ISSN 1518-3548

BANCO CENTRAL DO BRASIL

Working Paper Series 51

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September, 2002

ISSN 1518-3548
CGC 00.038.166/0001-05

Working Paper Series	Brasília	n. 51	Sep	2002	p. 1 – 28

Working Paper Series

Edited by:

Research Department (Depep)

(E-mail: workingpaper@bcb.gov.br)

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Credit Channel with Sovereign Credit Risk: An Empirical Test*

Victorio Yi Tson Chu**

Abstract

According to Bernanke and Gertler (1995), the Credit Channel amplifies the traditional monetary transmission and this amplification effect comes through the *firm's external finance premium*, which is a wedge between the expected return for the funds generated internally and the costs of funds raised externally to the firm. Traditionally, this wedge is the bank loan spread but we extend this concept to include the sovereign (country) credit risk and name it, Extended Credit Channel. Armed with this new concept and using a set up model, we estimate two econometric equations for the Brazilian economy after its inflation stabilization program. These two econometric equations measure: (1) the effects of the pure money channel (real interest rates and compulsory reserve requirements on demand deposits) and the extended credit channel (country credit risk and bank loan spread) on the economy's production, and (2) the impacts of the real interest rates, compulsory reserve requirements on demand deposits, and country credit risk on the bank loan spread. Both equations coefficients signs conform to the expected theoretical model. With the results of the estimated equation (1), we define a Product Loss Index Number to compare these two transmission channels (extended credit and pure monetary). This comparison shows that the extended credit channel is as relevant as the pure monetary channel.

Keywords: Credit Channel, Sovereign Credit Risk, Reserve Requirements and Bank Loan Spread.
JEL Classification: E44, E50, N16.

* The author thanks, without implicating, Eduardo L. Lundberg, Márcio I. Nakane, Eduardo Tonooka for their valuable comments and, Sérgio Mikio Koyama for his assistance with the data. The views expressed here are solely the responsibility of the author and do not reflect those of the Central Bank of Brazil.
** Research Department, Central Bank of Brazil. E-mail address: victorio.chu@bcb.gov.br

In his survey, Hubbard (1994) argues that "... the terms "money view" and "credit view" are not always well defined in theoretical debates over the transmission mechanism of monetary policy." These views are also denominated as a "money view" channel and "credit view" channel.

The traditional or "pure" money channel is defined as the transmission mechanism through basic interest rates and deposit reserve requirements. And, in this paper, we will define the credit channel according to the concept found in Bernanke and Gertler (1995), as a monetary transmission mechanism channel that is a companion to the "money" channel, particularly, the direct effects of monetary policy on interest rates that amplifies the borrower's *external finance premium*. This borrower's *external finance premium* is the difference between the costs of the loans interest rate and the cost of these funds for the lenders, namely the banks. Then, the credit channel is not seen as a freestanding or parallel to the money channel.

Most of the emerging markets are large borrowers in the international financial system; hence they also face an *external finance premium* that is usually quoted as a spread over the US Treasury bonds.

Before proceeding, we must address the following questions: What is the importance of the credit channel? And how relevant is the sovereign credit risk as a component of the credit channel?

Thus, in this article we tackle this sovereign *external finance premium* by extending the traditional credit channel to include the country or sovereign credit risk.

What lies behind this extension of the credit channel is the effect associated to a country's economy when faced with adverse changes on its *external finance premium*. As it is well documented in many articles, like Hermalin and Rose (1999), Reinhart (2002), and Magalhães, Moreira and Rocha (2002), the deterioration of a country's credit rating, which translates in an increase of its external finance premium, is not the cause for decline of its macroeconomic or credit conditions but it is just mirroring the worsening of the country's economic risk or its economic expectations. Rigobon (2001) shows how a country's upgrade to investment grade credit rating increases the inflow of foreign funds, improving the overall condition of the economy. When well managed, this improvement to investment grade credit rating creates a virtuous circle: increasing investment, the economy grows, credit rating betters up which increases the inflow of funds and so on.

Therefore, the motivation for this paper is to answer the following set of questions:
(Q1) What are the magnitude of the effects on income derived from this difference between the funds cost of the financial intermediaries, namely the banks, and the cost of the loans to borrowers?
(Q2) How relevant is sovereign credit risk premium effect on the credit channel and on the economic activity?

Our theoretical model is based on the economic model presented in Chu and Nakane (2001), which was built on the loan interest-rate clearing-price framework fashioned by Bernanke and Blinder (1988). And it was adapted to suit for a variable representing the difference between the banks' loans interest rate and the cost of these resources, namely, the bank loan spread.

The first empirical equation was based on a cointegration model with an error correction term, and estimated the relationship between the real income (using the Industrial Production Index as a proxy) and the components of the pure money channel (legal reserves on demand deposits and real interest rates) and the extended credit channel (bank loans spread and sovereign country credit risk) for Brazil after its Inflation Stabilization Program in July 1994.

Our second empirical equation, also based on a cointegration model with an error correction term, searches for a relation between the bank loan spread and those other components of the monetary transmission, namely, the legal reserves, interest rates and country credit risk.

After estimating these two equations, we calculate the sensibility of the dependent variables to changes in the explanatory variables. We create a Product Loss Index to compare the impact of the pure money channel and the extended credit channel, which results that the effects of the extended credit channel can be as relevant as the pure money channel.

The paper is divided in four parts. First, we make a short description of the model found in Chu and Nakane (2000) and adapt it for the bank loans spread. Second part describes the data for Brazil used for the empirical test. In the third part, we present the econometric model and the estimated equations and discuss the results. Finally, the last part is the conclusion.

1. The Model

In this section we will make a short description of the theoretical model presented in Chu and Nakane (2001).

The main hypotheses concerning this economy with four agents: banks, government, households and firms are:

H1) The monetary authority follows an inflation-targeting regime and determines two policy instruments: a short-term nominal interest rate and the required reserve ratio on demand deposits (α). In the short-term and under inflation targeting regime, there is no uncertainty about the inflation, therefore the monetary authority can control the real interest rate $r_B = \bar{r}_B$, where $\bar{r}_B$ is the real interest rate on public bonds. These two policy instruments are assumed to be exogenous in the model. And the supply of public bonds B^g is infinitely elastic at the real interest rate $\bar{r}_B$.

H2) Let S (y, r_B) be the households real savings and y the real income. The partial derivatives are $S_y > 0$ and $S_{r_B} > 0$.

H3) Firms finance their investments I (r_B, r_L) through bank loans that cost the loan interest rate r_L, where $I_{r_B} < 0$ and $I_{r_L} < 0$. And I (r_B, r_L) = S (y, r_B). The variable banking loan spread (γ) represents the difference between banking loan interest rate and the basic interest rate paid by the public bonds.

H4) Banks' have only demand deposits, no capital and hold three assets: legal reserve requirements on demand deposits (R), public bonds (B^b) and loans (L^b). Bank's balance sheet will be equal to:

(1) $R + B^b + L^b = D^b$

Where D^b is banks' total deposits. It is assumed that the banks accept passively all the deposits demanded by the non-bank public. And the non-banks public deposits demand function is $D^d(y, r_B)$ with $D_y^d > 0$ and $D_{r_B}^d < 0$ as its partial derivatives. The banks do not pay interest for the demand deposits that are subject to legal reserve requirements and they do not carry excess reserves beyond the minimum established by the monetary authority.

(2) $R = \alpha D^b$

Let $B^b(\sigma, r_L)$, where σ is variable that represents the economy's risk. The assumption for its partial derivatives is $B_\sigma^b > 0$ and $B_{r_L}^b < 0$. It is assumed that the demand for public bonds is totally inelastic with respect to its own interest rate.

Applying $B^b(\sigma, r_L)$ in equation (1) and substituting for (2) we will have the following banks' supply of loans function:

(3) $L^b = (1-\alpha) D^b - B^b(\sigma, r_L)$

The non-bank public's demand for bank loans is denoted by $L^d(r_L, y)$ with partial derivatives $L_{r_L}^d < 0$ and $L_y^d > 0$.

With these assumptions, the market clearing condition for the goods market corresponds to the IS schedule with a negative slope in the (r_L, y) plan:

(4) $$\left.\frac{dr_L}{dy}\right|_{IS} = \frac{S_y}{I_{r_L}} < 0$$

The market clearing conditions for the deposits and bank loans represented in a single schedule is made by using equation (3) with $D^b = D^d(y, r_B)$ and $L^b = L^d (r_L, y)$, then,

(5) $$(1- \alpha)D^d(y, r_B) - B^b(\sigma, r_L) = L^d(r_L, y)$$

Equation (5) provides the set of (r_L, y) that assures the simultaneous equilibrium in the deposit and loan markets represented by the schedule DL. This DL schedule can have a positive or negative slope in the (r_L, y) plan:

(6) $$\left.\frac{dr_L}{dy}\right|_{DL} = \frac{(1-\alpha)D_y^d - L_y^d}{B_{r_L}^b + L_{r_L}^d} \gtrless 0$$

The sign uncertainty comes from the numerator's unknown sign result, but in any event, the DL slope is assumed to be greater than the IS slope.

The economy's general equilibrium is represented in Figure 1. With a positive slope for DL and r_L^* and y^*, represent, respectively, the equilibrium values for r_L and y.

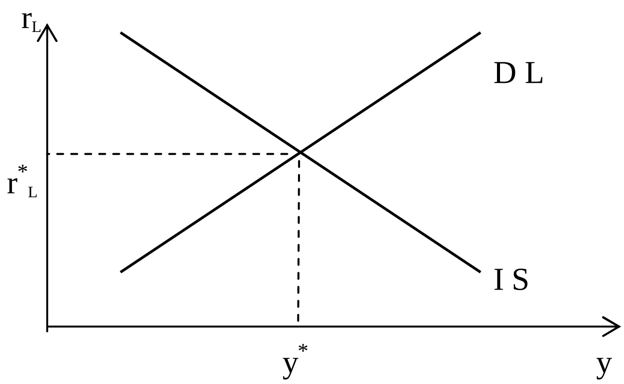

Figure 1: The Economy's General Equilibrium.

The model's exogenous variables are α, r^*_B, and σ. Table 1 summarizes the comparative static results for the model[1].

Variable λ	$dy^*/d\lambda$	$dr^*_L/d\lambda$
α	-	+
$\bar{r}_B$	-	?
σ	-	+

Table 1: Comparative Static and $\bar{r}_B$ is the basic real interest rate.

After this brief description of Chu and Nakane (2001), we will adapt their model for the bank loan spread γ^*, where $\gamma^* = r^*_L - r_B$, by replacing r^*_L for $(\gamma^* + r_B)$ and deriving the equations found in the appendix of Chu and Nakane (2001) for the bank loan spread γ^* variable.

In Table 2, we present these results. And in the Appendix, it is shown the mathematical derivation of those equations with the loan spread γ^*.

Variable λ	$dy^*/d\lambda$	$d\gamma^*/d\lambda$
α	-	+
$\bar{r}_B$	-	?
σ	-	+

Table 2: Comparative Static with y^* and γ^*.
The variable $\bar{r}_B$ is the basic real interest rate.

The signs of derivatives related to the spread (γ^*) are intuitive:

An increase in α results in additional compulsory reserve requirements for demand deposits, meaning that the banks will have a lower volume of money for lending purposes, therefore we will have a higher γ^*. And an opposite situation happens when α

[1] The proofs of the results presented in Table 1 appear in the Appendix of Chu and Nakane (2001).

decreases, with a larger volume of funds resulting in a lower γ^*. Figure 2 shows graphically the effects of an increase of α.

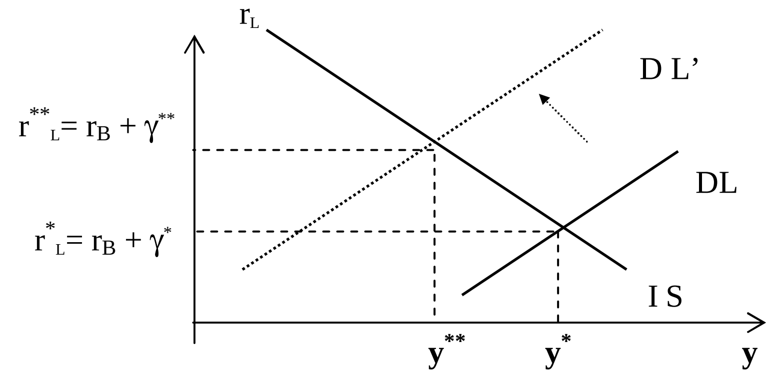

Figure 2: Effects of Increasing the Required Reserve Ratio ($\alpha^{**}>\alpha^*$) with $\gamma^{**}>\gamma^*$.

Lowering the economy-wide risk σ leads the banks to reduce their demand for public bonds freeing resources for loans, this will move the DL curve to the right, resulting in an opposite situation from Figure 2. This effect is shown graphically in Figure 3.

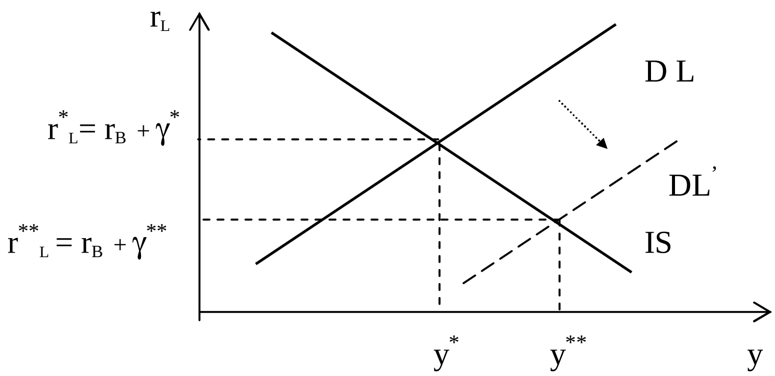

Figure 3: Effects of Decreasing the Economy-wide Risk ($\sigma^*>\sigma^{**}$) with $\gamma^*>\gamma^{**}$.

Increases in the variables α, $\bar{r}_B$ and σ result in a shift of the DL schedule to the left or upward that lower the y^* for the same IS schedule.

2. The Data

We made an empirical test with the data from the Brazilian economy. Our test sample starts in August/1994 and goes till September/2001, consisting of 86 monthly observations. The Brazilian hyperinflation stabilization plan started in July/1994, then we choose August/1994 as starting month, because there were some inflation residuals contaminating the July inflation index. These data contain the following variables:

Country Credit Risk (*Risk*)– it consists of the monthly geometric average price of the Brazilian foreign debt (C-Bond) and is measured as annual spread over the U.S. Treasury Bonds. This spread measures the country credit risk or, in other words, the Brazilian sovereign credit risk. The Augmented Dickey-Fuller test for unit root was performed and could not reject that the series is integrated of order one, I(1).

Spread (*S*)– it is the banking loan monthly spread published in the monthly and annual report[2] produced by the Brazilian Central Bank. It is basically a weighted average of fixed loans and credit instruments offered by the main private banks in Brazil. The unit root tests indicated that this series is I(1).

Real Interest Rates plus one ($1+r_B$) – where r_B is the geometric average monthly basic interest rate of the economy determined by the Brazilian Central Bank SELIC (*i*) divided by the General Price Index (IGP-DI) published by FGV. The unit root test rejected at 5% significance, meaning that the series is stationary at series level, I(0).

Product (Y) – it is represented by the monthly Industrial Production Index collected by IBGE (*Brazilian Institute of Geography and Statistics*) and it was seasonally adjusted by the multiplicative X-11 methodology. Applying the unit root tests resulted that the series is integrated of order one, I(1).

Compulsory Reserve Requirements (α) – it is the legal reserve requirement for the banks' demand deposits. These are the reserves, as a percentage of demand deposits that the banks are obliged to deposit at the monetary authority. Unit root tests indicated that the series is integrated of order one, I(1).

Figure 4 presents a graphic with the Risk (C-Bond as % a.y. spread over the U.S. Treasury Bonds) and the behavior of the Industrial Production Index Seasonally Adjusted. It is possible to see that the valleys of the C-Bond are accompanied by an increase of the Industrial Production, suggesting a negative relationship between these two variables.

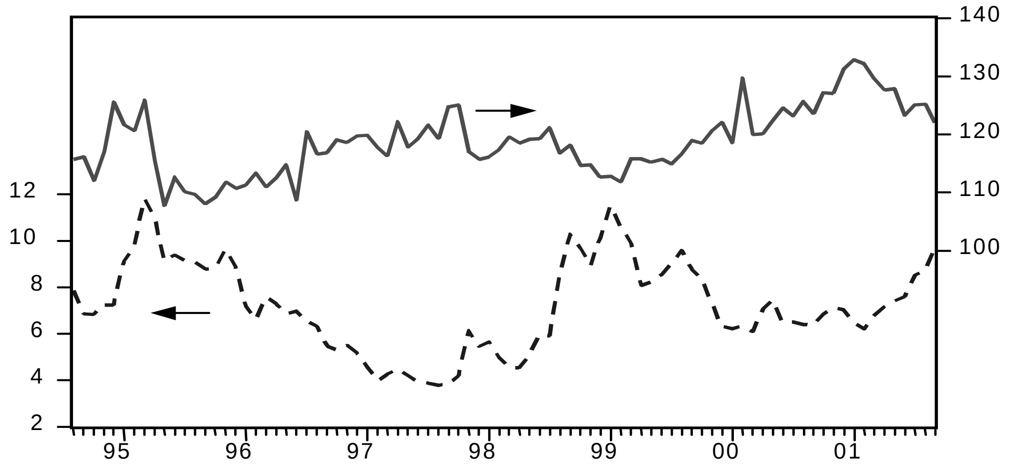

Figure 4: Dotted Line - Risk % a.y. over Treasury

Bold Line - Industrial Production Season Adjusted.

Figure 5 is a graphic of the Loan Spread (% a.m.) versus the Compulsory Reserve Requirements as a percentage of Total Demand Deposits. It can be seen that the drop of the legal reserve requirements is accompanied by a reduction of the loan spread.

[2] Banco Central do Brasil, "Notas dos Juros e Spread Bancário no Brasil" (monthly report) and "Juros e Spread Bancário no Brasil" (report for the years 1999, 2000 and 2001). These reports also describe the calculus methodology for these loan spreads.

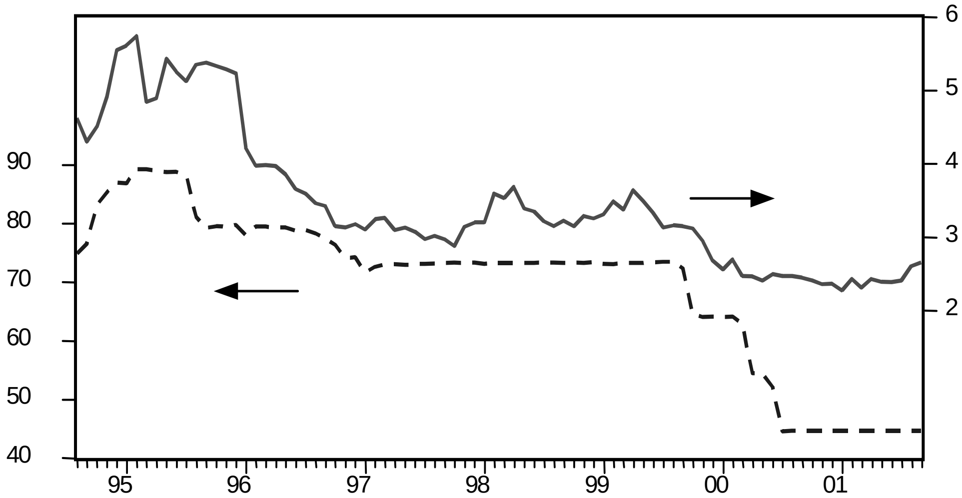

Figure 5: Dotted Line - % Compulsory Reserve

Bold Line - Loan Spread % a.m.

3. Empirical Model

3.1. Empirical Model for the Product (Y)

From Table 2, the empirical model for the dependent variable product Y, which has the Industrial Production Index Seasonally Adjusted as its proxy, is explained using the explanatory variables from Table 2: compulsory reserve requirements (α), real interest plus one (1+ r_B) and (*risk*) measured by the Brazilian sovereign credit risk (C-Bond); with an additional varaible: bank loan spread (S).

The Johansen test was performed up to 12 lags for a group of these 5 variables and co-integration could not be rejected for at least 3 co-integration vectors.

The presence of co-integration resulted in the necessity of an Error Correction Term (ECTY) for our econometric model. The specification of ECTY[3] is:

[3] The econometric program that we used did not provide the standard deviation for the coefficients of the deterministic trend (*) and the intercept (**).

$$ECTY_t = \ln Y_t + 0.077083 \ln Risk_t + 11.62011 \ln(1+r_B)_t - 0.348324 \ln S_t - 0.015774 \alpha_t - 0.002053 Trend - 5.81037$$

(0.01589) (1.39767) (0.07020) (0.01866) (*) (**)

Where the term Trend represents a linear trend variable.

The econometric model for the product Y was:

$$\Delta \ln(Y)_t = \sum_{j=1}^{n} \xi_j \Delta \ln Y_{t-j} + \sum_{j=0}^{n} \zeta_j \Delta \ln Risk_{t-j} + \sum_{j=0}^{n} \omega_j \Delta \ln(1+r_B)_{t-j} + \quad (7)$$

$$+ \sum_{j=0}^{n} \beta_j \Delta \ln \alpha_{t-j} + \sum_{j=0}^{n} \omega_j \Delta \ln S_{t-j} + \delta ECTY_{t-1}$$

The econometric test was performed assuming all variables as I(1), including the variable real interest rate plus one (1+ r_B). The difference operator for the variables logarithm is represented by the Δ operator.

The estimation of the coefficients of the econometric equation for the product Y, represented by Industrial Production Index Seasonally Adjusted, is shown in Table 4 below. The sign for the sum of the coefficients for each variable accords to the prediction of our theoretic model. The discussion of these results are presented in the following sub-section 3.3.

Table 4: Estimated Econometric Equation for Product Y

Dependent Variable: $\Delta \ln Y_t$			
Variable	**Coefficient**	**Std. Error**	**t-Statistic**
$\Delta \ln Y_{t-1}$	-0.437323	0.086003	-5.084998
$\Delta \ln Y_{t-4}$	-0.149864	0.085990	-1.742821
$\Delta \ln Risk_t$	-0.067580	0.023288	-2.901918
$\Delta \ln(1+ r_B)_{t-2}$	0.735783	0.263039	2.797237
$\Delta \ln(1+ r_B)_{t-9}$	-0.735944	0.248503	-2.961508
$\Delta \ln(1+ r_B)_{t-12}$	-0.548211	0.238608	-2.297537
$\Delta \ln Spread_{t-1}$	-0.120808	0.054495	-2.216851
$\Delta \ln \alpha_t$	0.145041	0.077130	1.880482
$\Delta \ln \alpha_{t-8}$	-0.167872	0.076972	-2.180958
$ECTY_{t-1}$	-0.070964	0.024932	-2.846265
Adjusted R-squared: 0.491663		**Durbin-Watson stat: 2.190872**	

Our tests did not reject normality (Jarque-Bera), homocedasticity (Arch(1) and White) and residuals are not correlated.

3.2. Empirical Model for the Spread (S)

The empirical model for the dependent variable Spread (S), which is a monthly rate, consisted of three variables: compulsory reserve requirements (α), real interest plus one ($1+ r_B$) and MRisk, which is a conversion of C-Bonds annual spread over U.S. Treasury Bonds to monthly spread over U.S. Treasury Bonds. Equation (8) shows mathematically the conversion of the annual Risk (Cbond) to monthly risk rates (MRisk):

(8) $$MRisk = (1 + Risk)^{1/12}$$

We performed the Johansen test up to the 12 lags for a set of these 4 variables and co-integration could not be rejected for at least 2 co-integration vectors.

The existence of co-integration produced the need of an Error Correction Term (ECTS) for our econometric model. The specification of ECTS is:

$$ECTS_t = \ln Spread_t - \underset{(0.11199)}{0.693660} \ln MRisk_t - \underset{(3.29866)}{17.43029} \ln(1 + r_B)_t - \underset{(0.14303)}{0.60048} \alpha_t - 0.218101$$

Except for $\ln(1 + r_B)$ which is I(0), those other 3 variables, Spread (S), compulsory reserve requirements (α) and monthly risk rates (MRisk) are all I(1). And the difference operator for the variables logarithm is represented by the Δ operator.

The econometric model for the Spread was:

(9) $$\Delta \ln(Spread)_t = Constant + \sum_{j=1}^{n} \Delta \ln(Spread)_{t-j} + \sum_{j=1}^{n} \xi_j \Delta \ln \alpha_{t-j} + \\ + \sum_{j=0}^{n} \zeta_j \Delta \ln MRisk_{t-j} + \sum_{j=0}^{n} \omega_j \Delta \ln(1 + r_B)_{t-j} + \delta ECTS_{t-1}$$

Our final estimation for the coefficients of the econometric equation for the Spread is shown in Table 5.

Table 5: Estimated Econometric Equation for the Spread

Dependent Variable: Spread			
Variable	Coefficient	Std. Error	t-Statistic
Constant	0.024429	0.010781	2.266037
$\Delta \ln Spread_{t-2}$	0.236747	0.094574	2.503298
$\Delta \ln Spread_{t-3}$	-0.160601	0.099413	-1.615494
$\Delta \ln Spread_{t-4}$	-0.266109	0.099319	-2.679329
$\Delta \ln Spread_{t-7}$	-0.176287	0.094000	-1.875400
$\Delta \ln Spread_{t-11}$	-0.231517	0.083909	-2.759128
$\Delta \ln MRisk_{t-8}$	0.115184	0.043782	2.630857
$\Delta \ln \alpha_{t}$	0.339996	0.157733	2.155515
$\Delta \ln \alpha_{t-5}$	0.451151	0.146564	3.078177
$\Delta \ln \alpha_{t-6}$	0.318329	0.145719	2.184548
$\Delta \ln(1+ r_B)_{t}$	2.200057	0.555877	3.957810
$\Delta \ln(1+ r_B)_{t-1}$	-1.444039	0.729013	-1.980814
$\Delta \ln(1+ r_B)_{t-2}$	-1.100265	0.621179	-1.771252
$\Delta \ln(1+ r_B)_{t-3}$	2.261766	0.593387	3.811619
$\Delta \ln(1+ r_B)_{t-5}$	-0.969302	0.506735	-1.912838
$\Delta \ln(1+ r_B)_{t-7}$	1.123173	0.593310	1.893061
$\Delta \ln(1+ r_B)_{t-8}$	-2.725414	0.555900	-4.902705
$\Delta \ln(1+ r_B)_{t-12}$	-1.250886	0.486525	-2.571063
$ECTS_{t-1}$	-0.062721	0.025932	-2.418649
Adjusted R-squared: 0.454738	Durbin-Watson stat: 2.272964		

The performed tests for normality (Jarque-Bera), homocedasticity (Arch(1) and White) were not rejected and residuals are not correlated.

Also, the Wald test with the null hypothesis for the sum of coefficients of $\Delta \ln(1+ r_B) = 0$ resulted in its rejection at 1% significance, as presented in Table 6.

Table 6: Wald test results for the sum of the coefficients of $\Delta \ln(1+ r_B)$.

Wald Test:			
Null Hypothesis:	C(11)+C(12)+C(13)+C(14)+C(15)+C(16)+C(17)+C(18)=0		
F-statistic	7.536553	Probability	0.008152
Chi-square	7.536553	Probability	0.006046

3.3 Discussion of the Results

Our empirical results for the Brazilian economy are in accordance with what's predicted by the Chu and Nakane's (2001) theoretical model. And a sensibility analysis for a medium term economic horizon is presented in Tables 7 and 8, respectively, for the estimated Product Equation and Bank Loan Spread Equation.

(1) The product Y equation

The coefficients signs are: negative for Risk (CBond), negative for real interest rate, negative for the bank loan spread and negative for α - compulsory reserve requirements for demand deposits.

Table 7: Sensibility analysis for the coefficients of the Estimated Product Equation.

	Industrial Production Index: annual rate rounded to second decimal	**$\{(Y_t/Y_{t-1})-1\}$**
Risk	Increase of 10% of Risk	-40 b.p.
$(1+ r_B)$[4]	Increase of 10% of $r_{B(t)}$ with $r_{B(t-1)}$ = 8% a.y, depends on level of $r_{B(t-1)}$	-25 b.p.
Spread	A 10% Spread Increase.	-72 b.p.
α	Increase of 10% compulsory reserve requirement.	-14 b.p.
b.p. = basis point		

Since the range of our risk (C-Bond) as spread over the Treasury is between 600 b.p. to 1,000 b.p. then a 10% increase in risk, representing an additional of 60 b.p. to 100 b.p., translates into an estimated drop of – 40 b.p. in the year product.

The effects of the real interest rate is approximate, because our variable is $(1+ r_B)$ and not only r_B, hence, at the level of r_B = 8% a.y. which corresponds to a value of $1+ r_B$ (= 1.08) and 10% of it amounts nearly 100 b.p. a year, resulting in an estimated loss of -25 b.p. over the country's yearly production.

Since the bank loan spread is very high in Brazil, a 10% increase on the loan spread equals an addition of a number within the range of 350 b.p. to 750 b.p., which will have an estimated negative impact of –72 b.p. on the year's production. And for α, the compulsory reserve requirement on demand deposits, its effects is smaller, in the present case of α = 45% of the demand deposits, a 10% increase equals an addition of 450 b.p. resulting in an estimated negative impact on the yearly production of –14 b.p.

[4] The result is approximate since to find the $\ln((1+X_t/(1+X_{t-1}))$ in the case of real interest rates depends on the exact number of X_t and X_{t-1}.

In summary, we can see that the variable that has the largest negative impact on the Industrial Production Index is the Sovereign Credit Risk (C-Bond), which for a 10% increase in the sovereign risk (with the risk on the range of 600 b.p. to 1,000 b.p. over the US Treasury bonds) generates a loss on the production index in the range of –0.6666 to –0.4[5].

Defining PLIN as Product Loss Index Number[6], this index number represents how many basis points of yearly production loss for each basis point change of the explanatory variable. Thus, after the sovereign credit risk, the real interest rate (at the initial interest rate in the neighborhood of 8 % a year) will have a negative impact of –0.25 on PLIN and the bank loan spread, for the spread at 34.495% a year, will result in a product loss index number of -0.2087. And the smallest impact on PLIN for a 10% increase in the variable is related to the compulsory reserve requirement, at today's value of α = 45% to α = 49.5% of the demand deposits, this will produce a negative change of -0.03111 to the production loss index number. Table 8 summarizes all the impacts on the product loss index number (PLIN) for an adverse change in the macroeconomic variable.

Table 8: Variables impact on the product in terms of a loss index number.

Product Loss Index Number: Estimated Product Loss Index Range		
Increase of 10% of Risk (Country Credit Risk) range: 60 to 100 b.p.	-0.66667	-0.40
Increase of 10% of Rb(t), with initial Rb(t-1) = 8% a.y. (Variations depend on initial Rbt-1)	-0.25	-0.25
Increase of 10%, for annual spread (initial spread of 34.49%)	-0.2087	-0.2087
Increase of 10% for α (compulsory reserve requirement) initial α(t-1) = 45%	-0.03111	-0.03111

Table 9 below compares the sum of the product loss index number for those two channels of transmission: Extended Credit Channel (with the variables: Country Credit Risk and Bank Loan Spread) and Pure Monetary Channel (with the variables: real interest rates and compulsory reserve requirements). It can be seen that the extended credit channel affects sensitively on the yearly production. Since the overall impact

[5] The division of the loss in b.p. per 10% change of the variable in b.p. generates a loss index number, for instance, (-40 b.p./60b.p.) equals –0.666 for the upper limit of the risk variable impact.
[6] The Product Loss Index sign is negative because in the coefficients signs of the econometric equation are negative.

depends on the initial state, we can say, at the very least, that the Extended Credit Channel affects the economy as much as the pure monetary channel.

Table 9: Comparing the effects of Extended Credit Channel and Pure Monetary Channel

Sum Of Product Loss Index Number: Estimated Range Extracted from Tables 7 and 8		
Extended Credit Channel effects (Country Credit Risk and Bank Loan Spread)	-0.87537	-0.6087
Pure Monetary Channel effects (real interest rates and compulsory reserve requirements)	-0.28111	-0.28111

(2) The bank loan spread (S) equation

The coefficients signs are: positive for Risk (CBond), positive for real interest rate and positive for α - compulsory reserve requirements for demand deposit.

Table 10: Sensibility analyses for the coefficients of the Estimated Loan Spread Equation

Spread$_t$ – Spread$_{t-1}$, where Spread$_{t-1}$= 34.49% a.y, and rounded to second decimal		
Risk	Increase of 10% of Risk (C-Bond)	77 b.p.
(1+ r_B)	Increase of 10% of $r_{B(t)}$ with $r_{B(t-1)}$ = 8% a.y, depends on level of $r_{B(t-1)}$	57 b.p.
α	Increase of 10% compulsory reserve requirement	293 b.p.
b.p. = basis point		

Repeating the same analysis for the bank loan spread within the same 10% range increase assumed for those explanatory variables in the product equation described above, and from a initial bank loan spread of 34.49% a year, we get the following results:

For a range of 60 b.p. to 100 b.p. addition limits to the risk (C-Bond) variable at the annual rate, we will have an estimated annual spread increase of 77b.p.

The additional real interest rate, considering that the actual variable is (1 + r_B) and the initial r_B is 8% a year, is 57 b.p. for the annual rate.

Of these three variables (risk, real interest rate and reserve requirements), the largest impact on the bank loan spread comes from the legal reserve requirements. An additional 10% of the compulsory reserve requirements on demand deposits (α), which at present moment stands at 45% rate, resulting in a new α of 49.5% rate will increase the annual bank loan spread by an estimated 293 b.p.

4. Conclusion

This paper is a follow-up of a theoretic model contained in Chu and Nakane (2001) and makes an empirical test based on that theoretical model. The monetary authority has control over two policy instruments: short term real interest rate and the compulsory reserve requirements for the demand deposits. More specifically, we cover empirically the effects of transmission to the bank loans called credit channel and, extend it to include the sovereign country credit risk measured, using C-Bonds, as a spread over the US Treasury bonds.

The impact on the Brazilian economy of this extended credit channel, which is the sum of the effects of the bank loans spread and the sovereign credit risk (as a proxy for an economy-wide risk) can be as relevant as the pure money channel (interest rates and legal reserve requirements).

Hence, in determining the effects of the credit channel for emerging countries economies it is important to include a parameter that indicates the expected risk of the economy. A useful proxy for this risk is the sovereign country credit risk.

Appendix

The results from the Appendix of Chu and Nakane (2001) are presented and they will be used to generate new equations for the spread γ^* variable.

Given the two equations represented by the IS and DL

$I(r_B, r_L) = S(y, r_B)$

$(1- \alpha)D^d(y, r_B) - B^b(\sigma, r_L) = L^d(r_L, y)$

Let Δ the system's Jacobian determinant solved at the equilibrium, which is equal to:

$$\Delta = I_{r_L} + (B^b_{r_L} + L^d_{r_L})\left[\left.\frac{dr_L}{dy}\right|_{DL|} - \left.\frac{dr_L}{dy}\right|_{IS|}\right] > 0$$

Since the DL slope is assumed to be less steep than the IS slope then the Δ sign is positive.

Knowing that

(10) $r^*_L = r_B + \gamma^*$

And by equation (10), assuming that $\frac{dr_B}{d\alpha} = 0$, and substituting and deriving the equations below, comes:

1.1 Variations in α

(11) $\frac{dr^*_L}{d\alpha} = \frac{D^d S_y}{\Delta} > 0$

$$\frac{dr^*_L}{d\alpha} = \frac{dr_B}{d\alpha} + \frac{d\gamma^*}{d\alpha} = \frac{d\gamma^*}{d\alpha} = \frac{D^d S_y}{\Delta} > 0$$

(12) $\frac{d\gamma^*}{d\alpha} = \frac{D^d S_y}{\Delta} > 0$

(13) $\frac{dy^*}{d\alpha} = \frac{D^d I_{r_L}}{\Delta} < 0$

1.2 Variations in $\bar{r}_B$

(14) $$\frac{dr_L^*}{d\bar{r}_B} = \frac{dr_B}{d\bar{r}_B} + \frac{d\gamma^*}{d\bar{r}_B} = \frac{(S_{r_B} - I_{r_B})[(1-\alpha)D_y^d - L_y^d] - (1-\alpha)S_y D_{r_B}^d}{\Delta} \gtrless 0$$

As $r_B = \bar{r}_B + \Gamma$, where Γ is inflation and $\frac{d\Gamma}{d\bar{r}_B}$ <0, an increase in the real interest rate in the public bonds lowers the inflation rate.

(15) $$\frac{dr_B}{d\bar{r}_B} = \frac{d\bar{r}_B}{d\bar{r}_B} + \frac{d\Gamma}{d\bar{r}_B} = 1 + \frac{d\Gamma}{d\bar{r}_B} \gtrless 0$$

(16) $$\frac{d\gamma^*}{d\bar{r}_B} = \frac{(S_{r_B} - I_{r_B})[(1-\alpha)D_y^d - L_y^d] - (1-\alpha)S_y D_{r_B}^d}{\Delta} - \frac{dr_B}{d\bar{r}_B}$$

Since $\frac{(S_{r_B} - I_{r_B})[(1-\alpha)D_y^d - L_y^d] - (1-\alpha)S_y D_{r_B}^d}{\Delta} \gtrless 0$ and using equation (15) then,

(17) $$\frac{d\gamma^*}{d\bar{r}_B} = \frac{(S_{r_B} - I_{r_B})[(1-\alpha)D_y^d - L_y^d] - (1-\alpha)S_y D_{r_B}^d}{\Delta} - 1 - \frac{d\Gamma}{d\bar{r}_B} \gtrless 0$$

(18) $$\frac{dy^*}{d\bar{r}_B} = \frac{(S_{r_B} - I_{r_B})[(B_{r_L}^b + L_{r_L}^d] - (1-\alpha)D_{r_B}^d I_{r_L}}{\Delta} < 0$$

1.3 Variations in σ

(19) $$\frac{dr_L^*}{d\sigma} = \frac{dr_B}{d\sigma} + \frac{d\gamma^*}{d\sigma} = \frac{S_y B_\sigma^b}{\Delta} > 0$$

As assumed in our initial hypothesis that r_B is determined exogenously by the monetary authority under an inflation targeting framework and σ is a measure of the economy-wide risk, therefore these two assumptions lead to the hypothesis that $\frac{dr_B}{d\sigma} = 0$. Thus:

(20) $$\frac{d\gamma^*}{d\sigma} = \frac{S_y B_\sigma^b}{\Delta} > 0$$

(21) $$\frac{dy^*}{d\sigma} = \frac{B_\sigma^b I_{r_L}}{\Delta} < 0$$

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