BANKING PRODUCTIVITY AND ECONOMIC FLUCTUATIONS: Colombia 1998-2000.

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Abstract

I build a general equilibrium, financial accelerator model that incorporates an explicit technology for the intermediary sector. A credit multiplier emerges because of a borrowing constraint that is a function of asset prices, internal funds and lending rates. With this financial friction I show that small changes in the productivity and intermediation costs of banks generate large and persistent fluctuations in economic activity. The transmission channel relies on the role that assets and internal funds play as collateral. After a negative shock hits financial intermediation productivity, the resulting credit crunch and economic slowdown induce a fall in asset prices and internal fund accumulation. This further modifies the present and future volume of collateral, thereby amplifying and propagating the initial shock. I argue that changes in banking regulation in Colombia in the late 1990's increased intermediation costs, reduced banking productivity and induced a credit channel story that fits the theoretical model presented here. This new regulation enhanced the credit crunch and economic slowdown that was already underway. Colombian data on loan/deposit interest rate spreads, credit volume, asset prices and economic activity support this argument.

Keywords: Financial accelerator, banking productivity, intermediation costs, borrowing limit, credit crunch, amplification, propagation.

JEL: E32, E42, E44, G21.

1. INTRODUCTION

During the last three and a half years the economic performance of Colombia has been disastrous. The unemployment rate has fluctuated around 18% in the seven most important cities (and above 15% overall). The average growth rate for the years 1998,1999 and 2000 was negative. In addition, an asset price plunge began in late 1997. This situation contrasts with the early nineties when Colombia grew at rates exceeding 4% and was catalogued as one of the top emerging markets in the world. This economic downturn has been accompanied by a severe crisis in the financial sector that began in late1997 or early 1998 [See Arias (2000)]. Since then, real credit has suffered a severe crunch. Between January of 1998 and January of 2001 the stock of real credit fell 30%. Between July of 1999 and May of 2000 more than 30% of the financial system's stock of assets was capitalized by the government.[1] Many other financial intermediary institutions failed and were liquidated or bailed-out by the government. The fiscal cost of the bail out has been estimated at 6% of GDP.[2][3]

In order to alleviate the financial distress and to finance the bail-out, the Colombian government issued new banking regulation towards the end of 1998.[4] For instance, whenever the outstanding value of a home mortgage debt exceeded the market value of the home, debtors were given the right to repay completely the debt by giving back their home to the financial institution that issued the credit. The financial institution receiving the home was given the right to a loan from the government equivalent to the value of the corresponding loss. The loan is to be repaid at six month intervals during a ten year period at an interest rate equal to forecasted inflation by the central bank plus five percentage points.[5] Additionally, an upper bound of 1.5 times the current bank interest rate was imposed on unpaid home mortgage credits.[6] The new regulation also prohibited banks from translating home mortgage repayment request expenditures to individual debtors.[7] One of the most controversial regulatory changes was a new tax on financial transac-

[1] *Source*: Banco de la Republica, Subgerencia de Estudios Economicos. See Arias (2000).

[2] *Source*: Foresight Colombia, July 4, 2000.

[3] The banking crisis in Colombia was parallel to a currency crisis. In 1999 the exchange rate regime (a target zone) collapsed and the exchange rate was allowed to float "freely".

[4] Decree 2331, of November 16,1998. The new regulation can be consulted in: http://juriscol.banrep.gov.co:8080/cgi/normas_buscar.pl

[5] Article 14 of Decree 2331.

[6] Article 15 of Decree 2331.

[7] Article 16 of Decree 2331.

tions aimed at financing the bail-out and capitalization of troubled institutions. Indeed, as of November 17, 1998 most financial transactions were to be taxed at a 2 per 1000 rate.[8] This rate was later risen to 3 per 1000.

The purpose of all this new regulation was to aid a troubled financial system. Whether this was accomplished has not yet been determined. What is clear is that the spread between the loan and deposit interest rates in Colombia systematically rose to higher levels in 1999, just after the new banking regulation and financial transaction tax was introduced. It is argued in this paper that this hike in the loan-deposit interest rate spread reflects a rise in intermediation costs and financial inefficiency attributable to the new banking regulation. In other words, the new regulation and the 2/1000 financial transaction tax tightened banking operational constraints and introduced additional costs into financial intermediation activity. Consequently, financial intermediaries suffered a productivity meltdown as they lost operational versatility and additional real resources were required to operate with and implement the new regulations and tax.[9] As a result, financial intermediaries had to charge a higher loan-deposit interest rate spread in equilibrium, as observed in the data. While aimed at alleviating financial distress, the new regulation actually reduced the productivity of financial intermediaries and increased intermediation costs.

This negative productivity shock to financial institutions exacerbated the credit crunch and corresponding economic contraction that was already underway. But this did not occur in a linear fashion. Interestingly, it seems that the Nov./1998 shock was significantly amplified and propagated into the future. Indeed, the data show that after 1998 the economic contraction has been longer lived and more persistent than most previous downward economic fluctuations in Colombia. This paper pursues the idea that *due to the new banking regulation of Nov./1998 and to borrowing constraints attributable to the credit crunch that was already underway, what otherwise would have been a regular and short-lived economic contraction became the biggest economic downfall of recent Colombian history.*

I suggest a general equilibrium model capable of replicating recent macroeco-

[8] Articles 29 and 30 of Decree 2331.

[9] In addition to the new banking regulation of Nov. 1998, between 1996 and 1999 new regulation was also passed in Colombia ordering bankers to verify that deposits beyond a certain volume did not come from illicit activities [Articles 102-107 from the Organic Statute of the Financial System; Law 365 of 1997, articles 9,24 and 25; Law 526 of 1999, article11]. In carrying out this police work, Colombian bankers have to spend additional time and resources before they can accept and intermediate a deposit. This can be interpreted as an additional negative productivity shock to the Colombian financial system.

nomic regularities in Colombia. The model shows how a negative productivity shock to financial intermediaries, interpreted as a perverse regulatory change for the financial system, is amplified and propagated in macro aggregates due to credit constraints. On an empirical level the contribution of the paper is a qualitative and quantitative approximation to the recent macroeconomic behavior of Colombia, in the light of its new banking regulation. In fact, it can be claimed that *the punchline of the paper is that the qualitative and quantitative predictions of the model are in line with the recent behavior of macroeconomic variables in Colombia if it is accepted that the new banking regulation of Nov/1998 was a negative productivity shock to its financial system.* Nonetheless, the model applies to any other episode where the banking sector experiences a productivity shock. Thus, on a theoretical level the contribution of the paper is important for evaluating the welfare impact of regulatory changes and policies that modify the productivity of banks in environments with financial frictions.

The paper is organized as follows. The next section briefly relates the paper to the existing literature. Section three presents the empirical facts regarding the macroeconomic behavior of Colombia before and after the new banking regulation of Nov/1998. In section four I argue that this new regulation induced a rise in intermediation costs and a corresponding slump of banking productivity in Colombia. Section five suggests a theoretical model that rationalizes how a negative productivity shock to the financial system can account for the observed macroeconomic behavior in Colombia during the period 1998-2000. In section six I use the model to implement a numerical experiment that simulates the response of the artificial economy to an adverse productivity shock in the financial system. The idea there is to replicate qualitatively, and to some extent quantitatively, the macroeconomic behavior of Colombia after the Nov/1998 regulation and the associated negative productivity shock to financial intermediation. The last section concludes.

2. LINKS TO THE LITERATURE

Links between banking productivity and regulation in the financial arena have been established in the literature. The idea is that with the tightening of regulatory constraints, banks tend to loose versatility in their operations and, consequently, experience a fall in productivity. On the other hand, a deregulatory process increases competitive forces in the financial system so that "banks not allocating their resources efficiently would perish unless they could become more like their efficient competitors by producing more output with existing inputs". [Semenick (2001), pp. 122].

Berg, Forsund and Jansen (1992) find a productivity fall in Norwegian banks prior to the deregulation of the Norwegian financial system in the 1980's. They also document a fast productivity increase in the post-deregulation years up to 1989. Their results indicate that the observed productivity gains were mainly due to the convergence of inefficient banks towards the production possibilities frontier rather than a shift of the frontier itself. Berg et. al. (1993) expanded the study to Finland and Sweden. Zaim (1995) documents similar results for Turkish banks. Bhattacharya, Lovell and Sahay (1997) find that the impact of liberalization on the productivity of Indian banks depends on the type of ownership. Gilbert and Wilson (1998) argue that privatization of Korean financial institutions, rather than deregulation of deposit interest rates, induced an increase in banking productivity. Leightner and Lovell (1998) find that the average bank in Thailand experienced rapid total factor productivity growth between 1989 and 1994, as the financial and foreign exchange systems of this country were liberalized. Khumbakar et. al (2001) study Spanish savings banks between 1986 and 1995, a period during which the Spanish banking industry went through major regulatory reforms. They find high levels of technical inefficiency but high rates of productivity growth due to frontier shifts attributable to the deregulatory process.

In a recent paper Semenick (2001) computes the Malmquist index of U.S. commercial banks with more than US$ 500 million in assets for the period 1980-1989.[10] He divides his sample into those banks that are allowed statewide branching, those with limited branching and those constrained to unit branching. He finds that during the 1980's the three groups of banks exhibit cumulated productivity growth rates of 4.6%, 3.2% and -0.3%, respectively. In short, his results indicate that banks facing tighter branching constraints exhibit less productivity growth than those facing looser branching regulation. Humphrey (1991) studies the relationship between deregulation and banking productivity in the US during the 1980's. He finds that between 1977 and 1987 productivity growth of U.S. banks ranges between -0.07% and 0.6% per year. He attributes this variation to the deregulation of the 1980's. Other studies that find positive productivity growth

[10] The Malmquist index is computed with data envelopment analysis. The latter "is a linear programming methodology that constructs a non-parametric, piecewise-linear, best practice frontier from observable input and output data" [Semenick (2001), pp. 122]. The index decomposes productivity fluctuations into two elements: i) expansion of the frontier (technological change) and ii) convergence towards the frontier (efficiency change or catching up).

in U.S. banks during the 1980's (the decade of financial deregulation) are Hunter and Timme (1991) and Bauer, Berger and Humphrey (1993). Tirtiroglu, Daniels and Tirtiroglu (1998) look at a longer time period,1946 -1995, and document a negative overall impact of regulation over U.S. commercial banking TFP growth.

In contrast, some studies have found negative or zero productivity growth rates in the U.S. during the 1980's, the era of deregulation. Elyasiani and Mehdian (1995) find a productivity regress in U.S. banks between 1979 and 1986, the pre and post deregulation years. Humphrey and Pulley (1997) average data between 1977 and 1988 and also find productivity regress in U.S. banks during the 1980's. Note that these results contradict the expected mapping between deregulation and productivity growth. However, by studying only two spaced years or by averaging out data these authors could have overlooked major productivity fluctuations in U.S. banks during the years in between [see Semenick 2001]. These findings could also indicate that banks face difficulties in their adjustment towards the increased competition and freedom created by deregulation [Khumbakar et. al. (2001)]. Other studies that document zero or negative productivity growth rates in U.S. banks during the 1980's are: Berger and Humphrey (1992), Humphrey (1993), Bauer, Berger and Humphrey (1993) and Wheelock and Wilson (1999).[11] In any case, all the substantial empirical evidence documenting some link between productivity of financial intermediaries and regulatory changes in the banking arena motivates and is relevant to the idea behind this paper.

An environment that articulates some sort of credit channel seems the appropriate theoretical structure to study the recent Colombian case given the ongoing credit crunch and contraction of the Colombian economy at the time the new banking regulation was issued. Studies using financial accelerator models and credit channel stories have already shown that conditions and frictions in financial markets play a key role in explaining an economy's reaction to exogenous macroeconomic shocks.[12] These types of models can be classified in two cate-

[11] Very good surveys of all these studies can be found in Khumbakar et. al (2001) and Semenick (2001).

[12] A financial accelerator is a self-feeding, internal finance mechanism that propagates and amplifies shocks. Usually, in this literature the firm's ability to finance its production plan is an increasing function of the value of its assets. When the value of these assets increases (either because the price of assets increases or because the firm reinvests more profits), the firm is able to expand its production plan (either because some external finance premium falls or because borrowing limits become less stringent). A higher level of production and investment increases asset demand (and asset prices) and/or earnings (and reinvestment of profits), thus increasing even further the value of the firm's assets and its ability to expand its production plan. And so

gories: i) agency cost models[13] and ii) borrowing limit models[14]. Unfortunately, the role of productivity fluctuations in the financial sector has been overlooked by these studies. The reason is that existing financial accelerator or credit channel models lack an appropriate representation of the banking technologies through which resources are intermediated. Indeed, most of these models treat financial intermediation as a costless, invisible and intangible activity. This basically boils down to assuming that the financial intermediary is simply an additional constraint in the economy [Chari, Jones and Manuelli. (1995)].[15]

The model suggested in this paper blends the financial regulation - banking productivity empirical link and the financial accelerator literature in an attempt to replicate the recent macroeconomic behavior in Colombia. It builds upon the borrowing limit-financial accelerator idea by using an environment similar to the one suggested by Kocherlakota (2000). A different feature is that banks operate with a costly intermediation technology. For every unit of deposits they accept, a fraction is lost in the intermediation process. This intermediation cost creates a spread between the deposit and lending rates. It also determines the productivity of intermediation. Naturally, a lower cost implies a higher productivity.

The model economy is populated by many households. Each one has access to a technology that needs land, internal funds and external funds (from banks) to operate. To avoid the risk of default banks impose a credit constraint on the household: it cannot borrow beyond the value of its collateralizable resources (value of landholdings plus internal funds). This credit constraint pushes up the value of land. Whenever the borrowing constraint binds, land will be valued not only because of its direct contribution to output (as an input of production), but also because it contributes indirectly to output through the role that it plays as collateral. Accumulating an additional unit of land increases the household's

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on. The financial accelerator mechanism is at work. It is the basic source of propagation and amplification of shocks.

[13]e.g.: Bernanke and Gertler (1989), Bernanke and Gertler (1990), Carlstrom and Fuerst (1997), Bernanke, Gertler and Gilchrist (1999).

[14]e.g.: Scheinkman and Weiss (1986), Kiyotaki and Moore (1997), Cooley and Quadrini (1999), Cooley, Marimon and Quadrini (2000), Schneider and Tornell (2000), Kocherlakota (2000), Caballero and Krishnamurthy (2000), Aghion, Bacchetta and Banerjee (2000a, 2000b), Mendoza (2001).

[15]Models with costly intermediation technologies have been used elsewhere in the literature "for banks to play a non-trivial macroeconomic role" [Edwards and Vegh (1997) pp. 246; see also King and Plosser (1984), Diaz-Gimenez et. al. (1993) and Cole and Ohanian (2000)]. But this literature assumes that the financial system is frictionless and, hence, financial intermediation activities have a negligible macroeconomic effect.

future volume of collateral. More collateral tomorrow increases the future availability of external funds, thereby expanding future output indirectly. This feature of the asset is not present in the Kocherlakota (2000) model either.

The punchline of the theoretical model suggested here is a credit channel that amplifies and propagates small, transitory shocks to banking productivity. In fact, small changes in the productivity of the intermediation technology generate large and persistent fluctuations in economic activity. The credit channel arises because borrowing constraints that depend on asset prices, internal funds and lending rates induce static and dynamic credit multipliers a-la Kiyotaki and Moore (1997). The transmission mechanism is triggered by a rise in lending rates that tightens borrowing constraints on impact. The credit crunch is magnified and propagated by the fall in asset prices and internal fund accumulation that accompanies the lower level of economic activity and that further tightens the credit limit on impact and in the future.

3. COLOMBIA 1998-2000

Figures 1-5 present the evolution of the following macroeconomic variables in Colombia[16]: i) real GDP cycle (1977:I-2000:III), ii) stock prices in real terms (1991:01-2001:01), iii) gross and net of non-performing loans stock of real credit (1992:01-2001:06), iv) ex-post real loan rate (1990:01-2000:02) and v) loan/deposit interest rate spread (1986:01-2000:12). When financial distress erupted in Colombia (end of 1997, beginning of 1998) its GDP entered into a cyclical contraction, asset prices plunged, real credit was crunched and the real loan rate increased significantly. As is well documented by the empirical literature [see Caprio and Klingebiel (1996), Demirguc-Kunt and Detragiache (1997), Kaminsky and Reinhart (1998, 1999), Kaminsky (1999) and Demirguc-Kunt, Detragiache and Gupta (2000)], this macroeconomic behavior is typical of credit crunch and financial distress episodes. Note also that during the initial phase (or year) of the crisis the loan/deposit interest rate spread did not display any drastic fluctuation. There is only an isolated hike in June of 1998.

But in 1999, just after the new banking regulation of Nov/1998 was introduced, the loan/deposit interest rate spread systematically rose to higher levels. For instance, the average spread between the nominal annual loan rate and the nominal annual 3-month certificate of deposit rate between Jan/1986 and Dec/1998 was

[16] A detailed description of the data is available in the Data Appendix.

997 basis points. The corresponding average spread for the period Jan/1999-Dec/2000 was 1166 basis points, a 17% increase with respect to the pre-1999 average. The average spread for the period Jan/2000-Dec/2000 was 1423 basis points, a 43% increase with respect to the pre-1999 average.

After the regulation was issued, the economic contraction became wider and longer lived than most other previous downward economic fluctuations in Colombia (and only comparable to the mid-80's recession). Indeed, when the new financial transaction tax and banking regulation were implemented in the fourth quarter of 1998, GDP was already 1.8% below trend. By the first and second quarters of 1999, it declined further to 4.5% and 6.3% below trend, respectively. Moreover, in the following quarters (and until 2000:III) GDP remained between 4.7% and 5.5% below its pre-1998:III trend value.

In a similar fashion, after the implementation of the banking regulatory changes, asset prices maintained their downward momentum. In fact, by January of 2001 real stock prices had fallen to their 1991 level. This means that between December of 1997 and January of 2001 a 60% fall in real stock prices was observed, with 26 of these percentage points being lost after December of 1998 (the date of the new regulation). To put the severity of this crash in perspective, in the U.S. between 1929 and 1932 (the Great Depression) the S&P Index fell about 68% in real terms [Cole and Ohanian (2000)]. Another familiar stock market crash episode is that of Japan in the early nineties when the Nikkei Index fell about 55% in real terms between 1989 and 1992 [Cole and Ohanian (2000)].[17] The Colombian asset price plunge exceeds that of Japan and is close to the one experienced during the Great Depression in the U.S.

Additionally, once the new banking regulation was in place real credit was further crunched in Colombia after a slight recovery in the third quarter of 1998. For instance, comparing the total stock of real credit in January of 2001 with its corresponding value in December of 1997 reveals a 30% fall, with 24 of these percentage points being lost after December of 1998 (the date of the new regulation). These numbers are higher if non-performing loans are not considered. The realized real loan interest rate also displayed another peak around the time of the new regulation. While the average for this rate between Jan/1990 and Dec/1997 was 14.68%, by the fourth quarter of 1998 this rate had more than doubled to an average of 33.32%.[18] On the eve of the Great Depression the U.S. commer-

[17] There have been stronger stock market crashes. For example, the decline in Thai equity prices (in dollars) since their 1995 peak exceeds 80% [Kaminsky and Reinhart (1998)].

[18] The corresponding monthly values are 34.62%, 33.08% and 32.26% in October, November

cial paper realized real interest rate rose 70% from 5.6% in the fourth quarter of 1927 to 9.5% in the fourth quarter of 1928 [Romer (1993)]. Yet, in Colombia the corresponding jump was more than 100%.

In sum, the macroeconomic effects of the initial credit crunch and the associated economic contraction were enhanced dramatically after the new banking regulation and financial transaction tax were implemented. Were the regulatory changes responsible for the observed macroeconomic behavior? The next section tries to answer this question. The underlying idea is that *the new banking regulation and financial transaction tax of November of 1998 constitute a negative productivity shock to financial intermediation that was also amplified and propagated, turning what otherwise would have been a regular, short lived, economic contraction into the deepest, downward, economic swing of recent history in Colombia*. Why was this shock amplified and propagated? Section five will suggest a theoretical model with a financial imperfection that may answer this question.

4. BANKING PRODUCTIVITY IN COLOMBIA AFTER THE NOV/98 REGULATION

To pursue the argument that the regulatory changes of Nov/1998 turned out to be an adverse productivity shock to the financial system, first consider a bank that uses a constant returns to scale (crs) technology to intermediate resources. Suppose that the bank accepts deposits at given rate R, uses the intermediation technology to provide loans at rate ρ and, for every unit of deposits, loses $z \in [0, 1)$ units in the corresponding intermediation process. Under this environment banks behave competitively and are price takers so that in every period they solve the following static problem:

$$Max_{\{d_t\}} \quad (1 + \rho_t)(1 - z_t)d_t - (1 + R)d_t$$

Free entry and exit drives profits to zero and in equilibrium banks produce where the relative price of their output $(1 + \rho)$ equals their marginal cost:

$$1 + \rho_t = \frac{1 + R}{1 - z_t}$$

or:

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and December of 1998, respectively.

$$\frac{1+\rho_t}{1+R} = \frac{1}{1-z_t}$$

Intermediation cost z creates a spread between the lending and deposit rates. In fact, the spread or ratio between the gross lending rate and the gross deposit rate is a metric of the inverse of the average (and marginal) productivity of deposits $[1/(1-z)]$. The higher the productivity of the financial system, the lower the ratio between the gross lending rate and the gross deposit rate and vice-versa. This result is important because it provides a simple way to measure productivity changes in the financial sector using observed data of the gross lending rate to gross deposit rate ratio or spread.

Using this result, figure 6 measures the inverse productivity of the financial system in Colombia during the period Jan/1986-Dec/2000. In particular, it shows the behavior of the ratio between the gross annual nominal loan rate and the gross annual nominal 3-month certificate of deposit rate.[19] Note that this ratio displays a fairly steady pattern until January of 1999. Beginning in January of 1999, less than two months after the new banking regulation and financial transaction tax was introduced, this ratio took a dramatic hike. For instance, between Jan/1986 and Dec/1998 the average for this ratio was 1.33. The average for this ratio during the period Jan/1999-Dec/2000 was 1.81. This represents a 33.14% increase with respect to the pre-1999 average. The average for this ratio during the period Jan/2000-Dec./2000 was 2.17. This represents a 63.36% increase with respect to the pre-1999 average.

Assuming the financial structure of the economy is as simple as the one suggested in the previous paragraphs, it is possible to back up the corresponding percentage change in the productivity of the banking sector $(1-z)$ with the percentage change in the ratio between the gross loan and deposit interest rates. Let $y = (1+\rho)/(1+R)$. Hence:

$$\frac{\dot{y}}{y} = -\frac{\dot{\overline{(1-z)}}}{(1-z)}$$

[19] The annual nominal loan rate is "tasa activa total sistema" (monthly average) calculated by Superintendencia Bancaria in Colombia. Two different annual nominal deposit rates are used: "tasa de interes de los CDT a 90 dias, total sistema" (monthly average) and "tasa de interes de los CDT a 90 dias, bancos y CF" (monthly average). Source is Banco de la Republica. Period is 1986:01-2000:12. See Data Appendix.

where · symbolizes a derivative with respect to time. As expected, any change in the ratio between the gross loan and deposit interest rates maps back into an equiproportional opposite sign change in financial intermediation productivity. Thus, the data reveal a drastic negative productivity shock to financial intermediaries in Colombia right after the new banking regulation was issued. According to the data, if the financial system of Colombia were as simple as the one suggested above, the banking productivity meltdown following the regulatory changes of Nov/1998 would range from 30% to 60%!

This evidence might have some flaws. First, the Colombian financial system is far more complex than the one depicted above and the Jan/1999 rise in the loan-deposit interest rate spread might be capturing other phenomena like i) the sudden deterioration of loan quality, ii) an increase of banking risk due to the increase in macroeconomic instability (i.e. frequent and high swings in the real interest rate) and the maturity mismatch between deposits and loans and/or iii) an increase in noncompetitive practices as several banks failed and were removed from the market.[20] Furthermore, it can be argued that the fact that the jump in the spread coincides with the implementation of the new banking regulation is simply a coincidence. In fact, the three phenomena mentioned above also occurred around the time the new regulation was being implemented. Hence, a very skeptical reader might argue that the behavior of the domestic loan-deposit interest rate spread after Nov/1998 does not necessarily imply, for a more realistic financial sector, that the productivity of financial intermediaries fell back 30%-60% due to the banking regulation issued in that date.

However, three important facts support the claim that there is an element of response in the Colombian loan-deposit interest rate spread to the regulatory changes of Nov/1998. First, the new banking regulation of Nov/1998 was a *major* change in the rules of the banking arena game in Colombia. Second, the spread jump occurs some days *after* and not days before or at the same time the new regulation was issued. Third, the range of the spread jump (30%-60%) is big enough so as to allow, among other phenomena, for the presence of a negative productivity shock in the financial system of the Colombian economy.

[20] Using panel data techniques and monthly data available for 22 commercial banks for the period 1992-1996, Steiner, Barajas and Salazar (2000) find that non-financial expenses are a statistically significant component of the loan-deposit interest rate spread in Colombia and that, on average, non-financial expenses explain 27.6% of such spread. However, they also find that the rest of the spread is explained by non-performing loans (34.4%), reserve requirements (22.1%) and market power (15.9%).

Figure 7 provides additional evidence that the Jan/1999 loan-deposit interest rate spread jump implies, at least partially, a productivity regress of the Colombian financial sector due to the Nov/1998 banking regulation. Specifically, this picture shows the quarterly evolution of a proxy for labor productivity in the financial sector of the Colombian economy during the period Mar/1992-Dec/2000. The proxy is constructed as the ratio between the stock of real credit (including non-performing loans) from the whole financial system and the number of financial sector employees in the seven main metropolitan areas.[21] In order to obtain labor productivity proxies for the different types of financial institutions that exist in Colombia, the stock of real credit from the whole system is also disaggregated into credit from banks, credit from savings and mortgage loan institutions (CAV), credit from financial corporations (CF) and credit from companies of commercial finance (CFC).

The labor productivity indicator fell 4.59% for the whole system between Dec/1997 and Dec/1998, the first year of financial distress. This is not surprising. In particular, the labor productivity indicator increased 9.12% for banks and fell 29.16%, 11.93% and 14.35% for CAV, CF and CFC, respectively, during that first year of crisis. This is not surprising either if one thinks that financial distress erupted more severely in the three latter types of financial institutions than in banks. Between Dec/1998 and Dec/2000, the period comprising the first two years in which the new regulation was in effect, the labor productivity proxy fell 18.78% for the whole system. This represents, for each of these two years, a fall in financial intermediation productivity twice as large as the one observed during the first year of the crisis. Furthermore, during this period the labor productivity proxy fell 3.79%, 54.83%, 9.28% and 32.96% for banks, CAV, CF and CFC, respectively. It is also worth noting the sharp falls in labor productivity of the whole system and of banks in the first and fourth quarters of 1999, the first year during which the regulation was in place.

The story is very simple. When financial distress erupted towards the end of 1997, labor productivity in the Colombian financial sector began to erode as a whole (4.6%). Even though the labor productivity of banks was still growing,

[21] During credit crunch episodes the level of financial activity is better proxied by the outstanding stock of real credit (including non-performing loans) rather than by the corresponding flow of new real credit. The reason is that possible disintermediation amid financial distress might yield negative new credit flows for some years. Additionally, monitoring clients or dealing with non-performing loans also represents activity for the banking sector and this is not captured by the flow of new loans.

that of the other type of financial institutions was falling sufficiently so as to drive down the whole system's labor productivity level. After the new banking regulation was in place in December of 1998, labor productivity of all types of financial institutions began to plunge and continued to do so during the next two years. In fact, during this period the system as a whole lost almost an additional one fifth (18.8%) of its former labor productivity level. The biggest contribution to this fall came from savings and mortgage loans institutions. As above, the evidence suggests that the new banking regulation of Nov/1998 constitutes a visible and significant negative productivity shock to financial intermediation in Colombia.

In the next section a model capable of rationalizing the empirical facts of sections two and three is suggested. The ultimate objective is to construct an artificial economy in which to study the effects of a negative banking productivity shock similar to the one observed in Colombia towards the end of 1998, and to compare the response of this artificial economy to that observed in Colombia during the years 1999 and 2000, the post shock/post-regulation years.

5. MODEL

This section suggests a theoretical model that predicts a macroeconomic behavior similar to the one observed in Colombia between the end of 1997 and the end of 2000. Again, the idea is to use this model in order to replicate qualitatively and quantitatively the response of the main macro aggregates in Colombia to the negative productivity shock to financial intermediaries in late 1998.

5.1. Basic Assumptions

The economy is inhabited by an infinite number of identical, infinitely-lived, risk-averse entrepreneurial households. The mass of households has measure 1. In every period households have access to a riskless technology that needs land and internal and external funds as inputs to produce final good as output. The three inputs are complementary in production. Internal funds and land are accumulated by the household from one period to the other. External funds are supplied by a banking sector in the form of intraperiod loans at rate ρ. Total land supply is fixed at 1. Internal funds represent installed physical capital belonging to the household while external funds should be interpreted as working capital provided by financial intermediaries. One possible motivation for this loan-in-the-production function assumption is that firms usually need to pay for some intermediate inputs (or labor services) in advance of production and must rely on the liquidity provided by banks to do so. Without these liquid external funds firms could not operate their technologies. In this sense, external funds can be understood as a different input of production.

Banks operate with a costly, crs, intermediation technology. For every unit of deposits they accept, a fraction z is lost in the intermediation process. Note that this cost determines the productivity of intermediation. Of course, a lower cost implies a higher productivity. It is assumed that banks take intraperiod deposits from international financial markets at rate R. This rate is exogenously determined by supply and demand conditions in foreign credit markets.

Even though the household's technology is riskless (i.e. free of shocks), funding the household is risky for the bank. In every period the household has the option of running away with the proceeds from the project (i.e. the technology's output) without paying back the loan to the bank. But in doing so the household must leave its total assets (i.e. land plus undepreciated internal funds) behind. Moreover, default is not penalized with market exclusion. Banks know of this possibility and so they take care not to let the household borrow more than the value of its landholdings plus undepreciated internal funds. In other words, to avoid the risk of default banks impose a natural credit constraint on the household. *The household cannot borrow beyond the value of its collateralizable resources (value of landholdings plus undepreciated internal funds).*

Note that agents can trade in three markets [relative price of each market in $(\cdot)$]: i) final good (1), ii) land (q) and iii) loans (ρ). The order of events in every period is very simple. When the household wakes up in any given period it has some internal funds (x) and some landholdings (l). At the same time the productivity of the banking sector [i.e. its intermediation cost (z)] is revealed. The levels of z and R determine the equilibrium lending rate (ρ) that will be charged by banks for any intraperiod loan. Additionally, the price of land (q) has been simultaneously determined in the land market.

Since the marginal cost of a loan $(1+\rho)$ is known at this point, the household now determines its optimal demand for external funds or loans (b^*). However, because of the credit constraint, the volume of loans that the household finally receives (b) need not be equal to the optimal volume (b^*). If the outstanding value of debt associated to the optimal loan volume $(1+\rho)b^*$ is *less than or equal to* the household's total volume of collateralizable resources [$ql + (1-\delta)x$ where δ is the depreciation rate of internal funds], then the household is not credit constrained and its demand for loans is satiated completely:

$$b = b^* \leqslant \frac{ql + (1-\delta)x}{(1+\rho)}$$

Otherwise, the household's credit constraint binds and the volume of external funds received is equivalent to:

$$b = \frac{ql + (1-\delta)x}{(1+\rho)} < b^*$$

The volume of loans extended to the households determines the volume of deposits (d) taken by domestic banks from international financial markets. With x, l and b the household operates its technology $F(x, b, l)$. After production takes place, resources available to the household in terms of final good are given by $F(x, b, l) + (1 - \delta)x + ql$. The household allocates these resources to four uses: i) consumption (c), ii) accumulation of internal funds (x'), iii) purchasing of land for next period (ql') and iv) repayment of the outstanding debt $[(1 + \rho)b]$.

Note that it is optimal for the household to repay the loan because the credit constraint imposed by financial intermediaries is simply an incentive compatibility constraint aimed at repayment. Keeping in mind that default is not penalized with market exclusion, whenever the household flees at the end of a period without paying back its debt it receives a payoff equivalent to:

$$F(x, b, l)$$

However, if it stays and pays back the loan, it will obtain a payoff equivalent to:

$$F(x, b, l) + ql + (1-\delta)x - (1+\rho)b$$

Incentive compatibility with repayment requires:

$$F(x, b, l) \leqslant F(x, b, l) + ql + (1-\delta)x - (1+\rho)b$$

or:

$$b \leqslant \frac{ql + (1-\delta)x}{(1+\rho)}$$

which is simply the credit constraint imposed by banks on households. Thus, it is always optimal for households to repay any loan extended to them. As in other credit limit models, borrowing is so tightly constrained by the level of collateral that default never occurs in equilibrium.

5.2. Household's Problem

Formally, the household solves the following sequential problem:

$$Max_{\{c_t,b_t,x_{t+1},l_{t+1}\}} \quad E_0 \sum_{t=0}^{\infty} \beta^t U(c_t)$$
$$s.t.$$
$$c_t + x_{t+1} + q_t l_{t+1} + (1+\rho_t)b_t = F(x_t, b_t, l_t) + (1-\delta)x_t + q_t l_t$$
$$b_t(1+\rho_t) \leqslant q_t l_t + (1-\delta)x_t$$
$$c_t, x_t, l_t \geqslant 0$$
$$q_t, \rho_t \ given$$
$$x_0, l_0 = 1 \ given$$

It is assumed that $F_{ij}(x,b,l) = F_{ji}(x,l,b) > 0 \veebar i,j = 1,2,3$. In other words, land, internal funds and external funds are complementary inputs in the production technology. The complementarity assumption between land and internal funds is also used by Kocherlakota (2000). More on this complementarity assumption ahead. Note also that if the constraint is binding, any fall in asset (i.e. land) prices, in landholdings or in internal fund volume and any lending rate hike will tighten the constraint.

Let λ_t represent the Kuhn-Tucker multiplier associated to the borrowing constraint. λ_t can be interpreted as the shadow price of collateral. Optimality conditions for the household are:

$$\lambda_t = \frac{U'(c_t)[F_2(x_t, b_t, l_t) - (1+\rho_t)]}{(1+\rho_t)} \tag{1}$$

$$U'(c_t) = \beta E_t\{U'(c_{t+1})[F_1(x_{t+1}, b_{t+1}, l_{t+1}) + (1-\delta)] + \lambda_{t+1}(1-\delta)\} \tag{2}$$

$$q_t U'(c_t) = \beta E_t\{U'(c_{t+1})[F_3(x_{t+1}, b_{t+1}, l_{t+1}) + q_{t+1}] + \lambda_{t+1} q_{t+1}\} \tag{3}$$

Equation (1) is a key result of the model. It establishes that if $F_2(x_t, b_t, l_t) > (1+\rho_t)$ then $\lambda_t > 0$ and the borrowing constraint binds. Contrarily, if $F_2(x_t, b_t, l_t) = (1+\rho_t)$ then $\lambda_t = 0$ and the borrowing constraint does not bind. Simply put, the entrepreneurial household always wants a level of external funds that equates the marginal productivity of this input to the gross loan rate. The latter is simply the marginal cost of external funds. Of course, optimality dictates that marginal productivity and cost of external funds always be equated. However, if the optimal level of external funds exceeds the borrowing limit, this optimality condition is not possible. In this case the household will take as higher a loan volume as it can and the borrowing constraint will bind. Moreover, the marginal productivity of external funds will exceed its marginal cost (or gross loan rate) and an inefficiency will result in the economy. As a result, the demand for external funds will be determined in the following way:

$$\begin{aligned} If \;\; F_2\left[x_t, \frac{q_t l_t + (1-\delta)x_t}{(1+\rho_t)}, l_t\right] &> 1+\rho_t \;\; then \;\; b_t = \frac{q_t l_t + (1-\delta)x_t}{(1+\rho_t)} \;\; and \;\; \lambda_t > 0 \qquad (4) \\ If \;\; F_2\left[x_t, \frac{q_t l_t + (1-\delta)x_t}{(1+\rho_t)}, l_t\right] &\leq 1+\rho_t \;\; then \;\; b_t \ni F_2(x_t, b_t, l_t) = (1+\rho_t) \;\; and \;\; \lambda_t = 0 \end{aligned}$$

The Euler Equation governing the consumption-internal fund accumulation decision of the household follows from equations (1) and (2):

$$\begin{aligned} U'(c_t) &= \beta E_t\{U'(c_{t+1})[F_1(x_{t+1}, b_{t+1}, l_{t+1}) + (1-\delta) \qquad (5) \\ &+ [F_2(x_{t+1}, b_{t+1}, l_{t+1}) - (1+\rho_{t+1})]\frac{(1-\delta)}{(1+\rho_{t+1})}]\} \end{aligned}$$

The left hand side (lhs) of (5) captures the marginal loss of utility from accumulating an additional unit of internal funds for next period. The right hand side (rhs) captures the expected present discounted value of the corresponding marginal utility gain. As (5) states, along the optimal consumption-internal fund accumulation path the marginal loss and gain of accumulating an additional unit of internal funds must always be equated. Note, however, that the marginal benefit of accumulating an additional unit of x has two components. The first one is standard and is presented in the first line of (5). Since x is an input of production, accumulating an additional unit of x rises next period's output in $F_1(x_{t+1}, b_{t+1}, l_{t+1})$ and its undepreciated part can be sold for $(1-\delta)$. The second component reveals the value of internal funds as collateral and is presented in the second line of (5). Accumulating an additional unit of x loosens next period's credit constraint in $(1-\delta)/(1+\rho_{t+1})$. Each of these additional units of available external funds generate a net gain of $[F_2(x_{t+1}, b_{t+1}, l_{t+1}) - (1+\rho_{t+1})]$ units of output to the entrepreneurial household. Note that this gain is only relevant if the borrowing constraint is binding [i.e. only if $F_2(x_{t+1}, b_{t+1}, l_{t+1}) > (1+\rho_{t+1})$

and $\lambda_t > 0$]. In consequence, as long as the borrowing constraint binds the collateral properties of internal funds enhance their marginal contribution to output. Equation (5) is very important to the story of the paper. It dictates consumption smoothing to the household. Hence, it also captures the household's incentive to cut internal fund accumulation whenever there is a reduction in revenues such as the one that results after a credit crunch is triggered by a lending rate hike due to a fall in banking productivity.

The pricing equation for land follows from (1) and (3):

$$\begin{aligned} q_t U'(c_t) &= \beta E_t\{U'(c_{t+1})[F_3(x_{t+1}, b_{t+1}, l_{t+1}) + q_{t+1} \\ &\quad +[F_2(x_{t+1}, b_{t+1}, l_{t+1}) - (1+\rho_{t+1})]\frac{q_{t+1}}{(1+\rho_{t+1})}]\} \end{aligned} \tag{6}$$

The lhs of (6) captures the marginal utility loss from buying an additional unit of land for next period. The rhs portrays the expected present discounted value of the corresponding marginal utility gain. As shown by (6), along the optimal consumption-land accumulation path the marginal loss and gain of buying an additional unit of land must always be equated. As with internal funds, the marginal benefit of purchasing an additional unit of land comes from two sources. The first source is typical and is presented in the first line of (6). Since land is an input of production, purchasing an additional unit of land increases next period's output in $F_3(x_{t+1}, b_{t+1}, l_{t+1})$ and, afterwards, that unit of land can be sold for q_{t+1}. The second source comes from the value of land as collateral and is presented in the second line of (6). Buying an additional unit of l loosens next period's credit constraint in $q_{t+1}/(1+\rho_{t+1})$. Each of these additional units of available external funds generate a net gain of $[F_2(x_{t+1}, b_{t+1}, l_{t+1}) - (1+\rho_{t+1})]$ units of output to the entrepreneurial household. Again, note that this gain is only relevant if the borrowing constraint is binding [i.e. only if $F_2(x_{t+1}, b_{t+1}, l_{t+1}) > (1+\rho_{t+1})$ and $\lambda_t > 0$]. In sum, as long as the credit constraint binds the collateral properties of land enhance its marginal contribution to output.

Iterating forward on (6) and imposing a no-bubble condition reveals an expression for the price of land (see technical appendix):

$$q_t = E_t\left\{\sum_{j=1}^{\infty} \beta^j \frac{U'(c_{t+j})}{U'(c_t)} \left[F_3(x_{t+j}, b_{t+j}, l_{t+j}) \prod_{i=1}^{j-1} \Omega_{t+i}\right]\right\} \tag{7}$$

where:

$$\Omega_t = \frac{F_2(x_t, b_t, l_t)}{(1+\rho_t)}$$

As usual, the price of land is given by the expected present discounted value of its forever flow of future rental payments. Discounting is done with the stochastic discount factor as with any other asset. As expected, future rental payments to land include not only its future direct contribution to output as an input of production $[F_3(x_{t+j}, b_{t+j}, l_{t+j})]$, but also its future cumulated indirect contribution to output as collateral $\left(\prod_{i=1}^{j-1} \Omega_{t+i}\right)$. Of course, land's indirect contribution to future output as collateral is only relevant if the borrowing constraint binds at least for some future period [i.e. if $F_2(x_{t+j}, b_{t+j}, l_{t+j}) > (1+\rho_{t+j})$ and $\Omega_{t+j} > 1$ for some $j \geqslant 1$].

Equation (7) is a nice result because it shows that credit constrained agents value assets not only for their future direct rental payments but also for their future role as collateral. But equation (7) also reveals the reason for assuming complementarity in the three inputs of production x,b and l. As evidenced in (7), rental payments to land are an increasing function of the marginal productivity of land (l) and external funds (b). Complementarity between x and (b, l) implies that a reduction in internal fund accumulation (i.e. a fall in x') reduces $F_3(x', b', l')$ and $F_2(x', b', l')$ or Ω'. Hence, a credit crunch that induces a cut in x' also induces a fall in future rental payments to land and, consequently, a fall in its current price (q), thus triggering the credit multipliers (more on the credit multiplier ahead). Complementarity is what articulates the transmission channel from the credit crunch to asset prices and back to the credit constraint. Of course, either complementarity between x and l or between x and b is enough to do the trick. But assuming both generates a bigger kick out of the credit multiplier.

5.3. Financial Structure and Bank's Problem

Banks are modelled in the same way as in section four, where it was argued that the new banking regulation of Nov/1998 in Colombia induced a negative productivity shock to financial intermediaries. Banks own a crs technology to intermediate resources from international financial markets to domestic entrepreneurial household projects. Specifically, banks accept deposits from foreign credit markets at rate R. This rate is exogenously determined by demand and supply conditions in those markets. Banks use the intermediation technology to provide intraperiod safe loans to domestic households at rate ρ. Note that $(1+\rho)$ is the relative price of banking output.

The intermediation technology is costly in the sense that, for every unit of deposits, $z \in [0,1)$ units are lost in the intermediation process. Recall that this captures the idea that in order to intermediate deposits into loans, banks have to carry out a variety of costly activities like evaluating creditors, managing deposits, renting buildings, maintaining ATMs, etc. [Edwards and Vegh (1997)]. Thus, in every period the volume of intermediated resources is given by:

$$I = (1-z)d$$

This technological specification is similar to the one used by Cole and Ohanian (2000). In their paper the intermediation technology is $G(D,Z)$ where D is uninstalled physical capital, Z is intermediation capital (in fixed supply), $G(\cdot)$ exhibits crs and $D - G(D,Z) \geqslant 0$ captures resources used in the intermediation process. Under the technology specified here there is no intermediation capital but there is a productivity parameter $(1-z)$ playing an analogous role. There is no uninstalled physical capital either but deposits d play the same role. Finally, under this specification resources lost in the intermediation process are given by $d - I = d - (1-z)d = zd < d$.

With crs in the intermediation technology it is possible to assume an atomistic structure in the banking industry. This assumption is also consistent with the fact that firms of many sizes coexist in the financial sector. Under this environment banks behave competitively and are price takers. Formally, in every period banks solve the following static problem:

$$Max_{\{d_t\}} \quad (1+\rho_t)(1-z_t)d_t - (1+R)d_t$$

Free entry and exit will drive profits to zero so that in equilibrium banks produce where the relative price of their output $(1+\rho)$ equals marginal cost. This is:

$$1+\rho_t = \frac{1+R}{1-z_t} \tag{8}$$

Equation (8) is crucial to the results of the paper because it shows that any shock to banking productivity is transmitted to the borrowing constraint through the lending rate (ρ). Note that the intermediation cost (z) also creates a spread between the lending and the deposit rates:

$$\frac{1+\rho_t}{1+R} = \frac{1}{1-z_t}$$

This last equation shows that the ratio between the gross lending rate and the gross deposit rate is a metric of the inverse of the average (and marginal) productivity of deposits $[1/(1-z)]$. The higher the productivity of the financial system, the lower the ratio between the gross lending rate and the gross deposit rate. Recall that this result was important in section three because it provided a way to measure productivity changes in the financial sector using observed data.

Finally, it is assumed that $z \in [0, 1)$ moves according to a stochastic process Γ. In other words, the intermediation cost fluctuates randomly through time.

5.4. Market Clearing Conditions

In this economy markets clear if:

$$b_t = (1-z_t)d_t \quad \Longrightarrow \quad \textit{loans market} \tag{9}$$

$$l_t = 1 \quad \Longrightarrow \quad \textit{land market} \tag{10}$$

$$c_t + x_{t+1} = F[x_t, (1-z_t)d_t, 1] + (1-\delta)x_t - (1+R)d_t \quad \Longrightarrow \quad \textit{final good market} \tag{11}$$

At this point equilibrium concepts must be defined. First a stationary equilibrium for the non-stochastic version of the model is introduced. Next, a recursive competitive equilibrium for the stochastic version of the model is defined. The latter facilitates the solution for the numerical experiment below.

5.5. Stationary Equilibrium

Under the non-stochastic version of the model z must be set at its unconditional mean $E(z)$.

Definition 1. *A stationary equilibrium is the vector* $\zeta_{ss} = (c_{ss}, x_{ss}, l_{ss}, b_{ss}, d_{ss}, z_{ss}, q_{ss}, \rho_{ss})$ *that solves:*

$$\begin{aligned} b_{ss} &= \frac{q_{ss}l_{ss} + (1-\delta)x_{ss}}{1+\rho_{ss}} \quad if \;\; F_2\left[x_{ss}, \frac{q_{ss}l_{ss} + (1-\delta)x_{ss}}{1+\rho_{ss}}, 1\right] > 1+\rho_{ss} \quad (1_{ss}) \\ b_{ss} &\ni F_3(x_{ss}, l_{ss}, b_{ss}) = 1+\rho_{ss} \quad otherwise \end{aligned}$$

$$1 = \beta \left[F_1(x_{ss}, b_{ss}, 1) + \frac{F_2(x_{ss}, b_{ss}, 1)}{1 + \rho_{ss}}(1 - \delta) \right] \tag{2_{ss}}$$

$$q_{ss} = \frac{\beta F_3(x_{ss}, b_{ss}, 1)}{1 - \beta \frac{F_2(x_{ss}, b_{ss}, 1)}{1 + \rho_{ss}}} \tag{3_{ss}}$$

$$1 + \rho_{ss} = \frac{1 + R}{1 - z_{ss}} \tag{4_{ss}}$$

$$d_{ss} = \frac{b_{ss}}{(1 - z_{ss})} \tag{5_{ss}}$$

$$l_{ss} = 1 \tag{6_{ss}}$$

$$c_{ss} = F[x_{ss}, b_{ss}, 1] - \delta x_{ss} - (1 + R)d_{ss} \tag{7_{ss}}$$

$$z_{ss} = E(z) \tag{8_{ss}}$$

5.6. Recursive Competitive Equilibrium

Whenever the economy is shocked out of steady state a different equilibrium concept must be used. Due to its usefulness in the experiment that follows, the concept of recursive competitive equilibrium is now introduced. Let $S = (z, X)$ be the aggregate state vector and $s = (x, l)$ be the household's individual state vector.

Definition 2. *P1 is the following dynamic programming problem for the household*

$V(S, s) = Max_{s',b}\{U[F(x, b, l) + (1 - \delta)x + q(S)l - x' - q(S)l' - (1 + \rho(S))b] + \beta EV(S', s')\}$

s.t.

$b \leqslant \frac{q(S)l + (1-\delta)x}{1+\rho(S)}$

$S' = [\Gamma, H(S)]$

Definition 3. *P2 is the following static problem for the bank*

$Max_d\ [1 + \rho(S)](1 - z)d - (1 + R)d$

Definition 4. *A recursive competitive equilibrium is*

1. *A value function:* $V(S, s)$.
2. *A set of individual decision rules:* $s'(S, s)$ *and* $b(S, s)$.

3. *A demand for deposits:* $d(S)$.

4. *A set of pricing functions:* $q(S)$ *and* $\rho(S)$.

5. *A stochastic process and an aggregate law of motion:* $[\Gamma, H(S)]$.

   such that:

- *Given (4) and (5), (1) and (2) solve (P1).*

- *Given (4), (3) solves (P2).*

- *Markets clear:*

   1. $l'(z, X, X, 1) = 1$
   2. $b(z, X, X, 1) = (1 - z)d(z, X)$

- *Aggregate Consistency:* $x'(z, X, X, 1) = H(z, X)$.

5.7. Credit Channel

In this economy there is a credit channel which is articulated by a static and dynamic multiplier a-la-Kiyotaki and Moore (1997). The multipliers propagate and amplify any change in banking productivity. Consider an adverse productivity shock to banks meaning that their intermediation cost goes up. This would induce a contemporaneous hike in the loan rate charged by banks in equilibrium. The jump in the loan rate immediately tightens the borrowing limit of the household. As a result, households suffer a crunch in the volume of external funds or working capital available to them. Their ability to finance production is reduced with this credit crunch. As their revenue falls, they instantaneously reduce their accumulation of internal funds in an attempt to smooth out consumption. Recall that land is an asset and, as such, its price is given by the present discounted value of its forever flow of future rental payments. As shown previously, these rental payments have two components. The first one comes from the direct contribution of land to future output as an input of production. The second one comes from land's indirect contribution to output as collateral (recall that accumulating more land today increases external fund availability tomorrow and, thereby, tomorrow's output, as long as the borrowing constraint binds). Not surprisingly, these rental payments are an increasing function of the future marginal productivity of land

and external funds. Since internal funds are complementary to both land and external funds, the instantaneous reduction in internal fund accumulation implies a fall in the future marginal productivity of land and external funds. Consequently, the future flows of direct and indirect (or collateral-based) rental payments to land fall. As a result, in the period of the shock the price of land falls. This reduces the value of land on impact and, hence, tightens even further the borrowing constraint. The credit crunch is enhanced and revenue and internal fund accumulation fall even more; and so on. This story is repeated again and again. This is the static multiplier. It basically magnifies the initial impact of the shock.

But this is not the end of the story. The reduction in internal fund accumulation reduces the volume of collateral available for next period. Thus, the borrowing constraint of next period is also tightened even if the shock has vanished and the lending rate has returned to its normal level. This propagates the credit crunch or reduced availability of external funds into the next period. Hence, household revenue and internal fund accumulation fall in the period following the shock. And so on. The story told above is repeated in the periods after the shock. This is the dynamic multiplier. It propagates into future periods the effect of the shock. The economy takes longer to converge back to the steady state than in a financially frictionless setup.

6. NUMERICAL EXPERIMENT

In this section the credit channel of the theoretical model is studied within a numerical experiment that aims at replicating the negative productivity shock endured by financial intermediaries in Colombia after the new banking regulation was issued. First the assumptions (i.e. functional forms and parameter values) for the numerical experiment are presented. Then the results are discussed.

6.1. Functional Forms and Parameter Values

For this experiment the following functional forms and assumptions are used:

- $U(c) = \log(c)$
- $F(x, l, b) = x^{\alpha} l^{1-\alpha} + Ab$
- $z'\tilde{}\ iid\ \ uniform\ [0, \overline{z}]$

Note that external funds yield output through a linear technology while internal funds and land are combined in a Cobb-Douglas technology. As the reader will see, this is just a simplifying assumption to facilitate the choice of parameter values. If $A = 1$ the example reduces to the one suggested by Kocherlakota (2000).

Under this setup external funds are neither a complement nor a substitute to internal funds and land. As said earlier, the lack of complementarity between internal and external funds will reduce the kick obtained from the credit multipliers. Yet, the multipliers are still present due to the complementarity between internal funds and land. Recall that this complementarity assumption is enough to do the trick.

Note that the loan demand decision is taken according to the following rule:

$$\begin{aligned} If\ A &= (1+\rho_t) \implies b_t \in [0, \infty] \\ If\ A &> (1+\rho_t) \implies b_t \longrightarrow \infty \\ If\ A &< (1+\rho_t) \implies b_t = 0 \end{aligned}$$

Parameter values are set so that $A > (1+\rho_t) \veebar t$. This is guaranteed with the following condition:

$$A = \frac{(1+R)}{1-\overline{z}} + \varepsilon$$

where ε is an arbitrarily small number. In other words, A is constructed so that it always exceeds the highest possible gross loan rate of the economy. The important point to note is that, under these circumstances, in every period the household will want the highest loan volume it can get. Consequently, its borrowing constraint will be binding in every period:

$$b_t = \frac{q_t l_t + (1-\delta) x_t}{1+\rho_t} \veebar t$$

In the technical appendix it is shown that a sufficient condition to satisfy the no-bubble condition is $\beta F_2(x_t, b_t, l_t) < (1+\rho_t) \veebar t$. Under the present setup this is equivalent to $\beta A < (1+\rho_t) \veebar t$. To guarantee that this condition is satisfied at all times β is defined as:

$$\beta = \frac{(1+\rho_{ss})}{A} - \varepsilon$$

where ρ_{ss} is the steady state loan interest rate.

The following parameter values were used for the experiment:

TABLE 1

Primitive Parameter	Value
δ	0.025
α	0.5
R	0.019
$\overline{z}$	0.0385
ε	0.001

$\Longrightarrow$

Parameter	Resulting Value
β	0.978
ρ_{ss}	0.039
A	1.0608

Each period should be thought of as a quarter. The value for R implies a quarterly deposit interest rate of 1.9% which is equivalent to the average quarterly ex-post deposit real interest rate in Colombia for the period January/1990-February/2000.[22] This rate should be associated to the safe quarterly rate that any depositor obtains in international financial markets. The value for $\overline{z}$ was chosen so that the steady state quarterly loan interest rate is 3.9%, which coincides with the average quarterly ex-post loan real interest rate in Colombia for the period January/1990-Febreuary/2000.[23] The value for ε implies a gross return to loans (i.e. A) of 6.1% in every period and a value for β of 0.978. The quarterly depreciation rate is set at 2.5% and the elasticity of final output to both internal funds and land is 0.5. This last value was chosen as a benchmark so that output is neither land nor internal fund intensive. One caveat regarding parameter values applies. These are just reasonable numbers used to implement a quantitative exercise. There is no calibration whatsoever to long-run empirical regularities. This is future work and so specific quantitative responses should be taken with caution.

6.2. Results

Initially the economy is set at its steady state $\zeta_{ss} = (c_{ss}, x_{ss}, l_{ss}, b_{ss}, d_{ss}, z_{ss}, q_{ss}, \rho_{ss})$, which is the solution to:

$$b_{ss} = \frac{q_{ss} + (1-\delta)x_{ss}}{1+\rho_{ss}}$$

$$1 = \left[\beta\alpha x_{ss}^{\alpha-1} + \frac{A(1-\delta)}{1+\rho_{ss}}\right]$$

[22] The corresponding annual rate is 8%.

[23] The corresponding annual rate is 16.5%.

$$q_{ss} = \frac{\beta(1-\alpha)x_{ss}^{\alpha}}{1 - \frac{\beta A}{1+\rho_{ss}}}$$

$$1 + \rho_{ss} = \frac{1+R}{1 - z_{ss}}$$

$$d_{ss} = \frac{b_{ss}}{(1 - z_{ss})}$$

$$l_{ss} = 1$$

$$c_{ss} = x_{ss}^{\alpha} + Ab_{ss} - \delta x_{ss} - (1+R)d_{ss}$$

$$z_{ss} = \frac{\overline{z}}{2}$$

Once in steady state, z is given a one-time positive shock that induces a one-time 50 basis point increase in the lending rate (ρ). The magnitude of the corresponding fall in banking productivity $(1-z)$ is 0.48%. In any case, the shock drives the lending rate from 3.9% (its steady state value) to 4.4%. Recall that these are quarterly rates. In annual terms the shock is equivalent to a rise in the loan rate from 16.65% to 18.80%. Even though no definitive stance is taken here with regards to the magnitude of the shock observed in Colombia, looking at this country's annual ex-post real loan rates shows that the average between Jan/1999 and Feb/2000 (the period right after the new regulation was issued) was 18.85%. In contrast, the average for the period Jan/1990-Feb/2000 was 16.65%. Hence, the magnitude of the shock used in this experiment mimics crudely the negative productivity shock suffered by financial intermediaries in Colombia after the new banking regulation of Nov/1998 was implemented.[24]

In the period following the shock z goes back to its unconditional mean and the loan rate falls back to its stationary 3.9% level. The use of a one time shock instead of a persistent or longer lived one is necessary to isolate the propagation features of the credit channel. The response of the artificial economy is obtained by solving this economy's $(P1)$ and $(P2)$ in the context of a recursive competitive equilibrium. The solution to $(P1)$ was obtained with the linear-quadratic method. Figure 8 shows the response to the shock of i) internal funds (x), ii) asset prices (q),

[24] Why not use a shock to z so that $(1+\rho)/(1+R)$ rises 30%, as observed in the data? Again, bacause other factors might have played a role in this 30% figure and filtering out those components attributable to phenomena other than the new regulation is complicated. In fact, with a shock of such magnitude the model blows away.

iii) the loan rate (ρ), iv) the loan volume (b), v) output (Y) and vi) consumption (c).

Table 2 presents the percent deviation from steady state of variables ρ, x, q, b, Y and c during the ten periods that follow the shock. On impact, asset prices (q), credit (b) and output (Y) fall almost 9% while consumption (c) falls only 7%. This is a consequence of the household's desire to smooth consumption. Yet, the real loan rate (ρ) only rose 50 basis points (a 12.82% increase[25]). Note also that the shock vanishes immediately and the loan rate returns to its stationary level in the period following the shock. Yet, internal funds (x), asset prices (q), the loan volume (b), output (Y) and consumption (c) remain considerably depressed and below their stationary levels for several periods after the shock. For instance, in the period following the shock internal funds (x) fall more than 12%. This is expected because in order to smooth consumption after a negative income shock, the household cuts internal fund accumulation. A very interesting response is that of consumption. As evidenced from table 2 the response of consumption displays a hump. Consumption falls contemporaneously with the shock but falls even more in the period after the shock. Furthermore, in the following periods consumption remains below its impact or shock-period level.

TABLE 2: Percent Deviations from Steady State

period ↓ / variable ⟶	ρ	**x**	**q**	**b**	**Y**	**c**
t	*+12.82%*	*0*	*-8.79%*	*-8.91%*	*-8.89%*	*-7.06%*
t + 1	*0*	*-12.42%*	*-8.63%*	*-8.77%*	*-8.77%*	*-8.79%*
t + 2	*0*	*-12.20%*	*-8.48%*	*-8.61%*	*-8.61%*	*-8.63%*
t + 3	*0*	*-11.97%*	*-8.32%*	*-8.46%*	*-8.45%*	*-8.47%*
t + 4	*0*	*-11.76%*	*-8.17%*	*-8.31%*	*-8.30%*	*-8.32%*
t + 5	*0*	*-11.55%*	*-8.03%*	*-8.16%*	*-8.15%*	*-8.17%*
t + 6	*0*	*-11.34%*	*-7.88%*	*-8.01%*	*-8.00%*	*-8.02%*
t + 7	*0*	*-11.13%*	*-7.74%*	*-7.86%*	*-7.86%*	*-7.87%*
t + 8	*0*	*-10.93%*	*-7.60%*	*-7.72%*	*-7.72%*	*-7.73%*
t + 9	*0*	*-10.73%*	*-7.46%*	*-7.58%*	*-7.58%*	*-7.59%*

[25] This is equivalent to a 0.48% rise in the *gross* loan rate $(1 + \rho)$ and also to a 0.48% fall in banking productivity $(1 - z)$.

Are these responses of the artificial economy similar to those observed in Colombia after the new banking regulation was implemented? Between the first quarter of 1999 and the third quarter of 2000 real GDP in Colombia has been, on average, 5.24% below its pre-1998:III trend, with a maximum deviation of -6.3% in the second quarter of 1999.[26] This is less than what the artificial economy displays. Between December of 1998 and January of 2001 stock prices in the Colombian economy have fallen a little more than 40% in real terms. This is a considerable plunge but still below what the artificial economy predicts (66%). Between December of 1998 and January of 2001 total real credit in Colombia was crunched 30%. This number is also overshot by the prediction of the artificial economy (67%). But, again, specific quantitative results from the artificial economy should be taken cautiously given that the model was not calibrated to long-run empirical regularities. Moreover, available macroeconomic data for the period following the new banking regulation (the shock) is limited given that it was only implemented two and a half years ago. One caveat also applies. Parameter alpha was set at 0.5 so as to avoid any bias towards land or internal fund intensiveness. A proper choice of alpha can yield results more close to those in the data.

In any case, the results are illustrative of the propagation and amplification features of the model because this specific setup allows the borrowing constraint to articulate an extreme case of amplification and propagation. Indeed, if there were no financial friction and the borrowing constraint were slack, the level of external funds (b) would not affect the level of household revenue and consumption.[27] The reason is simple. For the credit constraint to be slack, it must be the case that $A = 1 + \rho$. Thus, the net gain from receiving an additional unit of b is zero. This is different to the binding constraint case where the net gain from an additional unit of b is $A - (1 + \rho) > 0$. In consequence, in the absence of a binding borrowing constraint the one-time shock to intermediation costs z and the corresponding gross loan rate hike drive to zero the volume of loans on impact (because with the shock $A < 1 + \rho$). However, household revenue, internal fund accumulation and consumption remain unchanged as net resources for the household do not change. Asset prices also remain unchanged because the future flow of direct rental payments to land (i.e. of marginal productivity of land) has not changed and, since the credit constraint is always slack, the future flow of indirect (or collateral-based) rental payments to land is zero and has not changed either. In

[26] The deviations from trend are: 99:I=-4.5%, 99:II=-6.3%, 99:III=-5.5%, 99:IV=-5.4%, 00:I=-4.7%, 00:II=5.5%, 00:III=-4.9%.

[27] Also, the level of external funds demanded and supplied is indeterminate.

the period following the shock the gross loan rate returns to its stationary level and the loan volume may jump to any level because its value is indeterminate. Yet, household revenue, internal fund accumulation, asset prices and consumption remain unchanged. Contrarily, if the borrowing constraint binds, the shock gives birth to a long-lived and more than proportional response in every macroeconomic variable. Hence, the financial friction arising from a binding borrowing constraint introduces an extreme case of amplification and propagation in this economy due to the credit channel explained in section 5.

7. CONCLUSION

Economic performance in Colombia during the last three years has been disappointing. The unemployment rate is currently above 15%. The average economic growth rate for the years 1998,1999 and 2000 was negative. Asset prices have been falling since the end of 1997. This situation contrasts with the early nineties when Colombia grew at rates exceeding 4% and was catalogued as one of the top emerging markets in the world. This economic downturn has been accompanied by a severe crisis in the financial sector that began in the end of 1997 or early 1998. Indeed, real credit suffered a severe crunch starting in January of 1998 and the real loan rate took a big hike around the same time. In order to alleviate financial distress and to finance the bail-out, the Colombian government issued new banking regulation towards the end of 1998. Whether financial distress in Colombia was alleviated or not is a question that has not yet been answered. What is true though is that in January of 1999, less than two months after the new regulation was issued, the spread between the domestic loan and deposit interest rates increased considerably.

This paper argues that this hike in the loan-deposit interest rate spread reflects a rise in intermediation costs attributable to the new banking regulation. The new regulation and the 2/1000 financial transaction tax tightened banking operational constraints and added costs to financial intermediation activity. Consequently, financial intermediaries suffered a productivity meltdown as they lost operational versatility and additional real resources were required to implement and continue to operate under the new regulations and tax. As a result, financial intermediaries had to charge a higher loan-deposit interest rate spread in equilibrium, as observed in the data. While aimed at alleviating financial distress, the new regulation ended up reducing the productivity of financial intermediaries and increasing intermediation costs.

Not surprisingly, this negative productivity shock enhanced the credit crunch and corresponding economic contraction that was already underway. The enhancement, however, did not proceed in a linear way. The data show that the effects of the shock were amplified and propagated into the future. Specifically, the contraction of GNP became wider and longer lived than most previous downward economic fluctuations. Asset prices maintained a downward trend. Real credit was further crunched after a slight recovery in the third quarter of 1998. Additionally, the real loan rate displayed another peak around the time of the new regulation. In sum, the macroeconomic effects of the initial credit crunch and financial distress were significantly amplified and propagated after the new banking regulation and financial transaction tax were implemented.

This paper suggests a general equilibrium, financial accelerator model that incorporates an explicit technology for the intermediary sector and explains how a negative productivity shock to financial intermediaries is amplified and propagated due to credit constraints. This financial imperfection articulates static and dynamic credit multipliers that amplify and propagate productivity shocks to financial intermediaries. The credit channel arises because of borrowing constraints that depend on asset prices, internal funds and lending rates. The transmission mechanism is triggered by a rise in lending rates that tightens borrowing constraints on impact. The credit crunch is magnified and propagated by a fall in asset prices and internal fund accumulation that accompanies the lower level of economic activity and that further tightens the credit limit on impact and in the future. The qualitative predictions of the model are in line with the recent behavior of macroeconomic variables in Colombia if one accepts that the new banking regulation of 1998 was a negative productivity shock to its financial system. *In short, due to the new regulation and to financial imperfections (specifically credit constraints), what otherwise would have been a regular and short-lived economic contraction, became the biggest economic downfall of recent Colombian history.*

Some questions and issues remain open for further research. It seems reasonable to think that the financial sector is constantly exposed to productivity shocks. If so, why did credit limits or financial imperfections kick in only with this last productivity shock? In other words, why did previous productivity shocks to financial intermediaries not generate large and persistent fluctuations as the one recently observed in Colombia? Maybe previous shocks were negligible or really small and did not generate significant real effects. After all, the last shock stems from major regulatory changes in the banking arena. Another possibility is that borrowing constraints did not bind when previous shocks arrived. In contrast, the last shock arrived in the middle of an economic contraction and credit crunch when credit limits are more likely to be binding. These are just tentative answers to be explored in further research.

Another issue that arises has to do with the life-span of the productivity shock from the new banking regulation. Is this shock transitory or permanent? If it is transitory, is it also very persistent? If the shock is permanent or transitory but very persistent then the enhanced macroeconomic effects that are observed in Colombia need not be the result of a financial friction but simply a direct consequence of the life-span of the shock. It would be difficult to argue that the shock was perceived as permanent since the new regulation was issued as an emergency mechanism to temporarily alleviate ongoing financial distress and to finance the bail-out of troubled institutions. The regulation is still operating but some of its decrees (especially the financial transaction tax) are expected to disappear at some point in the future, as initially announced by the government. On the other hand, evaluating the persistence of the shock is difficult because new elements have been added to the original regulation after it was implemented in November 17 of 1998. For instance, the government recently decreed an increase of the financial transaction tax rate from 2 per 1000 to 3 per 1000. In any case, it is reasonable to assume that financial intermediaries eventually find a way to adapt to the new regulation until the associated productivity effects vanish completely. If so, the shock should not be very persistent and the credit multipliers articulated by the borrowing constraint are relevant in explaining the amplification and propagation of the shock, as observed in the data. Again, this is just a tentative answer. A rigorous evaluation of the life-span of the shock is left for future research.

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9. TECHNICAL APPENDIX

In this appendix I show the derivation of equation (7). Equation (6), which dictates optimality in land accumulation, is:

$$\begin{aligned} q_t U'(c_t) &= \beta E_t\{U'(c_{t+1})[F_3(x_{t+1}, b_{t+1}, l_{t+1}) + q_{t+1} \\ &\quad +[F_2(x_{t+1}, b_{t+1}, l_{t+1}) - (1+\rho_{t+1})]\frac{q_{t+1}}{(1+\rho_{t+1})}]\} \end{aligned} \tag{6}$$

This is:

$$\begin{aligned} q_t U'(c_t) &= \beta E_t\{U'(c_{t+1})[F_3(x_{t+1}, b_{t+1}, l_{t+1}) + q_{t+1} \\ &\quad +\frac{F_2(x_{t+1}, b_{t+1}, l_{t+1})}{(1+\rho_{t+1})} q_{t+1} - q_{t+1}]\} \end{aligned} \tag{6.1}$$

Let $\Omega_t = F_2(x_t, b_t, l_t)/(1+\rho_t)$. With this notation equation (6.1) is:

$$q_t U'(c_t) = \beta E_t\{U'(c_{t+1})[F_3(x_{t+1}, b_{t+1}, l_{t+1}) + \Omega_{t+1} q_{t+1}]\} \tag{6.2}$$

or:

$$q_t = \beta E_t \left\{ \frac{U'(c_{t+1})}{U'(c_t)} F_3(x_{t+1}, b_{t+1}, l_{t+1}) \right\} + \beta E_t \left\{ \frac{U'(c_{t+1})}{U'(c_t)} \Omega_{t+1} q_{t+1} \right\} \tag{6.3}$$

Using (6.3) to substitute for q_{t+1} in (6.3) implies:

$$\begin{aligned} q_t &= \beta E_t \left\{ \frac{U'(c_{t+1})}{U'(c_t)} F_3(x_{t+1}, b_{t+1}, l_{t+1}) \right\} \\ &\quad + \beta E_t \left\{ \frac{U'(c_{t+1})}{U'(c_t)} \Omega_{t+1} \left[\beta E_{t+1} \left[\frac{U'(c_{t+2})}{U'(c_{t+1})} F_3(x_{t+2}, b_{t+2}, l_{t+2}) \right] + \beta E_{t+1} \left[\frac{U'(c_{t+2})}{U'(c_{t+1})} \Omega_{t+2} q_{t+2} \right] \right] \right\} \end{aligned} \tag{6.4}$$

Using the law of iterated expectations (6.4) becomes:

$$\begin{aligned} q_t &= \beta E_t \left\{ \frac{U'(c_{t+1})}{U'(c_t)} F_3(x_{t+1}, b_{t+1}, l_{t+1}) \right\} \\ &\quad + \beta^2 E_t \left\{ \frac{U'(c_{t+2})}{U'(c_t)} \Omega_{t+1} F_3(x_{t+2}, b_{t+2}, l_{t+2}) \right\} \\ &\quad + \beta^2 E_t \left[\frac{U'(c_{t+2})}{U'(c_t)} \Omega_{t+1} \Omega_{t+2} q_{t+2} \right] \end{aligned} \tag{6.5}$$

Using (6.3) to substitute for q_{t+2} in (6.5) implies:

$$\begin{aligned} q_t &= \beta E_t\left\{\frac{U'(c_{t+1})}{U'(c_t)}F_3(x_{t+1},b_{t+1},l_{t+1})\right\} \\ &+\beta^2 E_t\left\{\frac{U'(c_{t+2})}{U'(c_t)}\Omega_{t+1}F_3(x_{t+2},b_{t+2},l_{t+2})\right\} \\ &+\beta^2 E_t\left\{\frac{U'(c_{t+2})}{U'(c_t)}\Omega_{t+1}\Omega_{t+2}\left[\begin{array}{c}\beta E_{t+2}\left[\frac{U'(c_{t+3})}{U'(c_{t+2})}F_3(x_{t+3},b_{t+3},l_{t+3})\right] \\ +\beta E_{t+2}\left[\frac{U'(c_{t+3})}{U'(c_{t+2})}\Omega_{t+3}q_{t+3}\right]\end{array}\right]\right\} \end{aligned} \tag{6.6}$$

Using the law of iterated expectations (6.6) becomes:

$$\begin{aligned} q_t &= \beta E_t\left\{\frac{U'(c_{t+1})}{U'(c_t)}F_3(x_{t+1},b_{t+1},l_{t+1})\right\} \\ &+\beta^2 E_t\left\{\frac{U'(c_{t+2})}{U'(c_t)}\Omega_{t+1}F_3(x_{t+2},b_{t+2},l_{t+2})\right\} \\ &+\beta^3 E_t\left\{\frac{U'(c_{t+3})}{U'(c_t)}\Omega_{t+1}\Omega_{t+2}F_3(x_{t+3},b_{t+3},l_{t+3})\right\} \\ &+\beta^3 E_t\left[\frac{U'(c_{t+3})}{U'(c_t)}\Omega_{t+1}\Omega_{t+2}\Omega_{t+3}q_{t+2}\right] \end{aligned} \tag{6.7}$$

After additional iterations and imposing the no bubble condition:

$$Lim_{j\to\infty}E_t\left[\frac{U'(c_{t+j})}{U'(c_t)}q_{t+j-1}\beta^j\prod_{i=1}^{j}\Omega_{t+i}\right]=0 \tag{6.8}$$

equation (7) is obtained:

$$q_t = E_t\left\{\sum_{j=1}^{\infty}\beta^j\frac{U'(c_{t+j})}{U'(c_t)}\left[F_3(x_{t+j},b_{t+j},l_{t+j})\prod_{i=1}^{j-1}\Omega_{t+i}\right]\right\} \tag{7}$$

Note that a sufficient condition for (6.8) to hold is:

$$\beta\Omega_t \leqslant 1 \quad \forall t$$

This is:

$$\beta \frac{F_2(x_t, b_t, l_t)}{(1+\rho_t)} \leqslant 1 \quad \forall t$$

10. DATA APPENDIX

- **GDP cycle:** Seasonally adjusted quarterly gross domestic product in millions of 1994 pesos (quarterly values are not annualized). Seasonal adjustment was done with the X-11 ARIMA method. Linear trend was calculated by fitting an OLS line between seasonally adjusted GDP in 1977:I and 1998:II. HP trend was calculated with $\lambda = 1600$. Source is DANE in Colombia. Period is 1977:I-2000:III.

- **Asset prices in real terms (Dec./97=100):** Monthly closing value of the Bogota Stock Market Index (IBB). To deflate and obtain the real values the CPI (1998:12 =100) was used. Resulting values were normalized by the December/1997 value. Source is Banco de la Republica in Colombia. Period is 1991:01-2001:01.

- **Real credit volume (Dec./97=100):** Monthly opening value in millions of pesos of the total stock of credit (gross and net of non-performing loans) from the financial system [Banks, Savings and Mortgage Loan Institutions (CAV), Financial Corporations (CF), Companies of Commercial Finance (CFC), Leasing Companies, Cooperative Organisms and Special Institutions]. To deflate and obtain the real values the CPI (1998:12 =100) was used. Each observation was normalized by the December/1997 value. Source is Banco de la Republica in Colombia. Period is 1992:01-2001:06.

- **Real loan rate:** Monthly values of the ex-post real annual loan interest rate. This rate is calculated as $(1 + i^l)/(1 + \pi) - 1$, where i^l is the observed nominal annual loan interest rate and π is the realized annual inflation rate. The nominal annual loan rate used is "tasa activa total sistema" (monthly average) calculated by Superintendencia Bancaria in Colombia. Inflation rates were calculated with the CPI (1998:12 =100). Source is Banco de la Republica. Period is 1990:01-2000:02.

- **Loan/deposit interest rate spreads:** Monthly basis point difference between the nominal annual loan interest rate and the nominal annual 3-month COD interest rate: $i^l - i^d$. The nominal annual loan rate is "tasa activa total sistema" (monthly average) calculated by Superintendencia Bancaria in Colombia. The nominal annual 3-month COD rate is "tasa de interes de los CDT a 90 dias, total sistema" (monthly average). Source is Banco de la Republica. Period is 1990:01-2000:12.

- **Inverse productivity of financial system:** Monthly ratio between the gross nominal annual loan interest rate and the gross nominal annual 3-month COD interest rate: $(1+i^l)/(1+i^d)$. The nominal annual loan rate is "tasa activa total sistema" (monthly average) calculated by Superintendencia Bancaria in Colombia. The nominal annual 3-month COD rate is "tasa de interes de los CDT a 90 dias, total sistema" (monthly average). Source is Banco de la Republica. Period is 1986:01-2000:12.

- **Labor productivity of financial system:** Quarterly ratio between the opening real stock of credit (in millions of pesos and gross of non-performing loans) and the number of employees in the financial sector in the seven main metropolitan areas. To deflate and obtain real credit values the CPI (1998:12 =100) was used. Source for employment is DANE - Encuesta Nacional de Hogares. Source for credit volume is Banco de la Republica. Period is 3/1/1992-12/1/2000.

11. FIGURES

Figure 1a

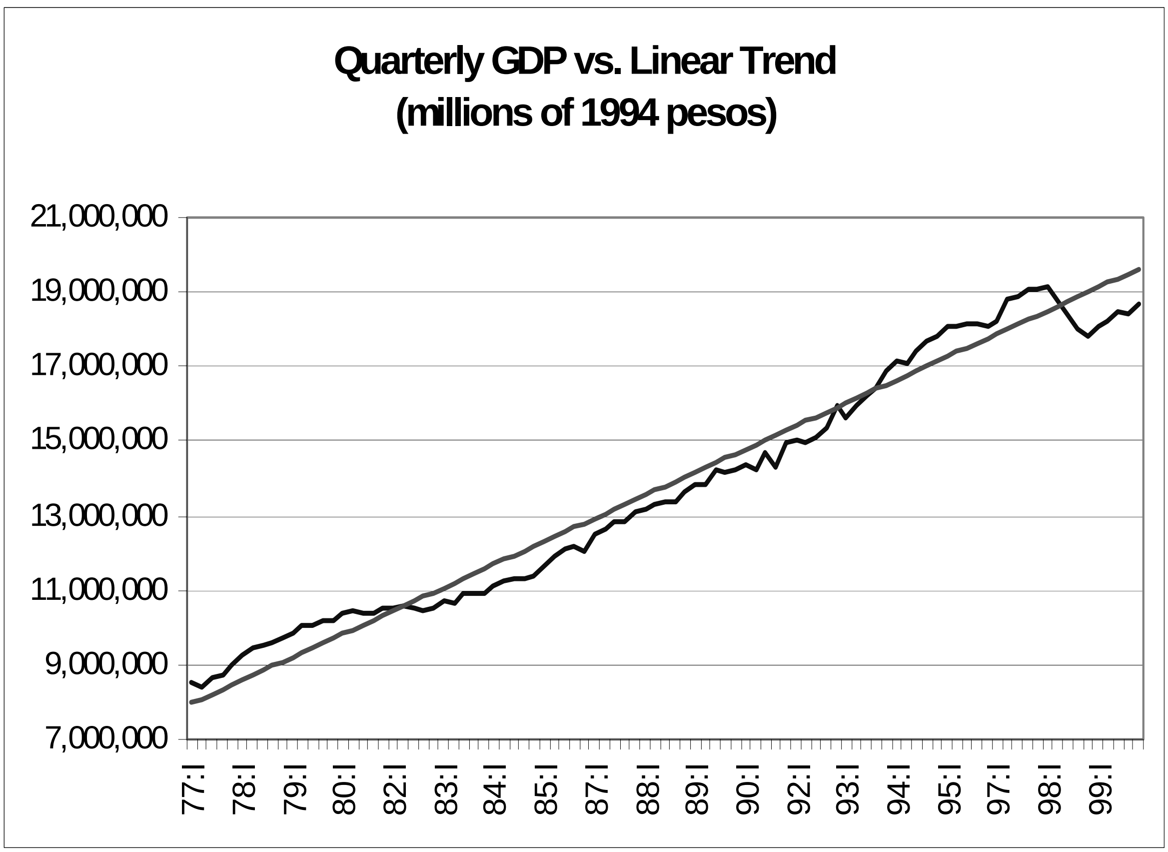
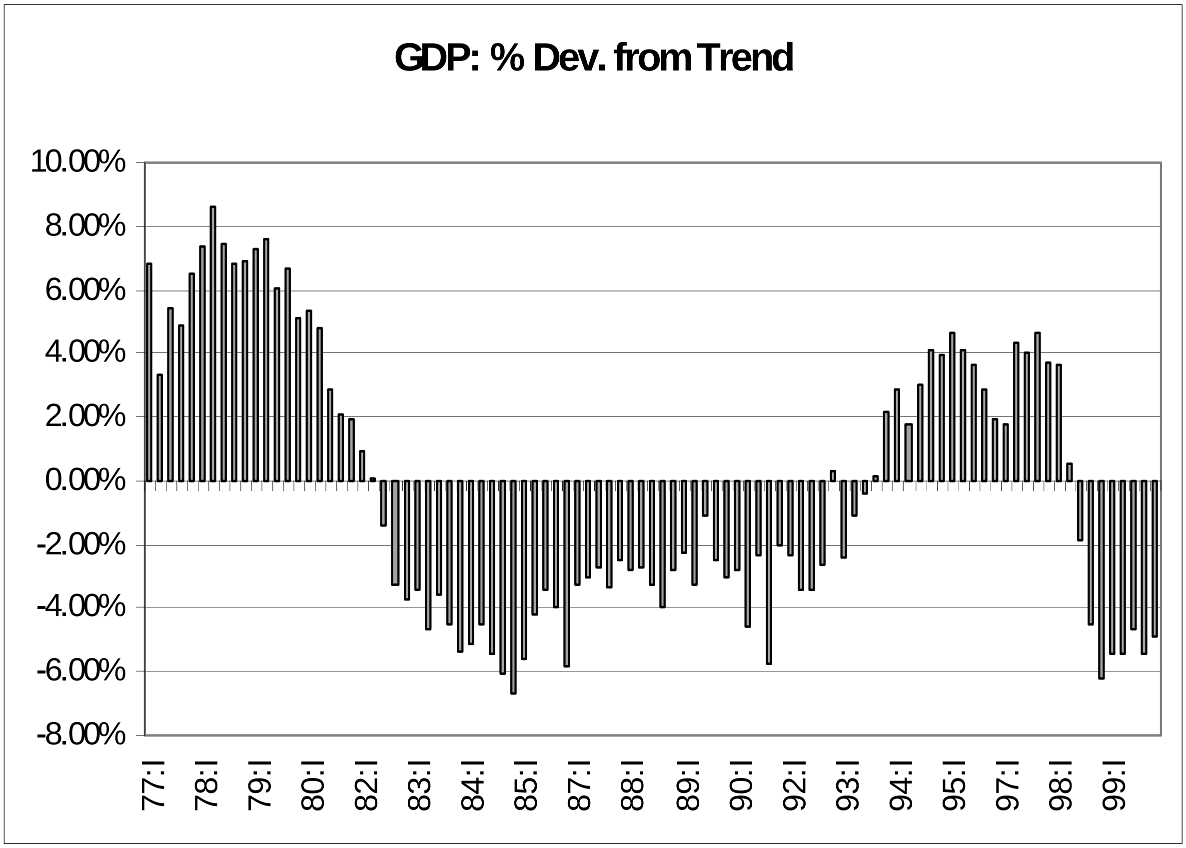


Figure 1b



GDP: % Dev. from Trend
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
-2.00%
-4.00%
-6.00%
-8.00%
77:I
78:I
79:I
80:I
82:I
83:I
84:I
85:I
87:I
88:I
89:I
90:I
92:I
93:I
94:I
95:I
97:I
98:I
99:I

Figure 2

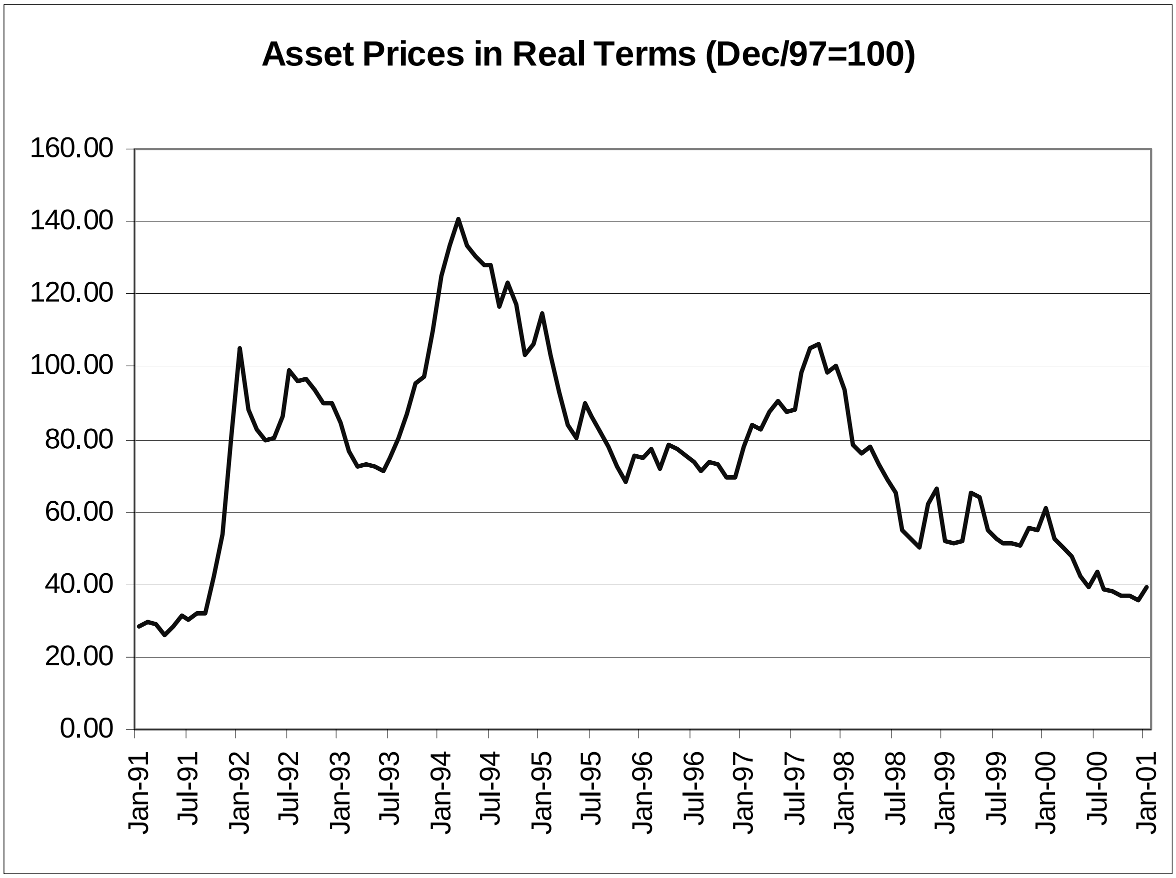

Asset Prices in Real Terms (Dec/97=100)
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Jan-00
Jul-00
Jan-01

Figure 3

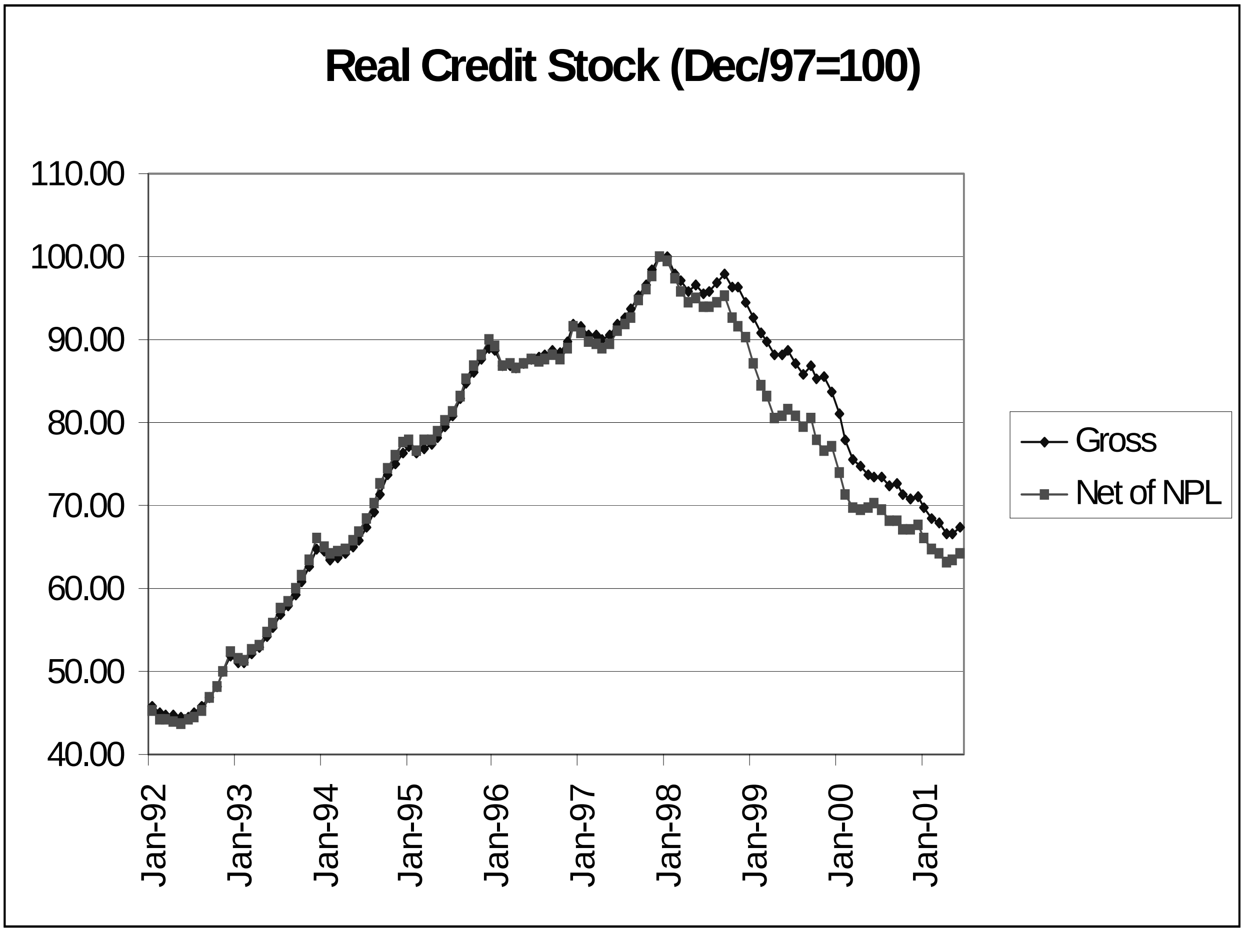

Real Credit Stock (Dec/97=100)
110.00
100.00
90.00
80.00
70.00
60.00
50.00
40.00
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Gross
Net of NPL

Figure 4

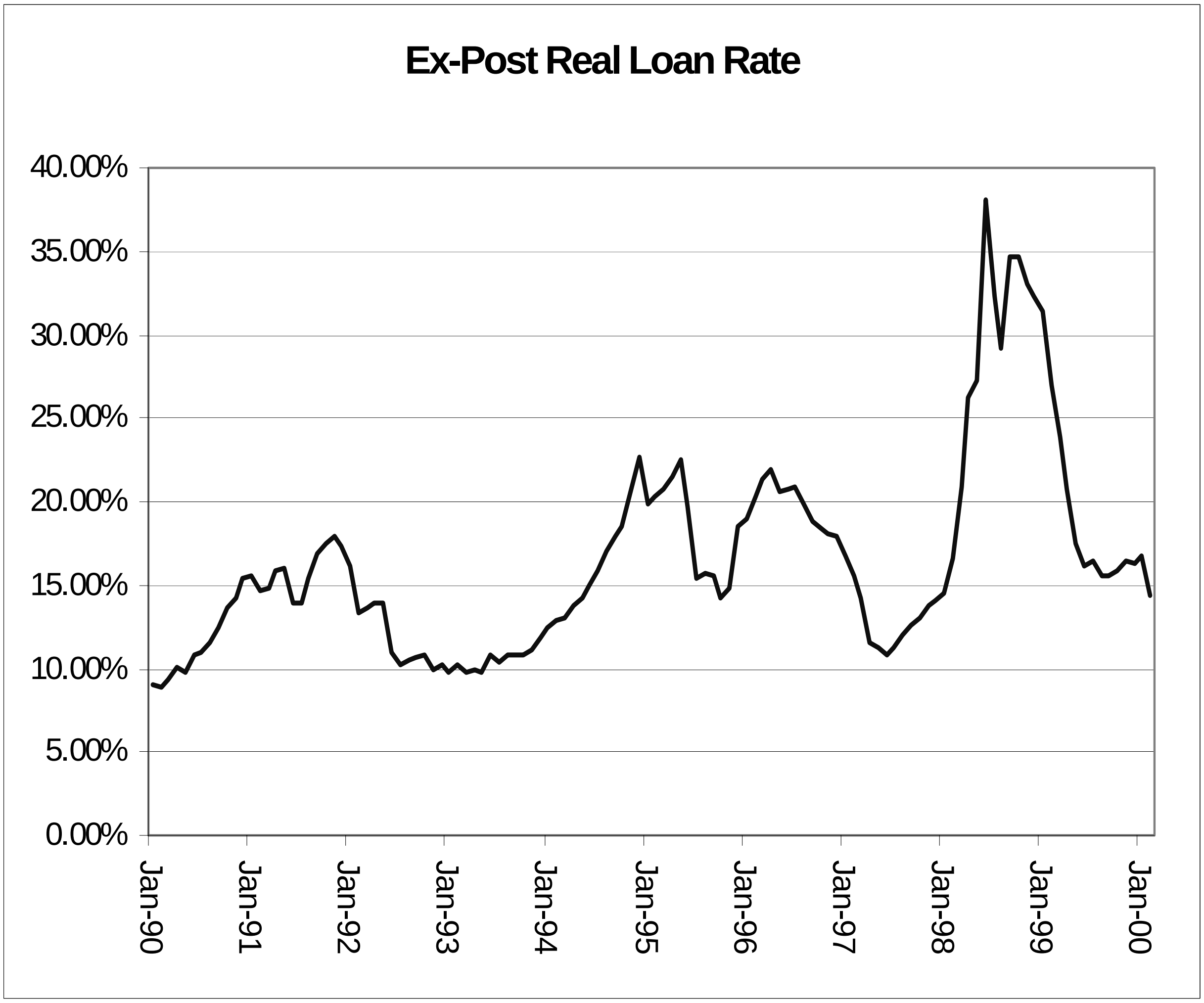

Ex-Post Real Loan Rate
40.00%
35.00%
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00

Figure 5

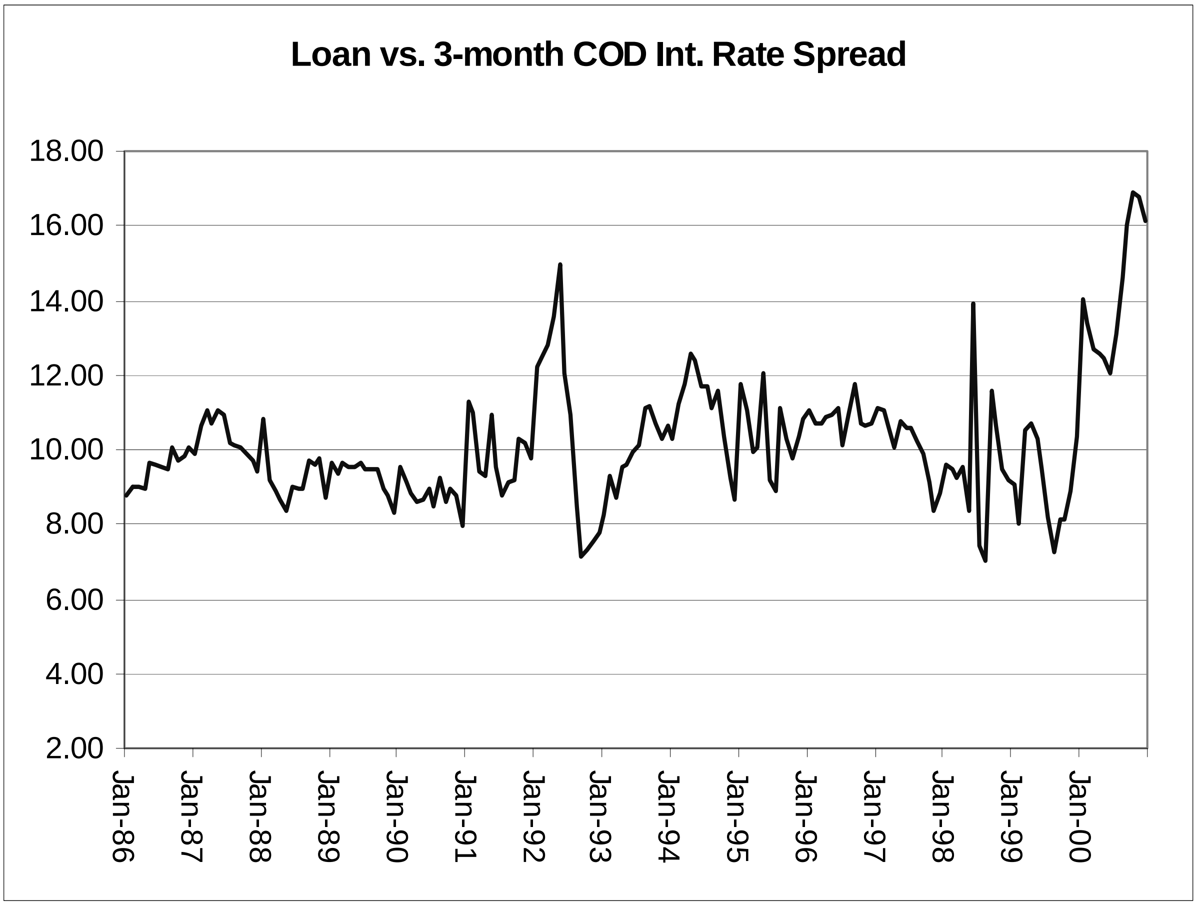

Loan vs. 3-month COD Int. Rate Spread
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00

Figure 6

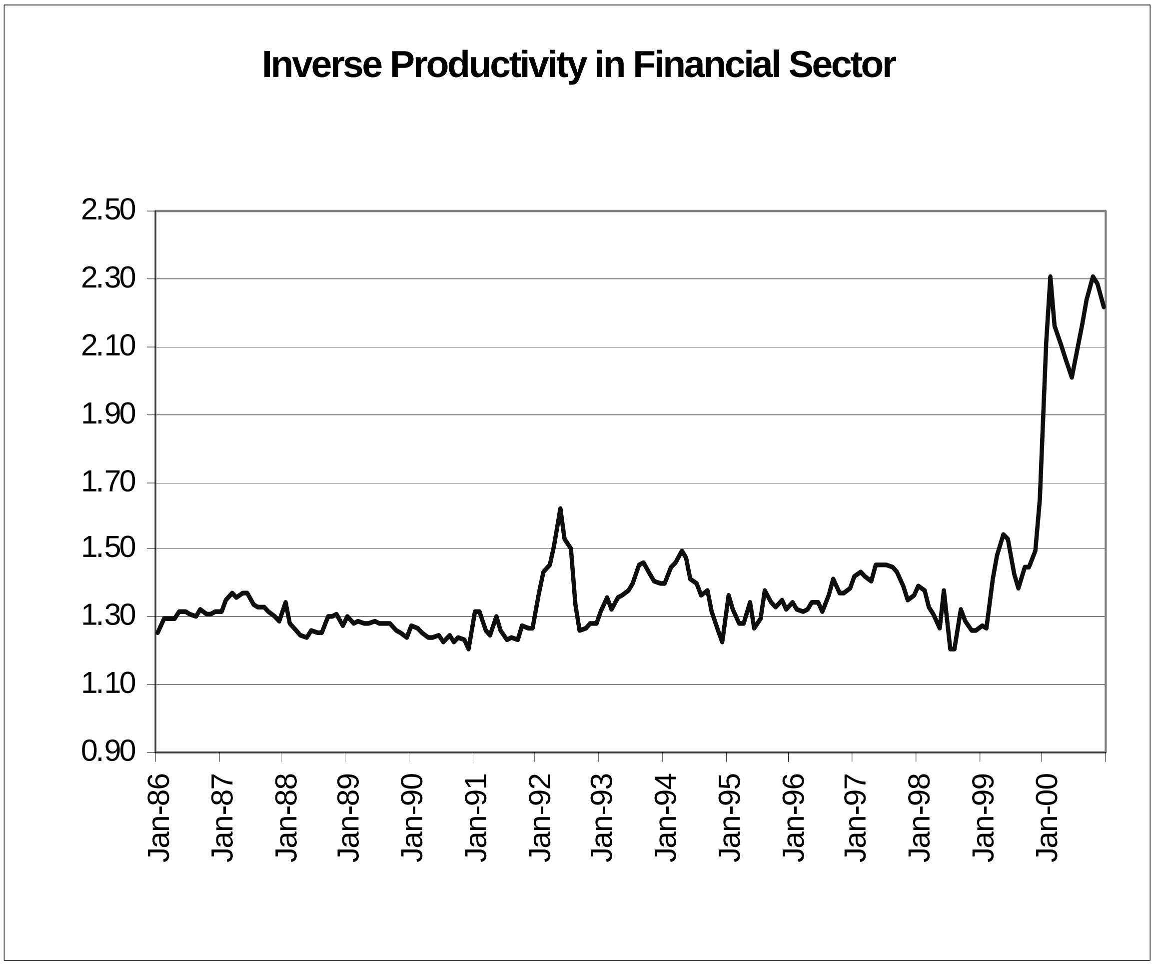

Inverse Productivity in Financial Sector
2.50
2.30
2.10
1.90
1.70
1.50
1.30
1.10
0.90
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00

Figure 7

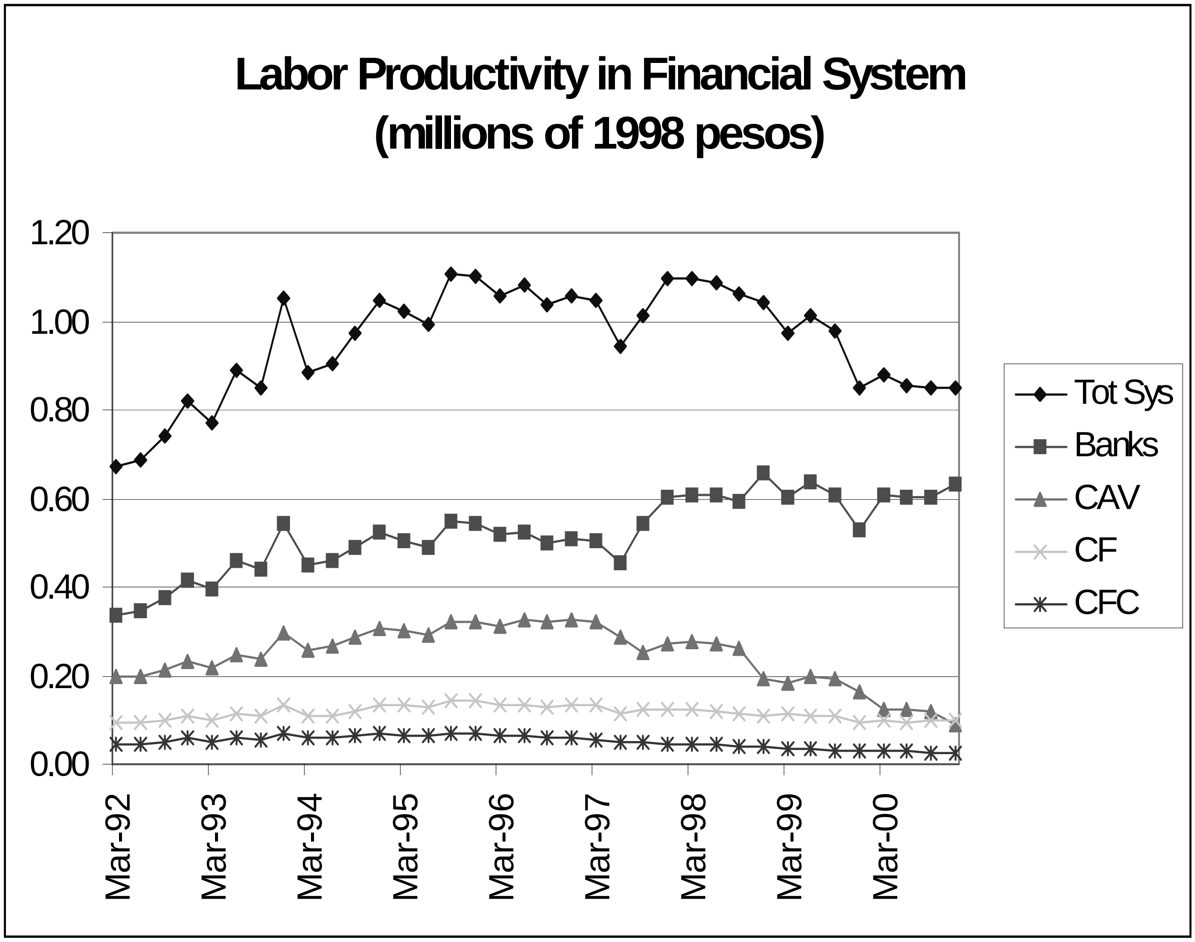
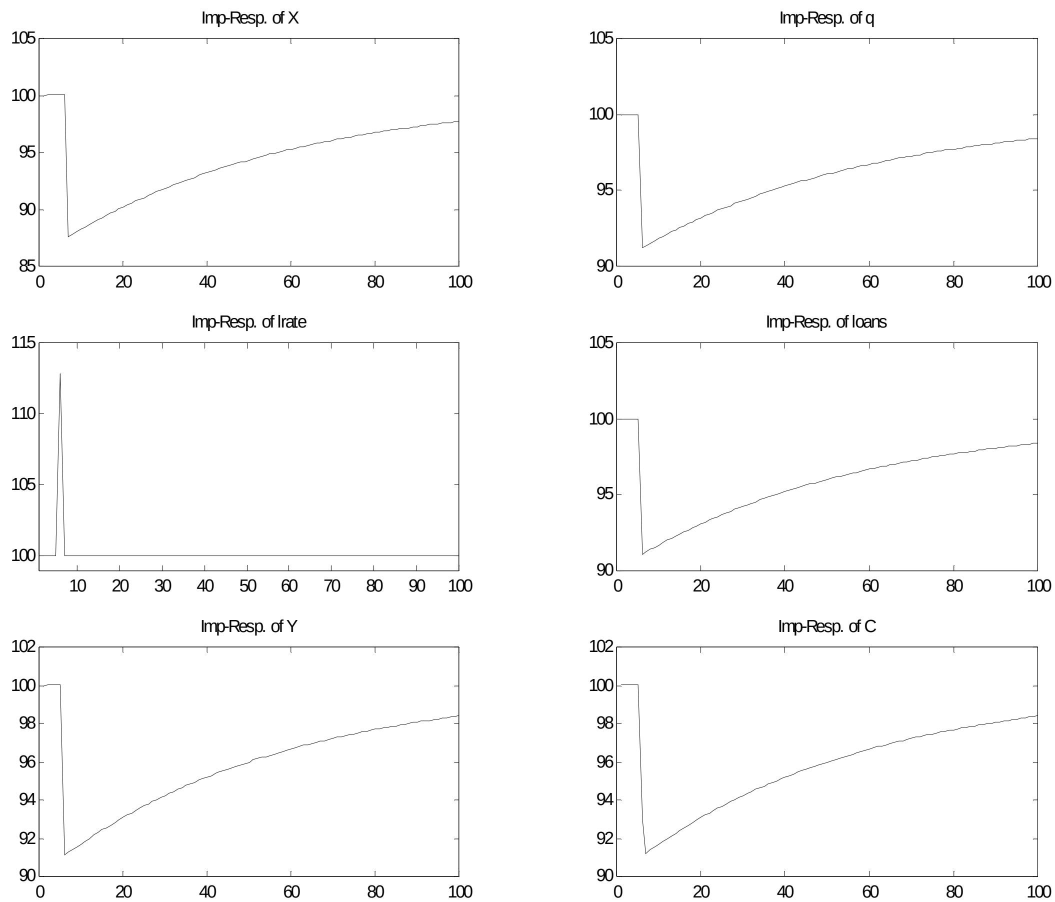

Labor Productivity in Financial System
(millions of 1998 pesos)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Mar-92
Mar-93
Mar-94
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Mar-00
Tot Sys
Banks
CAV
CF
CFC

Figure 8


Imp-Resp. of X
105
100
95
90
85
0
20
40
60
80
100
Imp-Resp. of q
105
100
95
90
0
20
40
60
80
100
Imp-Resp. of Irate
115
110
105
100
10
20
30
40
50
60
70
80
90
100
Imp-Resp. of loans
105
100
95
90
0
20
40
60
80
100
Imp-Resp. of Y
102
100
98
96
94
92
90
0
20
40
60
80
100
Imp-Resp. of C
102
100
98
96
94
92
90
0
20
40
60
80
100