Université catholique de Louvain
Département des Sciences Economiques

Thèse présentée en vue de l'obtention du grade de
Docteur en Sciences Economiques et de Gestion

Three Essays in Macroeconomic Policy

Lucia Granelli

3 July 2017

Composition du Jury:

David de la Croix (*Université catholique de Louvain*) (promoteur)
Marcel Gérard (*Université catholique de Louvain*) (promoteur)
Thomas Baudin (*Université de Lille*)
Rigas Oikonomou (*Université catholique de Louvain*)
Luca Pensieroso (*Université catholique de Louvain*)

Président du Jury:

Fabio Mariani (*Université catholique de Louvain*)

To my mother.

Acknowledgements

There are so many persons towards whom I feel thankful. They are all those who accompanied me during the process of writing my Phd thesis, which can be compared to an incredibly enriching journey that has lasted for about six years.

To begin with, I would like to thank my thesis supervisors, Professor David de la Croix and Professor Marcel Gérard. In particular, I would like to thank Marcel Gérard for having given me the opportunity to start my PhD work under his supervision. In the same way, I would like to thank David de la Croix for having supervised me during the second part of my PhD, during which I have learnt how to build and calibrate sophisticated economic models. I would also like to thank both my thesis supervisors for allowing me to continue this work when, a bit more than two years ago, I chose to no longer work as a teaching assistant for the economic department of the Université catholique de Louvain.

The members of my jury of the Université catholique de Louvain have played a key role in the development of my work. I fully acknowledge that the discussions with Fabio Mariani, Thomas Baudin, Rigas Oikonomou and Luca Pensieroso have always constituted an important value added for my work. Equally, I wish to express my gratitude to all the scientific and the administrative staff that I had the chance to have as colleagues when I worked as teaching assistant for the Mons campus, the Institute of European studies, the Economic School, and the Institut de Recherche Economique et Sociales (IRES) of the Université catholique de Louvain. You made special all the moments that I spent with you, whether they were moments of work, relaxation or discussion.

I wish to extend my appreciation also to Professor José-Víctor Ríos-Rull, who welcomed me during my stay at the University of Minnesota between July and September 2015. Over those months, I had the opportunity to meet some of the professors that I consider among

the leading economists in their field of study, such as Tim Kehoe, Larry E. Jones, Ellen Mc Grattan, and Alice Schoonbroodt. At the same time, that experience allowed me to meet the graduate students of the Economics department of the University of Minnesota. With them I could share my experience as PhD student and always have an enriching dialogue.

Finally, I would like to thank my friends, my current colleagues at the European Commission and my past colleagues at Bruegel who have encouraged me up to the end of my PhD. Above all and everyone, I would like to express my deepest gratitude to my family, because the time I spent writing my PhD thesis has often coincided with time I could not devote to them.

The content of this PhD thesis does not reflect the official opinion of the European Commission. Responsibility for the information and views expressed therein lies entirely with the author.

Contents

General Introduction

This work is composed of three chapters, all dealing with fiscal policies related either to personal income or to household income. The first chapter presents a theoretical model, covering different options for the international taxation of personal income. The second chapter develops a quantitative model to assess the effect of pro-nativist fiscal subsidies on the fertility decisions of households. The third chapter extends the results of the second chapter by introducing agents' heterogeneity. This introduction briefly summarizes the main results obtained in the three chapters of this work.

The first chapter presents a model depicting the main characteristics of two systems of international information exchange, notably the existing European Union Savings Directive and the US Foreign Account Tax Compliance Act (FATCA). In particular, the first paper presents a portfolio investment model with two countries, where an investor can decide to change his initially given asset distribution in the two countries to maximize his after-tax profit. The model analyses different tax settings under which governments operate and maximizes the national welfare functions: source based taxation, residence based taxation and a costly information exchange regime. The model also introduces separate tax regimes for foreign and domestic savings, allows for investment in different types of assets and analyses the effect of differences in the population of the two countries.

The results of the model highlight that the first-best solution is a residence based system of taxation, which leaves investment decisions undistorted and allows national governments to tax domestic citizens with the same rate on their worldwide income. In addition, the chapter points out that information exchange cannot be a full substitute of residence-based taxation due to the existence of the costs relating to collecting and exchanging information. It also demonstrates that, if a government had full source tax power over the income of its residents in a foreign country, this could constitute another means of establishing resident taxation.

The first chapter enriches the results of the existing literature. The advantages of the residence principle compared to source based taxation have been already pointed out by other papers. As argued by Keen and Ligthart (2006a), the more basic theoretical case for resident based taxation can be traced back to the seminal Diamond-Mirrlees (1971) production efficiency theorem. At the same time, the analysis of the role played by information costs comes from the observation that perfect and costless information exchange is effectively the basis for the residence principle, unless tax payers are completely honest and declare all taxes paid abroad.

Given the existing literature, the first chapter of this work constructs a unique framework, flexible enough to gather under a unique umbrella different international taxation settings. Using this framework, the chapter analyses the role played by information costs and their distribution between countries. Also, it explores the consequences of introducing some technical features; tax rates for foreign and domestic income separately set by a government, costly information exchange, received information quality linked with the quality of the information exchanged, and presence of tax evasion due to the existence of untaxed investments.

The second paper assesses the effects of pro-nativist family tax policies on fertility. It studies how fertility decisions are affected by a permanent shock in fiscal subsidies linked to the number of children had by a household. The emphasis is placed on three specific policies undertaken by the US government throughout the 20th century and still in place at present, namely the exemption for dependents, the child and dependent care expenses credit, and the child tax credit. Using a four-period overlapping generation model with endogenous population, the paper simulates how a comparable increase in each of these instruments modifies the equilibrium of an economy.

Within the theoretical literature linking fiscal policies with fertility, the pioneering contribution of Cigno (1986) shows the importance of introducing the number of children in the utility function of households: once fertility is considered as a variable under household control, tax benefits can decrease child bearing costs and increase the quantity of children at the expenses of their quality. Then the works of Becker (1981), Becker and Barro (1988) and Barro and Becker (1989) underlined the importance of considering the links existing between different generations of the same family. Their vision of parents as altruistic households that choose fertility and consumption by maximising a dynastic utility function shifts the focus of the theoretical literature from the positive relationship between fiscal subsidies for families and

fertility to the negative relationship between the size of social security systems and fertility. As a result, since the end of the 1980s, an extensive literature has evaluated the effects of social security on fertility.[1] At the same time, other papers have studied the responsiveness of fertility to other aspects of public policies, like the decision to tax jointly or individually the income of two spouses (Apps and Rees, 2004, 2007, 2010) or even to the introduction of a cap on gas emissions (de la Croix and Gosseries, 2012).

Quantitatively, fertility is found to be elastic with respect to aggregate shocks by calibrated general equilibrium models. Jones and Schoonbroodt (2016) calculate a contemporaneous elasticity of fertility to productivity shocks lying between 1 and 1.7 and a lagged elasticity lying between -0.9 and -1.6. By contrast, the few empirical papers that have estimated the effect of tax subsidies on the fertility rate have reached quite different conclusions.[2] As far as the US are concerned, two main papers (Whittington et al., 1990; Crump et al., 2011) have applied a time series analysis regressing the value of the personal exemption per dependent child on the general fertility rate. These pieces of work find a marginal effect of the value of the dependent child tax exemption on the fertility rate ranging between 0.011 and 0.236, suggesting that an increase in the tax value of the personal exemption of $100 increases the general fertility rate from 1 up to 24 births maximum per 1000 women.

In turn, the second chapter of this thesis contributes to the literature linking fiscal policies and fertility in three ways. First, it digs further into the question first explored by Cigno (1986) and analyses the relationship between tax benefits for children and fertility decisions. In particular, it assesses this relationship distinguishing among different kinds of tax benefits in order to evaluate theoretically and quantitatively why and by how much different tax instruments may have different effects on fertility. Moreover, it assesses that link looking at the allocation of time among work, leisure and childcare chosen by parents. Second, parents' decision to spend time with their children are not motivated by educational reasons, differing from what is usually assumed in the literature. Rather, education is excluded from the analytical framework used in the paper and child-caring activities is motivated as one of the components of parents' utility function. Parents thus spend time with their children as they perceive utility from doing so and need to pay the cost of childcare services if they want to do other activities like working or enjoying leisure. Third, in order to discipline the

[1] See, for example, Bental (1989), Prinz (1990), Nishimura and Zhang (1992), Cigno and Rosati (1992), Cigno (1995), Rosati (1996), Wigger (1999), and more recently Boldrin et al. (2015), Cremer et al. (2008), and Manuelli and Seshandri (2009).

[2] Gauthier (2007) offers a complete review of works that link family policies on fertility in industrialized countries.

analysis, the deep parameters of the model are estimated through indirect inference using Crump et al. (2011) as benchmark. This exercise allows to conciliate the different values of the elasticity of fertility to aggregate shocks found in the literature, from the value larger than one in dynamic general equilibrium models like Jones and Schoonbroodt (2016) to the value next to zero in empirical papers like Crump et al. (2011).

The third chapter represents both an extension of the second paper and an alternative explanation for the small effect that pro-nativist fiscal policies have on fertility. Indeed, the model used in the second paper excludes by assumption that households may be heterogeneous. On the contrary, going beyond the assumption of agents' homogeneity, the third paper considers households having different skills and hence different levels of income. In turn, households heterogeneity allows to interpret the small effect of pro-nativist fiscal policies as the average effect of these policies, which may be larger for the households at the bottom and smaller for those at the top of the income distribution. It allows also to explore the effects of taxing the inter-generational transfers of households at the top of the income distribution as an alternative policy to influence households' fertility choices.

There are already some papers developing a model of endogenous fertility with heterogeneous households. Keane and Rogerson (2015) and Greenwood, Guner and Knowles (2003) are two examples of this literature. Both papers, though, show an effect of fiscal policies on fertility that is rather large and hence in contrast with the empirical literature having estimated a positive, but rather small, effect of these policies on fertility. In the same vein, the analysis of the relationship between inter-generational transfers and fertility has been addressed in papers such as Becker and Barro (1988) and Barro and Becker (1989), Alvarez (1999), and Cordoba et al. (2015). While a first strand of literature has found a positive correlation between wealth and the number of children, with bequests being equal for each child and independent of the number of children, the last paper has found a significant inter-generational persistence of wealth with richer families having less children and higher inheritance rates.

The third chapter enriches the existing literature by providing a model of endogenous fertility and heterogeneous households, where pro-nativist fiscal subsidies have a small average effect on the size of families, but a stronger effect on the fertility of poorer households. Moreover, following a permanent increase in pro-nativist fiscal policies, the resulting increase in households' income is found to increase the fertility rate and to lower inter-generational transfers of richer households. Similarly to the results of Cordoba et al. (2015), hence, the third chapter

shows that inter-generational transfers are not independent from fertility decisions. It also points out that some degree of inter-generational persistence of wealth exists, as rich households are found to decrease their level of consumption to continue endowing their children with transfers, notwithstanding the increase in taxation.

Chapter 1

From the EU Savings Directive to the US FATCA: Taxing Cross Border Savings Income

Co-authored with Marcel Gérard

This paper is motivated by the recent innovations in the taxation of cross-border savings that took place in the European Union and the United States. We develop a model to assess the functioning of the different systems of international taxation used on both sides of the Atlantic. We consider agents as investors able to diversify their allocation of assets between countries and kinds of financial assets. Furthermore, we show the effects of the various settings investigated not only on the taxation of foreign savings income, but also on the tax rates applied to domestic savings. Finally, comparing the respective merits of diverse regimes of information exchange and coordinated withholding taxation, we explore the consequences of the loopholes in both the EU Savings Directive and the US Qualified Intermediary mechanism, and deal with the cost of information sharing. We find that only three tax designs ensure efficiency: a framework of taxation based on the principle of residence, perfect information exchange for all substitutable assets and strategies, and a system of withholding taxation where the residence country can choose the withholding tax rate and can receive all the withholding tax revenues collected abroad.

1.1 Introduction

On both sides of the Atlantic, many reforms have been recently undertaken in the field of the international taxation of cross border savings income. After decades of debates, in 2000 the Member States of the European Union (EU) came to a compromise in the Portuguese city of Feira. They agreed to set up a system of information exchange concerning interest income only. This system has been applied by all Member States since mid-2005 with an exception of three of them (Austria, Belgium and Luxembourg). Discussions to enlarge its scope are now in progress.

On the 1st of January 2001, the United States (US) launched the Qualified Intermediary (QI) mechanism, designed to cope with tax evasion. Becoming qualified intermediaries of the US Internal Revenue Service, financial institutions committed to report information on US taxpayers' income from US sources. Due to the presence of loopholes in the QI legislation, in March 2010 the US authorities completed it through the Financial Accounts Tax Compliance Act (FATCA). Furthermore, in February 2012 the US moved from a unilateral to a cooperative FATCA. Through a joint statement, the United States and some major EU Member States "have agreed to explore a common approach to FATCA implementation through domestic reporting and reciprocal automatic exchange and based on existing bilateral tax treaties" (U.S. Treasury Department, 2012, p.2).

In this paper we turn these facts into an economic model allowing us to evaluate the economic incentives embedded in the tax rules of the different systems that are in use on both sides of the Atlantic. Defining efficiency as a setup where both tax revenues are maximized and taxation does not distort the allocation of savings between assets and countries, we find that only three regimes can lead to a first best scenario: a pure residence-based setting, a framework of perfect exchange of information for all substitutable assets and strategies, and a system of withholding taxation where withholding tax rates are decided by the residence country and the whole amount of withholding tax revenues collected abroad is fully transferred to that country.

The present work brings four contributions to the literature. First, it shows the effect of the various settings investigated not only on the taxation of foreign savings income, but also on the tax rates applied to domestic savings. Second, it considers agents as investors able to diversify their portfolio not only between countries but also between different kinds of finan-

cial assets. Third, it explores the consequences of the legislative loopholes present in both the EU Savings Directive and the US QI mechanism, arguing that any attempt to reach an efficient tax design requires an equal treatment of all substitutable financial products or of all substitutable tax reporting strategies, in line with what pointed out by Hines (2009) using qualitative arguments. Finally, it deals with the cost of information sharing, distinguishing the case where a country needing information on income paid abroad to its residents also needs to acquire such information and thus to support its costs, from the case where each partner country is made responsible for the transmission of information regarding income paid to non-residents by its local financial institutions.

The paper is organized as follows. Section 1.2 provides with some more details regarding the institutional background. Section 1.3 proposes a survey of the relevant economic literature. The baseline economic model is described in Section 1.4. Section 1.5 introduces exchange of information in the baseline scenario. Sections 1.6 and 1.7 assess respectively the EU Directive and US QI mechanisms. Section 1.8 examines a framework of withholding taxation. Section 1.9 concludes.

1.2 Institutional background

In an open economy, savings invested abroad can in principle be taxed by the country where income is generated and most often where that income is paid out - called the source country or the paying agent country -, or by the country where the investor has his residence - the residence country -, or even by both. For a long time, savings income raising from a foreign source was only subject to a withholding tax levied at source. No exchange of information was organized between the source and the residence country and each country was a tax haven for its neighbor.

After World War II, the Model Tax Convention on Income and Capital proposed by the Organization for Economic Cooperation and Development (OECD) was the first extended attempt to allow the residence country to effectively tax worldwide the income of its residents.[1] The OECD Convention (OECD, 1963) allowed the source country to levy a withholding tax

[1]The League of Nations in 1921 began to work for eliminating double taxation through bilateral conventions. The first results of this effort were the Model Tax Convention of Mexico in 1943 and London in 1946. For a brief summary of the historical background of the OECD Model Tax Convention on Income and Capital, see the historical section of its 2010 full version (OECD, 2010).

on non-resident investors' income, whilst the country of residence of the taxpayer was left free to subject that income to its own tax system, provided that a credit was granted for the withholding tax levied abroad. A consequence of this system was that the residence country needed to get information from the source country in order to properly tax foreign income of its resident taxpayers and apply the crediting mechanism. Residence country legal authorities were actually entitled to claim such exchange, but could not always get all the necessary details or a high enough degree of precision of the information required.[2]

1.2.1 The EU approach: the EU Savings Directive

The absence of a well performing international tax scheme for capital income was rather unimportant as long as savings abroad remained contained. Within the European Union (EU), the increasing capital mobility resulting from the accomplishment of the Single Market in the late 1980's turned a marginal phenomenon into a larger one. The willingness to preserve undistorted capital movements across EU Member States, as well as the possibility of making foreign savings income contributing to government revenues, led the governments of the EU Member States to find a way of avoiding tax competition among countries. Two avenues were therefore suggested: either introducing a system of coordinated withholding taxes levied at source or systematically exchanging information among Member States.

The first attempt to coordinate the taxation of savings income was led by the EU Commissioner Christiane Scrivener. The proposal aimed at coordinating the withholding taxes levied by the EU Member States on interest income paid out to foreign investors having their residence in another EU Member State. The adoption of this proposal failed due to its rejection by a group of countries including Luxembourg and the United Kingdom, as unanimous agreement among Member States is required in tax matters. The second attempt was directed by Mario Monti, at the time Commissioner for Internal Market, Financial Services and Financial Integration, Customs, and Taxation. Monti's suggested reform asked each Member State to decide on one of the following two options: either a withholding tax levied at source, like in the Scrivener proposal, or a systematic exchange of information across EU internal borders. Even the adoption of that proposal, however, failed. Finally, as already mentioned in the introduction, an agreement was reached in 2000. The text of this agreement served as basis for the EU Directive on Savings Income Taxation (EU Commission,

[2]For example, this could happen because the source country administration was not entitled to legally obtain or to reveal to other subjects some information about foreign investors.

1989, 1998; Cattoir, 2006).

The EU Directive on Savings Income Taxation currently in force (EU Commission, 2001; Council of the EU, 2003) is based on a system of automatic exchange of information, but tentatively allows Austria and Luxembourg to apply the alternative system of coordinated withholding taxation that is also in use for tax relations with a series of countries not belonging to the European Union, namely Switzerland, Liechtenstein, Monaco, Andorra, and San Marino.[3]

The main concern with the EU Directive comes from the limitation of its scope to savings income in the form of interest payments and to some interest-based financial products. This leaves income from innovative financial products out of the EU Directive's field of application, as well as insurance contracts and dividends, which are close to debt claims. For that reason, in 2008 the EU Commission proposed an extension of the EU Savings Directive to a larger class of financial assets (EU Commission, 2008a). At present such extension is still under discussion.

1.2.2 The US view: QI and FATCA

On the 1st of January 2001, the United States launched the Qualified Intermediary (QI) mechanism. This system proposed US and foreign financial institutions to sign an agreement for becoming Qualified Intermediary of the US Treasury, committed to report information with regard to US taxpayers' income from US source. Two were the major loopholes. First, no reporting of non-US source income or assets was requested. Second, it was not clear whether the QI agreement obliged financial institutions to examine foreign shell entities owned by US taxpayers. As a result, nine years later, the US authorities revised the system through another legislative bill called FATCA, an acronym for Financial Accounts Tax Compliance Act.

FATCA was initially adopted on the 18th of March 2010, as part of the Hiring Incentives Restore Employment Act (HIRE), but is deemed to come into application between 2013 and 2017. Under FATCA, on the one hand, US taxpayers holding foreign financial assets are required to report this information on their annual tax return. On the other hand, foreign

[3]Belgium has stopped applying the withholding tax and started exchanging information since the 1st of January 2010.

financial institutions have to report directly to the US Internal Revenue Service name and details of all the accounts held by US persons or foreign entities in which a US taxpayer holds substantial ownership interest (U.S. Internal Revenue Service, 2012).

Both the EU Directive and the QI/FATCA approach are based on exchange of information, enabling the residence jurisdiction to know a taxpayer personal income and to tax it at an individualized, possibly progressive, rate decided by that residence jurisdiction. In other words, both systems aim to make possible the inclusion of foreign savings income into a worldwide income tax base in order to properly enforce a Haig-Simons global income tax (Haig, 1921; Simons, 1938). However, the two systems differ on a major issue. Although the primary agent in charge of providing information on the income paid out is in both cases the foreign financial institution - technically, the paying agent or the source country financial institution -, on the European side, the information is then channelled to the residence country tax authorities through the source country tax authorities, which are ultimately in charge of monitoring the quality of the information exchanged. By contrast, on the American side, this mission is up to the responsibility of the US tax authorities. In some sense, the US approach completely disregards local governments, being based on direct agreements between foreign financial institutions and US authorities.

As consequence of the QI/FATCA system, the US tax authorities bear the whole cost of monitoring foreign financial institutions, which is high notwithstanding the existence of penalties that act as deterrent for non-compliance. To alleviate this burden, the US has decided to shift from the current unilateral FATCA to a more cooperative system. On the 8th of February 2012, the US, jointly with France, Germany, Italy, Spain and the United Kingdom, issued an agreement intended to restore the role of foreign governments in the playing field (U.S. Treasury Department, 2012).

1.3 Review of the literature

This paper forms part of two strands of literature: the literature on international savings taxation and the literature on tax evasion.

The literature on cross-border savings taxation has generally tried to assess whether countries strategically prefer a system of information exchange over a withholding tax system,

why they prefer one above the other, and what the determinants of their choice are. In their seminal papers Bacchetta and Espinosa (1995, 2000) examine the incentives leading a government to share information about foreign investments with another government. They reach the conclusion that the informational behaviour of governments is a strategic variable that should be taken into account when designing the optimal international tax system. In addition, they show that the incentives to transmit information depend on the precise institutional setup of the international tax system. Indeed, they prove that, under some features of the tax system, there is no room at all for information sharing, while such exchange may exist and be used for strategic purposes under other institutional arrangements.

Similarly, Gordon and Bovenberg (1996) use asymmetric information to explain the international immobility of capital. Moreover, Eggert and Kolmar (2002, 2004) point out that, in a context of optimal taxation, the integration of international capital markets may lead governments to establish sub-optimal tax rates and, hence, to under-provide public goods. By contrast, cooperation among governments leads to another equilibrium solution, characterized by an efficient level of public goods provision as well as by complete and voluntary information exchange between national tax authorities.

More recent theoretical literature on the subject is inspired by the series of proposals formulated since the late 1980s by the EU Commission and culminated in the adoption of the EU Council Directive on Savings. Huizinga and Nielsen (2003), for example, analyze the minimum withholding tax proposal made by the EU Commissioner Christiane Scrivener in 1989. They set up a three-country model in which a typical EU country has to deal with an inside and an outside tax haven. They investigate what happens to the welfare of each country when the inside tax haven is forced to raise its withholding tax. In the same way, Keen and Ligthart (2006a, 2006b) and Gérard (2004) assess the impact on the social welfare of the innovative mechanisms of revenue sharing and shift from a source-based to a residence-based criterion of taxation, which the EU Commission implemented when the idea of a minimum withholding tax faced the opposition of some EU Member States. In particular, Keen and Ligthart (2006a, 2006b) demonstrate that any kind of withholding tax regime is Pareto dominated by a system of residence-based taxation implying full exchange of information.

The adoption of the Savings Directive by the EU Council in 2003 also gave birth to some empirical literature. Huizinga and Nicodème (2004) investigate the determinants of interna-

tional deposits, providing evidence that foreign deposits do react to taxation. Also, Ligthart and Voget (2012) analyze the key factors leading governments to exchange information and find that sharing decisions are taken on a reciprocal basis in most cases. Furthermore, Johannesen (2010) and Hemmelgarn and Nicodème (2010) show that the Directive has not led EU residents to manage major shifts in their international allocation of savings. They, however, suggest that further analysis should be conducted in order to understand whether the adoption of the EU Directive influenced agents' portfolio choices among different kinds of assets.

The literature on tax evasion and the institutional designs able to limit such behavior play also a role in this paper. The first contribution in this field is due to Allingham and Sandmo (1972), who model tax evaders as rational agents. Over the last six years, by contrast, economists have studied when paying taxes can be rationally preferred to evading them. Alm and Torgler (2006) and Frey and Torgler (2007), for example, show that tax evasion is restrained by the so called "tax morale". Likewise, Kleven et al. (2011, 2016) assess third-party tax reporting against self-reporting in the context of labour income taxation.

Developing Gérard (2004) and Keen and Ligthart (2006a, 2006b), in what follows we examine various tax designs for cross-border savings by adopting a formalization as close as possible to actual and potential institutional features. Namely, as baseline model we consider a pure decentralized source-based scenario where no information at all is exchanged and we study how a shift towards a neutral and efficient residence-based solution looks like for this framework. We then compare this latter setting with the OECD tax model where information is exchanged upon request. We include automatic and systematic exchange of information in this scenario, so to use it as a proxy for the residence based system prescribed in the EU Directive and called upon by the US FATCA. We hence assess the limits of both the European and the US legislation and find out the conditions to restore tax neutrality and efficiency within each of these settings. Lastly, we study a third scenario based on a system of coordinated withholding tax, like the one currently at work between Austria or Luxembourg and the other EU Member States.

1.4 The baseline model

Throughout this paper we present a simplified version of the model, where the countries considered are characterized by the same size of the population and all the financial assets

pay out the same interests. A complete version of the model is reported in the appendix. It should be noted that the results of this complete version, allowing for different country dimension and interest rate in the two countries, do not change the main results presented in what follows on the basis of the simplified version of the model. However, the complete - rather than the simplified - version of the model should be chosen to apply the results of the paper to a specific case and to derive quantitative results.

Consider two countries, say *home* and *foreign*. Suppose that in each country there is an investor representative of the behaviour of the whole population. The investor maximizes a utility function choosing the distribution of her portfolio between the two jurisdictions. In what follows, hence, we indicate with a superscript h the variables referring to the representative agent of population living in country *home* and with a superscript f those belonging to the representative agent of country $foreign$. In this simplified version of the paper, we abstract from the issues relative to different sizes of the population in the countries. In the appendix, instead, we will deal with this possibility and so we will explicitly take into account the country size. Moreover, in the model developed below we restrict the analysis to consider only two countries. As shown by Huizinga and Nielsen (2003), adding a third country into a framework of international savings taxation would not modify the main results of the model. Rather, it would lead to find lower values for the tax rates charged by the governments, while risking not to have a unique solution of the Nash game developed in what follows. In the same vein, in this paper we only consider risk-free assets so that the word "portfolio" refers to the bundle of risk-free assets held by an agent.

To begin with, we assume that there is a single kind of financial asset, providing investors from both countries with a pre-determined and given interest rate r. We make this assumption in order to keep the model simple and disregard monetary or exchange rate dynamics. We will relax the assumption of having a single financial asset in section 1.6. In the appendix, a distinction will also be made based on the country where the interests are paid out presumably being that of the issuer, that is the source country or the paying agent country. Therefore, a subscript h will indicate that interests are paid through a financial institution in country *home*, while a subscript f will refer to income paid out in country *foreign*.

In each country there is also a government which maximizes a social welfare function with respect to the tax rates under its authority. The model takes hence the form of a two-step non-cooperative game. In step 1, governments fix their respective tax rates on savings

income in a non-cooperative way. In step 2, investors select their portfolio. They decide on the distribution of their savings among the two locations and thus among the places where they will have their interests paid out. We solve that model backwards, first investigating the behaviour of the investors, then of the governments.

1.4.1 Pure source-based setting (S)

The investors

The representative investor of each country has a positive and real wealth w, with $w \in \mathbb{R}_+$, and selects the share of wealth that she invests in both jurisdictions so as to maximize her return on investment. In what follows we present only the simplest case where $w = 1$. In the appendix, where we present the solutions of the model in its more general form, we let $w \in \mathbb{R}_+$.

In this paper, we consider that the after-tax investment income fully corresponds to the utility of the representative agent. Therefore, we refer indifferently to the utility of the investor and her investment income. Besides, since agents can only invest in a single risk-free financial product with a given interest rate and since agents keep their assets until maturity, they only care about maximizing their after-tax return. Thus agents' utility maximization problem boils down to maximizing the net return of the portfolio.[4]

Given an arbitrary initial allocation of agents' savings, the representative investor of country *home* decides where to invest her wealth solving the following maximization problem:

$$\begin{aligned} \max_{a_h^h, a_f^h} \quad & U^h = \sum_{k=h,f} z_k^h a_k^h - \frac{v}{2} \sum_{k=h,f} \left(a_k^h - a_{0,k}^h\right)^2, \\ & s.t. \sum_{k=h,f} a_k^h = 1 \quad and \quad \sum_{k=h,f} a_{0,k}^h = 1, \end{aligned} \tag{1.1}$$

where $a_{0,k}^h \in [0,1]$ and $a_k^h \in [0,1]$ are respectively the initial and chosen fraction of savings invested in country k with $k \in \{h, f\}$, $v \in (0,1)$ is the adjustment cost due to a change in the initial allocation of the agent's savings, and $z_k^h \in \mathbb{R}_+$ is the after-tax interest rate. Note that the adjustment costs do not refer to the degree of capital mobility, but to the

[4]For the sake of simplicity, the game that we present in this paper is a one-period static game. The solutions presented hence correspond to a framework where investors and governments decide at one time portfolio allocations and tax rates and then keep their decisions for the rest of their lives.

transaction and information costs linked with the reallocation of capital. These costs can be thus modeled as a fraction v of the assets reallocated that the investor has to pay to a financial intermediary. While the value of v may be relatively small given that investors are supposed to choose the optimal allocation of their portfolio once and for all,[5] its value is not nil, for example because of the existence of tick size effects and security transaction taxes as shown in Hau (2006). Note also that these adjustment costs are supposed to increase with the share of the portfolio reallocated in another country because of the presence of higher administrative burdens linked with larger transactions, due for example to the presence of laws against money laundering. Moreover, the after-tax interest rate can be written as

$$z_h^h = (1 - t_h^h)\, r, \qquad z_f^h = (1 - t_f^h)\, r, \tag{1.2}$$

where $r \in (0, 1)$ stands for the before-tax interest rate paid out either in country *home* or in country $foreign$, while $t_k^h \in [0, 1]$ indicates the tax rate on the interest paid out in country k to a resident of *home*. The before-tax interest rate r is assumed to be given - *i.e.* there is no market for assets - for sake of simplicity. This assumption allows to use a simplified version of the welfare function in the two countries (see below). Also, it allows us to disregard how agents' decision may influence the productive side of the economy or create financial bubbles. Indeed, in this paper, we do not consider alternative reasons for investing abroad, such as hedging against exchange rate risks (Coeurdacier and Rey, 2013; Martin and Méjean, 2012) or against fluctuations in local wage income (Coeurdacier, Kollmann and Martin, 2010). In the same vein, we abstract from possible explanations that could justify the presence of factors biasing agents' choices toward their country of residence in (1.1), such as an imperfect knowledge of foreign institutions (French and Poterba, 1991; Portes and Rey, 2005).[6]

Assuming a quadratic cost in the utility function of the investor allows us not to impose any condition on the relation between the initial and final fraction of savings invested in a certain country.[7] Using the first order conditions linked to optimization problem in (1.1),

[5] See for example Tobin (1978, 1984), Stiglitz (1989), Summers and Summers (1989), Eichengreen, Tobin and Wyploz (1995).

[6] We have checked that the utility function U is concave and twice continuously differentiable with respect to its arguments. We have controlled for the validity of this result in all the sections of the paper. First and second conditions have been also verified throughout the whole development of the model presented in this work.

[7] Note that we are not dealing with the entry costs of the investment, which would lead to the concavity of the cost function. We suppose indeed that agents are already active investors and no longer have to sustain entry costs.

we find that

$$a_h^{h*} = a_{0,h}^h + \frac{z_h^h - z_f^h}{2v} = a_{0,h}^h + \frac{t_f^h - t_h^h}{2v}, \qquad a_f^{h*} = a_{0,f}^h + \frac{z_f^h - z_h^h}{2v} = a_{0,f}^h + \frac{t_h^h - t_f^h}{2v}. \tag{1.3}$$

The representative agent of country $foreign$ acts similarly. Throughout the paper, we will hence report the results for country $foreign$ only when necessary.

In each country the portfolio allocation of the representative agent depends on the initial share of wealth invested at home and the ratio between the differential between the after-tax net returns on the assets held in the two countries and the adjustment costs. In other words, if no exchange of information takes place between jurisdictions, then the optimal portfolio allocation of representative agents corresponds to the initial share of wealth invested in each country, adjusted for net-of-tax differences in returns taking into account the adjustment cost.[8]

The governments

In the second step of the game, each government maximizes its tax revenue. Under the assumption of a constant before-tax interest rate paid in each country, this assumption correspond to the case where a government maximizes a welfare function. In other words, the two governments are assumed to be Leviathan, without loss of generality given the partial equilibrium context of the paper. For a justification of that assumption, see Keen and Ligthart (1999, 2006a, 2006b).

In each country, the government chooses the tax rates under its control, knowing the best response function of investors. In this baseline scenario, where no information is exchanged between the two jurisdictions at stake, government of country *home* decides on the tax rate it charges on the domestic income of its residents, t_h^h, as well as on the withholding tax it levies on interest payments paid out in its territory to residents of the other country, t_h^f. The

[8]Transaction costs are multiplied by two because agents are supposed to pay a cost both for transferring assets from *home* to $foreign$ and from $foreign$ to *home*.

objective of government h is to[9]

$$\max_{t_h^h, t_h^f} W^h = r\left(t_h^h a_h^{h*} + t_h^f a_h^{f*}\right). \tag{1.4}$$

We have now assumed that each country is populated only by one agent. In the appendix, instead, we will present the solutions for the case of two countries of different size, with N^h and N^f being respectively the population of country *home* and of country $foreign$.

Solving the maximization programs of both governments, we obtain the best responses for the tax rates charged by *home*[10]

$$t_h^h = \frac{t_f^h}{2} + a_{0,h}^h \frac{v}{r}, \quad t_h^f = \frac{t_f^f}{2} + a_{0,h}^f \frac{v}{r}. \tag{1.5}$$

The tax rates charged turn out to be influenced by three factors. First, they are a positive function of the importance of adjustment costs v: the higher the cost that agents face for moving their savings, the higher the tax rate charged by a country can be. Second, they are also positive functions of the initial investment in a location: the higher the initial share of investors' wealth invested in a country, the higher the tax rate set by the government of that country, reflecting the lower need to attract further savings from the partner jurisdiction. Third, tax rates rise when the complementary tax rate paid by agents domestically or abroad increases.

The Nash equilibrium tax rates are equal to

$$t_h^{h*} = \frac{2v}{3r}(1 + a_{0,h}^h), \quad t_h^{f*} = \frac{2v}{3r}(1 + a_{0,h}^f). \tag{1.6}$$

In a context of pure source-based withholding taxation, countries have the possibility to discriminate between domestic rate for resident and non-resident investors. Countries can hence try to attract foreign capitals. For equal rate of returns and wealth in the two countries, tax rates charged to non-resident investors tend to be smaller whenever agents prefer to invest more in their domestic country ($a_{0,h}^h > a_{0,h}^f$). Moreover the tax rates increase with the cost of reallocating the portfolio, as a higher value of v implies a higher degree of captivity of the

[9] As for the agents' utility function, we have checked that government's revenue function is concave, with the concavity given by the presence of the portfolio allocation functions. Moreover we have also verified that the function is twice continuously differentiable with respect to its arguments as well as controlled for the validity of this result in all the sections of the paper. First and second conditions have been also examined for any of the described scenarios.

[10] In this paper we only consider interior solutions and focus on realistic values of the tax rates.

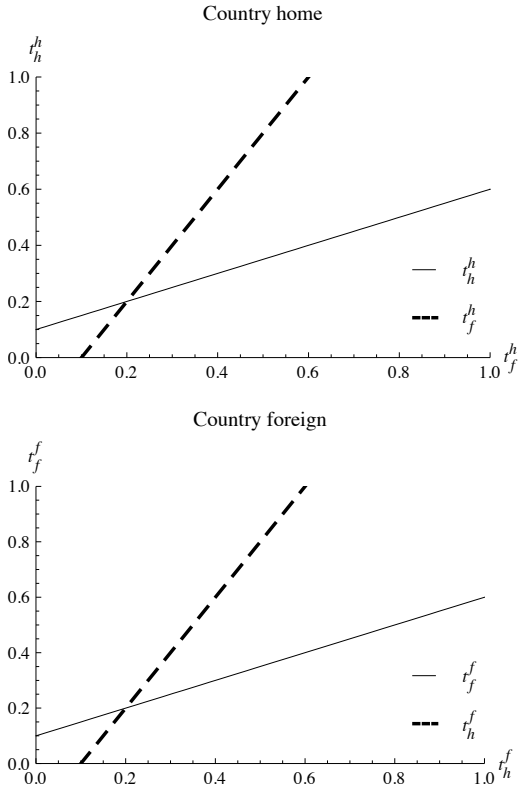


Figure 1.1: Best response functions for the domestic tax rate in country *home* (a) and country $foreign$ (b). In this figure, the initial portfolio is considered as evenly distributed among products, v is set equal to 0.01, while the interest rate is fixed at 5 percent.

taxpayers. By contrast, similarly to the best response functions, an increase of the interest rate decreases the equilibrium tax rates. This derives from the fact that governments care only about maximizing their revenues. Higher interests paid out allow them to reach the maximum of their revenue function with lower tax rates.

1.4.2 Pure residence-based setting (R)

With this simple setting, it is easy to show that shifting the power to tax from the source to the residence country increases tax revenues. Taxing at the same rate the income received by the residents of each jurisdiction domestically and abroad, in country *home* we have that $t_h^h = t_f^h = t^h$.

From (1.3), the optimal allocation chosen by the representative agent in each country corre-

sponds to the initial allocation,

$$a_h^{h*} = a_{0,h}^h, \qquad a_f^{h*} = a_{0,f}^h. \tag{1.7}$$

The government maximization problem in (1.4) instead becomes

$$\max_{t^h} W^h = r\left(a_h^{h*} + a_f^{h*}\right) t^h.$$

Each country is now free to fix its tax rate without taking into account the choices of its partner country. Each country can for example set a tax rate t^*, that is t^{h*} in the case of country *home*.[11]

Substituting the tax rates of equilibrium into the revenue functions, we can show under which conditions tax revenues increase when a government can tax the global income of its residents. For an even distribution of agents' initial portfolio, proposition I shows that the tax revenues collected by the government of country *home* under a residence-based regime are larger than that collected under a source-based principle of taxation when adjustment costs are low with respect to the interest rate. For adjustment costs tending to zero, $v \to 0$, the residence principle of taxation ensures larger tax revenues than the source principle for all positive values of the tax rate t^{h*}. Equivalently, the residence regime increases tax revenues when the optimal tax rate t^* chosen by a government under this setting is higher than the ratio between adjustment costs and the interest rate.

Proposition I: The residence-based scenario assures a higher level of revenues across the two countries the lower adjustment costs are with respect to the interest rate. For given adjustment costs and interest rate, moving from a source to a residence regime raises tax revenues if the optimal tax rate t^* under the residence regime is higher than the ratio between adjustment costs and interest rate.

Proof: For country *home* we have that:

$$W_R^h > W_S^h \text{ if } r\left(a_{0,h}^h + a_{0,h}^f\right) t^{h*} > r\left(t_h^{h*} a_h^{h*} + t_h^{f*} a_h^{f*}\right) <=> t^{h*} > \frac{v}{r}.$$

■

[11] Countries are now independent because investors are supposed to be immobile.

1.5 Information exchange (IE)

Information exchange is a way of getting closer to a situation where governments can tax the global income of their residents, as in residence-based regime. Interests continue to be taxed at source by the paying country, which can still discriminate between local and foreign investors. However, unlike in the framework based on the sole source principle, the residence country now may also tax interests obtained abroad by its residents, provided it grants them a credit for the withholding tax levied in the partner country and gets the relevant information. Different settings belonging to this scenario are spontaneous transmission of information or self-reporting, to adopt the terminology of Kleven et al. (2016), exchange of information upon request as advocated by the OECD, and automatic and systematic provision of information by the paying agent, either directly to the residence government of the investor, or indirectly through the agency of the tax authorities of the source jurisdiction (third party reporting in the terminology of those authors).

In this section we assume that getting or providing information is costless. We will relax this assumption in the next two sections, where we concentrate on the EU Savings Directive and on the evolution of the US practice from QI to unilateral and then cooperative FATCA. We will show especially under which conditions those settings replicate or are proxies for the residence-based framework described in section 1.4.2. Furthermore, we assume that the information received by the country of residence of the taxpayer is not always of the highest quality. Different national tax regulations can in fact allow public administrations to gather and to transmit different taxpayer details. Conversely, if investors rather than foreign administrations are those in charge of providing information to the government of the residence country, then this self-reported information may be partial.

The representative agent of country *home* faces the same utility maximization problem as in (1.1). The return on the share of her savings invested abroad, however, now also depends on the tax rate applied to her domestic income, whenever this rate is higher than the withholding tax charged in country $foreign$. Besides, it is a function of the quality of the information p regarding her cross-border savings, which is provided to the authorities of *home* either by the financial institutions or by the authorities of country $foreign$, in case of third party reporting, or even by the investor herself, in case of self reporting. We introduce the parameter p^f for qualifying the quality of the information obtained by country *home* from country $foreign$ and, similarly, the parameter p^h to indicate the quality of information obtained by

country *foreign* from country *home*. Consequently, p^h and $p^f \in (0,1)$. Upper and lower boundaries are excluded because, in the context of this institutional device, reporting is in principle mandatory for administration or investors so that people with a high degree of risk aversion (Allingham and Sandmo, 1972) or tax morale (Alm and Torgler, 2006; Frey and Torgler, 2007) will report some foreign income at least. For similar reasons we rule also out the possibility of having a perfect exchange of information, as we assume that the accuracy of the reporting cannot be checked (Gérard and Hadhri, 1994).

We model the effect of the quality of information reported by modifying the definitions of the after-tax returns. For instance, for the representative resident of country *home*, these are now defined as

$$z_h^h = \left(1 - t_h^h\right) r, \qquad z_f^h = \left[1 - t_f^h - max\left\{0, p^f \left(t_h^h - t_f^h\right) \right\}\right] r. \tag{1.8}$$

The credit granted to taxpayers in their country of residence for the withholding tax paid abroad is generally limited to the domestic tax liabilities on the income at stake. Therefore a country cannot charge a withholding tax larger than the upper limit of the creditable amount. In what follows, we consider that national tax rates are higher than foreign rates, so that investors have incentives to invest abroad positive shares of their savings and the model does not reduce to a pure source-based regime as the one already described in section 1.4.1.

The allocation of savings for the representative investor of country *home* continues to follow the formula found in (1.3), where after-tax returns are defined as in (1.8). The share of savings invested in the country of residence hence continues to decrease when the domestic tax rate rises $\left(\frac{\partial a_h^h}{\partial t_h^h} < 0\right)$ and to increase when the foreign withholding tax rate goes up $\left(\frac{\partial a_h^h}{\partial t_f^h} > 0\right)$. Nonetheless the outflow of savings toward the partner jurisdiction is cushioned by the importance of the exchange of information, as the share of savings invested abroad decreases $\left(\frac{\partial a_f^{h*}}{\partial p^f} < 0, \frac{\partial a_h^{f*}}{\partial p^h} < 0\right)$ when the quality of the information exchanged improves.

The objective function of each of the two governments now integrates a new source of tax revenue, *i.e.* that raising from their capacity to tax foreign income of their residents thanks to the cross border exchange of information. As a result, the government of country *home*

faces the following maximization program:

$$\max_{t_h^h, t_h^f} W^h = r\left(t_h^h a_h^{h*} + t_h^f a_h^{f*}\right) + p^f\left(t_h^h - t_f^h\right) a_f^{h*} r.$$

The optimal tax rates charged by *home* are given by

$$t_h^{h*} = \frac{2(1+a_{0,h}^h)}{[(3-2p^f)(1-p^f)]}\frac{v}{r}, \qquad t_h^{f*} = \frac{2\left[1+a_{0,h}^f(1-p^h)\right]}{[(3-2p^h)(1-p^h)]}\frac{v}{r}. \tag{1.9}$$

Tax rates are positive functions of the quality of the information exchanged with the other country. An increase in the quality of information exchange reduces tax motivated outflows of savings and thus allows governments to increase their respective domestic tax rate ($\frac{\partial t_h^{h*}}{\partial p^f} > 0$). Similarly, it incentivizes governments to increase the withholding tax on income paid out to non-residents ($\frac{\partial t_h^{f*}}{\partial p^h} > 0$), since this is credited on tax liabilities in the country of residence of the investors.

Nevertheless, exchanging information remains an intermediate solution between the source-based and the residence-based scenarios both with regard to tax rates and revenues. For low values of the quality of the information exchanged, this scenario tends to the source-based optimal solutions. On the other hand, when that quality is almost perfect, this setting resembles a pure residence-based setting, where the investor becomes insensitive to the difference between the domestic tax rate and the foreign withholding tax and keeps unchanged the initial distribution of her savings in order to avoid unprofitable and costly portfolio reallocations. Proposition II formalizes this result.

Proposition II: Tax revenues under the information exchange regime tend to the level of revenues obtained under a regime based on the residence principle for the quality of information tending to one, while they tend to a level of revenues corresponding to a pure-source scenario for the quality of information tending to zero. For country *home*,

$$W_{IE}^h \to W_S^h \text{ if } p^h = p^f \to 0, \qquad W_{IE}^h \to W_R^h \text{ if } p^h = p^f \to 1.$$

Proof: The proof of this proposition directly derives from (1.9). ■

If the governments of the two countries could choose what quality of information to exchange,

then they would face a prisoner's dilemma. Receiving high quality information increases the domestic tax rate - t_h^{h*} in (1.9) - and so increases tax revenues of the receiving country. However, transmitting high quality information makes the withholding tax rate imposed on foreign investor - t_h^{f*} in (1.9) - going up, with the result that a country can lose its attractiveness for foreign investors. Consequently, the information exchange regime cannot evolve into a pure residence-based regime.

Corollary: Tax revenues under the information exchange regime are lower than under a regime based on the residence principle, but higher than in a scenario purely based on the source principle. In each country,

$$W_S < W_{IE} < W_R.$$

1.6 EU Savings Directive (EU)

In the version currently applied by all EU Member States except for Austria and Luxembourg, the 2003 EU Council Directive on Savings Income has shifted the power to tax cross-border savings from the source to the country of residence of the investors. In principle this framework could constitute an application of the second scenario we have presented in the baseline model (*i.e.* the pure residence-based setting analyzed in section 1.4.2). Indeed, in this system of taxation each country can tax its citizens on the basis of their European-wide income. The EU Savings Directive, however, applies only to savings income in the form of interest payments and to some interest-based financial products.

The limited scope of the Directive may incentivize agents to hold products falling out of its range of application like insurance contracts. To show this, we consider that in both countries there exists a financial product falling out of the range of application of the Directive. Agents' income derived from holding this asset is taxed exclusively by the country where interests are paid out. In this case, the representative agent of country *home* maximizes the following utility function:

$$\begin{aligned} \max_{a_h^h, a_{h'}^h, a_{f'}^h} \quad & U^h = \sum_{l=h,h',f'} z_l^h a_l^h - \tfrac{v}{2} \sum_{l=h,h',f'} \left(a_l^h - a_{0,l}^h\right)^2, \\ & s.t. \sum_{l=h,h',f'} a_l^h = 1 \quad and \quad \sum_{l=h,h',f'} a_{0,l}^h = 1, \end{aligned} \tag{1.10}$$

where h now represents the financial product issued by country *home* and regulated by the Directive, whilst h' is the insurance product issued only in country *home* and f' is the one issued only in country $foreign$. Note that the financial asset f is no longer relevant for the agent in country *home*. Due to the introduction of the Directive, indeed, the financial asset f becomes a product equivalent to h for the agent in country *home*. The after-tax interest rate perceived on h' and f' can be written as:

$$\begin{aligned} z^j_{h'} &= (1 - t^j_{h'})\, r, \\ z^j_{f'} &= (1 - t^j_{f'})\, r, \end{aligned} \tag{1.11}$$

where $t^j_{h'}$ and $t^j_{f'}$ are respectively the tax rate at which the income coming from the detention of an insurance product is taxed by country *home* and by country $foreign$ disregarding the nationality of the asset owner, *i.e.* $j \in \{h, f\}$.

As in (1.3), the solution to the agent's maximization problem is given by

$$\begin{aligned} a^{h*}_h &= a^h_{0,h} + \frac{(z^h_h - z^j_{f'}) + (z^h_h - z^j_{h'})}{3v}, \quad a^{j*}_{f'} = a^j_{0,f'} + \frac{(z^j_{f'} - z^h_h) + (z^j_{f'} - z^j_{h'})}{3v}, \\ a^{j*}_{h'} &= a^h_{0,h'} + \frac{(z^j_{h'} - z^h_h) + (z^j_{h'} - z^j_{f'})}{3v}. \end{aligned} \tag{1.12}$$

The government of this country fixes its respective tax rates according to the following maximization problem:

$$\begin{aligned} \max_{t^h_h, t^j_{h'}} \; & W^h = r\left[t^h_h a^{h*}_h + t^j_{h'}(a^{h*}_{h'} + a^{f*}_{h'})\right], \\ & s.t. \;\; t^h_h, t^j_{h'} \leq 1. \end{aligned} \tag{1.13}$$

The best response functions for the government of country *home* are

$$t^h_h = \frac{3v a^h_{0,h} + r(2t^j_{h'} + t^j_{f'})}{4r}, \quad t^j_{h'} = \frac{3v(a^h_{0,h'} + a^f_{0,h'}) + r[2(t^h_h + t^j_{f'}) + t^f_f]}{8r}.$$

Tax rates are interdependent, implying that tax rates on financial products not regulated by the EU Savings Directive influence those that are taxed according to its rules. Equilibrium

tax rates are now equal to

$$\begin{aligned} t_h^{h*} &= \frac{3[a_{0,h}^h + a_{0,f}^f + 2(1 + a_{0,f'}^f - a_{0,h'}^h)]v}{10r}, \\ t_{h'}^{j*} &= \frac{[a_{0,h}^h + 2a_{0,f}^f + 4(a_{0,f'}^h + a_{0,f'}^f)]v}{5r}. \end{aligned} \tag{1.14}$$

Tax revenues under the EU Directive regime correspond to a scenario of pure source-based international taxation of savings. To illustrate this, the assets taxed according to the rules of the EU Directive can be compared to national assets taxed by the residence country, while the assets escaping the application of the Directive are similar to foreign assets taxed at a different rate established by the source country. This scenario thus conveys a level of tax revenues that is lower than in a situation of pure residence-based taxation. A pure residence-based taxation setting, in fact, would imply the application of the Directive to all financial assets. Similarly, corresponding to a pure source-based system of taxation, a limited application of the Directive leads governments to collect a lower level of tax revenues than in a framework of information exchange.

Proposition III: For an even allocation of investors' portfolio, tax revenues under the EU Directive regime equal those collected in a scenario of pure source-based taxation, hence lower than under a regime of information exchange or in a scenario where international taxation is purely based on the residence principle.

Proof: For country *home*, we have that

$$W_{EU}^h = W_S^h, \qquad W_{EU}^h < W_R^h \text{ if } r > v, \qquad W_{EU}^h < W_{IE}^h \text{ if } 0 < \{p^h, p^f\} < 1.$$

■

1.7 The US model

As already pointed out in section 1.2, in the United States the QI and FATCA systems are attempts to reach the outcome of a residence-based scenario by having all the necessary information about resident taxpayers. Like the EU Savings Directive though, the QI and FATCA systems have been confronted with serious limitations in the US. Because of these loopholes, the QI and FACTA regimes have turned out to be not at all equivalent to the

scenario with perfect exchange of information they were aiming at.

Two questions are separately addressed in this section, building extensions of the model developed in section 1.5. First, under the QI mechanism, US taxpayers could escape its application by channelling their income through a non-US person. In section 1.7.1 we show how, due to the exemption granted to foreigners, the QI mechanism has not had the expected positive effect on the level of tax revenues in the US.

Second, notwithstanding the US authorities decided to reinforce the QI mechanism with FATCA rules, acquiring or supplying information remains a costly activity. Indeed, under the EU Savings Directive mechanism, it is up to each EU Member State to provide its partner countries with such information. Under the QI and what we call unilateral FATCA, the US authorities are permitted to audit the primary supplier of the information, *i.e.* foreign financial institutions. In section 1.7.2 we demonstrate why the costs of this direct audit may explain the change in the attitude of the US authorities in favour of a cooperative FATCA based on an intergovernmental agreement.

1.7.1 QI loopholes

If an alternative channel for getting interest income from foreign assets exists, e.g. through an incorporated person subject to taxation at source instead of a regime of information exchange, then the after-tax foreign income for an investor having residence in country *home* in (1.8) becomes

$$z_f^h = \max\left\{ \left[1 - t_f^{hIE} - p^f \left(t_h^{hIE} - t_f^{hIE}\right)\right] r,\ (1 - t_f^{hS} - \tilde{c})r \right\},$$

where $\tilde{c}$ is the cost of that alternative channel, t_h^{hIE} and t_f^{hIE} are the two tax rates imposed domestically by country *home* or abroad by country $foreign$ under a regime of information exchange, while t_f^{hS} is the tax rate imposed by the source country - country $foreign$ - linked to that possibly more sophisticated device. Indeed $\tilde{c}$ might be understood as a fee paid to bankers or tax advisers. As a consequence, the US taxpayer will invest through a local firm, if

$$\tilde{c} < t_f^{hIE} + p^f \left(t_h^{hIE} - t_f^{hIE}\right) - t_f^{hS} \equiv RHS.$$

Substituting the two tax rates with their equilibrium values found respectively in (1.6) and (1.9), figure 1.2 shows that making use of more sophisticated devices is convenient only

when the quality of the information exchanged is low enough. Higher values of the quality of information exchange either require more sophisticated and thus more costly strategies ($\tilde{c}' > \tilde{c}$) to be used, or make inconvenient the use of alternative devices.

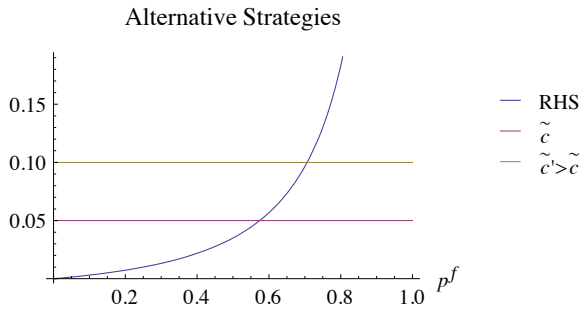


Figure 1.2: Costs of alternative strategies. The values of the initial portfolio allocation, interest rate and transaction costs are set as in Figure 1.

1.7.2 Costly information (CI)

The QI mechanism was improved thanks to the adoption of FATCA. This system however requires high level of information exchange for delivering all its effects. So far, we have assumed that getting information was costless for the recipient country. By contrast, the FACTA system implies that the US supports the whole burden of acquiring information. In this section we thus investigate the consequences of the existence of these costs.

If acquiring information is costly, jurisdiction *home* will support the cost ϕ of p^f. This cost is modeled as part of the taxpayers' portfolio allocated abroad that the government is not able to tax. With $\phi \in [0, 1]$, the tax revenue function then becomes

$$\max_{t_h^h, t_h^f} W^h = r\left[t_h^h a_h^{h*} + t_h^f a_h^{f*} + p^f(t_h^h - t_f^h)(1-\phi)a_f^{h*}\right]. \tag{1.15}$$

Due to the presence of ϕ, the equilibrium tax rates in (1.9) also evolve as follows:

$$t_h^{h*} = \frac{2(1+a_{0,h}^h)}{[3-2(1-\phi)p^f]\,(1-p^f)}\frac{v}{r}, \quad t_h^{f*} = \frac{2\{1+a_{0,h}^f[1-(1-\phi)p^h]\}}{[3-2(1-\phi)p^h]\,(1-p^h)}\frac{v}{r}. \tag{1.16}$$

The presence of a cost for acquiring information decreases the internal tax rate $\left(\frac{\partial t_h^{h*}}{\partial \phi} < 0\right)$,

as well as the external tax rate $\left(\frac{\partial t_h^{f*}}{\partial \phi} < 0\right)$. Tax revenues hence decrease for increasing values of ϕ. In particular, when ϕ assumes value 1 or the quality of information tends to zero, then the optimal tax rates becomes equal to the source-based solution seen in section 1.4.1; whilst, for $\phi = 0$, this framework is equivalent to the information exchange setting analyzed in section 1.5.

Moving from a unilateral mechanism to a cooperative agreement where each partner provides information regarding foreign accounts on its territory transforms (1.15) into

$$\max_{t_h^h, t_h^f} W^h = r\left[t_h^h a_h^{h*} + t_h^f a_h^{f*} + p^f(t_h^h - t_f^h)\left(1-(1-\chi)\phi\right)a_f^{h*} - \chi\phi p^h(t_f^f - t_h^f)a_h^{f*}\right].$$

The equilibrium solutions are now equal to

$$\begin{aligned} t_h^{h*} &= \frac{2\left[(1+a_{0,h}^h)(1+\chi\phi p^f)\right]}{\left[3-2(1-\phi)p^f\right](1-p^f)}\frac{v}{r}, \\ t_h^{f*} &= \frac{2\{1+a_{0,h}^f\left[1-p^h\left(1-(1-\chi)\phi\right)\right]+2\chi\phi p^h\}}{\left[3-2(1-\phi)p^h\right](1-p^h)}\frac{v}{r}. \end{aligned}$$

A higher value of $\chi \in [0,1]$, that is a higher share of the information cost ϕ paid by the partner country pushes up the internal tax rates and lowers the external tax rates. For a value of χ equal to 0, as in the unilateral FACTA mechanism, the tax rates chosen by the government of country *home* corresponds to those found in (1.16). As tax rates in (1.16) are lower than those corresponding to a situation of costless information, also the tax revenues collected by the government of country *home* are lower than in a framework of costless information exchange. By contrast, when the burden of acquiring information is totally supported by the partner jurisdiction $\chi = 1$, optimal tax rates are higher than in (1.16) and even higher than in a situation of costless information as in section 1.5,

$$\begin{aligned} t_h^{h*} &= \frac{2\left[(1+a_{0,h}^h)(1+\phi p^f)\right]}{\left[3-2(1-\phi)p^f\right](1-p^f)}\frac{v}{r}, \\ t_h^{f*} &= \frac{2\{1+a_{0,h}^f\left[1-p^h\right]+2\phi p^h\}}{\left[3-2(1-\phi)p^h\right](1-p^h)}\frac{v}{r}. \end{aligned}$$

Proposition IV: In a framework of information exchange, if acquiring information is costly ($\phi \neq 0$), tax revenues decrease with the burden of acquiring information that a country needs to support.

Proof: Comparing tax revenues in case of costless and costly information, for country *home* we have that

$$W^h_{CI} < W^h_{IE} \text{ if } \chi \to 0, \qquad W^h_{CI} > W^h_{IE} \text{ if } \chi \to 1.$$

■

1.8 Coordinated withholding taxation (W)

This last section before the conclusion is inspired by the innovative practice adopted by the EU for Member States allowed not to exchange individualized information, as well as for the tax relations with third countries. In general, withholding taxation does not require the collection of detailed and personalized information in order to function. It is hence a regime to be preferred to a regime of information exchange whenever two countries refuse any exchange of information (as in the case of some European Member States) or when the quality of information reported about taxpayers is very low.

Under this scenario country *home* and $foreign$ do not exchange individualized information but each of them transfers to its counterpart a fraction, 75% in the EU case, of the revenue collected from a withholding tax levied on interests paid to residents of that partner country. This transfer is done anonymously - the names of the investors are not mentioned. In the EU case, the rate of that withholding tax was initially set equal to 15% and it has progressively increased up to 35%.

Nothing changes concerning investor decisions with respect to the baseline model. They continue to solve the maximization problem explained in (1.1) and invest their savings according to (1.3). On the contrary, the maximization problem for the government of country *home* can be modified as follows

$$\max_{t^h_h, t^f_h} W^h = r\left[t^h_h a^{h*}_h + x\, t^h_f a^{h*}_f + (1-x)\, t^f_h a^{f*}_h\right], \tag{1.17}$$

where $x \in [0,1]$ is the percentage of the withholding tax that the two countries have exogenously agreed ex-ante to pass to each other. The best response functions of the tax rates charged by country *home* are now equal to

$$t^h_h = a^h_{0,h}\frac{v}{r} + \frac{(1+x)t^h_f}{2}, \quad t^f_h = a^f_{0,h}\frac{v}{r} + \frac{t^f_f}{2},$$

so that, the Nash equilibrium is constituted by,

$$t_h^{h*} = \frac{2v[1 + a_{0,h}^h + x\, a_{0,f}^h]}{r(3-x)}, \quad t_h^{f*} = \frac{2v(1 + a_{0,h}^f)}{r(3-x)}. \tag{1.18}$$

The tax rates levied by the two countries correspond to those found in (1.6), apart for the presence of the sharing factor x. In particular, in a system of coordinated withholding taxation, the slope of the reaction function of the domestic tax rate is larger than under no exchange of information due to the sharing agreement. The reaction function of the withholding tax rate charged to foreign investors, by contrast, keeps following the case of source-based taxation. Moreover, for $x = 0$, the expressions of the optimal tax rates found in this section coincide with those of the source-based scenario assessed as baseline model. For $x > 0$, the optimal tax rates in this scenario become higher than those found under a pure source-based setting studied in section 1.4.1. Consequently, with coordinated withholding taxes, tax revenues are also a function of the sharing coefficient x.

Proposition V: In a regime of coordinated withholding taxation, a positive sharing factor $x > 0$ increases tax revenues with respect to a regime of taxation at source.

Proof: From (1.18), for country *home* we have that

$$W_W^h \to W_S^h \text{ if } x \to 0, \qquad W_W^h > W_S^h \text{ if } x > 0.$$

■

1.8.1 Mixing withholding taxation with information exchange

In this section dedicated to coordinated withholding taxation, we have disregarded exchange of information up to now. However, the transfer of a fraction x of the revenue collected at source through the coordinated withholding tax to the state of residence of the investor does not exonerate the investor to report her foreign income in her state of residence, receiving a credit for the tax withheld at source.

Including reporting information of quality p in the coordinated withholding tax scheme modifies both the utility function for the investors and the function of tax revenues for the

governments. The former change involves information exchange in characterizing agents' portfolio allocation. The latter combines equations (1.9) and (1.18). It turns out that the two optimal tax rates at Nash equilibrium are now equal to

$$t_h^{h*} = \frac{2v[1 + a_{0,h}^h + x\, a_{0,f}^h]}{r(1-p^f)(3-2p^f-x)}, \quad t_h^{f*} = \frac{2v\left[1 + a_{0,h}^f(1-p^h)\right]}{r(1-p^h)(3-2p^h-x)}.$$

Self-reporting and withholding sharing reinforce each other to increase tax rates and tax revenues. The results for tax revenues are similar to what is stated by proposition V. In particular, if $x \to 0$ and $p^h, p^f \to 0$, the tax revenues under this regime tend to the level of revenues collected in a pure-source scenario. If $x \to 1$ and $p^h, p^f \to 1$, this regime tend to a residence-based framework. Finally, if $x \to 0$ and $0 < p^h, p^f < 1$, this regime restitutes the same level of tax revenues as under a setting of information exchange.

1.8.2 Mixing withholding with a residence-based principle

Gérard (2004) suggests to substitute taxing foreign income at residence, on the basis of a transmission of individualized information, with a system of income taxation at source. The tax rate should be decided by the country of residence and all collected revenues should be transferred anonymously to the country of residence. The rationale behind that proposition is that it fulfills the necessary conditions of the cross border enforcement of a Dual Income Tax (DIT), at least for the version of the DIT where capital income is taxed at a flat rate (Sorensen, 1994). This mechanism is also sufficient to enforce the Dutch Box 3 mechanism (Cnossen and Bovenberg, 2001).

In this last case, the program of the government is

$$\max_{t_h^h, t_f^h} W^h = r\left[t_h^h a_h^{h*} + t_f^h a_f^{h*}\right] \tag{1.19}$$

The first order condition with regard to t_h^h is the same as in a pure source-based scenario, while the second first order condition is now computed with regard to t_f^h instead of t_h^f. The two optimal tax rates correspond to (1.6), where t_h^f is replaced by t_f^h,

$$t_h^{h*} = \frac{2v}{3r}(1 + a_{0,h}^h), \quad t_f^{h*} = \frac{2v}{3r}(1 + a_{0,h}^f). \tag{1.20}$$

For an even distribution of the initial agents' portfolio allocation, neutrality of taxation can be obtained under this framework whenever governments decide that foreign income should be taxed at source but at the same rate as domestic income. Domestic and foreign tax rates become then identical and taxation no longer influences agents' investment decisions. Tax revenues reach the same level as in the pure-residence based scenario analyzed in section 1.4.2.

1.9 Summary and conclusion

In a framework of residence-based taxation or perfect exchange of information for all assets, the allocation of assets depends only on the initial allocation and return differentials. Any asset mobility due to taxation disappears. If the residence criterion applies to some assets only, tax rates levied on financial products for which the residence criterion holds are direct functions of the tax rates levied on products taxed according to a source criterion. Any change in these latter rates has consequences also for the tax rates of the assets following residence-based rules, meaning that governments can compete and distort the allocation of assets by choosing the tax rates levied on products not subject to the residence criterion. Also, if the quality of information exchanged between jurisdictions is limited, tax rates levied by partner countries play a role in the determination of domestic tax rates. As a result, only full exchange of information or a residence criterion applied to all products can avoid mobility of assets due to tax reasons and can increase government revenues. Extending the scope of the Directive, hence, is a way to restore the neutrality of taxation. Removing the limits of its application, the principle of residence would be valid for all kinds of assets paying interest rates.

Tax neutrality could be reached also thanks to a regime of withholding taxation, when the withholding tax rate is chosen by the residence country and all the collected revenues are transferred to that country of residence. In this case, it is sufficient that the withholding tax rate levied at source is set equal to the domestic tax rate. Defining efficiency as a situation where tax revenues are maximized and taxation does not distort the allocation of savings between assets and countries, only three regimes can lead to a situation of first best: 1) a pure residence-based setting; 2) a framework of perfect exchange of information concerning all substitutable assets - like in an extended version of the EU Directive - or strategies - like in the FATCA regulation; 3) a system of withholding taxation where withholding tax rates are decided by the residence country and the whole amount of withholding taxes is fully

transferred to that country.

Proposition VI: A regime of international saving taxation is efficient if it is based on the residence principle of taxation or on perfect information exchange for all substitutable assets and strategies or on a system of withholding taxation where the residence country can choose tax rates and receives all the withholding taxes collected abroad.

To conclude, this paper is motivated by the numerous innovations regarding the taxation of cross-border savings, which took place or are expected to take place in a near future on both sides of the Atlantic. On the European side, the principle of a Directive was decided in 2000 and has been enforced since mid-2005. However, it has many loopholes currently under examination. On the American side, the Qualified Intermediary status was proposed in 2003 to all banks across the world in order to make the US administration able to tax US taxpayers on the worldwide savings income. Given the loopholes of that mechanism, a new piece of legislation has been launched. This is known as FATCA and extends the application of the QI mechanism but remains characterized by the US getting information directly from foreign financial institutions, thus disregarding local governments. In February 2012, however, the US has issued a joint statement with the largest EU Member States for exploring a cooperative version of FATCA.

Against this background, we have developed a model comparing the respective merits of information exchange and levy of coordinated withholding taxes. Using that model we have contributed to address the following four issues. First, unlike the literature our model is based on, we show the effect of the various settings investigated not only on the taxation of foreign savings income, but also on the tax rates applied to domestic savings. Second, we consider agents as proper investors that can diversify their portfolio between countries as well as between different kinds of financial assets. Third, we explore the consequences of the loopholes in both the EU Savings Directive and the QI mechanism. The model sets forth that an equal treatment between all substitutable assets at home and abroad is required for any attempt to reach the efficient design depicted in the paper. By all substitutable assets we not only mean all substitutable products but also substitutable strategies to gain the return on those products. Fourth, we deal with the cost of information sharing, making a distinction between two situations. In the first, the country which needs the information also needs to acquire it and thus supports its costs, for example in terms of auditing financial institutions

across the world. This situation is characteristic of US QI and unilateral FATCA. In the second, each partner country is made responsible for the transmission of information regarding income paid to non-residents by its local banks or financial institutions. This alternative situation refers to the EU Savings Directive mechanism and to a cooperative version of FATCA.

We show that an efficient system of taxation allowing countries to tax individuals on their income could be achieved through an extension of the scope of the Directive and through a regime of perfect information exchange concerning all strategies and assets, like in the FATCA regulation. Moreover, we show that if accompanied by a residence-based choice of the withholding tax rate, a withholding tax setting constitutes an alternative efficient solution to the game. Indeed an alternative way to solve information sharing problems is to substitute taxing foreign income at residence with taxing that income at source, but at a rate decided by the country of residence and with all collected revenues transferred to the country of residence.

Finally, in the appendix, we also report the optimal tax rates that we obtain once country size, agents' wealth, and interest rates are no longer equal in both countries. Further research can concentrate on the quality of information and the dynamic aspects of the model. In this paper we have considered a static Nash game, whilst future work can investigate if the optimal solutions of a repeated Nash game differ from what shown in this paper. Moreover, the quality of information exchanged can be made an endogenous variable of the model depending, for example, on the size of the countries. Leaving aside the determination of the optimal domestic tax rates, such analysis can determine information exchanged as a function of the population of the two countries, showing that for smaller countries there is no incentive to participate in international agreements for exchanging information.

Chapter 2

Family Tax Policy in a Model with Endogenous Fertility à la Barro-Becker

This paper assesses quantitatively the effect of family fiscal policies on fertility, labour supply and parental childcare using a general equilibrium model with dynastic households. The model developed by Barro and Becker (1988) is modified through the introduction of time allocation decisions concerning labour, leisure and childcare. Simulations on US data show that, even being a macroeconomic model with endogenous fertility and altruistic agents, the model presented here can rationalize the low elasticity of fertility to family tax policies found in microeconometric studies.

2.1 Introduction

Over the last century, many countries have adopted pro-nativist fiscal policies either directly, giving families financial incentives related to the number of children, or indirectly, subsidizing childcare services. In both cases, as noted since Becker (1960), such policies should increase the demand for children, by reducing their cost in terms of goods or time.[1]

Empirical studies have generally found a positive but relatively small impact of tax incentives on fertility suggesting that, on average, families respond to such incentives, even if

[1]It should be noted that pro-nativist fiscal policies do not have an effect on voluntarily childless households, as this kind of households does not have a positive demand for children. This paper ignores voluntarily childless households because these families represent a small share of the population in the US and because a change in pro-nativist fiscal policies would be marginal with respect to their income (Gobbi, 2013; Baudin et al., 2015).

tax subsidies are not the main determinant underpinning fertility decisions. Whittington (1990) estimates the effect of the personal exemption for dependent children in the United States, using data from 1913 to 1984. Fertility is modelled as a function of both the personal exemption per dependent child and other economic and demographic variables. A marginal effect of the tax exemption is found on the fertility rate of US families. The value of this effect ranges between 0.121 and 0.236, suggesting that increasing by $100 the value of the personal exemption per dependent child increases the general fertility rate by 12 to 24 births per 1000 women. These results correspond to estimated elasticities of fertility with respect to the personal exemption ranging from 0.127 to 0.248. Crump et al. (2011) have revisited the analysis of Whittington (1990), extending the time dimension of the sample and addressing the concerns about possible spurious regression results. In their work, the elasticity of fertility with respect to a fiscal subsidy is lower, being equal to 0.077 - when the personal exemption per dependent child is the only measure taken into account - or 0.052 - when the personal exemption per dependent child is coupled with the child tax credit. Hence, Crump et al. (2011) estimate that increasing the value of the personal exemption per dependent child or the child tax credit by $100 increases the general fertility rate by 5 to 8 births per 1000 women; a result about three times smaller than what found by Whittington (1990).[2] As far as countries other than the US are concerned, the fertility response to fiscal subsidies remains positive but small. Gauthier and Hatzius (1997) find a benefit elasticity equal to 0.16 for family allowances across OECD countries, that is 16 additional births per $100 euro of additional family allowances. Milligan (2005) finds a value equal to 0.107 (11 births) calculating the elasticity of fertility for Quebecker families with respect to the allowance for newborn children benefits. Similarly, Cohen et al. (2013) exploit changes in Israel's child subsidy and identify a benefit elasticity equal to 0.192 (20 births), which is very close to the value 0.2 estimated by Laroque and Salanie (2008) for France.[3]

By contrast, within the theoretical literature, Cigno (1986) has first studied the link between fertility and fiscal policies. He argues that the trade-off between income and children may be more important than the one between income and leisure so that, once fertility is considered as a variable under household control, tax benefits can decrease child bearing costs and in-

[2]Crump (2011) does not explicitly report the value of the elasticities. However, these can be calculated on the basis of the regression coefficients reported in the paper and the fertility and fiscal subsidies time series used by the authors. The value of the elasticities reported in the text are calculated as the percentage change in fertility that a 1% increase in the tax benefit generates, taking average values for the fertility and subsidy time series as reference point.

[3]Other papers like Whittington (1992) and Whittington (1993) estimate the effect of tax subsidies on the probability of having a child. See Gauthier (2007) for a review of papers linking family tax policies and fertility in industrialized countries.

crease the number of children at the expense of their quality. Quantitative theoretical papers using the model developed in Becker and Barro (1988) and Barro and Becker (1989) go in the same direction, pointing out that fertility strongly responds to macroeconomic shocks. For instance, Greenwood et al. (2003) use a Barro-Becker model where they attribute a value equal to 1 to the elasticity of the altruism function with respect to the number of children. This leads them to argue that an increase in family size can be so large to counterbalance, and even to reverse, the welfare gains that child benefits should bring to families, as fertility turns out to be more than elastic to child benefits. In addition, Jones and Schoonbroodt (2010, 2016) have recently reproduced the US demographic transition over the last century and the baby boom and baby bust following the second world war. The quantitative analysis performed by Jones and Schoonbroodt (2016) shows that fertility is elastic with respect to aggregate shocks and, in particular, that the contemporaneous elasticity of fertility to productivity shocks lies between 1 and 1.7. Such large values of the elasticity are at odds with the empirical evidence reviewed above.

This paper aims to provide a model able to reproduce the elasticity of fertility to fiscal subsidies provided by the empirical literature. A general equilibrium overlapping generations model is set up so that adult households live for three periods and have altruistic preferences like in Becker and Barro (1988) and Barro and Becker (1989), the productive sector is represented by a neo-classical firm, and the public sector is made up by a government keeping its budget balanced. Households are assumed to be able not only to decide about consumption, savings, fertility and transfers to children as in the standard Barro-Becker framework, but also to optimize their time use in terms of work, leisure and childcare.

Furthermore, the elasticity of the households' fertility to tax subsidies is gauged through an exercise of indirect inference for calibrating the value of the altruism function elasticity characterizing the Barro-Becker model. Although Jones and Schoonbroodt (2016) assess the impact of a TFP rather than a fiscal shock on fertility, their work highlights the link between the value of the elasticity of the parental altruism function with respect to the number of children and the response of fertility to a macroeconomic shock. For the exercise of indirect inference, fertility changes following variations in the personal exemption per dependent child and in the child tax credit are simulated on the basis of the model built. US data for the period 1905-2005 are then used to match the fertility paths simulated through the model and the empirical estimates of the fertility response to fiscal subsidies provided by Crump et al. (2011).

The combined use of time allocation decisions in the standard Barro-Becker framework and indirect inference allows one to bridge the gap between the results of the empirical literature and the results of the theoretical literature. Indeed, time allocation decisions curb the fertility impulse response function of young households to a change in pro-nativist fiscal subsidies. At the same time, the calibration of the inter-temporal elasticities of substitutions of the households' utility function, including the one attached to fertility, allows the pinning down of the value of the theoretical impulse response function for fertility.

As a robustness check of the model built in this paper, it is also assessed how the balanced budget rule may affect the response of fertility to an increase in pro-nativist fiscal subsidies. As the tax rate increases in order to compensate for the rise in pro-nativist fiscal subsidies, the effect of these latter is smaller on the net income of young households, making an increase in fertility no longer compatible with an increase of households' consumption or time spent out of work. This result seems to suggest that a fertility policy has a substitution effect, due to the distortion of the relative price of an additional child, stronger than the income effect linked with the positive consequences of transfers or tax deductions on the budget of a household. Although this result calls for an analysis of the welfare implications of a fertility policy, such analysis is left aside because of the unsolved debate on the right welfare criterion to use in models with endogenous population (Baudin 2011, 2012).

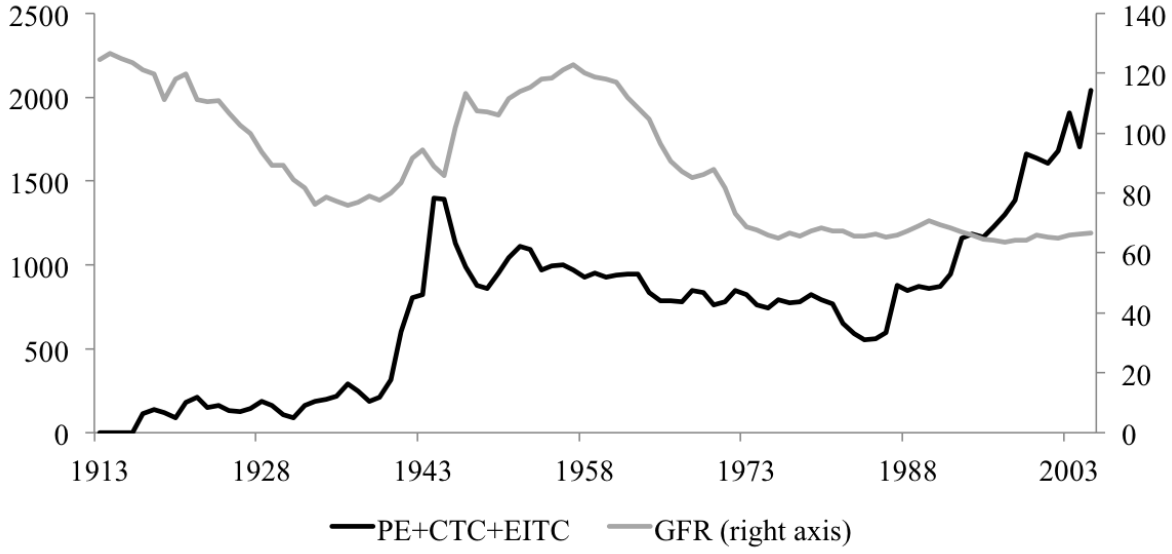
The structure of the paper is as follows. Section 2.2 briefly describes the main pro-nativist fiscal policies adopted in the US over the twentieth century. Section 2.3 develops the model underpinning the results in the rest of the paper. Section 2.4 provides the calibration for the parameters and variables of the model. Section 2.5 assesses the effects of different fiscal policies on fertility. Section 2.6 study the sensitivity of the fertility reaction function to a change in child subsidies with respect to some specific features of the model. Section 2.7 concludes. Appendix B.1 provides an alternative formulation of the Barro-Becker model.

2.2 Pro-nativist policies in the US

Over the last fifty years, many developed countries have adopted pro-nativist fiscal policies as a means to reverse declining birth rates. The World Population Policies Report of the United Nations offers a comprehensive review of the population policy situations for 200

countries (United Nations, 2013). In the US, in particular, there are three main types of pro-nativist fiscal benefits, namely the personal exemption per dependent child (PE), the childcare tax credit (CCTC) and the child tax credit (CTC). Figure 2.1 shows the evolution over the last century of their total value, measured in 2005 US dollars, and of the US general fertility rate, that is the total number of live births per 1000 women aged between 15 and 49 years.[4] As highlighted by Crump et al. (2011), this figure suggests that the correlation between the set of subsidies there considered and the general fertility rate is likely to be low, implying a low elasticity of fertility to pro-nativist fiscal policies.

Figure 2.1: Subsidy per child in 2005 US dollars and general fertility rate between 1917 and 2005.



Source: Crump (2011)

1. *Personal exemption for dependent child*: the exemption for dependents is an allowance that depends on the number of children had by an household. For this allowance, children must be less than 19 years old, or 24 years old if they are enrolled in a university as a full-time student. Since its introduction in 1917, this allowance has permitted to deduct from the gross income of the family a fixed amount per year per dependent person claimed. In nominal terms, the statutory value of the allowance increased from \$200 in 1917 to \$3'800 in 2012. The actual benefit granted on average to US households per each child, however, is the result of the product between the

[4]See the website of the Internal Revenue Service for more details, www.irs.gov.

marginal personal income tax rate, the real statutory value of the personal exemption and the number of children. This benefit increased from $112.91 in 1917 to $732.80 in 2012, with a peak of $1398.17 in 1944.

2. *Childcare tax credit*: introduced in the 1970s, the child and dependent care tax credit is a credit that working parents can claim against their tax bill, whenever they have paid childcare expenses in order to be able to work or look for work. The percentage of childcare expenditures that can be credited depends on the gross income earned by parents in the course of the year. For the year 2011, the credit rate varied between 20% for people earning $43'000 or more per year and increases up to 35% for families whose income is equal or lower than $15'000 per year.

3. *Child tax credit*: the child tax credit was introduced in 1997 by the Taxpayer Relief Act. Initially, families were given the possibility to credit $400 for each child younger than 17 against their federal income tax. This credit was extended already in 1999 and brought to $500, then to $600 by the Economic Growth and Tax Relief Reconciliation Act of 2001, and finally to $1'000 in 2003 by the Jobs Growth and Tax Relief Reconciliation Act. These increases, which were initially meant to be only temporary, were confirmed up to 2012 by the Tax Relief, Unemployment Insurance Reauthorization and Job Creation Act of 2010 and then made permanent by the American Taxpayer Relief Act of 2012 (Cordes et al., 2005). Differently from the personal exemption per dependent child, the actual benefit perceived by US households does not depend on the value of the marginal personal income tax rate, but only on the value of the credit in 2005 US dollars and the number of children.

4. *Others*: Other two tax subsidies may also influence family behaviour, namely the earned income tax credit, as its value also depends on the number of children had by an household, and tax-favored savings instruments that encourage families to save for sending their children to college. The ultimate goal of these two subsidies, however, is not purely linked to fertility. The former was introduced with the scope to increase income for families with very low earnings, while the value of this subsidy is not relevant for the average US taxpayer, being below $500 per family per year. It is hence a fiscal instrument targeted to fight poverty rather than low fertility. The latter, instead, relates to educational decisions and to the weight that parents attach to education in their preferences. However, the diffusion of instruments that encourage families to save for sending their children to college was rather contained within the time horizon studied in this paper, while it became more important under the Obama administration from 2009 onwards (College Savings Plans Network, 2016).

As this paper aims to isolate the effects of pro-nativist fiscal policies from other possible fiscal policies, only the first three fiscal policies described in this section have been considered in what follows.

2.3 Model

2.3.1 Households

As stated in the introduction, the aim of the paper is to have a theoretical paper based on the framework developed by Becker and Barro (1988) and Barro and Becker (1989), which can be calibrated in order to produce quantitatively sounding results for the pro-nativist policies considered. In Becker and Barro (1988) and Barro and Becker (1989), the authors assume that households are altruistic and derive utility from the utility of their descendants. Following this assumption, the utility of an agent can be written as

$$U_t = V_t + \beta\phi n_t^{1-\epsilon} U_{t+1}, \tag{2.1}$$

where U_t is the utility at period t of an household, composed by her life-time utility V_t and the utility of her descendants U_{t+1}. The number of descendants is indicated with n_t, β is the time discount factor, while ϕ is a parameter capturing the degree of parental altruism. As in the original framework proposed by Becker and Barro (1988) and Barro and Becker (1989), we assume that the altruism function $g(n) = \phi n_t^{1-\epsilon}$ is the same for all children and characterized by a constant elasticity with respect to the number of children. This implies that the parental utility is increasing and concave in the number of children, for a given level of the utility per child. In other words we assume that, choosing a function $g(n)$ that is increasing and concave in the utility of each child, the utility of the parents is attained when all children reach the same level of utility.[5]

Replacing the expression for the utility of the agents' descendants, $U_{1,t+1}$, and iterating this

[5] Alternative formulations for the altruism function have been proposed by Cordoba and Ripoll (2012).

substitution up to time T, equation (2.1) can be transformed as follows:

$$\begin{aligned} U_t &= V_t + \beta\phi n_t^{1-\epsilon}[V_{t+1} + \beta\phi n_{t+1}^{1-\epsilon} U_{t+2}] \\ &= V_{1,t} + \beta\phi n_t^{1-\epsilon} V_{t+1} + (\beta\phi)^2 (n_t n_{t+1})^{1-\epsilon}[V_{t+2} + \beta\phi n_{t+2}^{1-\epsilon} U_{t+3}] \\ &= \ldots \\ &= \sum_{s=t}^{T-1} (\beta\phi)^s \left(\prod_{s=t}^{T-1} n_{s-1}^{1-\epsilon} \right) V_s + (\beta\phi)^T \left(\prod_{s=t}^{T} n_{s-1}^{1-\epsilon} \right) V_T. \end{aligned}$$

In addition, indicating with N the number of adult households living in each period t, the following laws of motion for population can be retrieved,

$$\begin{aligned} N_{t+1} &= n_t N_t, \\ N_0 &= 1, \end{aligned}$$

so that $N_t = \prod_{s=-1}^{t-1} n_s$ and the utility at time $t = 0$ of the head of a dynasty becomes:

$$U_0 = \sum_{t=0}^{T-1} (\beta\phi)^t N_t^{1-\epsilon} V_t + (\beta\phi)^T N_T^{1-\epsilon} V_T. \tag{2.2}$$

If the transversality condition $\lim_{T\to\infty} (\beta\phi)^T N_T^{1-\epsilon} V_T = 0$ is satisfied, then (2.2) simplifies as

$$U_0 = \sum_{t=0}^{\infty} (\beta\phi)^t N_t^{1-\epsilon} V_t.$$

This transversality condition requires that the present value of future generations' utility converges to zero as time goes to infinity. It should be noted that this transversality condition does not imply that no children will be born as time goes to infinity. Rather, it implies that the head of a dynasty attributes a smaller weight to the future generations that are more distant in time.

We assume that adult agents live for three periods $a = \{1, 2, 3\}$, with a probability to survive to the next period of life equal to 1 for all periods. When young ($a = 1$) agents decide how much to consume, save and enjoy leisure. At the same time, they decide how many children to have and how much time to spend with them, other than how much to leave them as inter-generational transfers. When agents become middle-aged ($a = 2$), they keep choosing their consumption, savings and leisure. However, they no longer take decisions regarding their children as these latter have become independent young adults. When old ($a = 3$), agents only consume what saved in the previous period of their life. Moreover, agents are

considered as homogeneous in their choice, implying that the case of stay home parents is excluded by definition from the present framework. So the life-cycle utility of parents can be written as

$$V_t = \sum_{a=1}^{3} \beta^{a-1} \Big\{ u_c(c_{a,t+a-1}) + \zeta u_{ld}(l_{a,t+a-1}, d_{a,t+a-1}) + A \Big\},$$

where $c_{a,t+a-1}$ indicates the level of consumption of an adult for each period of its adult life. Other than consuming, adults can either work or enjoy leisure or spend time with their children. Thus $l_{a,t+a-1}$ and $d_{a,t+a-1}$ are respectively the time that adults devote to leisure and the time they spent with their children. The parameter ζ represents the relative weight associated to time variables in the life-time utility of an adult and A is a constant we use to pin down the marginal benefit of an additional descendant in the quantitative exercise of the next section.

As explicit formulation for the utility functions of consumption and time, a standard CRRA function is adopted for the utility of parents. For simplicity, it is assumed that agents can have children only the first period of their adult life and, consequently, that they can spend time with their children only when their age is $a = 1$. Moreover, as adults with children share their non-working time between leisure and activities with children, it is also assumed that leisure and time with children are not perfect substitutes. Their elasticity of substitution is indicated with the parameter ρ, which takes value 0 if $a \neq 1$. Setting $l_{3,t+2} = 1$, the utility of the head of the dynasty at $t = 0$ can be re-written as

$$U_0 = \sum_{t=0}^{\infty} (\beta\phi)^t N_t^{1-\epsilon} \Big\{ \frac{c_{1,t}^{1-\sigma}}{1-\sigma} + \zeta \frac{(l_{1,t} d_{1,t}^{\rho})^{1-\psi}}{1-\psi} + \beta \left(\frac{c_{2,t+1}^{1-\sigma}}{1-\sigma} + \zeta \frac{l_{2,t+1}^{1-\psi}}{1-\psi} \right) + \beta^2 \frac{c_{3,t+2}^{1-\sigma}}{1-\sigma} + A \Big\}.$$

where σ is the inverse of the inter-temporal elasticity of substitution for consumption and ψ is the inverse of the Frisch elasticity for leisure.

Both budget and time equations constraint the maximisation problem faced by the head of a dynasty in each period of time t. Notably, the budget constraint for a young household at age $a = 1$ is equal to

$$c_{1,t} + s_{1,t} + (1 - \xi_t)(1 - d_{1,t})\pi_t n_t + q_{t+1} n_t = h_{1,t} w_t - \left[(h_{1,t} w_t - \chi_t n_t) \tau_t - \omega_t n_t \right] + R_t q_t,$$

where s indicates savings, π is the childcare cost that young households have to pay when

they cannot personally take care of their children (in order to work or to enjoy leisure), q is the inter-generational transfer, χ is the personal exemption for dependent child that intervenes in the tax bill of the household before the imputation of the tax rate τ, ξ is the childcare tax credit reducing the cost of childcare, while ω is the child tax credit that is not influenced by the tax rate. w and R are the prices regulating the labor and capital markets of the economy, that is wage and the gross interest rate. The time that a young adult devotes to work is indicated by $h_{1,t}$, which is given by the following time constraint where the total amount at disposal of agent is standardized to 1 for each period of the life:

$$h_{1,t} = 1 - l_{1,t} - d_{1,t}.$$

In the next period of life, the budget constraint for middle-aged households is

$$c_{2,t+1} + s_{2,t+1} = h_{2,t+1} w_{t+1}(1 - \tau_{t+1}) + R_{t+1} s_{1,t},$$

where the time spent at work is given by

$$h_{2,t+1} = 1 - l_{2,t+1}.$$

In the last period of their life, households live out of their savings so that the budget constraint for old agents is

$$c_{3,t+2} = R_{t+2} s_{2,t+1}.$$

Solving the optimization problem of the head of dynasty at time $t = 0$, we obtain two Euler conditions: one regulating the choice between present and future consumption for young adults,

$$c_{1,t}^{\sigma} = \frac{c_{2,t+1}^{\sigma}}{\beta R_{t+1}},$$

and one regulating the same choice for middle-aged adults,

$$c_{2,t+1}^{\sigma} = \frac{c_{3,t+2}^{\sigma}}{\beta R_{t+2}}.$$

Moreover, two conditions regulate the decisions of young adults in terms of leisure and childcare,

$$\zeta l_{1,t}^{-\psi} d_{1,t}^{\rho(1-\psi)} = \tilde{\lambda}_t w_t (1 - \tau_t), \qquad \zeta \rho l_{1,t}^{1-\psi} d_{1,t}^{\rho(1-\psi)-1} = \tilde{\lambda}_t \left[w_t (1 - \tau_t) - (1 - \xi_t) \pi_t n_t \right].$$

In both conditions, $\tilde{\lambda}_t = N_t^{-\epsilon} c_{1,t}^{-\sigma}$ is the Lagrangian multiplier representing the shadow value for consumption. Moreover, the marginal benefit of the share of leisure and parental childcare can be found on the left-hand side of the two equations, while their marginal cost can be found on the right-hand side. It should be noted that fiscal variables intervene only in the right-hand side of the two conditions, with the tax rate of labour income decreasing the marginal cost of both leisure and parental childcare while the tax credit to decrease the cost of childcare services (ξ) increases the marginal cost of the time that parents spend with their children.

Only one condition determines the share of leisure enjoyed by middle-aged households,

$$\beta\zeta l_{2,t+1}^{-\psi} = \tilde{\lambda}_t \frac{w_{t+1}(1-\tau_{t+1})}{R_{t+1}}.$$

As for young households, the left-hand side of the equation represents the marginal benefit of an additional unit of leisure for middle-aged households, while the right-hand side captures the marginal cost of the latter. Both the marginal cost and the marginal benefit are discounted of one period, in order to have their present value.

Finally, two final conditions regulate the household's decision concerning inter-generational transfers and number of children. As for inter-generational transfers, the first order condition requires that the shadow value of today's consumption ($\tilde{\lambda}_t$) for each child (n_t) equalizes the present value of the shadow value of consumption one period ahead weighted by the altruism function ($g(n) = \phi n_t^{1-\epsilon}$),

$$\beta\phi n_t^{1-\epsilon} \tilde{\lambda}_{t+1} R_{t+1} = n_t \tilde{\lambda}_t.$$

As for the number of children, instead, the first order condition underpinning fertility decisions of households requires them to compare the marginal benefits and the marginal costs of having an additional child,

$$\begin{aligned}
&\beta\phi n_t^{-\epsilon} \left[(1-\epsilon) V_{t+1} + \tilde{\lambda}_{t+1} \left(h_{1,t+1} w_{t+1} (1-\tau_{t+1}) + \frac{h_{2,t+2} w_{t+2} (1-\tau_{t+2})}{R_{t+2}} \right) \right] \\
&= \tilde{\lambda}_t \left[(1-\xi_t)(1-d_{1,t})\pi_t - \chi_t \tau_t - \omega_t \right] + \beta\phi n_t^{-\epsilon} \tilde{\lambda}_{t+1} \left(c_{1,t+1} + \frac{c_{2,t+2}}{R_{t+1}} + \frac{c_{3,t+3}}{R_{t+1} R_{t+2}} \right).
\end{aligned}$$

The marginal benefit (left-hand-side of the equation) is constituted by the marginal utility and the future labour income of a child. The marginal cost is made up by the sum of the childcare cost that parents have to pay when they do not spend time with their children,

minus the fiscal subsidy that parents receive per child, and the additional descendant's future consumption.

2.3.2 Firms

A representative productive firm maximizes its profits choosing the quantity of labor to use in its production process, that is

$$\max_{L_t} \Pi_t = F(K_t, L_t) - w_t L_t - r_t K_t,$$

where w_t is the wage rate, while K_t and L_t are respectively the stock of capital and labor at the beginning of period t. The labor demand associated to (2.3.2) can be retrieved from the first order condition of this latter, which states that the marginal productivity of labor equals the wage rate

$$F'_L(K_t, L_t) = w_t.$$

We assume a Cobb-Douglas production function, $F(K_t, L_t) = z_t K_t^{\alpha} L_t^{1-\alpha}$, so that the wage rate is equal to

$$w_t = z_t(1-\alpha)k^{\alpha}.$$

where $k = \frac{K_t}{L_t}$ represents capital per worker and z_t is the total factor productivity.

The real interest rate r_t is equal to the marginal productivity of capital, that is

$$r_t = F'_K(K_t, L_t) = z_t \alpha k^{\alpha-1}.$$

The return on capital can be instead indicated as $R_t = r_t + (1-\delta)$, so to take into account that part of the existing stock of capital depreciates in each period and needs to be rebuilt via investments

$$I_t = K_{t+1} - (1-\delta)K_t.$$

At equilibrium, the clearing conditions for the capital and labor market require

$$K_{t+1} = s_{1,t}N_t + s_{2,t}N_{t-1} + q_{t+1}N_{t+1}, \qquad L_t = h_{1,t}N_t + h_{2,t}N_{t-1}.$$

In particular, according to the clearing condition for the capital market, today's savings equalize today's gross investment, above defined as the sum of the net investment and the investment necessary for replacing the capital depreciating in that period. The clearing

condition for the labour market, instead, requires that the demand for labour is equal to the supply of labour. It also highlights the perfect substitutability between the number of hours supplied by young and middle-aged households. This assumption is implicitly contained in the firm's problem and implies the independence of labour productivity from age considerations.

2.3.3 Government

The budget constraint of the government is

$$G_t = \left[\left(h_{1,t}w_t - \chi_t n_t\right)\tau_t - \omega_t n_t - \xi_t(1-d_{1,t})\pi_t n_t\right] N_t + h_{2,t}w_t\tau_t N_{t-1},$$

where G_t represents a fixed amount of unproductive public spending. In order to have a balanced budget at any point in time, the government is assumed to adjust the tax rate on labour income τ_t. For sake of simplicity, only taxation of labour income has been considered in this work as necessary for modelling some of the pro-nativist fiscal subsidies at stake. No taxation on capital or on consumption has been instead introduced in the budget constraint of the government as not essential to the functioning of the model.

An exception to this general equilibrium rule is made in the following section, where we calibrate the parameters of the model. Indeed, the indirect inference exercise that we use for the calibration of the model requires to work in a partial equilibrium environment, keeping constant the level of the tax rate τ_t. In Section 2.4, as a result, an increase in pro-nativist fiscal subsidies is supposed not to be compensated for by an increase in the tax rate of the government. In Section 2.6.2, by contrast, the effects of the same increase in pro-nativist fiscal subsidies are studied assuming that the balanced budget rule holds.

2.4 Calibration

The model described in Section 2.3 is calibrated at steady state, using 2005 data. In what follows, first, the requirements that any possible calibration should meet are reviewed, given the characteristics of the model. Then, the calibration of the four different categories of parameters contained in the model is described.

2.4.1 Requirements to be met by calibration

Given the characteristics of the model, any acceptable calibration must fulfill some preliminary conditions. First, utility must be increasing and concave in all arguments. Second, the utility of the dynastic head in (2.1) must satisfy the d'Alambert criterion for the convergence of a series, that is

$$\lim_{t\to\infty} \frac{(\beta\phi)^{t+1} N_{t+1}^{1-\epsilon} V_{t+1}}{(\beta\phi)^{t} N_{t}^{1-\epsilon} V_{t}} < 1,$$

which implies that at steady state

$$\beta\phi n_{ss}^{1-\epsilon} < 1.$$

Third, if households are altruistic, for a given number of children, an increase in the utility of children must increase the utility of the parents,

$$\beta\phi n_{ss}^{1-\epsilon} > 0.$$

Fourth, if parents like having children, increasing the number of children must increase the utility of parents, for any given level of the life-cycle utility that descendants will have. Using the utility of the dynastic head, this last condition requires that

$$\frac{\partial U_0}{\partial N_t}\,|_{N_t V_t} = \left(\frac{\sigma-\epsilon}{1-\sigma}\right)\left[c_{1,t}^{1-\sigma} + \beta c_{2,t+1}^{1-\sigma} + \beta^2 c_{3,t+2}^{1-\sigma}\right] + \zeta\left(\frac{\psi-\epsilon}{1-\psi}\right)\left[\left(l_{1,t} d_{1,t}^{\rho}\right)^{1-\psi} + \beta\left(l_{2,t+1}\right)^{1-\psi}\right] - \epsilon A > 0.$$

In accordance with the first requirement, also the increase in the benefit of having more people in a generation must be subject to diminishing returns. Contrarily to Jones and Schoonbroodt (2010, 2016), the introduction of a constant in the life-cycle utility function, A, allows to relax some of the requirements to be fulfilled by ϵ for given values of σ and ψ, while respecting this fourth requirement. Indeed, for values of σ and ψ larger than 1, ϵ no longer needs to be larger than σ and ψ and, for values of σ and ψ smaller than 1, ϵ no longer needs to be smaller than σ and ψ, as long as increasing the number of children increases the utility of the dynastic head for any given level of the children life-cycle utility. Hence, the introduction of a constant in the life-cycle utility function, A, allows to have the necessary room for manoeuvre to calibrate the value of ϵ by indirect inference, while keeping constant the values of σ and ψ.

2.4.2 Parameters set according to the literature

Concerning the calibration of the parameters taken from the literature, the inverse of the Frisch elasticity for the time that adult households spend out of work (ψ) is calibrated in

line with the existing literature. It is set equal to 2 in order to have a corresponding Frisch elasticity equal to $\frac{1}{2}$. Non-worked hours turn out to be relatively inelastic to variations in the wage rate, given a constant marginal utility of wealth. Similarly, the inter-temporal elasticity of substitution (IES) is fixed in line with existing literature. As starting point, we set the inverse of the IES (σ) equal to 1 so that adult households derive a logarithmic utility from consumption. A robustness check of these assumptions is then performed before the conclusion of the paper (see Section 2.6). As the range of values accepted by the literature for these two parameters is quite large - from 0.5 to 1.5 for σ and from 0.5 to 2 for ψ -, the robustness check of Section 2.6 allows verifying how a change in the assumed value of σ and ψ modifies the reaction of fertility to a pro-nativist fiscal shock.

2.4.3 Parameters set on the basis of macroeconomic data

As regards exogenous variables, Table 2.1 summarizes the imputed values. Internal Revenue Service data are used to set the variables representing fiscal subsidies. In particular, the personal exemption per dependent child, χ, is fixed to \$64000 as the yearly value of the exemption in 2005 was equal to \$3200 per child and the length of a generation we use in the model is 20 years. The value of the child tax credit, ω, corresponds to that received by an household having the average level of income in 2005, that is \$1000 per year for each child of the household. The childcare tax credit rate, ξ, is set at 20% as in 2005 the average income per worker fell in the last gross income bracket of the child tax credit scheme. The childcare cost π is set equal to \$190.98 thousand for the whole period of 20 years when children are assumed to be dependent from their parents, following the statistics reported by the US Department of Agriculture (2005). This cost corresponds to an annual cost of \$9549 and implies that, children being a net financial cost to parents, maximum fertility does not represent an optimal choice for parents. The value of government public expenditure is chosen using national accounts data. Out of the total public expenditure, only the part used as military spending has been selected. Indeed, this latter can be considered as unproductive public spending, thus allowing to abstract from the possible link between public spending and firms' production. The ratio between military spending and the reconstructed GDP (see Section 2.4.4) amounted to 5.10% in 2005.

2.4.4 Parameters exactly identified with empirical moments

Table 2.2 summarizes the parameters that are exactly identified by matching a series of empirical moments. The first moment matched is the real interest rate. The average of the

Table 2.1: Value of exogenous variables, 2005

Variable	Value (yearly)
Personal exemption	$\chi = \$\,3200$
Child tax credit	$\omega = \$\,1000$
Childcare tax credit	$\xi = 20\%$
Child cost	$\pi = \$\,9549$
Military spending/GDP	$\frac{G}{Y} = 5.10\%$

yearly interest rate on 20-years treasury bonds is calculated on the basis of 2005 monthly data. The value thus obtained, 4.65%, is used to set the time discount factor β equal to 0.8776. Gross fixed investments as percentage of GDP are used to pin down the value of the depreciation rate. Using national accounts, the values of consumption, investments and military spending is summed up, in order to reconstruct a value for the GDP that can fit into the notion of domestic production used in the model of section 2.3. The investment to GDP ratio obtained is 21.19%, corresponding to $\delta = 0.7924$. As standard practice for the calibration of macroeconomic models, the capital to GDP ratio and the productivity per worker from the Penn World Tables are used to attribute a value to the two parameters of the production function. Respectively, the capital share α is set equal to $\frac{1}{3}$ and the total factor productivity constant $z = 2.3127$.

Turning to the utility function, the relative weight of time spent out of work, ζ, and the share of total time young households spend with their children relative to that spent as leisure, ρ, are defined using American Time Use data. The average time that young adults spend enjoying leisure and taking care of children is calculated selecting individuals aged between 20 and 40 years having a child at least. Young adults spent on average 57.88% of their time in working related activities, 35.67% enjoying leisure and the remaining 6.45% taking care of their children. On the basis of these results, ζ is set equal to 0.2697 and $\rho = 0.1478$. The altruism factor ϕ is paired off with inter-generational transfers, using data coming from Gale and Scholz (1994). On the basis of the 1986 Survey of Consumer Finances (SCF), they report inter-generational transfers to be equal to 0.32% of total wealth and 2.84% of average income. This coincides with a value of ϕ equivalent to 0.9680. The constant of the life-cycle utility function, A, is calibrated to have the number of children in the model corresponding,

at steady state, to a yearly fertility rate of 0.007 as in Jones and Schoonbroodt (2016). To take into account the generation length, n is set equal to 1.1497 and thus $A = -26473.1315$. In turn, the introduction of the shifter A in the utility function of the households presents a double advantage. First, as mentioned earlier, it gives more flexibility in calibrating ϵ. Second, it allows one to have a parameter to pinpoint the level of the fertility rate n. Otherwise, the value of n should have been calibrated with the elasticity ϵ, forcing the model to match the level of an endogenous variable with the elasticity representing the reaction of the same variable to an exogenous shock.

Table 2.2: Matching parameters and matched moments, 2005

Matching parameter	Value	Matched Moment	Value (yearly)
Discount factor	$\beta = 0.8776$	20-years interest rate	$r = 4.65\%$
Depreciation rate	$\delta = 0.7924$	Investment-GDP ratio	$\frac{I}{Y} = 21.19\%$
Capital share	$\alpha = 1/3$	Capital share of labor	$w\frac{L}{Y} = 2/3$
TFP constant	$z = 2.3127$	Production per worker	$y = \$\,83400$
Utility relative weight	$\zeta = 0.2697$	Leisure	$l_1 = 35.67\%$
Leisure-childcare ratio	$\rho = 0.1478$	Time spent with children	$d_1 = 6.45\%$
Altruism factor	$\phi = 0.9680$	Transfers-income ratio	$\frac{qn}{h_1 w} = 2.84\%$
Utility constant	$A = -26473.1315$	Number of children	$n = 0.007$

2.4.5 Parameters calibrated by indirect inference

The elasticity of the altruism function with respect to the number of children, ϵ, is calibrated through indirect inference in order to match the effect of fiscal policies on fertility over the period 1905-2005. The empirical results taken as benchmark are those shown in Crump (2011). Indeed, as ϵ is an inter-temporal elasticity capturing changes in fertility taking place over time, it cannot be identified by simply matching it with the value of an empirical moment at a given point in time. In turn, the exercise of indirect inference allows simulating how fertility changes over time, taking into account different TFP paths and controlling for the time series of the pro-nativist fiscal policies at stake.

Table 2.3: Indirect inference results

	Empirical moments	Simulated moments	Value of ϵ
OLS, 1 moment	$\eta_{OLS} = 0.0774$	$\hat{\eta}_{OLS} = 0.0775$	$\epsilon = 1.77$
OLS, 2 moments	$\eta_{OLS} = 0.0774$ $\widetilde{\eta}_{OLS} = 0.0520$	$\hat{\eta}_{OLS} = 0.0582$ $\hat{\widetilde{\eta}}_{OLS} = 0.0143$	$\epsilon = 2.59$
ADL, 1 moment	$\eta_{ADL} = 0.0340$	$\hat{\eta}_{ADL} = 0.0416$	$\epsilon = 2.24$
ADL, 2 moments	$\eta_{ADL} = 0.0340$ $\widetilde{\eta}_{ADL} = 0.0241$	$\hat{\eta}_{ADL} = 0.0421$ $\hat{\widetilde{\eta}}_{ADL} = 0.1447$	$\epsilon = 1.69$

This exercise of indirect inference is performed varying both regression method, as in Crump et al. (2011), and number of moments, j. In all settings, the same objective function is minimized,

$$\min_{\mu} \sum_{j=\{1,2\}} Q_j(\mu, m) = \sum_{j} \nu_j(\mu_j - m_j)^2,$$

where Q is a quadratic function of the weighted distance between μ and m. μ is the vector of coefficients obtained from the empirical analysis performed by Crump et al. (2011). m is the vector of coefficients obtained thanks to the auxiliary model, which we use to run the same regressions as in Crump et al. (2011), but with simulated data. The inverse of the standard errors attached to the coefficients of the auxiliary model are used as weights ν_j.

The regressions run are as follows. First, an auto-regressive model of first order (AR1) is used to generate 100 TFP paths ($z_t = z_{t-1} + \kappa_t$, with $\kappa \sim wn(0,1)$) over the period 1905-2005. The coefficients of the AR1 model are calculated from the actual TFP data constructed by Chari et al. (2007) and the TFP paths are centered on the 2005 TFP data used for calibrating the production per worker (y). Then, in terms of the auxiliary model, in the simplest case, ordinary least squares method (OLS) are used to estimate the impact of the personal exemption per dependent child only on fertility. In particular, the general fertility rate of young adults constructed from simulated data, $GFR_t = 2 * n_t * \frac{20}{80} * 1000$, is regressed on the level of the personal exemption per dependent child, $PE_t = \tau_t \chi_t$, and the level of TFP, z_t:

$$GRF_t = \beta_0 + \beta_1 PE_t + \beta_2 z_t + \upsilon_t,$$

where the presence of υ_t derives from the uncertainty linked to the generation of the TFP random paths in the auxiliary model.

The moment matched by indirect inference is the elasticity obtained on the basis of the coefficient β_1, that is $\eta = \beta_1 \frac{\bar{PE}}{\bar{GFR}}$, where $\bar{PE} = \tau\bar{\chi}$ is the average value of the personal exemption per dependent child and $\bar{GFR} = 2 * \bar{n} * \frac{20}{80} * 1000$ is the average level of the general fertility rate over the period 1905-2005. Note that the value of the tax rate is considered to be constant because, as explained in Section 2.3.3, the government is assumed not to adjust the tax rate in order to compensate for increasing pro-nativist fiscal subsidies. This assumption is necessary when performing the exercise of indirect inference, as it allows one to have only exogenous variables on the right-hand side of the equation constituting the auxiliary model.

When more than one moment is used to identify ϵ, the regression of the auxiliary model changes as follows:

$$GRF_t = \widetilde{\beta}_0 + \widetilde{\beta}_1(PE_t + CTC_t) + \widetilde{\beta}_2 z_t + \widetilde{\upsilon}_t,$$

where $CTC_t = \omega_t$ is the amount of child tax credit received per child by the households with dependent children. The two moments that we use for evaluating the objective functions are then the two elasticities, η_{OLS} and $\widetilde{\eta}_{OLS}$, calculated respectively using β_1 and $\widetilde{\beta}_1$.[6]

As alternative setting, an auto-regressive distributive lag (ADL) regression model is run as in Crump et al. (2011). The two OLS regressions described above are replaced by the following regressions, containing the lag of both endogenous and exogenous variables:

$$\begin{aligned} GRF_t &= \beta_0 + \beta_1 PE_t + \beta_2 z_t + \beta_3 GRF_{t-1} + \beta_4 PE_{t-1} + \beta_5 z_{t-1} + \upsilon_t, \\ GRF_t &= \widetilde{\beta}_0 + \widetilde{\beta}_1(PE_t + CTC_t) + \widetilde{\beta}_2 z_t + \widetilde{\beta}_3 GRF_{t-1} + \widetilde{\beta}_4(PE_{t-1} + CTC_{t-1}) + \widetilde{\beta}_5 z_{t-1} + \upsilon_t. \end{aligned}$$

The two coefficients β_1 and $\widetilde{\beta}_1$ are then transformed in the two corresponding elasticities, η_{ADL} and $\widetilde{\eta}_{ADL}$, to be respectively matched with the values provided in Crump et al. (2011).

Table 2.3 reports the results obtained in the different settings described above. Across all settings, the value of ϵ is always larger than 1 and ranges between 1.69 and 2.59. Moreover, the OLS method generates a lower value of the distance function when using two moments, instead of only one, in the exercise of indirect inference. In this case, a value of ϵ equal to

[6] We compare elasticities rather than the regression coefficients in order to avoid possible issues related to different scales used for simulated and empirical data.

2.59 minimizes the distance between the vector of coefficients obtained from the empirical analysis performed by Crump et al. (2011) and the vector of simulated coefficients obtained from the auxiliary model. Henceforth, this value of ϵ is used as reference for the policy experiments contained in the next session of the paper.

2.5 Policy experiments

This section describes the results of two different policy experiments. In both cases the policy shock in question is considered to be permanent. However, the first policy experiment allows one to assess the effects of an increase in the personal exemption per dependent child, the childcare tax credit and the child tax credit. The second policy experiment aims to evaluate the outcome of changing the current allocation of public spending among the three subsidies, concentrating all resources in only one of them.

In the first policy experiment, the value of each subsidy is raised by the same amount, corresponding to 1% of the initial amount of GDP per worker. All the subsidies increase fertility in the first period following the increase in their value, because they decrease the relative cost of having a child (see Figure 2.2). Transforming the results in terms of general fertility rate, increasing the personal exemption per dependent child or the child tax credit by $100 increases fertility by 5.93 children per 1000 women in the period following the policy shock, in line with the results of Crump et al. (2011) where the same increase in the personal exemption per dependent child is found to increase fertility by 5.2 children if alone and by 7.7 children if coupled with an equivalent increase in the child tax credit.

The personal exemption per dependent child and the child tax credit have the same effect on fertility because the government does not vary the value of the tax rate to keep the budget balanced in each period of time, as it has been assumed for the indirect inference exercise in Section 2.4. Indeed, due to the way in which the two subsidies are imputed in the tax bill of the households, the impact of a change in the exemption per dependent child can be distinguished from that of a change in the child tax credit only if the tax rate is left free to adjust for balancing the budget (see below, Section 2.6.2). Moreover, the effect of the childcare tax credit turns out to be slightly stronger, increasing fertility by 5.96 children per 1000 women. The difference in the effect of the subsidies on fertility is due to the fact that the childcare tax credit, decreasing the cost of external childcare services for young adults

with children, allows such households to have a higher fertility rate while having to give up on a smaller share of their time spent at work (see Figure 2.3).

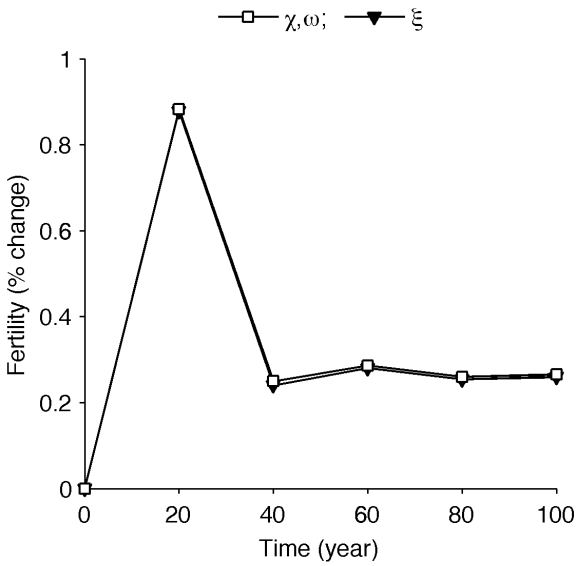


Figure 2.2: Fertility impulse reaction function to different pro-nativist fiscal incentives

As far as the other variables are concerned, all subsidies produce a positive income effect for agents that translate not only into higher fertility, but also into lower working hours and hence in favour of leisure and time spent with children. The change in the allocation of time by young households influences middle-aged households, who also decrease the amount of time they dedicate to work for enjoying more leisure from one period after the shock onwards (Figure 2.5). However, the initial positive effect of pro-nativist fiscal policies on both fertility and time spent out of work is, respectively, reverted or reduced when prices begin reacting to the variation of subsidies (Figure 2.4). Indeed, the effective labor force decreases due to the decrease in the working hours of young and middle-aged households, which overcompensates the increase in the active population caused by the higher fertility rate. The ratio between capital and the effective labor force, k_t, increases leading to an increase in the wage rate and a decrease in the interest rate. In turn, the increase in the wage rate causes an increase in working hours for young adults, compensated by a decrease in leisure, time spent with children and fertility, while a similar increase in working hours and a decrease in the share of time dedicated to leisure takes place for middle-aged households in the next period.

The just mentioned changes in the allocation of time, following the increase of pro-nativist

fiscal subsidies, revert the predictions of the Barro-Becker original framework where no time allocation decision is considered. Indeed, in the original Barro-Becker framework, an increase in a pro-nativist fiscal subsidy would strongly increase fertility and consumption for all young, middle-aged and old households. Contrarily to when time decisions can adjust in response to a change in fiscal subsidies, the ratio between capital and effective labor would decrease starting one period after the fiscal shock, due to an increase in fertility no longer compensated by a decrease in working hours. Households would then raise their savings and so diminish their consumption, under the influence of an increasing interest rate, while the wage rate would decrease, led by the increase in the labour force due to the higher level of fertility. As a result, if the time allocation of households was given, wage and interest rate dynamics would have reinforced the initial effect of pro-nativist fiscal subsidies on fertility.

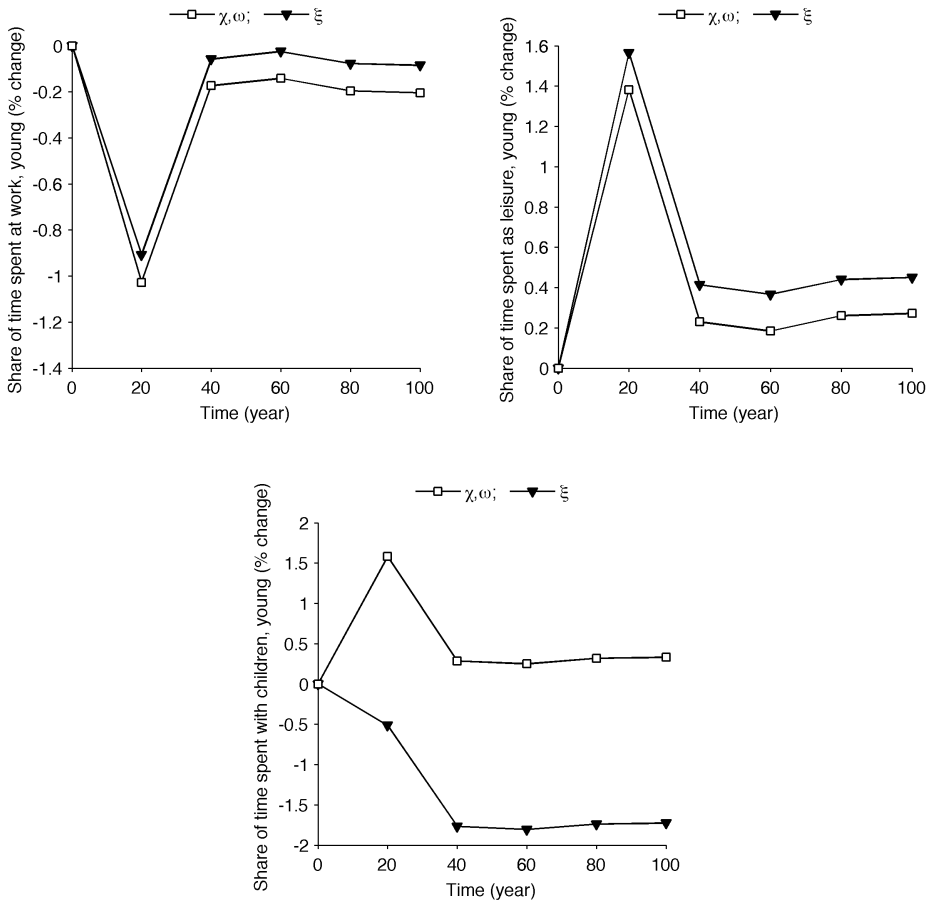


Figure 2.3: Effects of different pro-nativist fiscal incentives on the time allocation of young households

Turning to the interest rate, its decrease affects the savings decisions of all households and

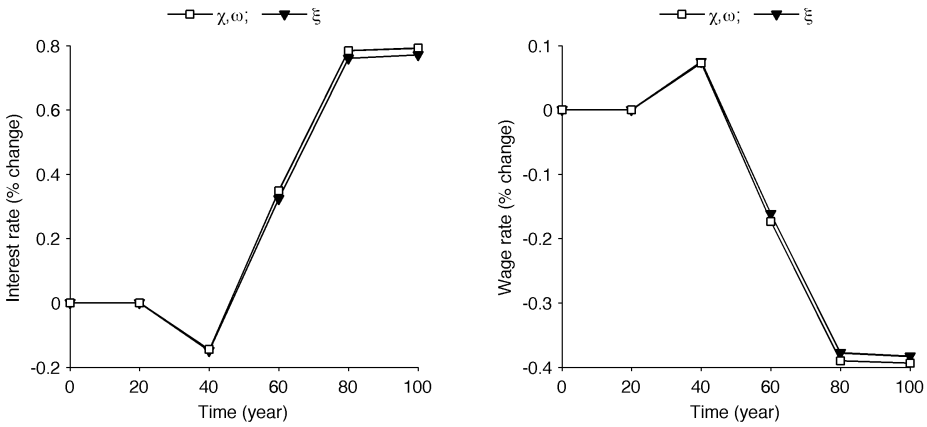


Figure 2.4: Effects of different pro-nativist fiscal incentives on the interest and wage rate

the inter-vivos transfer decisions of young adults. The decrease of the interest rate, in turn, decreases the return from savings and the inter-generational transfers, leading households to increase their present consumption and save a larger portion of their income either for their own future consumption or for the consumption of the following generation. Lower savings and inter-generational transfers lead to a decrease of investments in capital (Figure 2.6).

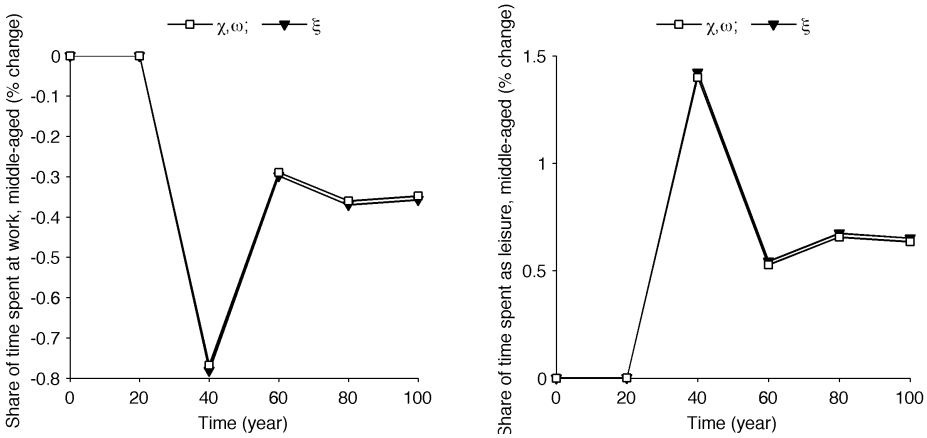


Figure 2.5: Effects of different pro-nativist fiscal incentives on the time allocation of middle-aged households

Consumption per capita increases for all generations of households. When pro-nativist fiscal subsidies increase, young households raise their level of consumption. Such increase is transmitted to middle-aged households in the next period and, then, to old households starting from two periods after the shock in pro-nativist fiscal subsidies. The dynamics of the wage

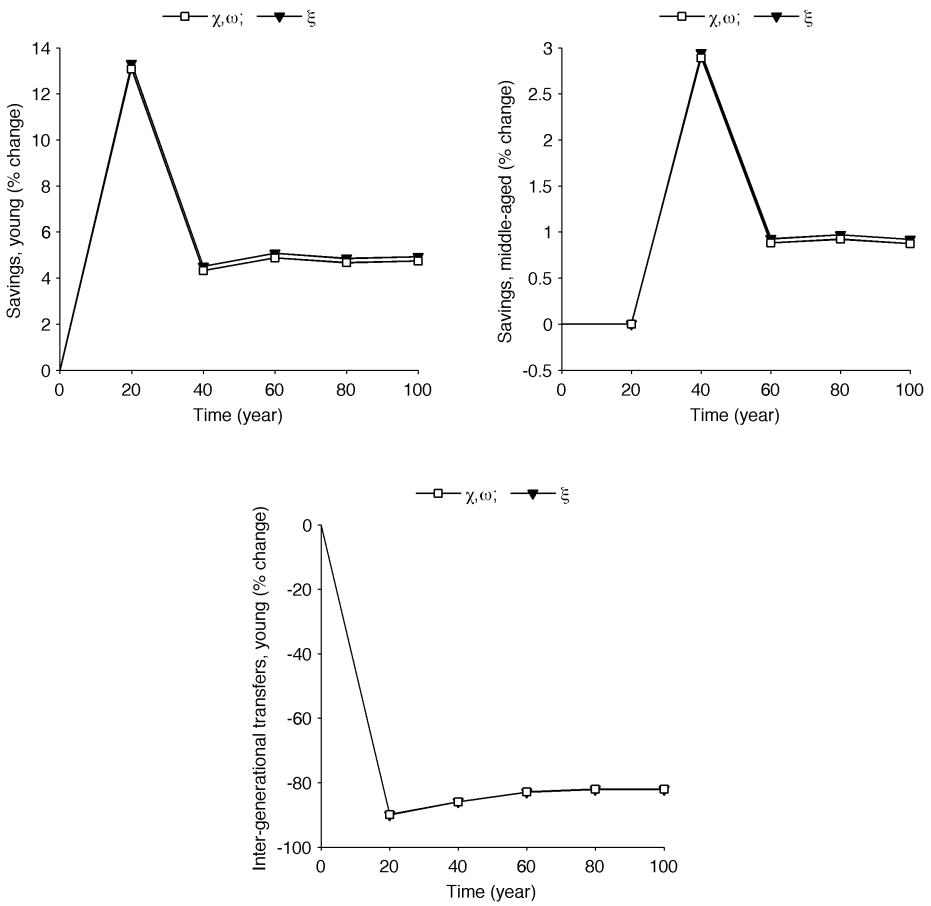


Figure 2.6: Effects of different pro-nativist fiscal incentives on savings and inter-generational transfers

rate described above curtail the initial increase in consumption enjoyed by each generation of households and lead such variable towards its new equilibrium value, below the level reached just after the increase of pro-nativist fiscal subsidies.

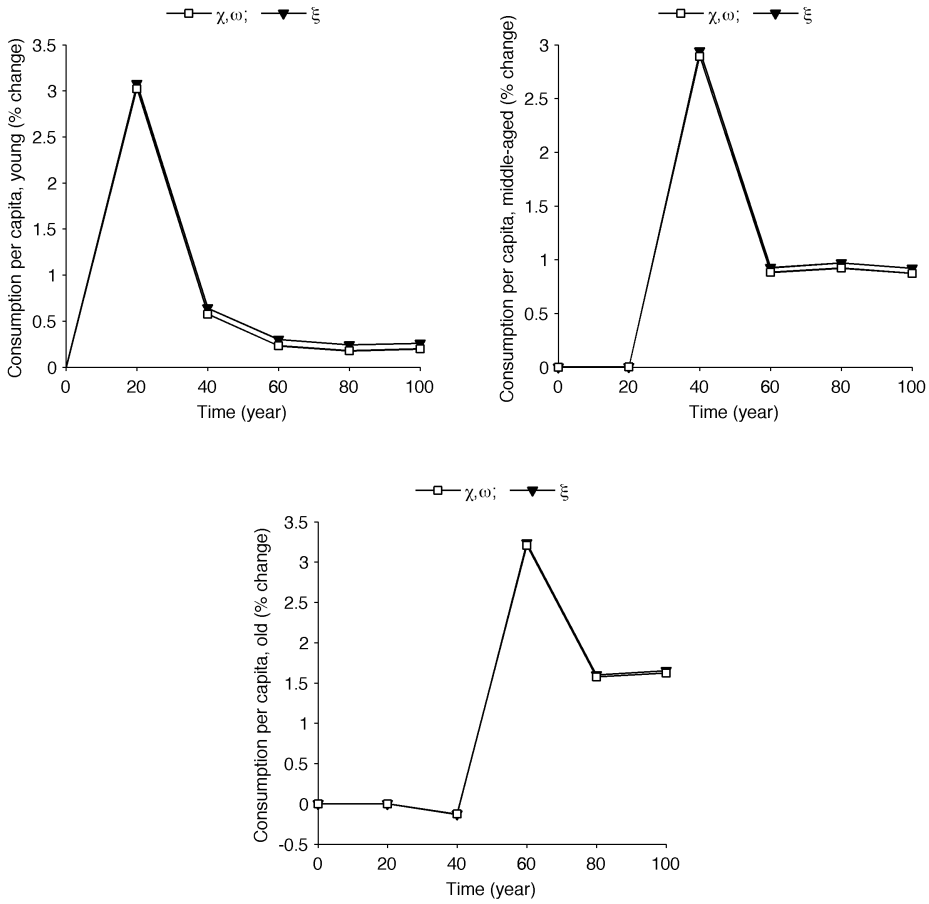


Figure 2.7: Effects of different pro-nativist fiscal incentives on consumption decisions

The second policy experiment highlights the effect of transforming all subsidies into childcare tax credit. Reducing to zero the personal exemption per dependent child and the child tax credit, while compensating this reduction through a higher value of the childcare tax credit, has almost no overall effect on fertility. As expected, fertility reduces only by 0.005 percent from its value at the initial steady state (see Figure 2.8), given that the first policy experiment revealed a very similar impact on fertility of each of the three subsidies. By contrast, the shift of subsidies towards the childcare tax credit, has a positive effect on the share of time allocated to work and to leisure. This latter increases respectively by 0.22% and 0.36%. It is compensated by a decrease in the share of time that parents spend with children. Given the reduction in the cost of external childcare services due to the increase in the childcare tax

credit, parents substitute part of the time they spend with children with external childcare. As a result, parental childcare decreases by 3.94% with respect to its value at the initial steady state.

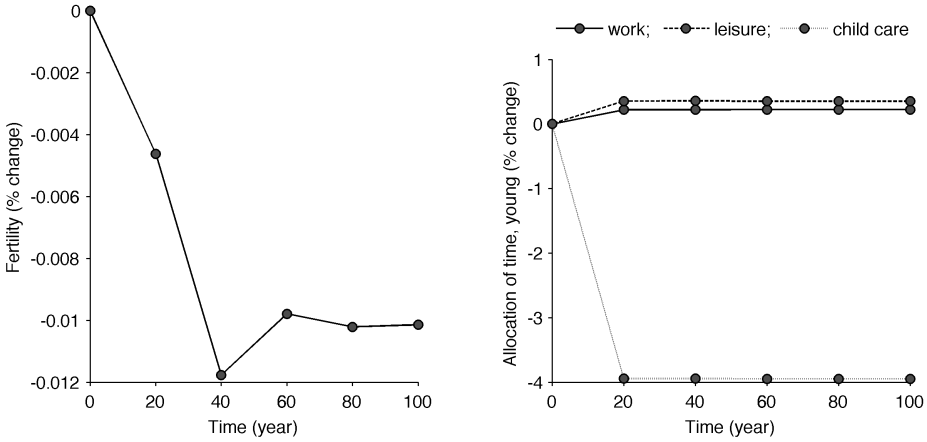


Figure 2.8: Percentage change in fertility and time allocation following a shift of subsidies in favor of the childcare tax credit.

2.6 Robustness checks

2.6.1 Assessing the role of ϵ, σ and ψ

The results described in Section 2.5 have been obtained for a given value of the three inter-temporal elasticities of the head of a dynasty utility function. This section digs deeper into the role these play in shaping the impulse response function of fertility with respect to pro-nativist fiscal subsidies.

The role of ϵ. In Section 2.4.2 an exercise of indirect inference is used to set the value of ϵ. Indeed, as shown in Figure 2.9 the value of such variable influences the impulse response function of fertility, both affecting the inter-temporal preferences of dynasty heads and the life-time preferences of adult households. Higher values imply that an adult household that is at the head of a dynasty attributes lower value to the utility of future generations. This implies that pro-nativist fiscal subsidies are used for increasing fertility of the present rather than future generations. That is, a higher value of ϵ implies that the marginal benefit of giving birth to an additional child today is higher than the marginal benefit of having an

additional child tomorrow, with the result that adult households have more children following an increase in pro-nativist fiscal subsidies, for given values of ψ and σ.

Higher values of ϵ imply also a larger elasticity of substitution between children and the other components of the life-time utility of adult households. In the same vein as the previous paragraph, higher values of ϵ imply that households are more keen to vary fertility decisions, rather than consumption or time allocation decisions, when pro-nativist fiscal subsidies increase. As a result, the value of the fertility impulse response function at the time of the pro-nativist subsidy shock is higher the higher the value of ϵ.

The role of σ and ψ. Also σ and ψ, similarly to ϵ, represent at the same time the inter-temporal elasticity and the elasticity of substitution of, respectively, consumption and the time spent out of work.

Higher values of σ lead to a smaller reaction of fertility following the increase in pro-nativist fiscal policies (see Figure 2.10), due to increased preferences for present consumption and a lower elasticity of consumption to income shocks. In this respect, the role played by σ is the same as in the original Barro-Becker model.

Concerning ψ, for a given value of the variables representing leisure and childcare, an increase in the value of ψ decreases the response of time that adults spend out of work to changes in the value of present and future income. As households tend to stick more strongly to their initial allocation of time, an increase in pro-nativist fiscal subsidies has a smaller effect on the share of time spent out of work, allowing households to use such increase in pro-nativist fiscal subsidies for raising their level of consumption and fertility. Given the importance of time allocation variables - working time hours in particular - in determining the change in the ratio between capital and effective labor, larger values of ψ imply also a larger fall in fertility after its initial increase following the rise in a pro-nativist fiscal subsidy (see Figure 2.11).

2.6.2 Assessing the role of the balanced budget rule

Following the balanced budget rule equally plays a role in determining the fertility response of households to pro-nativist fiscal subsidies. If the government decides to keep constant the

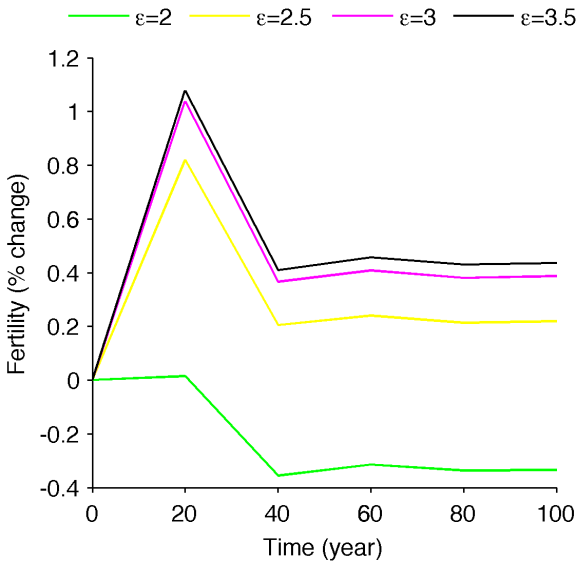


Figure 2.9: Effects of a change in the personal exemption per dependent child for different values of ϵ.

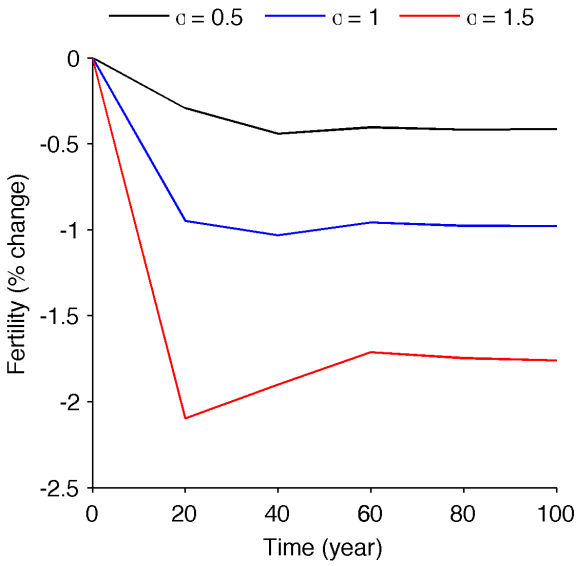


Figure 2.10: Effects of a change in the personal exemption per dependent child for different values of σ.

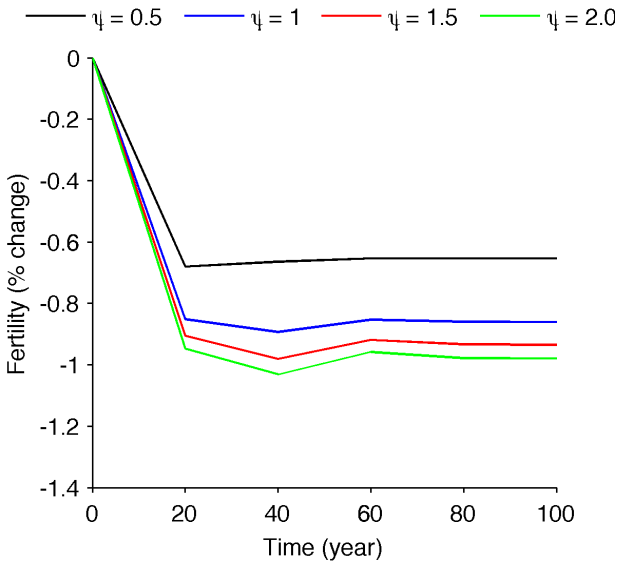


Figure 2.11: Effects of a change in the personal exemption per dependent child for different values of ψ.

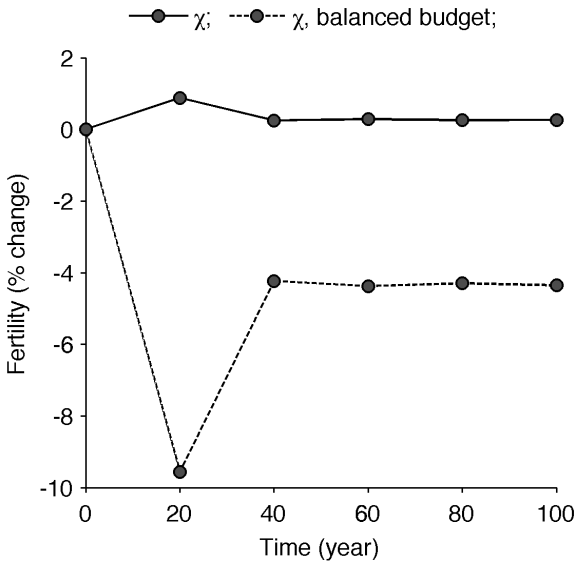


Figure 2.12: Increase in the exemption per dependent child, with and without balanced budget rule.

level of public expenditures over time and to increase the tax rate to respect the balanced budget rule, fertility is negatively affected by an increase of pro-nativist fiscal subsidies (see Figure 2.12). Moreover, as the tax rate is left free to adjust the government budget, the fertility response to an increase in the personal exemption per dependent child can be distinguished from the effect of an increase in the child tax credit. The effect is stronger in the former case because, in order to balance the budget, the adjustment of the tax rate increases the value of the personal exemption per dependent child, but not of the child tax credit.

The decrease in fertility is accompanied by an increase in the working time of young adults, compensated by a decrease in leisure and time spent with children. These changes in the time allocation decisions of young workers are limited by the increase in the wage rate resulting from the reduction of the labor force following the decrease in fertility. Middle-aged workers also increase their share of time spent at work and consequently decrease leisure, in order to compensate for the loss in disposable income caused by the increase in the tax rate.

Consumption per capita increases for young workers, whilst it remains constant for middle-aged workers and decreases for old households. Inter-generational transfers left by young workers to their children decrease, while savings held by young and middle-aged workers increase to smooth consumption over households' lifetime. This increase in savings is, in fact, necessary to counterbalance both the decrease in the interest rate, due to the increase in the capital per worker realized after the decrease in fertility, and the increase in the tax rate, which both tend to drag down consumption.

2.7 Conclusions

This paper studies the effect of pro-nativist fiscal subsidies on fertility. We have developed a Barro-Becker model, where adult households live for three periods and have altruistic preferences. Departing from the standard Barro-Becker framework developed by Becker and Barro (1988) and Barro and Becker (1989), we have assumed that adult households are able to optimize their time use in terms of work, leisure and childcare, beyond deciding upon consumption, savings, fertility and transfers to children. The introduction of time allocation decisions in the original Barro-Becker framework allows reconciling the conclusion of the micro-econometric literature on pro-nativist fiscal policies, where such policies have a small effect on fertility, and the theoretical macroeconomic literature, where fertility is deemed to

be elastic with respect to macroeconomic shocks. Indeed, the introduction of time allocation decisions for adult households helps limit the fertility impulse response function of young households to a change in pro-nativist fiscal subsidies.

The elasticity of households' fertility to tax subsidies has been gauged through an exercise of indirect inference. On the basis of the model built, fertility changes are simulated following variations in the personal exemption per dependent child and in the child tax credit. Both a change in the three subsidies and a shift in the allocation of public spending among the three subsidies are considered. US data for the period 1905-2005 are used to match the results of our simulations with the empirical estimates of the fertility response to fiscal subsidies provided by Crump et al. (2011). Moreover, Section 2.6 provides some sensitive analysis to the calibration obtained through indirect inference, showing how the three inter-temporal elasticities present in the model affect the impulse response function of fertility following a shock in the value of pro-nativist fiscal subsidies. Finally, the same section also discusses the role played by the introduction of a balanced budget rule. This contributes to further lower the response of fertility to an increase of pro-nativist fiscal subsidies, transforming it from positive into negative.

A better understanding of the possible link existing between fiscal policy, inter-generational transfers and fertility is left open for further research. In particular, agents are assumed to be heterogeneous in terms of age, but not in terms of personal wealth. By contrast, different levels of wealth may lead to different choices in terms of fertility and inter-generational transfers, with the implication that fiscal policies affecting wealth may equally have an impact on inter-generational transfer decisions and fertility.

Chapter 3

Family Tax Policy with Heterogeneous Altruistic Households

This paper presents a general equilibrium model, with overlapping generations and heterogeneous altruistic households. Taking into account the heterogeneity of households allows one to develop an alternative framework to explain why empirical estimations find pro-nativist fiscal subsidies to have only a small aggregate effect on the fertility rate of an economy, while fiscal subsidies have a larger effect on the fertility of the households who are their beneficiaries, as generally highlighted by theoretical models on fertility decisions. On the basis of this framework, different policy experiments are performed. First, an increase in pro-nativist fiscal subsidies is targeted only to the households having the lowest initial level of labour income; second, an increase in pro-nativist fiscal subsidies is generalized to all the groups of households; and, third, a change in the tax rate on the inter-generational transfers left by households with the highest labour income is assessed as a policy tool alternative to the use of pro-nativist fiscal subsidies.

3.1 Introduction

This paper contributes to further explain the small effect of pro-nativist fiscal policies on fertility. Granelli (2016) reconciles the conclusion of the micro-econometric literature on pro-nativist fiscal policies, where such policies have a positive but small effect on fertility (Whittington, 1990; Georgellis and Wall, 1992; Milligan, 2005; Crump, 2011), and the theoretical macroeconomic literature, where fertility has been usually considered to be elastic with respect to macroeconomic shocks (Jones and Schoonbroodt, 2010, 2016; Sobotka et al.,

2011; Pailhé and Solaz, 2012). In this work, two additional reasons leading pro-nativist fiscal policies to have a small effect on fertility are developed, notably the existence of aggregation effects and of the asymmetry of taxation.

Granelli (2016) considers only the case of homogeneous households. Exploiting agents' heterogeneity, this paper allows pro-nativist fiscal subsidies to change with the level of income of the households benefiting from such subsidies. As a result, first, this paper shows that the small effect of pro-nativist fiscal policies estimated by the empirical literature can be interpreted as the aggregate effect of those policies. This aggregate effect averages out the larger effect for the households at the bottom of the income distribution and the absence of their effect for the households having a higher level of income. Second, this paper investigates the possibility to use the taxation of inter-generational transfers as an alternative policy to influence households' fertility choices. This policy experiment allows one to better understand the consequences of the asymmetry of a fiscal policy, given that the taxation of inter-generational transfers targets only the group of households having a higher income. In this second case, pro-nativist fiscal subsidies may have a small effect on the overall fertility rate not due to the existence of aggregation effects, but because of the targeted group of households.

The consideration of heterogeneous households in a model of endogenous fertility has been already discussed in the economic literature. Many papers with endogenous fertility have evaluated the effects of fiscal policies on fertility (Eckstein and Wolpin, 1985; Bental, 1989; Cigno, 1995; Apps and Rees, 2004, 2007, and 2010). More recently, some authors have also highlighted the importance of considering households' heterogeneity in this debate. In particular, Guner et al. (2014) assess the relationship between households' taxation and households' characteristics, including income and number of children. Keane and Rogerson (2015) find that individual characteristics are a key determinant of adult households' choices, such as fertility, marriage and labour market participation. In the same vein, Greenwood et al. (2003) develop a framework where adult households decide about labour, marriage, divorce, and fertility. They assess the effect of the child tax credit program at play in the USA and they conclude that this type of fiscal subsidy fails to improve the well-being of the society. Incentivizing households to have larger families, the per-child resources for each household decrease so that the well-being of future generations becomes lower rather than higher. However, as discussed in Granelli (2016), this finding is at odds with the empirical papers that have studied the effect of pro-nativist fiscal policies on fertility, as these papers

have found a positive, but small, effect of these policies on fertility.

In this work, a model with heterogeneous households is used to explain why pro-nativist fiscal subsidies do not strongly affect the size of families, while having a positive effect on poorer households. This result is obtained by developing a general equilibrium version of a Barro-Becker dynastic model, where altruistic households choose their level of fertility along with their level of consumption, savings, allocation of time, and inter-generational transfers. The model is calibrated setting the inter-temporal elasticities similar to Granelli (2016), where the value of the elasticity of fertility is matched with the pro-nativist fiscal subsidies estimated by the empirical literature. As in Seshadri and Roys (2014), an increase in households' income following a permanent increase in pro-nativist fiscal policies has, on average, a limited effect on the fertility rate. Only poorer households increase their fertility rate starting from the period after the immediate positive effect of the policy shock and, then, gradually align this rate to the one of richer households.

This paper analyses also the relationship between inter-generational transfers and fertility. The introduction of heterogeneous agents allows one to group households by income and to subject different groups of households to different kinds of taxes. The present work assumes that, while all groups of households are subject to labour income taxation, only the group having the highest labour income is subject to inter-generational transfer taxation. The asymmetry of inter-generational transfer taxation offers an additional example to study the effect of fiscal policies on fertility and to explain why this effect is small.

Different papers have already highlighted the existence of a relationship between inter-generational transfers and fertility (Prinz, 1990; Cigno and Rosati, 1992; Rosati, 1996; Boldrin et al., 2015). A first strand of literature - including Becker and Barro (1988), Barro and Becker (1989) and Alvarez (1999) - has pointed out fertility choices as a mechanism through which altruistic parents reduce the inter-generational persistence of wealth and increase social mobility. In particular, these authors find a positive correlation between wealth and the number of children, with bequests being equal for each child and independent from the number of children. More recent papers, instead, have highlighted the inconsistency between the findings of that first strand of literature and the inter-generational persistence of wealth. For example, Cordoba et al. (2016) have developed a calibrated version of a Barro-Becker dynastic altruistic model of fertility choice and have embedded it into a Bewley framework of idiosyncratic risk. As a result, they find a significant inter-generational

persistence of wealth due to the choice of richer families to have fewer children and higher inheritance rates.

This work hence evaluates if a change in the taxation of inter-generational transfers for the group of richer households can constitute an alternative policy with respect to a pro-nativist fiscal subsidy. A higher taxation on the inter-generational transfers of richer households is found to increase their fertility rate and to decrease their inter-generational transfers. However, similarly to what Cordoba et al. (2016) highlighted, these changes in fertility and inter-generational transfers remain contained. This result is due to the richer households' choice to decrease their level of consumption and to continue to endow future generations with some capital, notwithstanding the increase in taxation of inter-generational transfers.

The rest of the paper is structured as follows. Section 3.2 develops the model underpinning the results in the sections of the paper illustrating the consequences of the policy shocks simulated. Section 3.3 provides the calibration for the parameters and variables of the model. Section 3.4 assesses the effects on fertility of different changes in the pro-nativist fiscal policy introduced in the model of Section 3.2. Section 3.5 studies the introduction of inter-generational transfer taxation as possible mean to influence fertility. Section 3.6 concludes.

3.2 Model

In this paper we use a general equilibrium model with overlapping generations, which is an extension of Granelli (2016). There are three types of households, distinguished by an exogenous ability type, x. The different level of ability translates into different levels of income, so that low ability type households have also a lower labour income, medium ability type households have a medium labour income, and high ability type households have the highest level of labour income. Moreover, within each group of households, each generation lasts for 20 years so that households live for a total of 80 years. In the second period of their life, when households become adult, they choose their level of fertility and transfers to their children, along with their level of consumption and savings. Households choose their allocation of time, which can be used to work, to enjoy leisure and to provide childcare to their own children. Becoming older, the set of choices upon which households can choose becomes smaller. In particular, starting from the third period of their life, when households

become older adults, they no longer need to choose their level of fertility, their transfers to children or how much time to dedicate to childcare activities. When they are in their fourth and last period of their life, households only consume what they have previously saved and do not need to take any other decisions.

The maximization problem for the two categories of households is similar to one described in Granelli (2016), but takes into account households' heterogeneity, that is:

$$
\begin{aligned}
U_{0,i} = \quad & \sum_{t=0}^{\infty}(\beta\phi)^t N_{t,i}^{\epsilon}\left\{A_i + \left[\frac{c_{1,t,i}^{1-\sigma}}{1-\sigma} + \beta\frac{c_{2,t+1,i}^{1-\sigma}}{1-\sigma} + \beta^2\frac{c_{3,t+2,i}^{1-\sigma}}{1-\sigma}\right] + \zeta\left[\frac{\left(l_{1,t,i}d_{1,t,i}^{\rho}\right)^{1-\psi}}{1-\psi} + \beta\frac{\left(l_{2,t+1,i}\right)^{1-\psi}}{1-\psi}\right]\right\} \\
s.t. \quad & c_{1,t,i} + \frac{c_{2,t+1,i}}{R_{t+1}} + \frac{c_{3,t+2,i}}{R_{t+1}R_{t+2}} + \left(1-d_{1,t,i}\right)\pi_{t,i}n_{t,i} + (1-\tau_{t,i}^{b})q_{t+1,i}n_{t,i} = \\
& h_{1,t,i}x_{1,t,i}w_t\left(1-\tau_t\right) + \chi_{t,i}n_{t,i} + \frac{h_{2,t+1,i}}{R_{t+1}}x_{2,t+1,i}w_{t+1}\left(1-\tau_{t+1}\right) + R_t q_{t,i},
\end{aligned}
$$

where c represents the level of consumption chosen by an adult household of age $a = \{1, 2, 3\}$ and ability type $i = \{1, 2, 3\}$, h, l and d represent the share of time that young adults dedicate respectively to work, leisure and childcare, n the number of children, π the per child cost of childcare, and q the inter-generational transfer that adult households leave to each of their children. In addition, w is the wage rate while $R = 1 + r - \delta$ is the gross interest rate at the net of the capital depreciation rate δ, τ is the tax rate on labour income, τ^b the tax rate on the inter-generational transfer, and χ a fiscal subsidy per child. In terms of parameters of the maximization problem, σ represents the inter-temporal elasticity of substitution, β the discount factor, A_i the utility constant, ζ the weight attached to time out of work in the utility function, ρ the elasticity of substitution between leisure and childcare, ψ the inter-temporal elasticity of substitution for the time out of work, ϕ the degree of altruism of adult households, and ϵ the discount factor for weighting the utility of future generations with respect to the current generation.

The solution of the maximization problem for each group of household is composed by the Euler equations regulating consumption over the three different periods of their life,

$$
c_{1,t,i}^{\sigma} = \frac{c_{2,t+1,i}^{\sigma}}{\beta R_{t+1}}, \qquad c_{2,t+1,i}^{\sigma} = \frac{c_{3,t+2,i}^{\sigma}}{\beta R_{t+2}}.
$$

For a given level of ability i, in each period of the households' adult life, there exists a trade-off between present and future consumption. The above Euler conditions regulate such trade-off by equalizing the level of present consumption with the level of consumption in the following period, divided by the discount factor and the interest rate.

Moreover, young adults choose how to allocate their time over different activities as follows,

$$\zeta_i l_{1,t,i}^{-\psi} d_{1,t,i}^{\rho_i(1-\psi)} = \tilde{\lambda}_{t,i} x_{1,t,i} w_t (1-\tau_t), \qquad \zeta_i \rho_i l_{1,t,i}^{1-\psi} d_{1,t,i}^{\rho_i(1-\psi)-1} = \tilde{\lambda}_{t,i} \left[x_{1,t,i} w_t (1-\tau_t) - \pi_{t,i} n_{t,i} \right].$$

In these first order conditions, λ is the Lagrangian multiplier, while π represents the cost of external childcare services that young households need to pay for either working or enjoying leisure. In addition, this cost of external childcare services is assumed to be a linear function, varying with the size of the cohort birth in each period of time t, $\pi_{i,t} = \pi_{0,i,t} + \pi_{1,i} n_{i,t} N_{1,i,t}$. In both equations, the expression on the left-hand-side represents the marginal benefit of an additional unit of leisure ($\zeta_i l_{1,t,i}^{-\psi} d_{1,t,i}^{\rho_i(1-\psi)}$) or time spent with children ($\zeta_i \rho_i l_{1,t,i}^{1-\psi} d_{1,t,i}^{\rho_i(1-\psi)-1}$). The expression on the right-hand-side, instead, represents the marginal cost of leisure or childcare in terms of forgone labour income ($\tilde{\lambda}_{t,i} x_{1,t,i} w_t$), at the net of taxes ($1-\tau_t$) and cost of childcare services ($\pi_{t,i} n_{t,i}$). The skill level ($x_{1,t,i}$) affects the marginal cost of leisure or childcare, as a higher skill level implies a higher level of labour income.

In a similar vein, for older adults, the allocation of time between work and leisure is regulated by the following first order condition,

$$\beta \zeta_i l_{2,t+1,i}^{-\psi} = \tilde{\lambda}_{t,i} \frac{x_{1,t+1,i} w_{t+1} (1-\tau_{t+1})}{R_{t+1}},$$

where the marginal benefit of an additional unit of leisure ($\beta \zeta_i l_{2,t+1,i}^{-\psi}$) is equalized to its marginal cost in terms of lost income ($\tilde{\lambda}_{t,i} \frac{x_{1,t+1,i} w_{t+1} (1-\tau_{t+1})}{R_{t+1}}$).

Lastly, for each group of households, there is also a first order condition regulating fertility decisions,

$$\begin{aligned} &\beta \phi_i n_{t,i}^{-\epsilon} \left[(1-\epsilon) V_{t+1,i} + \tilde{\lambda}_{t+1,i} \left(x_{1,t+1,i} h_{1,t+1,i} w_{t+1} (1-\tau_{t+1}) + \frac{x_{2,t+2,i} h_{2,t+2,i} w_{t+2} (1-\tau_{t+2})}{R_{t+2}} \right) \right] \\ &= \tilde{\lambda}_{t,i} \left[(1-d_{1,t,i}) \pi_{t,i} - \chi_{t,i} \right] + \beta \phi_i n_{t,i}^{-\epsilon} \tilde{\lambda}_{t+1,i} \left(c_{1,t+1,i} + \frac{c_{2,t+2,i}}{R_{t+1}} + \frac{c_{3,t+3,i}}{R_{t+1} R_{t+2}} \right), \end{aligned}$$

and one for inter-generational transfers,

$$\beta \phi_i \tilde{\lambda}_{t+1,i} R_{t+1} n_{t,i}^{1-\epsilon} = \left(1 - \tau_{t,i}^b\right) \tilde{\lambda}_{t,i} n_{t,i}.$$

These two conditions are similar to those found in Granelli (2016). Notably, the marginal benefit of an additional child (the left hand side of the first equation) is equal to the sum

of the marginal utility and the future labour income of that child. The marginal cost of an additional child is instead given by the cost of external childcare services, net of pro-nativist fiscal subsidies and the value of that child future consumption. At the same time, inter-generational transfers are regulated by the equality between the shadow value of future consumption ($\tilde{\lambda}_{t+1,i}$), discounted by the altruism function ($g(n) = \phi n_t^{1-\epsilon}$), and the shadow value of today's consumption ($\tilde{\lambda}_t$), at the net of taxes on transferred capital ($1 - \tau^b_{t,i}$).

The above first order conditions are accompanied by the three budget constrains faced by the three generations of adult households. For young adults, consumption ($c_{1,t,i}$), savings ($s_{1,t,i}$), childcare services ($(1-d_{1,t,i})\pi_{t,i}n_{t,i}$), and inter-generational transfers ($\left(1 - \tau^b_{t,i}\right) q_{t+1,i}n_{t,i}$) need to be compensated by the sum of labour income ($x_{1,t,i}h_{1,t,i}w_t\left(1 - \tau_t\right)$), pro-nativist fiscal subsidies ($\chi_{t,i}n_{t,i}$) and transfers received from the previous generation ($R_t q_{t,i}$),

$$c_{1,t,i} + s_{1,t,i} + (1 - d_{1,t,i})\pi_{t,i}n_{t,i} + \left(1 - \tau^b_{t,i}\right) q_{t+1,i}n_{t,i} = x_{1,t,i}h_{1,t,i}w_t\left(1 - \tau_t\right) + \chi_{t,i}n_{t,i} + R_t q_{t,i}.$$

For middle-aged and old households, the budget constrains simplify. Only consumption ($c_{2,t+1,i}$) and savings ($s_{2,t+1,i}$) figure among the expenses of middle-aged households, compensated by labour income ($x_{2,t+1,i}h_{2,t+1,i}w_{t+1}(1 - \tau_{t+1})$) and savings accumulated when young ($R_{t+1}s_{1,t,i}$),

$$c_{2,t+1,i} + s_{2,t+1,i} = x_{2,t+1,i}h_{2,t+1,i}w_{t+1}(1 - \tau_{t+1}) + R_{t+1}s_{1,t,i}.$$

For old households, instead, consumption ($c_{3,t+2,i}$) is the only expense to be compensated by savings ($R_{t+2}s_{2,t+1,i}$),

$$c_{3,t+2,i} = R_{t+2}s_{2,t+1,i}.$$

Next to the budget constraints, time constraints for young and old households ensure that working hours, leisure and childcare activities sum up to 1, given that households are endowed with a unit of time in each period of their adult life.

$$h_{1,t,i} + l_{1,t,i} + d_{1,t,i} = 1, \qquad h_{2,t+1,i} + l_{2,t+1,i} = 1.$$

Moreover, a representative productive firm maximizes its profits as follows

$$\max_{L_t} \Pi_t = F(K_t, L_t) - w_t L_t - r_t K_t,$$

where w_t is the wage rate, r_t the interest rate, while K_t and L_t are respectively the stock of capital and labor at the beginning of period t. The solution to firms' optimization problem

sets the price for labour and the price for capital equal to their marginal productivity,

$$w_t = F'_L(K_t, L_t) = z_t(1-\alpha)k_t^{\alpha}, \qquad r_t = F'_K(K_t, L_t) = z_t\alpha k_t^{\alpha-1},$$

where k is the ratio between the amount of capital (K) and labour (L) of the economy, z the total factor productivity and α the capital share of labour.

At the same time, the government sets the tax rate for the economy by respecting its budget constraint,

$$G_t = \sum_i \left[\left(x_{1,t,i} h_{1,t,i} w_t \tau_t - \chi_{t,i} n_{t,i} + \tau^b_{t,i} n_{t,i} q_{t+1,i} \right) N_{t,i} + x_{2,t,i} h_{2,t,i} w_t \tau_t N_{t-1,i} \right],$$

where public spending (G_t) is supposed to be unproductive for sake of simplicity and introduced into the model with the scope of pinning down tax rates at a realistic value. Public spending and pro-nativist subsidies ($\chi_{t,i} n_{t,i} N_{t,i}$) are financed through the revenues coming from labour income taxation ($x_{1,t,i} h_{1,t,i} w_t \tau_t N_{t,i}, x_{2,t,i} h_{2,t,i} w_t \tau_t N_{t-1,i}$) and inter-generational transfers taxation ($\tau^b_{t,i} n_{t,i} q_{t+1,i} N_{t,i}$). Moreover, in the same equation representing the government budget, $N_{t,i}$ is the number of young adult households of type i living at each period t, defined according to the following laws of motion for population,

$$\begin{aligned} N_{t+1,i} &= n_{t,i} N_{t,i}, \\ N_{0,i} &= 1. \end{aligned}$$

At equilibrium, the clearing conditions for the capital and labour market require that both the demand for capital and labour meet their respective supplies,

$$K_{t+1} = \sum_i \left[s_{1,t,i} N_{t,i} + s_{2,t,i} N_{t-1,i} + q_{t+1,i} N_{t+1,i} \right], \qquad L_t = \sum_i \left[x_{1,t,i} h_{1,t,i} N_{t,i} + x_{2,t,i} h_{2,t,i} N_{t-1,i} \right].$$

In particular, savings ($s_{1,t,i} N_{t,i}, s_{2,t,i} N_{t-1,i}$) and inter-generational transfers ($q_{t+1,i} N_{t+1,i}$) accumulated in one period build up the stock of capital for the following period (K_{t+1}), while the working time supplied by young ($x_{1,t,i} h_{1,t,i} N_{t,i}$) and middle-aged households ($x_{2,t,i} h_{2,t,i} N_{t-1,i}$) matches the firm's demand for labour (L_t).

Also, the resource constraints for the whole economy need to be verified. The total production of the economy is required to be shared among the two productive factors used, that is capital

and labour,

$$Y_t = w_t L_t + r_t K_t.$$

At the same time, the total production of the economy $Y = F(K_t, L_t)$ cannot be left unused and hence needs either to be consumed (C_t) or used for public spending (G_t) or invested (I_t)

$$Y_t = C_t + I_t + G_t,$$

where investment is equal to

$$I_t = K_{t+1} - (1 - \delta)K_t,$$

and consumption is defined as

$$C_t = \sum_a C_{a,t} + \sum_i \left[(1 - d_{1,t,i})\pi_{t,i} n_{t,i} N_{t,i}\right],$$

with $C_{a,t} = \sum_i c_{a,t,i} N_{t,i}$ for $a = \{1, 2, 3\}$.

3.3 Calibration

The model described in Section 3.2 is calibrated as preliminary step for running the policy experiments of Section 3.4. The calibration is performed under the assumptions made about the three elasticities of substitution of the model. In particular, the inverse of the Frisch elasticity for the time that adult households spend out of work, ψ, is set equal to 2, both to obtain a corresponding Frisch elasticity equal to $\frac{1}{2}$ and to have non-worked hours to be relatively inelastic with respect to changes in the wage rate for a given constant marginal utility of labour income. The inverse of the inter-temporal elasticity of substitution (IES), σ, is set equal to 0.5, as in Cordoba et al. (2016), while the elasticity of the altruism function with respect to the number of children is set in line with Granelli (2016), with $\epsilon = 2.5$.

As regards the exogenous variables, Table 3.1 summarizes their values. First, the parameter representing the ability type is set to match the level of income held by the third, sixth and ninth decile of the US household income distribution. Using data from the Current Population Survey of the Census Bureau, this corresponds to set $x = 0.67$ for the group of households having the lowest income ($i = 1$), $x = 2.56$ for the middle group ($i = 2$), and $x = 8.51$ for the group of households having the highest income ($i = 3$). As a result of this income disparity among different household groups, the personal exemption per dependent

child, χ_i, is calibrated equal to 732.80 \$ per year only for the poorest group of households. This value is set using data from the US Internal Revenue Service and Crump et al. (2011), where the personal exemption per dependent child is null for households belonging to sixth and ninth decile of the US income distribution. The value of χ_i is calculated by multiplying the yearly value of the exemption that was equal to 3200 \$ per child in 2005, the length of a generation we use in the model (that is 20 years), and the average tax bill against which this exemption can be deducted. In the same vein, the value of the tax on inter-generational transfers ($\tau^b = 0$) is initially set equal to 0.1% only of the group of households having the highest level of labour income and then doubled in Section 3.5.

Second, the cost of external childcare paid by young adults is calibrated by matching the figures reported by the US Department of Agriculture (2005). In this publication, the cost of external childcare reflects the household's level of income, as families with higher income ask for childcare services of higher quality. In particular, the total cost of childcare for the children of young households of type $i = 1$ is set equal to 1879.41\$ per year, while the total cost to be paid for external childcare services by young households of type $i = 2$ and $i = 3$ is set, respectively, equal to 3264.71\$ and to 7025.74\$ per year. Such total childcare cost is assumed to be the result of two components. The first is a cost that depends on the size of the cohort born at the same time, $\pi_{1,i} n_i N_{1,i}$. This cost reflects the presence of congestion effects linked to increasing population, as in de la Croix and Gosseries (2012). Although the congestion effect is allowed to differ by household group, the coefficient $\pi_{1,i}$ is assumed equal for all groups, so that $\pi_{1,1} = \pi_{1,2} = \pi_{1,3} = \pi_1$. It is matched with the coefficient of a linear regression obtained using US population data for the period 1935-2013, where the yearly average US population of a year t is considered as a function of the yearly average US population in the previous year $t-1$. The second component of the total childcare cost is a fixed cost ($\pi_{0,i}$, see Section 3.2), which is assumed to be related to the group to which young households belong. It is calculated as the difference between the total childcare cost of each group and the first component of the external childcare cost depending on the cohort size.

Lastly, the share of public expenditure out of the total production of the economy is set according to the US national accounting data. Selecting only the part of the US government public expenditures used for military spending, the ratio between this latter, G_t, and the total production of the economy, Y_t, was equal to 5.10% in 2005. Indeed, in this paper, as in Granelli (2016), only the part of public spending dedicated to military spending is considered out of the total amount of the US public expenditure. This choice is made for the

sake of simplicity as military spending may be considered an unproductive type of public expenditure. This allows one not to take into account the possible links that in reality may exist between public expenditure and firms' production.

Table 3.1: Value of exogenous variables

Variable	Value (yearly)
Military spending/GDP	$\frac{G}{Y} = 5.10\%$
$i = 1$	
Skill type	$x_{t,1} = 0.67$
Personal exemption	$\chi_{t,1} = \$\,732.80$
Child cost	$\pi_{t,1} = \$\,1879.41$
Tax on inter-generational transfers	$\tau^b_{t,1} = 0$
$i = 2$	
Skill type	$x_{t,2} = 2.56$
Personal exemption	$\chi_{t,2} = \$\,0$
Child cost	$\pi_{t,2} = \$\,3264.71$
Tax on inter-generational transfers	$\tau^b_{t,2} = 0$
$i = 3$	
Skill type	$x_{t,3} = 8.51$
Personal exemption	$\chi_{t,3} = \$\,0$
Child cost	$\pi_{t,3} = \$\,7025.74$
Tax on inter-generational transfers	$\tau^b_{t,3} = 10\%$

The endogenous variables, whose value is set to calibrate a corresponding parameter, are listed in Table 3.2. The net real interest rate is set equal to the average of the yearly interest rate on 20-years US treasury bonds, 4.65%. The corresponding discount factor, β, turns out to be equal to 0.6871. Next, the ratio between gross fixed investments and GDP is used to give a value to the depreciation rate. This ratio is equal to 21.19% of the US GDP reconstructed so as to take into account only the expenditures of the three sectors of the model described in Section 3.2, that is households' consumption, firms' investment and the government spending. Such a ratio corresponds to a value of the depreciation rate equal to

0.8972. Moreover, the share of capital into the US GDP and the productivity per worker are taken from the Penn Word Tables. Respectively, the former is set equal to 0.65 to obtain the value of the labour-capital share, α, equal to 0.35. The latter is set equal to 83400\$, corresponding to a value of the total factor productivity $z = 2.3110$.

Regarding the utility function, using data from the American Time Use survey, we set ζ - that is the relative weight of time spent out of work - equal to 0.0525, while we set ρ - that is the share of total time young households spend with their children relative to that spent as leisure - equal to 0.5122. In addition, the value of the altruism factor ϕ is calibrated using bequest data coming from Gale and Scholz (1994). In particular, given an amount of inter-vivos transfers equal to 0.32% of total wealth and 2.84% of average income, the value of the parameter ϕ is equal to 0.9185 for the households belonging to group $i = 1$ and $i = 2$, implying a positive ($\phi > 0$) but imperfect ($\phi < 1$) degree of altruism of these young households towards their future generations. Households of the group $i = 3$, instead, have a degree of altruism slightly lower than those of the other two groups (0.8227), as their inter-generational transfers are subject to taxation. Lastly, we allow the constant of the life-cycle utility function (A) to differ between the three groups of households. In particular, it is set equal to -1.9104 for the poorer group of households ($i = 1$), equal to -4.4011 for the second group of households ($i = 2$), and equal to -3.8337 for the richer group ($i = 3$). Notwithstanding the fertility rate is set equal to 1 for all groups of households, having a different constant of the life-cycle utility function allows to take into account the different size of three groups. Notably, the size of the poorest group of households is equal to one-third of the total population ($N_{1,i=1} = 0.3$), while households having the median income correspond to 60% of the total population ($N_{1,i=2} = 0.6$) and richer households to the remaining 10% ($N_{1,i=3} = 0.1$).

Tables 3.3 and 3.4 summarize the values of the initial steady state. In a nutshell, households with a higher ability type, $i = 2$ and $i = 3$, consume more over all their life-cycle than households with a lower ability type, $i = 1$. Households with a higher ability type also accumulate more savings and leave a more generous transfer to their children. At the same time, their allocation of time is more biased towards work, as they spend a larger share of the unit of time at their disposal working, both when they are young and middle-aged. They compensate this choice with a lower proportion of time spent as leisure, both when young and middle-aged, as well as with a lower proportion of time spent with their children. These results are in line both with the data of the American Time Use survey and the statistics of

Table 3.2: Matching parameters and matched moments

Matching parameter	Value	Matched Moment	Value (yearly)
Discount factor	$\beta = 0.6871$	20-years interest rate	$r = 4.65\%$
Depreciation rate	$\delta = 0.8972$	Investment-GDP ratio	$\frac{I}{Y} = 21.19\%$
Capital share	$\alpha = 0.35$	Capital share of labor	$w\frac{L}{Y} = 0.65$
TFP constant	$z = 2.3110$	Production per worker	$y = \$\,83400$
Utility relative weight	$\zeta = 0.0525$	Total leisure	$\frac{\sum_i l_i N_{1,i}}{\sum_i (h_i+l_i+d_i)N_{1,i}} = 26.91\%$
Leisure-childcare ratio	$\rho = 0.5122$	Total time spent with children	$\frac{\sum_i d_i N_{1,i}}{\sum_i (h_i+l_i+d_i)N_{1,i}} = 14.30\%$
$i = 1$			
Altruism factor	$\phi_1 = 0.9185$	Bequests-income ratio	$\frac{q_i n_i}{h_i x_i w} = 2.84\%$
Utility constant	$A_1 = -1.9104$	Number of children	$N_{1,i} = 0.3$
$i = 2$			
Altruism factor	$\phi_2 = 0.9185$	Bequests-income ratio	$\frac{q_i n_i}{h_i x_i w} = 2.84\%$
Utility constant	$A_2 = -4.4011$	Number of children	$N_{1,i} = 0.6$
$i = 3$			
Altruism factor	$\phi_3 = 0.8227$	Bequests-income ratio	$\frac{q_i n_i}{h_i x_i w} = 2.84\%$
Utility constant	$A_3 = -8.8337$	Number of children	$N_{1,i} = 0.6$

the US Department of Agriculture (2005), where households having a higher labour income tend to spend more time at work, enjoy less leisure, spend less time with children, and resort to external childcare services to a larger extent.

Table 3.3: Initial steady state

Variable	Value (20 years)	Value (yearly)
Tax rate on labour income	$\tau = 7.91\%$	-
$i = 1$		
Consumption, young households	$c_{1,ss,i} = 284190.11\$$	14209.51\$
Consumption, middle-aged households	$c_{2,ss,i} = 336878.28\$$	16843.91\$
Consumption, old households	$c_{3,ss,i} = 399334.71\$$	19966.74\$
Saving, young households	$s_{1,ss,i} = 41466.30\$$	2073.32\$
Saving, middle-aged households	$s_{2,ss,i} = 251993.79\$$	12599.69\$
Inter-generational transfers, young households	$q_{ss,i} = 10218.14\$$	510.91\$
Share of time spent at work, young households	$h_{1,ss,i} = 50.49\%$	-
Share of time spent as leisure, young households	$l_{1,ss,i} = 32.09\%$	-
Share of time spent with children, young households	$d_{1,ss,i} = 17.42\%$	-
Share of time spent at work, middle-aged households	$h_{2,ss,i} = 78.60\%$	-
Share of time spent as leisure, middle-aged households	$l_{2,ss,i} = 21.40\%$	-
$i = 2$		
Consumption, young households	$c_{1,ss,i} = 1256428.14\$$	62821.41\$
Consumption, middle-aged households	$c_{2,ss,i} = 1489366.93\$$	74468.35\$
Consumption, old households	$c_{3,ss,i} = 1765492.01\$$	88274.60\$
Saving, young households	$s_{1,ss,i} = 282967.15\$$	14148.36\$
Saving, middle-aged households	$s_{2,ss,i} = 1114085.56\$$	55704.28\$
Inter-generational transfers, young households	$q_{ss,i} = 47678.14\$$	2383.91\$
Share of time spent at work, young households	$h_{1,ss,i} = 61.25\%$	-
Share of time spent as leisure, young households	$l_{1,ss,i} = 25.40\%$	-
Share of time spent with children, young households	$d_{1,ss,i} = 13.35\%$	-
Share of time spent at work, middle-aged households	$h_{2,ss,i} = 84.17\%$	-
Share of time spent as leisure, middle-aged households	$l_{2,ss,i} = 15.83\%$	-

Table 3.4: Initial steady state, continued

Variable	Value (20 years)	Value (yearly)
$i = 3$		
Consumption, young households	$c_{1,ss,i} = 4580439.98\$$	229022.00\$
Consumption, middle-aged households	$c_{2,ss,i} = 5429642.65\$$	271482.13\$
Consumption, old households	$c_{3,ss,i} = 6436285.46\$$	321814.27\$
Saving, young households	$s_{1,ss,i} = 1272403.02\$$	63620.15\$
Saving, middle-aged households	$s_{2,ss,i} = 4061515.22\$$	203075.76\$
Inter-generational transfers, young households	$q_{ss,i} = 178067.36\$$	8903.37\$
Share of time spent at work, young households	$h_{1,ss,i} = 68.94\%$	-
Share of time spent as leisure, young households	$l_{1,ss,i} = 20.42\%$	-
Share of time spent with children, young households	$d_{1,ss,i} = 10.64\%$	-
Share of time spent at work, middle-aged households	$h_{2,ss,i} = 87.99\%$	-
Share of time spent as leisure, middle-aged households	$l_{2,ss,i} = 12.00\%$	-

3.4 Policy shocks

3.4.1 Increasing pro-nativist fiscal subsidy for households having lower income only

In this section, we use the model of Section 3.2 to run the policy experiments introduced in Section 3.1. In the first of these experiments, we assume an increase in the pro-nativist fiscal subsidy benefiting the households having lower income only. In particular, it is assumed that $\chi_{t,1}$ increases by 1% of the total public expenditure of the economy (G_t). All the effects of this shock are illustrated in Annex C.1.

With respect to the initial steady state, the fertility of lower income households increases in the first period following the policy shock (0.6%). This initial increase in the level of fertility, however, is accompanied by an increase in the cost of childcare services, which is a positive function of the level of fertility itself as explained in Section 3.3. The increase in the cost of childcare services reduces the effect of the pro-nativist policy on fertility, starting from the second period after the fiscal shock. As a result, the effects of the pro-nativist policy on fertility do not last over time. By contrast, households belonging to the group $i = 2$

and $i = 3$ decrease their level of fertility by 0.1%, as their income is initially reduced by the increase in the tax rate of 2% necessary to rebalance the increased pro-nativist subsidy for lower income households. Due to the decrease in their level of fertility, the cost of childcare services also decreases and creates a partial rebound of fertility starting from the second period after the shock.

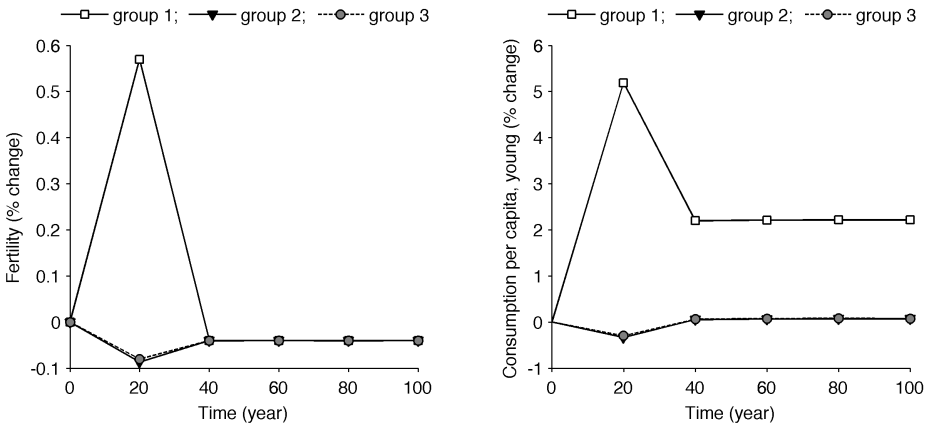


Figure 3.1: Fertility and consumption of young adults following an increase in the pro-nativist fiscal incentive for the households of group 1 ($i = 1$).

The income effect linked to the pro-nativist shock increases consumption for all the generations of households. Young adults start consuming 5.19% more, immediately after the increase in the fiscal subsidy they receive. Middle-aged and old households increase consumption in the following periods, with middle-aged households increasing their level of consumption by 5.33% and old households increasing it by 5.18%. The same income effect increases also leisure (1%) and time with children (1%) for young households having lower income. At the same time, also middle-aged households with lower income increase the share of their time dedicated to leisure, but by a smaller amount than young households (0.4%).

As in the case of fertility, the reaction of higher income households to the policy shock differs from the one of lower income households. When they are young adults, higher income households decrease their consumption by 0.34% if $i = 2$ and by 0.30% if $i = 3$. After this initial decrease, however, consumption of higher income households gets back to its initial level. When they are middle-aged and old, consumption of higher income households decreases, as the initial drop in their level of consumption is not compensated for by an equal increase in consumption over the following periods of their life. Moreover, as regards time allocation,

households with higher income decrease the share of time spent at work and increase the one for leisure and time spent with children by 0.1%, that is by a smaller amount than for households having lower income. This change in the allocation of time is not directly due to the income effect linked to the pro-nativist shock, which targets poorer households only. Rather, this change in the allocation of time is linked to the decrease in the fertility rate and the consequent decrease in the cost of childcare services for higher income households. This latter allows young adults with higher income to maintain the same level of consumption while enjoying more leisure and time with their children. When middle-aged, instead, the allocation of time remains fairly constant for higher income households, with a very small decrease in the share of time spent at work compensated for by more leisure.

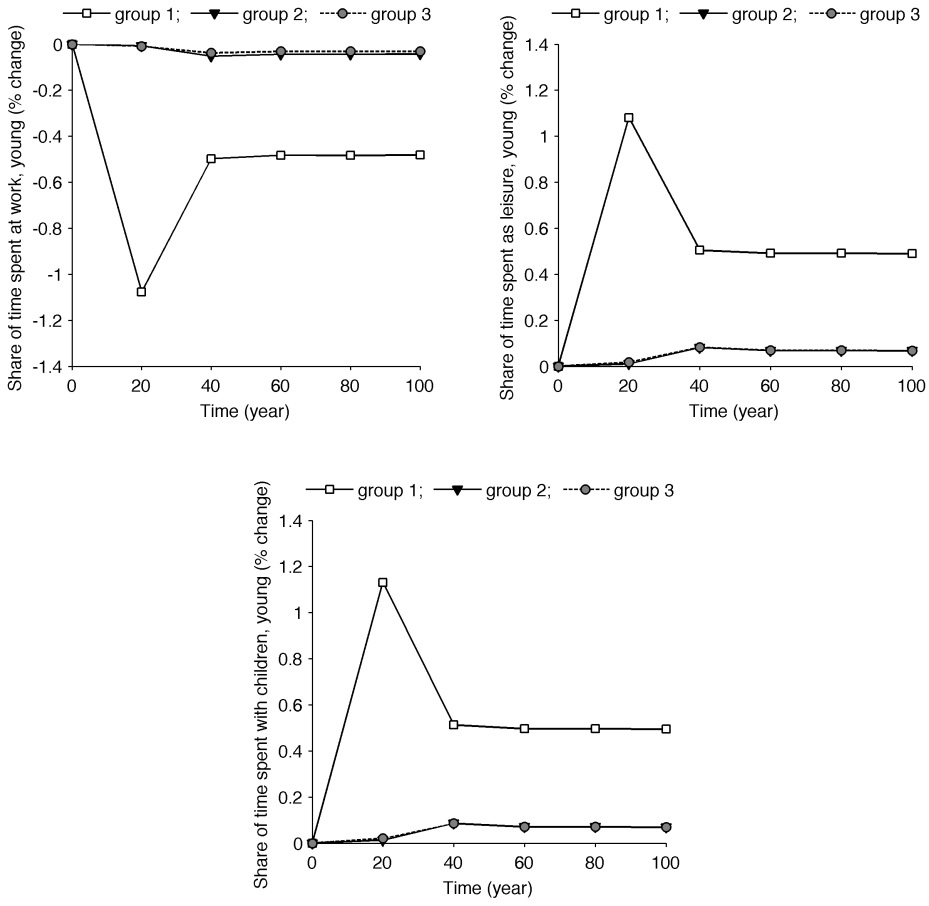


Figure 3.2: Time allocation of young households after the increase in the pro-nativist fiscal incentive for the households of group 1 ($i = 1$).

Saving choices go in the same direction as consumption choices for all types of households. When they are young adults, lower income households increase their savings by about 50%

in the first period after the shock and by 20% in the following periods. When they are middle-aged, instead, they decrease their savings by 5%. Meanwhile, the level of savings remains fairly stable for higher income households, both when these are young and middle-aged adults. As a result, lower income households need to decrease the inter-generational transfers for future generations, given the higher level of fertility, consumption and savings chosen. On the contrary, higher income households increase their level of inter-generational transfers. The decrease in their level of fertility, indeed, allows this group of households to increase their level of inter-generational transfers, while keeping constant their chosen level of consumption and saving.

3.4.2 Increasing pro-nativist fiscal subsidy for all groups of households

As an alternative policy experiment, the pro-nativist fiscal subsidy is increased by 1% of public expenditure (G_t) for all groups of households, rather than only for the households with the lowest level of income. As for the first policy shock, Annex C.2 provides the complete set of charts illustrating the effect of this second policy option.

Following the increase in the pro-nativist fiscal subsidy, fertility increases by almost 0.5% for the households with the lowest level of income. By contrast, fertility decreases by 0.1% for the households with median income, group $i = 2$, and almost by 0.2% for the group of households with the highest level of income, $i = 3$. These changes in fertility take place notwithstanding an increase in the cost of external childcare for the lowest income households, by 0.06%, and a decreases in this cost for the other two types of households. These changes in fertility, in fact, have to be assessed jointly with the increase in the tax rate needed to balance the government budget. Such an increase in the tax rate, equal to 2.25%, is double relative to the increase required in the policy experiment described above, eliminating any possible positive fertility effect of the higher fiscal subsidy for households with higher income.

The positive income effect, which accompanies the increase in the pro-nativist fiscal subsidy, leads all groups of households to increase their level of consumption. When young, all groups of households increase their consumption, with those having a higher income ($i = 2$ and $i = 3$) increasing it by 0.07% and those having lower income increasing it by 2.2%. This positive income effect on consumption then decreases with the age of the households. When middle-aged, households with the lowest level of income increase their level of consumption

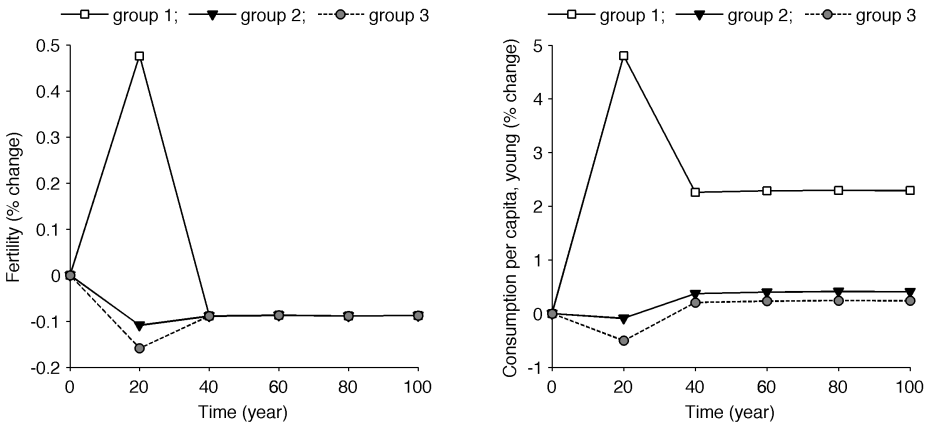


Figure 3.3: Fertility and consumption of young adults following an increase in the pro-nativist fiscal incentive for both groups of households.

by less than 2%, while households with a higher level of income can only maintain their initial level of consumption after having decreased it in the first period following the policy shock. When old, households with the lowest income continue to increase their level of consumption, but by 1.8%, while higher income households decrease their level of consumption by 0.5%. In this respect, the fiscal policy at stake can be classified both as a pro-nativist and as a redistributive fiscal policy, given it has stronger effects on the youngest and lowest income households.

The same positive income effect leads young adults to increase the share of their time spent as leisure and the one spent taking care of their children, while the one spent at work decreases. The effect of the policy on the allocation of time goes in the same direction for both lower and higher income households, although the size of this effect is larger for the households with the lowest level of income. In particular, for higher income young adults, the share of time spent at work decreases by 0.15%, while the share of time for leisure and the share of time spent with children increase by 0.2%. For those having a lower income, working time, leisure, and parental childcare decrease all by 0.6%. Besides, for all income groups, the allocation of time for middle-aged households changes in the same direction as for younger households. The size of the change in the allocation of time remains larger for the households with the lowest level of income. These latter decrease their working time by 0.15% and increase their leisure by 0.6%, while higher income households decrease their working time by 0.01% and increase leisure activities by 0.1%.

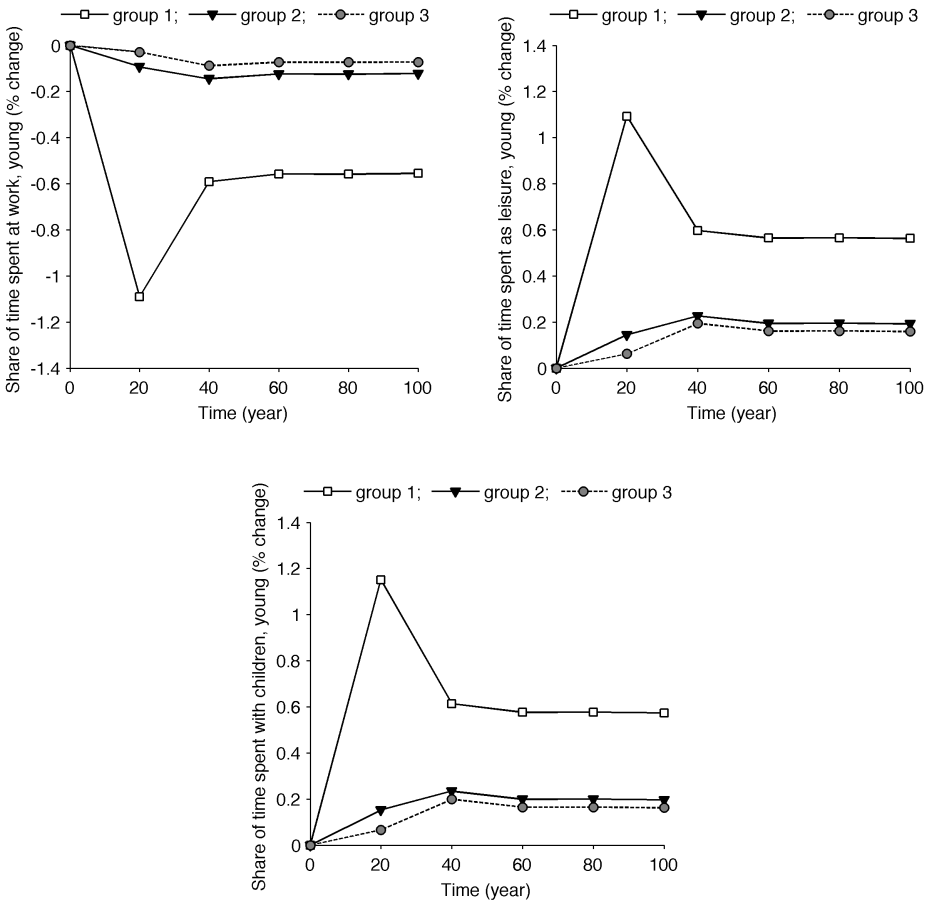


Figure 3.4: Time allocation of young households after the increase in the pro-nativist fiscal incentive for both groups of households.

As in the case of the first policy experiment, households with the lowest level of income ($i = 1$) decrease their inter-generational transfers. These households increase instead the savings for the next period of their life, by 50% just after the policy shock and by 20% afterwards. On the contrary, higher income households are able to increase the inter-generational transfers for their future generations by 10%, if they belong to the group $i = 2$, and by 20%, if they are part of the group $i = 3$. At the same time, higher income households are also able to, at least, keep constant their level of savings. Indeed, average income households increase their savings by 2%, when young adults, and by 5%, when middle-aged adults. Meanwhile, highest income households can only maintain their initial level of savings. Both when they are young and middle-aged adults, savings of highest income households return to their original level over the long run, after having fallen in the period immediately after the increase in the pro-nativist subsidy.

3.5 Taxation of inter-generational transfers

This section deals with the effects of a change in taxation of inter-generational transfers, considered as a policy tool alternative to a pro-nativist fiscal subsidy. It provides the results of two additional policy experiments, which both affect the value of the tax rate weighting on the inter-generational transfers of the highest income households ($\tau^b_{t,3}$).

As a first policy experiment, the value of $\tau^b_{t,3}$ is doubled, raising it to 20%. All impulse reaction functions are presented in Annex C.3. Notably, as regards fertility, this increases by 5% for the group of households that is directly targeted by the rise in the tax rate on inter-generational transfers ($i = 3$), while only a very marginal increase can be observed for the other groups of households ($i = 1$ and $i = 2$). These changes in fertility are sustained by a small decrease in the cost of childcare services for the highest income households (0.06%) and by a decrease in the tax rate on labour income (0.5%).

The level of consumption decreases for young households (up to 1%), remains stable at its original level for middle-aged, and increases for old households (up to 1.5%). These changes in consumption happen for all groups of households, with slightly larger values for households having the highest level of income ($i = 3$). Also, all groups of households modify their allocation of time. Indeed, the decrease in the tax rate on labour income cushions the negative effects of the higher inter-generational transfer taxation on the consumption of young

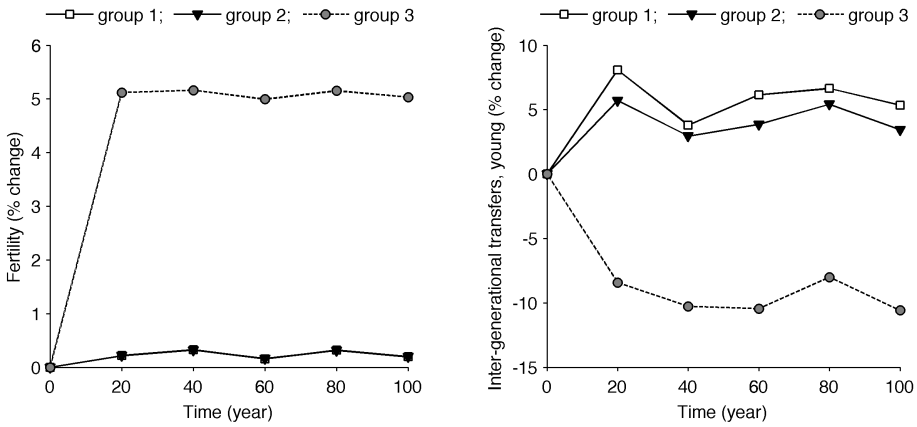


Figure 3.5: Fertility and consumption of young adults following an increase in inter-generational transfer taxation for the households of group 3 ($i = 3$).

households. Meanwhile, it leads them to slightly decrease their share of time spent at work and to increase both leisure and time spent with children. When middle-aged, households decrease the share of time spent at work (up to 0.06%) and increase the one spent as leisure (up to 0.4%). This very limited decrease in working time, allows households not to diminish their level of consumption during their last two periods of adult life.

Saving choices go in the opposite direction of consumption choices for all groups of households. Both young and middle-aged adult households are able to increase their level of savings over the long term, respectively up to 0.6% for young adults and 1.0% for middle-aged adults. The effect of inter-generational transfer taxation, instead, differs for each group of households. Those having a lower income and not being subject to the taxation of their inter-generational transfers increase these latter by 4%, if they belong to the average income group $i = 2$, or by 5%, if they belong to the poorest group of households $i = 1$. These higher inter-generational transfers compensate the stability of their level of fertility and the small increase in savings during their first period of adult life. On the other hand, being subject to a higher level of taxation on their inter-generational transfers, the households with the highest income decrease the transfers to their children by 10%. In this way, they trade off a higher level of fertility in exchange for a higher endowment for future generations.

As a second policy experiment, the value of the tax rate on inter-generational transfers ($\tau^b_{t,3}$) has been doubled as in the first policy experiment. However, this change has been now accompanied by an increase in the pro-nativist fiscal subsidies for poorer households ($\chi_{t,1}$)

of equal value. Annex C.4 gathers all charts illustrating the effects of this change.

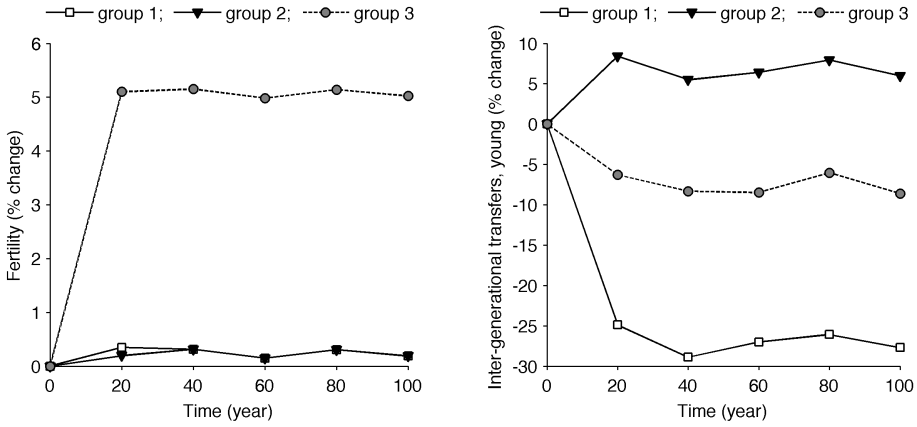


Figure 3.6: Fertility and consumption of young adults following an increase in inter-generational transfer taxation for the households of group 3 ($i = 3$) and an increase in pro-nativist fiscal subsidy for the households of group 1 ($i = 1$).

The main differences with respect to the previous policy experiment can be observed in the impulse reaction functions of the fertility rate and of the inter-generational transfers (see Figure 3.6). The 5% increase in the fertility rate of young households with the highest level of income ($i = 3$) is now reinforced by a more significant increase (0.35%) in the fertility rate of the poorest households ($i = 1$). At the same time, the households with the highest level of income as well as those with the lowest level decrease their transfers towards future generations. For the households with the highest level of income, this decrease is less pronounced than in the case of the previous policy experiment, being at 8% rather than 10%. Households with the lowest level of income, instead, behave in the opposite way relative to the previous policy experiment, decreasing by 30% the transfers to their children in place of increasing them by 5%. Inter-generational transfers continue to increase only for average income households ($i = 2$).

No major difference can be found as regards the other variables. Young adults tend to consume and work less, while enjoying more leisure and time spent with children. Also, young adults' savings for the following periods of their lives increase. Middle-aged households keep their level of consumption stable, decrease the time spent at work and increase leisure. Middle-aged adults increase even their level of savings, which corresponds to an increase in the level of consumption for old households.

3.6 Conclusions

This paper assesses the effect of a pro-nativist subsidy using an overlapping-generation general equilibrium model, with three different groups of households differentiated by ability type and hence by the initial level of their labour income. In particular, this paper analyses what the effect of an increase in pro-nativist fiscal subsidies is, first, for the poorest group of households only and, second, for all groups of households. As an alternative policy, this work shows also the consequences of an increase in the taxation of inter-generational transfers for the group of households with the highest labour income.

The main results of the paper are as follows. First, the introduction of households' heterogeneity allows one to give a further explanation to the puzzle highlighted by Granelli (2016) and briefly recalled in Section 3.1. Indeed, when the pro-nativist fiscal subsidy at stake in this paper is increased only for the poorest group of households, the overall effect of the change in this policy is attenuated by the different reactions of the fertility function for the three groups of households. Lowest income households increase their fertility, as they are those who benefit from the increase in the pro-nativist fiscal subsidy. Higher income households decrease their fertility rate, as they are assumed not to receive any pro-nativist fiscal subsidy and to be hit by the increase in the tax rate necessary to balance the budget.

Second, a generalized increase in the pro-nativist fiscal subsidy does not increase the fertility rate of all the three groups of households, but only of those with the lowest level of income. This kind of increase in the fiscal subsidy can be considered also as a redistributive policy, having effects on the consumption and the time allocation of the poorest group of households, beyond a pure pro-nativist fiscal subsidy aimed at increasing the fertility rate of the economy.

Finally, the increase of the tax rate on the inter-generational transfers left by the richer households to their children increases their fertility rate and decreases their inter-generational transfers. Even if subject to higher taxation of their inter-generational transfers, richer households prefer to decrease their level of consumption so as to cushion the decrease in the capital endowment left to future generations. In this sense, the model developed in this paper replicates the inter-generational persistence of wealth highlighted by the recent literature studying the relationship between fertility decisions and social mobility.

General Conclusion

This thesis investigates two different fiscal policies. The first is related to the taxation of personal income at international level. The second concerns the subsidization of households' fertility choices in a closed economy.

All chapters of this work present models mimicking existing policy schemes, although in a simplified manner. In particular, the first chapter develops a theoretical framework to compare a system of information exchange, similar to the one used in the USA, with the levy of a coordinated withholding tax, as required by the EU Savings Directive. The second chapter develops a Barro-Becker model, where adult households live for three periods, have altruistic preferences and are able to optimize their time use in terms of work, leisure and childcare, beyond deciding among consumption, savings, fertility and transfers to children. On that basis, the second chapter assesses quantitatively the effect of three different US pro-nativist fiscal subsidies on fertility, notably the personal exemption per dependent child, the childcare tax credit and the child tax credit. The third chapter extends the framework developed in the second chapter, by introducing three different groups of households differentiated by ability type and hence by the initial level of their labour income. Such extension allows one to simulate the effect of an increase in pro-nativist fiscal subsidies for the poorest group of households only, as well as for all groups of households. It also allows one to consider the taxation of inter-generational transfers as an alternative policy tool to stimulate the fertility rate of an economy, so as to study the effect of an increase in the taxation of inter-generational transfers on fertility.

Furthermore, all chapters of this work bring new contributions to the existing literature. The first chapter assesses the effects of the various settings investigated both on the income deriving from domestic and foreign savings. Also, it considers agents as investors able to split their savings among different countries and different assets. Finally, it copes with the cost of information sharing, making a distinction between the case where the country re-

quiring information is the one to cover its costs and the case where the partner country is made responsible for the transmission and the cost of the information needed. The second chapter includes an exercise of indirect inference to pin down the elasticity of households' fertility to tax subsidies. Along with the introduction of time allocation decisions, this exercise of indirect influence allows one to reconcile the small effect of pro-nativist fiscal policies generally found by the micro-econometric literature, with the larger effect generally pointed out by the macroeconomic literature on the subject. The third chapter, thanks to the introduction of households' heterogeneity, allows one to give a different explanation to the appearing divergence between the results of the micro-econometric literature and those of the macroeconomic literature. Indeed, a pro-nativist fiscal subsidy may have, on average, a small effect on the aggregate fertility rate, while having a stronger effect on the fertility reaction function of the households earning the least. The overall result of a pro-nativist fiscal policy, then, would simply be reflected by the effect of the different fertility reaction functions of the three groups of households.

The main conclusions of the different chapters of this work are as follows. The first chapter shows that both the system of taxation designed by the EU Savings Directive and the one underpinned by the FATCA regulation may represent efficient systems of international taxation under certain conditions. In particular, while the EU Savings Directive allows countries to tax individuals on their income, their scope is limited to interest-bearing products only. The extension of its scope to all kinds of financial products hence constitutes a necessary condition to reach an efficient solution of the game analyzed in the paper. Similarly, the FATCA regulation can represent the realization of a perfect exchange information regime, concerning all possible strategies and assets, but only assuming high quality of the information exchanged and low cost in sharing the information. The second chapter provides simulations of how fertility changes following both a change in the three subsidies considered and a shift in the allocation of public spending among the three subsidies. Using US data for the period 1905-2005, the results of these simulations match the empirical estimates of the fertility response to fiscal subsidies provided by Crump et al. (2011). Moreover, the second chapter provides some sensitivity analysis to the calibration obtained through indirect inference, showing how the three inter-temporal elasticities used in the model affect the impulse response function of fertility following a shock in the value of pro-nativist fiscal subsidies. It also discusses the role played by the introduction of a balanced budget rule, showing how this contributes to further lower the response of fertility to fiscal incentives. The third chapter then shows that both an increase in fiscal incentives targeted at households having the lowest level of income and a generalized increase in pro-nativist fiscal subsidies have a stronger

effect on the poorest households and a very limited effect on other groups of households. In that respect, it is shown that a generalized increase in pro-nativist fiscal subsidies has also redistributive effects on the consumption and the allocation of time of the poorest group of households. By contrast, an increase in the taxation of inter-generational transfers targeted at the richest group of households does not increase their fertility or decrease their transfers.

Finally, this thesis paves the way for further research. For instance, the first chapter is based on a static Nash game, while future work could address the same issues using a repeated Nash game model. Also, the quality of the information exchanged is assumed to be given, while it could be transformed into an endogenous variable of the model depending on the size of a country. In turn, this would allow one to demonstrate that smaller countries have no incentive to participate in international agreements for exchanging information. Besides, the second paper disregards the taxation of inter-generational transfers and assumes that agents are heterogeneous only in terms of age, but not in terms of skills or wealth. Although the third paper addresses these issues, it leaves unaddressed the additional variables influencing the inter-generational persistence of wealth. As mentioned previously, following an increase in the tax rate of inter-generational transfers the richest households prefer to decrease their level of fertility and keep endowing their future generations with a higher level of capital. This behavior could also be explained by other variables such as uncertainty or different preferences for different groups of households.

Appendix A

From the EU Savings Directive to the US FATCA, Taxing Cross Border Savings Income

In this appendix, we present the model in its complete version, once interest rates, agent's wealth and country population are allowed to be different in the two jurisdictions. The two rates, r_h for country $home$ and r_f for country $foreign$, can in fact differ for various reasons, including differences in terms of country risk or other country specific issues. Similarly, representative agents can dispose of different levels of wealth to invest, say w^h for country $home$ and w^f for country $foreign$. Countries also are not meant to be of equal size in terms of population. In what follows, we hence indicate with N^h the size of population in country $home$ and N^f the size of population in country $foreign$.

A.1 Source-based framework

As already pointed out, in the baseline scenario governments can choose different tax rates for local and foreign investors, because foreign interests are taxed at source by the host country and no information at all is exchanged between the residence and the host country. In such a framework, the representative investor of each country has a positive and real wealth w, with $w \in \mathbb{R}_+$, and selects the share of her wealth that she invests in both jurisdictions so to maximize her investment income.

Given an arbitrary initial allocation of agents' savings, the representative investor of country *home* decides how to invest her wealth solving the following maximization problem

$$\max_{a_h^h, a_f^h} \quad U^h = w^h \sum_{k=h,f} z_k^h a_k^h - \tfrac{v}{2} \sum_{k=h,f} \left(a_k^h - a_{0,h}^h\right)^2,$$
$$s.t. \sum_{k=h,f} a_k^h = 1 \quad and \quad \sum_{k=h,f} a_{0,k}^h = 1.$$

The after-tax interest rate, $z_k^h \in \mathbb{R}_+$, can be written as

$$z_h^h = (1 - t_h^h)\, r_h, \qquad z_f^h = (1 - t_f^h)\, r_f,$$

where $r_k \in \mathbb{R}_+$, with $k \in \{h, f\}$, stands for the before-tax interest rate paid out in country k.

Using the first order conditions, we find that

$$a_h^{h*} = a_{0,h}^h + \frac{z_h^h - z_f^h}{2} \frac{w^h}{v}, \qquad a_f^{h*} = a_{0,f}^h + \frac{z_f^h - z_h^h}{2} \frac{w^h}{v}.$$

In each country the portfolio allocation of the representative agent depends not only on the initial share of the agent's portfolio invested in that country and the differential between the after-tax net returns on the asset in the two jurisdictions, but also on the ratio between adjustment costs and agent's wealth. As shown in Section 1.4, if no exchange of information takes place between jurisdictions, then the optimal portfolio allocation of representative agents keeps corresponding to the initial share of wealth invested in each country, adjusted for a function of possible country differences in returns net of taxation.

In the second step of this game, each government maximizes its revenue and chooses the tax rates under its control, knowing the best response functions of investors. In this baseline scenario, the objective function of the government of country *home* is equal to

$$\max_{t_h^h, t_h^f} W^h = t_h^h a_h^{h*} r_h w^h N^h + t_h^f a_h^{f*} r_h w^f N^f,$$
$$s.t. \;\; t_h^h, t_h^f \leq 1,$$

with N^h and N^f being respectively the population of country *home* and $foreign$.

Solving the maximization programs of both governments, we obtain the best responses for

the tax rates charged by *home*,

$$\begin{aligned} t_h^{h*} &= \frac{1}{r_h}\left[a_{0,h}^h \frac{v}{w^h} + \frac{r_h - r_f(1-t_f^h)}{2}\right], \\ t_h^{f*} &= \frac{1}{r_h}\left[a_{0,h}^f \frac{v}{w^f} + \frac{r_h - r_f(1-t_f^f)}{2}\right], \end{aligned}$$

as well as the optimal tax rates,

$$\begin{aligned} t_h^{h*} &= \left(1 + a_{0,h}^h\right) \frac{2v}{3r_h w^h} + \frac{(r_h - r_f)}{3r_h}, \\ t_h^{f*} &= \left(1 + a_{0,h}^f\right) \frac{2v}{3r_h w^f} + \frac{(r_h - r_f)}{3r_h}. \end{aligned}$$

We find that the tax rates charged are influenced by three factors. First, they are a positive function of the importance of adjustment costs v with respect to agent's wealth. The higher the cost that agents face to move their savings, the higher the tax rate charged by a country can be. Second, they are also positive functions of the initial investment. The higher the initial share of investors' wealth invested in a country, the higher the tax rate set by the government of that country, reflecting the lower need of this latter to attract further savings from the partner jurisdiction. Third, the rates increase with the difference between the interest paid out in the two countries.

A.2 Residence-based framework

Shifting the power to tax cross-border savings from the source to the paying agent country, the representative agent of country *home* continues to maximize the same utility function as in the source-based framework, but her after-tax real net return on the two assets is now given by

$$z_h^h = \left(1 - t_h^h\right) r_h, \qquad z_f^h = \left(1 - t_h^h\right) r_f.$$

The return on foreign savings income is subject to the tax rate applied to domestic revenues by country *home*. The optimal allocation of investors having residence in country *home* does not change with respect to the source-based framework. In the simplified setting presented in the body of this work, the two after-tax real net returns become equal and the final portfolio

allocation always reflect the initial choice of agents.

The maximization problem for the government becomes

$$\max_{t_h^h} \; W^h = \left(t_h^h a_h^{h*} r_h + t_h^h a_f^{h*} r_f\right) w^h N^h,$$
$$s.t. \;\; t_h^h \leq 1.$$

Each country has just one tax rate to choose. Using the first order condition, it is easy to derive that for country *home*, it is optimal value is given by

$$t_h^{h*} = \frac{1}{2} + \frac{\left(a_{0,h}^h r_h + a_{0,f}^h r_f\right)}{\left(r_h - r_f\right)^2} \frac{v}{w^h}.$$

The tax rate equilibrium value is obtained straight from the first order condition, implying that each country fixes its tax rate independently. Proposition I holds and taxation is neutral for the allocation of savings as stated in proposition IV. The only difference with respect to the simplified scenario is that the optimal tax rates chosen by the countries no longer need to have the same value. As in the source-based framework, interest rates and agents' wealth influence the value of the optimal tax rate.

A.3 Information exchange

In a regime of information exchange, the representative agent of country *home* faces the same utility maximization problem as in source-based framework, but with the return coming from the share of her savings invested abroad depending also on the tax rate applied on her domestic income (if this rate is higher than the withholding tax charged in country $foreign$) and on the quality of the information regarding her cross-border savings.

The after-tax real net returns for the representative resident of country *home* are defined similarly to (1.8):

$$z_h^h = \left(1 - t_h^h\right) r_h, \qquad z_f^h = \left[1 - t_f^h - max\left\{0, p^f \left(t_h^h - t_f^h\right)\right\}\right] r_f.$$

The allocation of savings for the representative investor of country *home* follows the formula found in (1.3). If exchange of information does take place between jurisdictions, then the

share of representative agent's portfolio invested in the domestic asset is a positive function of the quality of the information exchanged between jurisdictions.

The government of country *home* faces the following maximization program:

$$\begin{aligned}\max_{t_h^h, t_h^f} W^h &= \left[t_h^h a_h^{h*} r_h + p^f \left(t_h^h - t_f^h\right) a_f^{h*} r_f\right] w^h N^h + t_h^f a_h^{f*} r_h w^f N^f, \\ s.t.\ \ & t_h^h, t_h^f \leq 1,\end{aligned}$$

with the equilibrium solutions for the tax rates charged by *home* given by

$$\begin{aligned} t_h^{h*} &= \frac{2v\left[a_{0,h}^h\left(r_h - p^f r_f\right) + r_h(1-p^f) - p^f(r_h - r_f)\right] + (r_h - r_f)\left(r_h - p^f r_f\right) w^h}{(3-2p^f)\left(r_h - p^f r_f\right)^2 w^h}, \\ t_h^{f*} &= \frac{2v\left[a_{0,h}^f(r_f - p^h r_h) - r_f\right] + (r_f - r_h)\left(r_f - p^h r_h\right) w^f}{(3-2p^h)\, r_h \left(r_f - p^h r_h\right) w^f}. \end{aligned}$$

Tax rates are positive functions of the quality of the information received from the partner country. Proposition II continues to hold. In addition, the larger the population of a country, the more this country will have incentives to participate in international agreements for exchanging information, in order to retrieve taxes on savings invested abroad.

A.4 EU Savings Directive

The EU Directive applies only to savings income in the form of interest payments and to some interest-based financial products. As in Section 1.6, if both countries issue a financial product falling out of the range of application of the Directive, h' and f', then agents' income coming stemming from holding h and f is taxed exclusively by the country of residence of the taxpayer, while income from h' and f' is taxed only by the country where interests are paid out.

In country *home*, the agent's maximization problem is

$$\begin{aligned}\max_{a_h^h, a_{h'}^h, a_{f'}^h} \quad U^h &= \sum_{l=h,h',f'} w^h z_l^h a_l^h - \tfrac{v}{2} \sum_{l=h,h',f'} \left(a_l^h - a_{0,l}^h\right)^2, \\ s.t. \sum_{l=h,h',f'} a_l^h &= 1 \quad and \quad \sum_{l=h,h',f'} a_{0,l}^h = 1.\end{aligned}$$

Similarly to (1.12), the solution to the agent's maximization problem is given by

$$\begin{aligned} a_h^{h*} &= a_{0,h}^h + \frac{(z_h^h - z_{f'}^j) + (z_h^h - z_{h'}^j)}{3}\frac{w^h}{v}, \quad a_{f'}^{j*} = a_{0,f'}^j + \frac{(z_{f'}^j - z_h^h) + (z_{f'}^j - z_{h'}^j)}{3}\frac{w^h}{v}, \\ a_{h'}^{j*} &= a_{0,h'}^h + \frac{(z_{h'}^j - z_h^h) + (z_{h'}^j - z_{f'}^j)}{3}\frac{w^h}{v}. \end{aligned}$$

The government of this country fixes its respective tax rates according to the following maximization problem

$$\max_{t_h^h, t_{h'}^j} \quad W^h = t_h^h(a_h^{h*} r_h + a_f^{h*} r_f) w^h N^h + t_{h'}^j (a_{h'}^{h*} w^h N^h + a_{h'}^{f*} w^f N^f) r'_h,$$
$$s.t. \;\; t_h^h, t_{h'}^j \leq 1,$$

whose optimal solution are equal to

$$\begin{aligned} t_h^{h*} &= \frac{\left(w^{h2}N^h + w^{f2}N^f\right)\left[70w^{h2}N^h + w^f N^f\left(29w^h + 36w^f\right)\right]}{9r\left(8w^{h4}N^{h2} + 17w^{h2}N^h w^{f2}N^f + 8w^{f4}N^{f2}\right)}\frac{v}{w^h}, \\ t_{h'}^{j*} &= \frac{2v\left[26w^{h3}N^{h2} + 16w^{f3}N^{f2} + w^h N^h w^f N^f\left(19w^h + 20w^f\right)\right]}{9r\left(8w^{h4}N^{h2} + 17w^{h2}N^h w^{f2}N^f + 8w^{f4}N^{f2}\right)}. \end{aligned}$$

Optimal tax rates are functions of the relative size of the two countries in terms of population and wealth. Having two tax rates to establish, each country can set its domestic tax rate at a higher level and use the withholding tax rate to attract foreign savings. Proposition III holds, with the proviso that larger countries may establish higher values for the optimal tax rates and thus face more significant movements of savings towards assets escaping the application of the EU Directive.

A.5 The US model with costly information

As explained in Section 1.7, when acquiring information is costly, in a regime of information exchange jurisdiction *home* supports the cost (ϕ) of p^f. The tax revenue function becomes then

$$\max_{t_h^h, t_h^f} W^h = t_h^h a_h^{h*} w^h N^h r_h + p^f\left(t_h^h - t_f^h\right) a_f^{h*}(1-\phi) w^h N^h r_f + t_h^f a_h^{f*} w^f N^f r_h.$$

Due to the presence of ϕ, the equilibrium tax rates in (1.9) become

$$\begin{aligned} t_h^{h*} &= \frac{2v\left[(a_{0,h}^h - 2p^f)(r_h - p^f r_f) + \left(r_h + (1-2\phi)p^f r_f\right)\right] + (r_h - r_f)\left(r_h - p^f r_f\right) w^h}{(3-2p^f)\left(r_h - p^f r_f\right)^2 w^h}, \\ t_h^{f*} &= \frac{2v\left[a_{0,h}^f(r_f - p^h r_h) + (r_f - \phi p^h r_h)\right] + (r_f - r_h)\left(r_f - p^h r_h\right) w^f}{(3-2p^h)\, r_h \left(r_f - p^h r_h\right) w^f}. \end{aligned}$$

Moving from a unilateral mechanism of getting information on financial accounts of its residents to a cooperative agreement where each partner provides information regarding foreign accounts on its territory transforms the government maximization problem into

$$\max_{t_h^h, t_h^f} W^h = t_h^h a_h^{h*} w^h N^h r_h + p^f (t_h^h - t_f^h) a_f^{h*} \left[1 - (1-\chi)\phi\right] w^h N^h r_f + (\chi\phi) p^h (t_h^f a_h^{f*} w^f N^f r_h),$$

with the optimal solution given by

$$\begin{aligned} t_h^{h*} &= \frac{2v\left[(a_{0,h}^h - 2p^f)(r_h - p^f r_f) + \left(r_h + (1-2\phi)p^f r_f\right)\right] + (r_h - r_f)\left(r_h - p^f r_f\right) w^h}{(3-2p^f)\left(r_h - p^f r_f\right)^2 w^h}, \\ t_h^{f*} &= \frac{2v\left[a_{0,h}^f(r_f - p^h r_h) + (r_f - \phi p^h r_h)\right] + (r_f - r_h)\left(r_f - p^h r_h\right) w^f}{(3-2p^h)\, r_h \left(r_f - p^h r_h\right) w^f}. \end{aligned}$$

As stated in proposition IV, for higher values of χ, that is for larger parts of the information cost ϕ paid by the partner country, the internal tax rate is higher while the external tax rate is lower. Tax revenues increase.

A.6 Coordinated withholding taxation

Under this scenario countries *home* and $foreign$ transfer each other part of their respective revenues coming from cross-border savings taxation. Nothing changes for the agents decision with respect to what said in the source-based framework. On the contrary, the maximization problem for the government of country *home* can be modified as follows:

$$\begin{aligned} \max_{t_h^h, t_h^f} \; & W^h = \left(t_h^h a_h^{h*} r_h + x t_f^h a_f^{h*} r_f\right) w^h N^h + (1-x)\, t_h^f a_h^{f*} r_h w^f N^f, \\ & s.t. \;\; t_h^h, t_h^f \leq 1. \end{aligned}$$

The optimal rates charged by country *home* are now equal to

$$\begin{aligned} t_h^h &= \frac{2v[(1+x)+a_{0,h}^h(1-x)]+(r_h-r_f)w^h(1-x)}{r_h(3-x)w^h} \\ t_h^f &= \frac{2v(1+a_{0,h}^f)+(r_h-r_f)w^f}{r_h(3-x)w^f} \end{aligned}$$

In a framework of coordinated withholding taxation, tax rates are higher than those levied in case of no exchange of information due to the sharing agreement. Proposition V thus holds insofar as the sharing agreement increases the tax revenues of a country.

Finally, allowing the two countries to differ in terms of population, interest rates, and agents' wealth does not affect the efficiency of the tax systems analyzed in this paper. These differences affect agents' portfolio allocation, the value of the optimal tax rates chosen by the governments and consequently the tax revenues collected in each country. As stated in proposition VI, however, only three settings represent the framework ensuring the efficient taxation of international savings: a pure residence-based setting, a framework of perfect exchange of information concerning all assets or strategies, and a system of withholding taxation where withholding tax rates are decided by the country of residence and the whole amount of withholding tax revenues is fully transferred to that country.

Appendix B

Family Tax Policy in a Model with Endogenous Fertility à la Barro-Becker

B.1 Alternative formulation of the Barro-Becker model

This Appendix provides an alternative formulation of the Barro-Becker model, which does not require extra constraints on the utility of the parents' maximization problem. This is possible by reformulating the Barro-Becker model as a planner's problem with benevolent parents for any value of the inter-temporal elasticity attached to the parents' utility function:

$$U = u(c) + \int_0^n p_i(n)u(x_i)di,$$

where c represents parental consumption, x_i is the consumption of child i, and n is the number of children. Moreover, the Pareto weight attached to the utility of parents is normalized to 1, while p_i are Pareto's weights defining the degree of parental altruism toward child i and may depend on the number of children n. $p_i(n) > 0 \, \forall i$ ensures to have benevolent parents.

Starting from the above parents' utility function, the Barro-Becker model can be obtained by setting $p_i(n) = p(n)$. Indeed, as long as the parent is unconstrained in the transfers made across children, setting $p_i = p \, \forall i$ (*i.e.* same Pareto weights for all children), ensures that the parent will choose $u'(x_i) = u'(x_j) \, \forall i, j$, and hence $x_i = x \, \forall i$. As a result, the parents' utility function becomes

$$U = u(c) + p(n)u(x) \int_0^n di = u(c) + np(n)u(x).$$

With $p(n) = bn^{-\epsilon}$, (B.1) can be transformed into

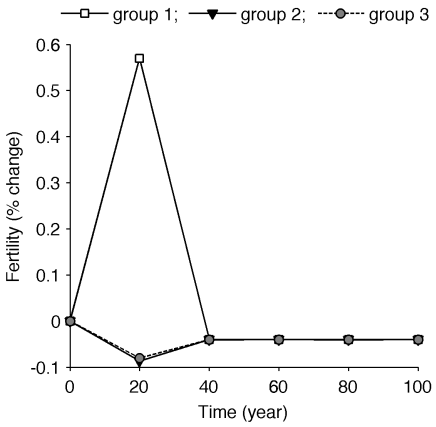
$$U = u(c) + bn^{1-\epsilon}u(x),$$

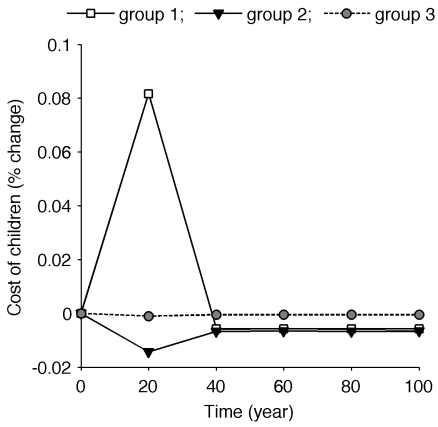
as in the Barro-Becker model. In this framework, even if $u(x) = \frac{x^{1-\sigma}}{1-\sigma}$ with $\sigma > 1$, verifying that $\epsilon > \sigma$ and $b > 0$ ensures that the expression $p_i(n) = p(n) = bn^{-\epsilon}$ is positive, so that the parent is indeed benevolent.

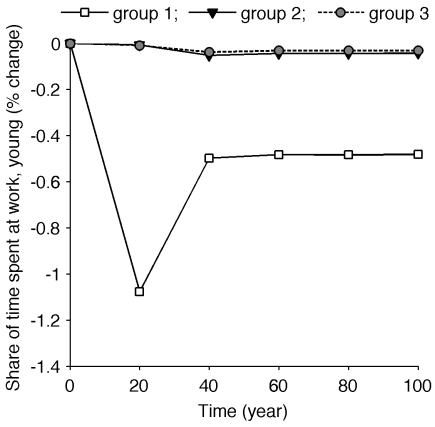
Appendix C

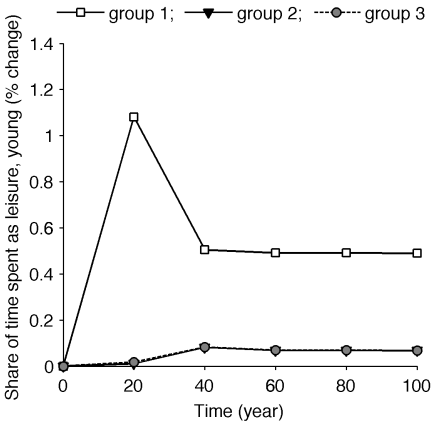
Family Tax Policy with Heterogeneous Altruistic Households

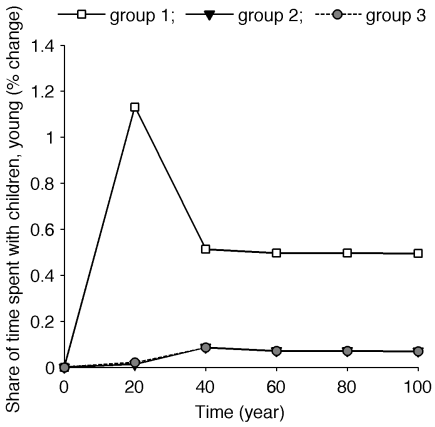
C.1 Effects of an increase in the pro-nativist fiscal incentive only for the poorest group of households

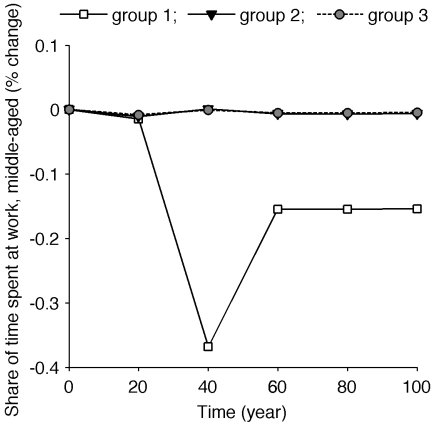


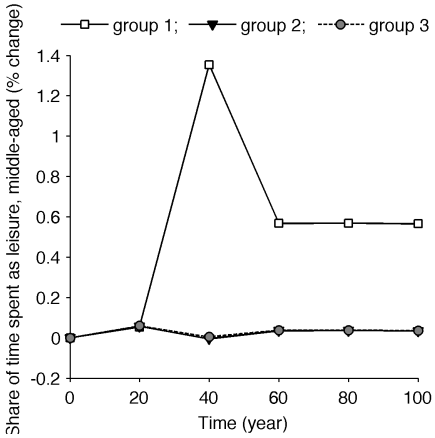


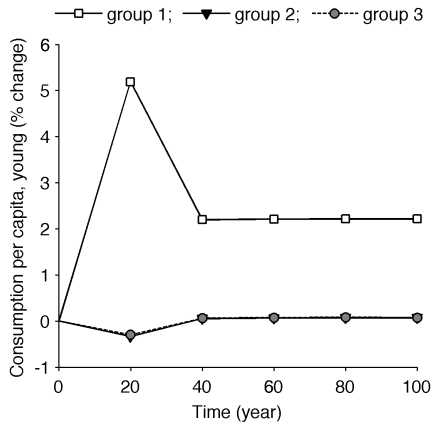

group 1;
group 2;
group 3
Share of time spent at work, young (% change)
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
0
20
40
60
80
100
Time (year)

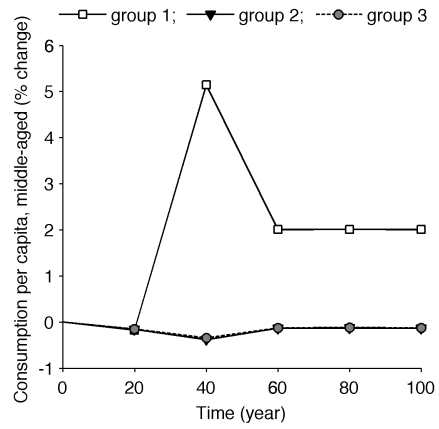

group 1;
group 2;
group 3
Share of time spent as leisure, young (% change)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
20
40
60
80
100
Time (year)

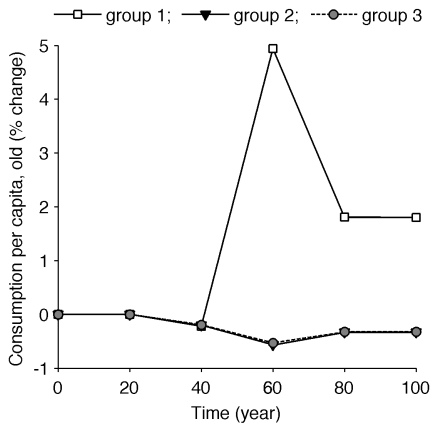

group 1;
group 2;
group 3
Share of time spent with children, young (% change)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
20
40
60
80
100
Time (year)

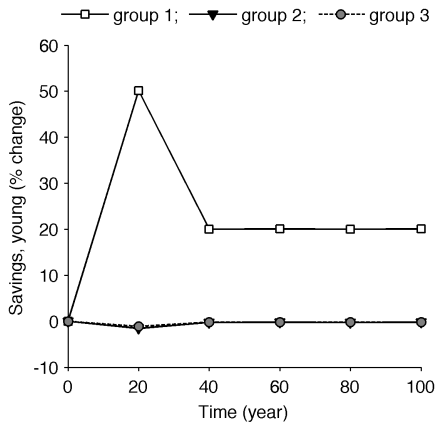

group 1;
group 2;
group 3
Share of time spent at work, middle-aged (% change)
0.1
0
-0.1
-0.2
-0.3
-0.4
0
20
40
60
80
100
Time (year)

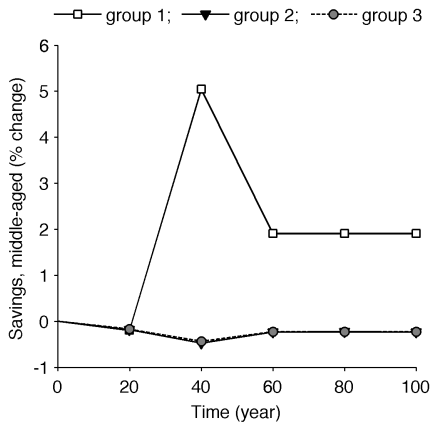

group 1;
group 2;
group 3
Share of time spent as leisure, middle-aged (% change)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
0
20
40
60
80
100
Time (year)

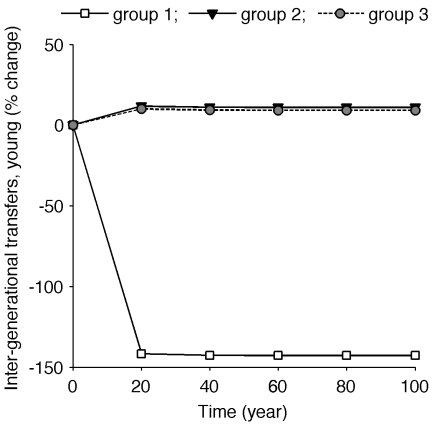

group 1;
group 2;
group 3
Consumption per capita, young (% change)
6
5
4
3
2
1
0
-1
0
20
40
60
80
100
Time (year)

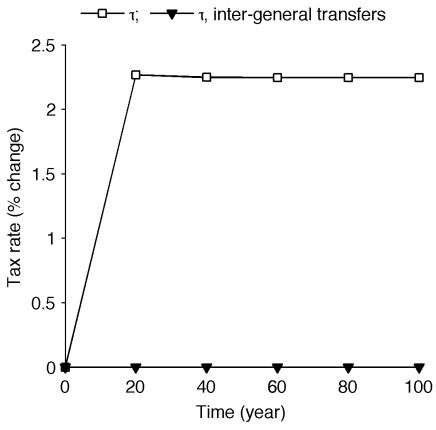

group 1;
group 2;
group 3
Consumption per capita, middle-aged (% change)
Time (year)


group 1;
group 2;
group 3
Consumption per capita, old (% change)
Time (year)

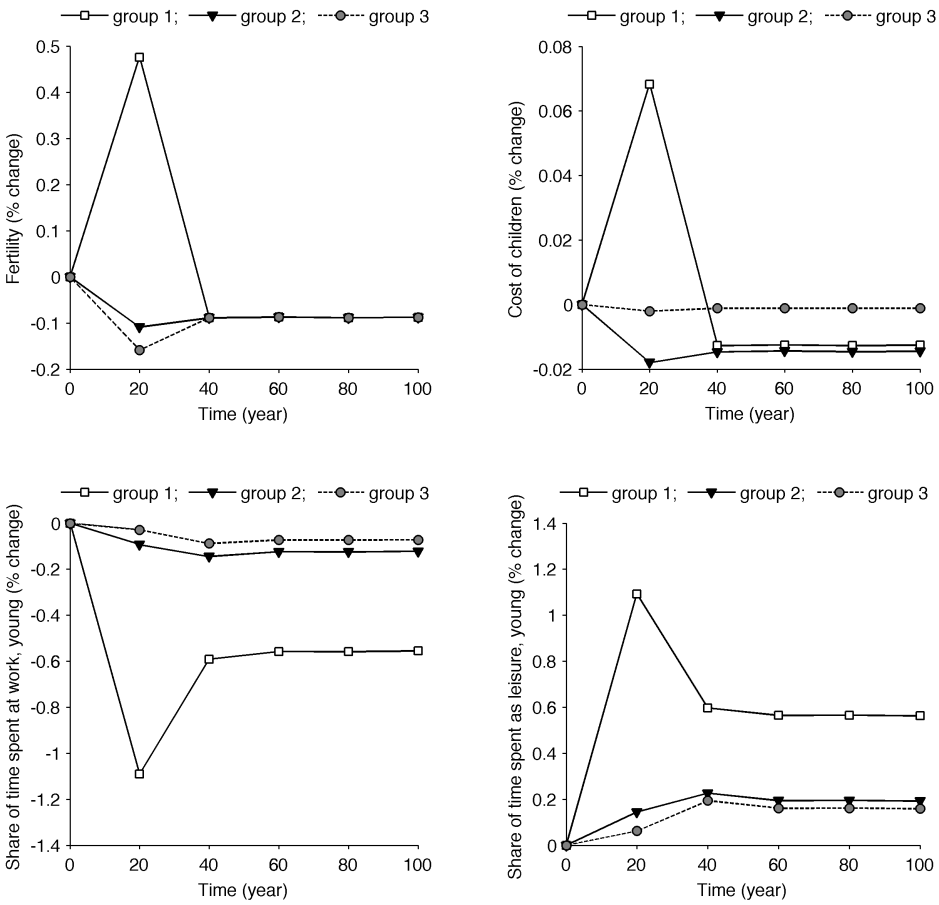

group 1;
group 2;
group 3
Savings, young (% change)
Time (year)

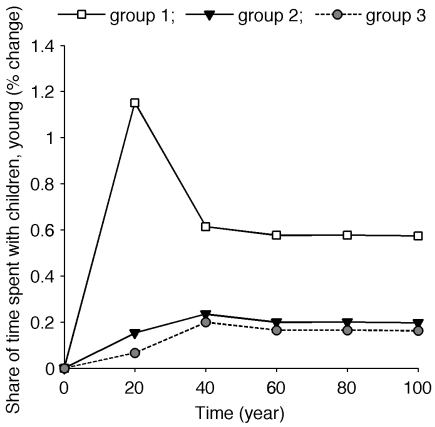

group 1;
group 2;
group 3
Savings, middle-aged (% change)
Time (year)

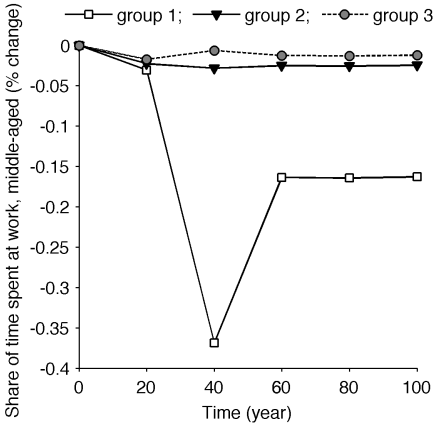

group 1;
group 2;
group 3
Inter-generational transfers, young (% change)
Time (year)

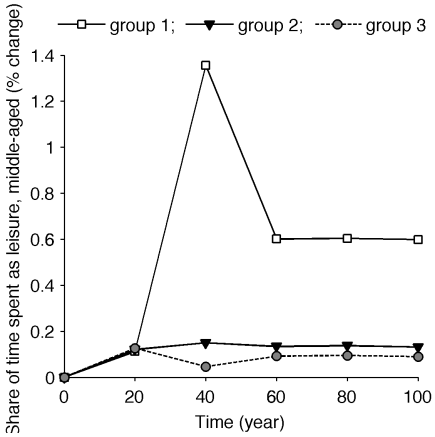

τ;
τ, inter-general transfers
Tax rate (% change)
Time (year)

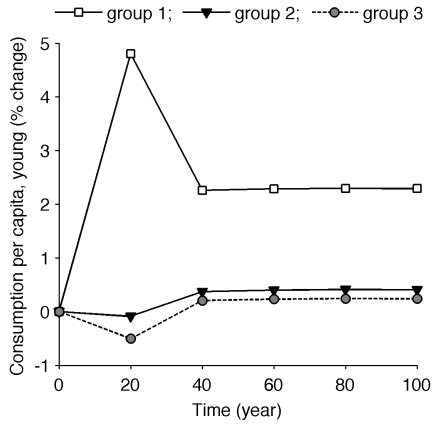
C.2 Effects of an increase in the pro-nativist fiscal incentive for all groups of households

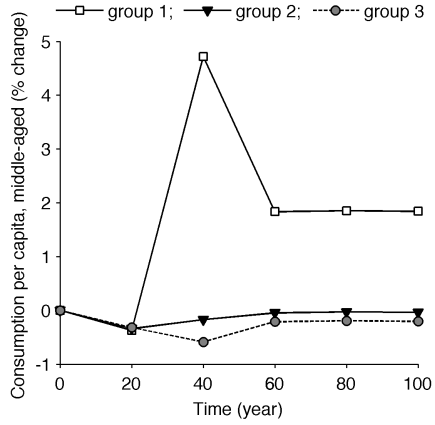


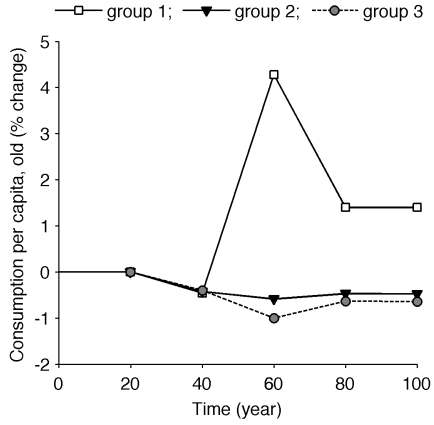

group 1;
group 2;
group 3
Share of time spent with children, young (% change)
Time (year)

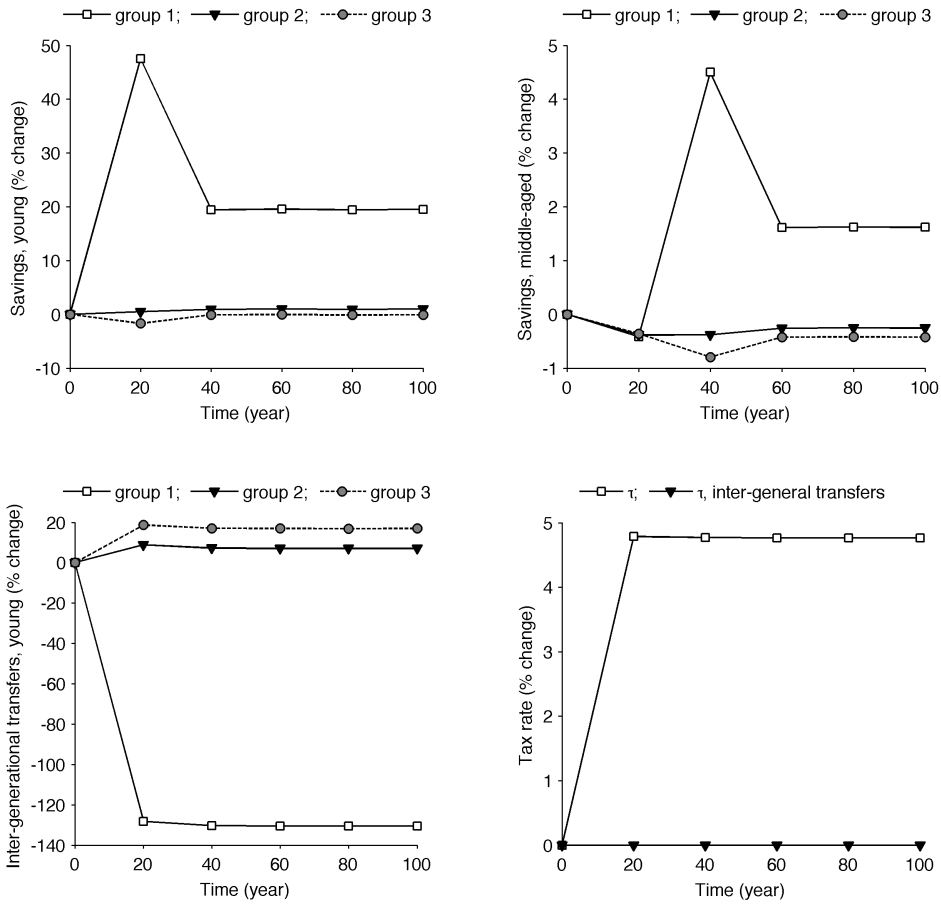

group 1;
group 2;
group 3
Share of time spent at work, middle-aged (% change)
Time (year)


group 1;
group 2;
group 3
Share of time spent as leisure, middle-aged (% change)
Time (year)

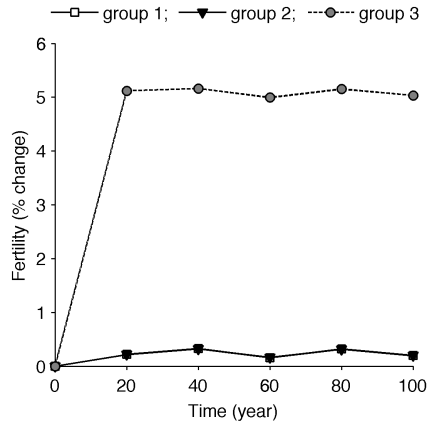

group 1;
group 2;
group 3
Consumption per capita, young (% change)
Time (year)

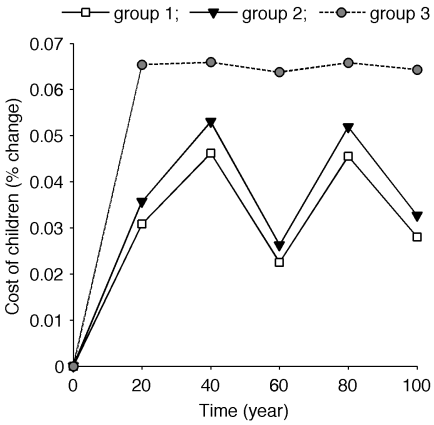

group 1;
group 2;
group 3
Consumption per capita, middle-aged (% change)
Time (year)

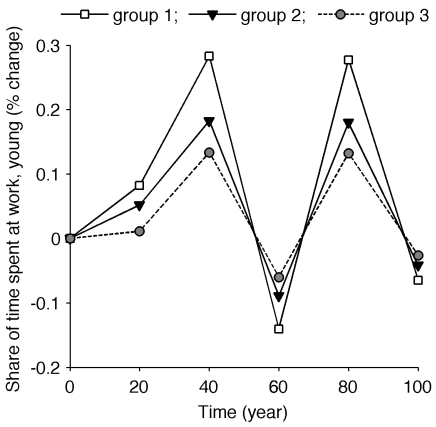

group 1;
group 2;
group 3
Consumption per capita, old (% change)
Time (year)

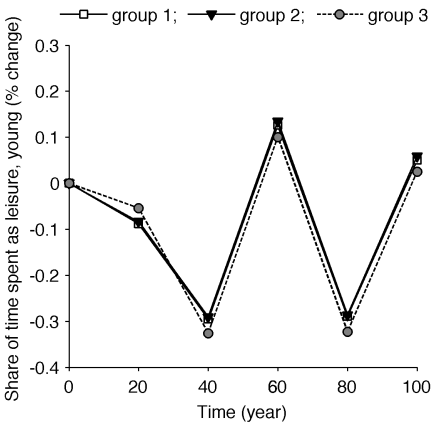

group 1;
group 2;
group 3
Savings, young (% change)
Time (year)
Savings, middle-aged (% change)
Inter-generational transfers, young (% change)
τ;
τ, inter-general transfers
Tax rate (% change)

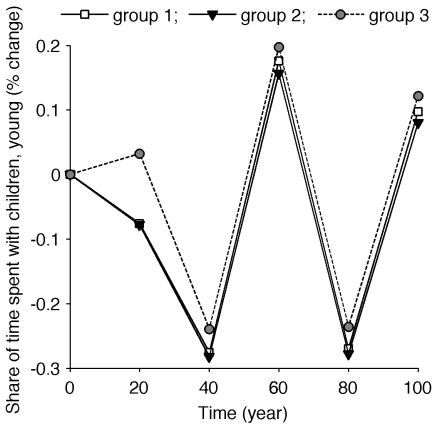
C.3 Effects of an increase in the taxation of inter-generational transfers

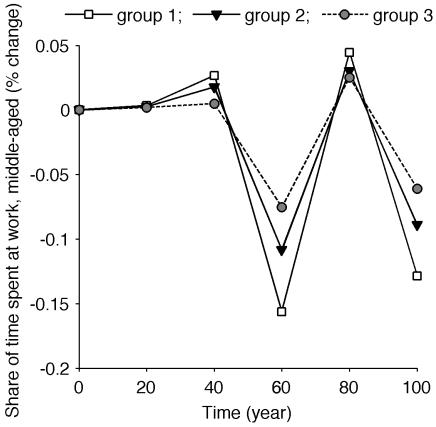


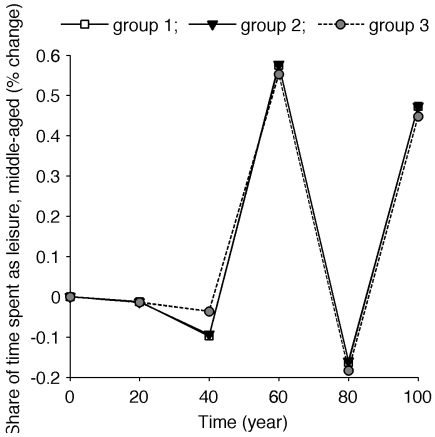


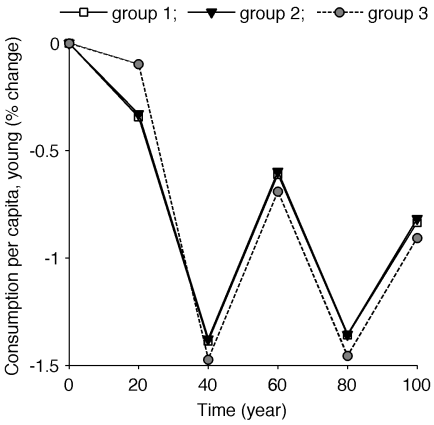


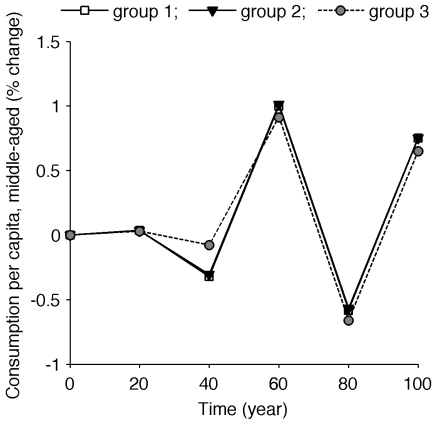


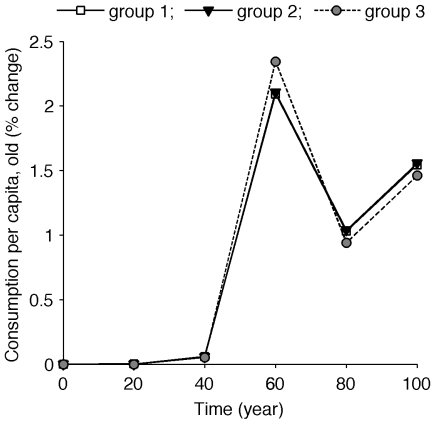

group 1;
group 2;
group 3
Share of time spent with children, young (% change)
0.2
0.1
0
-0.1
-0.2
-0.3
0
20
40
60
80
100
Time (year)

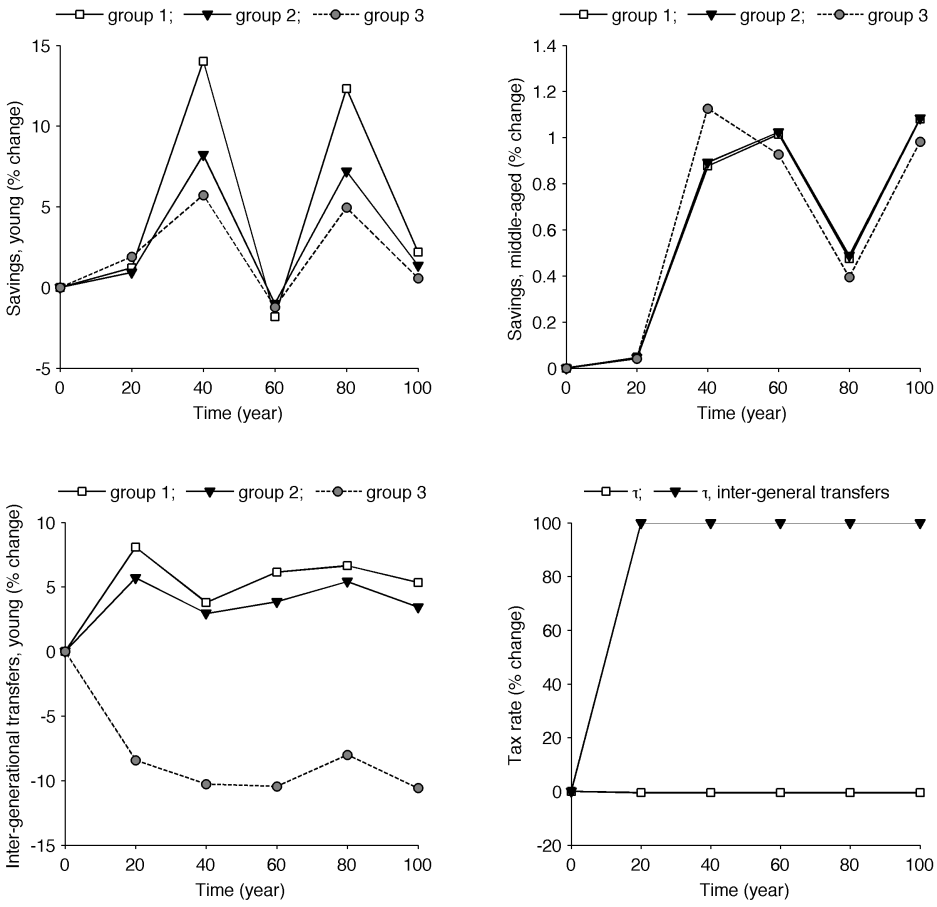

group 1;
group 2;
group 3
Share of time spent at work, middle-aged (% change)
0.05
0
-0.05
-0.1
-0.15
-0.2
0
20
40
60
80
100
Time (year)


group 1;
group 2;
group 3
Share of time spent as leisure, middle-aged (% change)
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
0
20
40
60
80
100
Time (year)

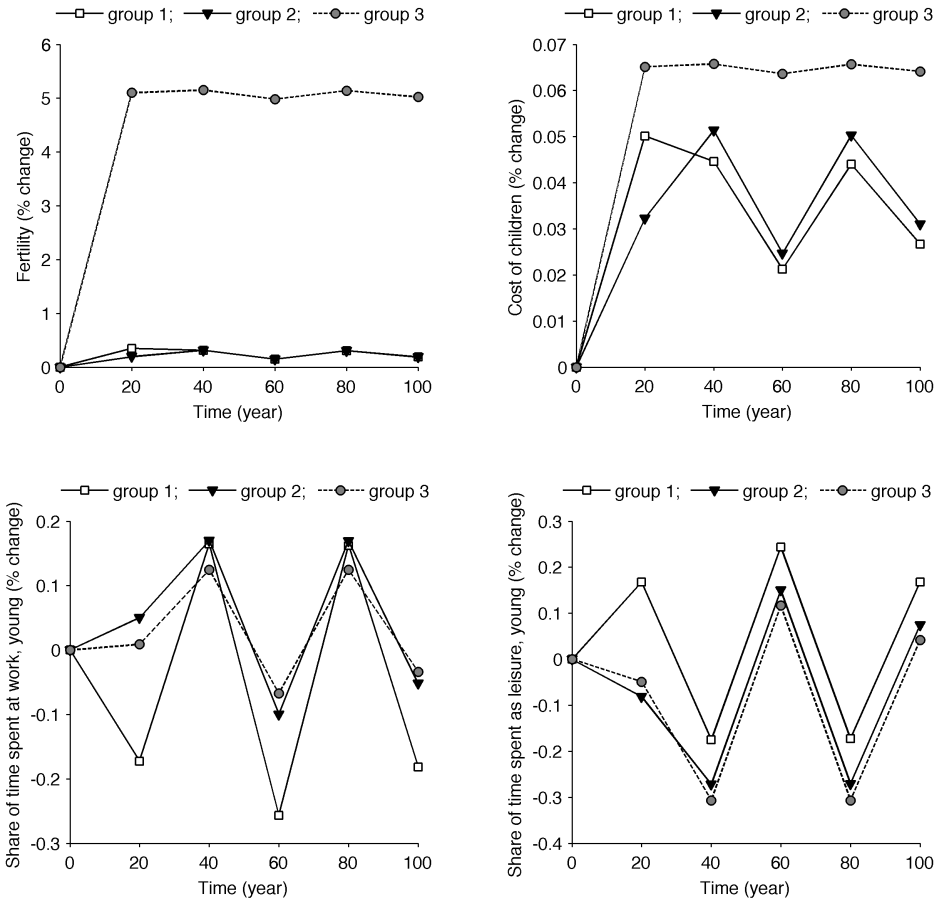

group 1;
group 2;
group 3
Consumption per capita, young (% change)
0
-0.5
-1
-1.5
0
20
40
60
80
100
Time (year)

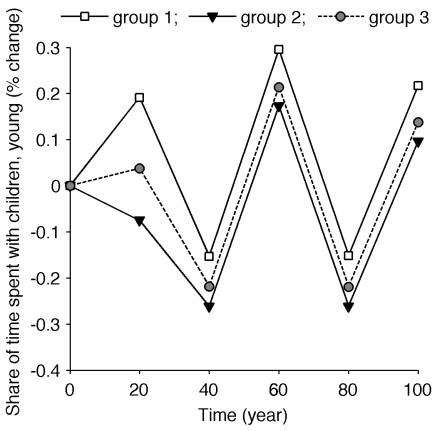

group 1;
group 2;
group 3
Consumption per capita, middle-aged (% change)
1.5
1
0.5
0
-0.5
-1
0
20
40
60
80
100
Time (year)

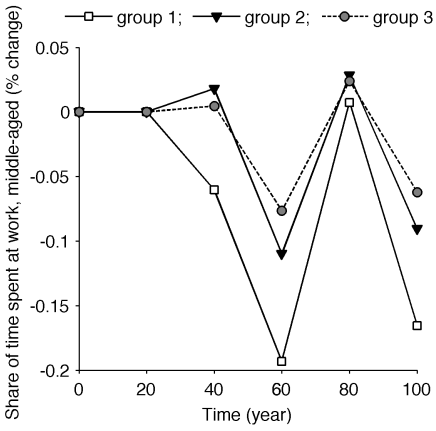

group 1;
group 2;
group 3
Consumption per capita, old (% change)
2.5
2
1.5
1
0.5
0
0
20
40
60
80
100
Time (year)

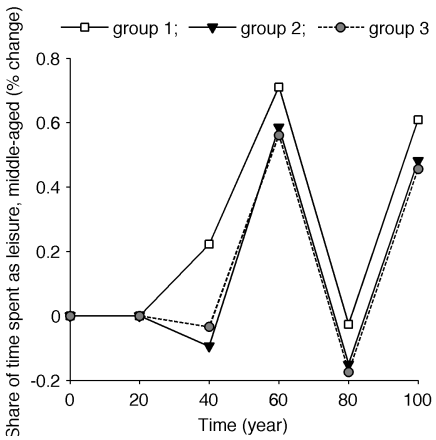

group 1;
group 2;
group 3
Savings, young (% change)
Time (year)
Savings, middle-aged (% change)
Inter-generational transfers, young (% change)
τ;
τ, inter-general transfers
Tax rate (% change)

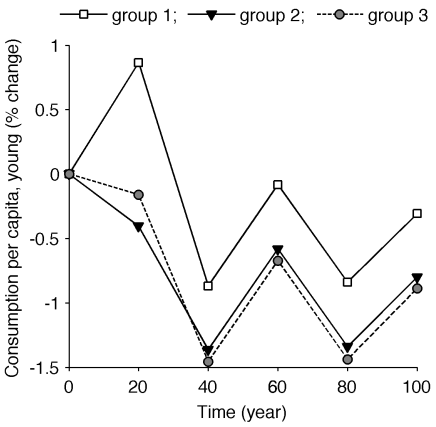
C.4 Effects of an increase in the taxation of inter-generational transfers, accompanied by an increase in the pro-nativist fiscal incentive for the poorest group of households

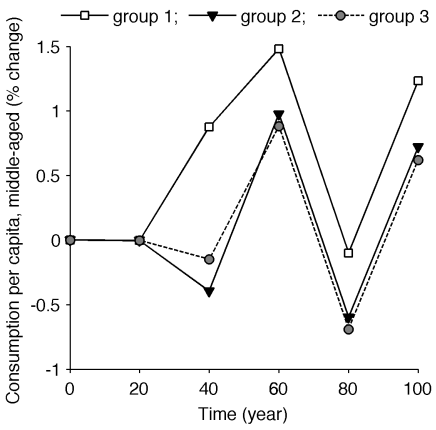


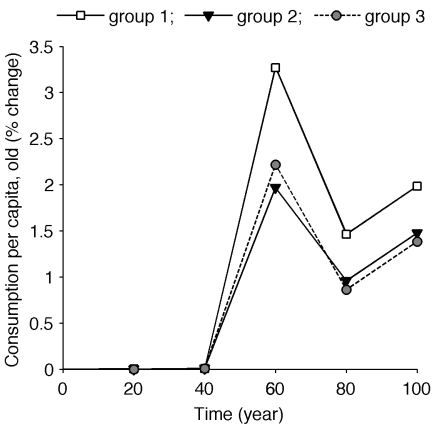

group 1;
group 2;
group 3
Share of time spent with children, young (% change)
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
0
20
40
60
80
100
Time (year)

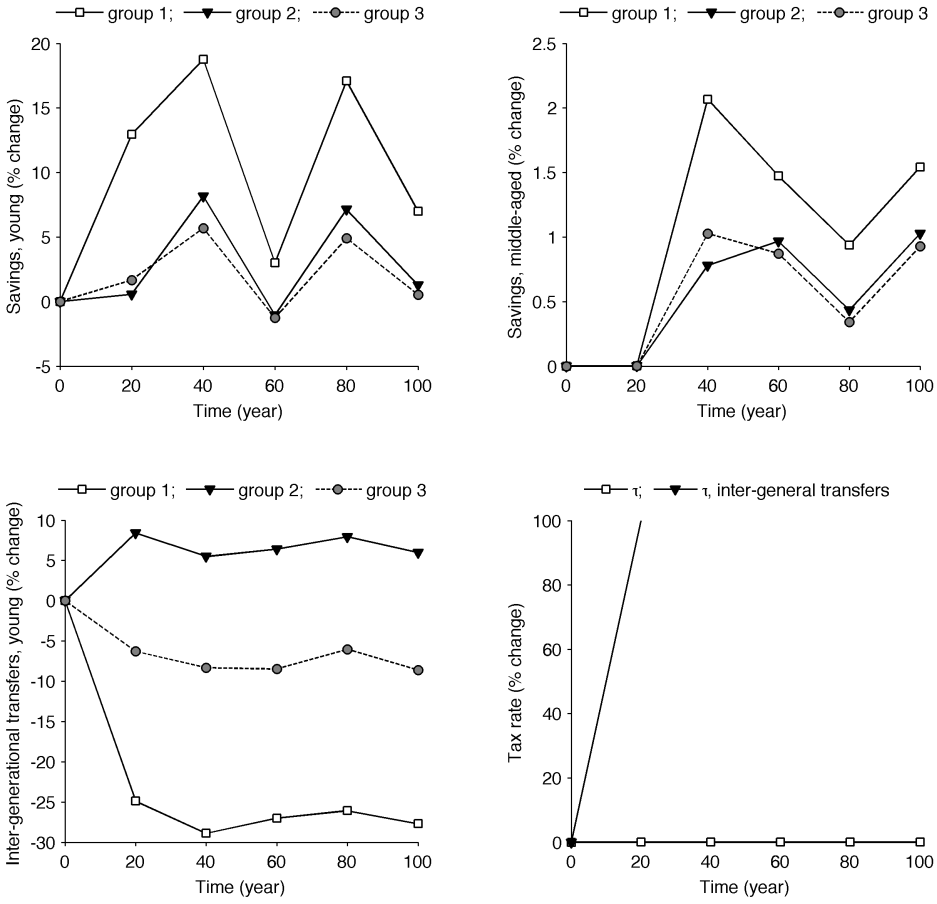

group 1;
group 2;
group 3
Share of time spent at work, middle-aged (% change)
0.05
0
-0.05
-0.1
-0.15
-0.2
0
20
40
60
80
100
Time (year)


group 1;
group 2;
group 3
Share of time spent as leisure, middle-aged (% change)
0.8
0.6
0.4
0.2
0
-0.2
0
20
40
60
80
100
Time (year)


group 1;
group 2;
group 3
Consumption per capita, young (% change)
1
0.5
0
-0.5
-1
-1.5
0
20
40
60
80
100
Time (year)


group 1;
group 2;
group 3
Consumption per capita, middle-aged (% change)
1.5
1
0.5
0
-0.5
-1
0
20
40
60
80
100
Time (year)


group 1;
group 2;
group 3
Consumption per capita, old (% change)
3.5
3
2.5
2
1.5
1
0.5
0
0
20
40
60
80
100
Time (year)


group 1;
group 2;
group 3
Savings, young (% change)
Time (year)
Savings, middle-aged (% change)
Inter-generational transfers, young (% change)
τ;
τ, inter-general transfers
Tax rate (% change)

Bibliography

[1] Allingham, M. and A. Sandmo (1972), "Income tax evasion. A theoretical analysis," Journal of Public Economics, 1, 323-338.

[2] Alm, J. and B. Torgler (2006), "Culture differences and tax morale in the United States and in Europe," Journal of Economic Psychology, 27, 224-246.

[3] Alvarez, F. (1999), "Social Mobility: The Barro-Becker Children Meet the Laitner-Loury Dynasties," Review of Economic Dynamics, 2(1), 65-103.

[4] Apps, P. and R. Rees (2004), "Fertility, Taxation and Family Policy," Scandinavian Journal of Economics, 106(4), 745-763.

[5] Apps, P. and R. Rees (2007), "The Taxation of Couples," Institute for the Study of Labor (IZA), Discussion Paper 2910.

[6] Apps, P. and R. Rees (2010), "Family labor supply, taxation and saving in an imperfect capital market," Review of Economics of the Household, 8(3), 297-323.

[7] Bacchetta, P. and M. P. Espinosa (1995), "Information Sharing and Tax Competition Among Governments," Journal of International Economics, 39, 103-121.

[8] Bacchetta, P. and M. P. Espinosa (2000), "Exchange-of-Information Clauses in International Tax Treaties," International Tax and Public Finance, 7, 275-293.

[9] Barro, R. J. and G. S. Becker (1989), "Fertility Choice in a Model of Economic Growth," Econometrica, 57(2), 481-501.

[10] Baudin, T. (2011), "Family policies: What does the standard endogenous fertility model tell us?," Journal of Public Economic Theory, 13(4): 555-593.

[11] Baudin, T. (2012), "The Optimal Trade-Off Between Quality and Quantity with Unknown Number of Survivors," Mathematical Population Studies, 19(2):94-113.

[12] Baudin, T., de la Croix, D. and P. E. Gobbi (2015), "Fertility and Childlessness in the United States," American Economic Review, 105(6), 1852-82.

[13] Becker, G. S. (1960), "An Economic Analysis of Fertility," in Demographic and Economic Change in Developed Countries, National Bureau of Economic Research, 209-240.

[14] Becker, G. S. and R. J. Barro (1988), "A Reformulation of the Economic Theory of Fertility," The Quarterly Journal of Economics, 103(1), 1-25.

[15] Bental, B. (1989), "The Old Age Security Hypothesis and Optimal Population Growth," Journal of Population Economics, 4(1), 285-301.

[16] Bertola, G., Foellmi, R. and J. Zweimller (2005), Income Distribution in Macroeconomic Models, Princeton University Press, Princeton.

[17] Boldrin, M., De Nardi, M. and L. E. Jones (2015), "Fertility and Social Security," JODE - Journal of Demographic Economics, 81(3), 261-299.

[18] Cattoir, P. (2006), "A history of the tax package: The principles and issues underlying the community approach," Taxation Papers 10, Directorate General Taxation and Customs Union, European Commission.

[19] Chari, V. V., Kehoe, P. J. and E. R. McGrattan (2007), "Business Cycle Accounting," Econometrica, 75(3), 781-836.

[20] Cigno, A. (1986), "Fertility and the Tax-Benefit System: A Reconsideration of the Theory of Family Taxation," Economic Journal, 384(96), 1035-51.

[21] Cigno, A. (1992), "Children and Pensions," Journal of Population Economics, 3(5), 175-83.

[22] Cigno, A. (1995), "Public pensions with endogenous fertility: Comment on Nishimura and Zhang," Journal of Public Economics, 57(1), 169-173.

[23] Cigno, A. and F. C. Rosati (1992), "The Effects of Financial Markets and Social Security on Saving and Fertility Behaviour in Italy," Journal of Population Economics, 5(4), 319-341.

[24] Cnossen, S. and A.L. Bovenberg (2001), "Fundamental tax reform in the Netherlands," International Tax and Public Finance, 8(4), 471-484.

[25] Cohen, A., Dehejia, R. and D. Romanov (2013), "Financial Incentives and Fertility," The Review of Economics and Statistics, 95(1), 1-20.

[26] College Savings Plans Network (2016), "529 Report: An Exclusive Mid-Year Review of 529 Plan Activity," Lexington, KY.

[27] Cordes, J. J., Ebel, R. D. and J. G. Gravelle (2005), The Encyclopedia of Taxation and Tax Policy, Urban Institute Press, Washington, DC.

[28] Cordoba, J. C. (2015), "Children, Dynastic Altruism and the Wealth of Nations," Review of Economic Dynamics, 18(4), 774-791.

[29] Cordoba, J. C. and M. Ripoll (2012), "Barro-Becker with Credit Frictions," Iowa State University, Department of Economics, Staff General Research Papers, 35531.

[30] Cordoba, J. C., Xiying, L. and M. Ripoll (2016), "Fertility, social mobility and long run inequality," Journal of Monetary Economics, 77(C), 103-124.

[31] Council of the European Union (2003), "Council Directive on taxation of savings income in the form of interest payments," Council Directive 2003/48/EC, 3 June 2003, Official Journal of the European Union, June 26, 2003.

[32] Coeurdacier, N., Kollmann, R. and P. Martin (2010), "International portfolios, capital accumulation and foreign assets dynamics," Journal of International Economics, 80(1), 100-112.

[33] Coeurdacier, N. and H. Rey (2013), "Home Bias in Open Economy Financial Macroeconomics," Journal of Economic Literature, American Economic Association, 51(1), 63-115.

[34] Cremer, H., Gahvari, F. and P. Pestieau (2008), "Pensions with heterogenous individuals and endogenous fertility," Journal of Population Economics, 21(4), 961-981.

[35] Crump, R., Goda, G. S. and K. J. Mumford (2011), "Fertility and the Personal Exemption: Comment," American Economic Review, 101(4), 1616-28.

[36] de la Croix, D. and A. Gosseries (2012), "The natalist bias of pollution control," Journal of Environmental Economics and Management, 63(2), 271-287.

[37] Diamond, P.A. and J.A. Mirrlees (1971), "Optimal Taxation and Public Production I: Production Efficiency"and "II: TaxRules," American Economic Review, 61, 8Ð27 and 261Ð278.

[38] Eckstein, Z. and K. I. Wolpin (1985), "Endogenous fertility and optimal population size," Journal of Public Economics, 27(1), 93-106.

[39] Eggert, W. and M. Kolmar (2002), "Residence-Based Capital Taxation in a Small Open Economy: Why Information is Voluntarily Exchanged and Why it is Not," International Tax and Public Finance, 9, 465-482.

[40] Eggert, W. and M. Kolmar (2004), "The Taxation of Financial Capital Under Asymmetric Information and the Tax Competition Paradox," Scandinavian Journal of Economics, 106, 83-105.

[41] Eichengreen, B., Tobin, J. and C. Wyplosz (1995), "Two cases for sand in the wheels of international finance," Economic Journal, 105, 162-172.

[42] European Commission (1989), "Tax measures to be adopted by the Community in connection with the liberalization of capital movements. Proposal for a Council Directive on a common system of withholding tax on interest income," Communication from the Commission to the Council, COM(89) 60 final.

[43] European Commission (1998), "Proposal for a Council Directive to Ensure a Minimum of Effective Taxation on Savings Income in the Form of Interest Payments within the Community," COM (1998) 295 final.

[44] European Commission (2001), "Proposal for a Council Directive to Ensure Effective Taxation on Savings Income in the Form of Interest Payments within the Community," COM (2001) 400.

[45] European Commission (2008a), "Proposal for a Council Directive amending Directive 2003/48/EC on taxation of savings income in the form of interest payments," Communication from the Commission to the Council, COM(2008) 727 final.

[46] European Commission (2008b), "Report From the Commission to the Council in accordance with Article 18 of Council Directive 2003/48/EC on taxation of savings income in the form of interest payments," COM(2008) 552 final.

[47] French, K. R. and J. M. Poterba (1991), "Investor Diversification and International Equity Markets," American Economic Review, American Economic Association, 81(2), 222-226.

[48] Frey, B. and B. Torgler (2007), "Tax morale and conditional cooperation," Journal of Comparative Economics, 35, 136–159.

[49] Gale, W. G. and J. K. Scholz (1994), "Intergenerational Transfers and the Accumulation of Wealth," The Journal of Economic Perspectives, 145-160.

[50] Gauthier, A. H. (2007), "The impact of family policies on fertility in industrialized countries: a review of the literature," Population Research and Policy Review, 26(3), 323-346.

[51] Gauthier, A. H. and J. Hatzius (1997), "Family Benefits and Fertility: An Econometric Analysis," Population Studies, 51(3), 295-306.

[52] Georgellis, Y. and H. J. Wall (1992), "The Fertility Effect of Dependent Tax Exemptions: Estimates for the United States," Applied Economics, 24(10), 1139-1145.

[53] Gérard, M. (2004), "Combining Dutch presumptive capital income tax and US qualified intermediaries to set forth a new system of international savings taxation," CESifo, Munich, WP 1340.

[54] Gérard, M. and M. Hadhri (1994), The European Tax Game and Welfare, in W. Pommerhehne (ed.) Public Finance and Irregular Activities, Public Finance/Finances Publiques, 49, pp. 211-231.

[55] Gobbi, P. E. (2013), "A model of voluntary childlessness," Journal of Population Economics, 26(3), 963-982.

[56] Gordon, R. H. and A. L. Bovenberg (1996), "Why Is Capital So Immobile Internationally? Possible Explanations and Implications for Capital Income Taxation," American Economic Review, American Economic Association, 86(5), 1057-75.

[57] Granelli, L. (2016), "Family Tax Policy in a Model with Endogenous Fertility à la Barro-Becker," Université catholique de Louvain, IRES Discussion Papers 10.

[58] Greenwood, J., Guner, N. and J. A. Knowles (2003), "More on Marriage, Fertility, and the Distribution of Income," International Economic Review, 44(3), 827-862.

[59] Guner, N., Kaygusuz, R. and G. Ventura (2014), "Income Taxation of U.S. Households: Facts and Parametric Estimates," Review of Economic Dynamics, 17(4), 559-581.

[60] Haig, R. M. (1921), The Concept of Income. Economic and Legal Aspects, The Federal Income Tax, Columbia University Press, New York.

[61] Hau, H. (2006), "The Role of Transaction Costs for Financial Volatility: Evidence from the Paris Bourse," Journal of the European Economic Association, 4, 862-890.

[62] Hemmelgarn, T. and G. Nicodème (2009), "Tax Co-ordination in Europe: Assessing the First Years of the EU-Savings Taxation Directive," Centre Emile Bernheim Working Paper No. 10/006, Université Libre de Bruxelles - Solvay Brussels School of Economics and Management, January 2010.

[63] Hines, J. R. Jr. (2009), "Reconsidering the Taxation of Foreign Income," Tax Law Review, 62, 2009.

[64] Hodrick, R. J. and E. C. Prescott (1997), "Postwar U.S. Business Cycles: An Empirical Investigation," Journal of Money, Credit and Banking, 29(1), 1-16.

[65] Huizinga, H. and G. Nicodème (2004), "Are International Deposits Tax-Driven," Journal of Public Economics, 88(6), 1093-1118.

[66] Huizinga, H. and S. B. Nielsen (2003), "Withholding Taxes or Information Exchange: The Taxation of International Interest Flows," Journal of Public Economics, 87(1), 39-72.

[67] Johannesen, N. (2010), "Tax Evasion and Foreign Bank Deposits. Evidence from a natural Experiment," University of Copenhagen, Economic Policy Research Unit Working Paper 2010-05.

[68] Jones, L. E. and A. Schoonbroodt (2010), "Complements Versus Substitutes And Trends In Fertility Choice In Dynastic Models," International Economic Review, 51(3), 671-699.

[69] Jones, L. E. and A. Schoonbroodt (2016), "Baby Busts and Baby Booms: The Fertility Response to Shocks in Dynastic Models," Review of Economic Dynamics, 22, 157-178.

[70] Kazuo, N. and J. Zhang (1992), "Pay-as-you-go public pensions with endogenous fertility," Journal of Public Economics, 48(2), 239-258.

[71] Keane, M. and R. Rogerson (2015), "Reconciling Micro and Macro Labor Supply Elasticities: A Structural Perspective," Annual Review of Economics, 7(1), 89-117.

[72] Keen, M. and J. E. Ligthart (1999), "Coordinating tariff reduction and domestic tax reform," Journal of International Economics 56 (2002), 489-507.

[73] Keen, M. and J. E. Ligthart (2006a), "Information Sharing and International Taxation: A Primer," International Tax and Public Finance, 13(1), 81-110.

[74] Keen, M. and J. E. Ligthart (2006b), "Incentives and Information Exchange in International Taxation," International Tax and Public Finance, 13(2), 163-180.

[75] Kleven, H., M. Knudsen, C., Kreiner, S., Pedersen and E. Saez (2011), "Unwilling or Unable to Cheat? Evidence from a Tax Audit Experiment in Denmark," Econometrica, 79(3), 651-692.

[76] Kleven, H., C. Kreiner and E. Saez (2016), "Why Can Modern Governments Tax So Much? An Agency Model of Firms as Fiscal Intermediaries," Economica, 83(330), 219-246.

[77] Kurian, G. T. and B. A. Chernow (2007), Datapedia of the United States: American History in Numbers, Bernan Press.

[78] Laroque, G. and B. Salanie (2008), "Does Fertility Respond to Financial Incentives?," Columbia University, Department of Economics, Discussion Papers, 0708-15.

[79] Ligthart, J. and J. Voget (2012), "The Determinants of Tax Information Sharing: A Panel Data Analysis," Tilburg University Working Paper.

[80] Manuelli, R. E. and A. Seshadri (2009), "Explaining International Fertility Differences," The Quarterly Journal of Economics, 124(2), 771-807.

[81] Martin, J. and I. Méjean (2012), "Invoicing Currency, Firm Size, and Hedging," Working Papers 2012-28, CEPII research center.

[82] Milligan, K. (2005), "Subsidizing the Stork: New Evidence on Tax Incentives and Fertility," The Review of Economics and Statistics, 87(3), 539-555.

[83] Nishimura, K. and J. Zhang (1992), "Pay-as-you-go public pensions with endogenous fertility," Journal of Public Economics, 48(2), 239-258.

[84] Organization for Economic Cooperation and Development (1963), Draft Double Taxation Convention on Income and Capital, OECD, Paris, 1963.

[85] Organization for Economic Cooperation and Development (2010), Model Tax Convention on Income and on Capital 2010, Full Version, OECD, Paris, 2010.

[86] Pailhé, A. and A. Solaz (2012), The influence of employment uncertainty on childbearing in France: A tempo or quantum effect?, Demographic Research, 26(1), 1-40.

[87] Portes, R. and H. Rey (2005), "The determinants of cross-border equity flows," Journal of International Economics, 65(2), 269-296.

[88] Prinz, A. (1990), "Endogenous Fertility, Altruistic Behavior across Generations, and Social Security Systems," Journal of Population Economics, 3(3), 179-92.

[89] Reichling, F. and C. Whalen (2012), "Review of Estimates of the Frisch Elasticity of Labor Supply," Congressional Budget Office, Working Papers, 2012-13.

[90] Rosati, F. C. (1996), "Social security in a non-altruistic model with uncertainty and endogenous fertility," Journal of Public Economics, 60(2), 283-294.

[91] Seshadri, A. and N. Roys (2014), "On the Origin and Causes of Economic Growth," Society for Economic Dynamics, 2014 Meeting Paper 310.

[92] Simons, H. (1938), Personal Income Taxation: the Definition of Income as a Problem of Fiscal Policy, University of Chicago Press, Chicago.

[93] Sobotka, T., Skirbekk, V. and D. Philipov (2011), "Economic Recession and Fertility in the Developed World," Population and Development Review, 37(2), 267-306.

[94] Sorensen, P.B. (1994), "From the global income tax to the dual income tax: recent tax reforms in the Nordic countries," International Tax and Public Finance, 1, 57-79.

[95] Stiglitz, J. E. (1989), "Using tax policy to curb speculative short-term trading," Journal of Financial Service Research, 3(2-3), 101-115.

[96] Summers, L. H. and V. P. Summers (1989), "When financial markets work too well: A cautious case for a security transaction tax," Journal of Financial Service Research, 3(2-3), 261-286.

[97] Tax Policy Center (2008), Taxation And The Family, A Citizens' Guide for the 2008 Election and Beyond, The Tax Policy Briefing Book, Tax Policy Center.

[98] Tobin, J. E. (1978), "A proposal for international monetary reform," Eastern Economic Journal, 4, 153-159.

[99] Tobin, J. E. (1984), "On the efficiency of the financial system," Lloyds Bank Review, 153(July), 1-15.

[100] United Nations (2013), "World Population Policies Report," Department of Economic and Social Affairs, Population Division, ST/ESA/SER.A/341.

[101] U.S. Department of Agriculture (2005), "Expenditures on Children by Families," Center for Nutrition Policy and Promotion, Publication Number 1528-2005.

[102] U.S. Internal Revenue Service (2012), "Foreign Account Tax Compliance Act (FATCA)," http://www.irs.gov/Businesses/Corporations/Foreign-Account-Tax-Compliance-Act-(FATCA)

[103] U.S. Treasury Department (2012), "Joint Statement from the United States, France, Germany, Italy, Spain, and the United Kingdom regarding an Intergovernmental Approach to Improving International Tax Compliance and Implementing FACTA," http://www.treasury.gov/press-center/press-releases/documents/020712 Treasury IRS FATCA Joint Statement.pdf.

[104] Whittington, L. A. (1992), "Taxes and the Family: The impact of the tax exemption for dependents on marital fertility," Demography, 29(2), 215-226.

[105] Whittington, L. A. (1993), "State Income Tax Policy and Family Size: Fertility and the Dependency Exemption," Public Finance Review, 21(4), 378-398.

[106] Whittington, L. A., Alm, J. and H. E. Peters (1990), "Fertility and the Personal Exemption: Implicit Pronatalist Policy in the United States," American Economic Review, 80(3), 545-56.