

WARSAW SCHOOL OF ECONOMICS  
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INCOME UNCERTAINTY, SOCIAL INSURANCE AND FAMILY:  
AN OVERLAPPING GENERATIONS MODEL APPROACH

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# 1 INTRODUCTION

Economic behavior changes over the life-cycle – this intuitive statement is absent in representative household models and gave rise to life-cycle models. The key interest in my thesis concerns the three distinctly different stages of life. At the first stage of life, during childhood and education, individuals consume but do not produce. At this stage of life, individuals are a private cost to their parents. At the last stage of life, during old age, individuals cannot produce either but need to consume. In between these two stages of life, individuals are able to produce and to save, i.e., postpone consumption.

Recognizing the stages of life gives rise to institutions and economic systems that facilitate the reallocation of resources from one age to another. Inter-generational transfers constitute an essential part of the reallocation system. This reallocation may occur via families or via public systems. Families play a fundamental role in child-rearing with large inter-generational transfers of money and time from parents to children. Traditionally, inter-generational family transfers have also been an essential part of the old-age support system. For the past 150 years, the governments become increasingly involved in facilitating inter-generational transfers: providing public education, health care, social security and income redistribution.

In this thesis, I add to the literature which asks a fundamental question: can outcomes at some stages of life can be improved by altering the choices at other stages of life. Specifically, I study family policies and their interaction with labor taxation and social security in a model with endogenous fertility and uninsurable earnings risk.

Typically, in economics public interventions improve outcomes – welfare – if and only if they are able to mitigate inefficiencies arising in the absence of interventions. The literature identifies three spheres of those inefficiencies, particularly relevant for my thesis. First, the **inter-generational contract of transferring resources between the generations of children, parents and grandparents has innate deficiencies**. There is no private market in which an intergenerational agreement on the transfer of resources between generations of children, parents, and grandparents could be concluded. Traditionally, the working generations provided for their parents and grandparents within a family when those reach the old-age. Additionally, the possibility of enforcing income from children already born is limited. The lack of defined property rights to the future income of children leads to a sub-optimally

low number of children, [Schoonbroodt and Tertilt 2014]. The government can create circumstances that make market exchange possible. Namely, intercede in transferring resources to the generation beyond productivity age through pay-as-you-go (PAYG) social security. Such an arrangement offers a contract between parents and unborn children and forces born children to support retired grandparents, thus standing in for the lacking property rights and unenforceable contracts.

Social security, however, gives rise to the second inefficiency: **externality associated with fertility**. Notably, the standard PAYG social security contract links fertility rate today with future social security benefits of the parents. Consequently, children become a merit good in the presence of PAYG social security. In addition to direct utility to their parents, by paying social security contributions in the future children generate return to the society as a whole. This externality is not taken into account when individuals decide about fertility, which results in suboptimal fertility and creates room for government intervention. There is extensive theoretical literature on the optimal size and shape of family policy that brings the private allocation to the optimal one [see, for example Fenge and Meier 2009; Fenge and Von Weizsäcker 2010; van Groezen and Meijdam 2008; Yasuoka and Goto 2011].

Indeed, the family policies and their impact on macroeconomic variables and welfare have also been extensively studied in the more recent and quantitative literature [see Fehr and Ujhelyiova 2013; Guner et al. 2020, for the case of Germany and the US, respectively]. However, these studies rely on a framework with deterministic income. Meanwhile, a third and final sphere of inefficiency – **the efficiency-equity trade-off in intra-generational transfers** – is well identified in the literature. Life events associated with earnings and health shocks give rise to uninsurable risks, which lead to lower number of children [Fraser 2001; Sommer 2016; Ejrnæs and Jørgensen 2020], excessive savings and lower consumption [Imrohoroglu et al. 1995; Floden and Lindé 2001; Krueger and Ludwig 2018]. Moreover, its relevance is increasing over time [see Meghir and Pistaferri 2004; Heathcote et al. 2010; McKay 2017], and as much 80% of wealth accumulated by young households is due to precautionary motive [Cagetti 2003]. These results signify a key premise that life uncertainty is in essence uninsurable. The government can provide at least partial redistribution through progressive labor income taxation and social security, but these interventions have a downside of reduced efficiency and thus imply second-best equilibria.

My contribution in this thesis is to fill in the gap in the existing literature by accounting for uninsurable earnings risk. I study optimal fertility and optimal public policy in a setup with endogenous decisions on the number of children in families. Extending the existing literature is not an aim in itself, rather it yields several important implications. First, in a life-cycle model with endogenous fertility and family policy, the subsidies for child rearing may in a sense pay for itself due to the externality through the social security. Second, the form of the tax-benefit system affects public insurance and therefore is not neutral for fertility. Third, given the costs associated with child-rearing, the efficiency-equity trade-offs may differ in models with endogenous fertility.

## 2 RESEARCH METHOD

As is standard in the literature, I use the overlapping generations approach to reflect the life cycle features. My approach accounts for PAYG social security, intra-temporal choice, inter-temporal choice and the benevolent government. The families decide about the number of children. What distinguishes my setup from the existing literature is that families face uninsurable earnings risk which are operationalized as idiosyncratic shocks.

I develop my setup in two versions. First, I construct a theoretical model to study allocation in competitive equilibrium. I show that this allocation is inefficient relative to the social optimum.<sup>1</sup> I show how the socially optimal fertility differs from the one in competitive equilibrium. Then, I construct the optimal family policy that brings the competitive equilibrium allocation to the optimal one. Second, I develop a fully fledged quantitative general equilibrium simulation model with overlapping generations (OLG), realistic demographics, idiosyncratic income shocks and endogenous fertility. This tool permits to relax some of the assumptions necessary to obtain results in the theoretical model. This tool permits also to quantify the effects for which I build intuition in the theoretical model. In OLG models, in contrast to Ramsey-growth models, households live finite horizons and face specific phases during the life-cycle. Building risk into the decision-making process makes it impossible to derive analytical solutions for the consumer problem. However, it is still possible to identify

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<sup>1</sup>The notion of social optimum employed in this thesis is that of constrained social optimum, as discussed extensively in Chapter ??.

the optimal allocation using the value function approach with numerical methods, specifically endogenous gridpoints method [Carroll 2006]. In the state-of-the-art overlapping generations models, households decide on consumption, labor supply and savings. Extending this framework with a family structure delivers an adequate framework to analyze the macroeconomic and welfare consequences of fertility choices and family policies.

### 3 RESEARCH HYPOTHESES AND CONTRIBUTION TO THE LITERATURE

In formulating the research hypotheses of this thesis, I build on the existing literature. It has been demonstrated in a theoretical setup in the past that PAYG social security reduces fertility relative to social optimum [see, for example Nerlove et al. 1985; Fenge and Meier 2009; Fenge and Von Weizsäcker 2010; van Groezen and Meijdam 2008; Yasuoka and Goto 2011]. Income risk reduces fertility, as has been demonstrated in empirical research with observational data [see, for example Sommer 2016; Ejrnæs and Jørgensen 2020] and in theoretical context [Fraser 2001]. Building on these developments I develop formalized proofs which extend the standard results in the literature. I formulate the following auxiliary hypotheses:

**Auxiliary Hypotheses.** *With idiosyncratic income shocks and PAYG social security:*

*AH1 fertility rate is lower than socially optimal,*

*AH2 fertility rate declines with risk.*

Notably, the literature in the past has studied on the externality of children in the PAYG social security in deterministic setups. The literature has also studied the role of risk and argued in favor of the prudence channel: with prudence in their preferences, the individuals have insurance motive and when choosing optimal number of children, adjust for the potential earnings risk. However, this literature has ignored the externality argument. I add the prudence channel to the externality argument, combining the two mechanisms in one framework. With both mechanisms working towards reducing fertility, the competitive equilibrium outcome could be even further away from social optimum than in a deterministic setup. While my theoretical setup is parsimonious in this regard, in a full-fledged computational model I

can show that in a sense, earnings risk raises the welfare costs of social security, because it boosts the costs of child-rearing without providing any additional benefits to families.

In line with previous literature, I show that with earnings risk fertility rate is lower. I provide formalized proofs in my theoretical framework, showing that income risk results in a lower fertility rate in competitive equilibrium. The same holds for the allocation in social optimum. I then use the full-fledged computational model to quantify the effects of earnings risk.<sup>2</sup> I compare the case with and without income risk and show that this channel is of paramount empirical relevance: with the same economy and preference parameters, fertility is considerably lower in a model with income shocks. The driving force behind this result is that income risk implies the need for precautionary savings and decreases consumption in the early life stage. Accordingly, it reduces the demand for children. My results are consistent with Fraser [2001] as well as more recent life cycle and observational data literature [see, for example Sommer 2016; Ejrnæs and Jørgensen 2020].

My novel theoretical result related to the role of prudence in fertility decisions with PAYG social security is my **first contribution to the literature**. It is important for two policy-relevant reasons. First, the room for policy intervention is even greater in setups adjusting for idiosyncratic earnings shocks than in deterministic setups. Accordingly, the potential for welfare gains is higher. Second, the relevance of the prudence channel provides important insights on what type of family policies are going to bring welfare gains. Notably, the families need not only to adjust for externality from the PAYG social security, but also have higher demand for insurance against the idiosyncratic shocks. These two results jointly imply that the government can satisfy demand for insurance by providing more redistribution in tax-benefit system. This novel observation gives rise to two main hypotheses:

**Hypothesis 1.** *The composition of family policies is not neutral to its welfare and macroeconomic consequences.*

**Hypothesis 2.** *Endogenous fertility improves the efficiency-equity trade-offs of insurance.*

With rising incidence and magnitude of income risk, the importance of intra-generational

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<sup>2</sup>My model is calibrated to the case of the US, a country for which data access makes my analyses feasible and a country which my analysis is of policy relevance. While some small features of the computational quantitative model reflect the institutional design in the US, after re-calibrating, my model is applicable to other countries. However, calibration of many important parameters could be impossible for many countries. I discuss this in detail in the opening of Chapter ??.

redistribution via tax-benefit system gains increasing coverage both in public and academic debate. Redistribution of income through the tax-benefit system e.g., labor income tax progression or progressive family transfers can partially insure against income shocks. Moreover, the importance of those government transfers is even greater for families with children. Those households have a more limited time endowment and less flexible expenditure profile comparing to childless couples. Hence, my **second contribution to the literature** is the analysis of the impact of the tax-benefit system on the fertility rate in the context of income risk. To this end, I look at the interaction between fertility and income risk when evaluating the welfare effects of social security and labor tax progression. Both social security and labor tax progression can provide intra-cohort redistribution and thus partially insure against the idiosyncratic income shocks. These shocks compound with intra-temporal and inter-temporal choices as well as fertility decisions to deliver income inequality.

Against this background, family policies may also provide insurance, in addition to the channels traditionally studied in the literature. What was entirely missing in the literature is how redistribution built into the tax-benefit system affects the link between income risk and fertility. To fill this gap, I characterize the role of the tax-benefit system in the household decision-making process, with special focus on fertility. I analyze the role of redistribution via social security and show that limiting the scope of inter-generational redistribution within the social security leads to lower fertility. Then I look at the role of income tax progression and show that a progressive tax scheme leads to a substantial labor supply decline. In partial equilibrium, this translates into fertility decline. However, if one accounts for the general equilibrium effect, the fertility rate increases with the progressiveness of the tax scheme.

Finally, I analyze the impact of family policies on household choices. Family policies lower the individual cost of child-rearing and, therefore, may limit the gap between socially optimal fertility level and the one chosen by families. They may lead to welfare improvement. The structure and the size of family policies vary across countries. Among the most popular instruments are tax credit, childcare, and child allowance. My **third contribution to the literature** is to study the role of the composition of family policy in a framework with heterogeneous households. Indeed, if all families were the same, the structure of the family policy would not affect its effectiveness [e.g., [Fenge and Meier 2009](#); [Van Groezen et al. 2003](#)]. However, for the sake of argument, consider for a change that heterogeneity ex ante is akin to different initial

productivity and heterogeneity ex post is akin to differential realizations of earnings shocks. In such case, family policies generate both inter-generational transfers and intra-cohort redistribution. Therefore, the shape of the family policy may be crucial for the outcomes. I am not the first to recognize the importance of household heterogeneity in the family policy design. [Kurnaz \[2018\]](#) study the optimal family policy in a framework with household heterogeneity, but he focuses on a single instrument – a tax credit. I extend this scope of instruments under analysis to include additionally childcare and child allowance. This allows me to study the composition effects of family policy.

Recall, that the composition effects may be driven by the initial theoretical finding of my thesis: greater demand for insurance is an important channel for household behavior, but it does not eliminate the other channels through which public policy can affect fertility choices of the families. Thus, I endeavor to find an optimal family policies mix. I compare the status quo scenario, which reflects the current structure of the tax and benefit system in the US, with the alternatives where I adjust the size of the child-related tax credit, childcare, and child allowance. I show that increasing expenditure on the family policy may lead to welfare improvement. Nevertheless, the composition of policy is crucial for welfare evaluation. We can obtain a positive or negative welfare effect for a very similar expenditure on family policy, depending on the composition. Policies that expand redistributive instruments, like child allowance and tax-credit, generate higher welfare gains. I also identify the optimal policy mix and show that it is more generous than the status quo policy in the US. A predominant fraction of expenditure in the optimal policy mix is designated to redistributive policies: child allowance and child-related tax-credit.

This analysis shows that there are important interactions between tax-benefit system and fertility. On theoretical grounds, it appears that the need for insurance is higher in models with families. Thus, as a final step of this thesis, I focus on the design of the redistribution via labor tax in the context of endogenous fertility and income risk. My **fourth contribution to the literature is to study efficient redistribution in a framework that accounts for the household structure, endogenous fertility, and family policies**. I build on a rich literature on optimal labor income tax design [see [Kindermann and Krueger 2020](#); [Bakış et al. 2015](#); [Imrohoroglu et al. 2018](#); [Heathcote et al. 2017](#)].

Indeed, accounting for the family structure in the context of optimal taxation receives



growing attention in the literature, [see [Guner et al. 2012](#); [Holter et al. 2019](#); [Sánchez-Marcos and Bethencourt 2018](#); [Borella et al. 2019](#)]. Nevertheless, the literature focuses on secondary earners and how differences in labor supply responses to taxes affect optimal taxation. Manipulating redistribution via the labor tax system generates a trade-off between insurance and efficiency. On the one hand, a progressive tax system partially substitutes for the insurance against income risk. On the other hand, it can discourage work. In a model with endogenous fertility, the efficiency loss would be partially mitigated by the higher fertility rate, leading to a younger population and relatively more cohorts in the workforce. Moreover, the insurance gain would be higher in the setup that accounts for children. The presence of children within a household limit the scope of insurance available to households on the other margins and hence increase the value of insurance provided by a progressive tax scheme. For example, since child-rearing is a time-intensive task, the family can adjust working hours less if the negative income shock hits compare to a childless couple.

First, I study the optimal labor income tax design for the status quo family policy. Second, I compare the results with the scenario where the optimal family policy mix described in the thesis is in place. I am not the first to study the optimal tax scheme in the context of endogenous fertility, see [[Petrucci 2015](#)]. However, he does not allow for progressive income tax and instead concentrates on the trade-off between capital and labor taxation. I show that increasing the redistribution via labor income tax leads to welfare gains. Moreover, higher redistribution leads to higher fertility levels. The need for higher redistribution via tax scheme in the US is in line with the current literature on the optimal tax scheme [see [Conesa and Krueger 2006](#); [Piketty and Saez 2013](#)]. I also show that the optimal tax scheme depends strongly on the structure of the family policy.

The state-of-the-art of the existing literature has shown that family policies may have significant effects on fertility in general equilibrium quantitative life-cycle models. These models provide results which are in line with empirical research using observational data. While some of the assumptions behind these models may seem like a simplification, they provide rich and insightful intuitions relating macroeconomic policies with family decisions of the households. My thesis aims to bring four contributions to the existing literature. First, I combine the tradition of externalities from endogenous fertility with a tradition of idiosyncratic shocks and prudence in fertility decisions. Hence, I provide novel insights into the interaction

between idiosyncratic shocks and optimal fertility. Second, I characterize the role of the tax-benefit system in the household decision-making process, with a particular focus on demand for insurance against the idiosyncratic shocks in the context of endogenous fertility. Children generate fixed costs and thus reinforce the need for precautionary savings and the importance of redistribution. I focus on policy-relevance; therefore, I evaluate partial insurance provided by redistribution in social security and labor taxation as instruments substituting for non-existent Arrow-Debreu securities. Third, I derive rich intuitions from this setup, which brings me to substantiating that, in fact, the composition of family policies is no less relevant than the magnitude of child-related public expenditure for delivering higher fertility rate and higher welfare. My fourth contribution is to show that even with optimal child-related expenditure, welfare can be improved through higher insurance in the public taxation system. This final result stems from identifying a novel channel of externality insurance motive: more insurance yields more children, which generates externalities in the presence of PAYG social security.

## 4 STRUCTURE OF THE THESIS

My thesis is structured as follows. In Chapter 1 I provide the introduction and description of research hypotheses. In Chapter 2, I provide a review of related literature. The purpose of this Chapter is to present comprehensive overview of two strands of the literature relevant to the thesis: fertility and insurance through the lenses of macroeconomic general equilibrium models. Through the Chapter I also substantiate the relevance of my modeling choices.

In Chapter 3, I build the stylized model to provide the intuition behind the need for child-related transfers. In this chapter I address **Auxiliary Hypotheses 3**. I prove that in a framework with endogenous fertility, income risk, and PAYG social security, the private fertility rate is suboptimal. I describe the policy that brings the private solution to the social optimum. Moreover, I show that private and the socially optimum fertility rate is decreasing in income risk. I take that intuition to a full-fledged model calibrated to the US economy in the followings Chapters.

In Chapter 4, I describe the computational quantitative model. I introduce the specifics of life cycle, families formation, and fertility decisions. This chapter also introduces the policy instruments across the aspects of government interventions: social security, labor income

tax progression and family policies. This chapter contains the formal definition of the recursive equilibrium notion employed in this model. The model chapter is complemented by two auxiliary chapters: calibration and solution methods. Chapter 5 portrays the insights for the solution method in my computational quantitative model. My thesis requires rich individual level data on time use, income processes and consumption expenditure patterns, as well as many targets for the macroeconomic aggregates. These are in detailed described in Chapter 6.

Chapter 7 is an intermediate step between the theoretical foundation described in Chapter 3 and the quantitative studies described in Chapters 8 and 9. I characterize the household decision-making process, with particular focus on fertility decisions. I analyze the role of redistribution via social security and the role of income tax progression. All analyses in this chapter are performed in partial equilibrium, which implies that the externality of fertility decisions are absent from the analysis. This way, I fully account for the decision mechanisms at the family level. Chapter 7, thus highlights the main mechanism driving the households' choices and the role of government transfers.

The study described in Chapter 8 focuses on the optimal family policies mix and their impact on welfare and macroeconomics — the research conducted in this chapter verifies **Hypothesis 1**. Family policies subsidize fertility. If set correctly, they may bring the private fertility level closer to the optimal one and increase welfare. I consider three types of family policies: public child care, child-related tax credit, and child allowance. Those policies imply different redistribution patterns within a cohort. I find that not only size but also the construction of family policies are nonneutral for welfare and macroeconomic effect. Moreover, besides subsidizing fertility, family policies may offer partial insurance. I study the insurance build into the tax-benefit system explicitly in Chapter 9.

Chapter 9 focuses on the optimal redistribution via labor income tax in the context of endogenous fertility and addresses the **Hypothesis 2**. I show that the relationship between the welfare effect and the redistribution scale via labor tax is hump-shaped. The current tax system in the case of the US offers too low redistribution. Implementing the optimal tax generates large welfare gains. Welfare gains are additionally boost by endogenous fertility channels because higher redistribution leads to higher fertility levels. I also argue that the optimal tax scheme depends strongly on the structure of the family policy.

Chapter 10 concludes with the main policy implications of my thesis, as well as the limitations of my approach and avenues for further research. As is typically the case in macroeconomic computational models, my contributions are not without limitations. For the purposes of tractability, the model is necessarily a simplification. This simplification allows to isolate and quantify the channels of interest, but it also necessarily ignores some potentially important mechanisms. The model accounts for earnings risk, but not for health risks. In particular, fertility intentions are fully realized, and there is no uncertainty about the actual number of children born to a given family and in the economy. I do not account for the transitory path, where most of the policy costs are concentrated. Comparing only steady states is not uncommon for literature on the optimal tax and transfer design due to numerical difficulties. However, accounting for transition is necessary to evaluate the public support for given policy reform. Moreover, I ignore the fertility preferences of the government, public investment in pro-natalist technologies, etc. These are areas of important policy inquiries, but they are not directly related to the main topics of my thesis: efficiency-equity trade-offs of redistribution in models with endogenous fertility and PAYG social security.

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