Effects of Inflation Uncertainty on Credit Markets:

A Disequilibrium Approach

by

Taner M. Yigit[a]

Bilkent University

Abstract

The following analysis provides a microeconomic foundation to how inflation uncertainty adversely affects output by examining the impact of unpredictable inflation on credit markets. We claim that non-diversifiable risks such as inflation uncertainty will cause financial agents to act in a risk-averse manner. Such risk aversion will adversely affect credit markets i) directly by reducing credit availability, and ii) indirectly by raising the cost of borrowing. Simultaneous Tobit analysis of eight countries confirms that inflation fluctuations not only lead to disequilibrium in these markets, but also negatively affect total amount of credit.

Keywords: Inflation Uncertainty, Disequilibrium, Credit Markets, and Risk Aversion

JEL Classifications: E440, C340

[a] Bilkent University, Department of Economics, IISBF, Bilkent, 06533 Ankara-TURKEY; Tel: 90 (312) 2901898 Fax: 90 (312) 2665140 E-mail: tyigit@bilkent.edu.tr

Effects of Inflation Uncertainty on Credit Markets: A Disequilibrium Approach

1 Introduction

The increasing number of countries[1] (and lately the European Central Bank) adopting inflation targets as the primary objective of monetary policy is not only a compromise between rules and discretion, but also a pursuit to reduce adverse effects of inflation uncertainty. Numerous studies (Friedman, 1977; Froyen & Waud, 1987; Grier & Perry, 2000) have shown the harmful effects of unpredictable inflation on macroeconomic activity. In the study below, we provide a microeconomic foundation to explain this negative effect by analyzing the effects of inflation uncertainty on credit markets. Analysis of eight countries reveals that inflation fluctuations not only lead to disequilibrium in these markets, but also negatively affect total amount of credit.

Previous studies on the effects of inflation uncertainty on credit markets have resulted in different claims. On one hand, Ingersoll & Ross (1992), and Dixit (1994) claim that real interest rate and price uncertainty deters investors and pushes them to choose the "option to delay". Landskroner & Ruthenberg (1985), and Miller (1992) also find that total credit is negatively affected by inflation uncertainty due to increased bank costs. On the other hand, Huizinga (1993), and George & Morriset (1995) claim that uncertainty of inflation will sometimes lead to higher profit fluctuations and may result in increased investment. Regardless of their conclusion, all of these papers share the assumption of equilibrium when characterizing credit markets. Such a depiction is rejected by the credit rationing literature (Stiglitz & Weiss, 1981; Williamson, 1987), which claims that increased uncertainty in the economy causes the banks to ration credit and lead to disequilibrium in credit markets. They support this claim by empirical evidence that finds credit availability to be a significant explanatory variable in the determination of investment (Fry, 1980; Blejer & Khan, 1984; Voridis, 1993), indicating a quantity constraint in the determination

[1] Group of countries that adopted this regime consists of Australia, Canada, Finland, Israel, New Zealand, Spain, Sweden, the United Kingdom, Poland, and the Czech Republic.

of credit. These contentions of the credit rationing literature motivate our analysis of the effects of inflation uncertainty on credit markets, allowing for possibility of credit market disequilibrium.

We base our model of credit markets on profit-maximizing risk-averse agents. We believe that risk aversion is a better characterization of agents (despite the traditional risk neutrality) in the existence of non-diversifiable risks such as inflation uncertainty. The outcome of such a supposition is the possibility of disequilibrium in credit markets or curbed credit. Similar to credit rationing models, disequilibrium is caused by a non-monotonic loan supply. We deviate from these models, however, since we contend that banks adverse reaction to a combination of credit *and* interest risks determines the shape of the loan supply, rather than information problems. Turning our attention to loan demand, we notice that surprisingly the effect of inflation uncertainty on loan demand is ambiguous. The net effect depends on whether price changes more than real interest rate due to inflation fluctuations. Such formulation of the credit markets provides a microeconomic basis for why inflation uncertainty reduces economic activity.

The empirical part tests the implications of the theoretical section, namely that inflation uncertainty causes risk aversion, which in turn results in rationed credit. In order to validate such claims, we use a methodology that allows for the existence of disequilibrium in the credit markets. Utilizing Simultaneous Tobit estimation not only avoids distortions caused by possible censored data, but also enables precise determination of how loan demand and supply are affected by unpredictable inflation, even when one of them is not observed. Estimations confirm risk aversion and disequilibrium in majority of a sample of eight countries. More importantly, we find that inflation uncertainty adversely affects these credit markets, 1) directly by reducing credit availability, and 2) indirectly by raising the cost of borrowing. Results also show that inflation uncertainty has significant bearing on *both* developed and developing country credit markets regardless of their depth.

Next section briefly explains the derivation of the theoretical model. Section three explains the estimation technique along with description of the data. In the fourth section, we present results of the empirical analysis on the eight countries used in the research. Concluding remarks appear in the paper's final section.

2 Model

Our model assumes identically risk-averse agents on both sides of imperfect credit markets. Both the firms and the banks maximize an objective function of the form $\Gamma = E(\Pi) - \frac{\lambda}{2}\operatorname{var}(\Pi)$ (where Π represents profit and λ is the coefficient for risk aversion[2]). The setting of our model also includes asymmetric information, where firms know that there is a possibility of their loan applications can be rejected, and the banks know that there is a possibility of default on the loans granted. Such general formulation results in a credit market disequilibrium generated by a non-monotonic loan supply.

2.1 Loan Supply

With n borrowers, the bank's ex-post profit from borrower i (Π_i) is:

$$\Pi_i = \begin{cases} R_L L_i + R_B B + \tilde{e}F - R_D D - \left(\pi^e + \tilde{\mu}\right)\left(L + B - D\right) & \text{with probability } p \\ R_B B + \tilde{e}F - R_D D - \left(\pi^e + \tilde{\mu}\right)\left(L + B - D\right) & \text{with probability } (1-p) \end{cases} \quad (1)$$

with the balance sheet constraint,

$$(1-\rho)D = L + B + F \quad (2)$$

where p is the exogenous probability of successful loan projects in the loan pool, F is the foreign currency holdings of the bank with $\tilde{e} \sim N(e^e, \sigma_e^2)$ as the uncertain real depreciation (devaluation) of the domestic money; $\tilde{\mu} \sim N(0, \sigma_\mu^2)$ is the deviation from the optimal forecast of inflation π^e, and R_L, R_B and R_D are the gross loan (L), bill (B), and deposit (D) rates[3], respectively. We deviate from the classic assumption of credit rationing models, p being a decreasing function of loan rate

[2] The parameter λ is determined by the tangency of the mean-variance efficient frontier with the banks' or firms' utility function, and so it reflects their behavior towards risk. The bank or the firm becomes more risk averse as λ gets larger.
[3] $R_i = 1 + r_i$

for notational and mathematical simplicity. Risk aversion still leads to a non-monotonic loan supply when banks face a combination of interest and credit risks.

In their maximization of the objective function, the banks use deposits to lend to a) the private sector in the form of loans, b) the government by purchasing highly liquid bills, or c) to speculate in the foreign exchange market (inflation hedge). Banks are price takers in the loan market if there is equilibrium in the market, and they are price setters otherwise. In other words, in cases where there is no market equilibrium, the banks choose the loan quantity and rate. The sources of uncertainty are the stochastic inflation rate (interest risk), which affects the real rates of the assets or liabilities in the bank's portfolio, uncertainty about the exchange rate, and the probability of loan repayment (credit risk).

Solution to the maximization of the banks' objective function leads to three significant comparative statics results. First, the loan supply is non-monotonic in the loan rate (backward bending). This backward bending supply is caused by the interaction of credit and interest risks in a risk-averse environment. The next significant result is the negative effect of inflation uncertainty on the loan quantity due to increases in interest risk deterring banks from lending. Last but not least, unpredictable inflation leads to climbing loan rates, indirectly reducing total lending via negative effects on loan demand. Other comparative statics, and optimal loan rate and quantity are displayed in Appendix and Table A1.

Loan Demand

We utilize a flexible accelerator model to describe the investment behavior of firms in the existence of capital price (real interest rate) and inflation uncertainty. In this framework, n identical firms have the same distribution function for the return on the projects in which they intend to invest. Maximizing the same objective function as the banks with respect to investment,

(L_i^d), the firms use a Clower dual decision process[4] since they know that banks will meet their financing demand only at certain times (e.g., with probability τ). The τ will be endogenous since it is the probability of equilibrium, $\sum L_i^d = L$ [5]. The investment project outcome (Y_i) of a typical firm is stochastic with a distribution function *G(Y)*. Therefore, firms will prefer to default and get zero return if their project return is below the loan repayment value (or break-even rate)_ i.e., if

$$Y_i \le R_L^* L_i^d \tag{3}$$

, where R_L^* is the real loan rate.

Under these assumptions, a general form of profit for firm *i* is

$$\Pi_i = \Pi\left(Y_i^*, K_i^*, L_i^d, \left(Y_i - Y_i^*\right); w^*, R_L^*, p^*\right) \tag{4}$$

, where Y_i^* and K_i^* are the existing levels of output capacity and capital respectively, w^* is the wage rate, L_i^d is the desired capital stock change $\left(K_i - K_i^*\right)$, and R_L^* and p^* are the random real prices of capital and output.

Maximization after the linearization of Π_i around K_i^* and Y_i^* gives us the optimal solution displayed in the Appendix. Comparative statics show that the effect of inflation uncertainty on loan demand is not as clear-cut as mentioned in previous studies (George & Morisset, 1995). Its impact will depend crucially on the comparison of real rate uncertainty (σ_r^2) and covariance between prices of capital and output ($\sigma_{r,\pi}$), both functions of inflation fluctuations (σ_μ^2). Loan demand will increase if inflation uncertainty is the larger cause of covariance between prices of capital and output, since this correlation minimizes profit fluctuations. The reverse will be true if inflation fluctuations are the predominant reason of real rate uncertainty, since σ_r^2 reduces the

---

[4] Actual investment will be bound by the amount of loans supplied $L \le \sum_n L_i^d$.

[5] This condition does not mean that the individual firm has control over altering their chances for loans.

cost of delaying an investment project. Other relevant comparative statics results are summarized in Table A2.

Combining the results from both sides of the credit market (Tables A1 and A2) gives us a system that can be described with the graph below. The following section will devise the estimation technique specific to such a scenario.

(Insert Figure 1 here)

3 Estimation Method and Data

A linear representation of the solutions to the first order conditions, the loan supply and demand can be written as

$$\begin{aligned} L^s &= \alpha_0 + \alpha_1 R_L + \alpha_2 R_L^2 + \alpha_3 X_1 + u_1 \\ L^d &= \beta_0 + \beta_1 R_L + \beta_2 X_2 + u_2 \end{aligned} \tag{5}$$

where X_i are the exogenous variables, and R_L is the loan rate. Disturbances u_i are assumed to be normal, with different variances and no covariance.

Since the banks refuse to lend above a certain rate due to the increased variance in profits, this scenario is similar to controlled price models of disequilibrium econometric techniques (Maddala, 1983). The price control in these models can be compared to the model's maximum rate, obtained by the tangency point. The important difference from the previous models is that this interest rate is endogenous and determined by the tangency point of the loan demand and supply in Figure 1. In equilibrium, we have an ordinary simultaneous equations framework where $L^d = L^s = L$ and R_L^* is the prevailing interest rate, which equals

$$R_L^* = \frac{-(\alpha_1 - \beta_1) + \sqrt{(\alpha_1 - \beta_1)^2 - 4\alpha_2(\alpha_0 - \beta_0 + \alpha_3 X_1 - \beta_2 X_2 + u_1 - u_2)}}{2\alpha_2} \tag{6}$$

When a market-clearing rate does not exist, we observe the maximum loan rate R_L^m

$$R_L^m = \frac{-(\alpha_1 - \beta_1)}{2\alpha_2} \tag{7}$$

and the loan quantity that corresponds to it. The observed loan quantity is always equal to the loan supply, and the regime switches to disequilibrium when loan demand exceeds supply and becomes unobservable. The indicator function

$$u_1 - u_2 > \frac{[\alpha_1 - \beta_1]^2}{4\alpha_2} - [\alpha_0 - \beta_0 + \alpha_3 X_1 - \beta_2 X_2] \tag{8}$$

is determined according to whether the equilibrium interest rate exists or not.

Since regime switches are not observable, we use Maddala & Nelson (1974) approach to derive the likelihood function suitable for the model. Given the joint normal distribution of $g(u_1, u_2)$, the unconditional density function $l(\cdot)$ for the loan rate and quantity is

$$\begin{aligned} l(L, R_L) = & \left[\int_L^{\infty} f\left(L^s, L^d \middle| R_L = R_L^m; u_1 - u_2 > I\right) dL^d * P\left(\left|u_1 - u_2 > I\right)\right] \\ & + \left[|J| h\left(L^s, L^d \middle| R_L = R_L^*; u_1 - u_2 \le I\right) * P\left(\left|u_1 - u_2 \le I\right)\right] \end{aligned} \tag{9}$$

The term in the first bracket describes the density of being in disequilibrium whereas the latter part describes equilibrium. Since there are two possible regimes with unobserved switches, this likelihood function is the sum of two conditional densities that span the possible outcomes multiplied by the probabilities[6] associated with them. In the equation above *f* is the joint density of L^d and L^s, derived by a transformation using the equations (5) treating R_L as a constant at R_L^m, that is, the transformation from $(u_1, u_2) \rightarrow (L^s, L^d)$. The integral sign is used to add this density function for all the possible values of L^d greater than *L* since these values are not observable. In other words, in this disequilibrium part of the unconditional density function, $R_L = R_L^m$, $L = L^s$, and $L^d > L^s$. The joint density *h* is also derived from density *g*, as in any simultaneous equations

[6] We have used the unconditional probabilities rather than the conditional probabilities _for example, $P(L^d > L^s | L)$ due to the controversial results about benefits of including them into the model. Even though Quandt & Rosen (1985) have found that conditional probabilities provide a sharper discrimination between the regimes, Burkett (1981) could not find any substantial differences between the two of them.

model via a transformation from $\left(u_1, u_2\right) \rightarrow \left(L, R_L\right)$; $\left|J\right|$ is the absolute value of the Jacobian of the transformation that equals $\left|-\beta_1 + \alpha_1 + 2\alpha_2 R_L\right|$. The economic interpretation of the equilibrium part of this equation $L = L^s = L^d$, and the interest rate is determined by market equilibrium.

Maximizing sum of the logs of equation (9) over the sample period enables us to estimate the parameters and answer some of the questions posited earlier in the introduction. We can also test for the existence of disequilibrium by using Hausman (1978), Revankar (1978), and Wu (1973) tests (HRW), which examine the interest rate's dependence on the error terms. Viewing demand and supply equations as a simultaneous equations system, leads to the correlation of the error terms u_1 and u_2 to the interest rate in market equilibrium. In disequilibrium, however, loan rate is determined only by the banks' optimization, not by the market equilibrium, causing independence between the interest rate and all error terms. Therefore, rejection of the null hypothesis of independence between R_L and either u_1 or u_2 points toward the presence of equilibrium[7].

Data

The first half of the sample countries (Brazil, Greece, Korea, and Mexico) have been chosen due to high levels of uncertainty in their economies despite having gone through financial reforms with considerable success[8]. Inflation and exchange rate fluctuations are the main proxies utilized to represent the uncertainties in these countries. Italy, Germany, Switzerland, and the United Kingdom are the developed countries chosen either through an inflationary period in their history (Italy and the UK) or the Kugler (1987) paper, which finds evidence of disequilibrium in these countries (Germany and Switzerland).

We use quarterly data from 1980 to 1995 for the developing countries and longer sample periods for the developed countries (1971-95 for Germany, 1972-95 for Italy, 1975-95 for

[7] In the empirical results section, we test the correlation between interest rate and the supply error term (R_L and u_1) for each country to verify the results of the original tests.

Switzerland, and finally 1968-95 for the UK). Explanatory variables used in the demand side (variables in matrix X_2) of the credit market are: inflation uncertainty, expected price level, expected project return, wage, and capital stock. We use expected industrial production as a proxy for the project return while deriving capital stock from quarterly capital formation[9]. Independent variables on the supply side (X_1) are: deposit rate, treasury bill rate, expected inflation, inflation uncertainty, expected depreciation, depreciation uncertainty, and interest-exchange rate covariance.

In order to derive the uncertainty variables, we first estimate appropriate models for price level, inflation, exchange rate depreciation, and project return by using ARIMA models, including other macro variables when necessary. Following the determination of the appropriate model, the predicted value is obtained as a proxy for the optimal forecast used by the agents in the economy. The deviation of this forecast from the actual observation is taken to be the unpredictable part of inflation or exchange rate. We use the squares of these residuals (similar to Miller, 1992) as the proxies for inflation and exchange rate uncertainty.

We have obtained the major portion of my quarterly data from the International Financial Statistics of the IMF, and completions have been attained from DataStream, OECD, publications by the Central Banks or the Bureaus of Statistics in these countries, and in some cases directly from the Central Banks.

4 Empirical Results

As previously mentioned, our research goals are threefold: (a) to determine whether the sample countries' financial institutions and firms act in a risk averse fashion, (b) to ascertain whether or not there is disequilibrium in the sample countries, and (c) to search for direct and indirect effects of inflation uncertainty in credit markets. Simultaneous Tobit is used to derive the maximum likelihood estimates (Tables 1 and 2) for the whole model. We then utilize these estimates to

---

[8] Some higher inflation countries have been left out of the sample due to data availability.

derive loan demand and supply projections. Significance of the uncertainty terms' coefficients addresses goal '*a*' above while use of demand and supply projections along with the HRW technique[10] resolves '*b*'. The maximum likelihood coefficients help determine the direct and indirect effects of inflation uncertainty --- namely, '*c*'.

Reader should note that the countries analyzed do not always form clear-cut categories, and some assumptions may therefore be oversimplifications. Examples of these assumptions are the use of a uniform financial market model to represent the entire sample (both developing and developed countries) and investigation of a microeconomic partial equilibrium framework utilizing macro data. Therefore, the results obtained should be perceived as an attempt to understand the workings of financial markets with (price or quantity) constraints and uncertainties rather than as deterministic policy recommendations. Thus, this research may be considered more of a diagnostic analysis than a remedial one.

(Insert Tables 1 and 2 here)

Risk Aversion

The findings displayed in Tables 1 and 2 indicate that almost all of the countries analyzed react to unpredictable part of inflation or exchange rate. The higher the uncertainty level in the country, the higher the number of these variances to which its financial institutions react. For instance, Brazil's monetary authorities have been anything but predictable (at least until the introduction of the "real"). Consequently, all possible variance terms come out significant in our estimations for this country. Since inflation and exchange rate are highly variable, Brazil's financial institutions have to consider not only the expected real returns of investments but also the fluctuations around them. At the other end of the spectrum, in Germany, the only significant variance term is the depreciation uncertainty. Since Germany has a very conservative central bank, it has been

---

[9] Depreciation rate of capital is assumed to be zero. For some cases, where capital formation data is unavailable, quarterly capital stock values are interpolated from annual data.

[10] The F-statistic value obtained with their technique is compared to the critical value of $F_{1,4}$

extremely successful in reducing the public perception of uncertainty levels in inflation and the exchange rate. This credibility has allowed the German financial markets to enjoy protection from reacting unpredictable shocks to real returns. A surprising outcome is how the British financial institutions include the uncertainty around inflation and exchange rate in their maximization function. Even in Switzerland with a fairly low and seemingly stable inflation, the financial markets show wariness about the inflation fluctuations and incorporate them into their decision process. In fact, every sample financial market other than Germany's included inflation uncertainty in their portfolio decisions. Therefore, our assumption of risk-averse financial institutions is validated by our estimations proving that systemic risks, which cannot be diversified by these agents, will affect their decision process.

Disequilibrium

The assertion of backward bending loan supply leading to disequilibrium is unambiguously supported by 4 of the 8 countries analyzed. Tests on Brazil, Korea, Mexico, and Italy not only gave low F-statistics on the HRW tests (Table 3), but they also displayed significant non-monotonicity of loan supply. Confirmation of risk aversion from above coupled with this disequilibrium evidence strengthens the of the theoretical section, which link emergence of credit market imbalance due to high levels of non-diversifiable risk.

HRW F-test and non-monotonic loan supply results derived here for Germany conflict with the lack of evidence for risk aversion in the previous section. Its coefficient estimates capturing a backward bending loan supply hint for disequilibrium due to high levels of credit risk, especially around the time of interest rate hikes during the OPEC oil crises and the German unification[11]. The remaining three countries in the sample --- Greece, Switzerland, and the UK --- gave out mixed signals in terms of accordance with the findings of the theoretical section. Switzerland pointed toward equilibrium when tested for the independence of the error terms from the interest rate even though a backward bending loan supply was obtained from the ML estimations. The combination of their concave loan supply with a relatively steep loan demand indicates possible correlation between the loan rate and the error term[12]. Switzerland was not the only country that gave out mixed signals, however. Greece and the UK both displayed convex loan supplies even though their F-statistic indicated existence of disequilibrium. Greece had the majority of data points on the negative sloped region of the loan supply indicating a market disequilibrium (consistent with F-statistic from the HRW test) caused by financial repression and possibly negative real rates. The UK, on the other hand, required further tests since the majority of loan rate data points are above the inflection point. Subsequent tests show that a sluggish adjustment of loan rates to excess demand[13] in the credit markets is responsible for the F-statistic's pointing toward disequilibrium.

Effects of Inflation Uncertainty

Table 4 summarizes the direct or indirect (through the loan rates) effects of inflation uncertainty on credit markets. Comparative statics derived from the model claim that unpredictable inflation would raise interest rates, decrease loan supply, and affect loan demand depending on the comparison between the real rate uncertainty and the covariance of output to capital prices. Along with the direct effects displayed in Tables 1 and 2, most of these countries also show signs of indirect influence of inflation fluctuations causing increases in the interest rates. The only country with no direct or indirect effect is Germany, which of course has the most conservative and credible monetary authority among the sample countries. In general, the estimations display that most of the remaining seven countries have coefficients of the expected sign in both the direct and indirect effects for inflation uncertainty variable. A close inspection of

---

[11] This result is more in line with credit rationing argument of Stiglitz & Weiss (1981).
[12] This correlation is probably due to our choice of inflation hedge used in the loan supply, namely the use of exchange rate and omission of foreign interest rates. Since Swiss banks hold a very high level of foreign securities in their portfolio, and since Swiss banks' loan rate is very highly correlated to the German T-Bill rate, the use of a simplistic model designed more for developing country credit markets may have been polluting the disequilibrium test, causing the rejection of the null hypothesis.
[13] Claims of slow adjusting loan rates is not in conflict with Kugler's (1987) not finding any evidence for sluggish interest rates since his analysis ends in 1983, the beginning year of sluggish rates in my analysis.

the results reveal that adverse effects of inflation fluctuations are enhanced when financial market uncertainties (e.g., credit risk) are high.

(Table 4 here)

Some unpredicted and anomalous results are also apparent in Table 1. For instance, the positive sign for the coefficients of inflation uncertainty in the loan supply (in Greece and Mexico) cannot be explained by the theoretical workings of this paper. The Greek result, namely the positive relation between the loan supply and the inflation uncertainty, is likely caused by the coincident decreases in both after financial liberalization. Most firms turned to either foreign banks or the stock market to meet their financing needs. In the Mexican case, a similar trend in the opposite direction can be shown as the reason for their anomaly: increasing inflation uncertainty coincides with rising loan supply, especially after interest rate deregulation, due to the rapid expansion of the financial markets (30% to 50% increase in M4). However, a closer investigation of the structure of these countries' financial markets may shed more light to these anomalous results.

5 Conclusion

This paper analyzes the effects of inflation uncertainty on credit markets by using a disequilibrium framework. The theoretical section displays how inflation uncertainty increases the risks associated with the portfolios of firms and banks, cause these agents to act risk aversely, and create grounds for disequilibrium. The empirical section confirms our assumptions of risk aversion and disequilibrium, establishing that use of a disequilibrium estimation technique is called for in sample credit markets. Tests on both developed and developing countries show that inflation uncertainty has significant bearing on credit markets either directly or indirectly regardless of depth of financial markets. Therefore, the removal of inflation uncertainty will decrease the risk around these contracts and will ensure efficiency and growth of investment in a country. Evidence in this research strengthens the argument for inflation targeting and explains its rising popularity as the choice of monetary policy.

Appendix

Deriving the solution only for loan quantity is

$$L = \frac{\frac{2}{\lambda} p R_L - \Theta_1}{2p(1-p)R_L^2 + \Theta_2}$$

where

$$\Theta_1 = \frac{2\left(R_D - \rho\pi^e\right)}{\lambda\left(1-\rho\right)} + \operatorname{cov}(\tilde{\rho},\tilde{\mu})\left(\frac{F\rho}{1-\rho}\right) + \frac{2\rho\sigma_\mu^2\left(\rho B + F\right)}{\left(1-\rho\right)^2}$$

$$\Theta_2 = \frac{2\rho^2\sigma_\mu^2}{\left(1-\rho\right)^2}$$

In disequilibrium loan rate and quantity are:

$$R_L = \frac{-\Theta_2}{\lambda\Theta_1\left(1-p\right)}$$

$$L = \frac{-\Theta_1}{\Theta_2}$$

Corresponding comparative statics results are:

(Insert Table A1 here)

Solving for optimal investment level gives us

$$L_i^d = \frac{-R_L^* - \lambda\left[A_1 + A_2\right]}{\lambda\left[\sigma_r^2 R_L^{*2} + \left(1-\tau\right)R_L^{*2}\right]}$$

where

$$A_1 = -pR_L^*\sigma_{r,\pi}\left(\overline{Y}_i - Y_i^*\left(\cdot\right)\right)$$

$$A_2 = -\left(1-\tau\right)R_L^* p^*\left(\overline{Y}_i - Y_i^*\left(\cdot\right)\right)$$

Corresponding comparative statics results are:

(Insert Table A2 here)

References

Blejer, M. I., and M. S. Kahn, 1984, Government Policy and Private Investment in Developing Countries, International Monetary Fund Staff Papers 31, 379-403.

Dixit, A. K., and R. S. Pindyck, 1994, Investment Under Uncertainty, (Princeton University Press)

Friedman, M., 1977, Nobel Lecture: Inflation and Unemployment, Journal of Political Economy, 85, 451-72

Froyen, R. T., and R. N. Waud, 1987, An Examination of Aggregate Price Uncertainty in Four Countries and Some Implications for Real Output, International Economic Review 28, 353-72.

Fry, M. J, 1980, Saving, Investment, Growth and the Cost of Financial Repression World Development 8, 317-327.

George, A. and J. Morisset, 1995, Does price uncertainty really reduce private investment? A small model applied to Chile, Applied Economics 27, 517-522.

Grier, K. B., and M. J. Perry, 2000, The Effects of Real and Nominal Uncertainty of Inflation and Output Growth: Some GARCH-M Evidence, Journal of Applied Econometrics, 15, 45-58

Hausman, J. A., 1978, Specification Tests in Econometrics, Econometrica 46, 1251-72.

Huizinga, J., 1993, Inflation Uncertainty, Relative Price Uncertainty and Investment in US Manufacturing, Journal of Money, Credit and Banking 25(3), 521-549.

Ingersoll, J. E. Jr. and S. A. Ross., 1992, Waiting to Invest: Investment and Uncertainty, Journal of Business, 65(1), 1-29.

Kugler, P., 1987, Credit Rationing and the Adjustment of the Loan Rate: An Empirical Investigation, Journal of Macroeconomics, 9 (4), 505-525.

Landskroner, Y. and D. Ruthenberg, 1985, Optimal Bank Behavior under Uncertain Inflation, Journal of Finance, 40 (4), 1159-1171.

Maddala, G. S. and F. D. Nelson., 1974, Maximum Likelihood Methods for Models of Markets in Disequilibrium., Econometrica 42, 1013-1030.

Maddala, G. S., 1983, Methods of Estimation for Models of Markets with Bounded Price Variation, International Economic Review, 24, 361-378.

Miller, V. J., 1992, Inflation Uncertainty and the Disappearance of Financial Markets: The Mexican Example, Journal of Economic Development, 17, 131-152.

Quandt, R. E. and H. S. Rosen., 1985, Is there chronic excess supply of labor? Economics Letters 19, 193-198.

Revankar, N. S., 1978, Asymptotic Relative Efficiency Analysis of Certain Tests of Independence in Structural Systems, International Statistical Review 19, 165-79

Stiglitz, J. E. and A. Weiss., 1981, Credit Rationing in Markets with Imperfect Information American Economic Review 71 (3), 393-410.

Voridis, H., 1993, Ceilings on Interest Rates and Investment: The Example of Greece, Review of Economics and Statistics, 75 (2), 276-283.

Williamson, S. D., 1987, Costly Monitoring, Loan Contracts, and Equilibrium Credit Rationing, Quarterly Journal of Economics, 135-145.

Wu, D., 1973, Alternative Tests of Independence between Stochastic Regressors and Disturbances, Econometrica 41, 733-50.

Table 1: Maximum Likelihood Estimates for Coefficients of the Loan Supply Equation

L^s variable	Brazil	Greece	Korea	Mexico	Germany	Italy	Swiss	UK
R_L	7.14^{**}	-4.86^{**}	1.93^{**}	24.25^{**}	1.34^{**}	1.49^{**}	0.42^{**}	-9.77^{**}
R_L^2	$-.7^{**}$	$.1^{**}$	$-.07^{**}$	-2.67^{**}	$-.09^{**}$	$-.03^{**}$	-0.05^{**}	$.6^{**}$
R_D	$.36^{**}$	$-.20^{*}$	.05	$-.36^{*}$	-.029	$-.66^{**}$	$-.008^{**}$	$-.36^{**}$
R_B	-1.46^{**}	.02	$-.05^{**}$	1.14	.78	-.095	-.83	-.014
$\mathrm{cov}(e,\mu)$	$-.003^{**}$	-.001	-.007	$-.48^{*}$	.16	.007	-.057	-0.085^{**}
σ_μ^2	$-.004^{**}$	$.67^{*}$	$-.011^{**}$	$.040^{*}$	.21	$-.12^{**}$	$-.0009^{**}$	$-.23^{**}$
σ_e^2	$.0004^{**}$	.021	.014	.26	-5.32^{**}	-1.71	0.17	$.018^{*}$
π^e	$.021^{**}$	-9.03^{*}	-.37	.078	$-.65^{**}$	$-.25^{*}$	$-.10^{**}$	1.25

Note: ** indicates significance at 5% while * is 10%.

Table 2: Maximum Likelihood Estimates for Coefficients of the Loan Demand Equation

L^d variable	Brazil	Greece	Korea	Mexico	Germany	Italy	Swiss	UK
R_L^*	-4.41^{**}	$-.066^{**}$	$-.0037^{**}$	-2.79^{**}	$-.043^{**}$	$-.057^{*}$	$-.33^{**}$	-3.60^{**}
w^*	$-.020^{**}$	$.0035^{**}$	$.022^{**}$	4.37^{*}	1.36^{**}	-7.09^{**}	$-.018^{**}$	25.60^{**}
$\sigma_{r,\pi}$	$.05^{*}$	-.012	-.03	.038	.002	$.011^{*}$	.07	-0.23
σ_μ^2	$.0014^{**}$	$-.062^{*}$	$.0004^{*}$	-.004	-.11	-.035	$-.001^{*}$	0.11^{**}
$\overline{Y}_i - Y_i^*$	$.078^{**}$	$.0046^{*}$	.0021	$.36^{**}$	$.064^{**}$	$-.032^{**}$	$-.009^{**}$	-2.77^{**}
$\overline{p}^*$	.042	$.12^{*}$	$.028^{**}$	.026	9.54^{**}	$-.069^{**}$	$.029^{**}$	1.12

Note: ** indicates significance at 5% while * is 10%.

Table 3: F-statistics results from the disequilibrium (HRW) test

Country	Brazil	Greece	Korea	Mexico	Germany	Italy	Switzerland	UK
F-statistic	7.15	2.32	0.25	6.43	0.013	5.19	10.38**	3.23

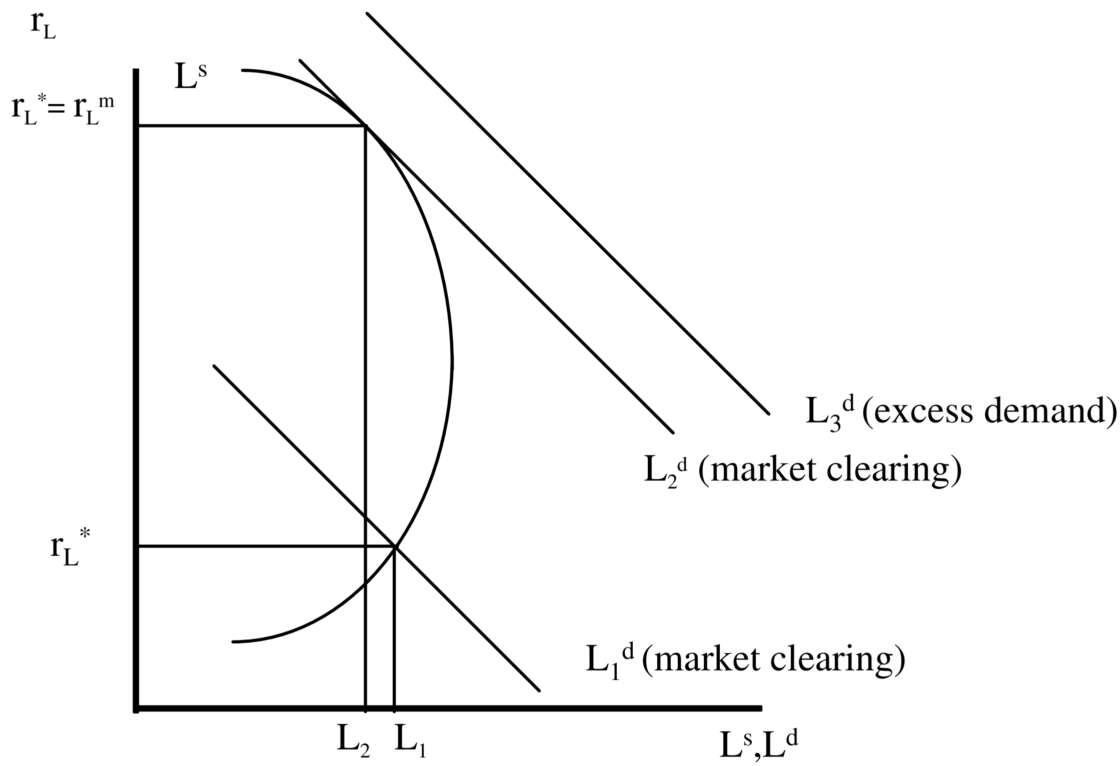
Note: F-statistics are compared with the 5% critical value of $F_{1,4} = 7.71$. Values above this level are indicated by **, causing rejection of independence of the error term from the loan rate, pointing to equilibrium.

Table 4: Direct and Indirect Effects of Inflation Uncertainty on Credit Markets

Country	Direct Effect (on loans)	Indirect Effect (on rates)
Brazil	$L^s \downarrow$, $L^d \uparrow$	None
Greece	$L^s \uparrow$, $L^d \downarrow$	$R_L \uparrow$
Korea	$L^s \downarrow$, $L^d \uparrow$	$R_L \uparrow$
Mexico	$L^s \uparrow$	$R_L \uparrow$
Germany	None	None
Italy	$L^s \downarrow$	$R_L \uparrow$ (lagged effect)
Switzerland	$L^s \downarrow$, $L^d \downarrow$	None
UK	$L^s \downarrow$, $L^d \uparrow$	$R_L \uparrow$

Table A1: Comparative statics results for loan supply		
Variable	Symbol	Sign
Loan rate	R_L	+/−
Deposit rate	R_D	−
T-Bill rate	R_B	−
Hedging factor	$\mathrm{cov}(e, \mu)$	−
Inflation uncertainty	σ_{μ}^{2}	−
Exchange rate uncertainty	σ_{e}^{2}	+
Expected inflation	π^{e}	+

Table A2: Comparative statics results for loan demand		
Variable	Symbol	Sign
Real loan rate	R_L^*	−
Wage	w^*	−
Covariance of capital and output prices	$\sigma_{r,\pi}$	+
Inflation uncertainty	σ_{μ}^{2}	+/−
Expected return	$\overline{Y}_i - Y_i^*$	+
Expected price	$\overline{p}^*$	+


r_L
L^s
$r_L^* = r_L^m$
L_3^d (excess demand)
L_2^d (market clearing)
r_L^*
L_1^d (market clearing)
L_2
L_1
L^s, L^d