. Kapitel 1 och 4 studerar hushåll i koppling till kreditmarknader, medan kapitel 2 och 3 studerar individer på arbetsmarknaden.


Vi använder svensk administrativ paneldata för att studera kassaflödeskanalen. Det finns många anledningar till varför Sverige är

Våra resultat visar på tydliga skillnader i hur hushåll reagerar på en förändring i räntor. Vi mäter specifikt den differentierade responsen, det vill säga hur olika sorts hushåll reagerar på ränteförändringen utöver en gemensam, aggregerad, respons. Resultaten visar att mer skuldsatta hushåll, samt hushåll med rörliga räntor, reagerar mer på förändringar i penningpolitik. Generellt visar resultaten på vikten av att ta hänsyn till fördelningen av skuldsättning bland hushåll, eftersom hushåll i olika delar av fördelningen inte kan antas bete sig likadant.

Det finns flera exempel på situationer och omständigheter där risk kan spela roll för individers arbetsmarknadsutfall. I kapitel 2, Should I Stay or Must I Go? Temporary Refugee Protection and Labor-Market Outcomes, som är författat tillsammans med Birthe Larsen och Elisabet Olme, studerar vi en specifik typ av risk, eller osäkerhet: risken att flyktingar deporteras och inte får stanna i sitt värdland. Vår utgångspunkt är en debatt som har vuxit över de senaste åren, i och med att Europa har sett stora inflöden av flyktingar och flera länder,
som en följd, har implementerat strikta invandringslagar. Vi är specifikt intresserade av skiftet från permanenta till temporära uppehållstillstånd, då vi fortfarande har begränsad kunskap om deras påverkan på flyktingars integration i samhället överlag och på arbetsmarknaden mer specifikt.


Det är inte självlivligt vilka effekter vi kan förvänta oss reformen. Förespråkare och motståndare till den här typen av policy har lyft fram argument för att den kan såväl hjälpa som stjälpa integrationen av flyktingar. Vi kan även tänka oss att effekterna ser olika ut för olika individer, beroende på hur nära arbetsmarknaden de befinner sig, eller beroende på ursprunglig utbildningsnivå. För att närmare kunna förstå vilka mekanismer som ligger bakom hur reformen påverkade olika individer konstruerar vi en teoretisk ”search and matching”-modell, där det finns heterogenitet i kunskapsnivå. Med hjälp av detta ramverk tar vi fram hypoteser som kan jämföras med våra empiriska resultat.


I kapitel 3, Risk-Sharing and Entrepreneurship, som är författat tillsammans med Paula Roth, analyserar vi ett annat område där risk kan spela roll, nämligen för individens yrkesval. Mer specifikt studerar vi vilken roll som riskdelning kan spela när individer behöver välja mellan säkra och osäkra yrkesval. Vi abstraherar från den arbetslöshetsrisk som finns i verkligheten och definierar att vara löntagare som ett säkert yrke, medan entreprenörskap räknas som ett osäkert yrke. Med denna uppdel-
ning vill vi lyfta fram att inte alla entreprenörer blir framgångsrika, utan att det finns en risk för misslyckande när man startar ett eget företag. Med riskdelning, å andra sidan, avses den försäkring som finns att tillgå om man misslyckas, i form av ekonomiska bidrag eller egna sparpengar.


Våra resultat visar att när skattesatsen går upp (och därmed även bidragen som betalas ut från staten till misslyckade entreprenörer), så ökar andelen individer som väljer att bli entreprenörer. Samtidigt minskar andelen av dessa entreprenörer som väljer att anstränga sig. Det beror på att en högre grad av riskdelning minskar värdet av att anstränga sig, eftersom skillnaden mellan vad framgångsrika och misslyckade entreprenörer tjänar minskar. Vi analyserar också vilken typ av individer som väljer entreprenörskap vid olika skattesatser och riskdelningsnivåer, vilket är relevant om vi vill analysera gruppen av entreprenörer och hur komposisonen av denna grupp beror på graden av riskdelning som finansieras av staten. Våra resultat är i linje med bågge motiven som har framhävts i litteraturen: riskdelning spelar roll för yrkesvalet och fler individer väljer entreprenörskap vid högre grad av riskdelning, men det är även viktigt, givet att entreprenörerna åstadkommer mer om de anstränger sig, att riskdelningen inte är alltför hög, eftersom detta bromsar in total innovation.


Under senare år har såväl beslutsfattare som media lyft frågan om hur vikten av familjefinans påverkar vilka individer som har tillgång till bostadsmarknaden, samt vilka som påverkas av striktare lånevillkor.
Utifrån denna diskussion är det tydligt att man, för att förstå vilka som drabbas av strikta lånevillkor, behöver ta hänsyn till föräldrars respons och ekonomiska förutsättningar, utöver unga individers egna ekonomiska situation.

I det här kapitlet studerar jag vikten av att ta hänsyn till två specifika typer av länkar mellan föräldrar och barn: (1) att föräldrar har möjlighet att ge inter-vivos överföringar, det vill säga överföringar under sin livstid, och (2) att föräldrar kan lämna ett finansiellt sparande och nettovärdet av sitt boende som arv. Jag inleder med en översikt över den empiriska litteraturen om vikten av föräldrar för barns utfall på bostadsmarknaden, som visar att: (i) familjefinans används för att lättta på lånebegränsningar, (ii) ekonomiska överföringar ökar sannolikheten att unga blir bostadsägare, och (iii) i vilken utsträckning familjefinans används beror på lånevillkor och konjunkturläge. Jag går vidare till att studera individers beteende i en så kallad "overlapping generations"-modell, som innehåller länkar mellan föräldrar och barn. Här fokuserar jag på finansiella länkar i termen av inter-vivos överföringar och arv, motiverade av (ensidigt) altrusistiska preferenser hos föräldrarna - det vill säga att föräldrarna bryr sig om barnens nytta - och studerar portfölj- och bostadsvärd för både föräldrar och barn. I modellen kan föräldrarna aningen äga eller hyra sin bostad, medan barnen till dessa föräldrar själva behöver välja sitt boendeform. De som äger sin bostad kan finansiera delar av kostnaden för denna genom ett bostadslån. Jag analyserar individernas beteende i modellen, samt hur de reagerar på strikta lånevillkor i form av begränsningar av belåningsgraden.

Resultaten av modellen visar på vikten av föräldrars ekonomiska resurser för barnens bostadsvärd. I och med att föräldrarna har olika boendeformer har de också olika utgifter för sitt boende, samt olika möjligheter till att lämna arv. I en jämvikt där alla priser är konstanta överför föräldrar som hyr och föräldrar som äger väldigt lika belopp till barnen under sin livstid. Däremot finns det en skillnad i kompositionen av arv, där föräldrar som äger sitt boende sparar mindre i den finansiella tillgången och istället kompenserar med nettovärdet av sitt boende. Vid
den nivå av föräldrarnas förmögenhet där barnen väljer att bli bostadsägare sker en viss förändring i föräldrarnas överföringar; inter-vivos överföringar ökar i en långsammare takt när föräldrarna blir rikare och istället ökar det finansiella sparandet något mer. Det finns en generell skillnad mellan generationer, i att föräldrar minskar sin skuldsättning i takt med att deras förmögenhet ökar, medan barn (som äger sin bostad) istället bibehåller en mer eller mindre konstant belåningsgrad när de blir rikare (vilket sker i takt med att deras föräldrar har en större förmögenhet). När huspriserna istället växer över tid syns större skillnader mellan föräldrar som hyr och föräldrar som äger sitt boende, samt mellan deras barn. Generellt lägger föräldrar större vikt på inter-vivos överföringar, jämfört med finansiellt sparande.

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