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Abstract

The paper studies the impact of income inequality on the monetary policy and the feedback, in a partial equilibrium framework. Wealth differences of depositors play crucial role in determining aggregate deposits, available for loans. Non-homothetic structure of depositors' return function makes distribution of deposits relevant for the aggregate. Unequal distribution of resources leads to a lower (deposit) price elasticity for the rich relative to the poor, and this results in higher markups and lower level of collected total deposits. Interaction between monetary policy and income inequality leads the following results: (i) higher inequality reduces the power of monetary policy in terms of depositors' responsiveness to the policy changes and (ii) expansionary (contractionary) monetary policy increases (decreases) savings differences.

The model provides a new source of financial friction, relevant for economies with high income inequality.

Keywords: Deposit holdings inequality, non-homothetic technologies, monetary policy.

JEL code: D31, D43, E52, G21.

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Introduction

The issue of income inequality is at the heart of macroeconomics, and its implications in financial markets are worth exploring. In this paper I provide a theoretical model which demonstrates how depositors' income inequality may determine economic outcomes in a partial equilibrium context. A sufficiently high income inequality among depositors leads to optimal policy adjustments from the banks' side, and this crucially changes the nature of equilibrium relations. I also discuss the effectiveness of the monetary policy in its very simple design, when inequality is high enough to be relevant.

In the standard monetary economics literature, thanks to homothetic preferences and technologies, income differences do not have any impact on macroeconomic outcomes, and their decisions can be viewed as if they have been generated by a representative household. The literature extensively uses constant elasticity of substitution form of preferences (Dixit and Stiglitz (1977)) which exclude any impact of heterogeneity on the aggregated average outcome, as these forms yield linear Engel curves and preserve constant ratio of goods for both rich and poor. Consequently, the structure of demand functions are identical and the aggregated demand does not hinge on the distribution of endowments. Despite the consistent use of homothetic preferences, which are very handy for technical manipulations, empirical evidence rejects this assumption (Deaton and Muellbauer (1980)), asserting that income heterogeneity *does* have an impact on consumption choices.

In order to analyze the impact of income heterogeneity among depositors on the financial market and the monetary policy, I use the model framework by Foellmi and Zweimuller (2011) (henceforth FZ for these subsequent papers), in which the authors provide a channel by which income inequality affects the industry structure and unemployment. They solve a general equilibrium model to study the interaction between market power and income inequality, and non-homothetic structure of the return function[1] and increasing price elasticity are crucial

[1]FZ have non-homothetic preferences, while in our model we have depositors' of non-homothetic return function.

for the obtained results.

Relevance of inequality for macroeconomic outcomes stems from the fact that agents, heterogeneous in wealth, have different demand elasticities. High (deposit) price elasticity for the poor relative to the rich, together with non-homothetic return function, implies different structures of demand. Given the type of an agent, rich or poor, price elasticity is increasing due to a linear demand, but the elasticity for the poor is high because of smaller slope. Finite marginal return at zero implies that poor agents will find some deposits not enough attractive to buy (the repayment rate will be too low) and they will be excluded from these deposit markets, implying that there will be banks that will issue deposits only for the rich. The underlying mechanics of exclusion is directly grabbed from FZ and adjusted for deposit markets. That I have partial equilibrium model, makes my solution significantly different from that of FZ's model[2], and the results are extended for policy implications.

In the model banks' activities essentially involve three financial markets, deposit, loan and funds borrowing from the central bank. It turns out that the optimal policy rules in deposit and loan markets can be derived in a separate manner and the link between these rules is determined by the central bank's policy rate, as a linear combination of the repo and the reserve requirement rates. There is deposit production and hence a price for deposit, and the bank optimally chooses the quantity of deposits that are eventually transformed to loans.

The devise I put forward is a simple analogy between love for variety of consumers and the diversification motive of investors. Modeling desirability for variety of goods goes back to Hoteling (1929), and much later to Lancaster (1975). A relatively recent approach by Dixit and Stiglitz (1977) have been extensively used in DSGE models. Markowitz (1952) model on optimal portfolio selection, based on diversification motive, on the other hand, is the baseline model for the capital asset pricing model (CAPM) literature. That is, diversification of choices lies both at the heart of economics and finance theories. In my model, I discuss

[2]The arguments, I bring to prove the propositions, also appeared in FZ, are mostly different from those in FZ.

symmetric banks, and, importantly, for such equilbiria it is straightforward to check that the optimal (deposit) portfolio allocation coincides with the mean-variance structure implied allocation. I model deposit contracts, in which the price of the contract is implicitly payed by depositors[3]. In order to explicitly account for the fact that investors have different, *subjective* perceptions of these costs due to savings (wealth) differences, I deviate from the standard portfolio selection approach.

The main findings in the model are as follows. For sufficient level of inequality exclusion emerges. Under the exclusion regime there are banks that sells deposits only to the rich with lower demand elasticity and the result is lower level of collected deposits and higher markups for banks. Higher inequality leads to more exclusion and less total deposits, as banks exercise their monopoly power more intensively. Thus we replicate the results by FZ, for financial markets in the partial equilibrium context. These results hinge on non-homothetic structure of the objective function, finite marginal return at zero and increasing (deposit) price elasticity. These properties come naturally, when modeling agents' deposit return function.

I also discuss the influence of inequality on monetary policy and the converse - how *real* savings inequality are affected by the monetary policy. This type of two sided exercise is possible, since both *nominal* wealth distribution and the policy rate (repo) are exogenous to the model. First, the higher is inequality, the lower is the power of monetary policy. Contractionary monetary policy increases deposit rate for both exclusive and mass deposits, which increases total deposits. Higher inequality will distort a part of growth in total deposits, since higher exclusion that occurs implies that less bank will produce for the mass, who buy more deposits from a given bank and have higher elasticity. In case of expansionary monetary policy, substitution of private deposits with the Central Bank's funds will be less effective, since we will have less exclusion and more banks will sell to the mass. Thus, inequality attenuates the effectiveness of monetary policy, since in average depositors are

[3] The rate of deposit repayment is net of this cost.

less responsive to the latter. Contractionary monetary policy in its turn mitigate savings differences in terms of real assets. As the poor is more elastic to a price change, she will buy more deposits with lower price (higher deposit rate) than the rich, and the resulting savings differences will decrease net of interest payments. As deposit rate is lower for the mass, interest payments will further equalize agents' asset holdings. The converse is observed when the Central bank decreases the policy rate (repo rate minus reserve requirement rate) - income inequality deepens and the poor suffers from expansionary policy, as far as it concerns her savings invested in deposits.

The paper has the following structure. I provide the literature review in Section 1. Section 2 describes the model. Two types of equilibria, symmetric versus asymmetric, are characterized in Section 3. Monetary policy implications are stated in Section 4. I discuss the significance of the model and directions of possible extensions in Section 5. Then concluding remarks follow. Most of the proofs are relegated to Appendix.

1 Review of literature

The interaction of income inequality and financial markets is by no means a delicate issue. The streamline of monetary economics literature neglects any impact of consumer heterogeneity on aggregated variables like consumption and investments, and hence on the monetary policy rule, instead motivating the non-neutrality of financial sector assuming price stickiness and monopolistic competition in the supply side. The New Keynesian DSGE macro models, based on price staggering of Calvo (1983) type and monopolistic competition due to Dixit and Stiglitz (1977), have become a standard framework for monetary analysis. Relatively early development of this literature is effectively analyzed in Clarida et al. (1999). Another paper by the same authors (Clarida et al. (2001)) and Gali and Monacelli (2005) provide open economy extensions for these models. Comprehensive treatments of this literature, addressing both theory and policy issues, are provided by Walsh (2010). Another strand of the literature starts from the seminal work by Bernanke et al. (1998), incorporating different types of financial imperfections into otherwise standard models. They argue that due to complex nature of financial contracts, the movements in the real economy are propagated by the financial sector (financial accelerator). The very recent literature incorporates housing into that model framework (see e.g. Iacoviello (2005) and Andres and Arce (2009)) and, in addition, assume monopolistic competition in deposit and loan markets (Gerali et al. (2010)). All these models stay within the paradigm of the representative agent, and the literature, though very numerous, have essentially circumvented the income heterogeneity problem.

Within the class of non-homothetic preferences economic research distinguishes at least two types: hierarchic and symmetric preferences. In the case of hierarchic preferences needs are ordered and if the consumer has additional income, she will first buy a good with higher priority. In symmetric preferences goods are identical in terms of priority and additional income will be spent only accounting for relative prices. For both cases some goods may not be spent if the price will be too high. Hierarchic preferences has been used by e.g. Murphy et al. (1989), who analyze the impact of inequality on the industry structure. A chapter by Bertola et al. (2006) is devoted to hierarchic preferences. Symmetric non-homothetic preferences have been used by FZ, and though there is no ordering of goods according to priorities, non-homotheticity and finite marginal utility at zero make inequality relevant for macroeconomic outcomes, independent from goods ordering. In the model I have a symmetric type of non-homothetic return structure and will discuss its properties in detail, keeping it parallel with FZ, whenever applicable.

In fact, homothetic structures do not exclude possibility of feedbacks from a policy rule to income distribution - it only ensures irrelevance of inequality for the aggregate, as a target variable for policymakers. In what follows, policy implications for inequality remains relevant regardless of preference types, and still there are only few papers that explore the impact of monetary policy on inequality and the feedback. Romer and Romer (1999) provide empirical findings for effects of monetary policy on income distribution in the short and long run. They distinguish at least three channels by which expansionary monetary policy positively influences the well being of the poor in the short run: (i) a temporary increase of average income reduces poverty[4]. (ii) the poor are more eager to substitute labor with leisure when there are more employment opportunities[5] and (iii) if the poor are net nominal debtors, they will benefit from unexpected inflation.These channels, however, create only temporary effect and monetary policy cannot generate permanent effect. The authors' conclusion for the long run is that low inflation and stable aggregate demand ensure more favorable conditions for the poor.

More recently, Fowler and Wilgus (2008) study two-side interaction between monetary policy and inequality in a calibrated DSGE model. These authors assume agent heterogeneity in terms of workers and capitalists, following to Judd (1985) and Krusell (2002). They discuss different specifications for the monetary policy rule as a function of inequality and replicate cyclical fluctuations in the U.S. economy. In particular, they find that the lagged Gini coefficient positively affects the current level of monetary policy. The model is highly stylized with respect to transfers, which are supposed to capture distributional effects of inflation absent in the model. They also stress the importance of agent heterogeneity in theoretical models in the context of "jobless recovery"[6], as dynamic optimal monetary policies take it into account as a distributional phenomenon that is missing in representative agent models.

The above mentioned papers discuss monetary policy effects on income distribution and the feedback in a general equilibrium context and derive these effects from primary earnings in the real sector. That is, the income distribution changes are due to consequences of monetary policy in the production process, while inequalities may arise from differences in savings, optimally chosen from intertemporal consumption/investment choice. Saving

[4]One has to distinguish the concepts poverty and inequality. A typical measure of poverty is the fraction of population below a poverty line, while a common measure of inequality is Gini coefficient.

[5]This is adversely affected by transfers that the poor receives in the period of recession, when expansionary monetary policy takes place.

[6]See Bernanke (2003).

differences stem from wealth differences and it comes natural to suppose that the rich will save more than the poor in absolute values, so that the status ordering will be preserved[7]. The aim of this paper is to analyze short run, direct consequences of savings inequality both on the financial and real sectors of an economy, isolated from factor income inequalities, amplified/mitigated due to initial inequalities and conducted economic policy. Thus we do not close the chain and study a partial equilibrium model. The essential aspect of my novelty is that homothetic structure of depositors' return function, which makes savings inequality relevant for outcomes and policy, comes from risk diversification, when depositors invest their wealth in deposits. There is nonzero probability that a given bank will default and therefore an agent buys deposits from many banks. When modeling a return function that accounts for risk diversification, it naturally turns to be non-homothetic and in effect savings inequalities generate real effects in an economy.

In general, these results have no comparison base with the findings in the literature. For instance, both Romer and Romer (1999) and Fowler and Wilgus (2008) independently find that expansionary monetary policy improves the well being of the poor. My finding in this context is opposite, but not much compatible, since I analyze savings distribution contrary to these authors, who are concerned with factor income distribution. To my knowledge, there is no paper discussing interaction channels of monetary policy and savings inequality in financial markets.

2 The model

2.1 Non-homothetic returns

We have continuum of depositors (deposit consumers), normalized to 1, and each of them invests her savings in deposits. A continuous range of deposits are provided by banks as

[7] As our model "starts" from savings, we need not say anything to what extent savings distribution differs from income distribution. Savings or deposits distribution is exogenous in the model and we do comparative statics exercise to study properties.

differentiated products, that is, the j-th bank sells a deposit of type j, $j \in [0, N]$. Agents are concerned with their total return of investments, and they account for nonzero probability of default, the same for all banks. Despite the same rate of default for banks, agents' perception of default does not assume any significant default correlation among banks. The salient feature of the return function is that the repayment per unit of deposit is decreasing in volume of deposits in a linear fashion. This functional device captures agents' incentives to diversify their deposit portfolio. When buying D quantity of deposits from the bank j, the gross return per unit of deposit will be contracted by the amount $\frac{1}{2}\gamma D_j$, and the overall loss will be $\frac{1}{2}\gamma D_j^2$. As we see, if an agent holds an additional unit of deposit from the same bank, her losses per unit will increase. Again, this is the depositors' perception and, for simplicity, these losses are neglected, when repayments are taken place. Thus we assume that no default occurs ex post, but ex ante there is some probability of default, as a linear function of deposits.

I follow to the notation of Foellmi and Zweimuller (2011) (FZ) and denote the type of consumer by θ. Then the θ type of households' optimal investment problem is

$$\max_{\{D_j\}} \int_0^N \left(\mathbf{E}R - \frac{\gamma}{2} D_j \right) D_j dj$$

subject to

$$\int_0^N P_j D_j dj \leq W(\theta),$$

where the index j refers to a bank, P_j is interpreted as a bank specific price for one unit of deposit, ER is the expected profit from an alternative, (physical) production activity, and $W(\theta)$ is agent specific wealth, to be totally consumed on deposits. Transformation of attracted financial resources into deposits is a production process and the product (deposit) has its price, P.

As an alternative technology, I assume that an agent can be involved in entrepreneurial activity taking risk and making efforts, in order to earn profit from the constant return to scale technology. The profit rate R is stochastic and production involves entrepreneurial effort. Intensives to diversify deposit portfolios comes from agents' beliefs on nonzero probability of banks' default, and this reflects the adverse attitude of agents towards uncertainty. That is, agents are risk averse. The expected rate of return from investing one unit of deposit is

$$\mathbf{E}R^d = \mathbf{E}R - H_d(\gamma, D) - P$$

and the ex ante net earnings from entrepreneurship per unit of capital is

$$\mathbf{E}R^r = \mathbf{E}R - H_e(\sigma_R, K) - E$$

where $H_d(\gamma, D)$ and $H_e(\sigma, D)$ are the agent's risk control in deposit and production technologies. The profit function is $\Pi(K) = RK - EK$, with the random variable R, which has the probability density function f_R and the standard deviation σ_R. The price for deposit contract is payed to the bank as compensation for the bank's effort to produce one unit of deposit. The ex-ante no arbitrage condition implies that $H_d(\gamma, D) + P = H_e(F, K) + E$. As already noted, all banks fulfill their commitments according to the signed deposit contracts, we take the ex post value $H_d = 0$.

In our partial equilibrium framework, in which the overall deposit supplied is fixed, we implicitly assume that all arbitrage opportunities concerning investment choices in two technologies, are exhausted. That is, for each agent, with the total capital $S = D + K$, the following should hold:

$$\mathbf{E}R^r(K) = \mathbf{E}R^d(D). \tag{1}$$

Important for our further analysis, we have the same expected profit rate for each agent as a target rate, $\mathbf{E}R$, from which bank specific costs are subtracted. Whenever there will be two prices P_1 and P_2 in the economy, then from $H_d(\gamma, D) - H_e(F, K) = E - P$ it follows that different types of agents will hold different portfolio composition[8]. In further analysis,

[8]The no-arbitrage condition (1) implies that whenever $S_1 = S_2$ and $P_1 < P_2$, we have $D_2 > D_1$ and

in order to save notation, I use R instead of $\mathbf{E}R$, as there will be no room for confusion.

The net return on a deposit is decomposed in two parts: systemic $R - \frac{\gamma}{2}D_j$,[9] and bank specific, P_j. A deposit consumer is going to pay P_j, against the return $R - \frac{\gamma}{2}D_j$, per deposit j. The way I put the problem, is a standard consumer optimization problem, in which consumer's wealth is crucial in determining individual perception of a unit cost that scales the market price opposite to the wealth.

Let us denote $Q(D) \equiv (R - \frac{\gamma}{2}D)D$. We restrict the parameter γ so that $Q'(D) = R - \gamma D > 0$ for $D > 0$. We have $Q''(D) = -\gamma$, $Q'(D) = 0 \Leftrightarrow D = R/\gamma$ and $\lim_{D\to 0} Q'(D) = R$. Thus the return function Q has a saturation point and its marginal value at zero is finite. The last property is crucial for inequality effects, since there will be deposits with too high prices, which will not be afforded by the poor. The higher the default parameter γ, the lower the marginal return and the smaller the saturation. Following to FZ, I write the Lagrangian directly as a function of the type of an agent. The value of the Lagrangian does not depend on wealth only, prices matter as well. However, since each bank is of measure zero with respect to the whole economy, changing one individual price does not change the value of the Lagrangian multiplier. Then, the agent θ decides on the optimal quantity of deposit issued by the bank j, following to the first order condition:

$$R - \gamma D_j(\theta) - \lambda(\theta)P_j + \lambda_j(\theta) = 0; \lambda(\theta) > 0, \lambda_j(\theta) \geq 0.$$

We can put the conditions in the following form:

$$\begin{cases} R - \gamma D_j(\theta) = \lambda(\theta)P_j, & \text{if } R/\lambda(\theta) > P_j, \\ D_j(\theta) = 0 & \text{if } R/\lambda(\theta) < P_j. \end{cases} \tag{2}$$

That is, if the subjective price of the deposit j is higher than the limiting highest marginal

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$K_1 < K_2$.

[9] I refer to the term $R - \frac{\gamma}{2}D_j$ systemic, since the fundamentals entering the net return, R and γ have no a bank index.

return, $\lambda(\theta)P_j > R$, the agent will not buy the deposit issued by the bank j.

The deposit price elasticity of individual demand curve depends on the wealth and can be written as

$$\eta(\theta, j) = \frac{\partial D_j(\theta)}{\partial P_j}\frac{P_j}{D_j(\theta)} = \frac{Q'(D_j(\theta))}{D_j(\theta)Q''(D_j(\theta))} = \frac{R - \gamma D_j(\theta)}{\gamma D_j(\theta)}$$

2.2 Banks

Banks attract financial resources and provide loans. Both products, deposits and loans, are differentiated, and the extent of differentiation determine monopoly power of banks. We assume symmetry for banks in loan and deposit markets and solve the model for symmetric case. The profit function of a bank has the following form (the bank index suppressed):

$$\Pi(R^l, P, B^{CB}) = (1-\delta)L(R^l)R^l - R^r B^{CB} - D(P)R^d - \bar{K}, \tag{3}$$

subject to

$$L(R^l) \leq B^{CB} + D(P) + \bar{K}, \tag{4}$$

$$\alpha L(R^l) \leq \bar{K}, \tag{5}$$

$$B^{CB} \leq \bar{B}^{CB}. \tag{6}$$

where R^l is the loan rate, $R^d = 1 + R + \omega^{res} - P$ determines the (gross) deposit rate, R^r is the central bank's refinanicg rate (repo), the factions $L(\cdot)$ and $D(\cdot)$ are loan and deposit demand functions, respectively and $\bar{K}$ is the bank owners' capital, which is fixed. The parameter $\delta \in (0, 1)$ determines the share of loans that are not repaid back to the bank (losses), and $\omega^{res} \in (0, 1)$ is the reserve requirement rate, set by the central bank for each unit of deposit produced. The parameter $\alpha \in (0, 1)$ is another restriction from the central bank, which controls loan-deposit ratio from above. Given the fixed level of capital, banks have two sources of long term fund raising, private savings and the funds offered by the central bank.

If attracted deposits fall short from allocated loans, $L(R^l) - D(P) > 0$, the gap is filled by the borrowing from the central bank, otherwise the bank lends to the public institution. We restrict our analysis to the interior solution, so that $L^* \in (0, \bar{K}/\alpha)$, $B^{CB*} < \bar{B}^{CB}$. This enables to effectively plug the constraint (4) with equality into to the objective function, in order to get rid off B^{CB}:

$$\Pi(R^l, P) = (1-\delta)L(R^l)R^l - R^r(L(R^l) - D(P) - \bar{K}) - D(P)R^d - \bar{K}. \tag{7}$$

Banks have monopoly power both in deposit and loan markets, which ensures nonzero markups in these markets and leads to the following condition:

$$R^d < R^r < R^l$$

Then it is useful to write the profit function as

$$\Pi(R^l, P) = L(R^l)(R^l - R^r) + D(P)[R^r - (1 + R + \omega^{res} - P)] + \bar{K}(R^r - 1).$$

It is easy to note that the terms in the sum are only linked through the repo rate, and we can think of two separate activities. First, the bank collects D amount of deposits by the rate R^d and lend to the central bank by R^r, and second, it borrows L amount from the central bank by the rate R^l and lends these resources to the private sector by R^l. As a result, $\max_{R^l} \Pi(R^l, \bar{P})$ reduces to $\max_{R^l} L(R^l)(R^l - R^r)$ and $\max_P \Pi(\bar{R}^l, P)$ reduces to

$$\max_P D(P)[P - \{1 + R - (R^r - \omega^{res})\}]. \tag{8}$$

There is an important point on deposit pricing. In fact, despite the separation of two markets (deposits and loans), such that they are connected only by the policy rule, it is essential from the social viewpoint how effectively savings are transformed into deposits.

The model states that 100 dollars generates $D < 100$ dollars of time deposits, and the remaining part, $(100 - D)$, is demand deposits. A higher P means that the bank finds optimal to generate profits immediately from deposit markets, and does not direct the P dollars to the loan market. Thus demand deposits stop being productive in the sense that they are not involved in a physical production process. This is possible, as long as the borrowing technology by the central bank is not binding. The higher the price for time deposits, the higher the gap between loans and time deposits. If the central bank wants to ensure the same volume of loans in a real sector, it has to finance this gap. Since we do not model demand for liquidity, time deposits are treated as reserves, since they are not subject to early withdrawal and do not assume interest payments. Throughout the paper, I use the term *reserves* for demand deposits. Also, time deposits are simply called deposits to save the space.

What happens with the available reserves $W - D(1 + \omega^{res})$? The funds provided by the central bank are long term and they can be directed to the private sector in form of loans. I also assume existence of a government bonds market, as a short term investment technology ensuring high liquidity for invested funds. Also, there is an interbank market, where banks provide resources and borrow for investing in government bonds. Overall, there are two types of investments technologies, long (loans, central bank funds and deposits) and short (government bonds and interbank markets). Decision making of the bank i in the interbank and bonds markets is as follows (the index i suppressed):

$$\max_{B^{IB}, A^{GB}} R^{GB} A^{GB} - R^{IB} B^{IB}, \tag{9}$$

subject to

$$A^{GB} \leq B^{IB} + W - D(1 + \omega^{res}), \tag{10}$$

where B^{IB} and A^{GB} stand for the interbank market funds (borrowed or lent) and government bonds, respectively, and (R^{IB}, R^{GB}) are their corresponding gross rates. Then, if banks will lend or borrow in the interbank market, the rate should be the same as in the of government bonds, $R^{IB} = R^{GB}$.[10]

In fact, banks face to two optimization programs, and the issue is how optimally to split W between deposits D and reserves $W - D(1+\omega^{res})$, so that the overall profit from two programs reaches its maximum. As long as the unconstrained maximum D^* insures $[P - \{1 + R - (R^r - \omega^{res})\}] \geq R^{GB}$, the bank carries two stage maximization, first deciding on the long term asset allocation from (7 - 6) and then plugging optimal D^* in (9 - 10) to invest the rest, $W - D(1+\omega^{res})$, in government bonds. Now, suppose there is $\tilde{D} < D^*$, such that

$$P(\tilde{D}) - \{1 + R - (R^r - \omega^{res})\} = R^{GB}. \tag{11}$$

Then it becomes optimal for the bank to produce only $\tilde{D}$ of deposits out of W and the rest, $W - \tilde{D}(1+\omega^{res})$, invest in government bonds, since more deposits would be feasible only by lower price. The following Lemma formulates an important observation on the financial market structure:

Lemma 1 *A sufficiently high rate of government bonds may crowd out deposits that are transformed into loans. The central bank, in order to keep the level of loans fixed, needs to fill the gap $L - D$. Condition (11) may result also, cetirus paribus, due to too high R or too low monetary policy rate, $(R^r - \omega^{res})$.*

Throughout the paper, I refer to the monetary policy rate the repo rate, net of reserve requirement rate, $R^r - \omega^{res}$. However, I suppress the term ω^{res}, and whenever I have R^r labeling as *repo* rate, I mean the net rate of the monetary policy, $R^r - \omega^{res}$. This holds without loss of generality.

I consider government bonds and interbank markets as short term asset markets, since economies with inequality are mostly emerging markets, where these financial markets are

[10] Government bonds and interbank funds are perfect substitutes, and if the interbank market is perfect and banks take R^{GB} given (no power in the government bonds market), then the vector $(B_1^{IB}, ...B_N^{IB})$ such that $\int_0^N B_i^{IB} = 0$, is not unique, in particular,$(0, ..., 0)$ is solution. That is, the interbank market has no essential role.

underdeveloped and short term liabilities are traded. As long as the interbank market provides long term funds, then these resources can be directed to the real sector, and there will be no impact of savings inequality on the economic fundamentals and monetary policy. In short, both D^* and $W - D^*(1+\omega^*)$ will be available for long term lending. The model does not explain the emergence and differences in reserves the banks have due to different demand they face, instead it motivates the existence of excess (and different) demands for government bonds that are saturated at the expense of investments in long term assets.

In the remaining part of the paper we discuss the case, when the optimal D^* is not binding, $P(D^*) - \{1 + R - R^r\} > R^{GB}$. Also, we assume that government bonds and interbank markets are platforms for only trading short term assets, and long term assets (loans) are possible to raise from deposits (private sector funds) and central bank provided funds.

We turn to the problem (7). Optimality conditions for an interior interior solution, necessary and sufficient, can be written in a Lerner index form. For the loan market we have

$$\frac{R^l - R^r}{R^l} = \frac{1}{\epsilon_l(R^l)};$$

and for the deposit market,

$$\frac{P - (1 + R - R^r)}{P} = \frac{1}{\epsilon_d(P)}, \tag{12}$$

where $\epsilon_l(R^r)$ and $\epsilon_d(P)$ are demand elasticities for loans and deposits, respectively. Thus the profit markups in the loan and deposit markets are inversely related to corresponding demand elasticities. Thus the standard result, which is the equilibrium price (the loan rate for the loan market and the price of unit deposit in the deposit market) and hence the markup is higher when demand elasticity at that price is lower, holds.

Next we model the loan market. We assume a representative firm that decides on the bundle of differentiated loan basket[11]. Banks are monopolistic competitors in the loan market with the demand function in the spirit of Dixit and Stiglitz (1977), and it can be shown that the optimal loan demand function for the bank j can be written as

$$L(R_j^l) = \left(\frac{R_j^l}{\bar{R}^l}\right)^{\frac{1}{\phi-1}} \bar{L}, \tag{13}$$

where $\bar{R}^l$ and $\bar{L}$ are the average loan rate and volume in the economy, respectively. When the bank j optimizes the loan volume[12] and, the optimal loan rate is set $R_j^l = R^r/\phi$. That is, though banks offer differentiated products in the loan market, their rates and quantities turn to be identical. The parameter $\phi \in (0,1)$, the same for all banks, measures the extent of diversity of loans and defines the markup, $1 - R^r/R^l = 1 - \phi$. Then, demand functions of all banks are same,

$$L = \frac{\Omega}{NR^l} = \frac{\Omega\phi}{NR^r}. \tag{14}$$

Equation (14) determines an optimal quantity of loans, each bank sells to the real sector. The interesting feature of the loan market is that, without any assumption on the symmetry among banks, it turns out that they are symmetric in terms of loan rate and quantities. The result hinges on the separability of optimization in the loan and deposit markets. It is immediate, that the lower the repo rate, the higher the output. The reverse argument holds for Ω, another exogenous parameter in the model.

Here is important to identify the sources of borrowed resources. In the above setting, a lower repo does not tell much about the composition of borrowing. The main object for our analysis will be deposit market, in which we will explore interaction of banks and (deposit)

[11] The representative firm solves the following problem:

$$\max_{\{L_j\}} \left(\int_0^N L_j^\phi dj\right)^{\frac{1}{\phi}}, \text{ subject to } \left(\int_0^N L_j R_j dj\right) = \Omega,$$

where $\phi \in (0,1)$ measures the extent of substitutability between the products of any two banks and Ω is the firm's resources that can be directed to buy loans, a function of collateral.

[12] If banks choose R_j^l, $j \in [0,N]$, to maximize $L(R_j^l)(R^l - R^r)$ subject to the demand function in (13), the solution is unique and interior, $R_j^l = R^r/\phi$.

consumers as a function of the policy rate, in line with other fundamentals. Before we impose restriction on types of consumers - only two types, poor and rich - it is useful to write the elasticity of deposit demand for the general distribution (for details, see FZ, 2003):

$$\epsilon_d(P_j) = \int_{\hat{\theta}(P_j)}^{\bar{\theta}} \frac{D_j(\theta)}{D_j} \eta(\theta, j) dF(\theta).$$

That is, the elasticity of the deposit j is a weighted average of individual elasticities, and the weights are $D_j(\theta)/D_j$, where $D_j = \int_{\hat{\theta}(P_j)}^{\bar{\theta}} D_j(\theta) dj$, horizontally aggregated demand, and $\hat{\theta}(P_j)$ identifies the first individual with the lowest wealth, who buys the deposit j.

2.3 Two types of agents: poor and rich

I am going to assume two types of agents, the rich and the poor. This restriction on the wealth distribution simplifies the analysis crucially, but not at the expense of generality. For those economies, in which the middle class is not dominating among the three, our assumption seems natural and not really restrictive. I follow to FZ and express the wealth of the rich as a function of the wealth of the poor, leaving the latter exogenous. Also, I normalize the average savings to one, so that average savings remains invariant to changes in inequality. Poor households are indexed by P and their share in population of continuum 1, is β. Respectively, rich households are indexed by R and have share $1-\beta$. Thus we have a formula for the average income,

$$\beta W_P + (1-\beta) W_R = 1,$$

and denoting $\upsilon \equiv W_P$, we endogenize the wealth of the rich,

$$W_R = \frac{1-\beta\upsilon}{1-\beta}.$$

After horizontal aggregation of individual demand functions (2), we obtain the market (deposit) demand curve for the deposit j:

$$D_j = \begin{cases} 0, & \text{if } P_j \in [R/\lambda_R, \infty), \\ \frac{(1-\beta)}{\theta}(R - \lambda_R P_j), & \text{if } P_j \in [R/\lambda_P, R/\lambda_R) \\ \frac{1}{\theta}[R - ((1-\beta)\lambda_R + \beta\lambda_P)P_j] & \text{if } P_j \in [0, R/\lambda_P) \end{cases} \tag{15}$$

The market demand curve is piecewise linear, and a bank optimally decides to whom offer its deposit, either to both rich and poor (the mass), or exclusively to the rich. When there will be banks that will sell deposits only to the rich, we will have *exclusion*[13]. There will be an endogenous number $n \in [0, N]$, so that the first n banks will issue deposits for the mass, and the remaining $(N - n)$ banks sell deposits only to the rich. As a result, poor households will be *excluded* from consuming $(N - n)$ types of deposits, as their willingness to buy these deposits will fall short from the market price of these deposits. Banks exercise their monopoly power more intensively under the exclusion regime, as the prices for $[N - n]$ deposits will be too high for the poor, and the per bank volume of deposits issued only for the rich will be smaller relative to deposits issued for the mass.

Before turning to the asymmetric equilibrium, in which exclusion occurs, we study the symmetric one.

3 Symmetric versus asymmetric equilibrium

3.1 Symmetric equilibrium

Symmetric outcome assumes symmetric deposit quantities and prices in the equilibrium. This outcome is feasible, since deposits enter the households' return function symmetrically, and households, despite their heterogeneity in terms wealth, hold identical portfolios. Symmetric equilibrium will hold, if heterogeneity of deposit consumers will not be sufficiently strong, and banks will not deviate from the symmetric equilibrium strategy and sell only to

[13] I keep the notation and terminology as close as possible to FZ throughout the paper.

the rich. Thus if inequality is not that high, banks will not find profitable to issue deposits exclusively for the rich, as sufficiently high price (lower return), necessary to deviate from the general strategy, will not be affordable for the rich.

As we have argued, the banks' profit maximization, essential from the aspect of deposit market's interaction, can be reduced to (the bank index suppressed)

$$\max_P D(P)(P - \tilde{R}), \text{ subject to (15)} \tag{16}$$

where $\tilde{R} \equiv (1 + R - R^r)$. Solving (16) for the prices, one for all and the other for only rich, we obtain:

$$P_j = \begin{cases} \frac{1}{2}\left(\frac{R}{\lambda_R} + \tilde{R}\right), & \text{if only the rich buy,} \\ \frac{1}{2}\left(\frac{R}{\Omega} + \tilde{R}\right), & \text{if all consumers buy;} \end{cases} \tag{17}$$

where, for compactness, we denote $\Omega \equiv (1 - \beta)\lambda_R + \beta\lambda_P$.

If we solve the model for symmetric equilibrium, the price and the quantity are not a function of inequality parameters, β and υ.[14] Thus we have the result by FZ, that is, in the symmetric equilibrium case, if $\frac{Q'(D)}{Q''}$ is affine linear, income distribution does not affect on the price and hence the markup. The market demand of deposits is unaffected by the savings distribution and the interaction between inequality and aggregate outcomes is one sided, only from outcomes to distribution, but not the converse.

We then derive conditions that force banks not to deviate from the general strategy to sell deposits to all. The symmetric outcome is an equilibrium, if, given that all other banks sell deposits to the mass (both rich and poor), no bank has an incentive to sell only to the rich, offering different repayment. This will be the case, if for each bank we have

$$\Pi^E < \Pi^M \iff D^e(P^e)(P^e - \tilde{R}) < D^M(P^m)(P^m - \tilde{R}), \tag{18}$$

[14] The symmetric equilibrium price(s) and quantity(ies) are $P^s = \frac{NR\tilde{R}+2\theta\pm\sqrt{(NR\tilde{R})^2+4\theta^2}}{2NR\tilde{R}\theta}$ and $D^s = \frac{R}{\theta}\left[\frac{P^s-\tilde{R}}{2P^s-\tilde{R}}\right]$, respectively. Despite the multiple solution to the problem for symmetric case, the higher price and corresponding quantity need not satisfy the condition that makes optimal to deviate from the general strategy.

where the superscripts E and M correspond to *Exclusion* and *Mass*, respectively. We can express maximized profits in (18) as functions of λ_R and λ_P, using (17) for all consumers and the expression of D^s in the footnote (14). Then the no-deviation condition can be reduced to

$$(1-\beta) < \frac{\lambda_R}{\Omega}\left[\frac{R-\Omega\tilde{R}}{R-\lambda_R\tilde{R}}\right]^2. \tag{19}$$

The right hand side (RHS) of (19) is increasing on the inequality parameter, υ. It turns out that, at some value of $\bar{\upsilon}$, the inequality in (19) will not hold for all $\upsilon < \bar{\upsilon}$.[15] In other words, if the resource allocation is too polarized, a given bank will find profitable to deviate from the general strategy (to sell to the whole customer base) and offer deposits exclusively to the rich, as the rich now has sufficient resources to attract and her elasticity is lower, and the bank can charge a higher monopoly price.

These above findings are summarized in the Proposition:

Proposition 1 *A given composition of population by β, there is a lower bound of inequality measure $\bar{\upsilon}$, such that for all $\upsilon > \bar{\upsilon}$ savings inequality has no influence on the equilibrium deposit rate and the quantity, and hence on the monetary policy rule and the loans flowing to the real sector.*

3.2 Asymmetric equilibrium

It follows that, for sufficiently high savings inequality, there will be banks that will sell only to the rich. Then, there will be two types of deposits in terms of pricing, one that is sold to the mass, both rich and poor, and other sold only to the rich. Given that each bank has either of this option, but not both, in the equilibrium the number of banks serving only to the rich will be determined endogenously.

We start from the no-arbitrage condition, which must hold under the exclusion regime, $\Pi^E < \Pi^M$. The optimal deposit quantities for the rich, D_r^e and D_E^M, and for the poor,

[15] As λ_R and λ_P are linear functions of wealth, RHS of (19) decreases without bound.

D_P^m, can be expressed as functions of optimal prices, using optimal demands in (15) and eliminating λ_R and Ω through (17). We have $D_r^e = \frac{R}{\theta}\left[\frac{P^e-\tilde{R}}{2P^R-\tilde{R}}\right]$, $D_R^M = \frac{R}{\theta}\left[\frac{2P^R-P^m-\tilde{R}}{2P^R-\tilde{R}}\right]$ and $D_P^m = \frac{R}{\theta}\left[1-\frac{1}{\beta}\left(\frac{1}{2P^m-\tilde{R}} - \frac{(1-\beta)}{2P^R-\tilde{R}}\right)P^m\right]$.

Then, market equilibrium quantities can be easily derived,

$$D^e = (1-\beta)\frac{R}{\theta}\left[\frac{P^e-\tilde{R}}{2P^e-\tilde{R}}\right],\ D^m = \frac{R}{\theta}\left[\frac{P^m-\tilde{R}}{2P^m-\tilde{R}}\right]. \tag{20}$$

Under the no-arbitrage condition, which implies the existence of exclusion regime, we then obtain a formula for P^e, as a function of P^m, at the moment treating it as exogenous:

$$P^e - \tilde{R} = \frac{(P^m-\tilde{R})^2 + (P^m-\tilde{R})\left\{(P^m-\tilde{R})^2 + (1-\beta)(2-P^m)\tilde{R}\right\}^{\frac{1}{2}}}{(1-\beta)(2P^m-\tilde{R})} \equiv g(P^m),$$

and it can be easily checked that $g'(P^m) > 0$. In the following Proposition, central for the model, we establish the uniqueness of the asymmetric equilibrium and (ii) the equilibrium price responses to increasing inequality.

Proposition 2 *(i)The asymmetric equilibrium is unique, (ii) higher inequality, in terms of lower υ, leads to higher prices, both for mass and exclusive deposits.*

Proof. (i) The markup condition for the exclusive deposits segment is

$$1 - \tilde{R}/P^e = 1/\epsilon(P^e;\upsilon) = \frac{R-\lambda_R(\upsilon)P^e}{\lambda_R(\upsilon)P^e}. \tag{21}$$

(i) The LHS of (21) is strictly increasing, while the RHS is strictly decreasing in P^e. The price for mass deposits, P^m, is also strictly decreasing on P^e and hence equilibrium prices P^e and P^m are unique. As equilibrium deposits D^e and D^m in (20) are also monotone in P^e and P^m, respectively, equilibrium quantities are also unique.

(ii) Now, let us perturb the parameter υ downwards. As the wealth of the rich will increase, the λ_R will decrease and the RHS of (21) will shift upward. The resulting equilibrium price P^e, and hence P^m, will be higher. ■

In the Appendix, we provide another mechanism for equilibrium and price changes to inequality.

At this point, we have that (i) asymmetric equilibrium exists and it is unique and (ii) higher inequality leads to higher prices. Monopoly power that banks exercise towards customers, is different in the mass and exclusive markets: the lower the demand elasticity, the higher the monopoly power, hence the higher markups and dead weight losses. Therefore, in order to have the complete picture, we need to identify responses of exclusion, total deposits and markups, to inequality change.

Proposition 3 *Higher inequality, in terms of lower v, leads to*

(i) more exclusion,

(ii) a decrease in total deposits and

(iii) higher markups,

Proof. See Appendix. ■

Higher exclusion means that poor consumers will be excluded from more deposit markets, as the new price will be too high (too low return) for them. Lower elasticity for a price will empower banks to ensure higher markup, thus generating higher social welfare losses. Each bank is now better off in terms of profits, but total deposits will now be lower, since there are banks, which will shift the customer base from the mass to (only) the rich.

That banks will increase the price for the rich is quite intuitive. Higher inequality means the rich is now even richer, and she is less elastic to a price change, as the slope of her demand becomes steeper. Less elastic demand enables banks to increase the price and hence the markup. The profits of banks that previously served only to the rich will increase, relative to those working for the mass. The no-arbitrage condition implies that some banks will switch from selling to the mass to (only) the rich.

The fact that $-Q'(D(\theta, P))/(Q''(D(\theta, P))D(\theta, P)$ is decreasing in $D(\theta, P)$, is crucial. For each price, lower wealth will decrease demand and hence the elasticity. This enables banks to increase the equilibrium price for the mass sector as well. As some banks move to excluded deposits sector, this enables the remaining banks to increase equilibrium quantity deposits.

What happens in loans market, which is linked to the deposits market through the policy rate? Given no change in the policy, *per se* higher inequality will not affect the volume of loans, but only the composition of borrowed resources. As part of deposits are forgone, the gap should be filled by the borrowing from the central bank. The assumption of an exogenous repo rate excludes any correction of supply curve by the central bank, as a response to the demand shift, and the real sector will be unaffected by the change of savings distribution.

In the model, we distinguish two distributions, nominal and real savings distribution, the former in units of quantity of money, and the latter in units of deposits, being net or interest payments included. Thus the terms 'nominal' and 'real' refer to the units by which we measure wealth. Comparative statics on υ determines the change of real savings distribution, namely, differences in deposits holdings between rich and poor. As the price increases for mass deposits and the poor becomes even poorer, her total deposit holdings, υ/P^m, will be lower. The improved position of the rich will be (partially) deprived by higher prices, but still the increased inequality will hold for deposit holdings. After banks's gross repayments, inequalities will be mitigated, as $R - P^m > R - P^e$.

Nest we turn to the monetary policy implications for the model.

4 Monetary policy and savings inequality

General perception for the monetary policy is that it affects the aggregate outcomes hoping that the latter represents individual outcomes fairly well. This is the notion of a representative agent, and monetary economics literature, with few exceptions, hinge on this concept. The target of the monetary policy is devised as optimal and hit from the prospect of a representative agent, while it might be irrelevant for those, who are too different from the representative. Savings inequality matters due to non-homothetic returns and hence it becomes relevant for the policy. I discuss (i) how inequality affects on the effectiveness of the monetary policy, and (ii) how the implemented policy redistributes resources back (whether it has equalizing power or the converse). Despite the static nature of the model, this two-sided exercise is feasible, as both inequality and policy parameters are exogenous.

Before turning to the equilibrium with exclusion, I discuss the implication of the policy rate in a symmetric equilibrium. A higher repo rate makes central bank funds more expensive and banks substitute these funds by private funds, charging lower price for deposits. Moderate changes of repo rate will not affect the structure of the economy, since the equilibrium price will not decrease enough in (17), so that the poor can buy these deposits. However, if the repo rate increase is dramatic, prices will drop drastically and excluded goods will also be available for the poor. The converse holds for the expansionary monetary policy: a lower rate will lead banks to substitute private resources with the public and this will increase prices. If the inequality in (18) is not that strong, then the LHS, increasing on R^R, will collapse to an equality, which is the condition for asymmetric equilibrium.

Next we assume asymmetric equilibrium, which will hold as well after the policy is implemented. We start from exploring the influence of savings inequality on the effectiveness of monetary policy. The effectiveness of monetary policy is discussed in terms distorted quantity of deposits that should have been collected from depositors (contractionary monetary policy), or limited power of quantitative easing (expansionary monetary policy).

Now, suppose the central bank increases the repo rate. The first observation is that it leads to more exclusion.

Proposition 4 *Under the exclusion regime, an increase (decrease) in the repo rate leads to more (less) exclusion.*

Proof. See Appendix. ■

The result, at the first glance strange, is very intuitive. Take the poor. Since his demand is elastic (more than 1), we have $d(D_P^m P^m) > 0$, which means that n should decrease in order to stay within the feasible set, $nD_P^m P^m = \upsilon$. Thus the poor buys from each bank more deposits, but now less banks will serve to the poor (mass). We know that exclusion is a source of distortion, since more banks are selling to the poor only with a higher price and hence ensure higher markup. The two counter factors, lower prices that increase sells for each bank and higher exclusion that leads to some banks to switch from selling mass to the rich only, does not enable to have a clearcut answer about to what direction total deposits change. A numerical example shows that total deposits increase for broad range of parameters υ, γ and R. If we base on the numerical example, then we can claim the following: *Monetary policy is less effective, when savings inequality is high.* In other words, monetary policy, targeted to generate additional deposits, will be more successful for lower inequality. The converse argument can be put for expansionary policy. In fact the effectiveness hinges only on the monotonicity of D^{tot} in R^r, regardless of value υ.

The policy consequence on total deposit composition is also interesting to explore. The issue is, for instance, whether a higher repo rate has income equalizing power or not. The answer is Yes and it again hinges on higher elasticity of the poor, relative to the rich.

Proposition 5 *Let* $\mathbf{D}_P \equiv nD_P^m$ *and* $\mathbf{D_R} \equiv (N-n)D_r^e + nD_R^M$. *Then a higher repo rate leads to a decrease in wealth differences in terms of deposit holdings,* $\mathbf{D_P}'(R^r)/\mathbf{D_P}(R^r) > \mathbf{D_R}'(R^r)/\mathbf{D_R}(R^r)$*, and corresponding gross repayments.*

Proof. See Appendix. ■

In this context, expansionary monetary policy, which promotes employment and economic growth, increases deposits holding inequality. Savings are only a part of real earnings from production, and in our model these earnings are fixed. This result does not contradict to the findings of Romer and Romer (1999) and Fowler and Wilgus (2008), that expansionary monetary policy is more beneficial for the poor. These benefits are deprived due to deterioration of savings' income distribution to some extent, depending on the preferences and technologies and hence consumption-investment intertemporal choice.

5 Discussion

The model is a scatter of the banking sector of an economy. Its relevance hinges on a certain situation that a given economy may or may not have. That deposit holdings, supplied by economic agents, are inelastic to relative prices to some extent, is natural, considering transaction costs that agents should incur to transfer their holdings from one savings technology to another. The other issue is the consumption-savings intertemporal choice, as a function of capital rate of return. Differences in intertemporal choice for different income classes will depend on the extent of risk aversion the rich and the poor pattern, and our assumption of fixed deposit savings, invariant to the policy rule, is not realistic. In fact we are to identify savings distributional effects of the policy net of the factors, present in the real sector of an economy.

The model is relevant for economies with transfers. Imagine a labor exporting economy, in which transfers are the only source of income for a significant part of the population. Also, the banking sector is the only savings technology available to the mass. When these transfers are arrived, a part of it will be transformed into time deposits, since agents need these funds only for some period later on, in order to afford current consumption. Capital owners, the rich in an economy, will be more sensitive to changes of deposit rates, as they have alternative technologies in the real sector, but still they hold the part of their wealth in the form of time deposits (financial wealth). This environment is exactly the one for which the model is relevant and provides answers concerning interaction between savings inequality and monetary policy. In the model, the impact of deposit holdings inequality on the real economy and economic policy hinges on underdeveloped interbank markets, in which long term assets are not traded. Many emerging market economies have the above described structure, and the model can be useful to understand the mechanics of the consequences of monetary policy in the financial sector. The model can be tested empirically for these economies and this will bring additional value to the model in terms of its applicability in policy making decisions.

The salient feature of the model is that I treat deposits as a (financial) good, which is produced and sold directly to the customer from one side, and it is transformed into the loan on the other side. A higher price decreases the net return for a deposit, and this means that a dollar will produce lesser deposit. This is a simple design and there is no loss of generality concerning deposit market and itself deposit as a financial product, but it only provides a channel to model agents individual perceptions for deposit returns. For the poor the same return is perceived less than for the rich, since agents scale these returns with respect to their financial wealth. We can generalize the novelty and say that they scale the prices with respect to their total wealth, assuming that the rich will anyway hold more deposits and than the poor.

A natural extension of the model will be to assume regular (homothetic) preferences for agents and solve the model as a general equilibrium, intertemporal choice involved. Then distributional effects stemming from real earnings will be relevant for outcomes through financial markets, as saving differences will affect the composition of loan resources and hence the real earnings. High income inequality is commonly observed in emerging market economies, and underdevelopment of financial markets in these economies can be explained by our model framework - those who have accumulated capital are not eager to invest in deposits, since the repayment rate is too low. The rich families instead prefer to open their own banks or hold large shares in firms with monopoly power. Another interesting question is how the shocks will be propagated if we embed our novelty model into a heterogeneous agent DSGE framework. During the crisis, when firms face high loan rates due to poor collateral conditions, some capitalists are expected to substitute equities with deposits, and the resulting deposit holdings inequality will increase. The model then predicts that (i) monetary policy will be less effective in general and (ii) expansionary policy will further increase inequality, in particular.

Another theoretical extension is to model market discipline within our framework. If we close the provision of public funds, then the volume of loans is a direct function of volume of deposits. In addition, if we assume that bank managers can make effort to reduce the risk on loans repayment, then we will have a stylized channel for market discipline, that is, the ability of private agents to control bank risk-taking. A simple structure of market discipline channel by Gropp and Vesala (2004) can be used, in which demand for loans and supply of deposits are exogenously given. In our model, these functions are derived from the optimization programs of firms and households. The price for deposit contract will depend on an additional factor, the risk scaled by the effort, the latter chosen by the bank. From the market discipline literature we know that depositors ask for higher deposit interest rate, in case the bank default risk increases. Recalling that non-homothetic return on time deposits leads to interest rate discrimination between the rich and the poor, the central question will be to identify the impact of the monitored optimal risk taking on deposit rate differential.

The existence of public (central bank) funds enables banks to hold perfectly symmetric loan portfolios so that differences in demand deposits do not directly spill over into the loans market. That is, bank managers are not subject to discipline when selecting loans portfolio. Contrary to this, depositors discipline bank managers in the government bonds and interbank markets, in which time deposits are the available funds, and the nature of market discipline depends on the extent of savings differentials. This channel becomes relevant in the context of stochastic liquidity demand and can be studied within the framework by e.g. Allen et al. (2009). The following question can be asked: Whenever wealth differences among the private agents become relevant for the aggregate supply of deposits, how decision makings on the short term assets are corrected by that factor in the presence of stochastic liquidity demand? This is another market discipline channel - the wealth (savings) status of private agents is the central determinant that makes banks asymmetric and their choices in the interbank and government bonds markets crucially depend on the savings inequality.

Concerning potential empirical challenges, when testing our model, I identify at least two of them. If we find an evidence that may support our hypothesis, we should check for the risk premium that rich households are perhaps to pay for implicit insurance, the banks provide to rich depositors. Government owned deposit insurance funds guaranty deposit repayments (in case of banks default) with an upper bound that usually cover an average deposit. It then follows that, if there is no explicit insurance contract for large deposits, rich depositors themselves should discipline banks.

Second, if there are banks that serve only rich clients, they may provide additional services and these costs will be subtracted from time deposit rates. For instance, in emerging markets, a branch of a worldwide known bank is trusted more, since information outflows are less probable, and this gives additional monopoly power for that bank to set lower deposit rates. That the rich depositors are more vulnerable to such risks is evident, and a bank that wants to serve rich clients, needs to ensure such conditions for them. In what follows, this becomes a necessary condition for the bank to attract deposits from the rich, and it cannot be the only factor to explain deposit rate differential, since the equilibrium deposit rate, as demonstrated, should also account for differences in marginal return of savings between the rich and the poor, explaining the rate differential.

Conclusion

The model solution implies that higher inequality leads to more exclusion and less total deposits, as banks exercise their monopoly power more intensively. This result hinges on nonhomothetic structure of the objective function, finite marginal return at zero and increasing (deposit) price elasticity. These properties come naturally, when modeling agents deposit return function.

The model answers the following policy question: how real savings inequality are affected by the monetary policy and the converse. First, the higher is inequality, the lower is the power of monetary policy. Higher inequality will distort a part of growth in total deposits, since higher exclusion implies that less bank will produce for the mass, who buy more deposits from a given bank due to higher elasticity. In case of expansionary monetary policy, substitution of private deposits with the Central Banks funds will be less effective, since we will have less exclusion and more banks will sell to the mass.

Contractionary monetary policy mitigates savings differences in terms of real assets. As the poor is more elastic to a price change, she will buy more deposits with lower price (higher deposit rate) than the rich, and the savings differences will decrease. As deposit rate is lower for the mass, interest payments will further equalize agents asset holdings. Also, when the Central bank decreases the repo rate - inequality increases and the poor suffers from the expansionary policy, as far as it concerns her savings invested in deposits.

Appendix

5.1 Uniqueness and price response to inequality

Under the exclusion regime, individual wealth constraint for the rich is

$$(N-n)D_R^r P^e + nD_R^m P^m = W_R, \tag{22}$$

and for the poor,

$$nD_P^m P^m = \upsilon. \tag{23}$$

We can solve (23) for n and plug the expression into (22). The resulting relation is

$$\frac{D_R^m}{D_P^m} + P^e D_R^r - \frac{\upsilon D_R^r}{P^m D_P^m} = \frac{1-\beta\upsilon}{1-\beta}. \tag{24}$$

The RHS in (24) is increasing on P^m.[16] This, together with (24), ensures the existence of unique equilibrium. Then the interesting question is, how optimal prices and quantities respond, when savings differences increase (υ decreases). It is easy to realize that if the increase in RHS of (24) is smaller than the increase of the left hand side (LHS) of (24) both due to contraction of υ, then higher inequality will lead to a higher price for the mass deposits, P^m, hence a higher price for exclusive deposits, P^e. In order for the above argument to hold, we need to prove that $\partial\left\{\frac{\upsilon D_R^r}{P^m D_P^m}\right\}/\partial\upsilon < -\partial\left\{\frac{1-\beta\upsilon}{1-\beta}\right\}/\partial\upsilon$, which reduces to $NP^e D_R^r < 1/(1-\beta)$.

Lemma 2 $NP^e D_R^r < 1/(1-\beta)$.

Proof. Aggregating individual budget constraints with respect to corresponding shares given by β, we obtain

$$(N-n)P^e D^e + nP^m D^m = 1, \tag{25}$$

[16] I do not prove this claim formally, but it is very close to the corresponding claim in FZ(2003), and, when simulating model, I show that for all relevant configuration of parameters, the increasing pattern is preserved.

Solving for n, we have

$$n = \frac{1 - NP^e D^e}{P^m D^m - P^e D^e}. \tag{26}$$

From the no-arbitrage condition, $D^e(P^e)(P^e - \tilde{R}) = D^m(P^m)(P^m - \tilde{R})$, we have

$$\frac{D^m}{D^m} = \frac{P^e - \tilde{R}}{P^m - \tilde{R}} > 1 \Rightarrow D^m > D^e. \tag{27}$$

Then, from the latter inequality, we have $(D^m P^m - D^e P^e) = \tilde{R}(D^m - D^e) > 0$. It follows from (26), that, in order to have a positive value for n, the nominator should be positive, $NP^e D^e < 1$. Realizing that $D^e = (1 - \beta)D^r_R$, the final result follows. ■

Proof of Proposition 3.

(i) When taking the total differentiation of the aggregated constraint in (25) with respect to P^m, and solving it for $n'(P^m)$, we have

$$n'(P^m) = \frac{-n\partial\{P^m D^m\}/\partial P^m - (N - n)\partial\{P^e D^m\}/\partial P^m}{P^m D^m - P^e D^e} < 0,$$

since we have shown in the proof of Lemma 2 that $P^m D^m - P^e D^e < 0$, and it is easy to check that $D^{m\prime}(P^m) > 0$ and $D^{e\prime}(P^m) > 0$, using formulas in (20) and the fact that $\partial P^e/\partial P^m > 0$.

(ii) We start from total deposits, $D^{tot} = (N - n)D^e + nD^m$, and evaluate its derivative,

$$D'_{tot}(P^m) = (N - n)D^{e\prime}(P^e)P^{e\prime}(P^m) + [-n'(P^m)D^e(P^m)] + n'(P^m)D^m(P^m) + n(P^m)D^{m\prime}(P^m).$$

Then, the condition $D'_{tot}(P_M) < 0$ is equivalent to

$$n'(P^m)D^m > (N - n)D^{e\prime}P^{e\prime}(P^m) + [-n'(P^m)D^e(P^e)] + n(P)D^{m\prime}(P^m) \equiv H,$$

where both sides are positive.

Now we take total differential of aggregate budget constraint (25) and with respect to P^m:

$$(N-n(P^m))D^{e\prime}(P^e)P^{e\prime}(P^m)P^e+[-n'(P^m)D^eP^e]+n'(P^m)D^mP^m+n(P)D^{m\prime}(P^m)P^m+\Theta=0,$$

where $\Theta \equiv (N-n(P^m))P^{e\prime}(P^m)D^e + n(P^m)D^m > 0$. Then, we can write

$$-n'(P^m)D^m > (N-n(P^m))(D^e)'(P^e)P^{e\prime}(P^m)\frac{P^e}{P^m}+\left[-n'(P^m)D^e\frac{P^e}{P^m}\right]+n(P)D^{m\prime}(P^m) > H.$$

since $P^e/P^m > 1$ from (27).

(iii) Higher inequality leads to higher equilibrium prices and deposits, and linear demands become steeper in both segments. As a result, for each price level the elasticity will be smaller, implying that the LHS of (12) will be upward shifted (it is decreasing in P). Considering that the Lerner index (RHS of (12)) is increasing in P, the new equilibrium markup will now be higher. ■

Proof of Proposition 4. In order to proof the claim, we will plug formulas for D^e and D^m, as functions of λ_R and λ_P, in (26) and calculate the derivative $n'(R^r)$. Using functions of optimal prices (17) in (20), we obtain

$$P^eD^e = \frac{1-\beta}{4\phi\lambda_R}(R^2-\lambda^2\tilde{R}^2) \equiv \Phi(R^r) \text{ and } P^mD^m = \frac{1}{4\phi\Omega}(R^2-\Omega^2\tilde{R}^2) \equiv Z(R^r).$$

Then we have (the argument R^r suppressed) $n'(R^r) = \frac{\Phi'(1-NZ)-Z'(1-N\Phi)}{(Z-\Phi)^2}$. Since $Z > \Phi$ and $\Phi' < H'$, for all R^r, we complete the proof, $n'(R^r) < 0$. ■

Proof of Proposition 5. For compactness let us denote $Q_1 = D^r_R(N-n)$, $Q_2 = D^m_R n$ and $Q_3 = nD^m_P$, so that the individual budget constraints can be written as $P^eQ_1 + P^mQ_2 = W_R$ and $P^mQ^3 = v$. Then, total differentiation of these constraints with respect to R^r, and using the formulas for optimal prices in (17), leads to the following expressions (the argument R^r

suppressed):

$$Q_1' P^e + Q_2' P^m = \frac{1}{2}(Q_1 + Q_2), \text{ and } Q_3' P^m = \frac{1}{2} Q_3. \tag{28}$$

From the first equation in (28) we have

$$\begin{aligned}
\mathbf{D_R'} &= Q_1' + Q_2' < \frac{P^e}{P^m} Q_1' + Q_2' \\
&= \frac{1}{2} \frac{Q_1 + Q_2}{P^m} = \frac{\mathbf{D_R}}{P^m},
\end{aligned} \tag{29}$$

and from the second equation, realizing that $\mathbf{D_P} = Q_3$, we have

$$\mathbf{D_P'} = \frac{D_P}{2P^m}. \tag{30}$$

From the last two relations, (29) and (30), we have the result, $\mathbf{D_P}'(R^r)/\mathbf{D_P}(R^r) > \mathbf{D_R}'(R^r)/\mathbf{D_R}(R^r)$.

It is easy to realize that after the interest payments, the inequality is further decreased because of higher interest rate payed to the poor than to the rich for each R^r. ■

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