On the Saving Behavior of European Households *

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Abstract

Whether household savings rise or continue to fall within major European economies, this triggered a question: What drives household saving decisions? This paper develops an overlapping generation model to analyze the underlying factors that determine the saving behavior among European households. We estimate the optimal saving function and show that an increase in youth labor supply causes a rise in household savings. In response to an increase in corporate equity, household savings experience a sustained decline. While a fall in interest rate translates into a decline in savings. The cross-sectional evidence from Europe between 1960 and 2020 is consistent with the theoretical prediction.

Keywords: Savings, interest rates, aging

JEL Codes: E21, J11, D14

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1 Introduction

The Eurozone saving rate has long been a central theme for policymakers. The European Commission reports that Eurozone household's saving jumped from 12.8% of disposable income in 2019 to 19% in 2020. The Covid-19 pandemic forced consumers to massively defer spending and engage in precautionary saving. Furthermore, we document that the saving rate declined since the 1990s in many European economies. Of the eleven major European economies, we found a pervasive decline in household saving in five countries after the global financial crisis. The pandemic crisis, like so many before, has sparked the debate over the major factors behind the saving trends across European economies and what drives savings behavior of households.

The main contribution of this paper is that we propose a specification of the optimal saving function that can be easily estimated in order to understand what drives household saving decisions. To date, few studies in the literature of determinants of saving adopted such an approach to investigate the potential factors affecting saving behavior, an early study by Brumberg (1956) is an exception. Our empirical specification of saving that emerges from the theoretical model controls for a variety of apparent factors that can explain household saving behavior. Saving decisions can be related to total hours worked and the average wage per hour. Furthermore, there is considerable empirical work on whether changes in the interest rate imply a positive or a negative effect on saving. Lastly, demographic factors, time, and country-specific factors might constitute reasonable determinants of household savings.

To investigate how the evolution of savings in Europe over the recent past is explained by these various factors, we specify an overlapping generations (OLG) model to clarify the mechanism linking household saving behavior in Europe to interest rate, wages, labor supply, equity, and aging. Households in this economy live for three periods and are identified as young, middle-aged, and old. These three age groups differ in their consumption, income (labor, capital and savings), ability to work,investment and saving decisions. We calibrate the model to replicate the effect of the interest rate and productivity shocks on household savings. We find that our benchmark model with an aging population predicts a small increase in savings following an increase of interest rates and a persistent responses after a positive shock to productivity. In addition, our model feature a non linear optimal saving function that accounts for a rich set of factors that can potentially affect the household decision to save, and delivers testable predictions. Based on cross-country data, we are able to estimate the household Euler equation. We find that there is a positive relationship between the average wage rate and the household savings. We find that hours worked by youth have contributed to a rise in savings. On the contrary, the rise in the share of older population leads to a decline in saving. Finally, we show that interest rates impact positively household saving.

Literature Review. Our paper contributes to the empirical literature on the determinant of personal saving. The seminal paper by Meade (1966) discusses the underlying forces that determine personal saving and develops a model that incorporates intergenerational transfers. Carroll and Summers (1987) who focus on the determinants of saving behavior in US and Canada.[1] As pointed out below, the data on the saving rate across European countries reveals a downward trend between 1990 and 2020, suggesting a greater dissaving among European households. These recent trends in saving patterns renewed interest in this literature. This line of research includes Fagereng et al. (2019), Choukhmane et al. (2019), Nardi et al. (2021), and Ordonez and Piguillem (2021).[2] Our main contribution to this empirical literature is that we use a non-linear optimal saving function that emerges from the theoretical model to identify and examine the potential factors affecting saving behavior.

Our work is also related to recent contributions that employ an overlapping generations model to uncover the patterns of saving Chen et al. (2007), Mehlum et al. (2016), Irmen (2017), Eggertsson et al. (2019a), Eggertsson et al. (2019b), and Miranda-Pinto et al. (2020). Our overlapping generations model is close in spirit to the model proposed by Coeurdacier et al. (2015). Their study highlights the divergence in private saving rate between advanced and emerging economies. Our study focus on the mechanism linking saving to economic aggregates and assumes that households may substitute capital for savings. A related idea is put forward in several studies on portfolio choice over the life cycle (Ameriks and Zeldes (2004), (Campanale et al., 2015), Fagereng

[1] Loayza et al. (2000) present an excellent summary of the literature on saving. For prior contributions see for example: Attanasio (1993), Leung (2000), Agosin (2001), Ma and Yi (2010), Mody et al. (2012), and Cronqvist and Siegel (2015).

[2] Consider Brunnermeier and Nagel (2008) and De Nardi and Fella (2017) discussing the relationship between wealth and savings. Another important work is Mian et al. (2020) who show that saving by top 1% of wealth distribution has been driven by a rise in the accumulation of financial assets, whereas dissaving of bottom 90% is driven by the rise in borrowing and a decline in the accumulation of financial assets.

et al. (2017), Gomes (2020), and Catherine (2021)). Our work proposes a new specification of the optimal saving function that can be easily estimated and allows us to understand and identify the interactions between households savings and other factors. The representation of the optimal saving function is dependent on population aging, interest rate, wages, labor supply, capital and capital gains, this is a crucial point because capital is the closest substitute of saving.

There is a vast literature on demographics and saving behavior to which our paper is related. Modigliani and Cao (2004) and Bairoliya and Ray (2021) document that the demographic structure affects the saving rate in China. Concurrent work by Curtis et al. (2015) find that demographic change explains half of the household saving rate, whereas Chamon and Prasad (2010) find that a demographic shift plays a minor role in explaining the saving behavior among urban households. We instead demonstrate that the increase of the middle age population causes dissavings in the economy. The empirical evidence we present in this paper is somewhat surprising on how the demographic dimension affect total saving. The relationship between the share of the middle-aged population (between ages 25 and 64) and savings turn to be negative.

Our paper is related to a series of papers attempting to deal with the effect of the interest rate on saving, in particular, Sandmo (1970), Carlino (1982), Constantinides et al. (2002), Eeckhoudt and Schlesinger (2008), and Wang (2004). Elmendorf (1996) offers different insights to the response of personal saving to changes in the interest rate in the context of a lifecycle model and finds that raising interest rate lead to an increase in total saving. Chetty et al. (2014) suggest that the interest elasticity of savings is low. Cao and Werning (2018) argue that agent have a natural inclination to save given the high interest rate. Most of the existing studies have usually been divided on whether interest rates have either positive or negative effects on saving. We offer empirical evidence that interest rates affects positively saving behavior.

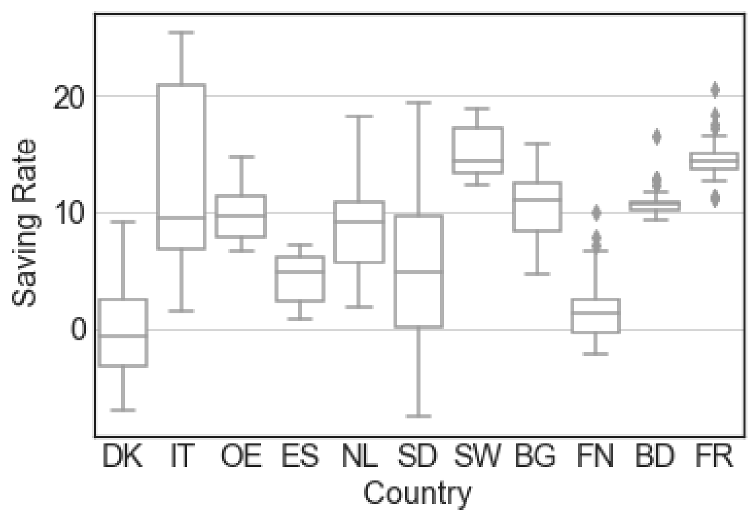
Paper Structure. The rest of the paper proceeds as follows. Section 2 documents stylized facts about saving in Europe. Section 3 develops the overlapping generations model and examines the interaction between saving and several factors using the non-linear optimal saving function. Section 4 presents how the model is calibrated and discusses the model predictions. Section 5 reviews the approach to analyze the determinant of the saving behavior, derives the regression specifications, and shows the model results. Section 6 concludes.

2 Recent Development in Household Saving: Evidence from Europe

Before the analysis of determinant of household savings, we establish a number of stylized facts about saving in European countries.

Saving rates varied widely across most European countries. A visual analysis suggests a divergence in saving rates between European countries. Figure 1 shows box plots of annual saving rate for the period going from 1960 to 2020 across European countries. Each box represent the interval of saving rate distribution for a specific country between 25 percent and 75 percent for all year observations. Perhaps surprisingly, saving rate in Denmark and Finland tend to concentrate around negative values. For all year observations, the distribution of saving rate is more volatile in Sweden and Italy. In contrast, there is low variability over time for France and Germany.

Figure 1: Saving Rate across Europe



Notes: Household gross saving as a percentage of gross disposable income. DK: Denmark; It: Italy; OE: Austria; ES: Spain; NL: Netherlands; SD: Sweden; SW: Switzerland; BG: Belgium; FN: Finland; BD: Germany; FR: France. Source: Datastream.

Saving rate has fallen almost everywhere in Europe. In Table 1, we report the average saving rate between the 1990 and 2020 across European countries, United States, Canada, and Japan - data obtained from Datastream. The table illustrates that the saving rate evolved differently in the various countries. For example, the saving rate declined from 19 percent between 1990 and 1994 to 4 percent between 2009 and 2014 in Italy, and from 12 to 9 percent in Germany. In Sweden the annual average saving rate increased rapidly from 2 percent between 1990 and 1994 to 11 percent between 2009 and 2014. Other European countries, such as France and Switzerland, have experienced a gradual increase in saving rate.

Table 1: Average Saving Rate in Europe, Canada, Japan, USA, 1990-2020 (percentage per year)

	Average saving rate				
	1990- 1994	1995 - 2003	2004-2008	2009-2014	2015-2020
Italy	19.53	11.13	8.38	3.76	4.42
Spain	6.72	6.37	3.11	4.40	5.03
Netherlands	11.89	6.46	2.79	7.76	11.76
France	13.66	14.07	14.50	15.37	15.42
Denmark	−1.46	−2.25	−2.97	0.48	5.70
Austria	15.48	10.88	11.41	8.69	10.08
Belgium	13.06	12.96	10.93	8.44	7.31
Finland	5.65	2.03	0.16	1.48	0.71
Germany	12.92	10.34	10.68	9.92	12.06
Sweden	2.72	2.15	5.63	11.54	14.79
Switzerland	13.71	13.43	14.23	17.01	18.80
Canada	11.52	4.70	2.33	4.36	5.19
Japan	14.65	8.95	3.13	2.67	4.09
USA	8.29	5.87	4.13	7.07	9.71

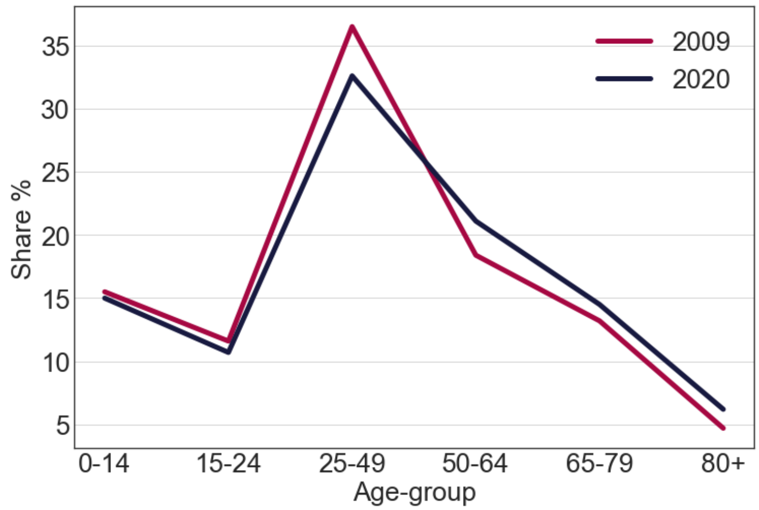
Source: Datastream.

The decline of the annual saving ratio since the mid-1990s in many European countries holds true also for Japan, Canada, and the United States. In Canada, the saving rate declined from about 11 percent during the period 1990-1995 to only 4 percent during the period 2009-2014. During the same period, the average annual rate in the United States fell slightly from 8 percent to 7 percent, while the personal saving ratio in Japan continued to decline from about 14 percent during the period 1990-1994 to only 2 percent during the period 2009-2014.

Rapid aging in Europe. Traditionally, aging has been regarded as an important factor explaining the saving behavior. Rapid aging in Europe seemingly reinforce the dissaving of retirees against the saving of workers. Over the period 2009 and 2020, Europe has experienced a major shift in the demographic structure. The share of population between 50 and 64 years has typically increased, in 2020 it reached 21 percent (17 percent in 2009). Similarly the share of population between 65 and 79 years and over 80 years increased considerably. In contrast, the decreasing weight of population between 25 and 49 years is thought to slow saving of workers and strengthen the dissaving in the economy.

The share of children in the total population in 2020 is slightly below its level in 2009. The decline in children's share can have a negative long-run effect on the working-age share as documented by Bairoliya and Ray (2021). For example, the recent relaxation of fertility control in China should slow the pace of population aging.

Figure 2: Share of Age Group between 2009 and 2020



Notes: The share of population for each age-cohorts to total population. The data covers the following countries: Belgium, Denmark, Germany, Spain, France, Italy, Netherlands, Austria, Finland, Sweden, Switzerland. Source: Eurostat.

To evaluate the effect of the demographic evolution on the saving behavior in Europe, we analyze the age distribution across some European countries. The Table 2 shows the proportion of the population by age groups across Europe in 2009 and 2019. One key observation to be drawn from the table is the significant aging throughout the period 2009-2019. The oldest group continued to increase across all countries, the retirees' mass ranges from 15 percent to 20.4 percent in 2009, and leaped to values between 18.5 and 22.9 percent in 2019.

Another striking observation is that the share of the population under the age of 15. While their share has typically declined in most European countries between 2009 and 2019 (for example see Denmark, France, Italy, Netherlands, Austria, Finland, and Switzerland). Belgium, Germany, and Spain maintained a constant percentage of the youngest group throughout this period. The only county that experiences a rise in the population under the age of 15 between 2009 and 2019 is Sweden.

The working-age population refers to individuals aged between 15 and 64. The reason for distinguishing between the labor force, young workers (15-24) vs middle-aged workers (25-64),

Table 2: Population demographics in Europe

Economy	Proportion of Population							
	0-14		15-24		25-64		65+	
	2009	2019	2009	2019	2009	2019	2009	2019
Belgium	16.9	16.9	12.1	11.4	53.9	52.8	17.1	18.9
Denmark	18.3	16.5	12.0	12.6	53.8	51.3	15.9	19.5
Germany	13.6	13.6	11.4	10.4	54.6	54.4	20.4	21.6
Spain	14.8	14.8	10.9	9.8	57.7	56.0	16.6	19.4
France	18.5	18.0	12.6	11.8	52.4	50.2	16.5	20.1
Italy	14.1	13.2	10.1	9.8	55.6	54.3	20.3	22.9
Netherlands	17.7	15.9	12.2	12.3	55.1	52.7	15.0	19.2
Austria	15.1	14.4	12.3	10.9	55.2	55.7	17.4	18.8
Finland	16.7	16.0	12.4	11.2	54.1	51.1	16.8	21.8
Sweden	16.7	17.8	13.2	11.3	52.3	51.0	17.7	19.9
Switzerland	15.3	15.0	11.9	10.6	56.1	55.9	16.6	18.5

Source: Eurostat.

is that the population between the age 15 and 24 is often perceived to receive low income at the beginning of their working life and thus modestly contributes to saving. The overlapping generations model we developed in Section 3 captures this fact.

Table 2 suggests that the share of the working-age population has decreased substantially in Europe due to population aging. It appears that the share of younger workers to the total population (between the age of 15 and 24) declines notably in all European countries except for the Netherlands and Denmark. The share of the middle-aged population (between the ages 25 and 64) decreases for most European countries. Note that only Austria has experienced an increase between 2009 and 2019. In Europe, the share of the labor force to the total population decreased progressively across countries, although the evolution has been substantially different. The effective weight of workers who save (pool of workers) dwindled while the share of the retirees mass who dis-save continues to rise.

The role of interest rate, labor and capital investment. While there are differences across European countries, the growing importance of saving in Europe is the result of a number of interacting factors. As has been noted by previous studies on the determinants of saving has attributed some role to labor supply and wages, because households can insure against future income shocks by increasing their hours worked, higher level of earnings can translate to high precautionary saving (Kim, 2021). Falling interest rates may be related to the downward trend in saving, agents may not be encouraged to save in assets that earn lower interest rate and can indeed find themselves inclined to save less (Cao and Werning, 2018). The dynamics of saving may be related also to capital and capital gains, see for example (Kirsanova and Sefton, 2007), who discussed the relationship between corporate equity and saving. From their perspective households may substitute capital for saving, bringing the proportion of capital in total assets to a level well above that of saving.[3] The overlapping generations model presented in the next section attempt to capture all these potential factors that can affect saving decisions.

3 Model

Consider an economy of overlapping generations in which individuals work and choose how much to consume, save, and invest when young, middle-aged and old. These generations live for three periods. There is a representative firm that combines labor and capital to produce a homogeneous good. The monetary authority sets the policy interest rate. In exchange of labor supplied individuals receive wages, while they receive a return on capital supplied to firms and gains from the savings at the risk-free rate when middle-aged. These resources can either be consumed, or be saved, or be invested in form of capital provision to firms. After retirement, individuals receive revenues from saving and capital provision which are the only source of income at their age. In our view, the assumption about the age structure of the overlapping generations model is important to understand the saving decisions.

Households. Preferences for households are a variant of the classic Diamond (1965) overlapping generations model of three-period. Households utility function is given by

$$E_{t-1}\{U(c^y_{t-1}, l^y_{t-1}) + \beta U(c^m_t, l^m_t) + \beta^2 U(c^o_{t+1})\}, \tag{3.1}$$

where c^j denotes the per capita consumption across age groups j at time t and $j \in \{y, m, o\}$ identifies age groups: young, middle-age, and old age. We define l^j as labor supply of an agent belonging to age groups j. We propose a utility function with constant relative risk aversion $(c^j)^{1-\sigma}/(1-\sigma)$ with $\sigma > 0$, and the disutility from hours of labor is of the form $-(l^j)^{1+\eta}/(1+\eta)$ with $\eta > 0$. The parameter η measures the curvature on the disutility of labor, and σ is the risk aversion parameter. The framework implies that $U(c^j)' > 0$, $U(c^j)'' < 0$ and $U(l^j)' < 0$, $U(l^j)'' < 0$. The expression in (3.1) features uncertainty, for example, households will face

[3] Recent work by Robbins (2019) shows the importance of accounting for capital gain in measure of income and savings.

uncertainty regarding whether monetary authority influence monetary policy by raising or lowering the policy interest rates.

Note also that the discount factor $0 \leq \beta \leq 1$ represents the weight of the utility of middle age versus young and old age and captures the degree of impatience. That is, households value future consumption but to a lesser degree than present ones.

We define the budget constraint of young agent as follow:

$$c^y_{t-1} + a^y_{t-1} + k^y_{t-1} = \omega_{t-1} l^y_{t-1}, \tag{3.2}$$

When young, this agent receives a labor income $\omega_{t-1} l^y_{t-1}$, which can be either consumed c^y_{t-1} or saved a^y_{t-1} or allocate funds to firms k^y_{t-1} in form of capital provision. We define the share of investment in total safe assets a_{t-1} and total equity k^h_{t-1} by the young as $z^y = a^y_{t-1}/a_{t-1}$ and $\zeta^y = k^y_{t-1}/k^h_{t-1}$. The parameter z^y denotes the share of total asset holdings owned by the young individuals, the capital share of young agents in total capital is given by ζ^y, and ω_{t-1} is the hourly wage rate. Households are assumed to know the wage rate ω.

The budget constraint of the middle-aged is given by:

$$c^m_t + a^m_t + k^m_t = \omega_t l^m_t + a^y_{t-1} r_{t-1} + ((1-\delta) + r^k_t) k^y_{t-1}, \tag{3.3}$$

The middle aged agents earns the wage rate ω and the rental rate of capital r^k from providing capital and labor services to firms. This agent can receive a labor income $\omega_t l^m_t$, a capital income $r^k_t k^y_{t-1}$ from invested units in the previous period, and asset earnings $a^y_{t-1} r_{t-1}$ from previous savings at risk free interest rate ($r_t = 1 + \iota_t$, where r_t is the gross interest rate and ι_t is the risk free interest rate). These revenues can either be consumed c^m_t, saved a^m_t, or invested in capital k^m_t. The middle-aged is aware of the wage rate ω, the interest rate r, and the capital rental rate r^k at the date when the decision of investment is made. We define $\zeta^m = k^m_t / k^h_t$ as the share of investment in equity and $z^m = a^m_t / a_t$ as the share of investment in safe assets by the middle-aged. To simplify, both z^y and z^m are fixed and do not vary across time. This assumption is appropriate to ensure a lower interest rate economy.[4]

Next, consider the budget constraint of the old agent is:

$$c^o_{t+1} = a^m_t r_t + ((1-\delta) + r^k_{t+1}) k^m_t. \tag{3.4}$$

[4] As a matter of logic the first order condition with respect to saving a_t, delivers the following optimality condition $\lambda_t z^m = E_t \beta \lambda_{t+1} z^y r_{t+1}$ where λ_t represents the marginal utility of saving. The assumption about the parameters z^m and z^y are important to pin down the value of a lower steady state interest rate.

This equation states that old agents earn no labor income but rather receive retirement income $a_t^m r_t$ and capital gain $r_{t+1}^k k_t^m$ and consume c_{t+1}^o. The retiree uses its funds to finance personal consumption. It is convenient to assume that aggregate capital supplied by households is given by $k_t^h = k_t^y + k_t^m$ and aggregate savings is defined by $a_t = a_t^y + a_t^m$.
Finally, the law of motion for capital is given by:

$$k_t^h = (1-\delta)k_{t-1}^h + f(i)i_t^h, \tag{3.5}$$

where new capital k_t^h depends on the existing capital k_{t-1}^h, which decays at the fixed rate δ, and on the new investment good i_t^h. We assume that the owners of the capital stock are the young and middle-aged agents who decide about the level of investment. The quantity of investment at period t is proportional to the adjustment cost function $f(i) = \left[1 - \kappa/2\left(i_t^h/i_{t-1}^h - 1\right)^2\right]$. The term $\kappa/2\left(i_t^h/i_{t-1}^h - 1\right)^2$ represents the cost that is increasing in the change of investment between periods i_t^h and i_{t-1}^h. The existence of the adjustment cost function in the model slows down the response of total investment to economic shock and generates a humped shape response of investment (see for instance Christiano et al., 2014). The young and middle-aged agents will respond by adjusting smoothly the adjustment cost. Households maximize their utility (3.1) subject to a set of budget constraints (3.2) (3.3) (3.4) and a capital accumulation constraint (3.5). The household's utility maximization problem implies a marginal utility $\lambda_t = (E_t\beta\lambda_{t+1}((1+\delta) + r_{t+1}^k)\zeta^y)/\zeta^m$

Capital producers. In this economy we assume that capital producer maximizes the expected profits subject to capital accumulation by choosing capital k_t^p and investment i_t^p

$$\text{maximize} \quad E_t[r_t^k k_{t-1}^p - i_t^p] \tag{3.6}$$

where r_t^k denote the return on capital supplied to firms. The law of motion for capital

$$k_t^p = (1-\delta)k_{t-1}^p + f(i)i_t^p, \tag{3.7}$$

k_t^p denotes capital owned by institutional investors assumed to depreciate at a fixed rate δ and $f(i)$ represent the capital adjustment cost function. The capital producer's expected profits maximization problem implies the marginal profit $\chi_t = E_t\beta\chi_{t+1}(r_t^k + (1-\delta))$.

Technology. A representative firm produce a homogeneous good y_t by operating a Cobb-Douglas production function:

$$y_t = z_t(k_t)^{\alpha}(l_t^y + l_t^m)^{1-\alpha}, \tag{3.8}$$

where α is the capital share of output and z_t is the aggregate productivity shock $\ln z_t = \rho^z \ln z_{t-1} + \epsilon_t^z$. The parameter ρ^z is the productivity smoothing parameter and ϵ_t^z is a stochastic disturbance that captures the shock to the productivity. The innovation ϵ_t^z is assumed to be an i.i.d. with mean zero and standard deviation σ^{ρ}. The aggregate capital supplied by households and capital producers is defined by $k_t = k_t^p + k_t^h$. The firm chooses the amount of capital input k_t and decides the amount of the labor input l_t^y and l_t^m, the firm can hire young workers or middle-aged workers. The firm's total cost takes the following form:

$$\omega_t(l_t^y + l_t^m) + r_t^k k_t, \tag{3.9}$$

where ω_t is the wage rate and r_t^k is the capital rental rate. The producer rent capital and hires labor from households by minimizing the production cost (3.9) subject to (3.8). The firm cost minimization problem implies the marginal cost $\mu_t = r_t^k / (\alpha z_t (l_t^y + l_t^m)^{\alpha} k_t^{\alpha-1})$.

Monetary Policy Rule. For simplicity we assume that the interest rate follows a process, that is:

$$\ln \iota_t = \rho^r \ln \iota_{t-1} + \rho^y \ln y_t + \epsilon_t, \tag{3.10}$$

where ρ^r is the interest rate smoothing parameter and ρ^y represent the response of policy rate to the output y. ϵ_t is a stochastic disturbance that captures the shock to the policy rate. The innovation ϵ_t is assumed to be an i.i.d. with mean zero and standard deviation σ^r.

Market Clearing Condition. The matket clearing conditions implies:

$$y_t = c_t + i_t, \tag{3.11}$$

where y_t is total output, i_t is total investment, and c_t is the total aggregate consumption of all age groups, $c_t = \Sigma_j^{y+m+o} c_t^j$. The market for capital and labor clear

$$k_t = k_t^h + k_t^p, \quad l_t = l_t^y + l_t^m. \tag{3.12}$$

The saving rate at time t is calculated as $s_t = a_t/(\omega_t(l_t^y + l_t^m))$, and the share of middle-aged workers in total labor force is given by $Q_t = l_t^m/(l_t^y + l_t^m)$. We now complete the description of the model by writing the government budget constraint

$$a_{t-1}r_{t-1} = g_t + a_t \tag{3.13}$$

The government issue bonds a which pay a gross interest rate r, and g denote the government revenues. This expression relates current and future government bond issuance to extra revenues. We assume that government revenues are potentially uncertain, and those revenues g are deemed to finance the principal and interest payments such that the government's budget is balanced. The shock is modelled as an AR(1) process $\ln g_t = \rho^g \ln g_{t-1} + \epsilon_t^g$, where ρ^g is a smoothing parameter and ϵ_t^g is a shock to government revenues.

Equilibrium Definition. A competitive equilibrium can be represented by a sequence of quantities, $\{c_t^y, c_t^m, c_t^o, a_t, i_t, i_t^h, i_t^p, k_t, k_t^h, k_t^p, l_t^y, l_t^m, y_t, z_t, g_t\}$, and prices $\{r_t, r_t^k, \omega_t, \lambda_t, \mu_t, \chi_t, \iota\}$.[5] The equilibrium of the model can be characterized as follow: (a) The younger individuals maximizes their expected utility function 3.1 subject to the budget constraint 3.2 and the capital accumlation 3.5. The young household chooses c_t^y, l_t^y, a_t^y, and k_t^y. (b) The middle aged individuals maximizes their expected utility function subject to budget constraint 3.3 and the capital accumulation constraint 3.5. The middle aged household chooses c_t^m, l_t^m, a_t^m, and k_t^m. (c) The old agents maximizes their expected utility function subject to budget constraint 3.4. The old household chooses c_t^o. (d) The monetary authority sets the policy interest rate 3.10. (e) The representative firms solves 3.9 subject to the production function 3.8. The representative firms chooses l_t and k_t. (f) Capital producers maximize their profits 3.6 subject to capital accumulation 3.7. Capital producers choose i_t^p and k_t^p. (g) The market for goods clear 3.11, and the market for labor and capital clear 3.12. (h) The government's budget constraint is satisfied 3.13.

What is behind the saving behavior? We are interested on how the optimal saving depends on the capital, the return on equity, the interest rate, the labor supply and the wage. We consider the

[5] Further details are in the Appendix.

optimality condition:

$$\beta^2\big(z^m a_t r_t + ((1-\delta)+r_t^k)\zeta^m k_t^h\big)^{-\sigma} = \big(\omega_t l_t^y - z^y a_t - \zeta^y k_t^h\big)^{-\sigma}\frac{\beta z^y r_t}{z^m}, \tag{3.14}$$

that yields the explicit saving function $a_t = F(r_t, \omega_t, l_t^y, r_t^k, k_t^h)$. Observe that optimal saving a_t is a function of hours worked when young l_t^y, the hourly wage rate ω_t, capital k_t^h, return on equity r_t^k, and of the gross interest rate r_t. Given the optimal saving function, we compute the partial derivatives to consider the effects of interest rate, wage rate, and labor supply on optimal saving. Further details are included in the appendix.

Proposition 1: *Under non-linear optimal saving function, it follows that an increases in youth labor supply l_t^y causes a rise in savings a_t, $\frac{\partial a_t}{\partial l_t^y} > 0$.*

$$\frac{\partial a_t}{\partial l_t^y} = -\frac{\beta\omega_t r_t\sigma z^y\left(-k_t\zeta^y - a_t z^y + l_t^y\omega_t\right)^{-\sigma-1}}{-\beta r_t\sigma z^{y2}\left(-k_t\zeta^y - a_t z^y + l_t^y\omega_t\right)^{-\sigma-1} - \beta^2 r_t\sigma z^{m2}\left(k_t\left(r_t^k-\delta+1\right)\zeta^m + a_t r_t z^m\right)^{-\sigma-1}} \tag{3.15}$$

It turns out that the impact of labor supply and wage rate on savings is strictly positive ($\partial a_t/\partial l_t^y > 0$). An increase in hours worked when young affects positively the savings behavior (see equation 3.15). Higher labor supply by the young generation entails high earned income, which encourages personal savings. Typically, households consume less when young because the younger generation receives a very low income. A number of economists have pointed out that rising income uncertainty can force households to have a greater propensity to save. Ghosh and Ostry (1997) emphasize this point by showing that greater macroeconomic uncertainty can result in greater saving. Carroll (2009) illustartes this point by analyzing how uncertainty affects the marginal propensity to consume out of a permanent shock. A positive shock to permanent income moves the wealth-to-income ratio below its target and increases precautionary saving.[6] Banks et al. (2001) highlight the same point by analyzing the impact of income risk associated with precautionary saving motives on consumption growth over the life cycle.

[6] See also Guerrieri and Lorenzoni (2017) who explain how recession driven by credit crunch can lead to the accumulation of precautionary savings.

Proposition 2: *A relative increase in the average wage rate lead to higher household savings,* $\partial a_t/\partial\omega_t > 0$.

$$\frac{\partial a_t}{\partial\omega_t} = -\frac{\beta l_t^y r_t \sigma z^y \left(-k_t\zeta^y - a_t z^y + l_t^y\omega_t\right)^{-\sigma-1}}{-\beta r_t \sigma z^{y2}\left(-k_t\zeta^y - a_t z^y + l_t^y\omega_t\right)^{-\sigma-1} - \beta^2 r_t \sigma z^{m2}\left(k_t\left(r_t^k - \delta + 1\right)\zeta^m + a_t r_t z^m\right)^{-\sigma-1}} \tag{3.16}$$

Equation 3.16 shows that a rise in the wage rate of the aging population will lead to an increase in personal savings as a consequence of the rise in personal income for young and middle-aged agents ($\partial a_t/\partial\omega_t > 0$). The increase in the average wage rate induces an increase in savings. Thus, it is important to recognize that the channel through which an increase in wages rate propagates is similar to the effect of an increase in labor supply. The wage effect is substantially less strong than the impact of an increase in the relative labor supply.

Proposition 3: *The optimal saving function implies that in response to an increase in corporate equity, household savings experience a sustained decline,* $\partial a_t/\partial k_t < 0$. *A relative increase in capital rental rate leads to a drop in total savings,* $\partial a_t/\partial r_t^k < 0$.

$$\frac{\partial a_t}{\partial r_t^k} = \frac{\beta^2 k_t \sigma \zeta^m \left(k_t\left(r_t^k - \delta + 1\right)\zeta^m + a_t r_t z^m\right)^{-\sigma-1}}{-\frac{\beta r_t \sigma z^{y2}\left(-k_t\zeta^y - a_t z^y + l_t^y\omega_t\right)^{-\sigma-1}}{z^m} - \beta^2 r_t \sigma z^m \left(k_t\left(r_t^k - \delta + 1\right)\zeta^m + a_t r_t z^m\right)^{-\sigma-1}} \tag{3.17}$$

$$\frac{\partial a_t}{\partial k_t} = \frac{\frac{\beta r_t \sigma z^y \zeta^y \left(-k_t\zeta^y - a_t z^y + l_t^y\omega_t\right)^{-\sigma-1}}{z^m} + \beta^2\left(r_t^k - \delta + 1\right)\sigma\zeta^m\left(k_t\left(r_t^k - \delta + 1\right)\zeta^m + a_t r_t z^m\right)^{-\sigma-1}}{-\frac{\beta r_t \sigma z^{y2}\left(-k_t\zeta^y - a_t z^y + l_t^y\omega_t\right)^{-\sigma-1}}{z^m} - \beta^2 r_t \sigma z^m \left(k_t\left(r_t^k - \delta + 1\right)\zeta^m + a_t r_t z^m\right)^{-\sigma-1}} \tag{3.18}$$

The framework predicts that an increase in capital and capital gain in the context household utility maximization decisions should lead to a decline in savings as captured by equations 3.17 and 3.18 (i.e. $\partial a_t \partial r_t^k < 0$ and $\partial a_t/\partial k_t < 0$) . Several studies have examined the link between precautionary savings and capital. Angeletos (2007), one of the most comprehensive contribution to this literature, provides empirical evidence that idiosyncratic investment risk reduces savings which contrasts the prediction of the Bewley-type model.[7] Other studies predict that capital and saving should moved together. This advanced by Mehlum et al. (2016), who show that capital accumulation amplifies incentives to save.

[7] For related papers see, Matthews (1954) who studies the interaction between saving and investment functions, Floden (2008) who shows that the additional capital accumulation in a dynamic framework is generated by permanent income motives rather than precautionary motives, and Apps et al. (2014) who show that under a two-person household framework, for higher than second order risk increases, saving is not necessarily raising.

Proposition 4: *Under the houshold saving optimal function, it follows that a fall in interest rate translates into a decline household savings, $\partial a_t / \partial r_t > 0$.*

$$\frac{\partial a_t}{\partial r_t} = \frac{\frac{\beta z^y}{z^m\left(-k_t\zeta^y - a_t z^y + l_t^y \omega_t\right)^{\sigma}} + a_t\beta^2\sigma z^m \left(k_t\left(r_t^k - \delta + 1\right)\zeta^m + a_t r_t z^m\right)^{-\sigma-1}}{-\frac{\beta r_t \sigma z^{y2}\left(-k_t\zeta^y - a_t z^y + l_t^y\omega_t\right)^{-\sigma-1}}{z^m} - \beta^2 r_t\sigma z^m\left(k_t\left(r_t^k - \delta + 1\right)\zeta^m + a_t r_t z^m\right)^{-\sigma-1}} \tag{3.19}$$

Equation 3.19 gives the partial derivative of the saving function with respect to the interest rate ($\partial a_t / \partial r_t > 0$). The effect of the interest rate on the optimal saving is strictly positive. A rise in the interest rate encourages agents to consume less, by making the present consumption more expensive relative to the future consumption. This leads to an increase in saving as it becomes more profitable to save because of the higher earnings on savings. In the next section, we investigate how saving behavior changes with respect to several economic factors.

4 Quantitative Analysis

4.1 Calibration

In this section, we discuss the choice of plausible values for the parameters of the overlapping generations model. In Table 3 we display the value of calibrated parameters to match the information we identified in the literature and the data. We assume that middle-aged and young individuals share equally the assets such that the initial steady-state value of the demographic variables $z^m = z^y$. The parameters ζ^m and ζ^y are the share of equity owned by young and middle aged households that equal $\zeta^m = \zeta^y = 0.5$. In this model, households can own equities directly. The relative weight of households is equal to 5 percent ($k^h/(k^h + k^p) = 0.05$), a number that is close to the corresponding number in Europe Union.[8] The discount factor β is chosen to target the interest rate ι, the initial interest rate of 1.5% at the steady-state is in line with the data for the European zone.

The capital depreciation δ is set to the value of 0.025, to target the average consumption to output ratio in Europe c/y. The capital depreciation rate δ is quite close to the value reported in Krusell and Smith (2015). We want the model implied capital to labor share to be consistent with

[8] European Commission and Financial Services User Group (2016) reports the share ownership structure of capital in the European Union.

the empirically observed k/l and equals to 0.62. The capital's share in total output α is set to 0.3, which is standard in the literature.

Table 3: Model Parameters

Variable	Symbol	Value	Target / Source
Panel A: Calibrated parameters			
Curvature on the disutility of labor	η	0.54	Ziliak and Kniesner (2005)
Coef. of relative risk aversion	σ	1	Standard in literature
Depreciation rate (Annual)	δ	0.025	Krusell and Smith (2015)
Cobb Douglas parameter	α	0.3	Standard in literature
Discount factor (Annual)	β	0.985	The ECB policy rate ι
Capital to labor ratio	$\frac{k}{l}$	0.62	Datastream
Investment adjustment cost	κ	2.48	Christiano et al. (2014)
Panel B: Exogenous shock parameters			
Coefficient on lagged interest rate	ρ	0.845	Albonico et al. (2017)
Coefficient on output	ρ^y	0.0592	Albonico et al. (2017)
Standard deviation	σ^r	0.520	Albonico et al. (2017)
Coefficient on gov. revenues	ρ^g	0.89	Albonico et al. (2017)
Standard deviation	σ^g	0.0012	Albonico et al. (2017)
Coefficient on productivity	ρ^z	0.87	Uhlig (2007)
Standard deviation	σ^z	0.0069	Uhlig (2007)

Our choice for the Frisch specific substitution elasticity of labor supply η is 0.54, which is based on the estimates of Ziliak and Kniesner (2005). As in Christiano et al. (2014), the monetary policy parameters ρ^r, ρ^y and σ^ρ equal to 0.850, 0.150 and 0.216 respectively. To calibrate the parameters describing the technology shock and government revenues shock, we set the baseline value for the autocorrelation parameters $\rho^z = 0.990$ (standard deviation $\sigma^z = 0.001$) and $\rho^g = 0.992$ (standard deviation $\sigma^g = 0.001$) to reflect the high persistent response of productivity and government revenues to its own shock.

For the coefficient of relative risk aversion (the inverse of the intertemporal elasticity of substitution) σ, we choose a value of 1, which is a standard value in the literature. Finally, we follow Christiano et al. (2014) in setting the investment adjustment cost $\kappa = 2.48$. This choice does not affect the steady state because in the steady state the adjustment cost function $f(i)$ equals 1.

4.2 Model Fit

In this section, we present the extent to which the overlapping generations model matches the observed European data. Table 4 documents the empirical ratios for European economies computed with data from Eurostat and Datastream. The data we used covers the period 1995-2020. In particular, we rely on the capital stock, the total employment in thousands of hours worked, the gross domestic product, the participation rate to the labor force of the population between 15-24 years and between 25-65 years, and the aggregate consumption. We compute the average values of the consumption to output ratio c/y, the capital to output ratio k/y, the capital to labor ratio k/l, the labor participation of young people l^y/l and the labor participation of middle age people l^m/l. Our data set includes the following European countries: Italy, Spain, Netherlands, Sweden, Switzerland, Denmark, Austria, Belgium, Finland, Germany, and France. We use this data to assess if the overlapping generations model captures well the quantitative features of the European economies.

Table 4 reveals clear differences between European economies. While in the Netherlands the ratio of capital to output is well below 5, it is above 7 in Austria. Also when comparing the capital to labor share k/l, there are large differences between European economies. For most European countries the capital to labor ratio is between 0.1 and 0.8, while Denmark and Sweden have values above 2. We also observe that the consumption to output ratio is quite similar across European economies. Furthermore, Table 4 shows that the share of young workers (workers aged 15-24) in the labor force ranges from 0.07 to 0.15 in Europe. For example, Spain, Italy, and France have the lowest labor participation of young people, while Netherlands, Denmark, and Switzerland have the highest participation rate. The middle aged people (workers aged 25-64) account for a large fraction of the overall working force and range between 0.85 and 0.93.

Table 4: Data

	Ratios				
	$\frac{c}{y}$	$\frac{k}{y}$	$\frac{k}{l}$	$\frac{l^y}{l}$	$\frac{l^m}{l}$
Italy	0.79	6.72	0.23	0.07	0.93
Spain	0.77	6.05	0.17	0.08	0.91
Netherlands	0.68	4.81	0.22	0.15	0.85
France	0.77	5.45	0.24	0.09	0.91
Denmark	0.70	5.05	2.05	0.15	0.86
Austria	0.71	9.13	0.36	0.13	0.87
Belgium	0.75	5.75	0.27	0.08	0.92
Finland	0.75	5.49	0.23	0.11	0.89
Germany	0.73	5.18	0.22	0.11	0.89
Sweden	0.71	5.40	2.31	0.10	0.90
Switzerland	0.63	5.57	0.44	0.14	0.86

Source: Datastream and Eurostat.
The consumption to output ratio is given c/y, the capital to output ratio is k/y, and the capital to labor ratio is k/l.
The share of youth labor in labor force is given by l^y/l, and the share of middle-age workers in labor force is l^m/l.

It is straightforward to compare the model predictions with the data. Note that the data values reported in the last column of Table 5 represent average values across countries. Table 5 reports the share of young and middle-age people in the labor force, the share of capital and consumption in output, and capital to labor ratio both for the model and for the data. The model captures the average empirical capital to labor ratio of 0.42 with 0.62 very well. Furthermore, model's consumption to output ratio c/y of 0.82 is in line with the value of 0.72 observed in the data. The model's fit of the capital to output ratio is close to the data (4.13 versus 5.78 in the data). Focusing on the labor participation, the model matches exactly the the values for young (0.10) and middle aged (0.90) people.

Table 5: Model vs Data

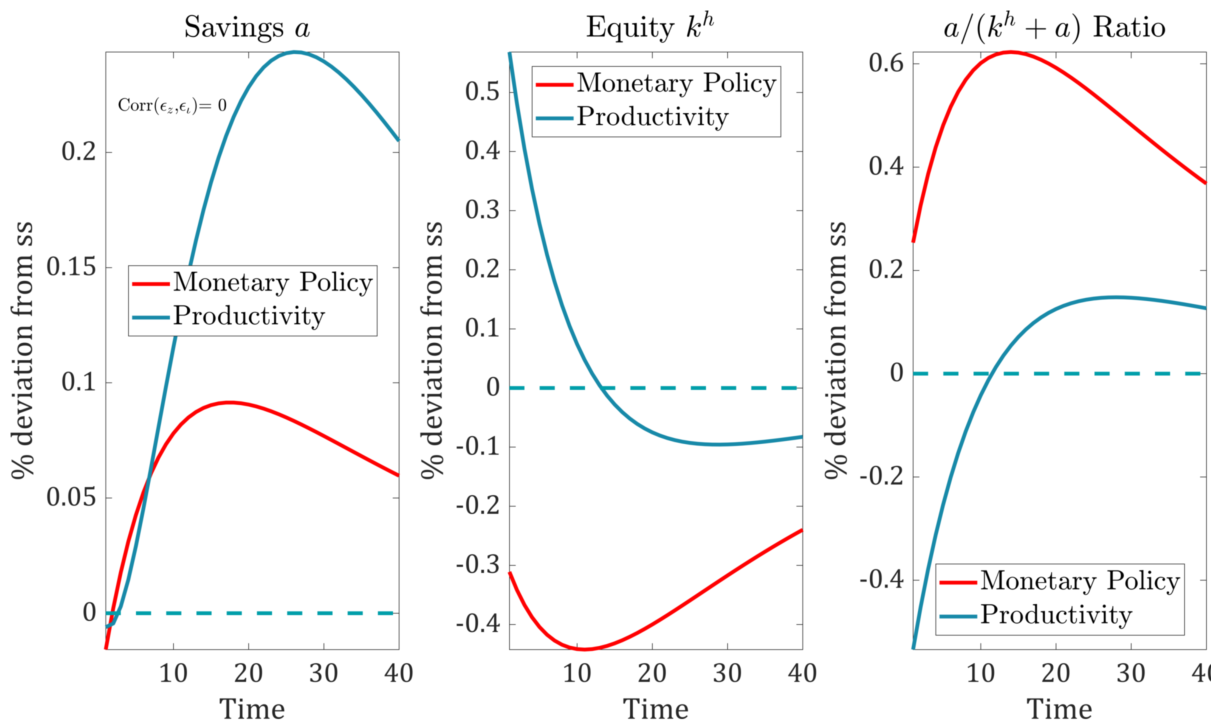
Ratio	Description	Model	Data
k/l	Capital to labor ratio	0.62	0.42
k/y	Capital to output ratio	4.13	5.78
c/y	Consumption to output ratio	0.82	0.72
l^y/l	Share of young people in labor force	0.10	0.10
l^m/l	Share of middle aged people in labor force	0.90	0.90

4.3 The Response of Saving to Monetary Policy and Productivity Shocks

In this section, we analyze how the interest rate and productivity affect household saving decisions. Figure 3 shows that a change of one basis point in monetary policy shock leads to a temporary increase of 0.25%. It is also interesting to note that Figure 3 shows a significant persistence in the response of saving. In our model individuals of a given age have different consumption and saving behavior. An increase in the interest rate makes households shift their spending. A strongly persistent response of saving to monetary policy shock may simply reflect a heterogeneous desire to save as the response takes a long time to return to the its steady-state. The theoretical intuition is simple, households increase their savings and reduce their consumption when the interest rate increases. The household savings rises because it becomes more profitable to save, and individuals who eventually classify themselves as savers take advantage of this temporarily high-interest rate and diverts their income into saving.

The logic behind the response of household savings to Monetary shock is framed as follows. Households in this economy seem to decrease their investment in equity by 0.4 when central bank raise interest rate, whereas the share of savings in total investment saw an increase by 0.6% in response to a contractionary monetary policy. This consistent with our theoretical model and with

Figure 3: Saving Responses to Productivity and Monetary Policy Shocks



Notes: Figure shows the response of household savings due to an increase by one percent of monetary policy rate and an one percent positive technology shock.

the findings in Cao and Werning (2018).

Our model implies a large saving response to the aggregate shock, compared to the monetary policy shock, savings is extremely sensitive to an increase in productivity, see Figure 3. We observed high variability in the savings, with an increase of 0.15% in the first 11 years. The response tends to be large and long-lived with an increase of 0.22% in the first 20 years and then followed by a decline and return to its initial level. More recent papers on the relationship between productivity and saving behavior seeks to provide empirical evidence that economic growth leads to saving. [9]

In an economy with three generations, aggregate productivity shock is still a dominant force. For instance, we have found that a positive productivity shock lead to an increase in savings and capital investment. The latter experience the largest but short-lived effects, in the first 15 years. To the extent that the economy is hit by a positive aggregate shock, total investment in

[9] See Aghion et al. (2016) for more on the effect of saving on productivity growth. Attanasio et al. (2000), for example, show that the effects of growth on the saving rate remain ambiguous, and depend on a number of factors. They find that the correlation between growth and saving disappears with the introduction of various controls that affect this relationship.

equity increase by 0.55%. Strikingly, the share of saving in total investment decline by 0.3% after a positive technology shock. The model implies that households may substitute saving for capital, and may prefer to reduce the share of savings and shift to equity investment.

5 Optimal Saving Function: Specification and Econometric Estimation

To give a sense to the evolution of saving rates across European economies, one might focus on the impact of potential factors such as: the dynamics of the interest rate, the evolution of wages and labor; on changes in household savings a_t. It is straightforward to identify the origin of personal saving by taking a loglinearized expression of the optimal saving function 3.14 which gives the following form:

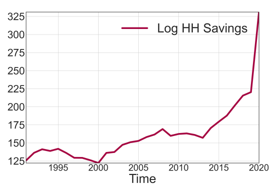
$$\begin{aligned}\ln a_t =& \frac{z^y \zeta^y}{z^{y2}\zeta^y + \beta z^{m2}} \ln \omega_t - \frac{\zeta^y z^y + \beta z^m \sigma}{\sigma(z^{y2}\zeta^y + \beta z^{m2})} \ln r_t + \frac{z^y \zeta^y}{z^{y2}\zeta^y + \beta z^{m2}} \ln l_t^y \\ &+ \frac{\beta(\beta(\delta-2)\zeta^m z^m - z^y \zeta^y)}{z^m} \ln k_t^h - \frac{\beta z^m \zeta^m}{z^{y2}\zeta^y + \beta z^{m2}} \ln r_t^k.\end{aligned}$$

We augment the specification by allowing for saving, wages, labor and interest rate to vary across time and countries. To make the model more realistic, we add some additional controls, such as demographic variables, to estimate the aggregate effect on personal saving at the country level using the following regression:

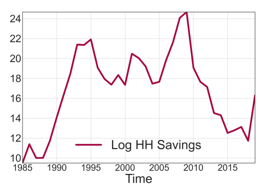
$$\ln a_{n,t} = \varsigma_0 + \varsigma_\omega \ln \omega_{n,t} + \varsigma_l \ln l_{n,t}^y + \varsigma_r \ln r_{n,t} + \varsigma_{r^k} \ln r_{n,t}^k + \varsigma_k \ln k_{n,t} + \varsigma_d \ln d_{n,t} + \varsigma_t + \varsigma_n + \epsilon_{n,t}, \tag{5.1}$$

where $\ln a_{n,t}$ denotes the log of household savings, $\ln \omega_{n,t}$ denotes the log of hourly wage rate, $\ln r_{n,t}$ denotes the log of interest rate, $\ln l_{n,t}^y$ is the log of hours worked by young workers between the age 15 and 24, ς_n represent the state fixed effects, and ς_t denotes the time fixed effect. We also include a control for demographic factors $d_{n,t}$ that represent the share of population by age group, and $\epsilon_{n,t}$ is the unobserved shock to savings.

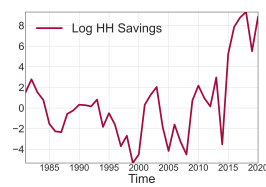
In equation (5.1), ς_r represents the effect of interest rate on saving, whereas the parameters ς_ω and ς_l measures the influence of the hourly wage rate and the effect of labor supplied by young workers, respectively. The term $\varsigma_d \ln d_{n,t}$ reflects the presence of demographic factors that affect saving behavior. Our data covers the period from 1960 to 2020. In particular, we look at the household saving rate, the net saving of households, the central bank policy rate, and the average compensation per hour worked. To construct the hours worked by young and middle aged, we use the participation rate to the labor force of the population between 15-24 years and between 25-65 years, and the total employment in thousands of hours worked. The demographic variables we have considered are proportion of population aged 0-14 years, 15-24 years, 25-49 years, 50-64 years, 65-79 years, 80 years and more. We consider the following European countries: Italy, Spain, Netherlands, Sweden, Switzerland, Denmark, Austria, Belgium, Finland, Germany, and France. Given the limited data coverage, the number of observations decreases as we include additional variables into the estimation.



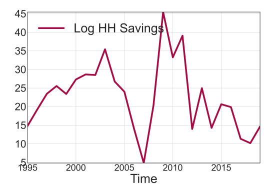
A. Germany



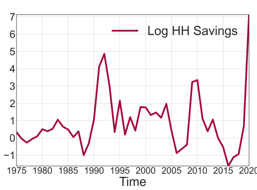
B. Belgium



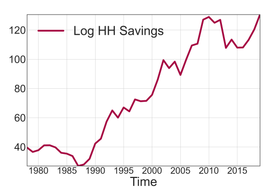
C. Denmark



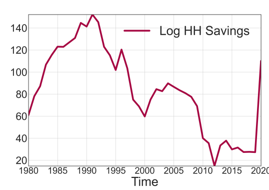
D. Spain



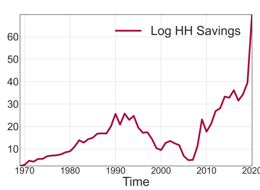
E. Finland



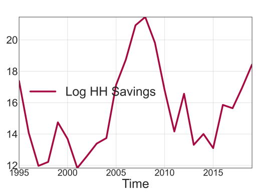
F. France



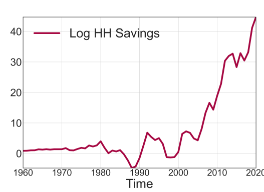
G. Italy



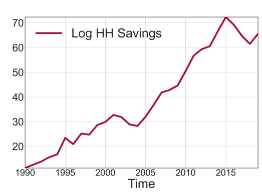
H. Netherlands



I. Austria



J. Sweden



K. Switzerland

Figure 4: Dynamics of Household Saving in Europe

Notes: The data is in Log and at year level over the period 1960-2020.Source: Datastream.

As documented previously saving rate has fallen almost everywhere in Europe. But does this phenomenon of downward pressure holds at the aggregate level? Figure 4 presents the recent developments in households saving in eleven major economies in Europe between 1960 and 2020.[10] We observe that household saving vary differently across European countries and over time. For instance, Germany, France, Netherlands, Denmark, Sweden and Switzerland experienced a positive growth in households savings between 2000 and 2020, but countries such as Italy, Spain, Finland, Austria, and Belgium faced downward pressure in households savings after the financial crisis of 2008.

In terms of the criteria to include the time and country fixed effects into the specification. We should note that the data exhibit significant heterogeneity of saving behavior, then the model with country fixed effects would be desirable. Additionally, we use a time fixed effects model to control for all time specific effects and time trends. The Hausmann test that will be discussed below helped us to decide whether fixed or random effects model should be used.

Table 6: The Effect of Demography on Household Savings

	Dependent variable: Household savings $\ln(a)$			
	(1)	(2)	(3)	(4)
Constant	-4.79**	-7.98***	36.55***	12.56***
	(2.05)	(1.19)	(6.42)	(1.95)
% of pop. ages 0-14	2.63***			
	(0.72)			
% of pop. ages 15-24		4.20***		
		(0.47)		
% of pop. ages 25-64			-8.51***	
			(1.62)	
% of pop. ages over 65				-3.55***
				(0.70)
Country fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
No. Observations	388	388	388	388
R^2	0.041	0.204	0.081	0.074

This table shows the results from regressions over the sample (1960-2020). Independent variables are: the share of population between 0 and 14 years, the share of population between 15 and 24 years, the share of population between 25 and 64 years, the share of population between over 65 years, country fixed effects, and time fixed effects. Statistical significance (Std. error in parenthese): 0.1*, 0.05**, 0.01 ***.

What is the Effect of Aging on Saving Behavior? Table 6 reports the regression results from a specification including year and country fixed effects. These results suggest that the demographic factor is important in the determination of household savings. There are several studies that attribute the dis-saving in the economy to the population aging (see e.g., Curtis et al. (2015);

[10]The data start for the following European countries: Denmark (1981); Finland (1975); Italy (1980); France (1978); Spain (1996); Germany (1991); Netherlands (1969); Sweden (1960); Switzerland (1990); Austria (1995); and Belgium (1985). The data end: Denmark (2019); Finland (2020); Italy (2020); France (2019); Spain (2019); Germany (2020); Netherlands (2020); Sweden (2020); Switzerland (2019); Austria (2019); and Belgium (2019).

Modigliani and Cao (2004); Higgins (1998); Chen et al. (2007); Coeurdacier et al. (2015)). It is important to emphasize that the increase of the share of population aged between 25 and 64 can cause the decline in household savings.

As would be expected, we find a negative effect of the share of the population ages over 65 on household savings. A decline in the share of middle age and the elderly population is associated with an increase in household saving. For example, if we increase the share of the population between 25-64 by 1 percent, the household savings will drop by -8.51 percent. A result in line with the findings of Higgins (1998).[11]

We focus now more on why an increase of the middle-age population causes dissavings in the economy. The negative relationship that emerges from our analysis may arise because people between ages 25-64, who still contribute to the labor force, decumulate faster to spend. As they approach the retirement age, they consume more and the household saving falls. After retirement, old people would finance their consumption out of retirement income and dis-save. This seems the most realistic explanation.

The parameter estimates reported in Table 6 suggest that an increase in the share of children and young population increases the household saving. Savings rises by 4.2 (2.63) percent when the share of the population ages 15-24 (0-14) increases by 1 percent. A potential explanation is that a higher share of children will require higher savings for expected future expenses. In the next section, we exploit macro data to develop a better view on factors that may explain the evolution of the saving across Europe.

Youth Labor Supply, Wages and Household Savings. Table 7 presents the estimates for the coefficient ς_{ω} using an alternative version of the Equation (5.1). We find a strong relationship between the hourly wage rate and saving. The coefficients are positive and statistically significant. The first column of Table 7 shows a regression coefficient estimate of 2.59 when both the country and the year fixed effects are included. In columns (3) the estimated parameter is considerably lower when we include only the country fixed effects (0.90). In column (4), the estimate turns out to be quite large (1.20) without the inclusion of time and country fixed effects. We can say that we

[11] It should be noted that Higgins (1998) shows a negative relationship between the expansion of elderly population and saving.

Table 7: Estimates of the Transmission Channel of Average Wage Rate on Saving

	Dependent variable: Household savings ln(a)			
	(1)	(2)	(3)	(4)
Constant	-5.23**	1.28	0.08	-0.85
	(2.28)	(1.40)	(0.39)	(0.78)
Average wage rate ln(ω)	2.59***	0.52	0.90***	1.20***
	(0.73)	(0.45)	(0.12)	(0.25)
Country fixed effects	Yes	No	Yes	No
Time fixed effects	Yes	Yes	No	No
No. Observations	289	289	289	289
R^2	0.051	0.005	0.161	0.075
H_0: OLS model with no FE is preferred				
OLS model with Time and Country FE				
Chi-2 Statistic			4.16	
P-value			0.12	
Decision			Accept H_0	

This table shows the results from ordinary least squares regressions over the sample (1960-2020), (1) with country and time fixed effects; (2) with time fixed effects; (3) with country fixed effects; (4) with no fixed effects. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01 ***.

expect about 2.59% increase in household savings when the average wage rate increase by 1%. We use a formal Hausman test to verify whether the OLS with fixed effects or the OLS with no fixed effects should be used. We observe that the value of Hausman test argues in favor of random effects model. Hence, we put more trust on the OLS with no fixed effects.

Table 8: Estimates of the Relationship Between Labor Supply and Saving

	Dependent variable: Household savings ln(a)			
	(1)	(2)	(3)	(4)
Constant	-25.19***	-1.29	-14.53***	-1.23
	(3.24)	(0.92)	(3.27)	(0.89)
Youth labor ln(l^y)	2.04***	0.32***	1.27***	0.31***
	(0.23)	(0.07)	(0.24)	(0.06)
Country fixed effects	Yes	No	Yes	No
Time fixed effects	Yes	Yes	No	No
No. Observations	251	251	251	251
R^2	0.262	0.093	0.109	0.088
H_0: OLS model with no FE is preferred				
OLS model with Time and Country FE				
Chi-2 Statistic			58.95	
P-value			0.00	
Decision			Reject H_0	

This table shows the results from ordinary least squares regressions over the sample (1960-2020), (1) with country and time fixed effects; (2) with time fixed effects; (3) with country fixed effects; (4) with no fixed effects. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01 ***.

Next, we estimate the effect of hours worked by younger individuals on savings. Table 8 reports the regression results from a specification including year and country fixed effects. The estimated parameter for labor supply by younger workers is positive and significant, indicating that household savings increases when the hours worked by younger individuals increases. Columns (1) - (4) lead to basically the same result: the relationship between labor supply and saving is positive and highly statistically significant. In general, the estimated coefficient on labor supply suggests that a 1% increase in the total hours worked by young workers would increase household savings by 2.04%. Table 8 reports the results of the Hausman test. Observe that the value of Hausman test argues in favor of time and country fixed effects estimation. The estimate of the time and country fixed effects model turns out to be more reliable than that of the random effects model. The p-value suggests that the time and country fixed effect model performs best in comparison to the other model specification.

The cross sectional evidence presented above using national level data impose basically an average effects of trends in youth labor supply and wages on savings across countries and over time. The estimation generate a positive relationship between youth labor supply, and household saving and between wages and household saving. We have also considered an empirical evidence using household level data from the Survey of Health Ageing and Retirement between 2005 and 2017,[12] and explored the effects of labor income on households saving. Our modified estimating equation write as

$$\ln a_{i,n,t} = \varsigma_0 + \varsigma_e ln(e_{i,n,t}) + \varsigma_d \text{age}_{i,n,t} + \varsigma_n + \varsigma_t + \epsilon_{i,n,t},$$

where $e_{i,n,t}$ denotes the labor income for individual i, at country n and time t. The term $a_{i,n,t}$ is household total saving, we control for the age of the household, and include country and time fixed effects to the equation. Results are displayed Table 9, the average effect of household labor income on saving is consistently positive and support the the cross sectional estimates. It is then true that if household labor income rises, then household saving would increase.

Savings, Interest Rate and Capital. We start by showing the relationship between the interest rate and saving rate in panel A of Figure 5. Recall that higher values of interest rate indicate a higher level of saving to income ratio. The figure displays the relationship between the saving rate and the interest rate. The interpretation that rises from the figure is that an increase in interest rate is associated with an increase in household savings. In Table 10, we report the parameter

[12]This paper uses data from SHARE Waves 1, 2, 3, 4, 5, 6, and 7. The survey is a collection of waves: 2005, 2007, 2009, 2011, 2013, 2015, 2017.

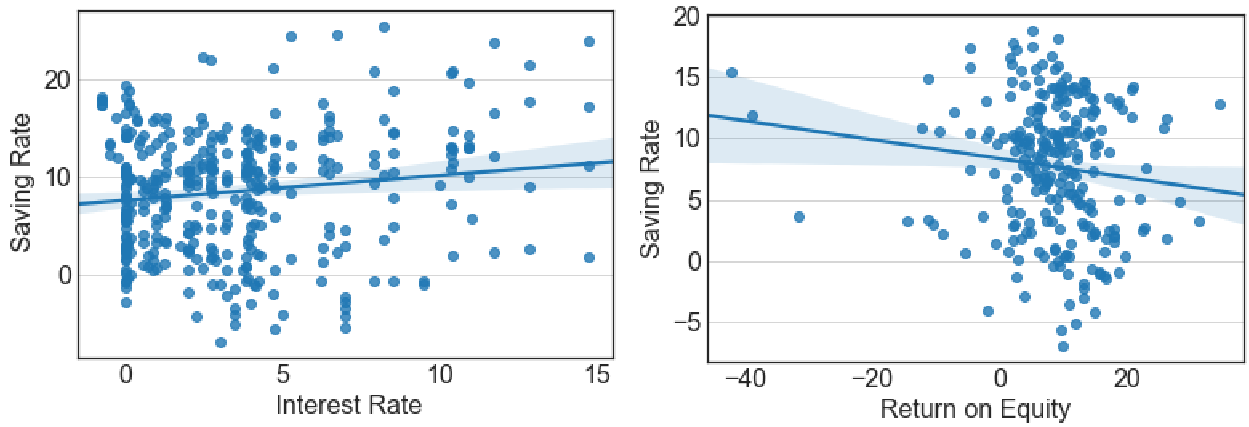
Table 9: Household Level Data - Estimates of the Relationship Between Labor Income and Saving, and Between Age and Saving

	Dependent variable: Household savings $\ln(a)$		
	(1)	(2)	(3)
Constant	9.24***	11.13***	8.43***
	(0.17)	(0.03)	(0.06)
Age	-0.00	-0.02***	
	(0.00)	(0.00)	
Labor Income $\ln(\omega_t l_t)$	0.13***		0.16***
	(0.01)		(0.00)
Country fixed effects	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes
No. Observations	14191	92883	40889
R^2	0.011	0.017	0.016

This table shows the results from ordinary least squares regressions with country and time fixed effects. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01 ***.

estimator for ς_r. Using the saving function equation (3.14), we include the share of both population aged between $25-49$, $0-14$, $15-24$, $25-64$ and over 65. As expected, the youth labor supply l^y variable have a statistically significant impact on the household savings. Furthermore, the parameter estimates for the impact of the interest rate on household savings reported in Column (1) is -0.16 statistically significatnt at level 5 percent, implying a negative impact of interest rate on household savings in the absence of time and country fixed effects. One striking feature of this result is that the interest rate influences negatively the level of household savings. When an increase in interest rate results into a decline in saving, this effect is called the "income effect". Future consumption becomes less expensive and individuals may prefer to consume more today and save less. These results are not in line with the existent literature. For example, the estimates displayed in Column (1) differ from those of Elmendorf (1996), who find that saving responds positively to increases in interest rate. However, it is important to mention that the empirical literature seems divided about the relationship between interest rate and saving.

One must be cautious when making conclusions about the relationship between interest rate and household saving. The results from the data show positive point estimates statistically significant at level 10 percent with 0.32 and 0.33 when we control for country specific attributes and time fixed effects that may influence saving, see Columns (2) and (3). It seems that households in Europe do increase saving when the policy rate increases. Yet these two quantitative evidence from the macro model and the regression results does not offer a clear conclusion about the sign



A. Saving Rate vs Interest Rate

B. Saving Rate vs Return on Equity

Figure 5: Saving Rate, Return on Equity and Interest Rate, Country Level

Notes: Yearly data at the national level over the period 1960-2020. Source: Datastream.

and the magnitude of the response of household savings to changes in interest rate.

So far we measured the relationship between interest rate and saving behavior in the absence of time trend and country-specific factors that may affect saving. In Table 11, we report the estimation results for the saving function under alternative specifications to deal with the measurement error that could bias our estimates. In column (1), with controlling for year, country fixed effects and the proportion of population under the age of 14, we find that ς_r is positive and statistically significant. When controlling for time, country fixed effects and young population (15-25) share (column (2)), the estimates remain positive and significantly different from zero. In column (3), we report results when using time, country fixed effects and control for middle age population. We conclude that the coefficient remains positive and statistically significant from zero. In column (5), when we control for time, country fixed affects and elderly population we find that ς_r is positive and statistically significant.

Clearly, the estimated coefficient is greatly sensitive to the introduction of time and country fixed effects. The absence of country and time dummies shifts the point estimate and gives a negative statistically insignificant coefficient (see Tables 10 and 11).

Now, we characterize the impact of return on capital on saving. Panel B of Figure 5 suggests that saving rate is actually decreasing with the return on equity. In column (1) of Table 11, the coefficient estimates for the return on equity is positive and statistically insignificant with

Table 10: Euler Equation Estimation

	Dependent variable: Household savings $\ln(a)$				
	(1)	(2)	(3)	(4)	(5)
Constant	3.27***	-21.18***	-19.31***	-1.07	175.33
	(0.15)	(3.77)	(3.27)	(1.21)	(157.37)
Interest rate $\ln(r)$	-0.16**	0.33*	0.32*	-0.08	0.07
	(0.07)	(0.18)	(0.18)	(0.09)	(0.08)
Average wage rate $\ln(\omega)$		0.79		1.32***	1.49***
		(0.80)		(0.36)	(0.46)
Capital $\ln(k)$					0.74***
					(0.12)
Youth labor supply $\ln(l^y)$		1.54***	1.59***		0.19**
		(0.24)	(0.24)		(0.08)
Return on equity $\ln(r^k)$					-0.09
					(0.14)
% of pop. ages $0-14$					-14.40*
					(7.67)
% of pop. ages $15-24$					-3.37
					(5.57)
% of pop. ages $25-64$					-27.87
					(25.24)
% of pop. ages over 65					-10.90
					(7.81)
Country fixed effects	No	Yes	Yes	No	No
Time fixed effects	No	Yes	Yes	No	No
No. Observations	288	207	208	243	177
R^2	0.021	0.225	0.221	0.103	0.466

This table shows the results from regressions over the sample (1960-2020). Independent variables are: interest rate, youth labor, average wage rate, capital, return on equity, the share of population between 0 and 14 years, the share of population between 15 and 24 years, the share of population between 25 and 64 years, the share of population over 65 years, country and time dummies. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01 ***.

0.01. The estimates remain insignificant even after the inclusion of several demographic controls. Whereas the point estimate of capital is significant and is equal to -0.92 (significant at level of 5 percent). In column (2), we add youth population as explanatory variable, like the results in column (1), we find a negative effect of the capital on saving. The coefficient is statistically significant at 5 percent level with a value of -0.85. Columns (3) and (4) reiterate the results obtained in the previous columns. The ς_k coefficients equal -1.13. Column (5) includes the proportion of elderly population and testifies a negative significant impact on household saving behavior. The specification in Table 11 presents evidence that capital have a negative impact on household savings. The estimated coefficients turn to be negative, significantly different from zero, and are barely unaltered.

The Estimation results reported in Table 12 show that demographic controls do neither mitigate the impact nor the statistical significance of the capital on saving. The point estimate of return on equity is positive but not significantly different from zero. In short, with the inclusion of time

Table 11: Determinants of Household Savings

	Dependent variable: Household savings $\ln(a)$				
	(1)	(2)	(3)	(4)	(5)
Constant	-3.61	-5.42	-11.49	-8.05	-1.74
	(9.56)	(8.14)	(13.17)	(18.71)	(10.34)
Average wage rate $\ln(\omega)$	0.80	0.81	0.60	0.55	0.59
	(1.06)	(1.05)	(1.05)	(1.07)	(1.06)
Capital $\ln(k)$	-0.92**	-0.85*	-1.13**	-1.13**	-1.03**
	(0.44)	(0.47)	(0.53)	(0.53)	(0.47)
Youth labor supply $\ln(l^y)$	1.36***	1.24**	1.53***	1.51***	1.44***
	(0.36)	(0.48)	(0.35)	(0.35)	(0.30)
Return on equity $\ln(r^k)$	0.01	0.01	0.01	0.01	0.01
	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
Interest rate $\ln(r)$	0.53***	0.53***	0.55***	0.55***	0.54***
	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
% of pop. ages $0-14$	-0.46				
	(1.54)				
% of pop. ages $15-24$		0.45			
		(0.93)			
% of pop. ages $25-64$			2.03	1.54	
			(3.30)	(3.80)	
% of pop. ages over 65				-0.37	-0.65
				(1.41)	(1.22)
No. Observations	177	177	177	177	177
Country fixed effects	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes
R^2	0.238	0.239	0.240	0.240	0.239

This table shows the results from ordinary least squares regressions over the sample (1960-2020). Independent variables are: average wage rate, capital, youth labor supply, return on equity, interest rate, the share of population between 0-14 years, the share of population between 15-24 years, the share of population between 25-64 years, the share of population over 64 years, time and country fixed effects. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01 ***.

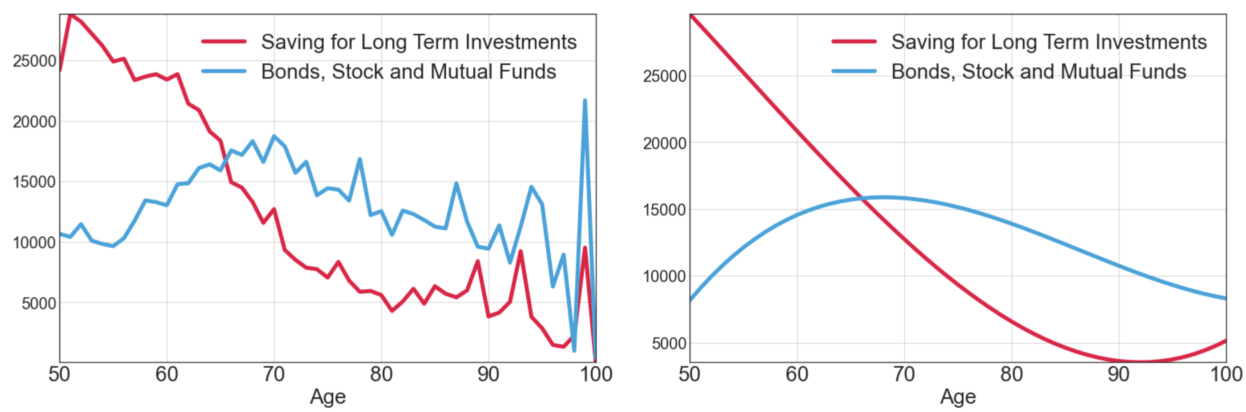
Table 12: Determinants of Household Savings

	Dependent variable: Household savings $\ln(a)$		
	(1)	(2)	(3)
Constant	-5.12	2.91***	17.05***
	(8.10)	(0.17)	(5.81)
Return on equity $\ln(r^k)$	0.01	0.08	
	(0.08)	(0.08)	
Capital $\ln(k)$	-0.94**		-0.91**
	(0.43)		(0.38)
Youth labor supply $\ln(l^y)$	1.42***		
	(0.30)		
Interest rate $\ln(r)$	0.53***		
	(0.20)		
Average wage rate $\ln(\omega)$	0.72		
	(1.03)		
No. Observations	177	186	223
Country fixed effects	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes
R^2	0.238	0.007	0.030

This table shows the results from ordinary least squares regressions over the sample (1960-2020). Independent variables are: average wage rate, capital, youth labor supply, return on equity, interest rate, country and time dummies. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01***.

and country fixed effects, we conclude that the interest rate has a positive significant impact on the household savings. This finding is consistent with an earlier work of Elmendorf (1996). Our estimation also suggest that capital and youth labor supply are important in explaining household savings.

Crowd-out in Savings. Next, we investigate the extent to which households shift from long term savings to corporate bonds. Panel A of Figure 6 shows how European households over 50 years alternate their saving decisions using the Survey of Health, Ageing and Retirement in Europe (SHARE). Between the age 50 and 80, saving for long term investment is higher than financial assets investment. Agents appear to prefer long term saving before retirement. When agent reach the retirement age, they are willing to substitute long term savings for corporate bonds. This change in saving choices reflect the substitution between long term and short term investment as stocks and bonds may provide higher rate of return over time.



A. Savings by Age

B. Filtered Data

Figure 6: Household Savings by Age

Notes: We take the mean value of saving for long term investment and for bonds, stocks and mutual funds by age. The data is fitted to polynomial of order three. Source: The Survey of Health, Ageing and Retirement.

Saving in long term investment is not sustainable after the age of 50, we link this decline in saving for long term investments to the behavior of households switching to saving in financial assets as households age. The pattern are consistent with our results in table 11, indicating a inverse relationship between corporate equity and saving at country level.

There is essentially a sharp decline in all form of assets after the age of 80, and households accumulate less assets at the final stage of life. This is clearly illustrated in Figure 6 Panel B, which plots the mean of households savings across age fitted to polynomial of order three. In particular, the long term savings of old households is relentlessly declining. Investment in corporate equity, in contrast, increased slightly because old households are eager to invest in short term investment such as stocks and bonds that may offer high returns.

6 Conclusion

We develop an overlapping generations model to understand the factors behind the saving behavior in Europe. The model is calibrated to European macro data. Our framework clarifies the mechanism linking saving to economic aggregates according to the household Euler equation that characterizes the optimal choice of household saving decisions. This optimality condition produces testable predictions that we will analyze empirically using cross-country data.

Using the theoretical model, we engage the optimal saving function to evaluate the drivers of household saving in Europe. We find strong evidence that an increase in youth labor supply leads to a rise in household savings. An increase of 1 percent of the hours worked by young people leads on average to a higher household savings, an increase of 2.03 percent. Analogously, our theoretical model predicts that wages are positively related to household savings. However, our empirical analysis provides little evidence that changes in wage rates cause dissavings. The empirical evidence using household-level data shows that the rise in labor income contributes significantly to the increase in total savings and saving decline as households age.

Additionally, we find an inverse relationship between corporate equity and household savings, a similar conclusion is drawn from household-level data, in which households over 50 substitutes long-term savings for corporate bonds and stocks as they age. Though we are unable to assign the decline in savings to changes in the capital rental rate, given that our estimation indicates an insignificant relationship.

In addition, the framework presented here allows us to identify the potential forces that may affect saving, including the effect of interest rate. While the existent literature has been inconclusive on whether the interest rates have either a positive or negative impact on saving, our model reveals a positive relationship between interest rate and saving. These findings are corroborated also by our empirical investigation. To sum up, the declining patterns in savings could in principle result from the long-term decline in interest rates. We are not claiming that interest rate is the primary driver of household savings, indeed, what we observed in the data is that saving varied considerably across European economies. After the outbreak of the global financial crisis, we have seen a sharp decline in interest rates. However, national household savings declined in a number of countries (for instance, Italy, Finland, Austria, Belgium, and Spain). But the household saving was moving in the opposite direction in others (for example in Germany, France, Netherlands, Sweden, and Switzerland).

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Online Appendix

On the Saving Behavior of European Households

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Appendix A Model Computations

A.1 Households

There are three generations, each is alive at any point in time. The lifetime utility is given by

$$E_{t-1}\beta^t U(c^y_{t-1}, c^m_t, c^o_{t+1}, l^y_{t-1}, l^m_t) = E_{t-1}\left\{\left\{\frac{(c^y_{t-1})^{1-\sigma}}{1-\sigma} - \frac{(l^y_{t-1})^{1+\eta}}{1+\eta}\right\} + \beta\left\{\frac{(c^m_t)^{1-\sigma}}{1-\sigma} - \frac{(l^m_t)^{1+\eta}}{1+\eta}\right\} + \beta^2\left\{\frac{(c^o_{t+1})^{1-\sigma}}{1-\sigma}\right\}\right\}$$

where $0 \leq \beta \leq 1$ is the discount factor, η is the curvature on the disutility of labor and σ is the risk aversion parameter. We let c^j denote the per capita consumption across age groups j at time t where $j \in \{y, m, o\}$ identifies age groups: young, middle-age, old age. l^y and l^m denote labor supply by young and middle age individuals. All agents maximize the utility subject to the budget constraints and capital accumulation:

$$c^y_{t-1} + z^y a_{t-1} + \zeta^y k^h_{t-1} = \omega_{t-1} l^y_{t-1},$$
$$c^m_t + z^m a_t + \zeta^m k^h_t = \omega_t l^m_t + z^y a_{t-1} r_{t-1} + ((1-\delta) + r^k_t)\zeta^y k^h_{t-1}$$
$$c^o_{t+1} = z^m a_t r_t + ((1-\delta) + r^k_{t+1})\zeta^m k^h_t$$

only young and middle age individuals supply labor in the first and second period of life at the hourly wage rate ω. In this economy, the young, middle age and old agents consume in each period. On the other hand, old agent earn no labor income in the third period of life but receive retirement income and consume.

We assume that only young and middle age population can purchase a safe asset a, where the share of asset holdings when the individual is young (middle-age) in the total asset holdings is given by z^y (z^m) and satisfy $\Sigma_i^{y+m} z^h = 1$. Both young and middle age agents save, but only the middle age and old age agents receive asset earnings at risk free interest rate r ($r = 1 + \iota$, where r is the gross rate and ι is the risk free interest rate).

$$k^h_t = (1-\delta)k^h_{t-1} + f(i)i^h_t$$

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When young and middle-aged, individuals can invest and offer capital k^h at rental rate r^k whereas the capital gains are received by the next generation. Therefore, the middle aged and young must accumulate capital units such that $k_t^h = (1-\delta)k_{t-1}^h + f(i)i_t^h$. They accumulate new capital k^h that depends on the existing capital which decays at the fixed rate δ and investment good i^h. The quantity of investment at period t is proportional to the adjustment cost function $f(i) = \left[1 - \frac{\kappa}{2}\left(\frac{i_t^h}{i_{t-1}^h} - 1\right)^2\right]$ and represent a small part of the existing capital k_{t-1}^h.

Solving by the Lagrange's method

$$
\begin{aligned}
\mathcal{L}_t^y &= E_0\left[\left\{\frac{(c_{t-1}^y)^{1-\sigma}}{1-\sigma} - \frac{(l_{t-1}^y)^{1+\eta}}{1+\eta}\right\} + \lambda_t\left(\omega_{t-1}l_{t-1}^y - c_{t-1}^y - z^y a_{t-1} - \zeta^y k_{t-1}^h\right)\right] \\
\mathcal{L}_t^m &= E_0\left[\beta\left\{\frac{(c_t^m)^{1-\sigma}}{1-\sigma} - \frac{(l_t^m)^{1+\eta}}{1+\eta}\right\} + \lambda_t\left(\omega_t l_t^m + z^y a_{t-1}r_{t-1} + ((1-\delta)+r_t^k)\zeta^y k_{t-1}^h\right.\right. \\
&\quad \left.\left. - c_t^m - z^m a_t - \zeta^m k_t^h\right)\right] \\
\mathcal{L}_t^o &= E_0\left[\beta^2\left\{\frac{(c_{t+1}^o)^{1-\sigma}}{1-\sigma}\right\} + \lambda_t\left(z^m a_t r_t + ((1-\delta)+r_{t+1}^k)\zeta^m k_t^h - c_{t+1}^o\right)\right]
\end{aligned}
$$

The household optimality conditions with respect to consumption: c_t^m, c_{t-1}^y, c_{t+1}^o, asset holdings a_t, labor: l_{t-1}^y, l_t^m, and capital k_t^h are derived as follow

$$\frac{\partial \mathcal{L}_t^y}{\partial c_{t-1}^y}: \quad \lambda_t = (c_{t-1}^y)^{-\sigma} \tag{A.1}$$

$$\frac{\partial \mathcal{L}_t^y}{\partial l_{t-1}^y}: \quad (l_{t-1}^y)^{\eta} = \lambda_t \omega_{t-1} \tag{A.2}$$

$$\frac{\partial \mathcal{L}_t^m}{\partial c_t^m}: \quad \frac{\lambda_t}{\beta} = (c_t^m)^{-\sigma} \tag{A.3}$$

$$\frac{\partial \mathcal{L}_t^m}{\partial l_t^m}: \quad \beta(l_t^m)^{\eta} = \lambda_t \omega_t \tag{A.4}$$

$$\frac{\partial \mathcal{L}_t^m}{\partial a_t}: \quad \lambda_t z^m = E_t \beta \lambda_{t+1} z^y r_{t+1} \tag{A.5}$$

$$\frac{\partial \mathcal{L}_t^m}{\partial k_t^h}: \quad \lambda_t \zeta^m = E_t \beta \lambda_{t+1}((1-\delta) + r_{t+1}^k)\zeta^y \tag{A.6}$$

$$\frac{\partial \mathcal{L}_t^o}{\partial c_{t+1}^o}: \quad \lambda_t = \beta^2 (c_{t+1}^o)^{-\sigma} \tag{A.7}$$

from (A.7) and (A.1)

$$\beta^2 (c_{t+1}^o)^{-\sigma} = (c_{t-1}^y)^{-\sigma} \tag{A.8}$$

Using the first order condition (A.5), the equation (A.8) can be rewritten as

$$\beta^2 (c_{t+1}^o)^{-\sigma} = E_t \frac{\beta (c_t^y)^{-\sigma} z^y r_{t+1}}{z^m}$$

which leads to

$$\beta^2\left(z^m a_t r_t + ((1-\delta) + r^k_{t+1})\zeta^m k^h_t\right)^{-\sigma} = E_t\left(\omega_t l^y_t - z^y a_t - \zeta^y k^h_t\right)^{-\sigma} \frac{\beta z^y r_{t+1}}{z^m}$$

from (A.3) and (A.4) we obtain

$$(c^m_t)^{-\sigma} = \frac{(l^m_t)^\eta}{\omega_t}$$

using (A.1) and (A.2) we obtain

$$(c^y_{t-1})^{-\sigma} = \frac{(l^y_{t-1})^\eta}{\omega_{t-1}}$$

given the optimality condition (A.5), we simplify the equation (A.6) and obtain

$$r_{t+1} = (r^k_{t+1} + 1 - \delta)\frac{\zeta^y z^m}{\zeta^m z^y}$$

The budget constraint of the young agent implicitly suggests that holdings of assets is equal to the difference between labor income, capital and consumption. These holding of asset purchased when young will serve to finance consumption, investment, and new asset holdings when middle-aged. Therefore, the middle aged agent will choose the optimal amount of asset a to maximize their expected utility subject to their budget constraint and capital accumulation, which is expressed in (A.5).

A.2 Technology

The problem of the intermediate good producer is to minimize the cost,

$$\omega_t(l^y_t + l^m_t) + r^k_t k_t$$

subject to the production function that relates inputs to outputs:

$$y_t = z_t k^\alpha_t (l^y_t + l^m_t)^{1-\alpha} \tag{A.9}$$

The Lagrangian form of the producer problem is given :

$$\mathcal{L} = \quad \omega_t(l^y_t + l^m_t) + r^k_t k_t + \mu_t[y_t - z_t k^\alpha_t (l^y_t + l^m_t)^{1-\alpha}],$$

where μ_t is the Lagrange multiplier associated with the production function. The first-order conditions with respect to labor l_t^y and l_t^m and capital k_t yield:

$$\frac{\partial \mathcal{L}_t}{\partial l_t^y}: \quad \omega_t - (1-\alpha) z_t k_t^\alpha (l_t^y + l_t^m)^{-\alpha} \mu_t = 0$$

$$\mu_t = \frac{\omega_t}{z_t (1-\alpha) k_t^\alpha (l_t^y + l_t^m)^{-\alpha}}, \tag{A.10}$$

$$\frac{\partial \mathcal{L}_t}{\partial l_t^m}: \quad \omega_t - (1-\alpha) z_t k_t^\alpha (l_t^y + l_t^m)^{-\alpha} \mu_t = 0$$

$$\mu_t = \frac{\omega_t}{z_t (1-\alpha) k_t^\alpha (l_t^y + l_t^m)^{-\alpha}}, \tag{A.11}$$

$$\frac{\partial \mathcal{L}_t}{\partial k_t}: \quad r_t^k - \alpha z_t (l_t^y + l_t^m)^{1-\alpha} k_t^{\alpha-1} \mu_t = 0$$

$$\mu_t = \frac{r_t^k}{\alpha z_t (l_t^y + l_t^m)^{1-\alpha} k_t^{\alpha-1}}. \tag{A.12}$$

The Euler equation implies the following:

$$\frac{\omega_t}{z_t (1-\alpha)(k_t)^\alpha (l_t^y + l_t^m)^{-\alpha}} = \frac{r_t^k}{z_t \alpha (l_t^y + l_t^m)^{1-\alpha} (k_t)^{\alpha-1}}$$

$$\frac{\omega_t}{(1-\alpha)} \left(\frac{l_t^y + l_t^m}{k_t} \right)^\alpha = \frac{r_t^k}{\alpha} \left(\frac{k_t}{l_t^y + l_t^m} \right)^{(1-\alpha)}$$

$$\frac{k_t}{l_t^y + l_t^m} = \frac{\alpha}{1-\alpha} \frac{\omega_t}{r_t^k}. \tag{A.13}$$

Then, we divide the total cost over total production which is equivalent to the marginal cost:

$$\text{Marginal cost} = \quad \mu_t = \frac{\omega_t (l_t^y + l_t^m) + r_t^k k_t}{z_t k_t^\alpha (l_t^y + l_t^m)^{1-\alpha}}$$

$$\mu_t = \frac{\omega_t + r_t^k \frac{k_t}{l_t^y + l_t^m}}{z_t \left(\frac{k_t}{l_t^y + l_t^m} \right)^\alpha}$$

We use equation (A.13) to simplify further the expression:

$$\mu_t = \frac{\omega_t + r_t^k \left(\frac{\alpha}{1-\alpha} \frac{\omega_t}{r_t^k} \right)}{z_t \left(\frac{\alpha}{1-\alpha} \frac{\omega_t}{r_t^k} \right)^\alpha}$$

$$\mu_t = \frac{\omega_t + \left(\frac{\alpha}{1-\alpha} \omega_t \right)}{z_t \left(\frac{\alpha}{1-\alpha} \frac{\omega_t}{r_t^k} \right)^\alpha}$$

$$\mu_t = \left[\omega_t + \left(\frac{\alpha}{1-\alpha} \omega_t \right) \right] \frac{1}{z_t} \left[\frac{\alpha}{1-\alpha} \frac{\omega_t}{r_t^k} \right]^{-\alpha}$$

$$\mu_t = \left(\frac{1}{1-\alpha} \right)^{(1-\alpha)} \left(\frac{1}{\alpha} \right)^\alpha \frac{(r_t^k)^\alpha (\omega_t)^{(1-\alpha)}}{z_t}. \tag{A.14}$$

We can write the zero profit condition for the producer as follows:

$$y_t - \omega_t(l_t^y + l_t^m) - r_t^k k_t = 0$$
$$z_t k_t^\alpha (l_t^y + l_t^m)^{1-\alpha} - \omega_t(l_t^y + l_t^m) - r_t^k k_t = 0$$
$$z_t \frac{k_t^\alpha}{(l_t^y + l_t^m)^\alpha}(l_t^y + l_t^m) - \omega_t(l_t^y + l_t^m) - r_t^k k_t = 0$$

then we divide by $(l_t^y + l_t^m)$

$$z_t \frac{k_t^\alpha}{(l_t^y + l_t^m)^\alpha} - \omega_t - r_t^k \frac{k_t}{l_t^y + l_t^m} = 0$$
$$\omega_t = z_t \left(\frac{k_t}{l_t^y + l_t^m}\right)^\alpha - r_t^k \frac{k_t}{l_t^y + l_t^m} \tag{A.15}$$

A.3 Capital Producers

In this economy we assume that capital producer maximizes the expected profits by choosing capital k_t^p and i_t^p

$$\text{maximize} \quad E_t[r_t^k k_{t-1}^p - i_t^p]$$

Capital producer uses the following technology to produce capital k_t^p:

$$k_t^p = (1-\delta)k_{t-1}^p + f(i)i_t^p, \tag{A.16}$$

where the adjustment cost function is given by $f(i) = \left[1 - \frac{\kappa}{2}\left(\frac{i_t^p}{i_{t-1}^p} - 1\right)^2\right]$.
The Lagrangian form of the capital producer problem is given :

$$\mathcal{L} = \quad \chi_t\left(r_{t-1}^k k_{t-1}^p - i_t^p + ((1-\delta)k_{t-1}^p + f(i)i_t^p - k_t^p)\right),$$

The first order condition with respect to capital is

$$E_t \beta \chi_{t+1}(r_t^k + (1-\delta)) = \chi_t$$

The first order condition with respect to investment is given by

$$\chi_t = \chi_t\left[1 - \kappa\frac{i_t^p}{i_{t-1}^p}\left(\frac{i_t^p}{i_{t-1}^p} - 1\right) - \frac{\kappa}{2}\left(\frac{i_t^p}{i_{t-1}^p} - 1\right)^2\right] + \beta\chi_{t+1}\left[\kappa\left(\frac{i_{t+1}^p}{i_t^p}\right)^2\left(\frac{i_{t+1}^p}{i_t^p} - 1\right)\right]$$

A.4 Market Clearing Condition

We define the market clearing condition:

$$y_t = c_t + i_t \tag{A.17}$$

The market for capital and labor clear

$$k_t = k_t^h + k_t^p, \quad l_t = l_t^y + l_t^m, \tag{A.18}$$

A.5 Government

We further assume that government does not optimize and government policies are assumed to be exogenous. The government budget constraint:

$$a_t r_t = g_t + a_{t-1} \tag{A.19}$$

government issue bonds a which pay a gross interest rate r, and g denote the government revenues that obey to an autoregressive order one process:

$$g_t = \rho^g g_{t-1} + \epsilon_t^g \tag{A.20}$$

where ρ^g is a smoothing parameter and ϵ_t^g is a shock to government revenues.

A.6 Monetary Policy

We assume that the monetary policy rule take the form:

$$\ln \iota_t = \rho^r \ln \iota_{t-1} + \rho^y \ln y_t + \epsilon_t, \tag{A.21}$$

Appendix B Steady State

Given the first order condition with respect to a we can compute the steady state value of interest rate factor r under the assumption that the discount factor and the shares of asset holding are know:

$$\lambda_t = E_t \lambda_{t+1} \frac{\beta z^y r_{t+1}}{z^m}$$
$$r_{ss} = \frac{\lambda_{ss}}{\lambda_{ss}} \frac{z^m}{\beta z^y}$$
$$r_{ss} = \frac{z^m}{\beta z^y}$$

We assume that middle aged and young individual share equally the assets such that the initial steady state value of the demographic variables $z^m = z^y$. This implies

$$r_{ss} = \frac{1}{\beta}$$
$$1 + \iota_{ss} = \frac{1}{\beta}$$
$$\iota_{ss} = \frac{1}{\beta} - 1$$

where ι_{ss} is the interest rate set by the central bank.
Capital rental rate r_t^k at the steady state equals:

$$E_t \beta \lambda_{t+1}((1-\delta) + r_t^k) = \lambda_t \zeta^m$$
$$\beta r_{ss}^k \lambda_{ss} \zeta^y = \lambda_{ss} \zeta^m - \beta(1-\delta)\lambda_{ss}\zeta^y$$
$$r_{ss}^k = \frac{\zeta^m}{\beta \zeta^y} - (1-\delta)$$

We can use (A.15) to compute the hourly wage rate at the steady state:

$$\omega_t = z_t \left(\frac{k_t}{l_t^y + l_t^m} \right)^{\alpha} - r_t^k \frac{k_t}{l_t^y + l_t^m}$$

It is convenient to parametrize the capital-labor share $\frac{(k_t)}{l_t^y + l_t^m}$ at the steady state as $\frac{k}{l}$. So that knowing the capital rental rate and the capital labor share at the steady state will be enough to compute the hourly wage rate ω_{ss}:

$$\omega_{ss} = z_{ss} \left(\frac{k}{l} \right)^{\alpha} - r_{ss}^k \frac{k}{l}$$

Then we can easily compute the producer marginal cost (A.14) at the steady state:

$$\mu_t = \left(\frac{1}{1-\alpha} \right)^{(1-\alpha)} \left(\frac{1}{\alpha} \right)^{\alpha} \frac{(r_t^k)^{\alpha} (\omega_t)^{(1-\alpha)}}{z_t}$$
$$\mu_{ss} = \left(\frac{1}{1-\alpha} \right)^{(1-\alpha)} \left(\frac{1}{\alpha} \right)^{\alpha} \frac{(r_{ss}^k)^{\alpha} (\omega_{ss})^{(1-\alpha)}}{z_{ss}}$$

For what concerns capital labor k_t and labor supplied by young individual l_t^y and by middle aged individuals l_t^m, we use the producer Euler equation (A.13)

$$\frac{k_{ss}}{l_{ss}^y + l_{ss}^m} = \frac{\alpha}{1-\alpha}\frac{\omega_{ss}}{r_{ss}^k}.$$

the first order condition with respect to capital (A.12)

$$\mu_{ss} = \frac{r_{ss}^k}{\alpha z_{ss}(l_{ss}^y + l_{ss}^m)^{1-\alpha}(k_{ss})^{\alpha-1}}.$$

and the definition of capital to labor ratio

$$\frac{k}{l^m + l^y} = \frac{k_{ss}}{l_{ss}^y + l_{ss}^m}$$

to solve simultaneously for the three unknown variables k_{ss}, l_{ss}^y, l_{ss}^m.
We then use the production function to compute the total output at the steady state

$$y_t = z_t k_t^\alpha (l_t^y + l_t^m)^{1-\alpha}$$
$$y_{ss} = z_{ss} k_{ss}^\alpha (l_{ss}^y + l_{ss}^m)^{1-\alpha}$$

Using the capital accumulation equation we can derive the steady state value of investment

$$k_t = (1-\delta)k_{t-1} + f(i)i_t$$
$$k_{ss} = (1-\delta)k_{ss} + f(i)i_{ss}$$
$$i_{ss} = \delta k_{ss}$$

where f(i) take the value of one in the steady state.
We compute the steady state of the consumer marginal utility

$$\beta(l_t^m)^\eta = \lambda_t \omega_t$$
$$\lambda_{ss} = \frac{\beta(l_{ss}^m)^\eta}{\omega_{ss}}$$

Personal saving ratio in this economy is defined as

$$s_t = \frac{a_t}{\omega_t(l_t^y + l_t^m)}$$
$$s_{ss} = \frac{a_{ss}}{\omega_{ss}(l_{ss}^y + l_{ss}^m)}$$

The saving to income ratio s_{ss} will be paramterized using the data. Then, we can easily derive the value of total personal saving at the steady state a_{ss}.
Capital suplied by household and institutonal investors can be computed as

$$k_t^h = k_t s^k$$
$$k_{ss}^h = k_{ss} s^k$$
$$k_t^p = k_t(1 - s^k)$$
$$k_{ss}^p = k_{ss}(1 - s^k)$$

the parameter s^k represent the share of capital owned by households. We can then use the capital accumulation equation to solve for investment of households and institutional investors:

$$\begin{aligned} i_t^h &= k_t^h \delta \\ i_{ss}^h &= k_{ss}^h \delta \\ i_t^p &= k_t^p \delta \\ i_{ss}^p &= k_{ss}^p \delta \end{aligned}$$

Then, we compute consumption by age groups:

$$\begin{aligned} c_{ss}^y &= \omega_{ss} l_{ss}^y - z^y a_{ss} - \zeta^y kss \\ c_{ss}^m &= \omega_{ss} l_{ss}^m + z^y a_{ss} r_{ss} + ((1-\delta) + r_{ss}^k)\zeta^y k_{ss} - z^m a_{ss} - \zeta^m k_{ss} \\ c_{ss}^o &= z^m a_{ss} r_{ss} + ((1-\delta) + r_{ss}^k)\zeta^m k_{ss} \end{aligned}$$

Market clearing condition

$$y_{ss}^* = c_{ss}^y + c_{ss}^m + c_{ss}^o + i_{ss}$$

Residual

$$Resid = y_{ss} - y_{ss}^*$$

Using the government budget constraint we can derive the value of government revenues:

$$\begin{aligned} g_t &= a_t r_t - a_{t-1} \\ g_{ss} &= a_{ss} r_{ss} - a_{ss}. \end{aligned}$$

Appendix C Proof and Correlation Matrix

In this section, we consider the impact of wages, youth labor, supply, capital, interest rate, and capital rental rate on household savings. We then present the correlation matrix of our model.

C.1 Proof

We consider the optimality condition:

$$\beta^2\left(z^m a_t r_t + ((1-\delta) + r^k_{t+1})\zeta^m k_t\right)^{-\sigma} = E_t\left(\omega_t l^y_t - z^y a_t - \zeta^y k_t\right)^{-\sigma} \frac{\beta z^y r_{t+1}}{z^m}$$

For notational convenience, we drop the expectations operator E_t and express all the variables in the same date $t+1$.

$$\beta^2\left(z^m a_t r_t + ((1-\delta) + r^k_t)\zeta^m k_t\right)^{-\sigma} = \left(\omega_t l^y_t - z^y a_t - \zeta^y k_t\right)^{-\sigma} \frac{\beta z^y r_t}{z^m}$$

that yields the explicit saving function $a_t = F(r_t, \omega_t, l^y_t, r^k_{t+1}, k_t)$, this function shows that the optimal saving will depend on hours worked when young, the hourly wage rate, and the gross interest rate, return on capital, and capital. We define the implicit relation

$$\Pi(r_t, \omega_t, l^y_t, a_t, r^k_t, k_t) = \beta^2\left(z^m a_t r_t + ((1-\delta) + r^k_t)\zeta^m k_t\right)^{-\sigma} - \left(\omega_t l^y_t - z^y a_t - \zeta^y k_t\right)^{-\sigma} \frac{\beta z^y r_t}{z^m}$$

with Π is differentiable and continuous such that $\Pi({r_t}^o, {\omega_t}^o, {l^y_t}^o, {a_t}^o, {r^k_t}^o, {k_t}^o) = 0$ whenever a_t is a solution. The partial derivative with respect to a_t is nonzero, $\frac{\partial \Pi(r_t, \omega_t, l^y_t, a_t, r^k_t, k_t)}{\partial a_t} \neq 0$.
We rewrite the implicit relation as follow $\Pi(r_t, \omega_t, l^y_t, r^k_t, k_t, F(r_t, \omega_t, l^y_t, r^k_t, k_t)) = \beta^2\big(z^m a_t r_t + ((1-\delta) + r^k_t)\zeta^m k_t\big)^{-\sigma} - \left(\omega_t l^y_t - z^y a_t - \zeta^y k_t\right)^{-\sigma} \frac{\beta z^y r_t}{z^m}$. Then, we apply the chaine rule and we obtain:

$$\begin{aligned}
\frac{\partial \Pi}{\partial r_t} + \frac{\partial \Pi}{\partial a_t}\frac{\partial a_t}{\partial r_t} &= 0 \\
\frac{\partial \Pi}{\partial \omega_t} + \frac{\partial \Pi}{\partial a_t}\frac{\partial a_t}{\partial \omega_t} &= 0 \\
\frac{\partial \Pi}{\partial l^y_t} + \frac{\partial \Pi}{\partial a_t}\frac{\partial a_t}{\partial l^y_t} &= 0 \\
\frac{\partial \Pi}{\partial r^k_t} + \frac{\partial \Pi}{\partial a_t}\frac{\partial a_t}{\partial r^k_t} &= 0 \\
\frac{\partial \Pi}{\partial k_t} + \frac{\partial \Pi}{\partial a_t}\frac{\partial a_t}{\partial k_t} &= 0
\end{aligned}$$

Given the implicit relation $\Pi(.)$ we can compute the partial derivatives $\frac{\partial \Pi}{\partial r_t}$, $\frac{\partial \Pi}{\partial a_t}$, $\frac{\partial \Pi}{\partial \omega_t}$, and $\frac{\partial \Pi}{\partial l^y_t}$, $\frac{\partial \Pi}{\partial r^k_t}$, and $\frac{\partial \Pi}{\partial k_t}$

$$\frac{\partial \Pi}{\partial r_t} = -a_t\beta^2\sigma z^m\left(a_t z^m r_t + k_t\left(r_t^k - \delta + 1\right)\zeta^m\right)^{-\sigma-1} - \frac{\beta z^y}{z^m\left(-k_t\zeta^y - a_t z^y + l_t^y\omega_t\right)^{\sigma}}$$

$$\frac{\partial \Pi}{\partial a_t} = -\frac{\beta r_t\sigma z^{y2}\left(-z^y a_t - k_t\zeta^y + l_t^y\omega_t\right)^{-\sigma-1}}{z^m} - \beta^2 r_t\sigma z^m\left(r_t z^m a_t + k_t\left(r_t^k - \delta + 1\right)\zeta^m\right)^{-\sigma-1}$$

$$\frac{\partial \Pi}{\partial \omega_t} = \frac{\beta l_t^y r_t\sigma z^y\left(l_t^y\omega_t - k_t\zeta^y - a_t z^y\right)^{-\sigma-1}}{z^m}$$

$$\frac{\partial \Pi}{\partial l_t^y} = \frac{\beta\omega_t r_t\sigma z^y\left(\omega_t l_t^y - k_t\zeta^y - a_t z^y\right)^{-\sigma-1}}{z^m}$$

$$\frac{\partial \Pi}{\partial r_t^k} = -\beta^2 k_t\sigma\zeta^m\left(k_t\zeta^m\left(r_t^k - \delta + 1\right) + a_t r_t z^m\right)^{-\sigma-1}$$

$$\frac{\partial \Pi}{\partial k_t} = -\frac{\beta r_t\sigma z^y\zeta^y\left(-\zeta^y k_t - a_t z^y + l_t^y\omega_t\right)^{-\sigma-1}}{z^m} - \beta^2\left(r_t^k - \delta + 1\right)\sigma\zeta^m\left(\left(r_t^k - \delta + 1\right)\zeta^m k_t + a_t r_t z^m\right)^{-\sigma-1}$$

We can now solve for the partial derivatives of the saving function $\frac{\partial a_t}{\partial r_t}$, $\frac{\partial a_t}{\partial \omega_t}$, $\frac{\partial a_t}{\partial l_t^y}$, $\frac{\partial a_t}{\partial r_t^k}$, and $\frac{\partial a_t}{\partial k_t}$.

$$\frac{\partial a_t}{\partial r_t} = -\frac{\beta z_{\mathrm{y}}}{z^m\left(-k_t\zeta^y - a_t z^y + l_t^y\omega_t\right)^{\sigma}} - \beta^2\sigma a_t z^m\left(k_t\left(r_t^k - \delta + 1\right)\zeta^m + r_t a_t z^m\right)^{-\sigma-1}$$

$$\frac{\partial a_t}{\partial \omega_t} = -\frac{\left(\frac{\beta l_t^y r_t\sigma z^y\left(l_t^y\omega_t - k_t\zeta^y - a_t z^y\right)^{-\sigma-1}}{z^m}\right)}{\left(-\frac{\beta r_t\sigma z^{y2}\left(-z^y a_t - k_t\zeta^y + l_t^y\omega_t\right)^{-\sigma-1}}{z^m} - \beta^2 r_t\sigma z^m\left(r_t z^m a_t + k_t\left(r_t^k - \delta + 1\right)\zeta^m\right)^{-\sigma-1}\right)}$$

$$\frac{\partial a_t}{\partial l_t^y} = -\frac{\left(\frac{\beta\omega_t r_t\sigma z^y\left(\omega_t l_t^y - k_t\zeta^y - a_t z^y\right)^{-\sigma-1}}{z^m}\right)}{\left(-\frac{\beta r_t\sigma z^y\zeta^y\left(-z^y a_t - k_t\zeta^y + l_t^y\omega_t\right)^{-\sigma-1}}{z^m} - \beta^2 r_t\sigma z^m\left(r_t z^m a_t + k_t\left(r_t^k - \delta + 1\right)\zeta^m\right)^{-\sigma-1}\right)}$$

$$\frac{\partial a_t}{\partial r_t^k} = -\frac{\left(-\beta^2 k_t\sigma\zeta^m\left(k_t\zeta^m\left(r_t^k - \delta + 1\right) + a_t r_t z^m\right)^{-\sigma-1}\right)}{\left(-\frac{\beta r_t\sigma z_t^{y2}\left(-z^y a_t - k_t\zeta^y + l_t^y\omega_t\right)^{-\sigma-1}}{z^m} - \beta^2 r_t\sigma z^m\left(r_t z^m a_t + k_t\left(r_t^k - \delta + 1\right)\zeta^m\right)^{-\sigma-1}\right)}$$

$$\frac{\partial a_t}{\partial k_t} = -\frac{\left(-\frac{\beta r\sigma z^y\zeta^y\left(-\zeta^y k_t - a_t z^y + l_t^y\omega\right)^{-\sigma-1}}{z^m} - \beta^2\left(r_t^k - \delta + 1\right)\sigma\zeta^m\left(\left(r_t^k - \delta + 1\right)\zeta^m k_t + a_t r_t z^m\right)^{-\sigma-1}\right)}{\left(-\frac{\beta r_t\sigma z^{y2}\zeta^y\left(-z^y a_t - k_t\zeta^y + l_t^y\omega_t\right)^{-\sigma-1}}{z^m} - \beta^2 r_t\sigma z^m\left(r_t z^m a_t + k_t\left(r_t^k - \delta + 1\right)\zeta^m\right)^{-\sigma-1}\right)}$$

By rearranging we obtain

$$\frac{\partial a_t}{\partial r_t} = \frac{\frac{\beta z^y}{z^m\left(-k_t\zeta^y - a_t z^y + l_t^y\omega_t\right)^{\sigma}} + a_t\beta^2\sigma z^m\left(k_t\left(r_t^k-\delta+1\right)\zeta^m + a_t r_t z^m\right)^{-\sigma-1}}{-\frac{\beta r_t\sigma z^{y2}\left(-k_t\zeta^y - a_t z^y + l_t^y\omega_t\right)^{-\sigma-1}}{z^m} - \beta^2 r_t\sigma z^m\left(k_t\left(r_t^k-\delta+1\right)\zeta^m + a_t r_t z^m\right)^{-\sigma-1}}$$

$$\frac{\partial a_t}{\partial \omega_t} = -\frac{\beta l_t^y r_t\sigma z^y\left(-k_t\zeta^y - a_t z^y + l_t^y\omega_t\right)^{-\sigma-1}}{-\beta r_t\sigma z^{y2}\zeta^y\left(-k_t\zeta^y - a_t z^y + l_t^y\omega_t\right)^{-\sigma-1} - \beta^2 r_t\sigma z^{m2}\left(k_t\left(r_t^k-\delta+1\right)\zeta^m + a_t r_t z^m\right)^{-\sigma-1}}$$

$$\frac{\partial a_t}{\partial l_t^y} = -\frac{\beta \omega_t r_t\sigma z^y\left(-k_t\zeta^y - a_t z^y + l_t^y\omega_t\right)^{-\sigma-1}}{-\beta r_t\sigma z^{y2}\zeta^y\left(-k_t\zeta^y - a_t z^y + l_t^y\omega_t\right)^{-\sigma-1} - \beta^2 r_t\sigma z^{m2}\left(k_t\left(r_t^k-\delta+1\right)\zeta^m + a_t r_t z^m\right)^{-\sigma-1}}$$

$$\frac{\partial a_t}{\partial r_t^k} = \frac{\beta^2 k_t\sigma\zeta^m\left(k_t\left(r_t^k-\delta+1\right)\zeta^m + a_t r_t z^m\right)^{-\sigma-1}}{-\frac{\beta r_t\sigma z^{y2}\left(-k_t\zeta^y - a_t z^y + l_t^y\omega_t\right)^{-\sigma-1}}{z^m} - \beta^2 r_t\sigma z^m\left(k_t\left(r_t^k-\delta+1\right)\zeta^m + a_t r_t z^m\right)^{-\sigma-1}}$$

$$\frac{\partial a_t}{\partial k_t} = \frac{\frac{\beta r_t\sigma z^y\zeta^y\left(-k_t\zeta^y - a_t z^y + l_t^y\omega_t\right)^{-\sigma-1}}{z^m} + \beta^2\left(r_t^k-\delta+1\right)\sigma\zeta^m\left(k_t\left(r_t^k-\delta+1\right)\zeta^m + a_t r_t z^m\right)^{-\sigma-1}}{-\frac{\beta r_t\sigma z^{y2}\left(-k_t\zeta^y - a_t z^y + l_t^y\omega_t\right)^{-\sigma-1}}{z^m} - \beta^2 r_t\sigma z^m\left(k_t\left(r_t^k-\delta+1\right)\zeta^m + a_t r_t z^m\right)^{-\sigma-1}}$$

The role of interest rate, wage rate, youth labor, capital rental rate and capital for saving is straightforward:

$$\frac{\partial a_t}{\partial r_t} > 0, \qquad \frac{\partial a_t}{\partial \omega_t} > 0, \qquad \frac{\partial a_t}{\partial l_t^y} > 0, \qquad \frac{\partial a_t}{\partial r_t^k} < 0, \qquad \frac{\partial a_t}{\partial k_t} < 0.$$

C.2 Correlation Matrix

It would be instructive to show the correlation matrix of our model demonstrate the potential linear relationship between saving a and an exhaustive list of economic factors. Table 13 reports the correlation matrix for the economic variables and household savings, the table shows that there is very little association between investment i^h and saving with -0.06. Whereas the correlation coefficients indicates that capital k have a strong negative correlation with household savings (-0.45).

Table 13: The Correlation Matrix

Variables	Description	a	r	r^k	ω	l^y	l^m	k^h	i^h
a	Savings	1.00							
r	Policy rate	-0.07	1.00						
r^k	Return on capital	-0.07	1.00	1.00					
ω	Wage rate	0.19	0.59	0.59	1.00				
l^y	Hours worked (young)	-0.46	0.54	0.54	0.79	1.00			
l^m	Hours worked (middle-aged)	-0.45	0.56	0.56	0.79	1.00	1.00		
k^h	Household capital	-0.45	0.55	0.55	0.79	1.00	1.00	1.00	
i^h	Household investment	-0.06	-0.13	-0.13	0.27	0.30	0.30	0.30	1.00

Table shows the correlation matrix of the calibrated model.

We also find a strong negative correlation between youth l^y and middle-aged l^m labor supply and savings, this result may seem surprising in light of existing evidence that households can increase their hours worked to insure themselves against future wage shocks, this will consequently leads to high level of earnings and thus savings (e.g., Low, 2005; Kim, 2021). In terms of the correlation between saving and wages ω, we find a positive correlation between the two aggregates with 0.19.

Perhaps our most striking results is that, both the interest rate r and return on capital r^k have a weak negative correlation with savings (with correlation coefficients of -0.07), caution is warranted when interpreting these results as possible causal factors. In light of this, we raise question as to how much saving patterns was due to factors that matter for European households.

Appendix D Data Sources and Description

Saving rate To produce table 13 we use the Datastream to compile data on saving rate by country and year for 1990-2021.

Table 14: Saving rate-Data Source

Country	Variable Name
Italy	*IT Household & Non-Profit Institutions, Net Saving Ratio SADJ*
Spain	*ES Household & Non-Profit Institutions, Net Saving Ratio SADJ*
Netherlands	*NL Household & Non-Profit Institutions, Net Saving Ratio SADJ*
Sweden	*SD Household & Non-Profit Institutions, Net Saving Ratio SADJ*
Switzerland	*SW Household & Non-Profit Institutions, Net Saving Ratio SADJ*
Canada	*CN Household & Non-Profit Institutions, Net Saving Ratio SADJ*
Denmark	*DK Household & Non-Profit Institutions, Net Saving Ratio SADJ*
Austria	*OE Household & Non-Profit Institutions, Net Saving Ratio SADJ*
Belgium	*BG Household & Non-Profit Institutions, Net Saving Ratio SADJ*
Finland	*FN Household & Non-Profit Institutions, Net Saving Ratio SADJ*
Germany	*BD Personal Savings Ratio (PAN BD Q0191) SADJ*
Japan	*JP Household & Non-Profit Institutions, Net Saving Ratio SADJ*
Unites States	*US Household & Non-Profit Institutions, Net Saving Ratio SADJ*
France	*FR Personal Saving Rate (CAL ADJ) SADJ*

Demographics To produce table 11, we use Eurostat data to retrieve the share of population in a certain age group compared to the total population [TPS00010] over the period 2009-2019 (Annual). The data covers the following countries: Belgium, Denmark, Germany, Spain, France, Italy, Netherlands, Austria, Finland, Sweden, Switzerland. The data have been extracted from Eurostat on 02/2021.

Table 15: Demographic Dimensions-Data Source

Variable Name
Proportion of population aged 0-14 years
Proportion of population aged 15-24 years
Proportion of population aged 25-49 years
Proportion of population aged 50-64 years
Proportion of population aged 65-79 years
Proportion of population aged 80 years and more

Calibration of Youth and Middle Age Labor Supply To compute the target value for the youth and middle age labor supply l^y and l^m as reported in tables 2 and 3, we compile data on employment by sex age and citizenship from the Eurostat.

Table 16: Labor Force Structure-Data Source

Dataset and Code	Age Class	Time Frequency
Employment by sex, age and citizenship (1000) [LFSA_EGAN__custom_999336]	From 15 to 24 years	Annual
Employment by sex, age and citizenship (1000) [LFSA_EGAN__custom_999336]	From 25 to 64 years	Annual

Table 17: Gross Domestic Product-Data Source

Variable	Description
OEGDP...ARIC aATGDPV	Austria, Expenditure Approach, Gross Domestic Product, Total, Current prices, not seasonally adjusted, Euro (Millions Euro) Source: 1995 - 2021, Source: Oesterreichische Nationalbank
BDJJA000	Germany, National Accounts, Expenditure Approach, Gross Domestic Product, Current prices, not seasonally adjusted, (Billions Euro), 1991 - 2020, Annual Source: Deutsche Bundesbank.
DKYEXP03A	Denmark, Gross Domestic Product, Expenditure Approach, Gross Domestic Product, Current prices, not seasonally adjusted, DKK (Millions Danish Krone), 1995 - 2020. Source: OECD
SDYEXP03A	Sweden, Gross Domestic Product, Expenditure Approach, Gross Domestic Product, Current prices, not seasonally adjusted, SEK (Millions Swedish Krona), 1993 - 2020, Source: OECD.
FRYEXP03A	France, Gross Domestic Product, Expenditure Approach, Gross Domestic Product, Current prices, not seasonally adjusted, (Millions Euro), 1980 - 2020, Annual Source: OECD
SWYEXP03A	Switzerland, Gross Domestic Product, Expenditure Approach, Gross Domestic Product, Current prices, not seasonally adjusted, CHF (Millions Swiss Franc), 1980 - 2020, Annual Source: OECD
ESYEXP03A	Spain, Gross Domestic Product, Expenditure Approach, Gross Domestic Product, Current prices, not seasonally adjusted, (Millions Euro), 1995 - 2020, Annual Source: OECD.
BGYEXP03A	Belgium, Gross Domestic Product, Expenditure Approach, Gross Domestic Product, Current prices, not seasonally adjusted, (Millions Euro), 1995 - 2020, Annual Source: OECD
ITOEXP03A	Italy, Gross Domestic Product, Expenditure Approach, Gross Domestic Product, Current prices, not seasonally adjusted, (Millions Euro). 1995 - 2021. Source: OECD
FNES547TA	Finland, Main Gross Domestic Product Aggregates (ESA2010), Gross Domestic Product and Main Components, Gross Domestic Product at Market Prices, Current prices, not seasonally adjusted, Millions Euro, 1990 - 2021, Quarterly. Source: Eurostat.
NLYEXP03A	Netherlands, Gross Domestic Product, Expenditure Approach, Gross Domestic Product, Quarterly Levels, Current Prices, (Millions Euro), 1995 - 2020, Annual. Source: OECD

Table 18: Purchasing Power Parities and Capital Stock-Data Source

Variable	Description
PPP	Purchasing power parities (PPP)Total, National currency units/US dollar, 1960 – 2020. Source: OECD.
FNPWCN	Finland, Capital Stock at Current Purchasing Power Parities, Current prices, not seasonally adjusted, (Millions U.S. Dollar), 1950 - 2019, Annual, Source: University of Groningen, PWT.
SWPWCN	Switzerland, Capital Stock at Current Purchasing Power Parities, Current Prices, USD, (Millions U.S. Dollar), Annual. Source: University of Groningen.
OEPWCN	Austria, Capital Stock at Current Purchasing Power Parities, Current Prices, (Millions U.S. Dollar), Annual. Source: University of Groningen, PWT.
BGPWCN	Belgium, Capital Stock at Current Purchasing Power Parities, Current Prices, (Millions U.S. Dollar), Annual. Source: University of Groningen, PWT
FRPWCN	France, Capital Stock at Current Purchasing Power Parities, Current Prices,(Millions U.S. Dollar), Annual. Source: University of Groningen, PWT.
ESPWCN	Spain, Capital Stock at Current Purchasing Power Parities, Current Prices, (Millions U.S. Dollar), Annual. Source: University of Groningen, PWT.
BDPWCN	Germany, Capital Stock at Current Purchasing Power Parities, Current Prices, (Millions U.S. Dollar), Annual. Source: University of Groningen, PWT.
DKPWCN	Denmark, Capital Stock at Current Purchasing Power Parities, Current Prices, (Millions U.S. Dollar), Annual. Source: University of Groningen, PWT.
SDPWCN	Sweden, Capital Stock at Current Purchasing Power Parities, Current Prices, (Millions U.S. Dollar), Annual. Source: University of Groningen, PWT
NLPWCN	Netherlands, Capital Stock at Current Purchasing Power Parities, Current Prices, USD, (Millions U.S. Dollar), Annual. Source: University of Groningen, PWT.
ITPWCN	Italy, Capital Stock at Current Purchasing Power Parities, Current Prices, (Millions U.S. Dollar), Annual. Source: University of Groningen, PWT.

Table 19: Total Hours Worked-Data Source

Variable	Description
DKESHB52	Denmark, Non-Financial Transactions (ESA2010), Total Employment (Thousands of Hours Worked) Domestic Concept : Total Economy : Paid, Current Prices, Euro, (Millions Euro), 1995 - 2020, Annual. Source: Eurostat.
BGESHB52	Belgium, Non-Financial Transactions (ESA2010), Total Employment (Thousands of Hours Worked) Domestic Concept : Total Economy : Paid, Current Prices, Euro, (Millions Euro), 1995 - 2019, Annual. Source: Eurostat
FRESHB52	France, Non-Financial Transactions (ESA2010), Total Employment (Thousands of Hours Worked) Domestic Concept : Total Economy : Paid, Current Prices, Euro, (Millions Euro), 1950 - 2019, Annual. Source: Eurostat.
ITESHB53	Italy, Non-Financial Transactions (ESA2010), Total Employment (Thousands of Hours Worked) Domestic Concept : Total Economy : Paid, Current Prices, Euro,(Millions Euro), 1995 - 2020, Annual. Source: Eurostat.
FNESHB52	Finland, Non-Financial Transactions (ESA2010), Total Employment (Thousands of Hours Worked) Domestic Concept : Total Economy : Paid, Current Prices, Euro, (Millions Euro), 1980 - 2020, Annual. Source: Eurostat.
ESNAEHRWP	Spain, Employment by Industry, Total, Hours Worked, Thousands Hour, 1995 - 2021, Volumes, not seasonally adjusted. Source: INE - National Statistics Institute, Spain.
SWESHB52	Switzerland, Non-Financial Transactions (ESA2010), Total Employment (Thousands of Hours Worked) Domestic Concept : Total Economy : Paid, Current Prices, (Millions Euro), 1995 - 2019, Annual. Source: Eurostat.
BDESHB53	Germany, Non-Financial Transactions (ESA2010), Total Employment (Thousands of Hours Worked) Domestic Concept : Total Economy : Paid, Current Prices, Euro, (Millions Euro), 1995 - 2020, Annual. Source: Eurostat.
OEESHB53	Austria, Non-Financial Transactions (ESA2010), Total Employment (Thousands of Hours Worked) Domestic Concept : Total Economy : Paid, Current Prices, Euro, (Millions Euro), 1995 - 2019, Annual. Source: Eurostat.
NLANLHT	Netherlands, Gross Domestic Product Per Hour Worked, Total Annual Hours Worked, (Millions Hour), 1969 - 2022 (Forecast), Annual. Source: DG ECFIN AMECO.
SDHOURW.P	Sweden, Hours Worked, Overall, Total ,(Millions Hour), 1980 - 2021, Volumes, not seasonally adjusted. Source: Statistics Sweden.

Appendix E Additional Regression Results

Table 20: The Effect of Demography on Household Savings

	Dependent variable: Household savings $\ln(a)$			
	(1)	(2)	(3)	(4)
Constant	-79.79***	276.33***	-141.93***	115.44***
	(27.07)	(48.74)	(24.46)	(37.36)
% of pop. ages 0-14	5.51***	-16.69***	8.12***	-10.61***
	(1.79)	(2.53)	(1.75)	(2.19)
% of pop. ages 15-24	6.62***	-7.80***	6.77***	-2.54
	(1.10)	(2.19)	(1.00)	(1.70)
% of pop. ages 25-64	10.96***	-44.43***	18.87***	-16.73***
	(4.01)	(7.91)	(3.46)	(5.79)
% of pop. ages over 65	2.29	-10.62***	10.54***	-3.39*
	(1.62)	(2.32)	(1.42)	(1.92)
Country fixed effects	Yes	No	Yes	No
Time fixed effects	Yes	Yes	No	No
No. Observations	388	388	388	388
R^2	0.256	0.141	0.289	0.212
		H_0: OLS model with no FE is preferred		
Model Name		Chi-2 Statistic	P-value	Decision
OLS model with Time and Country FE		942.5	0.0	Reject H_0

This table shows the results from ordinary least squares regressions over the sample (1960-2020), (1) with country and time fixed effects; (2) with time fixed effects; (3) with country fixed effects; (4) with no fixed effects. Independent variables are: the share of population between 0 and 14 years, the share of population between 15 and 24 years, the share of population between 25 and 64 years, the share of population between over 65 years, country fixed effects, and time fixed effects. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01 ***.

Table 21: The Effect of Demography on Household savings

	Dependent variable: Household savings $\ln(a)$			
	(1)	(2)	(3)	(4)
Constant	-4.79**	12.25***	12.26***	17.22***
	(2.05)	(2.59)	(1.10)	(1.54)
% of pop. ages 0-14	2.63***	-3.33***	-3.33***	-5.07***
	(0.72)	(0.91)	(0.38)	(0.54)
Country fixed effects	Yes	No	Yes	No
Time fixed effects	Yes	Yes	No	No
No. Observations	388	388	388	388
R^2	0.041	0.040	0.167	0.187
		H_0: OLS model with no FE is preferred		
Model Name		Chi-2 Statistic	P-value	Decision
OLS model with Time and Country FE		262.06	0.0	Reject H_0

This table shows the results from ordinary least squares regressions over the sample (1960-2020), (1) with country and time fixed effects; (2) with time fixed effects; (3) with country fixed effects; (4) with no fixed effects. Independent variables are: the share of population between 0 and 14 years, country fixed effects, and time fixed effects. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01 ***.

Table 22: The Effect of Demography on Household Savings

	Dependent variable: Household savings $\ln(a)$			
Constant	-7.98***	0.79	6.50***	11.23***
	(1.19)	(2.72)	(0.81)	(1.47)
% of pop. ages 15-24	4.20***	0.76	-1.47***	-3.33***
	(0.47)	(1.06)	(0.32)	(0.58)
Country fixed effects	Yes	No	Yes	No
Time fixed effects	Yes	Yes	No	No
No. Observations	388	388	388	388
R^2	0.204	0.002	0.054	0.079
		H_0: OLS model with no FE is preferred		
Model Name		Chi-2 Statistic	P-value	Decision
OLS model with Time and Country FE		492.7	0.0	Reject H_0

This table shows the results from ordinary least squares regressions over the sample (1960-2020), (1) with country and time fixed effects; (2) with time fixed effects; (3) with country fixed effects; (4) with no fixed effects. Independent variables are: the share of population between 15 and 24 years, country fixed effects, and time fixed effects. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01 ***.

Table 23: The Effect of Demography on Household Savings

	Dependent variable: Household savings $\ln(a)$			
Constant	36.55***	8.90	-13.52***	-33.83***
	(6.42)	(10.88)	(4.79)	(7.10)
% of pop. ages 25-64	-8.51***	-1.55	4.09***	9.20***
	(1.62)	(2.74)	(1.21)	(1.79)
Country fixed effects	Yes	No	Yes	No
Time fixed effects	Yes	Yes	No	No
No. Observations	388	388	388	388
R^2	0.081	0.001	0.030	0.064
		H_0: OLS model with no FE is preferred		
Model Name		Chi-2 Statistic	P-value	Decision
OLS model with Time and Country FE		539.2	0.0	Reject H_0

This table shows the results from ordinary least squares regressions over the sample (1960-2020), (1) with country and time fixed effects; (2) with time fixed effects; (3) with country fixed effects; (4) with no fixed effects. Independent variables are: the share of population between 25 and 64 years, country fixed effects, and time fixed effects. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01 ***.

Table 24: The Effect of Demography on Household Savings

	Dependent variable: Household savings $\ln(a)$			
Constant	12.56***	-2.68	-4.36***	-7.86***
	(1.95)	(2.61)	(0.74)	(1.34)
% of pop. ages over 65	-3.55***	1.96**	2.57***	3.83***
	(0.70)	(0.94)	(0.27)	(0.48)
Country fixed effects	Yes	No	Yes	No
Time fixed effects	Yes	Yes	No	No
No. Observations	388	388	388	388
R^2	0.074	0.013	0.197	0.139
		H_0: OLS model with no FE is preferred		
Model Name		Chi-2 Statistic	P-value	Decision
OLS model with Time and Country FE		207.8	0.0	Reject H_0

This table shows the results from ordinary least squares regressions over the sample (1960-2020), (1) with country and time fixed effects; (2) with time fixed effects; (3) with country fixed effects; (4) with no fixed effects. Independent variables are: the share of population between over 65 years, country fixed effects, and time fixed effects. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01 ***.

Table 25: Wages and Household Savings

	Dependent variable: Household savings $\ln(a)$			
Constant	-5.23**	1.28	0.08	-0.85
	(2.28)	(1.40)	(0.39)	(0.78)
Average wage $\ln(\omega)$	2.59***	0.52	0.90***	1.20***
	(0.73)	(0.45)	(0.12)	(0.25)
Country fixed effects	Yes	No	Yes	No
Time fixed effects	Yes	Yes	No	No
No. Observations	289	289	289	289
R^2	0.051	0.005	0.161	0.075
		H_0: OLS model with no FE is preferred		
Model Name		Chi-2 Statistic	P-value	Decision
OLS model with Time and Country FE		4.16	0.12	Accept H_0

This table shows the results from ordinary least squares regressions over the sample (1960-2020), (1) with country and time fixed effects; (2) with time fixed effects; (3) with country fixed effects; (4) with no fixed effects. Independent variables are: the average wage, country fixed effects, and time fixed effects. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01 ***.

Table 26: Youth Labor Supply and Household Savings

	Dependent variable: Household savings $\ln(a)$			
Constant	-25.19***	-1.29	-14.53***	-1.23
	(3.24)	(0.92)	(3.27)	(0.89)
Youth labor $\ln(l^y)$	2.04***	0.32***	1.27***	0.31***
	(0.23)	(0.07)	(0.24)	(0.06)
Country fixed effects	Yes	No	Yes	No
Time fixed effects	Yes	Yes	No	No
No. Observations	251	251	251	251
R^2	0.262	0.093	0.109	0.088
		H_0: OLS model with no FE is preferred		
Model Name		Chi-2 Statistic	P-value	Decision
OLS model with Time and Country FE		58.95	1.57	Accept H_0

This table shows the results from ordinary least squares regressions over the sample (1960-2020), (1) with country and time fixed effects; (2) with time fixed effects; (3) with country fixed effects; (4) with no fixed effects. Independent variables are: the youth labor, country fixed effects, and time fixed effects. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01 ***.

Table 27: Interest rates and Household Savings

	Dependent variable: Household savings $\ln(a)$			
Constant	2.39***	3.09***	3.04***	3.27***
	(0.41)	(0.69)	(0.06)	(0.15)
Interest rate $\ln(r)$	0.32	-0.07	-0.04	-0.16**
	(0.23)	(0.38)	(0.02)	(0.07)
Country fixed effects	Yes	No	Yes	No
Time fixed effects	Yes	Yes	No	No
No. Observations	288	288	288	288
R^2	0.008	0.000	0.009	0.021
		H_0: OLS model with no FE is preferred		
Model Name		Chi-2 Statistic	P-value	Decision
OLS model with Time and Country FE		4.98	0.08	Accept H_0

This table shows the results from ordinary least squares regressions over the sample (1960-2020), (1) with country and time fixed effects; (2) with time fixed effects; (3) with country fixed effects; (4) with no fixed effects. Independent variables are: the interest rate, country fixed effects, and time fixed effects. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01 ***.

Table 28: Youth Labor Supply, Wages, Interest Rates and Household Savings

	Dependent variable: Household savings $\ln(a)$			
Constant	-21.18***	-2.63	-19.54***	-2.95*
	(3.77)	(1.94)	(3.32)	(1.51)
Youth labor $\ln(l^y)$	1.54***	0.51***	1.44***	0.50***
	(0.24)	(0.07)	(0.24)	(0.07)
Average wage $\ln(\omega)$	0.79	-0.37	0.89***	-0.19
	(0.80)	(0.48)	(0.28)	(0.39)
Interest rate $\ln(r)$	0.33*	-0.14	-0.03	-0.14**
	(0.18)	(0.34)	(0.03)	(0.07)
Country fixed effects	Yes	No	Yes	No
Time fixed effects	Yes	Yes	No	No
No. Observations	207	207	207	207
R^2	0.225	0.210	0.212	0.207
		H_0: OLS model with no FE is preferred		
Model Name		Chi-2 Statistic	P-value	Decision
OLS model with Time and Country FE		36.78	1.99e-07	Reject H_0

This table shows the results from ordinary least squares regressions over the sample (1960-2020), (1) with country and time fixed effects; (2) with time fixed effects; (3) with country fixed effects; (4) with no fixed effects. Independent variables are: the interest rate, youth labor supply, wages, country fixed effects, and time fixed effects. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01 ***.

Table 29: Youth Labor Supply, Interest Rates and Household Savings

	Dependent variable: Household savings $\ln(a)$			
Constant	-19.31***	-3.77***	-17.13***	-3.52***
	(3.27)	(1.13)	(3.30)	(0.98)
Youth labor $\ln(l^y)$	1.59***	0.51***	1.47***	0.49***
	(0.24)	(0.07)	(0.24)	(0.07)
Interest rate $\ln(r)$	0.32*	-0.08	-0.11***	-0.13**
	(0.18)	(0.30)	(0.03)	(0.06)
Covariance Type:	Unadjusted	Unadjusted	Unadjusted	Unadjusted
Country fixed effects	Yes	No	Yes	No
Time fixed effects	Yes	Yes	No	No
No. Observations	208	208	208	208
R^2	0.221	0.207	0.172	0.206
		H_0: OLS model with no FE is preferred		
Model Name		Chi-2 Statistic	P-value	Decision
OLS model with Time and Country FE		31.69	6.07e-07	Reject H_0

This table shows the results from ordinary least squares regressions over the sample (1960-2020), (1) with country and time fixed effects; (2) with time fixed effects; (3) with country fixed effects; (4) with no fixed effects. Independent variables are: the interest rate, youth labor supply, country fixed effects, and time fixed effects. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01 ***.

Table 30: Wages, Interest Rates and Household Savings

	Dependent variable: Household savings $\ln(a)$			
Constant	-2.04	0.64	0.09	-1.07
	(2.45)	(2.13)	(0.59)	(1.21)
Average wage $\ln(\omega)$	1.40*	0.68	0.87***	1.32***
	(0.78)	(0.58)	(0.18)	(0.36)
Interest rate $\ln(r)$	0.35	0.07	0.04	-0.08
	(0.22)	(0.41)	(0.03)	(0.09)
Country fixed effects	Yes	No	Yes	No
Time fixed effects	Yes	Yes	No	No
No. Observations	243	243	243	243
R^2	0.027	0.007	0.112	0.103
		H_0: OLS model with no FE is preferred		
Model Name		Chi-2 Statistic	P-value	Decision
OLS model with Time and Country FE		4.63	0.20	Accept H_0

This table shows the results from ordinary least squares regressions over the sample (1960-2020), (1) with country and time fixed effects; (2) with time fixed effects; (3) with country fixed effects; (4) with no fixed effects. Independent variables are: the interest rate, wages, country fixed effects, and time fixed effects. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01 ***.

Table 31: Household Optinmal Saving Function

	Dependent variable: Household savings $\ln(a)$			
Constant	-148.36*	96.20	-47.10	175.33
	(84.84)	(157.96)	(80.32)	(157.37)
Youth labor $\ln(l^y)$	0.94*	0.01	0.86*	0.19**
	(0.52)	(0.09)	(0.48)	(0.08)
Average wage $\ln(\omega)$	0.65	3.37***	1.49**	1.49***
	(1.08)	(0.62)	(0.64)	(0.46)
Interest rate $\ln(r)$	0.64***	0.52	-0.01	0.07
	(0.21)	(0.34)	(0.04)	(0.08)
% of pop. ages 0-14	6.10	-12.55	1.27	-14.40*
	(4.29)	(7.64)	(4.07)	(7.67)
% of pop. ages 15-24	6.12*	-0.46	2.54	-3.37
	(3.33)	(5.61)	(3.15)	(5.57)
% of pop. ages 25-64	26.73*	-15.97	5.62	-27.87
	(14.77)	(25.37)	(13.38)	(25.24)
% of pop. ages over 65	6.73	-6.12	1.73	-10.90
	(4.49)	(7.82)	(4.31)	(7.81)
Return on equity $\ln(r^k)$	0.02	-0.41**	-0.09	-0.09
	(0.08)	(0.17)	(0.06)	(0.14)
Capital $\ln(k)$	-1.48**	0.89***	-0.22	0.74***
	(0.58)	(0.12)	(0.34)	(0.12)
Country fixed effects	Yes	No	Yes	No
Time fixed effects	Yes	Yes	No	No
No. Observations	177	177	177	177
R^2	0.260	0.526	0.259	0.466
		H_0: OLS model with no FE is preferred		
Model Name		Chi-2 Statistic	P-value	Decision
OLS model with Time and Country FE		2.99	0.98	Accept H_0

This table shows the results from ordinary least squares regressions over the sample (1960-2020), (1) with country and time fixed effects; (2) with time fixed effects; (3) with country fixed effects; (4) with no fixed effects. Independent variables are: the interest rate, wages, youth labor supply, capital, return on equity, the share of population between 0 and 14 years, the share of population between 15 and 24 years, the share of population between 25 and 64 years, the share of population between over 65 years, country fixed effects, and time fixed effects. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01 ***.

Table 32: Household Optinmal Saving Function

	Dependent variable: Household savings $\ln(a)$			
Constant	-3.61	-1.14	-15.00*	-1.21
	(9.56)	(3.14)	(8.85)	(3.17)
Youth labor $\ln(l^y)$	1.36***	0.00	1.40***	0.20**
	(0.36)	(0.09)	(0.33)	(0.08)
Average wage $\ln(\omega)$	0.80	2.98***	1.12**	0.95**
	(1.06)	(0.61)	(0.56)	(0.41)
Interest rate $\ln(r)$	0.53***	0.42	-0.02	0.10
	(0.20)	(0.33)	(0.04)	(0.08)
% of pop. ages 0-14	-0.46	-6.40***	-0.66	-4.00***
	(1.54)	(1.15)	(1.28)	(0.96)
Return on equity $\ln(r^k)$	0.01	-0.39**	-0.12*	-0.13
	(0.08)	(0.17)	(0.06)	(0.14)
Capital $\ln(k)$	-0.92**	0.85***	-0.17	0.65***
	(0.44)	(0.11)	(0.32)	(0.10)
Country fixed effects	Yes	No	Yes	No
Time fixed effects	Yes	Yes	No	No
No. Observations	177	177	177	177
R^2	0.238	0.499	0.246	0.434
		H_0: OLS model with no FE is preferred		
Model Name		Chi-2 Statistic	P-value	Decision
OLS model with Time and Country FE		32.39	3.42e-05	Reject H_0

This table shows the results from ordinary least squares regressions over the sample (1960-2020), (1) with country and time fixed effects; (2) with time fixed effects; (3) with country fixed effects; (4) with no fixed effects. Independent variables are: the interest rate, wages, youth labor supply, capital, return on equity, the share of population between 0 and 14, country fixed effects, and time fixed effects. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01 ***.

Table 33: Household Optinmal Saving Function

	Dependent variable: Household savings $\ln(a)$			
Constant	-5.42	-16.44***	-15.11**	-14.51***
	(8.14)	(4.10)	(6.41)	(3.80)
Youth labor $\ln(l^y)$	1.24**	0.15	0.95**	0.25***
	(0.48)	(0.09)	(0.43)	(0.08)
Average wage $\ln(\omega)$	0.81	0.97*	1.56***	0.32
	(1.05)	(0.53)	(0.54)	(0.40)
Interest rate $\ln(r)$	0.53***	-0.20	-0.01	-0.03
	(0.20)	(0.34)	(0.04)	(0.08)
% of pop. ages 15-24	0.45	1.43	1.29*	1.17
	(0.93)	(1.20)	(0.75)	(1.11)
Return on equity $\ln(r^k)$	0.01	-0.58***	-0.09	-0.27*
	(0.08)	(0.18)	(0.06)	(0.14)
Capital $\ln(k)$	-0.85*	0.80***	-0.18	0.71***
	(0.47)	(0.12)	(0.32)	(0.11)
Country fixed effects	Yes	No	Yes	No
Time fixed effects	Yes	Yes	No	No
No. Observations	177	177	177	177
R^2	0.239	0.402	0.258	0.380
		H_0: OLS model with no FE is preferred		
Model Name		Chi-2 Statistic	P-value	Decision
OLS model with Time and Country FE		17.48	0.01	Reject H_0

This table shows the results from ordinary least squares regressions over the sample (1960-2020), (1) with country and time fixed effects; (2) with time fixed effects; (3) with country fixed effects; (4) with no fixed effects. Independent variables are: the interest rate, wages, youth labor supply, capital, return on equity, the share of population between 15 and 24 years, country fixed effects, and time fixed effects. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01 ***.

Table 34: Household Optinmal Saving Function

	Dependent variable: Household savings $\ln(a)$			
Constant	-11.49	-35.24**	-5.27	-33.88***
	(13.17)	(15.31)	(12.59)	(12.95)
Youth labor $\ln(l^y)$	1.53***	0.13	1.31***	0.23***
	(0.35)	(0.09)	(0.33)	(0.08)
Average wage $\ln(\omega)$	0.60	1.22**	1.28**	0.44
	(1.05)	(0.55)	(0.51)	(0.41)
Interest rate $\ln(r)$	0.55***	-0.01	-0.01	-0.00
	(0.20)	(0.36)	(0.04)	(0.08)
% of pop. ages 25-64	2.03	5.20	-2.93	5.38*
	(3.30)	(3.47)	(2.47)	(3.03)
Return on equity $\ln(r^k)$	0.01	-0.48**	-0.11*	-0.22
	(0.08)	(0.18)	(0.06)	(0.14)
Capital $\ln(k)$	-1.13**	0.84***	-0.12	0.74***
	(0.53)	(0.13)	(0.32)	(0.11)
Country fixed effects	Yes	No	Yes	No
Time fixed effects	Yes	Yes	No	No
No. Observations	177	177	177	177
R^2	0.240	0.405	0.251	0.388
		H_0: OLS model with no FE is preferred		
Model Name		Chi-2 Statistic	P-value	Decision
OLS model with Time and Country FE		16.81	0.01	Reject H_0

This table shows the results from ordinary least squares regressions over the sample (1960-2020), (1) with country and time fixed effects; (2) with time fixed effects; (3) with country fixed effects; (4) with no fixed effects. Independent variables are: the interest rate, wages, youth labor supply, capital, return on equity, the share of population between 25 and 64 years, country fixed effects, and time fixed effects.. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01 ***.

Table 35: Household Optinmal Saving Function

	Dependent variable: Household savings $\ln(a)$			
Constant	-8.05	-52.03***	-1.25	-39.21***
	(18.71)	(16.08)	(16.17)	(13.34)
Youth labor $\ln(l^y)$	1.51***	0.06	1.29***	0.22***
	(0.35)	(0.10)	(0.34)	(0.08)
Average wage $\ln(\omega)$	0.55	1.79***	1.44**	0.50
	(1.07)	(0.58)	(0.64)	(0.41)
Interest rate $\ln(r)$	0.55***	0.01	-0.01	0.05
	(0.20)	(0.35)	(0.04)	(0.09)
% of pop. ages 25-64	1.54	6.69*	-3.60	5.70*
	(3.80)	(3.43)	(3.01)	(3.03)
% of pop. ages over 65	-0.37	4.02***	-0.46	1.83
	(1.41)	(1.41)	(1.15)	(1.18)
Return on equity $\ln(r^k)$	0.01	-0.47***	-0.10*	-0.20
	(0.08)	(0.18)	(0.06)	(0.14)
Capital $\ln(k)$	-1.13**	0.75***	-0.13	0.66***
	(0.53)	(0.13)	(0.32)	(0.12)
Country fixed effects	Yes	No	Yes	No
Time fixed effects	Yes	Yes	No	No
No. Observations:	177	177	177	177
R^2	0.240	0.436	0.252	0.396
		H_0: OLS model with no FE is preferred		
Model Name		Chi-2 Statistic	P-value	Decision
OLS model with Time and Country FE		41.31	1.81e-06	Reject H_0

This table shows the results from ordinary least squares regressions over the sample (1960-2020), (1) with country and time fixed effects; (2) with time fixed effects; (3) with country fixed effects; (4) with no fixed effects. Independent variables are: the interest rate, wages, youth labor supply, capital, return on equity, the share of population between 25 and 64 years, the share of population between over 65 years, country fixed effects, and time fixed effects. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01 ***.

Table 36: Household Optinmal Saving Function

	Dependent variable: Household savings ln(a)			
Constant	-1.74	-21.87***	-18.98***	-14.87***
	(10.34)	(4.40)	(6.54)	(3.35)
Youth labor ln(l^y)	1.44***	0.08	1.47***	0.23***
	(0.30)	(0.10)	(0.30)	(0.08)
Average wage ln(ω)	0.59	1.41**	1.15*	0.33
	(1.06)	(0.55)	(0.59)	(0.40)
Interest rate ln(r)	0.54***	-0.22	-0.02	0.04
	(0.20)	(0.33)	(0.04)	(0.09)
% of pop. ages over 65	-0.65	3.60**	0.33	1.68
	(1.22)	(1.41)	(0.95)	(1.18)
Return on equity ln(r^k)	0.01	-0.55***	-0.12*	-0.24*
	(0.08)	(0.18)	(0.06)	(0.14)
Capital ln(k)	-1.03**	0.70***	-0.16	0.61***
	(0.47)	(0.13)	(0.32)	(0.12)
Country fixed effects	Yes	No	Yes	No
Time fixed effects	Yes	Yes	No	No
No. Observations	177	177	177	177
R^2	0.239	0.422	0.245	0.384
		H_0: OLS model with no FE is preferred		
Model Name		Chi-2 Statistic	P-value	Decision
OLS model with Time and Country FE		35.61	8.57e-06	Reject H_0

This table shows the results from ordinary least squares regressions over the sample (1960-2020), (1) with country and time fixed effects; (2) with time fixed effects; (3) with country fixed effects; (4) with no fixed effects. Independent variables are: the interest rate, wages, youth labor supply, capital, return on equity, the share of population between over 65 years, country fixed effects, and time fixed effects. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01 ***.

Table 37: Household Optinmal Saving Function

	Dependent variable: Household savings ln(a)			
Constant	-5.12	-12.67***	-18.26***	-11.23***
	(8.10)	(2.58)	(6.18)	(2.15)
Youth labor ln(l^y)	1.42***	0.14	1.47***	0.24***
	(0.30)	(0.09)	(0.30)	(0.08)
Average wage ln(ω)	0.72	0.96*	1.25**	0.28
	(1.03)	(0.53)	(0.51)	(0.40)
Interest rate ln(r)	0.53***	-0.19	-0.03	-0.01
	(0.20)	(0.34)	(0.04)	(0.08)
Capital ln(k)	-0.94**	0.79***	-0.17	0.69***
	(0.43)	(0.12)	(0.32)	(0.11)
Return on equity ln(r^k)	0.01	-0.55***	-0.12**	-0.25*
	(0.08)	(0.18)	(0.06)	(0.14)
Country fixed effects	Yes	No	Yes	No
Time fixed effects	Yes	Yes	No	No
No. Observations	177	177	177	177
R^2	0.238	0.396	0.245	0.376
		H_0: OLS model with no FE is preferred		
Model Name		Chi-2 Statistic	P-value	Decision
OLS model with Time and Country FE		45.24	4.18e-08	Reject H_0

This table shows the results from ordinary least squares regressions over the sample (1960-2020), (1) with country and time fixed effects; (2) with time fixed effects; (3) with country fixed effects; (4) with no fixed effects. Independent variables are: the interest rate, wages, youth labor supply, capital, return on equity, country fixed effects, and time fixed effects. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01 ***.

Table 38: Household Optinmal Saving Function

	Dependent variable: Household savings $\ln(a)$			
Constant	2.91***	4.72***	3.36***	4.37***
	(0.17)	(0.39)	(0.14)	(0.32)
Return on equity $\ln(r^k)$	0.08	-0.77***	-0.13**	-0.61***
	(0.08)	(0.18)	(0.06)	(0.14)
Country fixed effects	Yes	No	Yes	No
Time fixed effects	Yes	Yes	No	No
No. Observations	186	186	186	186
R^2	0.007	0.104	0.025	0.092

	H_0: OLS model with no FE is preferred		
Model Name	Chi-2 Statistic	P-value	Decision
OLS model with Time and Country FE	34.58	3.09e-08	Reject H_0

This table shows the results from ordinary least squares regressions over the sample (1960-2020), (1) with country and time fixed effects; (2) with time fixed effects; (3) with country fixed effects; (4) with no fixed effects. Independent variables are: the return on equity, country fixed effects, and time fixed effects.. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01 ***.

Table 39: Household Optinmal Saving Function

	Dependent variable: Household savings $\ln(a)$			
constant	17.05***	-9.23***	-3.72*	-9.09***
	(5.81)	(1.50)	(2.16)	(1.35)
Capital $\ln(k)$	-0.91**	0.81***	0.45***	0.80***
	(0.38)	(0.10)	(0.14)	(0.09)
Country fixed effects	Yes	No	Yes	No
Time fixed effects	Yes	Yes	No	No
No. Observations	223	223	223	223
R^2	0.030	0.257	0.046	0.272

	H_0: OLS model with no FE is preferred		
Model Name	Chi-2 Statistic	P-value	Decision
OLS model with Time and Country FE	21.38	2.27e-05	Reject H_0

This table shows the results from ordinary least squares regressions over the sample (1960-2020), (1) with country and time fixed effects; (2) with time fixed effects; (3) with country fixed effects; (4) with no fixed effects. Independent variables are: the capital, country fixed effects, and time fixed effects. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01 ***.