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Intermediation Costs and Welfare

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Abstract

This paper studies quantitatively how intermediation costs affect household consumption loans and welfare. Agents face uninsurable idiosyncratic shocks to labor productivity in a production economy with costly financial intermediation and a natural borrowing limit. Reducing intermediation costs leads to two effects: First, for a given interest rate, borrowing costs decrease, which improves the ability of agents to smooth consumption overtime. Second, the demand for loans increases, which increases the interest rate. The aggregate welfare gain of reducing intermediation costs from 3.927 percent (US level) to 1 percent is about 1.14 percent of equivalent consumption in the baseline economy for an endogenous interest rate and and 1.90 for an exogenous interest rate. The gains are distributed unevenly: households at the bottom wealth decile improve welfare by 3.96 and 5.86 percent of equivalent consumption, while those at the top decile have a welfare gain of 0.35 and 0.2 percent, when the interest rate is determined endogenously and exogenously, respectively.

JEL Classification: E60; G38

Keywords: Intermediation costs; Distribution; Welfare; Bewley Model

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1 Introduction

Financial intermediaries play an essential role in the economy, transferring funds from agents who do not wish to use them immediately to those who do, improving the allocation of resources with consequences for efficiency and welfare. As Hahn (1971) pointed out, financial intermediation is not a costless activity: It uses real resources, such as labor and capital, and governments often tax such activity. This generates a wedge between the deposit and borrowing rates and consequently implies that households face different interest rates, depending whether they are savers or borrowers. In section 2, we provide data on intermediation costs, financial intermediary taxes and interest rate differentials in the United States and other economies, and explain our measure of intermediation costs.

This paper asks two positive questions: (i) What are the quantitative welfare implications of intermediation costs? (ii) Are the welfare effects evenly distributed across individuals with different levels of wealth? In order to address these questions, we construct a standard neoclassical growth model where individuals face uninsurable idiosyncratic shocks to labor productivity, an endogenous borrowing limit, and costly intermediation. Households smooth consumption over time by making deposits at a financial intermediary in good times and by running down credit balances or getting loans in bad times. Intermediation costs generate a wedge between loan and deposit rates, with interest payments on loans higher than the return on deposits. We assume that all intermediation is made by financial institutions and therefore abstract from direct borrowing and lending between households.[1] As in Martins-da-Rocha and Vailakis (2009), the intermediary has a labor intensive technology, maximizes profit, is remunerated by the marginal product of labor, and takes regulation as given.[2] See Hahn (1971), Díaz-Giménez, Prescott, Fitzgerald, and Alvarez (1992) and Mehra, Piguillem, and Prescott (2009) for similar approaches.

[1] This is optimal, for example, when monitoring is costly and there is no double coincidence of wants. Banks intermediate by bundling deposits together to make loans and diversify risk.

[2] Townsend (1978) and Greenwood and Jovanovic (1990) build economies in which financial institutions arise endogenously to share risk and smooth consumption by collecting information, pooling risk and allocating resources to high return investments. See also Diamond and Dybvig (1983), Krasa and Villamil (1992a) and Krasa and Villamil (1992b).

Our goal is to analyze the effects of intermediation costs on agents' intertemporal ability to smooth consumption and insure against labor income shocks. As a consequence, we focus on unsecured consumption loans, e.g., personal loans, credit card debt, lines of credit, etc., and abstract from the effects of intermediation costs on entrepreneurship and productivity. We discuss U.S. credit market data in detail in section 2. Unsecured consumption loans, while only a subset of the total credit market, allow us to construct a direct measure of intermediation costs for our quantitative exercise. In addition, the fraction of unsecured credit over all credit in the data provides another dimension on which we can assess the performance of our model. Our analysis also allows us to learn about the Bewley model.

We use our model to measure key statistics of the United States economy, including intermediation costs, and perform counter-factual experiments. Reducing intermediation costs leads to two effects. First, for a given interest rate, decreasing borrowing costs expands net borrowers' consumption possibility frontiers and even current savers may benefit (with positive probability they may need to borrow to smooth consumption in the future due to bad labor productivity shocks). Second, there is an indirect effect: lower intermediation costs imply an increase in the demand for loans, which raises the interest rate. This offsets part of the decrease in borrowing costs and also increases interest income, improving savers' welfare. The net impact of these effects requires a quantitative analysis.

We interpret a reduction in intermediation costs as an improvement in the financial intermediation technology or a reduction in taxes on financial transactions. The welfare analysis focuses on stationary equilibria and transitional dynamics. The transition is slow, and abstracting from it can lead to misleading welfare calculations. Also, mobility in wealth means that comparing, for instance, the agent with median wealth in two stationary equilibria may not involve the same household.

For the United States economy, we find three important quantitative results. Firstly, intermediation costs have a large effect on welfare. The average aggregate welfare gain of all agents from reducing intermediation costs from 3.927 percent (United States level)

to 1 percent (the level observed in the 10th percentile of countries with the lowest intermediation costs) is about a 1.14 percent consumption equivalent increase in the baseline economy. The indirect general equilibrium effect is also substantial. When we assume that the economy is integrated in the world capital market, and hence the interest rate does not adjust after a change in intermediation costs, the aggregate welfare effect is larger, about 1.90 percent of consumption equivalent to the baseline economy (a 66 percent increase over the endogenous interest rate case). When the interest rate is endogenous, the lowest wealth decile has an average welfare gain of 3.96 percent of baseline consumption, while the highest decile has an average welfare gain of roughly 0.35 percent. Therefore, inefficient intermediation affects heavily poor households that face bad income shocks.

The welfare effects of intermediation costs are not linear and depend on the level of interest rate differentials. To illustrate this, in section 4.3.2 we calibrate the model to the Mexican economy, which has an observed measure of intermediation costs that is about 65 percent larger than the United States. Surprisingly, the aggregate welfare effects of reducing intermediation costs from the Mexican level (6.5 percent) to 1 percent is not substantial, only about 0.34 percent of consumption equivalent in the baseline economy. This occurs because when intermediation costs are sufficiently high, agents do not borrow to insure against income shocks and instead accumulate assets to self-insure. The direct effect of a decrease in intermediation costs has an impact on only a few households at the bottom of the wealth distribution, but the welfare effect for these households is still substantial (average welfare increases by 2.66 percent of consumption equivalent to the baseline level for agents that are in the lowest decile of the wealth distribution).

The quantitative effects of intermediation costs on the ability of agents to use consumption loans to insure against labor income shocks and the associated welfare consequences have been largely neglected. An exception is Chia and Whalley (1999), but they use a two period exchange economy, while we consider an infinite horizon production economy and use standard calibration techniques. A related literature studies the impact of financial reform on long run productivity and economic growth (e.g., Amaral and

Quintin, 2005; Antunes, Cavalcanti, and Villamil, 2008; Castro, Clementi, and MacDonald, 2004; Erosa, 2001; Erosa and Hidalgo-Cabrillana, 2007).[3] Our positive question is related to this literature, but we focus on the effects of intermediation costs on consumption smoothing and welfare, rather than on entrepreneurship and economic development.[4]

This paper is also related to a large literature on supply-side economics. For example, Lucas (1990) found in a neoclassical growth model with homogeneous agents that eliminating capital income taxation results in a welfare gain across steady-states of over 5 percent of baseline consumption, and about 1 percent when transitional costs are taken into account. In a model similar to ours with heterogenous agents, Aiyagari (1995) shows that cutting the income tax to zero might lead instead to welfare losses, since capital income taxation can bring the interest rate close to the rate of time preference and affects agents differently.[5] In a homogeneous agents environment, Lucas (2000) shows that the welfare gains from reducing inflation from 10 percent to 0 is equivalent to an increase in consumption of slightly less than one percent.[6] Erosa and Ventura (2002), however, show that although aggregate welfare effects of moderate inflation are small, there are important distributional effects: poorer agents are negatively affected by inflation, but richer agents have welfare gains.[7] Our results show that for the United States, the welfare effects of reducing intermediation costs are substantial when compared to other supply-side reforms, with poor households benefiting most.

The paper proceeds as follows. Section 2 contains facts on intermediation costs and interest rate differentials. Section 3 describes the model and defines the competitive equilibrium. Section 4 calibrates the model and performs policy experiments to evaluate the welfare effects of changes in intermediation costs. Section 5 concludes.

[3]Intermediation or transaction costs have also been used to explain various asset pricing puzzles, such as the equity premium puzzle (Mehra and Prescott, 1985). See, for instance, Aiyagari and Gertler (1991).

[4]In a related article, Van den Heuvel (2008) shows that the welfare effects of bank capital requirements in the United States might be substantial. Souza-Sobrinho (2010) studies the welfare effects of mandatory reserves and selected loans in Brazil, and finds large quantitative welfare implications of such policies.

[5]See Chari and Kehoe (2000) for an overview of the effects of capital income taxation on the economy.

[6]Cavalcanti and Villamil (2003) show that in the presence of tax evasion moderate inflations can generate welfare gains instead of losses.

[7]See also the literature on the welfare gains of eliminating business cycles fluctuations (e.g., Alvarez and Jermann, 2004; Lucas, 1987; Storesletten, Telmer, and Yaron, 2001, among others.).

2 Intermediation Costs and Interest Rate Differentials

This section reports measures of intermediation costs and interest rate differentials for the United States and other economies. In the standard Belwey model, agents borrow and lend directly and such activity is costless. However, financial intermediation entails transaction costs to process applications, verify information, taxes, and so on. We measure intermediation costs directly, but first comment on an alternative approach – the net interest margin, which is related to the wedge between borrowing and deposit rates. Demirgüç-Kunt and Huizinga (1999) show that the net interest margin can be decomposed into the sum of after tax bank profit, overhead costs, loan loss provisions, and taxes, minus non-interest income, all divided by total assets:

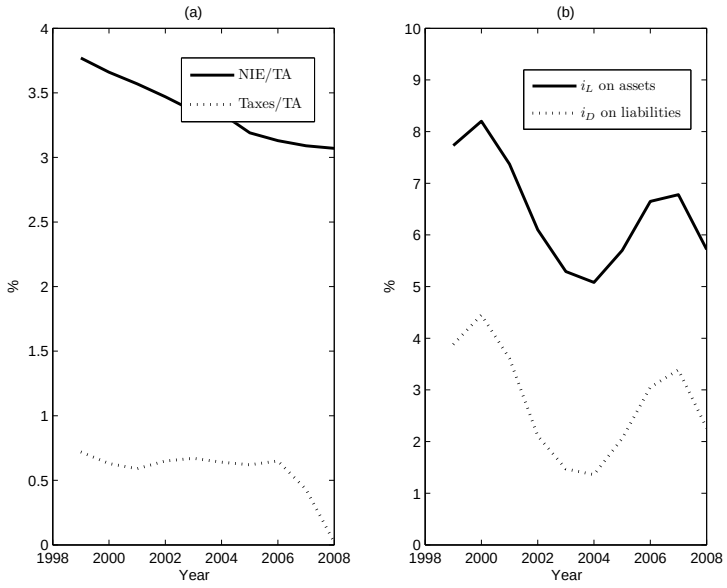
$$\text{NIM} = \frac{\text{After tax profits}}{\text{TA}} + \frac{\text{OVC}}{\text{TA}} + \frac{\text{LLP}}{\text{TA}} + \frac{\text{Taxes}}{\text{TA}} - \frac{\text{NII}}{\text{TA}}.$$

We construct a direct measure of intermediation costs based on overhead and bank taxes instead of an indirect measure based on interest rate spreads for two reasons: (i) no other measure of intermediation costs for unsecured consumption loans only is available; and (ii) interest rate spreads contain bank profit, default risk, and "other activities" that are not relevant for our model.[8] We now focus on our measures, overhead costs and taxes over total assets.

Figure 1 panel (a) reports financial intermediaries' noninterest expenses (i.e., overhead costs) relative to total assets in the United States from 1999 to 2008. This corresponds to salaries and benefits paid by banks, as well as banks' expenditures on capital and services, such as advertising, data processing and consulting. The average value from 1999 to 2008 is 3.365 percent of total assets held by financial institutions. This is a significant amount, since, as Mehra, Piguillem, and Prescott (2009) report, the amount intermediated in 2007 was about 1.72 times the Gross Domestic Product and data from National Income and Product Accounts (NIPA) show that the value added of the financial sector as a share of

[8] We assume free entry (hence economic profit is zero), default is offset by loan loss provisions, and abstract from the "other activities" in NII (gains in foreign exchange holdings, fiduciary services, etc.)

Figure 1: Panel (a): Nointerest expenses (NIE) relative to total assets (TA) and taxes relative to total assets. Panel (b): Interest rates on financial intermediaries assets and liabilities. Source: The 2009 Federal Reserve Bulletin (Bech and Rice, 2009, page A88, table A.1).



GDP is over 7 percent. This figure also reports taxes paid by banks over total assets and the average value from 1999 to 2008 is about 0.562 percent of total assets. Therefore, the average sum of taxes and noninterest expenses of financial intermediaries in the United States is roughly 3.927 percent of total banks' assets. Panel (b) of figure 1 shows that when we consider all financial intermediaries assets and liabilities in the United States, the average value of the wedge between deposit and borrowing rates from 1999 to 2008 is over 3.5 percentage points and highly persistent, consistent with our measure.

As mentioned in the introduction, we model unsecured consumption loans, which are only a small fraction of all loans. Federal Reserve Statistical Release Table G.19 on consumer revolving credit outstanding, which excludes loans secured by real estate and other secured loans (e.g., automobile loans), shows that unsecured loans are roughly 7.7 percent of output in the United States - this is the average value from 2004 to 2008. As we shall see in the calibration, our model produces an estimate close to this number and does not overestimate borrowing. The Bewley model with a natural borrowing limit but no interest rate wedge, however, produces a much larger figure for unsecured loans. Therefore,

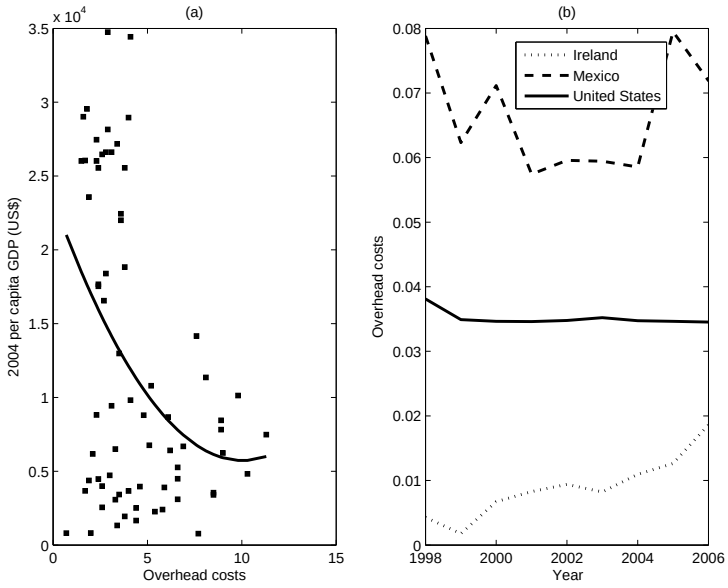
the introduction of a wedge between the deposit and borrowing rates improves the ability of Bewley models to match household consumption loan data. Furthermore, the wedge for unsecured loans is larger than for total intermediary assets and liabilities: Table G.19 shows that the average interest rate on (unsecured) credit card loans is roughly 12 percent per year, which is about 8 percentage points above the average deposit rate.[9] As a consequence, we might underestimate intermediation costs for unsecured household loans, since total assets is too broad a measure, e.g., securities and government bonds seem less likely to require the same resource expenditures as making loans to individuals.[10]

Figure 2 (a) graphs overhead costs over banks' total assets versus per capita GDP for selected countries and shows that intermediation costs measured by overhead costs are negatively related to per capita income. This is an interesting relationship, but as we made clear in the introduction this is not the focus of this article. Antunes, Cavalcanti, and Villamil (2008) and Erosa (2001) address this issue. Figure 1 (b) plots overhead costs over time for three countries and shows that on average they are roughly 6-7 percent in Mexico, 3.5 percent in the United States, and about 1 percent in Ireland. Barth, Caprio, Jr, and Levine (2006) show that differences in overhead costs across countries can be explained by banking sector policies and regulations, such as restrictions on bank entry and activities, government ownership of the banking industry and private monitoring of banks through information disclosure rules. We recognize that changing some of these policies and institutions might be difficult, since they reflect society's preferences about the role of government and there are strong vested interests behind them. However, our paper is a positive study of the quantitative impact on consumption loans and welfare of such bank policies and taxes, and the regulatory and supervisory strategies that affect bank efficiency.

[9]The wedge between deposit and loan rates is persistent in the United States. Using data for the 1980s, Díaz-Giménez, Prescott, Fitzgerald, and Alvarez (1992) show that for collateralized loans the average interest rate is nearly 4 percentage points higher than the return on bank deposits and for uncollateralized loans the spread exceeds 10 percentage points.

[10]Our estimate for intermediation costs is consistent with other sources. Data reported from Beck, Demirgüç-Kunt, and Levine (2000) show that overhead costs over total assets in the United States is 3.4 percent and Demirgüç-Kunt and Huizinga (1999) show that banks' taxes over total assets is 0.5 percent. Using these indirect sources would lead to intermediation costs of 3.9 percent. Using numbers reported by Evans and Schmalensee (1999) on the net cost of servicing accounts, Athreya (2002) sets the value of intermediation costs in the United States to be 3.4 percent, which is also close to our calibrated value.

Figure 2: Panel (a): (Overhead costs)/assets and GDP per capita. The solid line corresponds to the best second order polynomial fit. Panel (b): (Overhead costs)/assets in Ireland, Mexico and the US. Source: World Development Indicators and Database on Financial Structure and Economic Development. Updated data from Beck, Demirgüç-Kunt, and Levine (2000).



3 The model

There are three sectors in the economy: households, banking, and production. There is a continuum of infinitely-lived households, who are *ex-ante* identical and face idiosyncratic shocks to their labor productivity, but there is no aggregate uncertainty. Banks' only role is to intermediate among households, and intermediation is costly. The production technology exhibits constant returns to scale. The produced good can be used for consumption or investment. Below we describe the economy in detail.

3.1 The production sector

In any time period t, a production technology converts capital, K_t^y, and labor, N_t^y, into output Y_t according to:

$$Y_t = (K_t^y)^{\alpha}(N_t^y)^{1-\alpha}. \tag{1}$$

Parameter $\alpha \in (0,1)$ is the capital income share. Capital depreciates at rate $\delta \in (0,1)$ per period. Households competitively rent units of efficient labor and capital to firms and input rental prices are given by their net marginal productivity:

$$w_t = (1-\alpha)(K_t^y)^{\alpha}(N_t^y)^{-\alpha}, \tag{2}$$

$$r_t = \alpha(K_t^y)^{\alpha-1}(N_t^y)^{1-\alpha}. \tag{3}$$

Because the production function is homogeneous of degree one, profits are zero and firm ownership is unimportant.

3.2 The banking sector

Due to large monitoring costs agents do not write contracts directly and banks intermediate among households. Banks lend to households that wish to borrow, accept deposits from those that wish to save, and bundle small deposits together to make loans. In period t, let D_t^b be households' deposits and L_t^b be loans, with $i_{D,t}$ and $i_{L,t}$ the respective interest rates on deposits and loans. Let τ represent the tax paid on financial intermediation. We use a financial intermediation technology based on Martins-da-Rocha and Vailakis (2009). They assume that financial intermediation is labor intensive and that intermediation is remunerated by the marginal productivity of labor. Banks may also use capital. Define the intermediary technology by the following Leontief function:[11]

$$L_t^b = \eta^{-1}\min\{\nu^{-1}K_t^b, N_t^b\}. \tag{4}$$

Parameter $\eta^{-1} > 0$ measures intermediary efficiency. A small η implies that banks are very efficient in intermediation. When η goes to zero, banks do not need labor and capital to intermediate among households. Parameter ν^{-1} is the importance of capital relative to labor in the intermediary technology. Assume there is free entry into the banking sector.

[11] We calibrate ν and find that labor is about three times more important than capital in the intermediary technology, confirming Martins-da-Rocha and Vailakis (2009)'s labor intensity assumption.

The problem of the representative bank is to choose deposits, loans, labor and capital $(D_t^b, L_t^b, N_t^b, K_t^b)$ to maximize profit:[12]

$$\max\{(1+i_{D,t})L_t^b - (1+i_{D,t})D_t^b - \tau L_t^b - w_t N_t^b - r_t K_t^b\},$$

subject to

$$D_t^b \geq 0,\ D_t^b \geq L_t^b \geq 0,\ \text{and}\ L_t^b = \eta^{-1}\min\{\nu^{-1}K_t^b, N_t^b\}.$$

Free entry and competition in the banking sector imply zero profit in equilibrium. Thus,

$$i_{L,t} - i_{D,t} = \tau + \eta(w_t + \nu r_t) = \tilde{\tau}_t. \tag{5}$$

The wedge between lending and deposit rates can be decomposed into two factors:

1. intermediary taxes: τ; and
2. overhead costs: $\eta(w_t + \nu r_t)$.

Equation (5) shows that the wedge is determined endogenously by policy parameter τ, technology parameters η, ν, and factor prices.

3.3 The household sector

Households inelastically supply one unit of labor per period, and face idiosyncratic shocks to labor productivity. A household with shock $z_t \in \mathcal{Z}$ receives labor income $w_t z_t$, where z_t follow a finite state Markov process with support $\mathcal{Z}$ and transition probability matrix $\mathcal{P}(z, z') = \Pr(z_{t+1} = z' | z_t = z)$. The Markov chain generating z_t has just one ergodic set, no transient states and no cyclically moving subsets. Household preferences are defined over stochastic processes for consumption, c_t, and given by the following utility function:

$$\mathrm{E}_0\left[\sum_{t=0}^{\infty}\beta^t u(c_t)\right],\ \ \beta \in (0,1) \tag{6}$$

[12] Notice that there is no uncertainty at the aggregate level.

One-period utility, with inverse intertemporal elasticity of substitution $\theta > 0$, is

$$u(c) = \frac{c^{1-\theta} - 1}{1-\theta}\,.$$

3.3.1 The credit market and budget constraint

Agents own capital, k_t, make deposits, d_{t+1}, and get loans, l_{t+1} from financial intermediaries. A loan is a promise by a household in period $t-1$ to pay back $(1+i_{L,t})l_t$ to the bank at the beginning of period t, against the immediate delivery by the bank to the household of l_t units of final good. A deposit is a promise by the bank to deliver $(1+i_{D,t})d_t$ units of the final good at the beginning of period t against a deposit by a household of d_t units of final good during period $t-1$. Let γ_t denote lump-sum transfers.[13] Competition among banks drives interest rate $i_{D,t}$ to a level such that households are indifferent between making a deposit or investing in capital. One unit of consumption good invested in capital in period $t-1$ yields $1+r_t-\delta$ units of the consumption good in period t. If households deposit one unit of consumption good in period $t-1$, they will have available $1+i_{D,t}$ units of consumption good in period t. Therefore:

$$r_t - \delta = i_{D,t}\,. \tag{7}$$

If wedge $\tilde{\tau}_t$ is positive and agent net worth a_{t+1} is negative, then $k_{t+1} + d_{t+1} = 0$ and $l_{t+1} > 0$; likewise, $a_{t+1} > 0$ implies $l_{t+1} = 0$. Using this fact and arbitrage condition (7), the agent's budget constraint can be written as

$$c_t + a_{t+1} \leq a_t(1+i_t^*) + w_t z_t + \gamma_t\,, \tag{8}$$

where

$$i_t^*(a_t) = i_{D,t} + \tilde{\tau}_t \mathcal{I}(a_t < 0).$$

[13]The lump-sum transfers are important in the welfare calculations. We assume that intermediation costs are redistributed back to households. Therefore, welfare numbers indicate only the inefficiency generated by costly intermediation, which affects agents' ability to smooth consumption over time.

Indicator function $\mathcal{I}(a_t < 0)$ takes value 1 if $a_t < 0$ and 0 otherwise. Agent position in period t is entirely described by asset holdings and current labor shock, $x_t = (a_t, z_t)$.

3.3.2 Borrowing limit and households' problem

In order to avoid the no-Ponzi game scheme, we follow Aiyagari (1994) and consider the natural borrowing limit.[14] Aiyagari (1994) defines a "natural" borrowing limit where in an agent's worst possible state, $\underline{z}$, interest payments do not exceed labor income (i.e., current debt can at least be rolled over after a long spell of low productivity shocks). Let $\underline{z}$ be the agents' worst possible state. Then the natural borrowing limit is given by:

$$a_{t+1} \geq \underline{a}_{t+1}^{NB} = -\sum_{j=0}^{\infty} \frac{w_{t+1+j}\underline{z}}{\prod_{s=0}^{j}(1 + i_{t+1+s}^{L})}.$$

We assume a very large upper bound for assets, $\overline{a}$.[15] Define $X = [\underline{a}, \overline{a}] \times \mathcal{Z}$ and let χ be the associated Borel σ-algebra. For each $B \in \chi$, $\lambda(B)$ is the mass of households whose individual state vectors lie in B. An agent's value function depends on the current idiosyncratic state and aggregate variables such as the wage and interest rate, which are affected by the current measure λ_t. To compute this measure in the next period, households must know the current period's entire measure λ_t, and an aggregate law of motion, which we call H, such that $\lambda_{t+1} = H(\lambda_t)$. We will define $H(\cdot)$ shortly and use standard dynamic programming notation to denote future variables (e.g., $a' = a_{t+1}$ and $\lambda' = H(\lambda)$).

The value function of a household with net worth a and labor productivity z is defined by the following maximization problem:[16]

$$v(a, z, \lambda) = \max_{a'}\{u(a(1 + i^*) + wz + \gamma - a') + \beta E[v(a', z', \lambda')|z]\} \qquad (9)$$

[14] We also used an endogenous borrowing limit, as in Kehoe and Levine (1993) where agents always keep promises in equilibrium. The welfare implications of intermediation costs are roughly the same. We report only the natural borrowing limit, but endogenous borrowing limit results are available upon request.

[15] Such that if $a_t > \overline{a}$, then agents choose to decrease asset holdings, i.e., $a_{t+1} < \overline{a}$.

[16] Here we use budget constraint (8) in the one-period utility function.

subject to the natural borrowing limit[17]

$$a' \geq \underline{a}^{NB}. \tag{10}$$

3.4 Equilibrium

Let $x = (a, z)$ be the individual state vector of a particular agent. The policy function associated with problem (9) is $a' = h(x, \lambda)$. Given policy function $h(x, \lambda)$ we can compute $l' = h_l(x, \lambda)$ and $c = h_c(x, \lambda)$. Define $Q(x, \lambda, B; h)$ as the endogenous transition probability of the households' state vector, which describes the probability that a household with state $x = (a, z)$ will have a state vector lying in B next period, given current asset distribution λ and decision rule h. Therefore,

$$Q(x, \lambda, B; h) = \sum_{(h(x,\lambda),z') \in B} Pr(z' \in \mathcal{Z}|z)\,.$$

The aggregate law of motion implied by transition function Q is an object $T(\lambda, Q)$ that assigns a measure to each Borel set B, with $\lambda'(\cdot) = T(\lambda, Q)(\cdot)$, computed as

$$T(\lambda, Q)(B) = \int_X Q(x, \lambda, B; h) d\lambda\,. \tag{11}$$

[17] Since $X = [\underline{a}, \overline{a}] \times \mathcal{Z}$ is bounded, value function $v(a, z, \lambda)$ is a contraction mapping. Thus, there is a unique fixed point such that $v(a, z, \lambda)$ is the solution of (9).

The resource constraint and market clearing conditions for loans, capital and labor are

$$K = K^y + K^b \tag{12}$$

$$N = N^y + N^b \tag{13}$$

$$\int_X h_c(x,\lambda)d\lambda + K' + \tau \int_X h_l(x,\lambda)d\lambda = A(K^y)^\alpha (N^y)^{1-\alpha} + (1-\delta)K \tag{14}$$

$$\int_X h_l(x,\lambda)d\lambda = (L^b)' \tag{15}$$

$$\int_X h(x,\lambda)d\lambda = K' \tag{16}$$

$$\int_X z d\lambda = N\,. \tag{17}$$

Equation (16) takes into account that loans and deposits net out to zero. Moreover,

$$\gamma \int_X d\lambda = \tau \int_X h_l(x,\lambda)d\lambda. \tag{18}$$

Definition 1 *An equilibrium is a vector of prices (w, r, i_D, i_L) and a pair (h, H) such that: equations (2), (3), and (5) are satisfied; h is the policy function associated with (9) given H; $H(\lambda)$ coincides with $T(\lambda, Q)$; all markets clear; and (18) holds with equality.*

Definition 2 *A stationary equilibrium is an equilibrium where the probability measure λ is stationary, i.e., $\lambda(B) = T(\lambda, Q)(B)$ for all $B \in \chi$.*

4 Quantitative experiments

The purpose of the quantitative analysis is to assess numerically the impact of intermediation costs on welfare, including distributional effects. The exercises require us to calibrate the theoretical model (i.e., determine values for a set of parameters for preferences, technology, the stochastic process on labor productivity, and intermediation costs). We choose parameter values consistent with empirical observations in the United States and then perform counter-factual analysis by investigating the effects of alternative intermediation costs on the economy and welfare.

4.1 Calibration and computation

We now describe how parameter values are set. The model period is one year.

Utility and Production Technology: Risk aversion coefficient θ is set at 2.0,[18] consistent with micro evidence in Mehra and Prescott (1985). Utility discount factor β and depreciation rate δ are chosen jointly such that the real risk free interest rate is 2 percent and the capital to output ratio is 3, numbers consistent with the United States economy (see Castañeda, Díaz-Giménez, and Ríos-Rull, 2003). We obtain $\beta = 0.962$ and $\delta = 0.08$. The capital income share α is set to 0.30, which is in the range estimated by Gollin (2002).

Stochastic process on labor productivity: We follow Heathcote, Storesletten, and Violante (2008) and assume that the labor process is a composition of a permanent and a transitory component, such that:

$$ln(z_t) = u_t + \epsilon_t,$$

$$u_t = \rho u_{t-1} + \upsilon_t,$$

where ϵ_t and υ_t are drawn from identically independent distributions with mean zero and variance σ_ϵ^2 and σ_υ^2, respectively. Using United States data, Heathcote, Storesletten, and Violante (2008) estimate the persistence parameter to be equal to $\rho = 0.973$ and the average variance from 1985 to 2000 of the transitory component and stochastic component to be equal to $\sigma_\epsilon^2 = 0.0728$ and $\sigma_\upsilon^2 = 0.0176$, respectively. We use identical numbers for our labor process. We approximation each component with a Markov chain with 7 states.

Intermediation costs: We use the direct measures described in section 2 to estimate intermediation costs. Bech and Rice (2009, page A88, table A.1) show that in the United States the average non-interest expenses over assets from 1999 to 2008 is about 3.365 percent. In our model this corresponds to overhead costs, therefore $\eta(w + \nu r^K) = 0.0365$.

[18] The public finance literature has long recognized (e.g., King and Rebelo, 1990) that the welfare effects of public policies critically depend on the elasticity of inter-temporal substitution (EIS), where $\theta = \frac{1}{\text{EIS}}$. Appendix A contains sensitivity analysis with respect to parameter σ.

Table 1: Parameter values, baseline economy.

Parameters	Values	Comment/Observations
θ	2	Risk aversion coefficient based on micro evidence in Mehra and Prescott (1985)
α	0.30	Capital income share based on estimations by Gollin (2002)
β	0.962	Discount rate of utility such that real interest rate on risk free asset is 2%
δ	0.08	Capital depreciation rate such that capital to output ratio is $\frac{K}{Y} = 3$
ρ	0.973	Persistence parameter of the labor process estimated by Heathcote, Storesletten, and Violante (2008)
σ_ϵ^2	0.0728	Variance of the transitory component estimated by Heathcote, Storesletten, and Violante (2008)
σ_υ^2	0.0176	Variance of the persistence component estimated by Heathcote, Storesletten, and Violante (2008)
η	0.026	Calibrated to match banks' noninterest expenses over total assets based on Bech and Rice (2009)
ν	3.017	Calibrated to match banks' expenses on capital over banks' expenses on labor, based on Bech and Rice (2009)
τ	0.00562	Bank taxes over total assets based on Bech and Rice (2009)

They also show that expenses with occupancy (fixed assets) over expenses with salaries, wages and employee benefits is roughly 0.27 from 1999 to 2008, which implies that $\frac{\nu r^K}{w} = 0.27$.[19] This implies that in equilibrium $\nu = 3.017$ and $\eta = 0.026$. Finally, the same study reports that the average value for taxes over total assets paid by banks during the same period was 0.562 percent, which implies that $\tau = 0.00562$. The total level of intermediation costs in equilibrium is therefore equal to $\tilde{\tau} = 0.03927$.

Table 1 summarizes the parameters and how they were selected.

4.2 Baseline economy

[19]This is the ratio of $\frac{r^K K^b}{wN^b} = \frac{r^K \nu \eta L^b}{w \eta L^b} = \frac{r^K \nu}{w} = 0.27$. Noninterest expense also contains a third category (other), which includes a wide range of items that are not reported separately, such as expenses for advertising and marketing, data processing, and consulting. We assume that the ratio of expenses for capital and labor for this third category is similar to the remaining noninterest expenses. Results are not sensitive to small variations in ν.

Table 2: Selected statistics: US data and benchmark. Data for the US wealth and income distribution are from Castañeda, Díaz-Giménez, and Ríos-Rull (2003). The data on unsecured consumer debt outstanding over output are from the Federal Reserve Statistical Release, Table G.19. Percent of households with negative net worth is from the 2007 Survey of Consumer Finances.

	Capital-output ratio	Debt-output ratio	Percent of households with negative net worth	Wealth Gini (%)	Income Gini (%)	Percentage wealth in the top 1%	5%	10%	20%	in the bottom 20%	60%
US data	3.0	7.7%	6%	78	63	29.6%	54.0%	66%	79.5%	-0.4%	7.1%
Model (baseline) $\tilde{\tau} = 3.927\%$	3.0	1.3%	10%	71.6	42	10%	34%	52%	74%	-0.1%	8.4%
Model, $\tilde{\tau} = 0$ β_{baseline}	2.91	49%	44%	86.1	42	13%	43%	66%	90%	-10%	-12%
Model, $\tilde{\tau} = 0$ $\beta = 0.964$	3.0	14%	35%	80	42	12%	40%	60%	81%	-3.8%	0.4%

This section analyzes properties of the baseline economy. Table 2 reports statistics for the US and model economy. Observe that the model underestimates the wealth and earnings Gini index, but notice that in the model all inequality comes from idiosyncratic shocks to labor productivity, while in the data part is also due to observed differences in individual characteristics, such as schooling and experience. Since the model abstracts from such households characteristics, it should yield lower inequality than in the data. The model also misses the top tail of the wealth distribution. The first row of table 2 shows that in the data, the top 1 percent of households have 29.6 percent of all wealth. In the baseline model, the top 1 percent of households hold only 10 percent of total wealth.[20] The baseline model does a good job at the lower tail with households at the bottom 20 percent of the wealth distribution holding about -0.4 of total wealth in the data and -0.3 percent in the model. Households at the bottom 60 percent hold about 8 percent of all wealth in the data and 7 percent in the model.

Interestingly, the model with intermediation costs does a much better job at the left tail of the wealth distribution than the model without intermediation costs (third and fourth rows).[21] This occurs because there is much more borrowing in the model without intermediation costs than there is in the data. Some studies (e.g., Castañeda, Díaz-Giménez, and Ríos-Rull (2003) and Huggett (1993)) use an *ad-hoc* borrowing limit to match the lower tail of the wealth distribution. Our exercises show that a similar outcome can be achieved by using a positive wedge between the deposit and borrowing rates. However, the model with a positive wedge still misses the concentration of wealth in the upper tail of the wealth distribution, as in "standard" Bewley models.[22]

[20] Quadrini and Ríos-Rull (1997) and Castañeda, Díaz-Giménez, and Ríos-Rull (2003) note that this is a common feature of neoclassical growth models with heterogeneous agents and uninsurable idiosyncratic shocks to earnings. Quadrini (2000), for instance, shows that entrepreneurs accumulate more assets because they face risk associated with business activities and higher returns on savings than workers. Therefore, entrepreneurs play an active role in shaping the top tail of the wealth distribution.

[21] The difference between the third and fourth rows is the following: In row three, we use all parameters of the baseline economy reported in Table 1, except for $\tilde{\tau}$, which we set to zero (i.e., $\tau = 0$ and $\eta = 0$); in row four, we also set $\tilde{\tau}$ to zero, but we adjust the subjective discount factor such that the capital to output ratio is similar to the one in the baseline economy.

[22] When parameter ρ in the stochastic process for labor productivity is smaller than the 0.97 value we use, the fit of the wealth distribution improves. However, the labor process is usually very persistent, sometimes approaching a unit root.

In our model, banks play a standard role: they accept deposits and make loans to households. Because the loans in the model are unsecured, these bank assets correspond to a small fraction of all loans in the data. It is important that we do not overestimate such loans in our baseline economy, otherwise, we might overestimate the effects of intermediation costs on welfare. Section 2 reports that consumer revolving credit outstanding, which excludes loans secured by real estate and other secured loans (e.g., automobile loans), is roughly 7.7 percent of output in the United States. In our baseline model, the ratio of unsecured debt to output is about 1.3 percent. In the model without intermediation costs, outstanding unsecured consumer debt is roughly 49 or 13 percent of output, depending whether we adjust or not the subjective discount factor to match the capital to output ratio (see table 2). In addition, data from the 2007 Survey of Consumer Finances (SCF) show that roughly 6 percent of all households have negative net worth. In our baseline economy about 10 percent of households have a negative asset position. However, in the data due to, for instance, liquidity issues, some households with positive net wealth also rely on unsecured debt to smooth consumption and shocks. In fact, according to the 2007 SCF roughly 46 percent of all households have outstanding credit card debt. Therefore, our model does not seem to overestimate unsecured consumer lending.

In summary, a change in intermediation costs has two effects: a direct effect on the cost of borrowing and an indirect effect through general equilibrium price adjustments. When intermediation costs are reduced, for a given interest rate, the net borrowers' consumption possibility frontier expands, since it is cheaper to borrow to smooth consumption over time. Even net savers might be affected by this direct effect, since in period t they face a positive probability of becoming a net borrower in the future. In addition to this direct effect, there is an indirect one: lower intermediation costs imply an increase in the demand for loans, and therefore the interest rate rises. This affects all agents, increasing borrowing costs and the return on deposits, and implies a fall in the capital to output ratio and wages. Wealth becomes more unequal. See rows two and three of table 2.

We focus solely on the effects of intermediation costs on unsecured consumption

borrowing and abstract from entrepreneurial activities. Thus, changes in intermediation costs have relatively small effects on long run output. Results might be different if entrepreneurs are credit constrained and intermediation costs affect their ability to borrow. Antunes, Cavalcanti, and Villamil (2008), for instance, show that intermediation costs have a negative effect on entrepreneurial productivity and output even when the interest rate is endogenous. When entrepreneurs rely on bank loans to produce (rather than retained earnings or personal funds), intermediation costs may decrease firm size and productivity.

4.3 Welfare

4.3.1 The United States

We now analyze the quantitative welfare implications of intermediation costs in the United States. We measure the welfare implications by the average permanent consumption supplement (e.g., Lucas, 1987) that makes households in an economy with benchmark intermediation costs (3.927 percent) as well off as in an economy with no intermediation costs. If intermediation costs were zero, banks would not need to use labor and capital to intermediate among households.[23] We also evaluate the case in which intermediation costs are reduced but still positive.

One caveat is important: In evaluating the welfare effects of intermediation costs we cannot focus on steady-state equilibria. The median agent, for instance, in the initial stationary distribution is not necessarily the same median agent in the final stationary distribution, and this is true for all agents ranked according to the wealth distribution. There is social mobility in the economy and comparing value functions of two different steady-states for agents at the same point of the wealth distribution might be misleading. We calculate each agent's value function considering the transition from one steady state to another. This guarantees that we are evaluating the welfare of the same agent with

[23] We set $\tau = \eta = 0$. This experiment approximates the smallest overhead cost of 0.2 percent observed in the sample, in Ireland in 1994 (see Beck, Demirgüç-Kunt, and Levine, 2009) and provides a check on our model (i.e., $\tau = 0$ shuts down the wedge friction and returns us to the "standard" Bewley model).

and without a policy change.[24] Also, τL is redistributed back to households as a lump-sum transfer, isolating the effect of the inefficiency generated by costly intermediation on welfare, which affects agents' ability to smooth consumption over time.

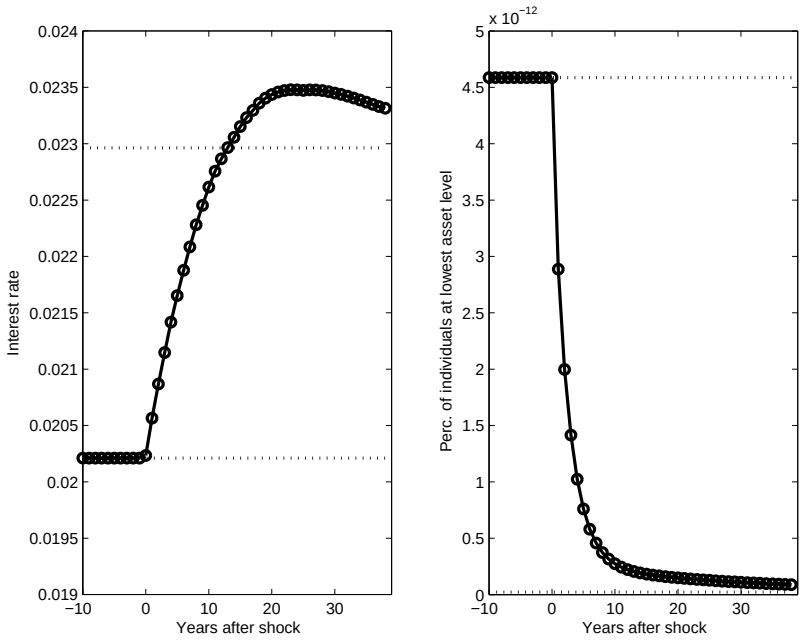


Figure 3: Transition from baseline economy ($\tau = 3.927\%$) to an economy with zero intermediation costs. Left graph: Interest rate. Right graph: Percent of individuals at lowest asset level.

The left graph in figure 3 plots the adjustments of the interest rate from the baseline economy to an economy with no intermediation costs. As discussed previously, the interest rate rises when intermediation costs decrease because of higher demand for unsecured loans. The right graph in figure 3 shows the percentage of individuals with the lowest asset level. This is the group of households that are credit-constrained. When $\tilde{\tau}$ decreases, the borrowing rate decreases, which makes borrowing constraints less tight. This implies that the percentage of households at the lowest asset level decreases and with a zero intermediation cost, this percentage is almost null.

Figure 4 displays a three dimensional graph of the welfare gains of decreasing intermediation costs from 3.927 percent to 0. The welfare gains are on the *z-axis*, while the

[24] If the transition from one stationary equilibrium to another is fast, one might abstract from transitional effects. However, the graph on the left in figure 3 shows that it takes about 12 years for the interest rate to reach about 85 percent of the distance between the first and the second steady-state values.

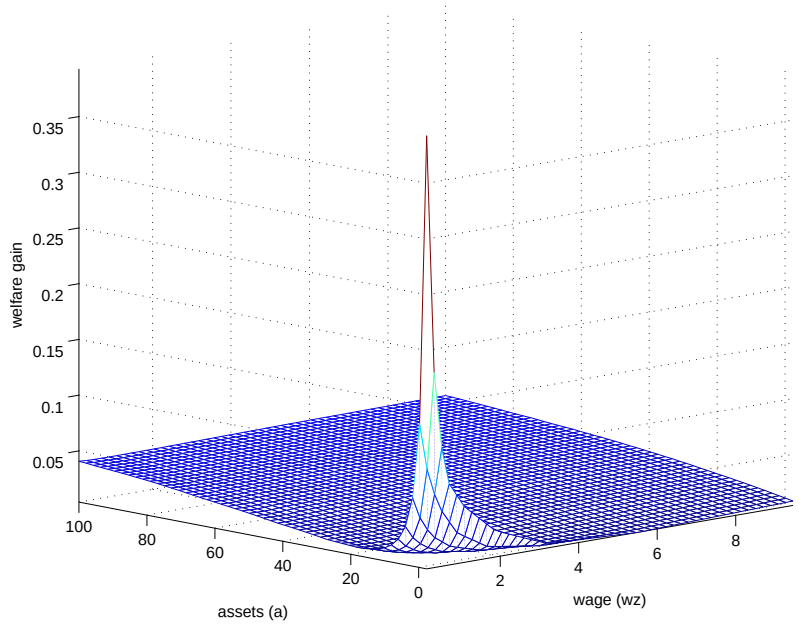


Figure 4: Distribution of welfare gains: change intermediation costs from 3.9% to 0%

x-axis and *y-axis* contain the labor shocks (wz) and agent net worth (a), respectively.[25] Qualitatively, all agents have positive welfare gains. Borrowing costs are lower since the lending rate decreases from 5.95 to 2.29 percent. This increases the ability of agents to smooth consumption over time, which increases welfare not only in the lower tail of the wealth distribution, but even for agents with positive net worth.[26] Additionally, a higher interest rate increases income from deposits,[27] which increases welfare in the upper tail of the wealth distribution. In the lower tail of the asset distribution, as productivity shocks improve, welfare gains are reduced. In the next section we will decompose the overall welfare effect of intermediation costs into a direct effect and a general equilibrium effect.

Quantitatively, the welfare gains are larger for agents with negative net worth and persistently bad labor productivity shocks. Table 3 part (a) reports the average welfare gain per income percentile. For agents at the bottom decile of wealth, average welfare gains from reducing intermediation costs from 3.927 to 1 percent are roughly 7 percent

[25] We use the shocks and the net worth of the each agent in the period before the policy change.

[26] There is a positive probability that an agent with positive wealth might experience negative labor shocks resulting in negative net wealth.

[27] The deposit interest rate increases from 2.02 to 2.29 percent.

Table 3: Welfare effects: United States

		Average welfare gain				
	Average welfare	Wealth percentile				
	gain	10%	25%	50%	75%	90%
Benchmark, $\tau_b = 3.927\%$						
Part (a): *Endogenous interest rate*						
τ = 0%	2.05	7.02	3.17	0.60	0.25	0.72
τ = 1%	1.14	3.96	1.73	0.41	0.21	0.35
Part (b): *Exogenous interest rate*						
τ = 0%	2.97	7.83	4.38	1.66	0.53	0.18
τ = 1%	1.90	5.87	3.07	1.18	0.49	0.2

of baseline consumption. However, welfare gains are substantial even for agents at the top of the wealth distribution. At the top decile, the average welfare gains are about 0.72 percent of baseline consumption, which is higher than the average welfare gains of those at the top 25 percent of wealth. The average welfare gains for households with the median level of wealth is roughly 0.60 percent of baseline consumption.

Table 3 reports an average welfare measure, a weighted average of the welfare gains of all agents in the economy,[28] which is about 2.05 percent of consumption equivalent of the baseline economy when $\tilde{\tau}$ decreases to 0 percent, a substantial measure. We also calculate the welfare gains for the case when intermediation costs decrease to 1 percent instead of 0 percent.[29] In this case, we decrease τ from its baseline value of 0.562 percent to 0 and change η, such that overhead costs over total assets ($\eta(w + \nu r^K) = 0.01$) is equal to 1 percent.[30] This is similar to a boost in productivity in the intermediary sector.

[28]We could instead calculate an "aggregate value function" as a weighted average of the value function of each agent. Then, we could calculate the aggregate consumption equivalent for the baseline economy and for the economy after the policy change. The welfare gains in this case are somewhat larger, so we use the method described in the text. For instance, the aggregate welfare gains using this alternative measure is about 3.88 percent when τ decreases from its baseline value to zero.

[29]Data from Beck, Demirgüç-Kunt, and Levine (2009) show, for instance, that from 1993 to 2006 the average overhead costs over total assets was less than 1 percent in Ireland. Moreover, the average value for the 10 percent of countries with the smallest cost is 1.1 percent.

[30]We could also keep τ at its baseline value and change η such that $\tau + \eta(w + \nu r^K) = 0.01$. Results are roughly the same.

Results are reported in row two of table 3, part (a). Welfare gains are not as large as when intermediation costs decrease to 0 percent, but they are still substantial. The average welfare gain is about 1.14 percent of consumption equivalent to the baseline and welfare effects are large in the lower tail of the wealth distribution. The bottom decile of wealth has an average welfare gain of 3.96 percent of consumption equivalent.[31]

Welfare decomposition

As explained previously, there are two effects on welfare after a change in intermediation costs: A direct effect and a general equilibrium one. Here we decompose the welfare change into these two effects. For a given interest rate, when intermediation costs decrease households' ability to smooth consumption over time improve. There is also an indirect effect on price adjustment since lower intermediation costs increase the demand for loans and therefore the interest rate. Such adjustments offset in part the benefits of lower intermediation costs for those with negative net wealth, but they increase interest income for those in the upper tail of the wealth distribution.

Table 3 part (b) reports the welfare gains from reducing intermediation costs for an exogenous interest rate. At the aggregate level, welfare gains are about 45 and 60 percent larger for an economy with an exogenous interest rate than than for an economy with endogenous price adjustments when intermediation costs decrease from the baseline value to 0 and 1 percent, respectively. Figure 5 shows the average welfare gain for each asset value when the interest rate is exogenous (dotted line) and endogenous (solid line), and intermediation costs decrease from the baseline level to zero percent. For the lower tail of the wealth distribution, welfare gains are larger when the interest rate is exogenous, but for the right tail of the wealth distribution, due to higher interest income, welfare gains are larger for the endogenous interest rate case. The two effects are quantitatively significant. Therefore, as in Antunes, Cavalcanti, and Villamil (2008) and Castro, Clementi, and MacDonald (2004), policy reforms aimed to improve intermediary efficiency would have stronger impacts on economies open to financial capital flows.

[31]The results depend on the coefficient of risk aversion, as shown in Appendix A.

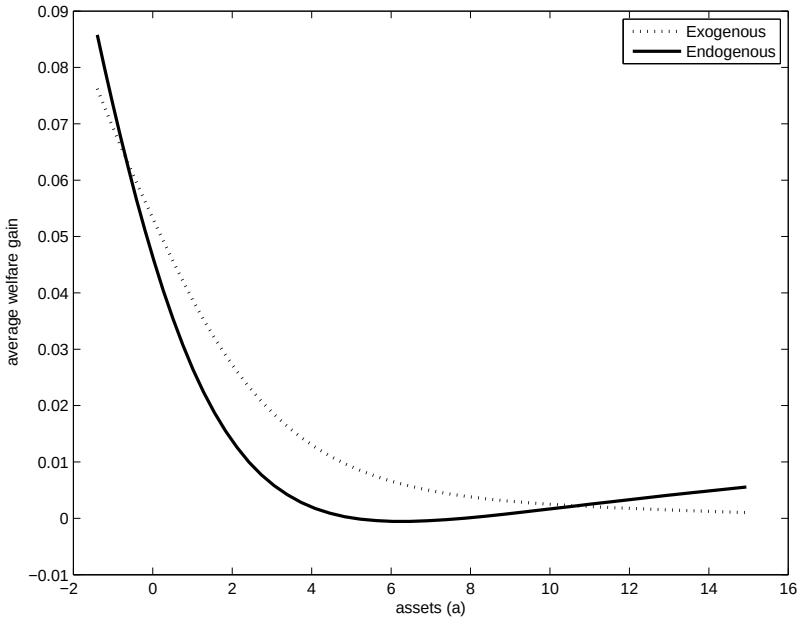


Figure 5: Average welfare gain per asset value from changing intermediation costs from 3.927 to 0 percent. Black solid line: Endogenous interest rate; Dotted black line: Exogenous interest rate.

4.3.2 Mexico

We now investigate the effects of a reduction in intermediation costs in an emerging market economy, i.e., Mexico. We set parameter values such that they are consistent with the Mexican economy. First, we keep the value of the following parameters as in the United States economy: risk aversion coefficient, $\theta = 2$, capital income share, $\alpha = 0.3$, and depreciation rate, $\delta = 0.8$.[32] We calibrate the discount factor, such that in equilibrium, the capital to output ratio in the model is roughly that in the data.[33] It remains to tie down the parameter values for the labor process and the intermediation technology.

In Bewley models, calibrating parameters that are consistent with an emerging market economy is difficult because one must find a reliable estimate of the idiosyncratic labor

[32]Bergoeing, Kehoe, Kehoe, and Soto (2002) use the same capital income share for the Mexican economy. As Gollin (2002) shows, the capital income share does not vary much across countries. The value of the depreciation rate does not change the results much; see Appendix A for sensitivity analysis of the risk aversion coefficient.

[33]From the Penn World Tables in Heston, Summers, and Aten (2006), we construct the capital to output ratio in Mexico and show it is about 20 percent lower than what is observed in the United States, which implies that $\frac{K}{Y} = 2.4$.

process for such economies.[34] In a recent article, Krebs, Krishna, and Maloney (2009) estimate the income process for the Mexican economy. As in our process, they assume that the labor process is the sum of a permanent component and a transitory component. The risk parameter of the persistent component for the Mexican economy is equal to 0.032, so we assume that $\sigma_{\upsilon}^2 = 0.032$. They estimate a large variance for the transitory component and argue that there is a lot of measurement error in the data.[35] Given that we do not have an unbiased estimator for this parameter, we keep it similar to the value of the United States economy, such that $\sigma_{\epsilon}^2 = 0.0728$. Finally, their permanent component is a random walk process, while we assumed a stationary process. Since it is very challenging to distinguish between a unit root and a very persistent stationary process in a short panel, we let the persistence parameter be identical to our previous value, such that $\rho = 0.973$.[36]

For the intermediation technology, Beck, Demirgüç-Kunt, and Levine (2009) report that the average banks' overhead costs over total assets from 1992 to 2007 in the Mexican economy was about 6.2 percent and Demirgüç-Kunt and Huizinga (1999) report that tax over total assets for the Mexican economy is 0.3 percent. Then $\eta(w + \nu r^K) = 0.062$, and $\tau = 0.003$, with $\tilde{\tau} = 0.065$. We also assume that the ratio of capital and labor used in intermediation in Mexico is similar to that of the United States, such that $\nu = 3.017$. Given that, the implied value for parameter η in equilibrium is 0.0541, which implies that banks in the United States are about twice more efficient than banks in Mexico. In equilibrium, the baseline deposit real interest rate is equal to 4.37 percent,[37] and the loan interest rate is equal to 10.87 percent.

Table 4 reports our aggregate welfare gains as well as the distributional welfare effects from decreasing intermediation costs from the baseline Mexican level of 6.5 percent to 0 and 1 percent, and also to the United States level of 3.927 percent.[38] Firstly, we observe

[34] A recent volume of the *Review of Economic Dynamics* provides labor process estimates for different countries. See Krueger, Perri, Pistaferri, and Violante (2010).

[35] Gorodnichenko, Peter, and Stolyarov (2010) estimate an even larger variance for Russia for both the transitory and permanent components.

[36] In a related paper, Kaplan and Violante (2009) show in a similar model to ours that when $\rho = 0.97$ the insurance coefficient for persistent shocks in the Bewley model is consistent with its empirical counterpart.

[37] This implies that the rental price of capital is 12.37 percent.

[38] In all simulations, we set $\tau = 0$ and changed η to match the required value for intermediation costs.

Table 4: Welfare effects: Mexico

	Average welfare gain	Average welfare gain Wealth percentile					Debt to output ratio	% of agents with neg. net worth
		10%	25%	50%	75%	90%		
Benchmark, $\tau_b = 6.5\%$							0.27%	3.19%
Part (a): *Endogenous interest rate*								
τ = 3.927%	0.05	0.98	0.07	0.01	0	0.01	0.37	4.13
τ = 1%	0.34	2.66	0.84	0.03	0.02	0.10	3.34	22.21
τ = 0%	0.53	3.68	1.46	0.01	0.00	0.13	5.77	30.07
Part (b): *Exogenous interest rate*								
τ = 3.927%	0.07	1.02	0.11	0.01	0.00	0.00	0.38	4.15
τ = 1%	0.52	3.13	1.32	0.20	0.06	0.00	4.00	23.72
τ = 0%	0.69	4.11	1.89	0.17	0.00	0.00	5.87	30.69

that the welfare effects of intermediation costs on welfare are not linear. When we change intermediation costs from the Mexican value to the United States level, average welfare increases by 0.05 percent of consumption equivalent to its baseline level. When intermediation costs decrease further to 1 and 0 percent, average welfare increases by 0.34 and 0.53 percent in equivalent consumption, respectively.

Surprisingly, the welfare values are much lower in magnitude than for the United States. For high intermediation cost values, agents avoid borrowing to insure against income shocks. Total consumption debt is only 0.27 percent of income and only 3 percent of all households rely on borrowing to smooth consumption when intermediation costs are equal to 6.5 percent. Given the high cost of borrowing, agents accumulate assets to self-insure against productivity shocks. Therefore, the direct effect of a reduction in intermediation costs affects only a few households at the bottom of the wealth distribution (see part (b) of table 4). For such households welfare effects are still substantial. For instance, when intermediation costs decrease from the Mexican baseline level to 0 percent, welfare increases by 3.68 percent of consumption equivalent to the baseline level for

agents at the bottom 10 percent of the wealth distribution. Although average welfare gains from reducing intermediation costs are not substantial in Mexico, the distributional impacts are large.

5 Concluding remarks

This paper developed a neoclassical growth model in which agents face uninsurable idiosyncratic shocks to labor productivity, a natural borrowing limit and costly financial intermediation. Intermediation costs generate a wedge between the loan and deposit rate. We calibrated the model to match key statistics of the United States economy and performed counter-factual experiments. Reducing intermediation costs leads to two effects. For a given interest rate, borrowing costs decrease. There is an expansion in the net borrowers' consumption possibility frontier, and even households with positive net wealth can benefit because they may need to borrow in the future to smooth consumption. There is also an indirect effect: lower intermediation costs imply an increase in the demand for loans, and therefore the interest rate rises. Such price adjustments offset part of the decrease in borrowing costs and increase interest income.

Quantitatively, we show that the welfare implications of intermediation costs for the United States are large. The average welfare gain from reducing intermediation costs from 3.927 (the US level) to 1 percent (the 10th percentile of countries with the smallest overhead costs) corresponds to about 1.14 percent of consumption equivalent of the baseline economy when the interest rate adjusts and 1.90 percent for a small economy integrated in the international financial market, substantial welfare measures. We also show that there are important distributional effects. For agents at the bottom decile of wealth, welfare gains are about 3.96 (5.87) percent of consumption equivalent when the interest rate is endogenous (exogenous). At the top decile of wealth welfare gains are 0.35 and 0.2 when the interest rate is endogenously and exogenously determined, respectively.

For an economy with larger intermediation costs such as Mexico, the welfare effects

of reducing intermediation costs are smaller than for the United States. The reason is that when the spread between deposit and borrowing rates is large, households avoid borrowing to insure against idiosyncratic income fluctuations. Instead, they accumulate assets to smooth consumption through self-insurance. Therefore, the direct effect of intermediation costs is relatively smaller. But for those households in debt, welfare gains of reducing intermediation costs are still large.

Our Bewley model with an interest rate wedge also provides insight into the "standard" workhorse Bewley model. We have shown that the wedge allows us to better match other dimensions of the consumption data and the lower 60 percent of the wealth distribution. The model continues to miss the upper tail when the labor productivity process is highly persistent.[39] We also check sensitivity to to the coefficient of risk aversion and find that welfare is much lower when σ approaches unity. The reasons are two-fold: First, there is less preference for consumption smoothing when $\sigma = 1$. Second, in equilibrium there is less borrowing and the direct impact of a reduction in intermediation costs affects fewer households.

Finally, our exercises show that policies aimed to reduce financial sector taxes and inefficiency, such as those related to bank entry restrictions, government ownership of banks, regulatory and supervisory institutions, and taxes, can have a large impact on consumption loans and household welfare, especially for poor households. Why then, do we continue to see high intermediation costs in some countries? Souza-Sobrinho (2010), for instance, provides an excellent analysis of a credit policy in Brazil that leads to high intermediation costs, and notes that vested interests make it difficult to eliminate the program. More generally financial sector reform might enhance competition, leading incumbents to block reforms that improve the functioning of financial markets (see Aghion, Burgess, Redding, and Zilibotti (2008), and Rajan and Zingales (2003)). We leave the political economy of financial reform for future research, but note its importance.

[39] This result is sensitive to the specification of the labor productivity process.

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A Risk aversion coefficient sensitivity

Lucas (1987) uses logarithmic utility, $\sigma = 1$, to calculate the welfare gains from eliminating all consumption fluctuations. As noted by several authors, Lucas' result is sensitive to the functional form for preferences (see, for instance, Otrok, 2001). In addition, it has long been recognized in the public finance literature (e.g., King and Rebelo, 1990) that the welfare effects of capital income taxation critically depend on the elasticity of intertemporal substitution (EIS), where $\sigma = \frac{1}{\text{EIS}}$. We investigate the welfare implications of intermediation costs when the utility function is logarithmic.[40] We re-calibrate parameters β and δ, such that, as in the baseline economy in table 1, the real risk free interest rate is 2 percent and the capital to output ratio is 3. The new values for β and δ are 0.9738 and 0.08, respectively.

Table 5 displays the welfare effects of intermediation costs when $\sigma = 1$. When τ decreases from 3.927 to 1 percent, average welfare gains are only 0.1 percent of consumption equivalent to the baseline economy. This is much smaller than when $\sigma = 2$. Agents at the bottom decile of wealth would still have an increase in welfare of roughly 0.61 percent of the consumption equivalent to the baseline. At the upper tail of the wealth distribution, welfare gains are positive but small. Notice that welfare gains in the lower tail of the wealth distribution are much higher for the case of $\sigma = 2$ than when $\sigma = 1$. When σ decreases agents are less risk averse and the cost of consumption fluctuations decreases. The direct effect is less important for smaller σ. Also, with a smaller σ, there is less borrowing and the direct channel of a reduction in intermediation costs affects fewer households than when σ is equal to 2. In fact, we can observe in tables 3 and 5 that, when the interest rate is exogenous, welfare gains are much smaller when $\sigma = 1$ than when $\sigma = 2$.

[40] Logarithmic utility is often used in macroeconomics due to its analytical properties. There is a large literature on empirical estimates of the EIS with a range of estimates. Individual data estimates tend to be higher (higher than 2) than aggregate data/time series estimates (lower than two and close to one). See Guvenen (2006) for a discussion.

Table 5: Welfare effects: Log-utility

	Average welfare gain	Average welfare gain Wealth percentile					Debt to output ratio	% of agents with neg. net worth
		10%	25%	50%	75%	90%		
Benchmark, $\tau_b = 3.927\%$							0.87%	8.66%
Part (a): *Endogenous interest rate*								
τ = 1%	0.1	0.61	0.27	0.01	0	0.01	16.74	36.41
Part (b): *Exogenous interest rate*								
τ = 1%	0.31	1.30	0.92	0.17	0.01	0	16.80	36.60