Inefficient Banking and Inflation: Evidence from Brazilian Hyperinflation*

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Abstract

What is the impact of inflation on the supply side of the banking sector? This paper draws lessons on the relationship between banking and inflation by exploring the Brazilian hyper-inflationary period during the 1990s. We formalize how banks can extract rents through "inflation profits" due to nominal deposits contracts in a model of heterogeneous banks with market power in the deposits market. The model implies the existence of low-productivity banks that are reliant on higher inflation to survive, competing with deposits from higher-productivity banks. These banks are inefficient, and a regulator would prefer to keep them outside the banking market. Using disaggregated bank balance sheet data, we construct an index of banks' reliance on inflation. We show that such a reliance predicts the exit of banks following disinflation. Our model's predictions of a disinflation are consistent with the Brazilian episode we study.

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1 Introduction

The costs high inflation bears on the economy are well-documented, ranging from uncertainty, indexation, the loss of purchasing power, and the exacerbation of inequality. As inflation is intrinsically related to money, one open question is how inflation changes the market structure of the financial sector. This paper advances our knowledge of this topic by showing how inflation can amplify market power distortions in the banking sector. We describe this mechanism in a model with heterogeneous banks and discuss the positive implications of our model in the context of the Brazilian hyperinflation episode and its successful disinflation plan, the Real Plan, in 1994.

Banks' main source of financing comes from deposits, where they likely exert some form of market power. One consequence of such power is seen when banks do not pass on increases in interest rates to their savings account holders, thus obtaining a relatively cheaper source of financing. In a banking sector model featuring market power, when inflation is high, the exertion of such market power becomes more pronounced and banks can extract higher rents from account holders. One reason to see why this is the case is that depositors still require banking services and money in their accounts even with very high inflation, irrespective of interest rates that are paid in these accounts. The reasons for such can vary from depositor inattention to liquidity services, collusion, geographical limitations in branch availability, or simply the time needed by consumers to move resources from low-interest savings accounts to higher-interest investments.

Irrespective of the reason, the fact is that an inelastic demand for deposits exists, thus allowing banks to leverage more into this cheap source of financing when inflation and nominal rates are higher. An intuitive way to understand the mechanism we describe in this paper is that with high inflation, banks will be financed at lower real rates, allowing a larger spread between their financing rates (deposits paid to costumers) and the interest they receive on their investments.

One consequence of such an easy source of financing is that even banks with low productivity will become profitable. With this idea in mind, we then ask: is inflation allowing low-productivity banks to exist, and are their existence a source of inefficiency for the aggregate economy? We answer this question both on theoretical and empirical grounds. On the theoretical side, we write down a model with heterogeneous productivity banks and a representative household that require deposits. Under these assumptions, we show that banking can indeed be inefficient so long as bank market power is sufficiently high or if there are high fixed setup costs for banks. More importantly, we show that with high inflation conditions

for inefficiency become easier to obtain.

On the empirical side, we explore in depth the 1994 Brazilian disinflation, an episode that credibly identifies the inefficiencies we propose. The Brazilian economy saw a sharp rise in the number of banks during the hyperinflation period until 1994, when a mix of monetary and fiscal policies managed to successfully halt the continuous increase of prices across the economy. Following the successful disinflation plan, the number of banks started decreasing, due both to failures as well as mergers. On the empirical side, we show how such a rise and drop in the number of banks can be partly attributed to a "selection" mechanism we describe: failures came mainly from banks' that survived on the grounds of making easy profits from inflation.

Outline The rest of the paper is organized as follows. In the next section, we describe the institutional details of the Brazilian banking system during the hyperinflation of the 90s. We also establish three descriptive facts to guide our analysis of the relationship between high inflation and banking. We then construct a model with heterogeneous banks and establish the main propositions that show how inflation can lead to the existence of inefficient banks. We also formalize the sources of inefficiency. Having the model in the background, in section 5 we describe a formal strategy to identify whether reliance on "inflation profits" is predictive of bank failure following the disinflation, i.e., whether banks that more readily leveraged on cheap deposit financing in high inflation had a hard time adapting to the new low inflation economic environment. Further, we also show that the competitive economy positive implications are very much in line with the hyperinflation event.

2 The Brazilian Banking Sector During The 1980s-1990s Hyperinflation

In July of 1994 Brazil implemented the Real Plan, a combination of fiscal and monetary policies that managed to tame hyperinflation, something that a myriad of preceding plans tried to do but was unsuccessful. The graph below illustrates the monthly inflation rates and the six stabilization plans that were enacted after Brazil's 1964-1985 military dictatorship ended.

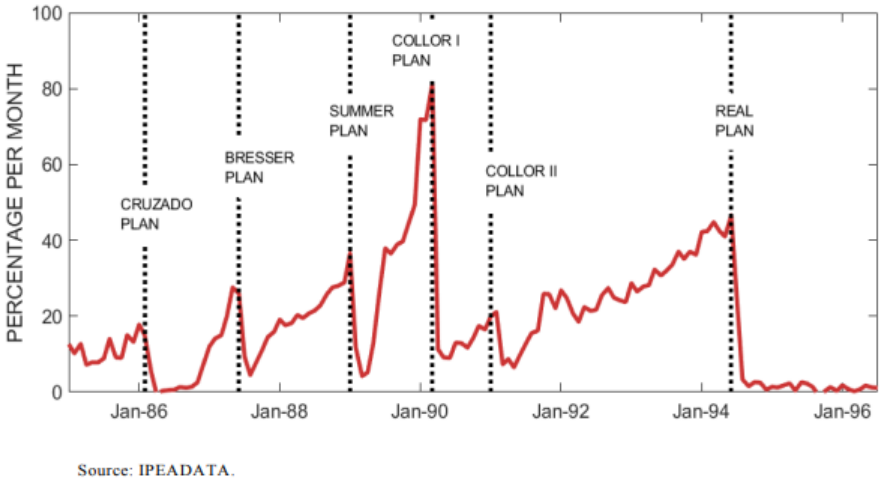

Figure 1: Brazilian monthly inflation, 1986-1996

Over the hyperinflation period, Brazil had four different currencies before the implementation of the current one, the Real. The high inflation period was one of economic distress, where goods would have their prices readjusted almost twice a month, families had to plan ahead in order to shop for groceries, and salaries would easily lose value if not spent or saved appropriately.

The curbing of inflation was evidently great for the economy as a whole, but not so much for the banking system, since it eliminated a very easy source of financing, deposits. As we show in the next section, banks were able to spread liability interest rates and assets rate of return. The stereotypical manifestation of this was on checking deposits, which even though represented a very small fraction of liabilities, with very high levels of inflation it still contributed to a very relevant rate of returns on bank equity. As a back of the envelope calculation, consider the example below:

Assets	Liabilities
100	Deposits = 2
	Other = 92
	Equity = 6

(a) Balance sheet in period t

Assets	Liabilities
142	Deposits = 2
	Other = 130.64
	Equity = 9.36

(b) Balance sheet in period $t+1$

Table 1: Example of inflation profits under 40% monthly inflation and 2% real interest rate

This example shows that even with very small deposit financing structure of 2%, with

40% monthly inflation, this would imply approximately a 10% monthly real return on equity.

On the other hand, economic and price stability eventually increased issuance of non-interest-bearing deposits, which at this point was a good sign since the arbitrage previously described represented already a negligible source of profits by 1995. This "new" form of financing was then used by banks to increase the supply of loans to the real economy. To avoid overheating, the Central Bank pursued a very aggressive tight monetary policy and set very high reserve requirements. In spite of this, loans increased during the first 12 months of the plan. The mix of high-interest rates and loans led to an increase in non-performing loans, which were aggravated by the contemporaneous Mexican tequila crisis. Non-performing loans increased from 5% in 1994 to 15% in 1997 (Baer and Nazmi, 2000).

Many of the banks that showed signs of trouble were public state banks, which existed in the first place as a way for local governments to leverage on the abovementioned easy inflation profits. To avoid a wave of public banks failure, the government created in 1997 a program that incentivized mergers and acquisitions of failing banks, named Reestructuring and Strenghthening of the Financial System Stimulus Program (Proer for the Portuguese acronym). This also represented an effort of the government for financial institutions to adhere the Basel principles. The fact that many of the unproductive banks were public is in no way at odds with our theory. Quite the contrary: our interpretation here is that the regulator wanted to clean the system. It is exactly the fact that many of these unproductive banks were public that allowed such a cleansing and also supported the Real plan. The loss of inflation profits by the state and local governments severely tied their hands and made them have to negotiate and ultimately accept the federal governments' plans of fiscal coordination, partly of which involved eliminating seigniorage revenues through state banks. Nonetheless, our results also apply when considering only the sample of private banks.

3 Data and Descriptive Facts

To empirically explore the relationship between banking and inflation during the Brazilian hyper-inflationary period, we rely primarily on the ESTBAN dataset, which is available through the Brazilian Central Bank. This dataset contains monthly disaggregated bank sheet information for all banks in the financial sector, starting in July 1988. From this dataset, we can obtain aggregated banking sectors data such as the number of banks, and the overall deposit ratio. The starting date is a limitation of the dataset; ideally, we would have data starting in the 1970s, when inflation was first rising (Figure 1 displays that monthly

inflation already hovered around 20% by January 1988).[1]

The level of disaggregation enables the exploration of different accounts on the bank's balance sheet, allowing us to assess the reliance on inflation profits for every bank operating from 1988 onward. It also allows us to explore cross-sectional statistics for the banking sector, such as the distribution of profit banks, the concentration of deposits, and bank's reliance on financial activities tightly related to inflation.

Our final dataset covers the period starting in July 1988 until December 2007. We exclude public banks from our empirical analysis when necessary, but we include them in banking sector-wide statistics. The data features 398 unique banks over 162 months (an unbalanced panel, as banks are created and fail).

3.1 Descriptive facts about the banking sector

We use the ESTBAN dataset to establish 3 facts about the banking sector during the hyper-inflationary period. We analyze on aggregate measures that are built as ratios of current values on the banks' balance sheets, thus avoiding any trends that are due to monetary corrections or changes of currency.

1. The number of private banks increased steeply in the period leading up to the Real Plan, then steadily declined. The private banking sector expanded rapidly during the late 1980s. In January 1988, there were about 150 private banks operating in the Brazilian banking sector; by January 1994, the number had risen to over 250 banks. The largest expansion took place in the late 1980s. Notably, the number of banks started to steadily decline after the Real plan, when inflation was brought down to the one-digit range.

[1] One can argue that the effects of high inflation depend on economic agents expectations about how long it would last. By January 1988, there had been two unsuccessful economic plans to curb high inflation, but the country would still see four more plans until inflation was brought under control.

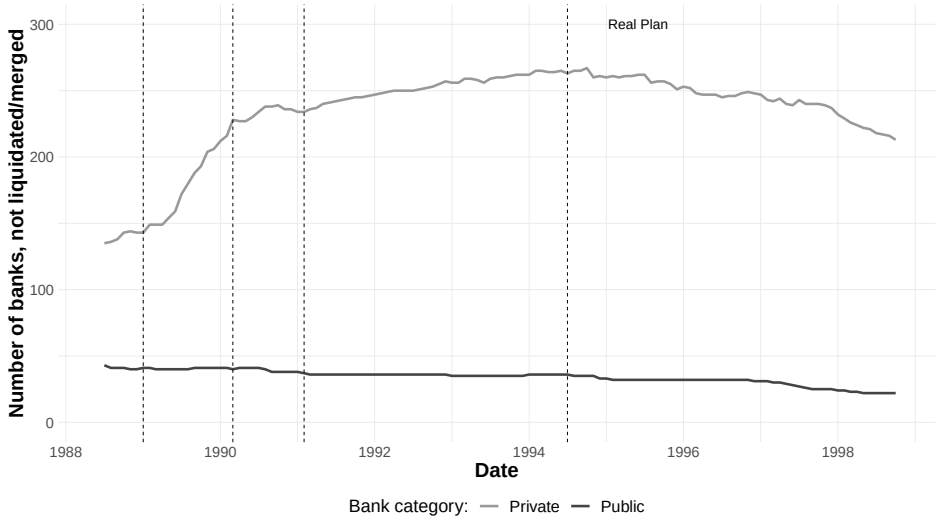

Figure 2: Number of private banks operating in the financial sector, 1988-2001

To highlight the rise and fall of the banks created in the hyper-inflationary period, we can further split the number of banks by the time period when they were created. We do so with three categories: banks created pre-July 1988 (that is, banks already established in the first period of our dataset), banks created between July 1988 and the Real Plan in July 1994, and banks created post-Real Plan. Figure 3 depicts the rise and fall of the "inflation banks": 134 private banks were created between July 1988 and 1994, and by 2000 over 50 of these banks had shut down their operations. We can also see that these banks failed more often than banks created pre-1988 over the post-Real period.

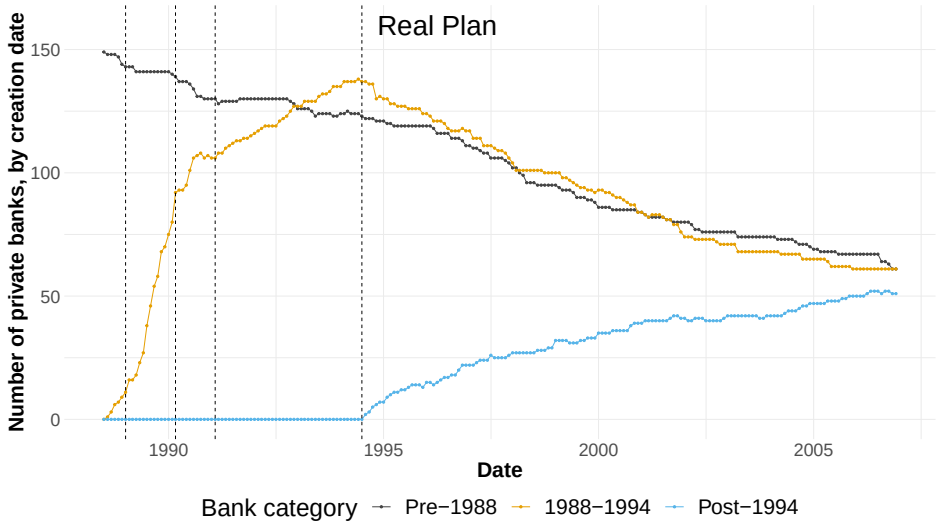

Figure 3: Number of private banks operating in the financial sector, 1988-2006

2. The share of deposits held by the 10 largest banks was continuously low between 1990 and 1994, rising steadily after the Real Plan. The Brazilian banking sector is notoriously concentrated, with a few large banks concentrating most of the assets and deposits in the banking sector. The 1990 Collor Plan entailed a confiscation of savings accounts, which may explain the sharp drop in the share of deposits held by 10 largest private banks, as depicted by Figure 4. However, the share of deposits of the 10 largest private banks did not recover and instead remained at about 50% between 1990 and the Real Plan. After the Real Plan, the share of deposits held by the 10 largest banks steadily increased, reaching 80% of the total deposits in the banking sector by 2010. The post-Real Plan period saw an increase of 5pp. in the share held by the 10 largest private banks.[2]

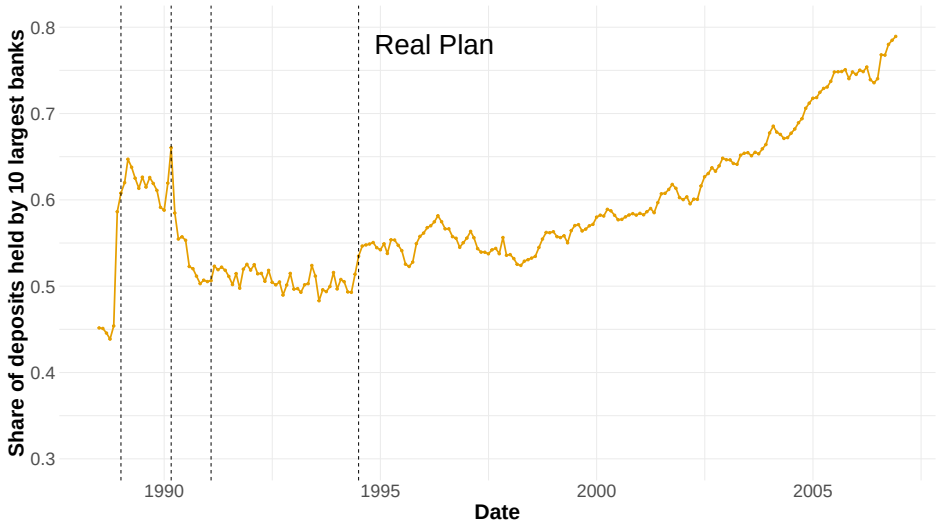

Figure 4: Share of total deposits held by largest 10 banks, 1988-2006

3. The average share of inflation-related revenues over total bank revenues drops sharply and steadily after the Real Plan. Using the ESTBAN dataset, we can construct a measure of revenues that captures gains from operations whose profitability relies strongly on inflation. Dividing these by the total operating revenues of a bank, we obtain a measure of "inflation revenues" which does not rely on corrections for the price level.[3] Although this measure is imperfect, we can see on Figure 5 that it tracks inflation rather closely: with the exception of the Summer Plan, the revenue collapses momentarily after each stabilization package, before picking up again as inflation increases. Only after the

[2]Results are similar if we consider the 10% largest private banks.
[3]We discuss this measure further in Section 5.1.

Real Plan the drop is permanent. In the post-Real period, the average inflation revenue share hovers around 10 to 20%, while during the hyperinflationary period, it ranges from about 20% to 50%.

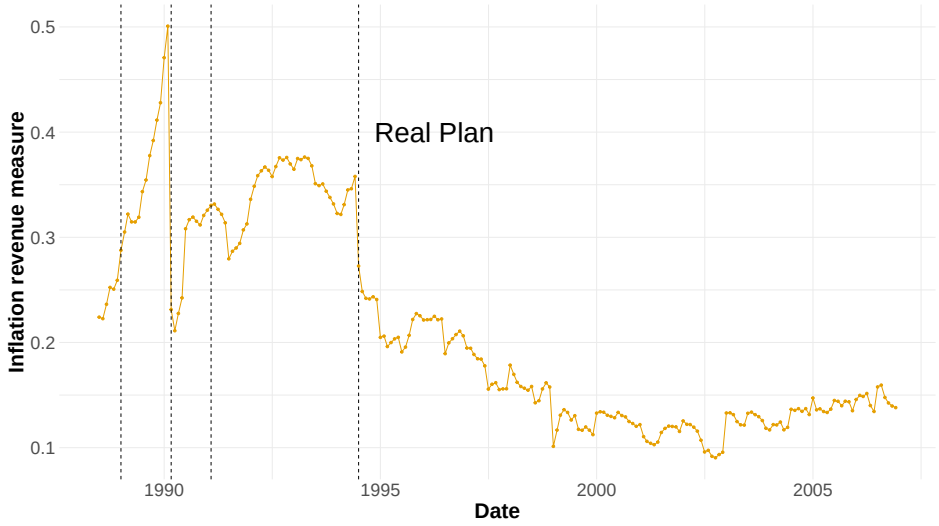

Figure 5: Share of revenue due to "inflation revenues", 1988-2006

Discussion Taken together, the three facts we show portray a quickly expanding banking sector that is over-reliant on inflation revenues to achieve profitability. The hyper-inflationary period saw a large expansion of private banks which is unparalleled in recent Brazilian history. This episode also coincided with a brief decentralization of deposits from the 10 largest banks in the financial sector in a notoriously concentrated banking sector. Finally, a large share of bank revenues can be traced back to economic activities whose nominal profitability increases with inflation. All these three phenomena receded with the introduction of the Real Plan, which ended the hyper-inflationary period.

4 Model

We present the micro-foundation of the link between inflation, deposits supply and banks market power. The economy lasts for only two periods and we assume that households can invest in cash and deposits. Beyond store of value, both assets provide differential benefits. Cash provides liquidity services enjoyed by the household, while deposits earn some endogenous nominal rate of return $R^D = \frac{1}{P^D}$. Deposits are composed of an aggregate of a continuum banks' deposits, allowing us to to capture banks' market power in a representative household setup (see Drechsler et al. (2017)). We first show that planner problem to highlight

the key trade-offs societies faces in this environment and then we decentralize the setting with banks.

4.1 Planner Problem

There are two periods $t = 0, 1$ and a deterministic inflation π at $t = 1$. Inflation here will be a parameter and we shall perform comparative statics on the resulting equilibrium as inflation increases. This is in line as to how we interpret the setting during the 80s and 90s in Brazil, where inflation was fundamentally caused by badly conducted fiscal and monetary policy and exogenous to the developments in the banking sector. The objective of society is to transfer wealth from period 0 to period 1. There are two sets of assets as savings technology to transfer wealth W_0 to period 1.

- money M: provides liquidity services governed by preference parameter $\ell \in [0, 1]$
- a continuum deposits D_i

Introduction of a new deposit variety requires a fixed cost F and each variety produces output in period 1 with a linear technology.

$$f(D_i) = R^L A_i D_i,\ A_i \in [0, 1],\ R^L > 1$$

In period 1, deposits are imperfect complements and yields utility aggregate utility D according to a CES aggregator:

$$D = \left(\int_i D_i^{\frac{\eta-1}{\eta}} di \right)^{\frac{\eta}{\eta-1}},\ \text{elasticity of substitution } \eta > 1 \tag{1}$$

Both money M and deposits D depreciate in real value and are worth $\frac{1}{1+\pi}$ unit of consumption at $t = 1$. With this we can write the social planner problem

$$\max_{M, \bar{A}, D_i} V \text{ s.t. } M + \int_{\bar{A}}^1 D_i di = W_0 \tag{2}$$

$$V = \underbrace{\frac{M}{1+\pi} + \frac{\left(\int_{\bar{A}}^1 D_i^{\frac{\eta-1}{\eta}} di \right)^{\frac{\eta}{\eta-1}}}{1+\pi}}_{\text{net of depreciation savings}} + \underbrace{\int_{\bar{A}}^1 R^L A_i D_i - \frac{D_i}{1+\pi} di}_{\text{deposits technologies}} - \underbrace{\int_{\bar{A}}^1 F di}_{\text{cost of variety}} + \underbrace{\left(\frac{M}{1+\pi} \right)^{\ell}}_{\text{liquidity preference}} \tag{3}$$

The key trade-offs involves using deposits to finance a potentially productive technology in period 1 and yields variety utility, but requires a fixed setup cost and provides less liquidity services than money. In Appendix A.1 we characterize the socially optimal allocation. In the text we will deal with a more constrained and simpler planner problem, which we call a regulator, that chooses directly the number of banks in the economy subject to a competitive equilibrium constraint. Not only this is simpler for the inefficiency argument, it also best resembles how an actual regulator could interevene in this economy.

4.2 Competitive Equilibrium

A representative household can save in cash M and deposits D_i at banks. Both assets are nominal, which means they lose real value with inflation π. Cash M provides liquidity services to households, governed by $\ell < 1$. Household maximizes total savings and liquidity services in period 1. Heterogeneous banks issue nominal deposits to maximize profits. Each bank must pay a fixed cost F to set up

4.2.1 Household problem

The representative household maximizes utility over final real wealth, W, and liquidity services, M, in period $t = 1$ according to a Cobb-Douglas aggregator[4]:

$$V(W_0) = \max_{M,D_i} \frac{M}{1+\pi} + \frac{D}{1+\pi} + \mathcal{P} + \left(\frac{M}{1+\pi}\right)^{\ell} \tag{4}$$

$$\text{s.t. } M + \int_{\bar{A}}^{1} P_i^D D_i di = W_0 \tag{5}$$

Optimal choice of deposits baskets implies the standard CES price index for deposits, with the slight difference that here the number of banks is determined in equilibrium and taken as given by households.

$$P^D = \left(\int_{\bar{A}}^{1} {P_i^D}^{1-\eta} di\right)^{\frac{1}{1-\eta}} \tag{6}$$

where $\bar{A}$ is the lowest productivity bank in the market

[4]As noted in Drechsler et al. (2017) a preference for liquidity arises in many models. For example, it arises from a cash-in-advance constraint (Galí (2015) or from a preference for extreme safety (Stein (1995)). In either case, it is natural to think of levels of wealth and liquidity as complements.

Banks' aggregate profits $\mathcal{P}$ rebated to the household. In period $t = 0$ households decide how to store wealth choosing between deposit and cash. In period $t = 1$ deposits pay a return of one unit and cash is discounted from the inflation in the period $(1 + \pi)$. We think as cash consisting of currency and zero interest deposits. Deposits include any interest bearing account at the banks. In the empirical section 5.1 we further clarify measurement.

4.2.2 Banks problem

Banks in this economy issues deposits to fund loans that earn some exogenous interest rate R^L. We do not model the loans market and take it as an exogenous constant.

Banks are ex-ante heterogeneous with respect to loan productivity A_i, given by a uniform distribution between $[0, 1]$. $A_i \in [0, 1]$ captures banks' i idiosyncratic productivity. A natural interpretation is that banks' differ in their credit screening abilities. Banks optimize profits obtained in the last period:

$$\mathcal{P}_i := \max_{D_i} A_i R^L P_i^D(D_i, \pi) D_i - D_i \tag{7}$$

To determine bank entry in this economy, we assume that banks have to pay some fixed cost to operate and normalize banks outside option to zero. For example, in competitive equilibrium bank entry that pins down $\bar{A}$ will be determined by a zero-profit condition.

4.3 Equilibrium

We will work with two concepts of equilibrium to illustrate how inflation can generate inefficient banking in this economy.

A competitive equilibrium is given by an entrance threshold $\bar{A}$, an equilibrium are allocations $\{\{D_i^*\}_{i\in[\bar{A},1]}, D^*, M^*\}$ and prices $\{\{P_i^*\}_{i\in[\bar{A}^*,1]}, P^{D*}\}$ such that:

- **Households:** Given prices $\{\{R_i^*\}_{i\in[\bar{A},1]}, R^{D*}\}$ households solve (1)-(4)
- **Banks:** Given a supply of deposits $R_i^D(D_i, \pi)$ banks solve (7)
- **Deposits market clear**
- **Free-entry**: $\mathcal{P}(\bar{A}) = 0$

We also define a regulator equilibrium, which is determined by an entrance threshold for $\bar{A}$ that optimizes household welfare. Formally, the regulator equilibrium is given by

an entrance threshold $\bar{A}$, an equilibrium are allocations $\{\{D_i^*\}_{i\in[\bar{A},1]}, D^*, M^*\}$ and prices $\{\{P_i^*\}_{i\in[\bar{A}^*,1]}, P^{D*}\}$ such that:

- **Households:** Given prices $\{\{R_i^*\}_{i\in[\bar{A},1]}, R^{D*}\}$ households solve (1)-(4)
- **Banks:** Given a supply of deposits $R_i^D(D_i, \pi)$ banks solve (7)
- **Deposits market clear**
- **Regulator**: $V^{reg} := \max_{\bar{A}} V$

One can immediately see that the regulator plan in this economy is weakly superior for the household than the competitive equilibrium. What is more interesting in the current setup is asking when the competitive equilibrium generates too many banks, which defines what inefficient banking is. We first describe some properties of any equilibrium that are useful to understand the trade-offs of too few or too many banks and then investigate the links between inefficient banking and inflation in this economy.

4.4 Pricing and Entrance in Equilibrium

A key endogenous object in this economy is the endogenous rate of return on deposits, which due to households love of variety will be tightly linked bank entry. Banks first order conditions imply

$$P_i^D = \left((A_i R^L (1+\xi)\right)^{-1} \tag{8}$$

Written in terms of returns to deposits

$$R_i^D := \frac{1}{P_i^D} = (1+\xi) A_i R^L \tag{9}$$

where $\xi^D := \frac{\partial P_i}{\partial D_i}\frac{D_i}{P_i} = -\frac{1}{\eta}$ is the supply elasticity of deposits at the optimal deposit issuance chosen by the bank. Note that from the household problem this elasticity is constant. This equation says banks issue deposits with a spread over loan interest rates that are increasing in bank's productivity. As in the monopoly framework, for the problem to be well defined we need $\eta > 1$.

Proposition 1: The aggregate rate of return on deposits is increasing with the number of banks:

$$R^D = \frac{1}{R^L(1+\xi)}\left(\frac{1}{\eta} - \frac{\bar{A}^\eta}{\eta}\right)^{\frac{1}{1-\eta}} \tag{10}$$

This and all remaining proofs for the competitive equilibirum are relegated to Appendix A.2.

Note that there are more banks in this economy whenever $\bar{A}$ is lower. This results follows from households preferences for deposits variety, which roughly interpreting the data could be reflecting more banking competition and greater banking service options.

Next we describe what happens with the number of banks as inflation increases.

Proposition 2: If inflation induces higher real deposits, then banks profits are increasing with inflation.

$$\mathcal{P}(A_i, \bar{A}, D) = Z_\eta \frac{D}{1+\pi}\left[\frac{A_i}{\left[1-\bar{A}^\eta\right]^{\frac{1}{\eta-1}}}\right]^\eta - F \tag{11}$$

where Z_η is decreasing to zero as $\eta \to \infty$ (convergence from monopolistic competition to the price-taking behavior).

This proposition is intuitive: if demand for banks saving technology increases, they become more profitable. The less trivial part is characterizing when deposits increases with inflation. Since inflation induces a negative wealth effect, depending on how preferences are specified, a cash hoarding effect due to liquidity services could actually push demand deposits down. For this, it suffices that the parameter governing liquidity services is not too large or that banks have sufficient market power (so η is high enough). This is the content of

Proposition 3: Equilibrium cash holdings decrease are amplified if

- $\downarrow \ell$: liquidity demand is not too high
- $\downarrow \eta$: banks have sufficient market power

The intutition for the latter condition is that, with market power:

- banks willingness to enter the market is big: $\uparrow \left|\frac{d\bar{A}}{d\pi}\right|$
- deposit rate response to entrance is large: $\uparrow \left|\frac{dR^D}{d\bar{A}}\right|$

With banks profits increasing with inflation, it is then clear that higher inflation induces bank entry. In particular, more unproductive banks will operate in this economy in high inflation environments. However, since the marginal entrant bank is always less productive, it is not obvious what happens to aggregate profits with higher inflation. The next proposition shows that aggregate profits decreases with more banks.

Proposition 4: Equilibrium profits $\mathcal{P}^*(\bar{A}) := \mathcal{P}(\bar{A}, \bar{A}, D(\bar{A}))$ is increasing in $\bar{A}$ if η is sufficiently high or aggregate bank sector productivity R^L is sufficiently high.

This result is important for the relationship between inflation, number of banks and welfare. In this economy, profits of banks could be a good thing since profits are eventually rebated to households. However, every bank requires a fixed setup cost. It turn out that aggregate profits are decreasing with the number of banks if banks do not have enough market power or if loans do not yield enough returns. Note that a direct of this proposition establishes uniqueness and existence of a competitive equilibrium subject to the same parametric restrictions. Profits are increasing in own productivity as we have seen (the first argument). It is also increasing in its second argument (reducing the number of banks). For deposits, we have seen that entrance (lower $\bar{A}$) increases the rate of return on deposits, which increases the demand for deposits. Hence, $\mathcal{P}(.,.,A)$ is decreasing in A, which shows that in principle this economy may have none or multiple equilibria. The intuition is that with η sufficiently large, deposits become close to perfect substitutes and therefore respond relatively little to entrance of banks.

4.5 Inefficient Banking with High-Inflation

With the link between inflation, number of banks and welfare clear, we now characterize in what sense is that high inflation could generate an excess of banks in the economy. For this, we define the regulator problem

$$V^{reg} := \max_{\bar{A}\in[0,1]} V \text{ s.t. decentralized equilibrium} \tag{12}$$

The regulator would like to increase deposits variety, but economize on fixed costs. This can be seen explicitly by the first order conditions

$$\underbrace{\frac{\partial V}{\partial R^D}}_{\geq 0}\underbrace{\frac{\partial R^D}{\partial \bar{A}}}_{(1)} + \underbrace{\frac{\partial V}{\partial \mathcal{P}}}_{=1}\underbrace{\frac{\partial \mathcal{P}}{\partial \bar{A}}}_{(2)} = 0 \tag{13}$$

(1) quality of HH savings technology (rate of return/deposits variety)

(2) fixed cost to create banks

In our economy:

(1) ≤ 0 due to idiosyncratic pricing

(2) ≥ 0 when evaluated at $\bar{A} = \bar{A}^C$

In the next proposition we define inefficient banking, a condition when the planner would like to pick less banks than the competitive equilibrium.

Proposition 5: Inefficient Banking If love of variety small (large η) or high fixed costs (F large)

$$\frac{\partial V}{\partial E}\frac{\partial E}{\partial \bar{A}}\bigg|_{\bar{A}=\bar{A}^{\text{free-entry}}} \geq \frac{\partial V}{\partial R^D}\frac{\partial R^D}{\partial \bar{A}}\bigg|_{\bar{A}=\bar{A}^{\text{free-entry}}} \tag{14}$$

Intuitively increasing $\bar{A}$ generates more profits for remaining banks + saves no fixed cost

The next is the main proposition derived from the model, that defines how inflation can worsen the inefficient banking problem.

Proposition 6: inefficient banking with high-inflation

If $\pi^H > \pi^L$

$$\bar{A}_H^{reg} - \bar{A}_H^C > \bar{A}_L^{reg} - \bar{A}_L^C \tag{15}$$

The intuition is that banks become more profitable, especially the most productive ones. Hence it is optimal to give a larger market share to these. This motivation for the regulator is further amplified since the competitive equilibrium benchmark with higher inflation satiates to a greater degree the love of bank variety.

4.6 Numerical Example

To illustrate the results in the model, consider the following calibration:

Inflation levels were chosen to roughly coincide with monthly inflation levels right before and after the real plan. Liquidity preferences are obtained from the commonly used value in the literature (e.g. **?**). Total initial wealth is normalized to 1. Fixed costs are set to 0.1% of the economy wealth. Real returns of banks projects R^L and the bank market power η are jointly set to generate a unique equilibrium. One could pick other combinations of these

Parameter	Description	Value
η	supply elasticity of deposit	20.0
R^L	real return on banks project	1+0.2
F	fixed cost to operate a bank	0.001
$1+\pi^H$	high inflation	1+0.7
$1+\pi^L$	low inflation	1+0.3
ℓ	liquidity preference	0.05
W_0	economy wealth	1.0

parameters. The model is not designed to yield quantitative predictions, but instead here we propose showing numerically the content of the above propositions with parameters that are reasonable.

Given these parameters, below we plot visually the content of proposition 5:

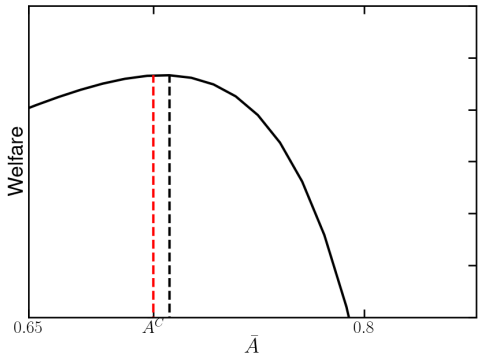

Figure 6: π_H

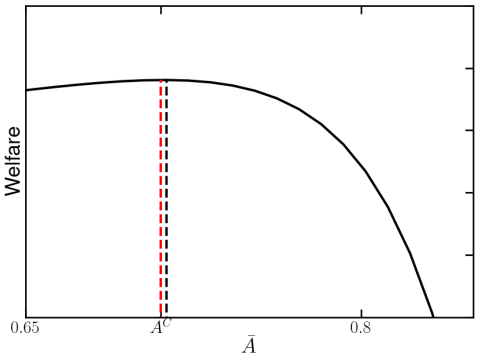

Figure 7: π_L

Figure 6, with high inflation, generates excessive banks which can be seen with the red line being at the left of the regulator's choice. As inflation decreases, the competitive equilibrium number of banks converges to the regulator's choice. Note that the content of Proposition 5 is not about the optimal level of inflation, but instead what a regulator would like given a level of inflation.

5 Empirical Validation

We now turn to evaluate our model in light of the banking data available.

5.1 "Inflation Profits" as Predictive of Bank Failure

As mentioned in Section 3, we leverage the richness of the ESTBAN dataset to construct a measure of a bank's reliance on "inflation profits" or "inflation revenues". We do so by

considering the breakdown of revenues within a bank. Revenues can be accrued through credit operations, interbank lending, foreign exchange markets, services, bonds, etc. To build our "inflation revenue" measure, we consider the share of a bank's revenue of two specific sources: the interbank lendings (which includes central bank deposits), and from bonds and derivatives. The revenue from this accounts are argued to be the ones most exposed to inflation in past work.

Building our measure as a share of nominal values has the advantage of abstracting away from correcting nominal values for inflation. Brazil's currency changed five times in ten years, and with monthly inflation hovering around 20pp., monetary adjustments are extremely influential when computing nominal values. Our measure however may capture some revenues which are invariant to inflation, thus being ultimately a proxy of a bank's reliance on high inflation to achieve profitability.

Our model conjectures that banks that are highly reliant on inflation-related revenues will be the ones most negatively affected by the Real Plan, once inflation is taken under control. Such banks are likely to have low productivity in the lending market, and only would be able to survive in the market because of the revenues accrued through economic activities whose gains correlate positively with inflation. Thus, once inflation is under control, these banks would struggle to survive, ultimately exiting the market.

To empirically evaluate the relationship, we use the ESTBAN dataset to build a (balanced) monthly panel, ranging from July 1994 to December 2006, of banks that were active during the 1988-1994 period. For each bank-month cell, we construct our measure of "inflation revenues" as mentioned above, which we denote by RI_{it}, where i denotes a bank and t a month. For each bank, we consider the pre-Real average of RI_{it}, $\bar{RI}_i$, as our regressor of interest. We then regress $\bar{RI}_i$ on a dummy $Survive_{it}$, which denotes if the bank is still operating. Thus, our regression equation takes the following format:

$$Survive_{it} = \beta_0 + \sum_{k=July1994}^{Dec2006} \beta_k \bar{RI}_i \times \mathbb{1}(k = t) + \varepsilon_{it}$$

We standardize $\bar{RI}_i$ across all banks included in the regressions, so we can interpret each β_k as the correlation between one standard deviation in our measure of banks' reliance on inflation and the probability of survival of bank in the post-Real period.

Figure 8 displays the results. Starting in July 1994, the point estimates tilt positively slightly, suggesting banks which failed right after the Real Plan were not very reliant on "inflation revenues". Starting in 1996 throughout 2006, however, the "inflation revenue"

measure is negatively correlated with bank failure, suggesting that the banks who existed before the Real Plan and failed in that time period were more reliant on "inflation revenues" than banks who survived. Numerically, our estimates suggest that by the 2000s, a one standard deviation increase in the reliance on "inflation revenue" is associated with a 10pp. decrease in the probability of bank survival. This is in line with the model prediction that lower-productivity banks enter the market as inflation increases, which in turn implies that once inflation is brought under control, these banks are unlikely to be productive enough to stay in the market.

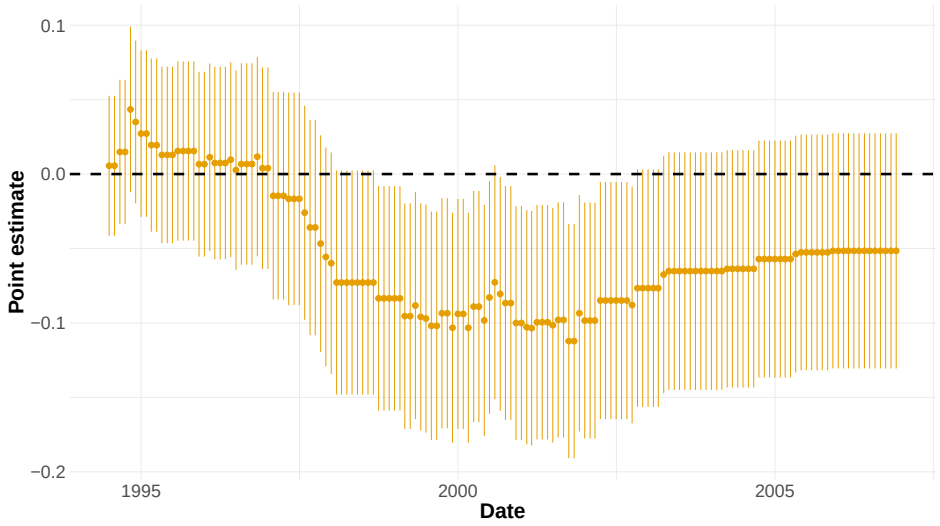

Figure 8: Point estimates of the correlation between "inflation revenues" and bank survival probability, 1994-2006

5.2 Positive Analysis of the Model

We now turn to some implications of the model that can be confirmed using the available data. In this analysis, we use the ESTBAN database to examine three facts predicted by the model: that deposits increase with greater inflation, that banks' profits increase with greater inflation, and that average productivity decreases with greater inflation.

1. Deposits increase with inflation: From the household problem, the increase of inflation leads to a substitution from money to deposits. As inflation increases, households tend to substitute money with deposits in order to protect their wealth from the declining value of money. This can be seen in the steady increase of the deposit-to-asset ratio in the economy, as shown in Figure 9 using ESTBAN balance sheet data. It is important to note

that the equilibrium level of deposits in this model is influenced by both the demand and supply sides of the economy. While the decrease in the real rate of return in the monopolistic competition may affect the supply of deposits from banks, the increase in the demand for deposits ultimately leads to an increase in the equilibrium level of deposits. This is because the increase in demand for deposits is not offset by the decrease in the real rate of return in the monopolistic competition with the assumptions of the model (in this case, the return on deposit chosen by the monopolist is the same).

The data also suggests that households favor deposits that offer some interest (long-term and savings), further supporting the idea that they are seeking to maximize wealth while subject to some liquidity constraints. In other words, households are substituting assets with different levels of liquidity in response to the differential rising cost of holding them.

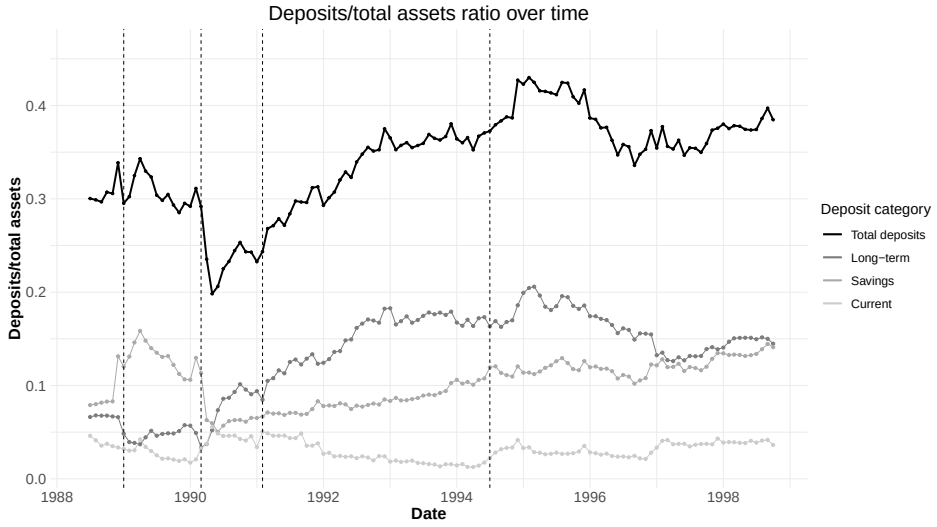

Figure 9: Monthly deposit/asset ratio in the banking system.

2. Profits increase with inflation: According to proposition 2, the model suggests that when inflation is high, banks tend to see an increase in profits. This is because high inflation leads to an increase in the demand for deposits. Banks can then use their market power, as well as the demand for liquidity among households, to generate profits by manipulating the spread rate and supply for deposits. It is important to note that this mechanism operates through the market power and liquidity demand of households, which allows banks to exert influence on the specific product they offer: deposits. [5]

[5]It's worth noting that the model does not imply that banks will also increase the difference between the interest rates on deposits and loans, but it is possible that they could do so in order to further increase profits. Even if the demand for deposits decreases in equilibrium as a result of this action, the overall profits

Figure 10 sheds some light on the relationship between inflation and profitability in the banking sector. While it is difficult to establish direct causation between the two, the data suggest that banks' profits and inflation are correlated. We can see that during the first years after the stabilization of the currency (Real Plan), banks experienced a significant decline in profitability. While this phenomenon has been documented (see IBGE (1997)), this study is the first to use data from banks' balance sheets and profit and loss statements from ESTBAN to examine it.

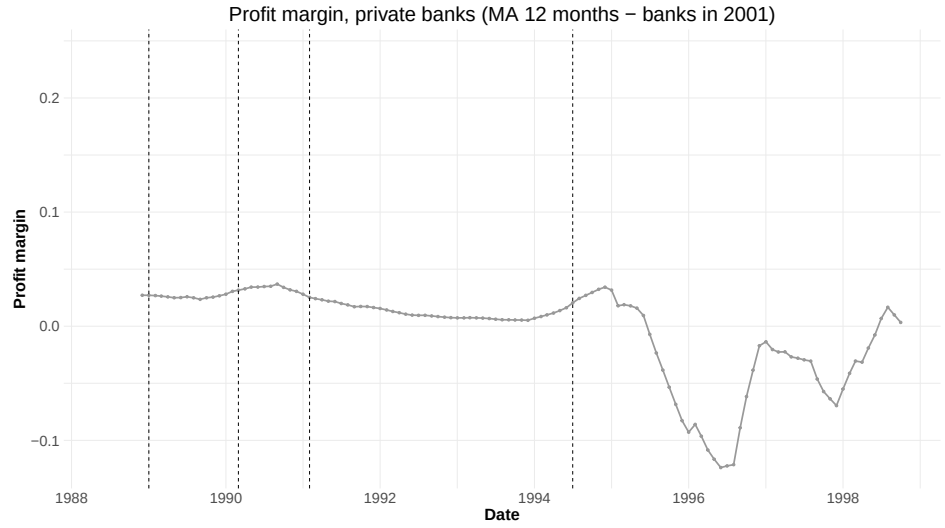

Figure 10: Moving average (12 months) of banks' profit margin

3. Increase in the number of banks and a decrease in the productivity of the sector ($\overline{A}$) with high inflation: As discussed, the model predicts that higher inflation leads to higher profits for banks. Additionally, the model posits that a fixed threshold for free entry leads to a increase in the number of banks (decrease in $\overline{A}$) in the economy. This comes from the fact that the free entry condition is satisfied for a lower A_i when the inflation in the economy is higher.

The mechanism proposed by the model to explain this relationship is as follows: Higher inflation leads to increased demand for deposits from households (Figure 9). This allows banks, given a certain level of productivity (A_i), to increase their profits (Figure 10) and lower the threshold ($\overline{A}$) in the free entry condition. As a result, the number of banks in the economy increases. Note that the deposit demand and the profit margin increase are in line with what we see in the data (as mentioned in the previous topics).

of the bank will still rise, since banks are profit-maximizing.

The Brazilian economy saw a significant increase in the number of private banks during a period of high inflation (descriptive fact number 1). This was followed by a steady decline in the number of banks after the stabilization of the domestic currency, which suggests that inflation may have an impact in entrance/exit of banks in the market. While there are other factors that contributed to the consolidation of the banking sector[6], the end of the "easy profit" period may also have played a significant role in this dynamics.

Another dimension that inflation can affect in the banking sector is the productivity of existing banks. The model suggests that productivity in this market declines with an increase in inflation (lower $\overline{A}$). Since direct data on the productivity of banks is not available, we try to gauge this dimension using some indirect forms of productivity measurement. Figure 11 shows the interquartile range of the return on credit [7]. Note that the model implies a higher interquartile range in periods of high inflation. In other words, there is more variability in the productivity of banks in a high inflation economy.

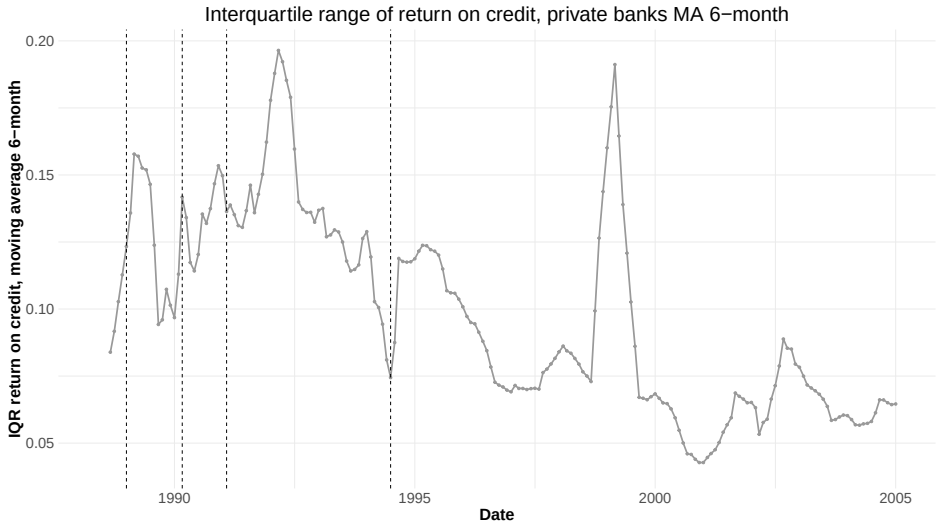

Figure 11: Interquartile range of return on credit

6 Conclusion

In this paper, we examine the effects of inflation on the banking system, using the Brazilian hyperinflationary crisis of the 1980s and 1990s as a case study. We argue that during periods

[6]Among these other factors are: the increase in the participation of international banks in the domestic economy, the ease of regulation for mergers and acquisitions of banks, and the decrease in the reliance on geographic location due to the growth of online banking. See see IBGE (1997) for further reference.

[7]Return on credit refers to the income generated from credit operations as a proportion of the amount of credit extended, as recorded on the asset side of a bank's balance sheet.

of high inflation, the liquidity needs of households and the market power of banks interact in a way that makes banks more profitable. Additionally, in a free market economy, the number of unproductive banks tends to increase during times of high inflation.

We find that a model with liquidity demand and banks' market power is consistent with the facts documented during the period: increase in deposits, profit increase from banks, increase in the number of banks and decrease in the productivity of the sector. The model implies the existence of low-productivity banks that are over-reliant on inflation profits to survive, competing with deposits from higher-productivity banks. Moreover, under some assumptions, the high inflation competitive equilibrium economy could generate an excess of banks, leaving space for policy actions.

Finally, we use disaggregated data from bank balance sheets to create an index of banks' reliance on inflation. This index is based on the proportion of a bank's revenue that comes from pure financial assets rather than credit operations. When banks can profit simply by collecting deposits and investing in bonds or central bank accounts, they do not have to bear credit risk. This can be especially lucrative during periods of high inflation. Our analysis shows that this index of banks' reliance on inflation can predict the exit of banks during the period of disinflation after the Real Plan.

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A Proofs

A.1 Planner Problem

Taking first order conditions with respect to D_i we find the optimal within allocation of deposits

$$D_i = DA_i^{\eta}\eta^{\frac{\eta}{\eta-1}}\frac{1}{\left(1-\bar{A}\right)^{\frac{\eta}{\eta-1}}} \tag{16}$$

Second order conditions are verified:

$$\frac{\partial^2 V}{\partial D_i^2} = \frac{1}{\eta}\left(\frac{D_i}{D}\right)^{\frac{-1}{\eta}} \underbrace{\left(\frac{D^{\frac{1}{\eta}}}{DD_i^{\frac{1}{\eta}}} - 1\right)}_{<0} \tag{17}$$

This then allows us to rewrite

$$\int_{\bar{A}}^{1} A_i D_i di = \frac{D\eta^{\frac{\eta}{\eta-1}}}{\left(1-\bar{A}\right)^{\frac{\eta}{\eta-1}}}\frac{1}{\eta+2}\left[1-\bar{A}^{\eta+2}\right] \tag{18}$$

With which we can then take first conditions with respect to D and $\bar{A}$
Given optimal allocation of deposits, optimal D and $\bar{A}$

$$D = W_0 - \left(\frac{\ell}{R^L(1+\pi)^{1+\ell}h(\bar{A})}\right)^{\frac{1}{1-\ell}} \tag{19}$$

where $h(\bar{A})$ is a function that satisfies $\lim_{\bar{A}\to 1} h(\bar{A}) = \infty$, $\lim_{\bar{A}\to 0} h(\bar{A}) = C_\eta$
First order conditions with respect to $\bar{A}$ yields

$$R^L(1+\pi)Dh'(\bar{A}) = F \tag{20}$$

where $\lim_{\bar{A}\to 1} h'(\bar{A}) = \infty$ and $\lim_{\bar{A}\to 0} h'(\bar{A}) = \tilde{C}_\eta$

A.2 Competitive Equilibrium

Proof of Proposition 1:

From the optimal pricing we can derive aggregate prices

$$P^D = \left(\int_{\bar{A}}^{1} P_i^{D\,1-\eta} di \right)^{\frac{1}{1-\eta}} \tag{21}$$

$$= \left(\int_{\bar{A}}^{1} \left(\frac{1}{\frac{\eta-1}{\eta} A_i (1+\pi) R^L} \right)^{1-\eta} dA_i \right)^{\frac{1}{1-\eta}} \tag{22}$$

$$= \frac{\eta}{(\eta-1)(1+\pi)R^L} \left(\int_{\bar{A}}^{1} \frac{1}{A_i}^{1-\eta} dA_i \right)^{\frac{1}{1-\eta}} \tag{23}$$

$$= \frac{\eta}{(\eta-1)(1+\pi)R^L} \left[\frac{1}{\eta} - \frac{\bar{A}^\eta}{\eta} \right]^{\frac{1}{1-\eta}} \tag{24}$$

The result follows by the definition of aggregate returns $R^D := \frac{1}{P^D}$.

Proof of Proposition 2:

Follows directly from algebraic manipulation of the profit function and aggregate prices:

$$\mathcal{P}(A_i, \bar{A}, D^*) = \left(\frac{\eta-1}{\eta} \right)^\eta \frac{1}{(\eta-1)} (1+\pi)^{\eta-1} \left(A_i R^L \left[\frac{\eta}{(\eta-1)(1+\pi)R^L} \left[\frac{1}{\eta} - \frac{\bar{A}^\eta}{\eta} \right]^{\frac{1}{1-\eta}} \right] \right)^\eta D \tag{25}$$

$$= \frac{1}{(\eta-1)} (1+\pi)^{\eta-1} \left(A_i R^L \left[\frac{1}{(1+\pi)R^L} \left[\frac{1}{\eta} - \frac{\bar{A}^\eta}{\eta} \right]^{\frac{1}{1-\eta}} \right] \right)^\eta D \tag{26}$$

$$= \frac{1}{(\eta-1)} \left(\frac{1}{\eta} \right)^\eta (1+\pi)^{\eta-1} \left(A_i R^L \left[\frac{1}{(1+\pi)R^L} \left[1 - \bar{A}^\eta \right]^{\frac{1}{1-\eta}} \right] \right)^\eta D \tag{27}$$

$$= \frac{1}{(\eta-1)} \left(\frac{1}{\eta} \right)^\eta (1+\pi)^{-1} \left(A_i \left[\left[1 - \bar{A}^\eta \right]^{\frac{1}{1-\eta}} \right] \right)^\eta D \tag{28}$$

Proof of Proposition 3:

Equilibrium cash holdings is

$$M^* = (1+\pi) \left(\frac{\ell}{R^D(\bar{A}) - 1} \right)^{\frac{1}{1-\ell}} \tag{29}$$

The result follows by directly taking derivatives.

Proof of Proposition 4:

Follows directly by taking the total derivative of $\mathcal{P}^*(\bar{A})$.

Proof of Proposition 5:

The condition for fixed cost F is obvious. Regarding bank market power, it is a direct corollary of proposition 2.

Proof of Proposition 6:

Follows directly from Proposition 2, 3 and 4.