Retirement in the Shadow (Banking)*

Guillermo Ordoñez† Facundo Piguillem‡

December 2017

Abstract

The U.S. economy has recently experienced a large increase in life expectancy and in shadow banking activities. We argue these two phenomena are intimately related. Agents resort on financial intermediaries to buy insurance against an uncertain life span after retirement. When they expect to live longer they are more prone to rely on financial intermediaries that are riskier but offer better terms for insurance – shadow banks. We calibrate the model to replicate the level of financial intermediation in 1980, introduce the observed change in life expectancy and show that the demographic transition is critical to account for the boom both of shadow banking and credit that preceded the recent U.S. financial crisis. We construct a counterfactual without shadow banks and show that they may have contributed 0.5GDP, which is larger than the cost of the crisis of around 0.2GDP.

JEL classification: E21. E44.

*We thank seminar participants at the ITAM-PIER Conference on Macroeconomics in Philadelphia, the SED Meetings in Warsaw, RIDGE 2017 in Montevideo, Universitat Autònoma de Barcelona, Bank of France, University of Padova and University of St Andrews for comments. The usual waiver of liability applies.

†University of Pennsylvania and NBER (e-mail: ordonez@econ.upenn.edu).

‡EIEF and CEPR (e-mail: facundo.piguillem@gmail.com).

1 Introduction

Since 1980 and until the great recession in 2007 the US economy experienced a steep increase in intermediated borrowing and lending, with household's debt growing from 1GDP to 1.7GDP. This "credit boom" has drawn the attention of both policymakers and scholars, particularly in relation to the magnitude of the subsequent financial crisis. Multiple reasons have been proposed, ranging from an atypical influx of foreign funds, i.e, the international savings glut, to pure financial speculation. Absent any fundamental improvement in the economy these explanations tend to consider the credit boom as excessive and then just detrimental for the economy in inducing a potential painful crisis.

In this paper we analyze the contribution of a domestic factor that has gone unnoticed so far but may explain this credit boom: the increase in life expectancy. In the United States, life expectancy increased dramatically from 74 years to around 79 years in a short period of three decades. We argue that this increase in the demand for precautionary savings has led to the arrival of new and more effective ways to supply insurance, such as shadow banking. We show that both of these developments are needed to account both for the observed expansion in private borrowing and the evolution of interest rates.

Our findings suggest that the observed patterns of credit may have been an efficient reaction of financial markets to demographic changes instead of the result of banking wrongdoing. Furthermore, we provide a measure of the benefits of shadow banking on facilitating those patterns, contributing to the discussion about the desirability of the new financial landscape in economies that experience structural and demographic changes.

Savings for retirement is indeed one of the most important reasons for the need of financial intermediation. A large fraction of total wealth is held by retirees. Wolff (2004) documents that more than a third of total wealth in the United States is held by households whose heads are over age 65. Consistent with this finding, Gustman and Steinmeier (1999) show that, for households near retirement, wealth is around one third of lifetime income. Even before retirement there is strong evidence that most people's savings are intended to be use after retirement.[1]

As workers save for retirement, they provide funds that can be used to finance productive investment opportunities and to cover the liquidity needs of those who in the past saved for retirement. The cost of the first activity, which we denote as *operation cost*, is the cost of finding the best available investment opportunities to allocate the funds, and

[1]Two classical papers making this point are Gale and Scholz (1994) and Kotlikoff and Summers (1981).

includes the process of finding productive opportunities, monitoring the management of projects and administering payments. The cost of the second activity, which we denote as *liquidity cost*, is the cost of transforming long-term risky loans into short-term safe assets that can be liquidated at stable nominal conditions in relatively short periods of time in case a fraction of investors larger than the one that are expected to withdraw funds (those that are in their retirement age) choose to withdraw their funds in advance.

Since the eighties, U.S. households' assets held in retirement funds duplicated as a fraction of GDP (from 55% in 1980 to 110% in 2010). Even though the increase in life expectancy induced a large increase in the demand for safe assets that can be provided by financial intermediaries, we document that at the same time there was also a large increase in the supply of safe assets. We show that the cost of intermediation, measured by the spread between lending rates and deposit rates, declined from a stable level of 4% in 1980 to around 3% before the recent financial crisis. Relying on Philippon (2015), who show that operation costs have been constant in the financial sector for almost a century, we conclude that the bulk of the decline in the cost of intermediation in the last three decades can be accounted for by a reduction in liquidity costs.

We argue that this decline in liquidity costs has been driven by the use of financial instruments channeled at the heart of what became known as "shadow banking." Securitization, for example, is the backbone of shadow banks. It allows for the creation of assets that, even though backed by productive risky loans, are designed to be information insensitive and to be liquidated with the same facility than government bonds and other liquid assets, which are backed instead by unproductive safe taxation. Furthermore, shadow banking allows banks to escape blunt, and potentially restrictive, regulatory constraints that inefficiently impose a fraction of their assets to be invested in unproductive asset classes, such as government bonds.

Are these two changes quantitatively large enough to accommodate the large increase in financial intermediation experienced by the United States since 1980? What are the individual contributions of higher retirement needs and shadow banking on growth and output? We show in a calibrated model with financial intermediation that the higher demand for safe assets (from an increase in insurance motives due to higher life expectancy) generates not only an increase in accumulation of assets, but also a decrease in the return to the safe assets. In turn, the decrease in the returns, together with the longer expected life, increases the benefits to search for higher yields. Since the shadow banking technology pays higher returns (due to lower liquidity costs), there is a switch of savers from traditional to shadow banking that allows for a larger supply of safe assets. We show that this mechanism can indeed quantitatively accommodate the large increase in financial assets as a fraction of GDP experienced by the United States.

As we need a model that consistently displays borrowers and lenders and their intereactions, we construct an overlapping generations model with heterogeneity on the bequest motives of individuals: individuals with high bequest motives hold capital and borrow from individuals with low bequests motives. All borrowing and lending is channeled through financial intermediaries that have to guarantee savers (lenders) that their assets are safe, which has an opportunity cost of not investing in more productive, but riskier, options – a liquidity cost. Securitization provided the technology to transform a part of those more productive and riskier assets into safe assets, then reducing the liquidity cost. The savers (lenders) can choose between two types of financial intermediaries: traditional banks (TB) and shadow banks (SB). The difference between them is that SB exhibits a lower liquidity cost (due to more securitization) that translates into higher interest rates paid over deposits. However, finding and operating with SB is more costly that finding and operating with TB. Thus, savers would choose to save for retirement through SB only if the present value of the difference in returns is larger than the search cost. As a result, for given returns differential, as the life expectancy increases, so it does the present value of the gains to move to shadow banks. In short, a higher life expectancy triggers an appetite for yields, and shadow banks can fulfill such appetite.

We calibrate the economy to 1980 and input the change in life expectancy to generate a counterfactual for 2005. We show that isolated (direct) impact of the increased demand for safe assets does generate more financial intermediation, but imposes an important downward pleasure on safe asset's returns that partially compensates the expansion of the financial sector. However, the downward pressure of returns triggers a switch of savers from traditional to shadow banks (appetite for yields) that allows for an increase in the supply of safe assets, increasing further the intermediated quantities by the financial sector while preventing the fall on interest rates.

Only including both changes we can account for the observed evolution of households' debt over GDP and total financial assets held in the economy, with an increase of around 75% in both figures. Absent the switch to shadow banking, the change in life expectancy would only account for an increase of around 10% in households debt over GDP and 6% on total financial assets. We also decompose the impact of shadow banking on output. Absent shadow banking, steady state output would have grown only half of what it grows when both forces are combined. These results highlight the importance of first understanding the determinants of financial markets to then assess their impact on aggregate dynamics.

Finally, as we are able to construct a counterfactual economy without shadow banks, we can compute the output gains from the lower interest rate spreads induced by this financial innovation and weight them against the output costs of a crisis that is assumed triggered by the operation of shadow bank activities. We find that, from 1980 to 2007, the existence of shadow banking increased output by half of 2007 GDP. This number can be put in context when compared to the cost of the great recession. The literature computes this cost by the difference between the potential GDP constructed by the CBO and the realized GDP. If we assign the cause and depth of the recession completely to the existence of shadow banking, its cost is 0.23 of 2007 GDP. This cost is however overestimated as it takes the potential GDP based on the existence of shadow banks to compute the costs of shadow banks, while a more consistent estimate comes from comparing a benchmark without shadow banks *and* without crisis with the realized output after the crisis. This exercise delivers a cost of 0.16 of 2007 GDP. As a summary, even if the crisis were only due to shadow banks, still the economy had gained around 0.3 of 2007 GDP by its existence.

Related Literature: We contribute to the recent academic and policy discussion on the effects of shadow banking for macroeconomic aggregates. While most of this debate focuses on the costs of shadow banks in terms of inducing crises and making financial systems fragile, much less is known about their potential positive macroeconomic effects. As in our paper, Moreira and Savov (2015) highlight that shadow banking improves liquidity provision during booms and enhances growth, but at the cost of increasing fragility. In their case, shadow banking expands during periods of low uncertainty in the economy and collapses when uncertainty increases. In contrast, we study the role of higher retirement saving needs and a higher demand for safe assets in boosting the use of shadow banks, which provide a better, but more fragile, alternative than traditional banks for their provision. Even though we focus on the positive macroeconomic effects of the run up of shadow banking, not on its demise, we are able to provide an estimate of the net gains of shadow banking in the U.S. since the eighties even when accounting (and completely blaming shadow banks) for the financial crisis in 2008.

In contrast to a rich literature (such as Caballero (2010), Caballero, Farhi, and Gourinchas (2016) and Carvalho, Ferrero, and Nechio (2016)) that argues that the increase in the demand for safe assets may have come from foreign countries saving needs (the wellknowing "savings glut" hypothesis) in this paper we focus on the increase on the demand of safe assets coming from higher needs for retirement of U.S. residents. Interestingly, a large part of the saving glut from foreign countries has been accommodated by an increase in U.S. government debt and the provision of U.S. government bonds. Shadow banking, then, has had a primary role in accommodating the domestic demand for safe assets, and indeed we find not only that these forces are substantial quantitatively but also that a calibrated model can account for most of these changes.

In this sense, the paper contributes to the discussion of the volume of retirement savings once we add financial intermediaries and their cost of intermediation explicitly. Even though there is a rich literature studying the relevance that savings for retirement purposes have on investment, output, and interest rates in macroeconomics, the impact of financial intermediation on those relations is less explored, with the exception of Mehra, Piguillem, and Prescott (2011). We extend their environment by making the financial sector, in particular the roles of traditional and shadow banking, endogenous.

Our work is also complementary to papers that micro found the effects of shadow banking on reducing liquidity costs. Gorton and Ordonez (2014) show that securitization, the tool most used for shadow banking activities, through pooling and tranching, reduced the incentives of information acquisition and allows risky assets to be combined and traded as safe assets, providing "safety" at lower costs. Similarly, Ordonez (2014) shows that shadow banking arises as an equilibrium response to regulations that are excessively, and inefficiently, constraining in times in which reputation concerns operate in financial markets, which happens for example when expected future business opportunities are very promising. We use these insights to understand how the increase in shadow banking was at the forefront of the observed decline in the liquidity cost.

In our model shadow banking provides safety at a lower cost by using a complex and costlier technology to transform risky assets into safe assets. The extra cost of this technology comes from the complexity needed to pool and tranche risky assets, its fragility and its predisposition to be subject to moral hazard. When the needs for safe assets increase, the relative benefits to operate with shadow banking increases and then there is a transition away from traditional banking activities. In this story we have abstracted from regulatory arbitrage, but we could modify the main trade-off to incorporate these considerations. Ordonez (2017), for example, highlight that shadow banking is beneficial because it allows an escape from blunt regulations at the cost of excessive risk-taking. Farhi and Tirole (2017) discuss how traditional banking is sustained on complementarities between costly public supervision and beneficial public liquidity guarantees, and how regulation (taxes and subsidies, ring fencing, etc) can accommodate these forces to avoid a migration towards shadow banking activities.[2]

Next we introduce a macroeconomic model with savings for retirement and financial intermediation, calibrate it and decompose the effects of shadow banking on welfare, output and the accumulation of assets.

2 Model

2.1 Environment

We study an overlapping generations economy populated by households that work on a competitive productive sector, save for retirement through financial intermediaries and are taxed by the government.

2.1.1 Households

Each period a measure $(1+\eta)^t$ of agents are born, where η is the population growth rate. Agents born at age $j = 0$ and live with certainty for T periods, during which they can work an inelastic amount of hours without utility cost. After age T they cannot longer supply labor (they retire) and die with constant probability $0 < \delta < 1$ thereafter. When an agent dies at age j it may leave bequest b_j that generates $\alpha \geq 0$ units of consumption utility per unit of bequest. Agents discount the future at the rate $\frac{1}{\beta} - 1$ and are heterogeneous on the intensity of their bequest motive, $\alpha \sim m(\alpha)$. Assuming that households value logarithmically the consumption at age j, which we denote by c_j, their present value of utility at a calendar period t is,

$$\sum_{j=0}^{T} \beta^j \log c_{t+j,j} + \sum_{j=T+1}^{\infty} \beta^j (1-\delta)^{j-T-1} [(1-\delta) \log c_{t+j,j} + \delta \alpha \log b_{t+j,j}] \tag{1}$$

As labor does not generate any disutility, each generation $j = 0, 1, ..., T$ (of measure 1) supplies one unit of labor inelastically. Hence $L = T$.

As is clear from equation (1), we assume the "joy-of-giving" type of bequest motive. This motive, however captures several forces. First, it is consistent with the empirical ob-

[2] Other papers that focus on the interactions between regulation and shadow banking include Harris, Opp, and Opp (2014), Plantin (2015) and Begenau and Landvoigt (2017).

servation that people leave equal bequest to their heirs. Second, as shown by De Nardi, French, and Jones (2010) and De Nardi, French, and Jones (2015), agents save after retirement as a precaution against medical expenses. As health is a normal good, the joy-of-giving specification also delivers this concern in a simple way. Thus, the reader must interpret the parameter α as capturing both precautionary savings against large potential health shocks at old age and pure bequest motives. As pointed out by De Nardi, French, and Jones (2015) it is almost impossible to properly disentangle the contribution of each effect.[3] Besides being instrumental in simplifying the solution of the model, our chosen specification is also useful to capture non-trivial effects of changes in the age structure over savings.[4]

We have also assumed an exogenous retirement age as a simplifying assumption that resembles the observed pattern of retirement in the U.S. As Bloom, Canning, and Moore (2014) argue, as life expectancy increases there are two effects affecting the retirement decision: 1) workers can extend their working life to compensate the longer life after retirement but, 2) due to the increase in labor productivity, the income effect increases the demand for leisure, and thus, decreases the retirement age. Hence, the final effect of increasing life expectancy in retirement age is ambiguous. In fact, Costa (1998) shows that the retirement age in the US, and many countries, has been continuously decreasing in the last 100 years, which points to the dominance of the income-wealth effect. As a result, with this assumption we would be understating the effect of aging on savings.[5]

Finally, one may wonder why we focus on the period after 1980 given that life expectancy has increased steadily during the twentieth century. However, as shown by the U.S. Social Security Administration, the life expectancy conditional on reaching 65 years old has been constant to 13 additional years until 1980 and then it has increased steady from 13 to 17 additional years until 2010.

In the balance growth path we only need to analyze the problem of an individual born at $t = 0$, as the problem of any other individual born at t is simply $c_{t,j} = (1 + \gamma)^t c_{0,j}$. We will denote $c_{0,j}$ simply as c_j when studying the balance growth path.

In terms of income, individuals have three sources. First, they receive labor income y_j

[3]See also Lockwood (2015) for an attempt to identify each component.

[4]For instance, if we had assume that agents are perfectly altruistic with respect to their offspring ("Barro-Becker" type of bequest motive), individual savings would be independent of both life span and survival probabilities. This would be at odds with the empirical evidence, as discussed by De Nardi, French, and Jones (2009).

[5]See also Bloom et al. (2007).

for the labor provided at age j during the first T years of their life (working age). Second, we assume that the bequest b_j that agents leave upon death at age j is equally distributed among all agents alive of age $T_I < T$. Thus, every agent receives an inheritance, $\bar{b}$, at age T_I. Finally, individuals may receive a transfer Tr_i from social security every period after retirement. Denoting agent i's saving returns by r_i and assuming a labor income tax τ, the agent i' that born at $t = 0$ has a consolidated total wealth at birth on the balance growth path of,

$$v_0^i = \sum_{j=0}^{T-1} \frac{(1-\tau)y_j}{(1+r_i)^j} + \frac{\bar{b}}{(1+r_i)^{T_I}} + \frac{(1+r_i)}{r_i+\delta} \frac{Tr_i}{(1+r_i)^T} \tag{2}$$

Notice that the only source of individual risk is the agent's life span. Thus, the only reason for saving is to hedge the risk of outliving one savings: there are only savings for retirement. We are abstracting from aggregate risk, which is not insurable in a closed economy, and other sources of idiosyncratic risk, like unemployment or health shocks during the working lifetime. From this point of view we are underestimating the amount of precautionary savings. Since all savings, independently of their original purpose, can be used in principle to hedge any kind of risk, before and after retirement, the bias would be small as long as the survival risk is sufficiently strong. As Gale and Scholz (1994) and Kotlikoff and Summers (1981) show, between 75% and 90% of individual savings can be explained by retirement reasons only.

In order to capture in the simplest possible way the different life strategies that different individual use to hedge the retirement risk, we restrict the households' choice set to two alternatives, 1) to buy annuities from financial intermediaries or 2) to self-insure. More importantly, we assume that households can only choose among these alternatives at age $j = 0$, and not at any other age $j > 0$. This assumption is made for simplicity, otherwise, as it will be clear later, it would be optimal for every household to follow the strategy with high returns when young and switch to the strategy with better insurance just before retirement. However, since Mankiw and Zeldes (1991) there is ample evidence that most households do not ever hold stocks and prefer to keep all their financial assets in riskless alternatives (this is known as participation puzzle). Even those households that decide to include stocks in their portfolios do not drastically change their strategies as they age.[6]

[6]Fagereng, Gottlieb, and Guiso (2017) argue that a combination of participation costs and a small "disas-

To be concrete, every agent have access to the following two strategies:

1) **Strategy B: Bank-insurance:** Sign an annuity contract with a financial intermediary (a Bank). An annuity contract between an agent and a financial intermediary specifies the payment that *the agent must make to the intermediary* during the agent's working age and the payment that *the intermediary must make to the agent* when the agent retires. This is, the agent consumes c_j as long as the agent is alive and leaves b_j to the heirs contingent on dying. There are two possible banks that the agent can choose to sign this annuity, a traditional bank (TB) or a shadow bank (SB). We assume that choosing and understanding a shadow bank is more costly for agents such that they have to pay a utility cost κ to sign the contract. We will describe how these two types of banks differ in their liquidity costs in more detail later.

2) **Strategy S: Self-insurance:** The agent saves, in equity or in bonds, part of her income while working and lives out her savings after retirement bequeathing any un-spent savings.

In short, households choose their retirement strategy when they are born and, based on this decision, they choose the sequence of consumption during their working life and after retirement.

2.1.2 Productive Sector

The productive sector operates every calendar period t with a Cobb-Douglas production function with exogenous growth rate γ,

$$
\begin{aligned}
Y_t &= K_t^{\theta}(\Gamma_t L_t)^{1-\theta} \\
\Gamma_{t+1} &= (1+\gamma)\Gamma_t
\end{aligned}
$$

where K is the aggregate stock of capital in the economy, L is the aggregate supply of labor and Γ is the average labor productivity. Thus, θ is the share of capital income over total income. Labor and capital markets are competitive, which implies that the rental rate

ter" probability are needed to rationalize the low change in investments. Alvarez, Guiso, and Lippi (2012) show that not only participation costs are needed, but also observational costs.

of the inputs equals their respective marginal productivity.

$$\delta_k + r_e = F_K(K_t, \Gamma_t L_t)$$
$$y_t = F_L(K_t, \Gamma_t L_t)$$

where δ_k is the capital depreciation rate. Along the balance growth path, $K_{t+1} = (1+\gamma)K_t$ and from the law of motion of capital investment is $X_t = (\delta_k + \gamma)K_t$.

2.1.3 Financial Intermediation

On the financial sector, we assume that perfectly competitive banks offer annuity contracts to households (those following strategy B) to save for retirement. They specify the gross rate $1 + r$ that a household receives per unit of saving made during the working age. With these savings, the bank can invest either in "safe government bonds" that pay with certainty a unit gross rate $1 + r_L$ per unit of bond or in a continuum of "risky loans' that pay a unit gross rate $1 + \widehat{r}_e > 1 + r_L$ per unit of loan, but only with probability $1 - s_b$, as with probability s_b the loan defaults and pays nothing. The expected return of bonds is then r_L, while the risk-adjusted expected return on loans is $r_e \equiv (1 - s_b)(1 + \widehat{r}_e) - 1$. Each bank takes these returns as given.

We denote the total savings obtained by a financial intermediary from agents choosing annuities by D, and all assets by A. We also denote the fraction of assets that the bank chooses to invest in loans by f. Finally, we assume that banks face a constant returns to scale technology, with a constant marginal cost of operation $\widehat{\phi}$ per unit of asset managed.

We impose liquidity considerations that put an upper bound on how much a bank can invest in loans while still obtaining savings. To capture these considerations in a simple way, we assume that banks are subject to potential coordination problems, under which all savers (agents that withdraw because they are retired and also agents during their working life) can decide at a moment to withdraw their funds (a bank run). In such event, if a bank does not have enough funds to cover these withdrawals, it must default completely on all depositors. This is naturally a very extreme assumption that captures very extreme forms of fire sales or trade freezes but simplifies the exposition greatly.

We assume that a bank is completely insulated from this possible coordination failure if it can liquidate enough assets at face value. In such event the bank can resort to all bonds and to a fraction z of the loans. This fraction z captures the easiness to liquidate (sell or collateralize) existing loans, considering that asymmetric information makes trading of loans difficult and costly. In contrast, all government bonds can be easily liquidated and used to cover withdrawals. Then, for a given rate r, the bank is resilient (and thus not subject to a bank runs) as long as,

$$[zf(1+r_e)+(1-f)(1+r_L)]A \geq (1+r)D \tag{3}$$

The zero-profit condition of the perfectly competitive financial intermediaries can be expressed as

$$[f(1+r_e)+(1-f)(1+r_L)-\widehat{\phi}]A = (1+r)D \tag{4}$$

Finally we assume no arbitrage (agents can buy bonds at no cost), which implies that

$$r = r_L,$$

, and that securitization becomes more difficult as bonds are a lower fraction of the bank's portfolio, this is $z(f)$ such that $\frac{\partial z}{\partial f} < 0$. As an example, assume

$$z(f) = e^{\psi \frac{f}{1-f}}$$

This function is a case in which z declines as f increases. Furthermore, the lower is ψ the better is the securitization technology.

Each financial intermediary chooses how much to invest A^* (taking as given the funds D obtained from agents choosing strategy B), the fraction f^* of those investments in loans (taking as given the return r_e) and the interest rate r^* to pay to savers (taking as given the securitization technology ψ). The next proposition summarizes the optimal choices by financial intermediaries.

Proposition 1. If operational costs are not high, ($r_e > \widehat{\phi}$) a bank invests all deposits, $A^* = D$, while f^* and r^* jointly solves

$$z(f^*) = \frac{1+r^*}{1+r_e} \tag{5}$$

and

$$\phi \equiv r_e - r^* = \frac{\widehat{\phi}}{f^*} \tag{6}$$

where f^* and r^* are increasing with securitization (decreasing in ψ).

Proof. When $r_e > r$ the objective is to maximize f subject to the liquidity constraint (3), $z(f)(1+r_e) \geq (1+r)$. In our example this implies

$$f = \frac{\log\left(\frac{1+r}{1+r_e}\right)}{\psi + \log\left(\frac{1+r}{1+r_e}\right)}$$

and subject to the zero-profit condition (4).

As from equation (5) f decreases with r and from equation (6) f increases with r, there is a unique equilibrium. As, fixing r, the fraction f increases as ψ decreases, then both r^* and f^* increases as ϕ decreases (as securitization becomes easier). QED

Combining the equilibrium conditions (5) and (6), in our example we can rewrite the risk-adjusted interest spread as

$$\phi = \widehat{\phi}\left[1 + \frac{\psi}{\log\left(\frac{1+r_e}{1+r}\right)}\right]. \tag{7}$$

The risk-adjusted interest spread has two main components: 1) the physical cost of production, represented by the *value added component*, $\widehat{\phi}$ and 2) the *liquidity component*. This last component depends on the securitization technology, decreasing as ψ decreases and securitization becomes easier.

Traditional and Shadow Banks: There are two technologies available in the economy, that differ in how loans are packaged, pooled and tranched to be traded as safe assets and easily liquidated in case of runs (perfect substitutes of bonds). We assume that some banks operate with ψ_{TB} while others with $\psi_{SB} < \psi_{TB}$. We refer to the former as traditional banks and the latter as shadow banks because a reason these banks may face different technologies is that they may be constrained by different regulatory constraints, based on the activities they perform. As it is clear from the previous analysis, and essential for our quantitative exercise, shadow banks can invest a larger fraction of their portfolio in more productive loans, face less liquidity costs and offer a larger return to their investors.

2.1.4 Government

The government consumes a constant proportion g of output (which is not valued by the consumers), follows a committed debt policy D_t^G, which is independent of prices and quantities in the economy and pay an average social security transfer of $\overline{Tr}_t$. The government collects taxes on labor income to balance the budget,

$$\tau y_t L_t + (D_{t+1}^G - D_t^G) = gY_t + \overline{Tr}_t + r_L D_t^G \tag{8}$$

We will assume hereafter that the social security transfer after retirement is a fraction ss_i of the last wage y_T at retirement, which may be conditional on the saving decisions of individuals, $i \in \{B, S\}$. This is,

$$Tr_{i,t} = ss_i y_{T,t}.$$

Note that keeping revenue and spending constant, the above constraint implies that changes on the debt policy would have an impact on returns and aggregate quantities. Along the balance growth path $D_{t+1}^G = (1+\gamma)D_t^G$.

2.1.5 Aggregates and Definition of (Stationary) Equilibrium

Next, we define aggregate variables and the stationary equilibrium. In what follows we focus on steady state comparisons, but in Section 5.1 we study the transition of this model and show that for our quantitative analysis the comparison of steady states capture most of the main benefits of shadow banking after the increase in life expectancy experienced in the US since the eighties.

First we specify aggregates along the balance growth path. Distinguish by $i \in \{B, S\}$ agents according to their saving strategy. Let $\mathcal{A}^i$ be the stationary set of agents α choosing strategy i, $\mu_i(\alpha) = m(\alpha)$ if $\alpha \in \mathcal{A}^i$ and define $\mu_i = \int_{\alpha \in \mathcal{A}^i} m(\alpha) d\alpha$. As in every period t a density $(1+\eta)^t m(\alpha)$ of agents are born and their survival probabilities are exogenous, the density of agents of age j is given by

$$\mu_j^i(\alpha) = \begin{cases} \frac{\mu_i(\alpha)}{(1+\eta)^{j-t}} & \text{if } j \leq T \\ \frac{(1-\delta)^{j-T-1}\mu_i(\alpha)}{(1+\eta)^{j-t}} & \text{if } j > T. \end{cases}$$

We use these measures to obtain aggregates for each agent type i, as functions of $(r_e, \bar{b})$.

$$\begin{aligned}
C(r_e, \bar{b}) &= \sum_{i=S,B} \sum_{j=1}^{\infty} \int c_j^i(r, \bar{b}; \alpha) \mu_j^i(\alpha) d\alpha \\
W^B(r_e, \bar{b}) &= \sum_{j=1}^{\infty} \int w_j^B(r, \bar{b}; \alpha) \mu_j^B(\alpha) d\alpha \\
W^S(r_e, \bar{b}) &= \sum_{j=1}^{\infty} \int w_j^S(r, \bar{b}; \alpha) \mu_j^S(\alpha) d\alpha \\
B(r_e, \bar{b}) &= \sum_{i=S,B} \sum_{j=T+1}^{\infty} \delta \int b_j(r, \bar{b}; \alpha) \mu_{j-1}^i(\alpha) d\alpha \\
L_t &= \sum_{j=0}^{T-1} (1+\eta)^{t-j}
\end{aligned}$$

where C is aggregate consumption along the balance growth path, w^B and w^S are the individual net worths for agents following strategies B and S, respectively; W^B and W_t^S are the corresponding aggregates, B is the aggregate bequest and L_t is total labor supply.

Definition 1 *Stationary Equilibrium.*

Given fiscal policies $\{g, ss_i, D^G\}$, a stationary equilibrium is characterized by saving decisions $\{\{B_{TB}, B_{SB}\}, S\}$, individual allocations $\{\underline{c}(\alpha), \underline{w}(\alpha), \underline{b}(\alpha)\}_{\forall\alpha\geq 0}$, aggregate allocations $\{Y, B, C, X, K\}$ and prices $\{y, r_e, r_L, r\}$ such that,

1. *Given prices $\{y, r_e, r_L, r\}$ and fiscal policies $\{g, ss_i, D^G\}$, the individual allocations $\{\underline{c}(\alpha), \underline{w}(\alpha), \underline{b}(\alpha)\}_{\forall\alpha\geq 0}$ solve the consumer-saver problem: households choose their retirement plan and consumption path to maximize utility.*

2. *Banks choose r and their portfolio allocation to maximize profits.*

3. *Factor prices are equal to marginal productivities.*

4. *The government chooses τ to balance the budget.*

5. *Markets clear,*

   - *Feasibility:* $Y = gY + C(r_e, \bar{b}) + X + \widehat{\phi}\frac{W^B(r_e,\bar{b})}{1+r}$
   - *Assets market:* $\frac{W^B(r_e,\bar{b})}{1+r} + \frac{W^S(r_e,\bar{b})}{1+r^e} = D^G + K$

- *Bequest=inheritance:* $\bar{b} = (1+\gamma)^{T_I} B(r_e, \bar{b})$

2.2 Equilibrium Characterization

We solve the equilibrium backwards. First we solve for the consumption path conditional on each saving choice. Then we show the optimal saving decision.

We first consider strategy B. The following analysis is regardless of whether the individual chooses to use traditional or shadow banking, as these cases will only change the received interest rate, r. Any household following strategy B would maximize the utility (equation 1) subject to equation (2). In the appendix we show that the solution is characterized by:

$$\begin{aligned} c_j^B &= \bar{C}^B \beta^j (1+r)^j v_0^B \\ b_j^B &= \alpha \bar{C}^B \beta^j (1+r)^j v_0^B \end{aligned} \tag{9}$$

for some constant $\bar{C}^B > 0$. Notice that b can be considered as another consumption good, so that intratemporal optimality imposes $b = \alpha c$. Furthermore, households signing annuities perfectly smooth consumption. For instance, if $\beta(1+r) = 1$ a household following strategy B would experience constant consumption through its life and would leave exactly the same bequest, independently of how long the household has lived. The above consumption plan implies the following pattern for the net worth of a household choosing strategy B.

$$\begin{aligned} w_0^B &= 0 \\ w_j^B &= (w_{j-1}^B - c_{j-1}^B + (1-\tau)y_j)(1+r), && 1 \le j \le T,\ j \neq T_I \\ w_j^B &= (w_{j-1}^B - c_{j-1}^B + (1-\tau)y_j)(1+r) + \bar{b}, && j = T_I \\ w_j^B &= \sum_{t=0}^{\infty} \frac{(1-\delta)^{t-1}}{(1+r)^t} \left[(1-\delta)c_{j+t} + \delta\alpha b_{j+t} - ss_B y_T\right], && j > T \end{aligned} \tag{10}$$

Agents are born with zero wealth, they work and lend to the financial intermediary any non-consumed income, which generates a return r. At age T_I each household receive an inheritance which is mostly saved, thus the net worth jumps at this age. After retirement the financial intermediary pays the signed agreement, hence the net worth for the household is the present value of the contract.

Now we consider strategy S. Households in this case must plan how much to save for retirement and how to spend those savings after retirement. This can be considered as two separated problems. We solve it backwards, i.e. we first solve the problem after retirement.

Given any net worth level after retirement, since all bequest are accidental $b_j = w_j$ for all $j \geq T$. Hence, the problem after retirement when self-insuring solves

$$V(w) = \max\{\log c + (1-\delta)\beta V(w') + \delta\beta\alpha \log w'\}$$

subject to

$$c + \frac{w'}{(1+r_e)} \leq w$$

where r_e is the risk-adjusted return on equity.

Given the assumed functional forms for consumption and bequest, it is straightforward to verify that the value function is logarithmic in w. That is,

$$V(w) = \bar{\nu}_1(\alpha) + \bar{\nu}_2(\alpha) \log w$$

$$\text{with } \bar{\nu}_2(\alpha) = \frac{1+\alpha\beta\delta}{1-(1-\delta)\beta}$$

Simple calculations show that the optimal consumption plan and the implicit optimal bequest plan are

$$\begin{aligned} c &= w/\bar{\nu}_2(\alpha) \\ w' &= (1+r_e)(w - c + ss_S y_T). \end{aligned} \tag{11}$$

Given this solution after retirement, the optimal plan at entry in the labor force solves

$$\max \sum_{j=0}^{T-1} \beta^j logc_j + \beta^T V(w_T)$$

subject to

$$\sum_{j=0}^{T-1} \frac{c_j}{(1+r_e)^j} + \frac{w_T}{(1+r_e)^T} \leq v_0^S$$

with v_0^S given by equation (2). The solution is

$$\begin{aligned} c_j^S &= \bar{C}^S \beta^j (1+r_e)^j v_0^S, \qquad j < T \\ w_T^S &= [1 - \sum_{j=0}^{T-1} \bar{C}^S \beta^j](1+r_e)^T v_0^S \end{aligned} \tag{12}$$

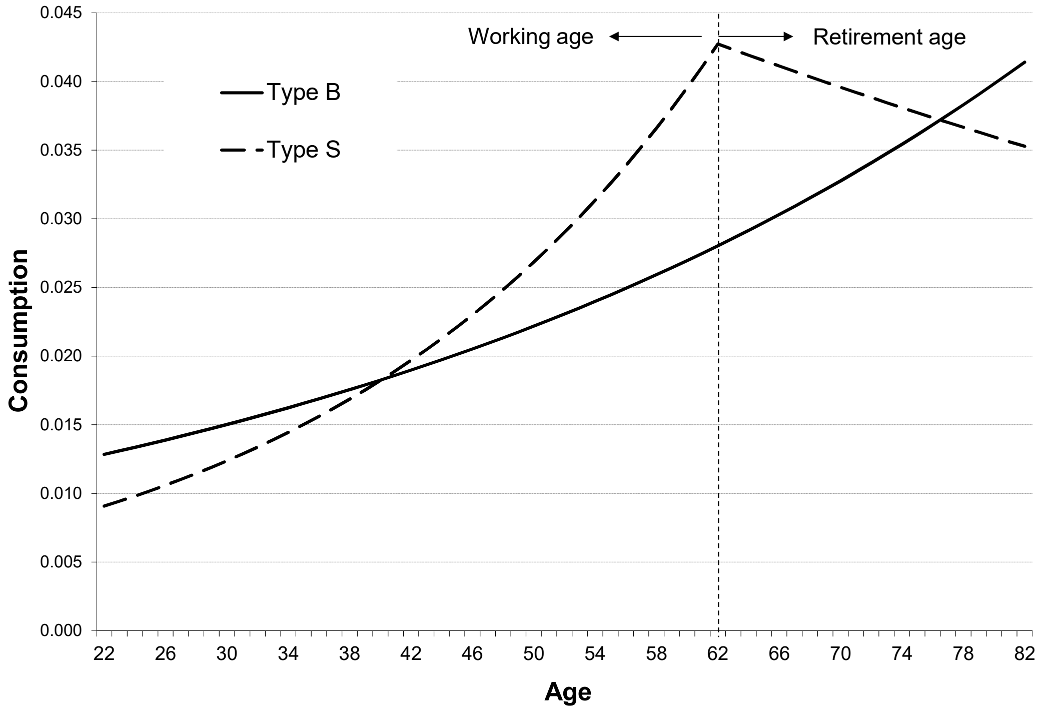
During working age, the net worth by agents that follow strategy S evolves as

$$\begin{aligned} w_0^S &= 0 \\ w_j^S &= (w_{j-1}^S - c_{j-1}^S + (1-\tau)y_j)(1+r_e), \qquad 1 \leq j \leq T,\ j \neq T_I \\ w_j^S &= (w_{j-1}^S - c_{j-1}^S + (1-\tau)y_j)(1+r_e) + \bar{b}, \qquad j = T_I \end{aligned} \tag{13}$$

There are two features of this economy that are apparent comparing equations (12) and (11) with (9). First, since $r_e > r$ before retirement the consumption of self-insuring households grows faster that the consumption of bank-insuring households. After retirement, however, self-insuring households experience a faster decline in consumption than bank-insuring households. In fact, the consumption of self-insuring households converges to zero as the household lives long enough (see Figure 1). The difference in the return has also implications for the net worth distributions. Since the return on assets of self-insuring households is larger than the return on bank-insuring households, their net worth grows faster.

Now, based on these different consumption paths, we characterize the saving decision. When a household chooses the retirement's saving plan, she faces the following considerations. First, conditional on choosing strategy B, the household must choose whether to sign the annuity contract with a traditional bank or with a shadow bank. The trade-off that these two alternatives present is that the return from saving in shadow banks is higher, but also is the cost to searching, finding and signing the contract. Since an utility cost κ is incurred at the time of signing the contract, the net present value of returns depend on the life expectancy (how many years the individual expects to have those returns). The next proposition shows that, conditional on signing an annuity contract, the agent chooses a

Figure 1: Lifetime pattern of consumption under strategies B and S



shadow bank as long as it expects to live long enough.

Proposition 2. There exists a unique $\delta^*(\alpha, \kappa) > 0$ such that, when $\delta \geq \delta^*(\alpha, \kappa)$ households that follow strategy B sign the annuity contract with traditional banks and when $\delta < \delta^*(\alpha, \kappa)$ they sign the annuity contract with shadow banks. Furthermore, $\delta^*(\alpha, \kappa)$ is increasing in α and decreasing in κ.

Second, after determining which is the optimal annuity contract to sign given δ households choose between strategies B and S. Strategy B has the benefit of fully insuring against the risk of living long but it has the cost of generating a low return on assets. Conversely strategy S has the benefit of generating high return on assets but it has the cost of not providing insurance. In particular, household's following strategy S could leave large amounts of accidental bequests. Of course, the stronger is the household's bequest motive the lower the implicit cost of accidental bequests.

Proposition 3. There are $\bar{\phi} > \underline{\phi} > 0$ such that for all $\widehat{\phi} \in [\underline{\phi}, \bar{\phi}]$, there exists a unique $\alpha^*(\delta) > 0$ such that, all agents with $\alpha < \alpha^*(\delta)$ follow strategy B and all agents with $\alpha \geq \alpha^*(\delta)$ follow strategy S.

Note that in this economy all agents have access to a full insurance technology, but some of them, those with large bequest motive, choose not to use it. They just self insure. This mechanism is in line with the recent finding by Lockwood (2012 and 2015), who argues that high bequest motive could be an explanation for the "annuity puzzle".

Using Proposition 2, from now on, and without lost of generality, we assume that the distribution of bequest motive is concentrated in two points, $\alpha = 0$ with probability μ and $\alpha = \hat{\alpha} > 0$ with the complementary probability $(1 - \mu)$. We will assume $\widehat{\alpha}$ is large enough such that these individuals do not change strategy when we perform quantitatively relevant changes in life expectancy, even though the individuals with $\alpha = 0$ who choose strategy B may change their preferred bank (traditional of shadow) to sign annuities.

Given the utility value of the available alternatives, each agent must decide the retirement strategy upon entrance to labor markets. It is clear that when $\alpha = 0$ the annuity strategy strictly dominates self-insuring, as $r_e \to r$. Thus, for $\alpha = 0$ there exists $\underline{\phi} = r_e - r > 0$ such that bank-insurance is a better strategy. Further, as α increases the value of both strategies increase. As long as $\frac{1+r_e}{1+r} \geq \beta \left[\frac{1-(1-\delta)\beta}{\delta\beta}\right]^{1-(1-\delta)\beta}$ the value of self-insuring increases faster than the value of bank-insuring. As a result, as long as the interest differential is neither too small nor too large, there is a threshold for the bequest motive such that all households with bequest motive below the threshold follow the annuity strategy, while the others self insure.

3 Measuring Shadow Banking and Intermediation Costs

In this Section, and in preparation to evaluate the model quantitatively, we document the evolution of intermediation costs since 1980 and discuss the role of shadow banking on interpreting such evolution.

As there are no readily available data for ϕ, as a proxy for intermediation costs we use spreads between interest received and interest paid in the financial sector from NIPA tables that encompasses the whole financial sector. We have to make, however, several adjustments that capture the complexity of measuring the difference between the rates from productive investments that borrowers pay and the rates captured by lenders. First, we have to acknowledge that productive investments opportunities are risky and some of those investments may not be recovered by the financial institution. For that reason we will adjust for "bad debt expenses" that subtract from the interest received. Second, when accounting for the rate paid by financial intermediaries to depositors and savers, we have to acknowledge that there are many other services provided that are not priced in, such as safety, accessibility to ATMs, financial advising, insurance, etc. For this reason we will adjust for "services furnished without payment" that adds to the interest paid.

To be more precise we want to measure $\phi = r_e - r$, where r_e has been cleaner by defaulting debt and $r = r_L + r_s$, with r_L represented by interest on savings and r_s by other services that are not prices by banks. Then

$$\phi = r_e - (\overbrace{r_L + r_s}^{r}) = \frac{\overbrace{fr^e + (1-f)r_L}^{r_T} - r_L}{f} - r_s.$$

The components of the last expression have counterparts in NIPA Tables, which we measure as follows:

1. r_T=(Total interest received - bad debt expenses)/hh's debt.

   This expression represents the average return on loans (or return on equity) that banks receive. To obtain this average we use Table 7.11, Line 28 of the NIPA tables, which provides the total interest received by private financial intermediaries and subtract Table 7.1.6 Line 12 of the NIPA table that provides "bad debt expenses" declared by corporate business.[7] To express these value as a return, Table D.3 of flow of funds provides information for all the liabilities of the main economic sectors. Since we are interested in private borrowing and lending, we subtract the outstanding government debt, that is Federal, state and local liabilities. We call the resulting *quantity privately intermediated debt*.

2. r_L=(Total interest paid)/hh's debt.

   This expression represents the average return on deposits (or return on debt) that depositors and savers receive. Table 7.11, Line 4 of NIPA tables provides information for the total interest paid on deposits by the financial sector, which we divide by privately intermediated debt as measured in the previous point.

3. r_s=(Services furnished without payment)/hh's debt.

   This expression represents the average return on services provided by financial intermediaries that are not explicitly charged to depositors and savers. We obtain this figure from

[7]To account correctly for final intermediation, as not all corporate business are financial intermediaries, we follow Mehra, Piguillem, and Prescott (2011) and assign half of it to the financial sector. We also perform alternative calculations assigning 25%, 75% and 100% to the financial without any qualitative change, just a translation of the level.

Table 2.4.5 line 88 of flow of funds, which we divide by privately intermediated debt as measured in the previous point.

4. f=Fraction of portfolio of financial intermediaries on productive investments

   This is perhaps the most difficult figure to mention and also central to our analysis. We assume that *shadow banking institutions* (hedge funds, SIVs, investment banks, money market funds, etc) have all their portfolio on productive investments, while traditional banks only have a fraction $\widehat{f}$ on productive investments, where $\widehat{f}$ is determined in part by their use of *shadow banking activities* (securitization, sponsoring of special purpose vehicles, participation in repo markets, etc). Defining the share of traditional banking institutions (those with a license as depository institutions) as s, we define

   $$f = s\widehat{f} + (1 - s)$$

   where we measure s as the fraction of consumer credit and mortgages to households that is channeled though traditional banks. We divide consumer credit from Table 110 line 14 plus mortgages from Table 110 line 15 from the total consumer credit and mortgages obtained by all households from the TAble D3 (columns 3 and 4).

   To measure $\widehat{f}$, which the fraction of loans in the portfolio of traditional banks, we divide all the loans from traditional banks (consumer credit, mortgages and others from Tables 110, lines 12, 14 and 15) from all the deposits (checkable and time and savings) in traditional banks from Tables 110, lines 23 and 24.

Combining these components, Figure Figure 2 shows spreads since the seventies. As is clear, right before 1980 spreads were stable at around 4%. There was an increase in the 80s and 90s, and a large decline that reached 3% before the great recession, to jump again in recent years to pre 1980s levels.

Figures 3 and 4 show the decomposition of the fraction of financial portfolios on loans between the importance of shadow banking institutions ($1 - s$ increased from 5% in the seventies to more than 50% in recent years) and the importance of shadow banking activities (making loans to increase in the portfolio of traditional banks, this is $\widehat{f}$, from 80% in the seventies to almost 100% before the crises, to collapse to 70% after the crisis).

Why did spreads decline? Have financial intermediaries increased their efficiency or improved their management of liquidity provision in the last decades?

Figure 2: Risk Adjusted Spread, ϕ

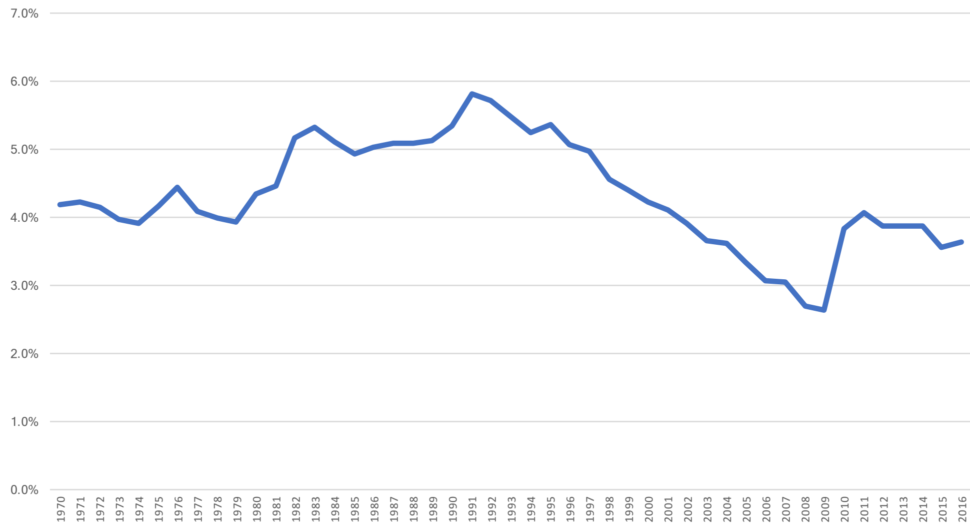


Figure 3: SB Intermediaries, $1 - s$

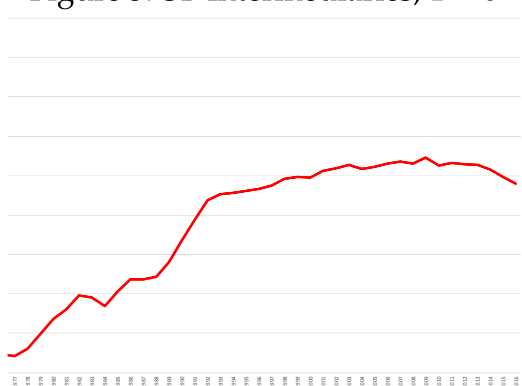
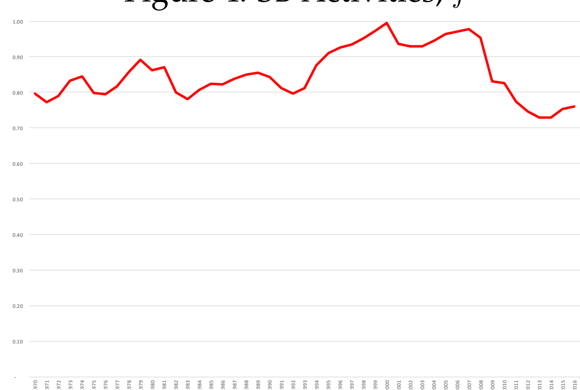


Figure 4: SB Activities, $\widehat{f}$



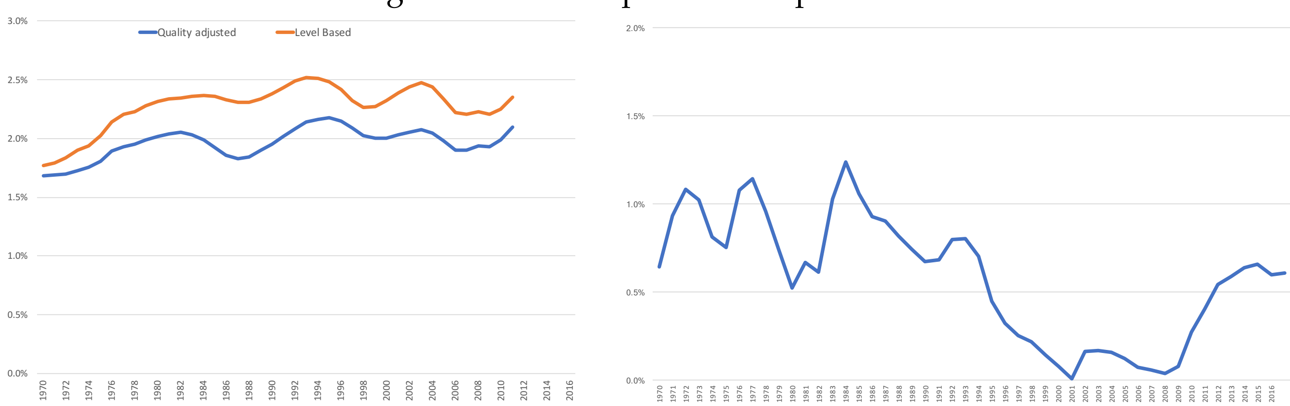
Philippon (2015) performs a thorough calculation of the changes in efficiency of the financial sector in the U.S. during the last 100 years using data on value added. He shows that $\widehat{\phi}$ has been constant for more than 100 years and that the technology in the financial intermediation exhibits constant returns to scale. He performs two alternative calculations, one assuming that the composition of the types of loans offered by the financial sector has remained stable during the sampling period and another adjusting for changes in the quality of the loans. The first panel of Figure 5 shows the evolution of $\widehat{\phi}$ estimated by Philippon (2015). The take away from this picture is that the efficiency of the financial sector during the period under consideration has remained relatively stable, with little changes.[8]

This result implies that most of the observed variation in the risk adjusted spread is accounted by the liquidity component. To see this, we define the liquidity cost by

$$\text{Liquidity cost } = (1 - f)(r_e - r_L),$$

this is the difference between the realized spread and the potential one in case $f = 1$. The second panel of Figure 5 shows the evolution of the liquidity cost during the period 1970 to 2016. During the seventies the liquidity cost of intermediation was around 1% and by 2007 the liquidity cost was almost 0%. After the recent financial crisis, the liquidity cost of intermediation increased again to almost 0.5%.

Figure 5: The Components of Spreads



In short, the last three decades have been characterized by a large increase in borrowing and lending and by a large drop in the financial intermediation spread. All the fall in the spread seems to be due to an important reduction in the financial sector' "liquidity cost." The shadow banking has had a direct impact by making assets with higher returns useful as safe assets in order to replace less profitable government bonds in banks' balance sheets.

[8]When computing the per-unit value added, Philippon (2015) explicitly, and correctly, discards the use of the intermediation spread as a measure of value added. As we show in equation (7), the intermediation spread is affected by other factors, that even though do not reflect physical costs, deeply affect the cost of financial intermediation. As the focus of this paper is on understanding the households' incentives to use the financial sector the intermediation spread is of first order relevance.

4 Quantitative Assessment of the Model

To perform a counterfactual experiment and decompose the macroeconomic effects of life expectancy (that led to an increase in the demand of safe assets) and the rise of shadow banking (that led to an increase in the supply of safe assets fueled by the increase in demand), we first calibrate the economy to replicate the main aggregates for financial intermediation in 1980. Then, we obtain the model's output for 2007 imposing newly observed life expectancy and intermediation costs. We analyze what would have happened if the United States had to face the demographic transition while forbidding the use of securitization and shadow banking.

4.1 Calibration for 1980

We calibrate the model to replicate yearly data. There are some parameters that are standard in the literature. These are, (i) the discount factor $\beta = 0.99$, (ii) capital share $\theta = 0.3$ consistent with a capital income share of output equal to 30%, (iii) labor productivity growth, $\gamma = 0.02$ and (iv) population growth, $\eta = 0.01$.

When choosing the capital depreciation rate, δ_k, we need to take into account what is the meaning of capital in our economy. In general, the literature targets a capital-output ratio of 2.7, which is the approximate ratio for the US economy when one focuses only on productive capital. In our environment capital encompasses many physical assets that constitute wealth for the household, as housing and land. Including these assets the capital output ratio would be around 3.4. Hence, we use as a benchmark $\delta_k = 0.0282$, which generates such a ratio of 3.4.

Regarding life cycle we assume that agents enter the labor force at age 22. Since the average retirement age is 62 we set $T = 40$. In addition, using the survey of consumer finances we found that households receive the inheritance on average at age 52. So, we set $T_I = 30$.

In our model $1 - \mu$ represents the proportion of households that directly hold equity. The flow of funds provides information about household's portfolio choices, showing that 28% of American households directly hold equity, which implies that 72% hold equity indirectly. This is $\mu = 0.72$.

In terms of the parameters that determine fiscal policies, we obtain the government spending as a fraction of GDP from NIPA tables, $g = 0.19$. The same way that the calibration of K/Y is important for the analysis, because transferring resources across time provides insurance, we need to carefully target the level of government debt. In 1980 the ratio of government debt to GDP was around 0.37, while in 2007 the same ratio was around 0.62. This in principle implies a larger provision of assets that can be used for insurance. However, a big part of the increase in government debt is held by foreign investors. Since, the relevant part for our analysis is the domestic availability of these assets, we define the **net supply** of government debt as total government debt **minus** debt help by foreign investors. In 1980 the proportion of public debt held by non-US residents was 20%, and set $D^G/Y = 0.30$.

Given these choices there are two parameters left to calibrate: the level of bequest motives of those households who have bequest motives, $\hat{\alpha}$ and the fraction of the last wage that the government transfer for social security after retirement, ss_i. As it is not clear what is the best way to calibrate them with exogenous sources of information we set $ss_S = 0$ and the other two replicate two important moments, 1) the government debt to GDP ratio of 0.3 in 1980 and, 2) the private debt to GDP ratio of 1 in 1980. In this way we obtain $\widehat{\alpha} = 7.5$ and $ss_B = 0.19$. To assess the validity of these parameters notice that $\widehat{\alpha}$ of 7.5 generates in the model a level of savings consistent with the findings from De Nardi, French, and Jones (2015). Also notice that the calibrated replacement ratio for the social security system ss_B of 19% of the last wage implies in the model a ratio of social security of 34% of the average wage. The social security administrations provides information for monthly average payments per retired beneficiary, which is around \$1.250 per month in 2015. Given an average annual wage of \$57.000 in 2014, this implies a ratio of 27%, which is smaller than the ratio generated by the model.[9]

Finally, there are two important parameters that we will exploit for the counterfactuals: the survival probability after retirement, δ, that captures life expectancy and the spread between borrowing and lending, ϕ, that captures the role of shadow banking. We start calibrating $\delta = 0.08$ for 1980, which implies a life expectancy of 12.5 year after retirement. In the counterfactual we decrease this value to $\delta = 0.06$, which implies a life expectancy of 16.67 years after retirement, which is the observed value in 2007.[10] As shown in Section 3 we start calibrating $\phi = 0.04$ for 1980. In the counterfactual exercises we decrease its value to $\phi = 0.03$, which is the observed value in 2007.

In terms of the performance of the model for those moments that have not been tar-

[9]Including MEDICARE and MEDICAID, however, this ratio increases and gets close to the implications of the model.

[10]This is slightly conservative since life expectancy is still in a downward path.

geted, it generates a ratio of private consumption to GDP of 0.58, very close to the observed 0.62 in 1980. The moment that the calibrated model fails to capture well is the amount of inheritance. While the model generates a 4.8% of GDP, most empirical studies estimate this figure to be around 2.7%. Those empirical estimates, however, abstract from inter-vivos transferees that could be larger in present value than the inheritance.

5 Decomposing Life Expectancy and Shadow Banking.

We now show the counterfactual exercise. The final goal is to decompose the effects of the change on both life expectancy and intermediation costs on asset accumulation, output and welfare, from 1980 to 2007.[11] We maintain for 2007 a government debt of 30% as a ratio of GDP, as the ratio increased to 62% but around 45% of the US federal debt was held by non-us residents.[12] Based on these figures we argue that that provision of government bonds during the period under consideration didn't play an important role in supplying public safe assets.

Since the economic environment affects both the revenue and transfers of the government, fiscal variables are endogenous but not their composition. Since the main concern for families in our model is insurance, we focus in the case in which both government debt to GDP ratio and replacement ratio (this is the proportion of wages obtained by the government after retirement) remain constant (roughly as in the data), while the labor tax adjusts to satisfy the government budget constraint. Later, we show the same simulations but keeping the labor tax constant and allowing the government debt to change. This last exercise is helpful to understand the underlying mechanisms affecting our results.

In Table 1, the first column shows the calibration results for 1980. The last column introduces the counterfactual when life expectancy increases (captured by a lower δ) and the agents that sign annuities move from traditional to shadow banks. Because of Proposition 1, there exists two levels of search cost, $0 < \underline{\kappa} < \bar{\kappa}$ such that if $\kappa \in [\underline{\kappa}, \bar{\kappa}]$ is optimal for those agents to choose traditional banks when $\delta = 0.08$ and shadow banks when $\delta = 0.06$. Due to the move from traditional to shadow banks, the intermediation spread falls from

[11] As over time the population growth rate has shown important changes, increasing to 1.4% in 1992, and then falling to 0.7% in 2011, in this counterfactual for 2007 we set $\eta = 0.007$. The population growth rate has first order effects, due to demographic accounting, to match the level of government debt and aggregate bequest in 2007, but its change have little effect on the observes changes in financial intermediation.

[12] See http://www.treasury.gov/resource-center/data-chart-center/tic/Pages/ticsec2.aspx. See also Bertaut et al. (2012) for a detailed discussion about the international saving glut in the US economy.

$\phi = 0.04$ to $\phi = 0.03$, as we observe in the data and model in Section 3.

Comparing the first and last columns, in which we allow both an increase in life expectancy and a reduction in spreads as observed in the data, the model generates a large increase in the output steady-state level (of around 6%), an increase in capital output ratio (from 3.4 to 3.9) and a large increase in households' total financial assets (from 1.3 to 1.96). While the data counterpart of the first two figures are difficult to observe, we use Table L100 of the flow of funds to measure the increase of households financial assets, a proxy for debt instruments. Subtracting from the total domestic non-financial assets (Line 1, Table L100) the corporate equity (Line 16, Table L100) and the equity on non-corporate businesses (Line 23, Table L100), we obtain a proxy for the net-worth of households that follow strategy B. In the US economy financial assets grew from 1.36 GDP to 2.33GDP, which is very close to the model's predictions. Finally, the model's prediction of the change in the new amount intermediated, measured by the Household Debt to GDP ratio, accounts for more than 90% of the observed change.

Now we can decompose the effects of the increase in life expectancy and the decline in intermediation costs by suppressing one at a time. The second column of Table 1 shows the counterfactual **without shadow banks**. We compute the model with life expectancy increasing in the same magnitude as observed in the data, but assuming that $\kappa > \bar{\kappa}$, so that the move to shadow banking does not happen. Without the move to shadow banking the increase in capital output ratio and steady state output would have been around 60% of the total increase with the presence of shadow banking (capital output ratio increased from 3.4 to 3.7 instead of to 3.9 while output increased from 1 to 1.034 instead of to 1.062). The increase in retirement needs generates a permanent increase of GDP of almost 3% instead of 6% with shadow banks. Also, absent shadow banking we would have observed a small change in the net worth held by agents as debt products in terms of GDP (from 1.3 to 1.4 instead of to 1.96) and household debt over GDP (from 1 to 1.1 instead of to 1.66). Finally, an increase in retirement needs without an improvement in intermediation costs would increase the demand for safe assets, which generates a reduction in their return (r declines from 0.020 to 0.013). Still, since there are more funds channeled to investment opportunities the equity return declines (r_e declines from 0.060 to 0.053).

Finally, the third column of Table 1 is a thought experiment **without an increase in life expectancy**, where we assume that κ falls below the lower bound $\underline{\kappa}$, reducing intermediation cost, even though life expectancy remains in the levels of 1980. To make the

Table 1: Counterfactual to 2007 (Fixed D^G)

Economy	1980 Benchmark	Larger δ $\kappa > \bar{\kappa}$	Same δ $\kappa < \underline{\kappa}$	δ & ϕ change $\kappa \in [\underline{\kappa}, \bar{\kappa}]$
Interm. Cost (ϕ)	4%	4%	3%	3%
Survival prob. (δ)	0.08	0.06	0.08	0.06
Interest Rates				
Borrowing Rate (r)	0.020	0.013	0.025	0.018
Lending Rate (r_e)	0.060	0.053	0.055	0.048
National Accounts				
Output	1.00	1.034	1.025	1.062
Capital output ratio	3.40	3.70	3.60	3.91
Net Worth				
Total	3.70	3.97	3.90	4.21
Equity (Plan S)	2.40	2.57	2.12	2.25
Debt (Plan B)	1.30	1.40	1.78	1.96
Data (FF: Table L100)	*1.36*			*2.33*
Bequest/Y	0.048	0.048	0.040	0.040
Government Debt/Y	0.30	0.30	0.30	0.30
Households Debt/GDP	1.00	1.10	1.48	1.66
Data (FF: Table D3)	*1.00*			*1.73*
Change on welfare at birth	-	-	0.3%	0.4%
Plan B	-	-	2.5%	2.8%
Plan S	-	-	-4.3%	-4.8%

exercise comparable to the fourth column, we assume that the intermediation costs decline in the same magnitude as observed in the data in 2007. In essence, this exercise shows what would have happened in our model with shadow banking but no increase in life expectancy and then extra needs for retirement since 1980. In this case, the increase in capital output ratio and steady state output would have been around 40% of the total increase with the higher retirement needs (capital output ratio increased from 3.4 to 3.6 instead of to 3.9 while output increased from 1 to 1.025 instead of to 1.062). That is, the arrival of shadow banking without an increase in demand of financial assets for higher life expectancy would have generated a permanent increase in GDP level of almost 3% instead of 6%. Also, we would have observed a large change in the net worth held by agents in terms of GDP (from 1.3 to 1.78 instead of to 1.96) and household debt over GDP (from 1 to 1.48 instead of to 1.66). Finally, a reduction in intermediation costs increase the supply of funds, inducing an increase in the return of safe assets (r increases from 0.020 to 0.025). Still, since there are more funds channeled to investment opportunities the equity return still declines (r_e declines from 0.060 to 0.055).

The different effects of retirement needs and shadow banking on asset returns emphasize the relevance of modelling both demand and supply of the asset markets, as pointed out by Justiniano, Primiceri, and Tambalotti (2013) and Justiniano, Primiceri, and Tambalotti (2015), who relate the credit boom in the first half of 2000s to the international saving glut. They stressed the fact that the fall in interest rates was due to the influx of foreign funds. From this point of view, our paper can be understood as accounting for the contribution of a "domestic saving glut" generated by longer living U.S. residents, which has been largely ignored in the literature. In particular, Justiniano, Primiceri, and Tambalotti (2013) argue that between one fourth and one third of the increase in the U.S. household debt can be accounted by the international saving glut. The domestic saving glut together with the fall in the liquidity cost can account for all of the increase in household debt.[13]

Remark on Welfare Effects

When there are changes to "preferences" (in our case life expectancy, δ, changes) affecting the computation of present values, comparisons across experiments become hard to interpret in terms of welfare. If in two experiments δ is the same, this is no longer a problem though. When this is the case, we use the consumption equivalent change necessary to make a household indifferent between the two alternatives. With logarithmic utility, as we have assumed, the calculations are quite simple.

Let $\underline{C} = \{c_t, b_t\}_{t=0}^{\infty}$ be the sequence of consumption and bequest for an agent at birth *before* a change on the economy and $\underline{\widetilde{C}} = \{\tilde{c}_t, \tilde{b}_t\}_{t=0}^{\infty}$ the analogous sequence *after* the change. We define the consumption equivalent parameter λ as the constant proportional change in every period allocation that makes the consumer indifferent between the two alternatives. That is, λ solves $\sum_{t=0}^{\infty}((1-\delta_t)\beta)^t u((1+\lambda)c_t, (1+\lambda)b_t) = \sum_{t=0}^{\infty}((1-\delta_t)\beta)^t u(\tilde{c}_t, \tilde{b}_t)$. Thus, if λ is positive the consumer benefits from the change while if it is negative the consumer is worse off. Since preferences are logarithmic. The above equation can be written

[13] As we mention in Section 4.1 most of the foreign funds went into government bonds. Thus, the direct effect of the international saving glut is likely small.

as $\sum_{t=0}^{\infty}((1-\delta_t)\beta)^t \log(1+\lambda) + \sum_{t=0}^{\infty}((1-\delta_t)\beta)^t u(c_t, b_t) = \sum_{t=0}^{\infty}((1-\delta_t)\beta)^t u(\tilde{c}_t, \tilde{b}_t)$. Let $U_0(C)$ be the utility at birth, then λ satisfies:

$$\left[\frac{1-\beta^{T+1}}{1-\beta} + \frac{\beta^T}{1-\beta(1-\delta)}\right] \log(1+\lambda) = U_0(\underline{\widetilde{C}}) - U_0(\underline{C})$$

$$\lambda = \exp\left[-\frac{1-\beta^{T+1}}{1-\beta} - \frac{\beta^T}{1-\beta(1-\delta)}\right] \exp\left[U_0(\underline{\widetilde{C}}) - U_0(\underline{C})\right] - 1$$

From now on, the change on welfare is expressed in terms of $100\lambda\%$.

Comparing column 1 and 3, which are computations based on the same $\delta = 0.08$ but lower intermediations costs due to shadow banking, we observe an increase in welfare of 0.3%. It is interesting to notice that the increase is due to a big consumption equivalent increase of 2.5% for the annuity type (which are almost 70% of the agents) while the welfare of the equity type decreases drastically by 4.3%.

The increase on welfare is higher (by 0.4%) when comparing columns 2 and 4, based on a higher life expectancy of $\delta = 0.06$. Again, the big gain in welfare comes from the bank-financing agents who benefit from the more efficient financial system in the economy by 2.8%, while self-financing agents get worse off, experiencing a lost of 4.3% of terms of life-time consumption. Notice that the relatively higher average welfare gain is due to the higher gain experienced by bank-financing agents.

Remark on allowing Government Debt/GDP to change

In the previous simulations we maintained D^G fix. In Table 2 we consider alternative scenarios for D^G. The first column just replicates the calibration in Table **??** while the second column replicates the counterfactual for 2007 when allowing both retirement needs and intermediation costs to vary (the last column of Table 1). The third column shows what would the equilibrium have been if the life expectancy had increased, the spread had decreased to 3% and the government were allowed to freely choose the level of debt without changing either taxes or transfers. In this case, the government becomes a net saver (given constant taxes and larger expenses due to the social security system, the only way to finance its expenses is to accumulate assets and to use the proceeds to compensate the shortfall of revenue). As the government stop providing public safe assets and start demanding them, there is a reduction in interest rates (r and r_e drops by 0.001). This implies that both the capital output ratio and the steady state output increase further that in the case of fixed D^G (almost 20% more in both cases). In addition, the household debt

Table 2: Counterfactual to 2007 (alternative D^G)

Economy	1980 Benchmark	2007 Calibration	Free D^G	All D^G Domestic
Interm. Cost (ϕ)	4%	3%	3%	3%
Survival prob. (δ)	0.08	0.06	0.06	0.06
Interest Rates				
Borrowing Rate (r)	0.020	0.018	0.017	0.020
Lending Rate (r_e)	0.060	0.048	0.047	0.050
National Accounts				
Output	1.00	1.06	1.07	1.05
Capital output ratio	3.40	3.91	4.00	3.83
Net Worth				
Total	3.70	4.21	3.96	4.45
Equity (Plan S)	2.40	2.25	2.16	2.34
Debt (Plan B)	1.30	1.96	1.80	2.11
Data (FF: Table L100)	*1.36*	*2.33*		
Bequest/Y	0.048	0.040	0.038	0.042
Government Debt/Y	0.30	0.30	-0.04	0.62
Households Debt/GDP	1.00	1.66	1.84	1.49
Data (FF: Table D3)	*1.00*	*1.73*		

explode to 1.84 GDP, almost 30% more than in the case of fixed D^G.

Finally, the last column assumes that the debt to GDP ratio moves from 0.3, as in 1980, to 0.62, which it would be domestic supply of government bonds in 2007 if the foreign nations would not hold any U.S. treasuries (see Section 4.1). The difference between this equilibrium and the observed in 2007 inform us about the indirect effect of the international saving glut on the US financial intermediation system. The main effect is an increase in the supply of public safe assets that maintain r at levels before the increase in life expectancy even though intermediation costs decline. This induces a decline of household debt to GDP ratio with respect to the case in which there is no global saving glut, to 1.49GDP instead to 1.66GDP. This result implies that the international demand for U.S. treasuries would account for around 25% of the generated increased in the US household debt. This number is very close to the interval provided by Justiniano, Primiceri, and Tambalotti (2013) for the contribution of the international saving glut to the credit boom in the 2000. However, in our setup the channel is different. There is no **direct** supply of foreign funds (lenders) generating incentives that stimulates household's borrowing. Instead, the foreign demand for U.S. treasuries crowds out the domestic demand for safe assets. Second, GDP would have increased less without a foreign saving glut.

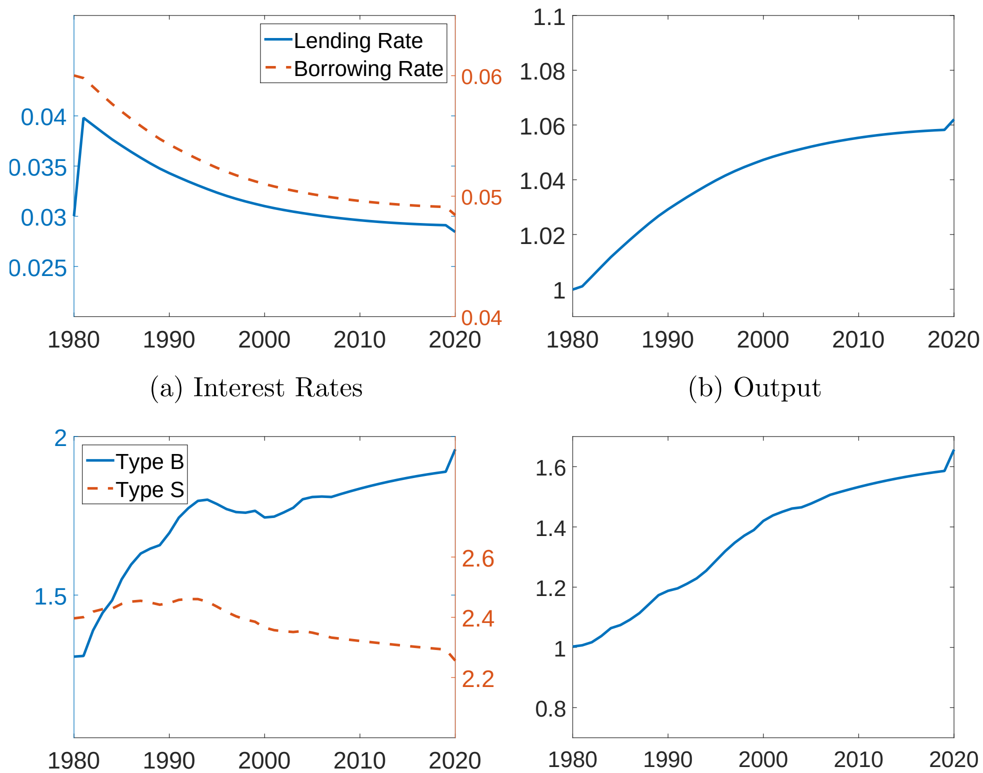
5.1 Transitions

Since it can take many years for an economy to converge to a new steady state, comparing two steady states may not be the best way to assess the impact of a life expectancy change in the economy from 1980 to 2007. In this section we show that the convergency is indeed quite fast: by the year 2010 most of the increase in debt, around 90%, has already happened. We also show that cyclical movements of economic activity play an important role accommodating the slow grow in debt during the early 80's and the subsequent speeding up in private indebtedness during the 2000's.

The computation of the transition, however, presents several challenges. First, at the time of the shock there is a distribution of agents indexed by age and assets. Who is affected when the death probability shock happens in 1980? In what follows, we assume that retired agents, at the moment of the shock, remain with the initial surviving probability $\delta = 0.08$, while the surviving probability for all working-age agents jump to $\delta = 0.06$. Second, some agents were already in an annuity contract. What happens what those contracts? We assume that after the shock all the existing contracts are renegotiated to take into account the new survival probability. Third, what happens with the government budget? We assume that the lump-sum transfers remain at the same absolute value as before the shock and that the government still follows a policy to maintain the debt to output ratio constant and equal to 0.3. As a result, the labor tax has to adjust during the transition to keep the government's budget balanced. Finally, what happens with retirement payments? We assume that for those already retired in 1980, these payments remain at the same level that were contracted before the shock.

In Figure 6 we show the transition dynamics of a shock that reduces δ from 0.08 to 0.06 and reduces ϕ from 0.03 to 0.02, while in Table 3 we present the values corresponding to the figure. In panel a) of the figure we see that immediately after the shock the spread falls.

Figure 6: Transition Dynamics: constant TFP



(a) Interest Rates (b) Output

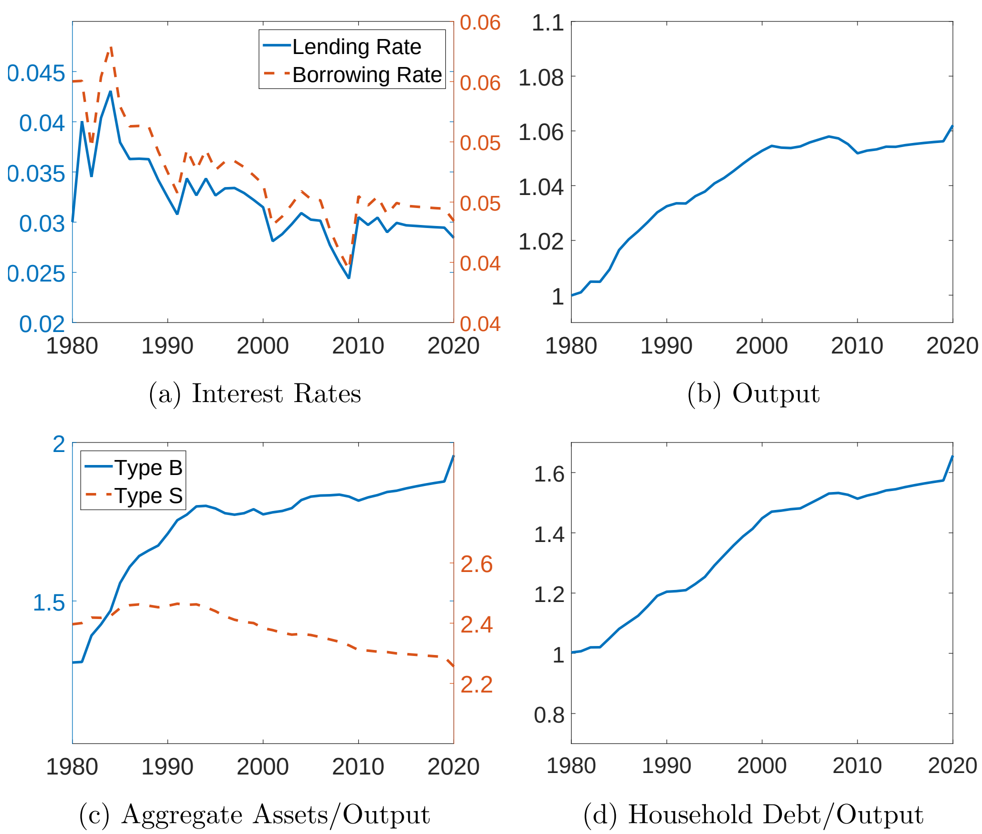
(c) Aggregate Assets/Output (d) Household Debt/Output

Table 3: Transition values

Variable/year	**1980**	**1985**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**
K/Y	3.399	3.528	3.648	3.735	3.796	3.838	3.866	3.883
Y	1.000	1.016	1.031	1.041	1.049	1.053	1.057	1.059
Type B Net worth	1.306	1.440	1.570	1.669	1.746	1.804	1.848	1.880
Type S Net worth	2.397	2.391	2.382	2.369	2.354	2.337	2.321	2.306
Total Fin. Assets	1.609	1.743	1.873	1.972	2.049	2.107	2.151	2.184
Gov. Debt/GDP	0.303	0.476	0.508	0.500	0.325	0.332	0.303	0.303
Private Debt/GDP	1.003	1.137	1.266	1.366	1.442	1.501	1.545	1.577

After the shock, both interest rates continuously decline until they reach the new steady state. The non-monotone convergency of the lending rate is because with the new life expectancy the capital stock is low respect to its desired value. Thus, the return on savings increases and slowly converges to the new, now lower, level of returns. This effect can be seen in the increasing pattern for the net worth of bank-insuring households in panel c). Also, in panel c) we see that the net worth of self-insuring households continuously fall, in spite of an increasing on the capital stock, as they increase the leverage ratio. As a result, in panel d) the household debt increase from 1GDP in 1980 to about 1.54 by 2007, almost 85% of the difference between steady states. In this dimension, the fall in the intermediation cost plays an important role. If the intermediation cost is kept constant at the 1980 levels, self-insuring households' net worth would have increased instead of falling, but in any case the household debt would have increased. Finally, in panel b) we see that by 2007 the output is very close to the new steady state.

Figure 7: Transition Dynamics: observed TFP



(a) Interest Rates

(b) Output

(c) Aggregate Assets/Output

(d) Household Debt/Output

Notice that the increase on private debt starts immediately after the shock, while in the US economy the accumulation of debt starts later. To that end we compute the transition path using the actual path for TFP (measured by the Solow residual) instead of fixing

$A = 1$ as in the previous simulations. In Figure 7 we show that the recessions in early 80's and early 90's slow down the convergence in the 80's, to speed up again in the second half of the 90's. Also notice that the monotone declining rate of the interest rate is mostly unaffected by the changes in the TFP, while the output and private debt are slightly above the figures computed in Figure 6.

6 On the Costs and Benefits of Shadow Banking

In this paper we have abstracted from the cost of shadow banking. The great recession is an example of how big this costs can be if indeed it was partly generated by a collapse in securitization and most instruments heavily used to provide liquidity at a lower cost in shadow banking activities. Using a methodology proposed by Luttrell, Atkinson, and Rosenblum (2013) and later expanded by Ball (2014) and Fernald (2014) that compares the potential output computed by the Congressional Budget Office (CBO) and the realized output we computed that the great recession generated a lost of GDP, in present value, of 23% of 2007 GDP. In Figure 8, this is the discounted value in 2007 of the difference between the dotted back line and the dashed red realized output after 2007.[14]

A natural question arises if shadow banking was responsible for the crisis, was it worth it? Was the contribution of shadow banking large enough to compensate the observed cost? The first approach to the answer can be found in Table 1, which can be used to compute the present value of its contribution to generate income. Since, shadow banking generates a permanent increase of output equivalent to 2.8% per year in the stationary equilibrium (1.062-1.034, see the second and forth columns of Table 1), discounting the future (growing) stream of income using the risk free interest rate we obtain a present value of around 3.3GDP of 2007. Nonetheless, this would be the gains from shadow banking in the long run absent any crisis. This is not, however, the correct number to compare with the losses after the crisis, in particular because previous to 2007 the economy was in a transition, not in the stationary equilibrium.

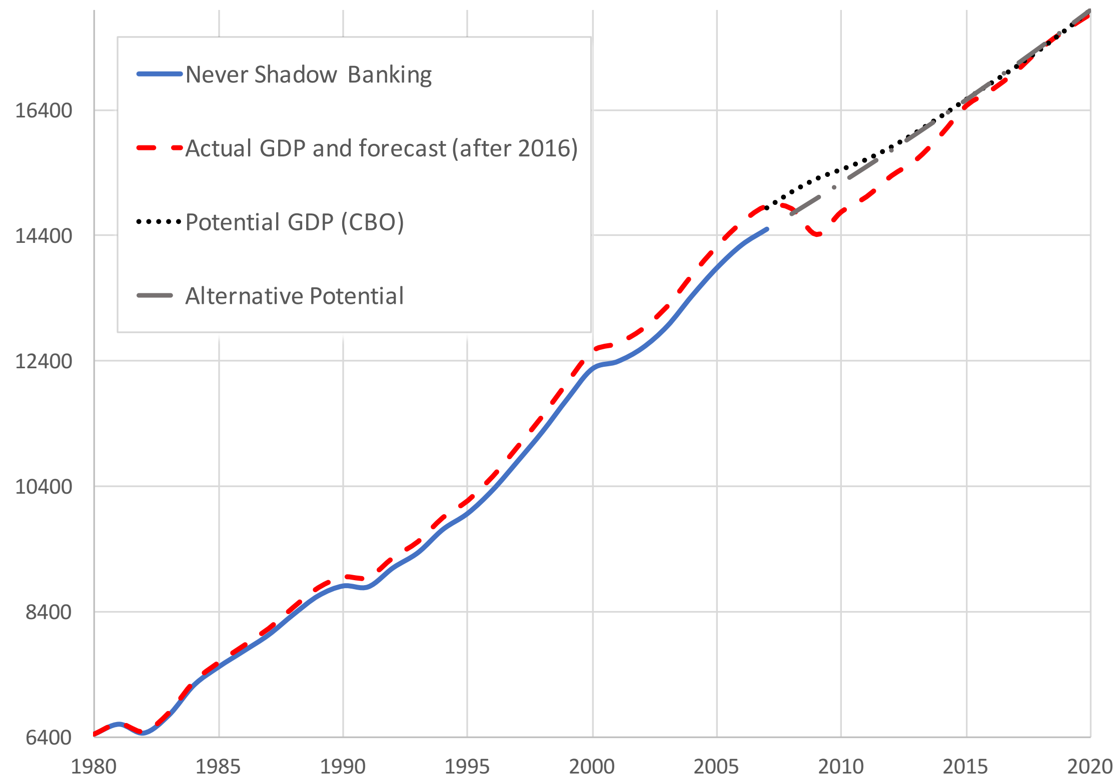
In order to compare meaningfully the benefits and cost of shadow banking surrounding the recent crisis, we compute a benchmark economy without shadow banks, this is without the potential gains from lower spreads but also without the cost of a crisis. To

[14]This is lower than the estimation in these papers that range from 40% to 90% of 2007 GDP, mainly because the CBO has revised down potential output in the last two years. For a detailed explanation about the calculations see the staff report Atkinson, Luttrell, and Rosenblum (2013).

perform this counterfactual we assume $\kappa > \bar{\kappa}$, so that after the increase in life expectancy individuals just keep choosing traditional banks and the spreads were at the 1980 level of 3%. We use the gap in output from the counterfactual and we extrapolate it to the realized GDP until 2007.

In this counterfactual there is no shadow banking previous to 2007, but we need to extend it such that there is no crisis after that. It is challenging to compute the potential output in the counterfactual as we should take a stand on how productivity and other variables would have evolved in the economy without a crisis. For this reason we will conservatively assume that the economy keeps increasing at the average growth level since 2007. This counterfactual is the blue solid line of Figure 8 until 2007 and the dashed-dotted grey line after 2007.

Figure 8: The costs and benefits of shadow banking



With our counterfactual we can now compute the gains from shadow banking before 2007 and its losses after 2007. The present value of the gap between the benchmark and the realized output from 1980 to 2007 (which, as we discussed, corresponds to a transition period) represents a 47% of 2007 GDP. The gap between the benchmark and the realized output from 2007 to 2020 represents a 16% of 2007 GDP. The comparison between these two numbers delivers a net gain from shadow banking, even after assigning all the cost of the crisis to it, of 30% of 2007 GDP.

Note that this cost based on our counterfactual is below the 23% that the literature has proposed taking as benchmark the potential output by the CBO. The reason is that the initial level of that potential output is the realized output before the crisis, which according to our model was high initially exactly because shadow banking was instrumental in increasing output. After the crisis, shadow banking activities collapsed and regulation has been enacted that restricted its resurgence. This may be the reason the CBO reduced the potential output estimation and why our counterfactual converges to their potential output estimation in 2017. In other words, measuring the cost of a financial crisis using potential output may be correct in terms of consequences for forgone income, but interpreting it as a cost of shadow banking is misleading as it could be indeed pointing to its value instead.

7 Conclusions

The recent discussion, both in academic and policy circles, about the demand of safe assets and its macroeconomic effects has focused on the "saving glut" from foreign countries. At the same time, the recent discussion about the role of shadow banking has focused on its pervasive effects on triggering painful crises. In this paper we argue that these two discussions are intimately related. While the higher foreign demand of safe assets seems to have been accommodated by an increase in government debt, the higher domestic demand of safe assets triggered by an increase in life expectancy has pushed an endogenous increase in the supply of safe assets by the private sector, more specifically securitization and shadow banking. We have explored quantitatively the individual roles of higher life expectancy and the rise of shadow banking on the accumulation of financial assets, private debt, output and welfare.

We show that a calibrated model with an increase in the demand of safe assets for retirement needs and shadow banking that reduces the cost of financial intermediation accommodates well the large increase in asset accumulation and output experienced by the United States since 1980. We find that in the absence of shadow banking assets would not have increased, while the capital-output ratio and output would have increased only half of what they did.

Our approach allows us to compute a counterfactual without shadow banks and we have shown that the gains from 1980 to 2007 of operating with shadow banking was of 47% of 2007 GDP. Further, even if we assume shadow banking was the sole responsible for the recent crisis and the whole great recession, its cost is of the order of 16% of 2007 GDP. In other words, our model suggest that there were net gains of having shadow banks even if it were true that it single handedly generated the great recession. These results are relevant in the discussion about the regulation of the banking system. Even though avoiding shadow banks or certain financial innovations, such as securitization, may have benefits in terms of reducing the likelihood and magnitude of financial crises, we show that it is also costly in terms of choking-off output.

References

Alvarez, Fernando, Luigi Guiso, and Francesco Lippi. 2012. "Durable Consumption and Asset Management with Transaction and Observation Costs." *American Economic Review* 102 (5): 2272–2300 (May).

Atkinson, Tyler, David Luttrell, and Harvey Rosenblum. 2013, July. "How bad was it? The costs and consequences of the 2007–09 financial crisis." Technical Report 20, Federal Reserve Bank of Dallas.

Ball, Laurence. 2014. "Long-Term Damage from the Great Recession in OECD Countries." NBER Working Paper 20185.

Begenau, Juliane, and TIm Landvoigt. 2017. "Financial Regulation in a Quantitative Model of the Modern Banking System." working Paper, Stanford University.

Bertaut, Carol, Laurie Pounder DeMarco, Steven Kamin, and Ralph Tryon. 2012. "ABS inflows to the United States and the global financial crisis." *Journal of International Economics* 88 (2): 219–234.

Bloom, David E., David Canning, Richard K. Mansfield, and Michael Moore. 2007. "Demographic change, social security systems, and savings." *Journal of Monetary Economics* 54 (1): 92 – 114. Carnegie-Rochester Conference Series on Public Policy: Economic Consequences of Demographic Change in a Global Economy April 21-22, 2006.

Bloom, David E., David Canning, and Michael Moore. 2014. "Optimal Retirement with Increasing Longevity." *Scandinavian Journal of Economics* 116 (3): 838–858 (07).

Caballero, Ricardo. 2010. "A Caricature (Model) of the World Economy." Working Paper, MIT.

Caballero, Ricardo, Emmanuel Farhi, and Pierre-Olivier Gourinchas. 2016. "Global Imbalances and Currency Wars at the ZLB." Working Paper, MIT.

Carvalho, Carlos, Andrea Ferrero, and Fernanda Nechio. 2016. "Demographics and real interest rates: Inspecting the mechanism." *European Economic Review* 88 (C): 208–226.

Corvae, Dean, and Pablo D'erasmo. 2013. "A Quantitative Model of Banking Industry Dynamics." Manuscript.

Costa, Dora L. 1998. "The Evolution of Retirement: Summary of a Research Project." *The American Economic Review* 88 (2): 232–236.

De Nardi, Mariacristina, Eric French, and John Jones. 2009. "Life Expectancy and Old Age Savings." *American Economic Review, Papers and Proceedings* 99 (2): 110–115.

———. 2010. "Why Do the Elderly Save? The Role of Medical Expenses." *Journal of Political Economy* 118:39–75.

———. 2015. "Savings After Retirement: A Survey." NBER working paper no. 21268.

Fagereng, Andreas, Charles Gottlieb, and Luigi Guiso. 2017. “Asset Market Participation and Portfolio Choice over the Life-Cycle.” *The Journal of Finance* 72 (2): 705–750 (March).

Farhi, Emmanuel, and Jean Tirole. 2017. “Shadow Banking and the Four Pillars of Traditional Financial Intermediation.” Working Paper, Havard University.

Fernald, John. 2014. “Productivity and Potential Output Before, During and After the Great Recession.” Federal Reserve Bank of San Francisco Working Paper 2014-15.

Gale, William, and John Karl Scholz. 1994. “Intergenerational transfers and the accumulation of wealth.” *Journal of Economic Perspectives* 8 (4): 145–160.

Gorton, Gary, and Guillermo Ordonez. 2014. “Collateral Crises.” *American Economic Review* 104 (2): 343–378.

Gustman, Alan, and Thomas Steinmeier. 1999. “Effects of pensions on savings: Analysis with data from the health and retirement study.” *Carnegie-Rochester Conference Series on Public Policy*, Volume 50. Elsevier, 271–324.

Harris, Milton, Christian Opp, and Marcus Opp. 2014. “Higher Capital Requirements, Safer Banks? Macroprudential Regulation in a Competitive Financial System.” Working Paper, Wharton School.

Justiniano, Alejandro, Giorgio Primiceri, and Andrea Tambalotti. 2013. “The Effects of the Saving and Banking Glut on the U.S. Economy.” In *NBER International Seminar on Macroeconomics 2013*, NBER Chapters, 52–67. National Bureau of Economic Research, Inc.

———. 2015. “Credit Supply and the Housing Boom.” Manuscript.

Kotlikoff, Laurence J., and Lawrence H. Summers. 1981. “The Role of Intergenerational Transfers in Aggregate Capital Accumulation.” *Journal of Political Economy*, pp. 706–732.

Lockwood, Lee. 2012. “Bequest Motives and the Annuity Puzzle.” *Review of Economic Dynamics* 15 (2): 706–732.

———. 2015. “Incidental Bequests: Bequest Motives and the Choice to Self-Insure Late-Life Risks.” Manuscript.

Luttrell, David, Tyler Atkinson, and Harvey Rosenblum. 2013. “Assessing the costs and consequences of the 2007 - 09 financial crisis and its aftermath.” *Economic Letter*, vol. 8 (Septiembre).

Mankiw, N. Gregory, and Stephen Zeldes. 1991. “The consumption of stockholders and nonstockholders.” *Journal of Financial Economics* 29 (1): 97–112.

Mehra, Rajnish, Facundo Piguillem, and Edward Prescott. 2011. “Costly Financial Intermediation in Neoclassical Growth Theory.” *Quantitative Economics* 2 (1): 1–36.

Moreira, Alan, and Alexi Savov. 2015. “The Macroeconomics of Shadow Banking.” Working Paper, Yale University.

Ordonez, Guillermo. 2014. "Confidence Banking and Strategic Default." Working Paper, University of Pennsylvania.

———. 2017. "Sustainable Shadow Banking." American Economic Journal: Macroeconomics. Forthcoming.

Philippon, Thomas. 2015. "Has the US Finance Industry Become Less Efficient? On the Theory and Measurement of Financial Intermediation." *American Economic Review* 105 (4): 1408–38.

Plantin, Guillaume. 2015. "Shadow Banking and Bank Capital Regulation." *Review of Financial Studies* 28 (1): 146–175.

Wolff, Edward. 2004. "Changes in household wealth in the 1980s and 1990s in the U.S." Levy Economics Institute Working Paper 407.