Slow(er) boom, sudden crash
Asymmetry on lending rates and financial frictions †

Guillermo L. Ordoñez [@]

UCLA - January, 2006

Abstract

Asset markets are characterized by slow booms and sudden crashes. Lending rates, for example, are more likely to experience big jumps rather than big drops. We focus on the comparison of this pattern across countries.

First, we document that lending rates are more asymmetric on economies with poor financial systems. Second, we explain this finding by introducing financial frictions into a model with endogenous flow of information. High agency costs restrict the generation of information that fuels booms. Contrarily, they are not so important in good times, being irrelevant on determining the magnitude or speed of crashes. Finally, by calibrating the model, we show that cross-country differences of asymmetry in lending rates fluctuations are well explained by differences on monitoring costs.

Keywords:
Asymmetry, lending rates, information dynamics, financial frictions.

JEL Codes: D82, D83, E32, E44

[0]† Many thanks to Andy Atkeson, Ariel Burstein, Christian Hellwig, David K. Levine and Hanno Lustig for excellent suggestions and to Laura Veldkamp for advice with the simulation code. Potential errors are mine.

[0]@ Economics Department, UCLA. Box 951477, Los Angeles, CA 90095-1477, U.S.A. guilord@ucla.edu; http://guilord.bol.ucla.edu/

1 Introduction

Asymmetry is a well known feature in asset markets. Lending rates, for example, exhibit sudden increases but slow and gradual reductions. The "tequila" 1994 peso crisis was a typical case of this pattern. It took just 4 months for Mexican lending rates to rose around 70 percentage points, but more than 30 months to return to pre-crisis levels.

Even when the explanation of this asymmetry has attracted a lot of attention in economics[1], differences across countries have been surprisingly absent from this literature. However, the study of these differences is of the utmost importance. High asymmetry on lending rate fluctuations means large crashes not compensated by equally large recoveries. This may cause financial distresses, banking crises and eventually growth reductions (Bergoeing et al. (2004)).

In this paper we make three contributions. The first one is empirical. By focusing on lending rates, we document a negative relationship between financial development and asymmetry. Lending rates on countries with high levels of monitoring and bankruptcy costs tend to be more asymmetric.

The second contribution is theoretical. We explain these empirical facts by introducing financial frictions and agency costs into a Veldkamp's (2005) model with endogenous flow of information.

In her complete information model, agents choose to invest or not in a risky asset based on an inference about the unobserved state of the economy, which is constructed from signals sent by current ventures. When agents think the state is good, many investments generate a large sample of observations. When the state changes to bad, there are a lot of signals in the economy, investors deduce easily conditions have changed and interest rates increase a lot. Contrarily, when the state is bad and changes to good, the limited number of existing ventures offer few signals about the switch, agents slowly learn about it and lending rates drop gradually.

We introduce asymmetric information between borrowers and lenders and costly state verification into this setup. High agency costs (such as monitoring and bankruptcy costs) increase lending rates in equilibrium, producing underinvestment and a reduction on the number of signals available in the economy.

However, the reduction of economic activity is not symmetric across states. In bad times, since the likelihood a venture fails is big, high agency costs impose big restrictions on loans, slowing down the creation of new economic activity. Contrarily, in good times agency costs are not so important in determining the number of ventures.

[1] Banerjee (1992,1993) and Welch (1992) explained crashes from herd behavior and information cascades. Jacklin et al. (1992), based on Glosten and Milgrom (1985), used a portfolio insurance model of stock market crashes. Allen et al. (2003) used an information based model of bubbles. Zeira (1994, 1999) proposed models of informational overshooting to explain booms and crashes in stock prices. Veldkamp (2005) used a model with endogenous flow of information to explain unconditional asymmetry.

For a review of asymmetries in real markets and aggregate economies see Van Nieuwerburgh and Veldkamp (2005) and Jovanovic (2005).

Hence, high agency costs slow down the learning that fuels booms but not the information that sustain big crashes. Naturally this is translated into greater asymmetry on lending rates.

The third contribution is quantitative. Calibrations of the model closely match the data on cross-country differences of asymmetry in lending rates fluctuations. Using these results we estimate agency costs per country, which are consistent with the very limited (mainly anecdotical and survey based) existing estimations in the literature. Roughly speaking, data on asymmetry of lending rates is consistent with monitoring costs of around 5% over total assets for developed countries and 30% for underdeveloped ones. The model is also able to explain cross-country differences on levels and volatility on lending spreads.

In Section 2 we report stylized facts about the negative relation between development of financial systems and asymmetry on lending rates and, particularly the positive relation between agency costs and asymmetry. In Section 3 we explain these findings by introducing financial frictions into a model with endogenous flow of information. In Section 4 we calibrate the model and obtain estimations of agency costs in different countries by matching the model with the data. Section 5 concludes.

2 Stylized Facts

In this section we report an interesting but unexploited source of asymmetry on lending rates across countries, namely the development of financial systems in general and the magnitude of agency and monitoring costs in particular.

In the first part different exercises are made to show that the less financially developed is a country, the higher the likelihood of having changes of lending rates highly asymmetric (i.e. the more likely to have crashes when compared with booms of the same magnitude).

Because we propose as the reason for that relation the monitoring costs, the enforcement characteristics and the easiness for the flow of information in a financial system, the second part of this section goes deeper and uses different alternative methods to show how the skewness in lending rates is particularly tied to monitoring and bankruptcy costs.

Finally, the last part discusses the possible relation between skewness on lending rates and skewness on real variables of the economy. The results show that it's not possible to consider asymmetry in interest rates just as a consequence of asymmetry of real variables. In this sense skewness on lending rates has to be explained separately from that on real variables. This will serve later as a justification to use a model that explains theoretically the relation between monitoring costs and lending rates asymmetries, independently from real variables.

In order to develop the mentioned exercises, asymmetry on lending rates will be measured by the skewness of the log changes distribution. In symbols,

$$Skewness = \frac{\sqrt{n}\left[\sum_{t=1}^{n}(x_t - \overline{x})^3\right]}{\left[\sum_{t=1}^{n}(x_t - \overline{x})^2\right]^{\frac{3}{2}}}$$

where n is the number of observations (periods per country), $x_t = \ln(\rho_t) - \ln(\rho_{t-1})$, ρ_t is the lending rate in period t and $\overline{x}$ is the sample mean of the series.

This measure is calculated over real lending rates constructed using monthly data from 1960 to 2004. Real lending rates are calculated by correcting nominal lending rates (from figure $60P..ZF...$) by a consumer price index (from figure $64P..ZF...$) based on information from the International Financial Statistics (IFS) published by the IMF. Even when skewness was obtained for 80 countries with more than 100 observations and not many changes in the collection methodologies, the following analysis will be based only on those countries that exhibit positive values, which correspond to approximately 75% of them. The reason for doing this is that many studies based on individual countries, and hence more reliable information, typically have found positive skewness (see Veldkamp, 2005 for a discussion). In our case we need to compare a lot of countries and we have to rely on a comparable common source of information like the IMF.

2.1 Negative relation between asymmetry on lending rates and financial development in general

2.1.1 Regressions

To analyze the relation between asymmetry on lending rates and financial development, the former is measured by the skewness of log changes in lending rates (as described before), while the later is measured for each country by the credit to private sector as a percentage of GDP obtained from the World Development Indicators (WDI) published by the World Bank.

As shown in Table 1, just regressing these two variables for different period samples (1960-90 and 1990-2004) and different country samples (all countries and OECD countries) it is possible to find a mild but statistically significant negative relation between them.

Table 1

Asymmetry on lending rates and financial development

Dependent Variable	All countries		OECD countries	
Lending rates skewness	1960-1990	1990-2004	1960-1990	1990-2004
Credit to Private Sector / GDP	-0.023	-0.021	0.000	-0.016
	(0.012)*	(0.008)**	(0.001)	(0.010)*
Constant	3.97	2.57	1.83	2.06
	(0.65)***	(0.49)***	(1.00)*	(0.67)***
Observations	53	57	12	12

* Significant at 10%, ** Significant at 5% and *** Significant at 1%. Robust standard errors are reported in parentheses.

Analyzing carefully the errors from previous regressions it is possible to see they present a structure, which can be clearly observed in the following plots between the two variables regressed, skewness on lending rates and credit to private sector. Figure 1 and 2 not only show the mentioned negative relation but also how many observations lie in the lower triangle part of the figure. This means countries with less developed financial systems are more prone to present high levels of skewness than countries with more developed financial sectors.

In this sense, even when the existence of a well developed financial system does not seem to be a necessary condition to have low skewness levels, it definitely seems to restrict the possibility of presenting high skewness levels. This is a relevant relation because skewness is a tail property that keeps track of booms and crashes. A higher positive skewness means a higher probability of presenting a huge crash when compared with the probability of having a boom of the same magnitude.

Figure 1

Skewness on lending rates and credit to private sector / GDP (1960-1990)

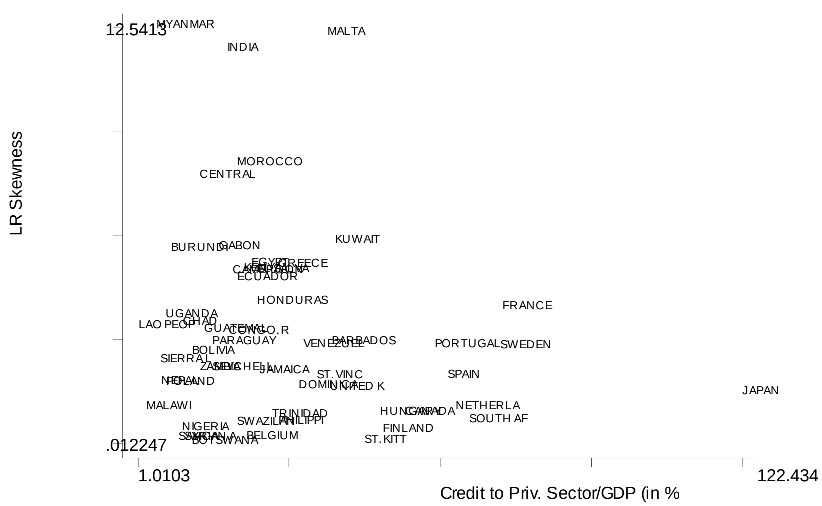
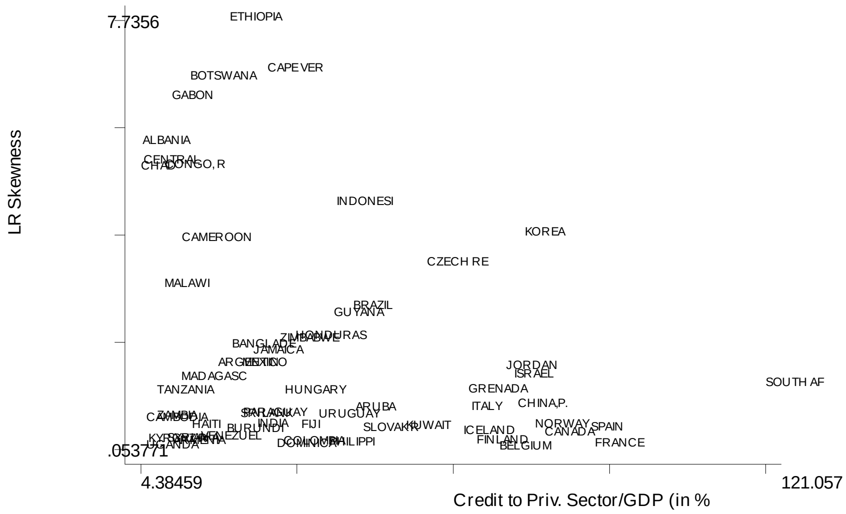


Figure 2

Skewness on lending rates and credit to private sector / GDP (1990-2004)



A possible reason less developed financial systems present both high and low asymmetry levels is the heterogeneity in volatility of those economies, which also have an impact over the skewness, as will become clear from the discussion of the model simulations in section 4.

To solve this problem skewness is controlled by the volatility of GDP per capita, the volatility of lending rates (both measured by the coefficient of variation), the average inflation in the period and the log of GDP per capita. As shown in Table 2, once controlled, a stronger negative relation between asymmetry of lending rates and financial development is obtained.

Table 2

Fitted asymmetry on lending rates and financial development

Dependent Variable	All countries		OECD countries	
Fitted LR Skewness	1960-1990	1990-2004	1960-1990	1990-2004
Credit to Private Sector / GDP	-0.017	-0.013	-0.019	-0.018
	(0.006)***	(0.003)***	(0.008)**	(0.004)***
Constant	3.61	2.29	1.84	0.79
	(0.19)***	(0.14)***	(0.58)***	(0.28)**
Observations	52	56	12	12

* Significant at 10%, ** Significant at 5% and *** Significant at 1%. Robust standard errors are reported in parentheses. Dependent variable is the fitted skewness controlled by log of GDPpc, volatility of GDPpc, volatility of lending rates and inflation.

After controlling for other variables, the errors do not seem to have a structure. This can be seen in Figures 3 and 4, which reply Figures 1 and 2 that present a clearer negative relation between skewness (fitted) and financial development, disappearing the lower triangular pattern observed without controls.

Figure 3

Fitted skewness on lending rates and credit to private sector / GDP (1960-1990)

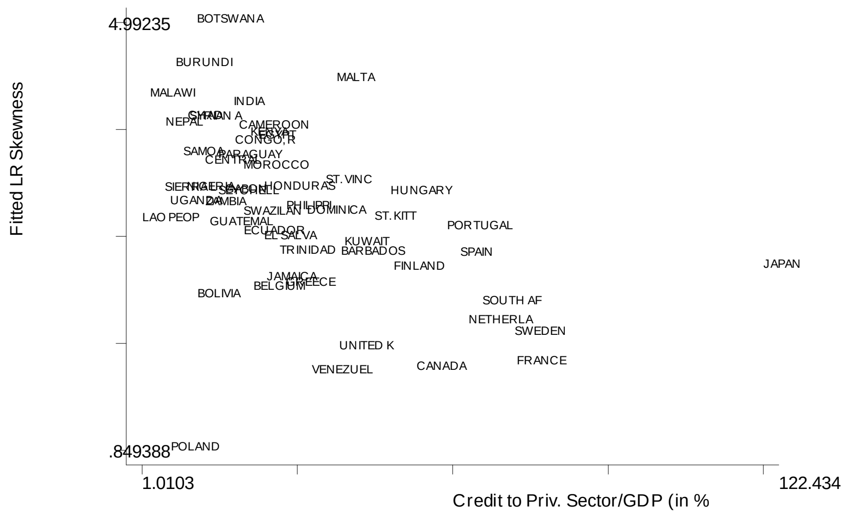
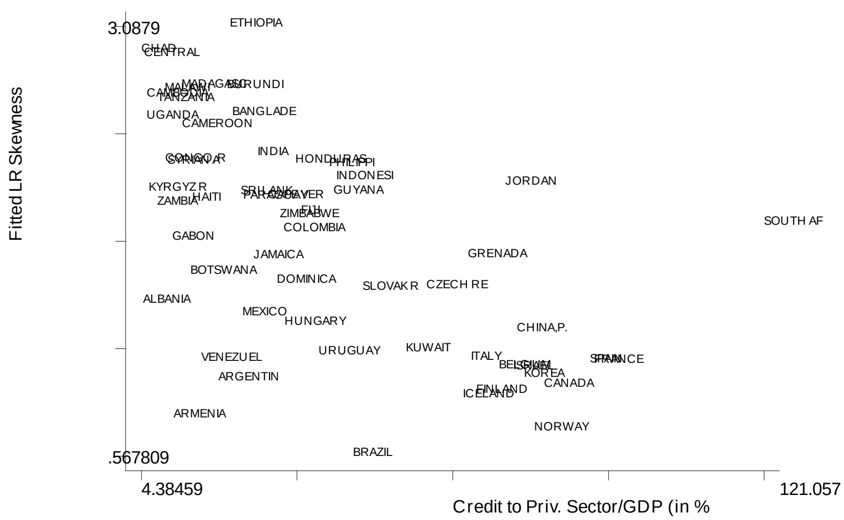


Figure 4

Fitted skewness on lending rates and credit to private sector / GDP (1990-2004)



2.1.2 Classifications

Another way to see the negative relation existing between asymmetry on lending rates and financial development in general is just by dividing countries in a diversity of classifications correlated with financial development groups and checking if there is, in average, a difference between them in terms of asymmetry on lending rates.

To do this exercise the following classifications are used:

a) Income groups as defined by the World Bank.

b) OECD and non-OECD countries.

c) Countries with high and low contract enforcement. A "contract enforcement" indicator from Levine et al. (2000) is used. This measure is an average between two indicators from La Porta et al. (1998), *Rule of Law,* which is an assessment of the law and order tradition of the country and *Government Risk*, which is an assessment of the risk the government modify a contract after it has been signed. In both cases the indices go from 1 (the worst possible situation) to 10 (the best possible situation). The cutoff between low and high contract enforcement was set on 7 in order to have a similar number of countries in both classifications.

d) Countries with and without Private Bureau. A "Private Bureau" from Djankov et al. (2004) is defined as a private commercial firm or non profit organization that maintains a database on the standing of borrowers in the financial system and its primary role is to facilitate exchange of information amongst banks and financial institutions.

While the use of the first two classifications is justified by the well known positive relation between economic and financial development (Levine, 1997), the last two classifications reflect the situation in terms of contract enforcement and access and availability of information to lenders, more in line with the specific channels this paper focuses on to explain why financial development affects asymmetry levels.

Table 3 presents the simple average of skewness for each classification group and for three different periods of time. The reason I divided the period 1960-90 in two will become clear in section 2.2.1.

Table 3
Asymmetry on lending rates by country classification.

Countries classification	1960-1980	1980-1990	1990-2004	1960-2004
Income Group 1 (Richest)	2.41	2.01	0.74	**1.72**
Income Group 2	2.11	2.87	1.88	**2.29**
Income Group 3	3.46	2.41	1.93	**2.60**
Income Group 4 (Poorest)	4.46	3.03	2.43	**3.31**
OECD	2.63	1.53	1.03	**1.73**
non-OECD	3.40	2.92	1.96	**2.76**
High contract enforcement	2.29	1.50	0.31	**1.37**
Low contract enforcement	3.93	1.87	1.25	**2.35**
Private Bureau	2.58	1.88	1.43	**1.96**
non-Private Bureau	3.11	3.30	1.97	**2.79**

Skewness by group is just the simple average of the skewness of "member" countries for the referred period

As can be seen, richer countries, OECD countries and countries with high contract enforcement and private bureaus present always less asymmetry than poorer, non-OECD countries or countries with low contract enforcement and no bureaus that easy the flow of information to lenders.

This goes hand to hand with the previous findings and represents another evidence of the negative relation between asymmetry on lending rates and financial development.

2.2 Negative relation between asymmetry on lending rates and agency costs in particular

The previous subsection shows the differences of asymmetries on lending rates across countries with different levels of financial and economic development. This paper proposes as specific explanations for this behavior differences in monitoring and bankruptcy costs and the degree of information asymmetry.

If this is true we should also find a negative relation between asymmetry on lending rates and the level of agency costs.

The problem is that no estimation of monitoring costs exists for many countries. In fact, as stated in Carlstrom and Fuerst (1997), even estimations of bankruptcy costs for the US are subjects of a great controversy.

Given the huge scarcity of information about these costs in the literature and, even more, the big dissent about the existing estimations for the US, in this section alternative ways are used to understand the specific impact of monitoring costs over asymmetries on lending rates.

Three alternative exercises are developed to cope with the inexistence of direct information on monitoring costs for many countries.

2.2.1 Evolution of technology and monitoring costs

Monitoring and bankruptcy costs depend a lot on technology because they are based on the efficiency to audit accounts and on the easiness to share and transmit information. Naturally, the better the available technology (such as computers and telecommunications), the less the monitoring costs existing on the financial sectors.

If the idea of this paper is correct and monitoring costs (inextricably related to financial development) increase the asymmetry on lending rates, we should observe a decrease in skewness for all countries along time, as monitoring costs are reduced due an improvement on information technologies

Effectively, this is a clear pattern that appears in Table 3. As can be seen, for each classification group the asymmetry in lending rates decreases along time. Information technologies improve importantly and continuously from 1960 to these days[2]. This enhancement in technology had an impact in reducing the costs of control because the easiness in the flow and processing of information.

This means that both asymmetry and monitoring costs decrease in the last decades, showing a positive relation between them. In section 3 an endogenous flow of information model will be introduced to explain theoretically this relation.

2.2.2 Proxies for monitoring costs

Another alternative method to understand the relation between asymmetry and monitoring costs, given the lack of direct information about the later, is by the use of proxy variables available for many countries. We will use two sets of proxies. The first one is based on a forthcoming research project by Djankov et al. (2005), that specifically analyzes the time and cost of closing businesses. The second set of variables refers to the performance of financial and banking systems in general to ease the access and availability of information.

1) Bankruptcy costs and duration. (Djankov et al. (2005)).

a) Cost of Bankruptcy: Costs of bankruptcy proceedings (as % of the estate value) that include court costs, as well as fees of insolvency practitioners, independent assessors, lawyers, accountants, etc. It is calculated based on answers by practicing insolvency lawyers to a multiple choice survey.

b) Time for Bankruptcy: Years to complete a procedure as estimated by insolvency lawyers.

c) Recovery Rate: Measures the efficiency of foreclosure. It shows how many cents on the dollar claimants (creditors, tax authorities, and employees) recover from an insolvent firm. The calculation takes into account whether the business is kept as a going concern during the proceedings, the discounted value due to the time spent closing down and court, attorney, etc.

[2] Merton (1987) constitutes an earlier and very powerful work on the impact of the informational technologies evolution over finance and monitoring.

Even when it seems these variables are exactly what we need as measures for monitoring costs, they have some drawbacks we should mention. First, the estimation of bankruptcy costs is based on a multiple-choice question, where the respondents choose among options biased towards zero[3]. Second, the variable presents a very low variance, with 30% of the countries reporting 8% of the estate value corresponds to bankruptcy costs and 30% reporting 18%. In this sense, recovery rate seems a better variable to capture our ideal measure of monitoring costs, given it is constructed considering more bankruptcy elements. (see methodology in Djankov et al. (2005)).

Table 4 presents simple OLS regressions between skewness on lending rates and these proxies. The general conclusion is that the more the monitoring costs, the more the asymmetry. This can be observed in the statistically significant positive coefficients for cost and time of bankruptcy and the statistically significant negative coefficient for the recovery rate of claimants. The regressions are made only for the period 1990-2004 because proxies are measured for 2004, not being relevant to explain processes occurred 40 years before.

Table 4

Asymmetry on lending rates and proxies for monitoring and bankruptcy costs.

Dependent Variable Lending rates skewness	1990-2004		
Cost of Bankruptcy	0.040 (0.014)***		
Time for Bankruptcy		0.205 (0.104)**	
Recovery Rate			-0.018 (0.008)**
Constant	0.844 (0.335)**	0.862 (0.419)**	2.152 (0.425)***
Observations	48	48	48

* Significant at 10%, ** Significant at 5% and *** Significant at 1%. Robust standard errors are reported in parentheses.

2) Contract enforcement and properties of the financial sector.

a) Contract Enforcement Days: The number of days to resolve a payment dispute through courts. Variable constructed as at January 2003 by Djankov et al (2004).

b) Legal protection to financial assets

c) Sophistication of financial markets

d) Health of banking systems

Variables based on surveys conducted by the Global Competitiveness Report, 1999 (published by the World Economic Forum and directed by Sachs, Porter

[3] The options in the survey are 0-2 percent, 3-5 percent, 6-10 percent, 11-15 percent, 16-20 percent, 21-25 percent, 26-50 percent, and more than 50 percent of the estate value of the bankrupt business.

and McArthur). The variables are measured by an index that goes between 1 and 7 (from the worst possible case to the best possible one).

Table 5 presents simple OLS regressions between skewness on lending rates and these proxies. The general conclusion is again that the more the monitoring costs and contract enforcement delays and the less the capabilities of financial and banking sectors to ease the flow of information, the more the asymmetry on lending rates. This can be observed in the statistically significant positive coefficient for contract enforcement and the statistically significant negative coefficients for the other variables. The regressions are also made for the period 1990-2004 for the same reasons explained in Table 4.

Table 5

Asymmetry on lending rates and proxies for monitoring and enforcement costs.

Dependent Variable Lending rates skewness	1990-2004			
Contract Enforcement Days	0.0042 (0.0015)***			
Legal protection to financial assets		-0.402 (0.186)**		
Sophistication of financial markets			-0.455 (0.145)***	
Health of banking systems				-0.546 (0.151)***
Constant	0.0099 (0.498)	3.19 (1.07)***	3.03 (0.75)***	3.85 (0.87)***
Observations	44	30	29	29

* Significant at 10%, ** Significant at 5% and *** Significant at 1%. Robust standard errors are reported in parentheses.

2.2.3 Financial Liberalization

Another possibility to see the relation between monitoring costs and asymmetry in lending rates is to follow the behavior of skewness before and after a shock in the financial system in which an abrupt change in the quality of monitoring costs occurred. Such a shock can be, for example, a financial liberalization process[4].

Financial liberalization processes represent a way in which financial systems become more prone to be influenced by modern foreign auditing and bankruptcy methods as well as more open to competition that propitiates the environment to adopt more efficient monitoring practices, a better enforcement of contracts and an easier flow of information.

[4] I'm indebted with Hanno Lustig for suggesting this idea.

If this is true, and in fact a financial liberalization process represents a situation in which, suddenly, monitoring costs decrease and in general the quality of information gets better, then those processes should be followed by a reduction in the asymmetry of lending rates only if the negative relation proposed in this paper really exists. In a similar vein, an anti liberalization process that restrict competition would lead to a worsening in the monitoring and auditing costs and therefore to an increase in the skewness of lending rates.

Table 6 shows a comparison of skewness in lending rates before and after the main financial liberalization event for 16 countries in which enough data can be encountered to reliably calculate skewness at both sides of the liberalization event (more than 100 observations at each side).

Data on financial liberalization is obtained from Kaminsky and Schmukler (2001) for the period 1973-1998. This database includes information on liberalization of capital accounts, domestic financial sectors and stock market capitalization. For capital accounts authors consider whether corporations are allowed to borrow abroad and whether multiple exchange rate mechanisms or other sorts of capital controls are in place. Regarding domestic financial liberalization authors explored interest rate controls (lending and deposits) and other restrictions such as directed credit policies or limitations on foreign currency deposits. Their analysis of stock market liberalization encompasses the degree to which foreigners are allowed to own domestic equity and restrictions on repatriation of capital, dividends and interests.

Table 6

Asymmetry on lending rates before and after a main financial liberalization event

Country	Main financial liberalization event		Type of liberalization	Skewness	
	Month	Year		Pre-Event	Post-Event
Canada	March	1975	KA	0.79	0.44
Finland	January	1990	SM and DFS	0.35	0.13
France	January	1985	DFS and KA	3.84	0.06
Italy	January	1992	KA	-3.73	0.82
Japan	January	1985	SM	1.83	-0.28
Korea	January	1991	SM	-5.16	3.79
Philippines	January	1994	KA and SM	0.31	0.17
Portugal	January	1986	SM	3.67	-0.37
Spain	December	1992	KA	2.04	0.45
Sweden	January	1984	KA	3.40	0.06
UK	October	1973	KA	3.88	1.48
US	July	1973	KA	-0.15	-0.09
Venezuela	June	1995	SM	2.33	0.40

Types of financial liberalization: KA=Capital Account, SM=Stock Markets, DFS=Domestic Financial Systems.

As can be seen, 10 out of 13 countries on the table present a reduction on the lending rates asymmetry right after the main liberalization event. In the table, three countries (Chile, Indonesia and Thailand) were not reported because they had experienced both financial liberalization and financial restriction processes over the relevant period, not being relevant just to pick one event.

Another interesting exercise to check for robustness in the results is to consider a comparison of asymmetry before and after the whole liberalization process and not just one event. To cover this possibility and to cope with the experiences of the three countries not considered before, Table 7 presents a summary of asymmetry before and after the whole financial liberalization process for each country, which naturally includes the main event specified in Table 6.

Table 7

Asymmetry on lending rates before and after a financial liberalization process

Country	START of financial liberalization process		END of financial liberalization process		Skewness	
	Month	Year	Month	Year	Pre-Process	Post-Process
Canada	March	1975	March	1975	0.79	0.44
Chile	January	1984	September	1998	1.13	0.56
Finland	January	1986	January	1990	1.79	0.13
France	January	1985	January	1990	3.84	0.10
Indonesia	January	1983	August	1989	1.50	0.95
Italy	May	1987	January	1992	-3.62	0.82
Japan	January	1979	January	1985	1.43	0.79
Korea	January	1988	January	1996	-6.83	0.87
Philippines	January	1976	January	1994	7.87	0.17
Portugal	January	1976	August	1992	4.46	-0.08
Spain	January	1981	December	1992	2.16	0.45
Sweden	January	1978	January	1989	3.66	0.06
Thailand	January	1979	June	1992	1.41	0.14
UK	October	1973	January	1981	3.88	1.98
US	July	1973	January	1982	-0.15	-0.86
Venezuela	March	1989	April	1996	1.50	0.44

As can be seen, 13 out of 16 countries considered experiment a reduction on the lending rates asymmetry after the whole financial liberalization process. From the countries that do not follow the pattern, Italy and Korea show very strange skewness levels (negative and of big magnitude) which is due to a huge lending rate decrease experimented only once while US basically does not present any skewness (not statistically different from zero) in either case.

What is also interesting to note is that the behavior of the asymmetry in fact reverts when considering financial restrictions and not financial liberalization processes. In this sense, only Chile, Indonesia and Thailand had in the period considered financial restriction processes. As shown in Table 8 when comparing before and after those processes, skewness on lending rates in fact increases.

Table 8
Asymmetry on lending rates before and after a financial restriction process

Country	START of financial restriction process		END of financial restriction process		Skewness	
	Month	Year	Month	Year	Pre-Process	Post-Process
Chile	June	1979	January	1983	0.13	1.13
Indonesia	March	1991	March	1991	0.95	4.76
Thailand	August	1995	May	1997	0.14	0.77

As a conclusion of this subsection, whether considering the historical evolution of technology, bankruptcy costs and duration, enforcement of contracts, health or sophistication of financial markets and the banking system or financial liberalization processes as proxies of monitoring costs and financial frictions in countries, it seems pretty robust the conclusion that the more the monitoring costs, the more the asymmetry on lending rates. Exercises comparing groups of countries along time, cross sections across countries and the behavior of lending rates per country lead to the same conclusion. It definitely seems to exist a positive relation between asymmetry of changes in lending rates and monitoring costs, enforcement possibilities and the degree of information flow and availability in the system.

2.3 Is the asymmetry on lending rates just a reflection of the asymmetry on real variables?

An obvious question at this point is whether the results found so far is just a reflex of what happens on the real side of the economy. If this is the case, the question should change from trying to explain why lending rates are more asymmetric in less developed countries to trying to explain why booms and crashes in the real side of the economy relate with the development of financial systems.

Not only this is a completely different question but also it means that the real side of the story cannot be considered separately. In any case Table 9 shows that skewness on lending rates is not correlated with skewness on real variables such as real household consumption or real GDP[5]. Data were taken yearly from the IMF's IFS.

[5] Real GDP was obtained by two methods. By deflating nominal GDP figures by CPI and by taking directly GDP in volumes figures from the IMF database.

Table 9
Correlation coefficients between skewness on lending rates and skewness on real variables.

Real variables	Correlation		
	1960-2004	1975-2004	1990-2004
Real GDP (deflated by CPI)	0.12	0.13	0.17
Real GDP (on Volume)	0.06	0.16	0.09
Real HH Consumption	0.12	0.09	0.12

As can be seen there is no correlation between asymmetry on lending rates and asymmetry on the real side of the economy. This means that a country with high asymmetry on real GDP, for example, not necessarily presents also high asymmetry on interest rates.

This section showed how the more developed a financial system and particularly the less the monitoring and bankruptcy costs, the more the enforcement of contracts and the better the flow of information, the less the asymmetry of lending rates those countries will show. This is important because a small asymmetry on lending rates means crashes and booms of the same magnitude are similarly likely. On the other side a big asymmetry means that booms are not as likely as crashes of the same magnitude.

The next section proposes an endogenous information model to explain this relation.

3 The Model

3.1 Description

This set up relies importantly on Veldkamp's model to explain asymmetries on interest rates, but expanding it to consider the impact of financial development over skewness differences across countries. The model intends to capture the described negative relation between asymmetry and financial development, a feature of the data not previously analyzed by the literature but clearly shown in the stylized fact's section.

Assume there is a credit market with a finite number N of entrepreneurs, who are potential risk neutral borrowers and a number M of perfectly competitive and risk neutral lenders. It will be assumed that N<M, giving to borrowers all the negotiation power.

In each period, each entrepreneur sees a business opportunity, with a given probability of success equal to all entrepreneurs but with different profits in case of success, v_i to each one, drawn from a support $v_i \in (\underline{v}; \overline{v})$ such that trivial agents who always invest or who never invest are not included. In order to pursue the project the entrepreneur has to take a loan of 1 unit, which is the cost of the venture, given he has no initial assets.

If the entrepreneur decides to borrow, he will do that at an endogenous lending interest rate $(1+\rho)$, which depends on the expected rate of default and on the financial development. If the entrepreneur decides not to borrow, he can always work for a exogenously given and fixed wage w. If the borrower is not lucky in the venture, he will receive a zero profit.

The lender also has two possibilities. After deciding the lending rate, he can lend if some entrepreneur is willing to borrow at that rate or he can just invest one indivisible unit of capital in a risk free bond that pays an exogenous and constant rate of return $(1+r)$

The probability of a venture success depends on an unobserved state variable that can take two possibilities, a good state G or a bad state B. If there are good times the probability of a loan being repaid is θ_g while in bad times that probability is given by θ_b, such that $\theta_g > \theta_b$. Agents are not able to identify the state of the economy when trading for a loan.

Until this point, the model is very similar to the one developed by Veldkamp. The problem with the original set up such as described above is its impossibility to explain differences in skewness across countries without changing fundamentals. For this reason the model is extended to assume information asymmetry and costly state verification. Lenders cannot see ex-post if in fact the borrower was successful or not. As in Townsend (1979) and Gale and Hellwig (1985), while cash flows are costlessly observable to entrepreneurs or borrowers, they are observable to external creditors only at some positive cost.

This feature forces the lender to rely on a standard debt contract as the one described by Gale and Hellwig (1985) to solve the information asymmetry. In return for receiving the loan in the first period, the borrower has to make a report. If the entrepreneur reports a success he is required to repay in the next period a state-invariant amount $(1+\rho)$. If the borrower reports a failure, creditors pay the monitoring costs, observe the truth and keep total profits ν_i if the entrepreneur lied and naturally 0 otherwise.

The timing of the model can be summarized as follows:

1) Agents enter each period with beliefs about the probability of being in a good state (μ_t)

2) A debt contract is set by lenders due to the costly state verification. After this decision, entrepreneurs decide whether or not to accept a loan and invest in a venture.

3) All lenders and entrepreneurs not participating in a loan contract, invest on their outside options. In this sense, lenders not matched with an entrepreneur invest in the risk free venture obtaining $(1+r)$ while entrepreneurs not taking a loan work in a job that pays w.

4) Borrowers report the result of their ventures, the contract is fulfilled and all payoffs are paid.

5) All reports and monitoring results are publicly observed.

6) State changes with a probability λ

7) Beliefs about the probability of being in a good state in the next period (μ_{t+1}) are updated.

3.2 Equilibrium

3.2.1 Definition

A subgame perfect equilibrium (SPNE), for an initial belief μ_0, is given by time sequences of borrowing decisions by each entrepreneur i $\{b_{it}\}$, reporting decisions by each borrower i if the venture is successful $\{z_{it}\}$[6], lending rates set by each lender j $\{\rho_{jt}\}$, monitoring probabilities when receiving unsuccessful reports by each lender j $\{\gamma_{jt}\}$ and beliefs (updated by Bayes formula) about the probability of being in a good state $\{\mu_t\}$, such that the following problems are solved in each period t:

a) Entrepreneurs: Given a set of available debt contracts, each entrepreneur i chooses to take or not a loan and from which lender to take it (b_{it}) and the probability of reporting the truth in case of having a successful venture (z_{it}), such that the following expected utility is maximized.

$$\max_{b_{it}\in\{0,1\};z_{it}\in[0,1];j\in\{1,\dots,M\}} b_{it}\theta_t\{z_{it}(v_i-(1+\rho_{jt}))+(1-z_{it})(1-\gamma_{jt})v_i\}+(1-b_{it})w$$

being θ_t the probability of a successful venture.

b) Lenders: Given strategies of other agents, each lender j chooses an interest rate $(1+\rho_{jt})$ and a monitoring probability when the borrower reports the venture was unsuccessful (γ_{jt}), such that the following expected utility is maximized.

$$\max_{\rho_{jt},\gamma_{jt}} l_{jt}\theta_t\{z_{it}(1+\rho_{jt})+(1-z_{it})\gamma_{jt}(v_i-c)\}-l_{jt}\gamma_{jt}(1-\theta_t)c+(1-l_{jt})(1+r)$$

being $l_{jt}=l(\rho_{jt},\rho_{-jt})=1$ if the borrower decides to take a loan from that lender j in period t.

c) Beliefs: Agents observe a number of successes[7] and failures during period t and form posterior beliefs μ_t^P, using Bayes' rule.

It is important to recall that the total number of ventures funded in each period t (n_t), which are basically the total number of signals per period from

[6] Recall the optimal report of the borrower in case the venture fails will be always to say the truth about the failure.

[7] If the real number of successes is called s^R, the number of successes observed and used in the updating will be $s=s^Rz+s^R(1-z)\gamma$. Naturally, in case $z=1$, $s=s^R$, the update will be the correct one.

where all action comes from, is equal to the total number of borrowers who decide to take out a loan in period t ($n_t = \sum_{i=1}^{N} b_{it}$).

From those n_t funded ventures, s_t are seen as successful and the formula for the posterior belief is[8]:

$$\mu_t^P = \Pr(G|s) = \frac{\theta_g^s(1-\theta_g)^{n-s}\mu_t}{\theta_g^s(1-\theta_g)^{n-s}\mu_t + \theta_b^s(1-\theta_b)^{n-s}(1-\mu_t)} \tag{1}$$

Adjusting these posteriors by the probability of a change in state, the probability of being in a good state in the next period is obtained by the following equation:

$$\mu_{t+1} = \Pr(G)_{t+1} = (1-\lambda)\mu_t^P + \lambda(1-\mu_t^P) \tag{2}$$

And finally, the probability of success of a given venture in the next period is given by[9]:

$$\theta_{t+1} = \Pr(s)_{t+1} = \mu_{t+1}\theta_g + (1-\mu_{t+1})\theta_b \tag{3}$$

3.2.2 Equilibrium results

To obtain the SPNE, working by backward induction, it is necessary first to obtain the optimum for lenders. Given they act in a competitive market, lenders make zero profits in equilibrium, which means the debt contract is set such that expected profits from lending are equal to the potential profits from investing in the free risk venture $(1+r)$.

Lenders have to solve for lending rates considering the costly state verification that arises because they do not have information about the successfulness of the venture they funded. Townsend, Gale and Hellwig showed that the optimal is given by the standard debt contract. When $c > 0$, this contract consists on the repayment on the second period of a state invariant amount $(1+\rho)$ in return for receiving one unit of capital in the first period. If the entrepreneur fails to pay that amount reporting an unsuccessful activity, lenders monitor the venture (paying the monitoring costs $c > 0$) and observe and keep for themselves the true company profits. Obviously those profits are either zero, in the case the entrepreneur tells the truth and the venture was in fact unsuccessful, or $v_i > (1+\rho)$, if the borrower lied and the venture was in fact successful.

Of course states in which monitoring occurs can be interpreted as bankruptcy and monitoring costs can be interpreted as bankruptcy costs for the economy as a whole.

In general, if we would have a continuum of possible profits π, lenders would determine $(1+\rho)$ such that profits be zero after considering the monitoring costs set in the debt contract to make borrowers always say the truth about the result

[8] Recall $C_s^n = C_{n-s}^n = n!/((n-s)!s!)$ and then drop from the equation.

[9] Sometimes, to save notation and when no confussion may arise, I will set aside the subscript $t+1$

of the venture. In that general case the solution would be obtained from solving $\int_{-\infty}^{1+\rho}(\pi - c)g(\pi)d\pi + \int_{1+\rho}^{\infty}(1+\rho)g(\pi)d\pi = 1 + r$

In our particular model this condition can be simply written as:

$$(1-\theta_t)(-c) + \theta_t(1+\rho_{jt}) = (1+r)$$

which determines that all loans accepted by borrowers have the same lending rate:

$$(1+\rho_t) = \frac{1+r}{\theta_t} + \frac{(1-\theta_t)}{\theta_t}c \tag{4}$$

Lenders always monitor when a venture is reported as unsuccessful for all j and t. The proof this is the optimal contract can be seen in Gale and Hellwig (1985). Given this behavior by lenders, in the optimum debt contract a successful borrower always reports the truth because in that case he gains $(\nu_i - (1+\rho)) > 0$, while in the case of telling a falsehood he gains nothing for sure.

Hence in equilibrium $\gamma_{jt} = 1$ and $z_{it} = 1$.

The only choice left is for the entrepreneurs to borrow or not, which is given as a cutoff value over v_i. Then, an entrepreneur borrows whenever $\theta_t(v_i - (1+\rho_t)) \geq w$

Given the previous result for $(1+\rho_t)$, the rule for borrowing is then,

$$v_i \geq \widetilde{\nu} = \frac{1}{\theta_t}[1 + r + w + (1-\theta_t)c] \tag{5}$$

As can be seen, when there are no monitoring costs or when the state verification is costless to the lenders ($c = 0$), this solution collapses to the original model developed by Veldkamp, in which there are no agency problems.

One of the most important results to trace from here is the number of ventures funded in the economy because this is the number of signals used by agents to update beliefs and to modify interest rates. The number of funded ventures is given by the sum of the entrepreneurs who decide to take the loans. Hence, in equilibrium.

$$n_t = \sum_{i \in \{1,\ldots,N\}} 1_{\{v_i \geq \widetilde{\nu} = \frac{1}{\theta_t}[1+r+w+(1-\theta_t)c]\}}$$

The number of ventures depends positively on the probability of a venture success θ_t in three ways. A higher θ_t increases the expected payoff of borrowing, decreases the market interest rate ρ and reduces the necessity of monitoring the venture because it reduces the probability of a false unsuccessful report.

Formally, the derivative of $\widetilde{\nu}$ with respect to θ_t is negative ($\frac{\partial\widetilde{\nu}}{\partial\theta_t} = -\frac{1+r+w+c}{\theta_t^2} < 0$). Of course a smaller $\widetilde{\nu}$ implies a higher number of signals n_t as long as the cumulative distribution of v_i is monotonically increasing or, which is the same, whenever the density function has mass in all points $v_i \in (\underline{v}; \overline{v})$.

Because θ depends also positively on the probability of being in a good state μ ($\frac{\partial\theta}{\partial\mu} = \theta_g - \theta_b > 0$ because $\theta_g > \theta_b$ by assumption), the number of funded ventures will depend also positively on the probability of being in a good state μ. Formally this can be seen in the derivative of the cutoff $\widetilde{\nu}$ with respect to μ ($\frac{\partial\widetilde{\nu}}{\partial\mu} = -(\theta_g - \theta_b)\frac{[1+r+w+c]}{(\mu\theta_g+(1-\mu)\theta_b)^2} < 0$) because by assumption $\theta_g - \theta_b > 0$. This means that, the greater the value for μ, the greater is θ, the smaller the cutoff value $\widetilde{\nu}$ and the more the number of funded ventures.

At this point it is important to see which are the main differences of introducing agency problems in this model. Two important properties are added by agency costs.

First, the greater the monitoring costs c the greater the lender interest rates because

$$\frac{\partial(1+\rho)}{\partial c} = \frac{1-\theta_t}{\theta_t} > 0$$

Second, the greater c, the greater the cutoff value $\widetilde{\nu}$ entrepreneurs profits v_i should surpass in order to borrow. In this sense, the greater the monitoring costs, the smaller the number of funded ventures in the economy. Formally,

$$\frac{\partial\widetilde{\nu}}{\partial c} = \frac{1-\theta_t}{\theta_t} > 0$$

Two important conclusions arise. First, monitoring costs generate underinvestment in all states. Second, the reduction in signals is not constant across states because, the worst the belief, the more the restriction imposed by agency costs on investment. This is because, when θ varies, c is scaled by a double effect in the numerator $(1-\theta)$ and in the denominator (θ).

As well explained in Veldkamp (2005), because the number of signals is changing continuously in this model, to write an explicit result as an analytical solution is intractable. This is why the results and conclusions from the model will be discussed with the help of Monte Carlo simulations in Section 4.

3.3 Asymmetry implications

This model generates time-irreversible lending rate changes, which basically means those changes have an asymmetric unconditional distribution where the probability of a large interest rate increase is higher than the probability of a decrease of the same magnitude.

Veldkamp (2005) provides a "four propositions" formal proof of the asymmetry generated by this endogenous information framework in contrast with a constant information economy, where changes on interest rates are time-reversible and symmetric.

Even when the intention of this paper is not to show how the endogenous formation of signals leads to time irreversibility and to asymmetric distribution of changes on lending rates, the following proposition offers a flavor about why this is the case and analyze how agency costs have an impact on that asymmetry and how differences in financial development may imply differences in skewness on the distribution of lending rates changes.

Proposition 1 *In an endogenous information economy, assuming $\theta_g > \theta_b$, agency costs increase asymmetry on lending rates.*

Proof. This proof proceeds in three steps. First, the concept of time reversibility is introduced showing why a constant information economy does not present asymmetry. The second step shows why an endogenous information economy is time irreversible and then, asymmetric. Finally, it's demonstrated that agency costs increase asymmetry in such a context.[10]

Step 1: Time reversibility in a constant information economy

Time reversibility is defined as the property of a stochastic process in which beliefs in a good state are the time-reverse of beliefs in a bad state. In symbols, $\Pr[\mu_{G,t+1} = x|\mu_{G,t} = y] = \Pr[\mu_{B,t+1} = x|\mu_{B,t} = y]$. In plain words, the increase in beliefs of being in good times if, for example, all signals are successful should have the same magnitude than the decrease of beliefs if all signals were unsuccessful.

Going to this extreme case, which represents the situation where the maximum possible booms and crashes are obtained, consider the prior for the probability of being in a good state is $\mu_t = x$. If suddenly, all n signals fail ($s = 0$), $\mu_{t+1} = y < x$. If in the following period all n signals are successful ($s = n$) and the process is time reversible, we should obtain that $\mu_{t+2} = z = x$.

If the economy has constant information, then the number of signals are the same (say n) no matter the prior belief μ. Considering, without loss of generality, the case of equally informative signals $\theta = \theta_g = 1 - \theta_b > \frac{1}{2}$ and assuming no state change ($\lambda = 0$), it's easy to show time reversibility.

If the initial belief is $\mu_t = x$ and in period t all n signals fail ($s = 0$), then, using equations (1) and (2).

$$\mu_{t+1} = y = \frac{(1-\theta)^n x}{(1-\theta)^n x + \theta^n (1-x)} \tag{6}$$

[10] This proof is based on the case in which there is no state change ($\lambda = 0$) just to offer a flavor about why the endogenous information model delivers asymmetry on interest rates. This is not a critical assumption to show the impact of agency costs. A more general proof (with $\lambda > 0$) can be found in Veldkamp (2005).

Similarly, if in the following period all n signals are successful ($s = n$), then

$$\mu_{t+2} = z = \frac{\theta^n y}{\theta^n y + (1-\theta)^n (1-y)} \tag{7}$$

and replacing (6) into (7), $\mu_{t+2} = z = x$. Hence, in a constant information environment, beliefs respond to a time reversible stochastic process.

Step 2: Time irreversibility in an endogenous information economy

In an endogenous information economy, the number of signals is not independent on the beliefs of being in a good state. In fact, the greater the probability assigned to be in good times μ, the less the cutoff $\widetilde{\nu}$ given in equation (5) and the more the ventures funded (the signals n). Considering the same arguments and assumptions used in step 1, it's possible to show the stochastic process is not time reversible anymore.

Assume as before $\mu_t = x$ and in period t all n_x signals (the subscript is now necessary because n differs at different beliefs μ) are a failure ($s = 0$), then,

$$\mu_{t+1} = y = \frac{(1-\theta)^{n_x} x}{(1-\theta)^{n_x} x + \theta^{n_x}(1-x)} \tag{8}$$

Now, given $y < x$, borrowers are less confident about being in good times, the number of ventures decline and hence the number of signals in the economy becomes $n_y < n_x$

If in the following period all n_y signals are successful ($s = n_y$), then

$$\mu_{t+2} = z = \frac{\theta^{n_y} y}{\theta^{n_y} y + (1-\theta)^{n_y}(1-y)} \tag{9}$$

now replacing (8) into (9),

$$\mu_{t+2} = z = \frac{\theta^{n_y}(1-\theta)^{n_x} x}{\theta^{n_y}(1-\theta)^{n_x} x + (1-\theta)^{n_y}\theta^{n_x}(1-x)}$$

and

$$z - x = \frac{\left[\theta^{n_y}(1-\theta)^{n_x} - (1-\theta)^{n_y}\theta^{n_x}\right] x(1-x)}{\theta^{n_y}(1-\theta)^{n_x} x + (1-\theta)^{n_y}\theta^{n_x}(1-x)} \tag{10}$$

It's easy to check that $z - x < 0$ as long as $\theta > \frac{1}{2}$ and $n_y < n_x$. This basically means that highest possible decreases in beliefs (from x to y) are more likely than increases in beliefs (from y to z) of the same magnitude. This is the same to say, considering equation (4), that highest possible increases in lending rates are more likely than decreases in lending rates of the same magnitude, which is a necessary and sufficient condition for the existence of positive asymmetry on lending rates.

Exactly the same conclusion (that $z < x$) can be obtained reverting the order of successes and failures.

Hence, in an endogenous information economy, beliefs respond to a time irreversible stochastic process and lending rates present positive asymmetry.

Step 3: The effect of monitoring costs on lending rates asymmetry

The magnitude and importance of the asymmetry is summarized by the difference $z - x$ (equation 10) because it shows the degree of irreversibility in the stochastic process and the gap in the probability of obtaining an increase in lending rates over the probability of having a decrease of the same magnitude.

The gap $z - x$, for a given starting belief x and a given θ, only depends on the difference (not on the levels) between n_y and n_x, which basically comes from the gap on cutoffs for those beliefs $\widetilde{\nu}_y - \widetilde{\nu}_x$ (assuming the cumulative distribution of v is monotonically increasing). For example, if v is distributed uniformly $n_y - n_x$ is a negative and linear function on $\widetilde{\nu}_y - \widetilde{\nu}_x$.

The difference in cutoffs between beliefs x and y is

$$\widetilde{\nu}_y - \widetilde{\nu}_x = \frac{(x-y)}{xy}[1 + r + w + c] \tag{11}$$

which is positive when $x > y$ because confidence on good states decrease, $\widetilde{\nu}_y > \widetilde{\nu}_x$ and the number of funded ventures decreases ($n_y < n_x$). The opposite is true when $x < y$.

Hence, the impact of monitoring costs c over the gap $n_y - n_x$ can be obtained from its impact over $\widetilde{\nu}_y - \widetilde{\nu}_x$. Taking derivatives.

$$\frac{\partial(\widetilde{\nu}_y - \widetilde{\nu}_x)}{\partial c} = \frac{(x-y)}{xy} \tag{12}$$

which is positive when $x > y$ and negative when $x < y$

Two conclusions can be drawn from the last equation. First, the higher the differences in beliefs $(x - y)$, the greater the impact of c on the number of funded ventures. Second, monitoring costs do not have the same effect in the change of beliefs if μ is closer to 1 than to 0. For a given difference in beliefs $(x - y)$ the less confident agents are about being in good times (x close enough to 0), the more important is the impact of c on the gap between signals because agency costs become more stringent.

To check the impact of agency costs over symmetry assume the initial belief is $\mu_t = x$ and all ventures fail such that $x > y$. By equation (11) $\widetilde{\nu}_y > \widetilde{\nu}_x$ and $n_y < n_x$. The question is if the gap is bigger under high agency costs or in the presence of insignificant monitoring costs.

The answer is given by equation (12) because the greater the agency costs c the bigger is the gap $\widetilde{\nu}_y - \widetilde{\nu}_x$ (or which is the same fixing x the greater $\widetilde{\nu}_y$) and also the bigger the gap $n_y - n_x$ (or which is the same fixing x the smaller n_y) and relying on equation (10) the widener the time irreversibility $(z - x)$.

Hence, in an endogenous information economy with financial frictions, the greater the agency costs c, the more important the asymmetry on lending rates.
$\blacksquare$

Basically the proposition tells that in the presence of monitoring costs $c > 0$, the gap of signals increases across different states or beliefs, generating a smaller reduction in the maximum possible increase in the lending rates than the reduction in the maximum possible decrease. This translates into a greater asymmetry of the changes on lending rates, when compared with the case without monitoring costs.

This implies that the introduction of monitoring costs reduces both the magnitude of booms and crashes but decreases more the magnitude of recoveries, increasing the asymmetry. This is a result shown empirically in subsection 2.3, where we found asymmetry is mostly due to slower booms and not to sharper crashes. Even more, literature on slow recoveries (see Bergoeing et al. (2004)) presents additional elements to confirm the prediction that monitoring costs increase asymmetry fundamentally by making booms slower.

3.4 Additional testable predictions of the model

This model delivers a serie of testable predictions Naturally, the most important one is that agency costs increase asymmetry on lending rates, as shown in Proposition 1. This was the fact that motivates the introduction of agency costs in an endogenous information model and was carefully tested in Section 2.

But there are also a couple of conclusions from the model that can be tested as well in the data.

3.4.1 Countries with less developed financial systems present higher lending rates

Countries with less developed financial systems should present, in average, higher lending rates than countries with highly developed financial systems or, which is the same, with less financial frictions and agency costs.

Formally, from equation (4),

$$\frac{\partial(1+\rho)}{\partial c} = \frac{1-\theta_t}{\theta_t} > 0 \tag{13}$$

Even when this relation seems very natural from a casual observation of economic data, some basic regressions were estimated to check that lending rates in average are greater in countries with less developed financial systems in general and high monitoring costs in particular.

Table 10 shows a couple of regressions between lending rates average and financial development (again measured by credit to private sector as a percentage of GDP). The estimations are made only for the period 1990-2004[11], using both a sample of all countries and a restricted sample of OECD countries.

[11] Only the period 1990-2004 is used here because, unlike skewness, which is calculated using changes on lending rates along time for each country, averages of lending rates are more dependent on the measurement methodology used. In this sense, IMF's information for the nineties is more standardized across countries, making comparisons more reliable.

Table 10

Lending rates average and financial development

Dependent Variable	1990-2004	
Lending rates average	All countries	OECD countries
Credit to Private Sector / GDP	-0.195	-0.227
	(0.039)***	(0.027)***
Constant	28.69	26.24
	(2.63)***	(1.93)***
Observations	59	12

* Significant at 10%, ** Significant at 5% and *** Significant at 1%. Robust standard errors are reported in parentheses.

As can be seen, in general, more developed financial systems imply lower levels of lending rates. In fact, an increase of 1% in credit to private sectors as a percentage of GDP implies a reduction of around 0.2% in lending rates.

Table 11 is a mixture between Tables 4 and 5 but using as a dependent variable lending rates average. The goal is to measure more specifically the relation between levels on lending rates and proxies for monitoring, enforcement and flow of information costs. Variables not reported (cost and time of bankruptcy and contract enforcement days), even when having the correct sign, are not significant.

Table 11

Lending rates average and proxies for monitoring and enforcement costs.

Dependent Variable	1990-2004			
Lending rates average				
Recovery rate	-0.25			
	(0.06)***			
Legal protection to financial assets		-4.89		
		(1.82)**		
Sophistication of financial markets			-5.01	
			(1.54)***	
Health of banking systems				-3.18
				(1.21)**
Constant	30.16	45.79	41.00	35.64
	(3.84)***	(8.10)***	(8.65)***	(6.84)***
Observations	50	32	31	31

* Significant at 10%, ** Significant at 5% and *** Significant at 1%. Robust standard errors are reported in parentheses.

Also in this case it is possible to see that the better the functioning of financial markets in terms of sophistication, technology, flow of information, etc, the lower are the lending rates existing on those countries.

An important drawback is that, unlike regressions to explain skewness, comparisons of lending rate levels across countries may be capturing important differences in methodologies and definitions in the dataset.

All in all, even when we have to be more careful with these regressions than those explaining skewness, results seem consistent with the particular prediction of the model that agency costs increase interest rates, leading to underinvestment.

3.4.2 A higher asymmetry on lending rates is related to slower booms rather than to sharper crashes

The model also predicts that big asymmetries generated by high monitoring costs are characterized by slower booms rather than by sharper crashes. The intuition is that, in good times investors become very confident about the probability of success. In this context monitoring costs lose importance to determine the number of signals in the economy. Hence, when a crash occurs, it is based on similar conditions, no matter the magnitude of agency costs.

Contrarily, when times are bad, monitoring costs introduce serious borrowing constraints and reduce importantly the signals in the economy. If times change, booms are slower the fewer the number of signals. In this sense financial frictions introduce a sharper effect in booms rather than in crashes.

To show this formally, consider a country A with monitoring costs (c_A), higher than those on country B (c_B). Obtaining the difference in the number of signals (or cutoffs from equation (5)).

$$\widetilde{\nu}_A - \widetilde{\nu}_B = \frac{(1-\theta_t)}{\theta_t}(c_A - c_B) \tag{14}$$

This difference increases monotonically as θ_t decreases, or which is the same, $\frac{\partial(\widetilde{\nu}_A - \widetilde{\nu}_B)}{\partial \theta_t} = -\frac{(c_A - c_B)}{\theta_t^2} < 0$. For example, if $\theta_t = 1$ (very good times) there is no difference in cutoffs, which means agency costs do not affect at all the construction of signals in the economy. Contrarily, if $\theta_t = 0$ (very bad times) the difference in cutoffs is infinite.

Given crashes occur after good times (where θ_t is high), the difference in their magnitude between the two countries is almost unaffected by differences in monitoring costs since the number of signals are very similar. Contrarily, booms occur after bad times when θ_t is low and monitoring costs reduce the number of signals a lot. In this context booms in country A will be way slower than booms in country B.

All in all, monitoring costs impact on asymmetry mostly by lowering the duration of booms rather than by sharpening crises.

To test this prediction we generate an indicator per country called *Booms duration* that measures the proportion of periods the economy is recovering toward the trend or going below it. There is not a standard measure in the literature for this concept so we will propose just a ratio between numbers of booms or recovery periods over the total periods in the sample.

First we obtain a trend for the lending rates using a standard HP filter. We then identify those periods in which the change in real lending rates is smaller than the change in the trend series, representing periods of booms or recovery in which rates decrease in comparison to the trend. Naturally the other periods are crash periods. Taking the participation of boom or recovery periods in the total the variable *Booms duration* is obtained. The greater this measure the slower are booms and recoveries.

Table 12 presents OLS regressions between skewness on lending rates and the *Booms duration* for the samples used before. A positive coefficient means countries with high asymmetry on lending rates are characterized by booms and recoveries that take in average more time to occur than crashes.

Table 12

Asymmetry on lending rates and duration of booms

Dependent Variable	All countries		OECD countries	
Lending rates skewness	1960-1990	1990-2004	1960-1990	1990-2004
Booms duration	7.69	6.89	2.03	3.03
	(2.47)***	(2.22)***	(2.37)	(1.68)*
Constant	-1.87	-1.82	0.80	-0.28
	(1.20)	(1.03)*	(1.29)	(0.60)
Observations	67	57	15	12

* Significant at 10%, ** Significant at 5% and *** Significant at 1%. Robust standard errors are reported in parentheses.

As can be seen it is possible to find positive and significant positive relations between the magnitude of the skewness and the duration of booms which means high asymmetry is mostly characterized by slower booms rather than by sharper crashes.

In the following section some computations are shown in order to see in what extent the differences in monitoring costs across countries help to explain the differences in lending rates skewness existing in the data.

4 Simulations

In this section an endogenous information economy with agency costs, as the one discussed before, will be calibrated to see if the model is able to replicate the magnitude of differences in skewness delivered by the data.

Simulations are done using the same calibrated parameters used by Veldkamp (2005) to make our results comparable with hers. Table 13 summarizes the list of parameters used.

Table 13
Parameters used in the simulation

$\boldsymbol{\theta_g}$	$\boldsymbol{\theta_b}$	$\boldsymbol{\lambda}$	**r**	**w**	**N**
0.97	0.95	0.027	0.0042	1	25

Veldkamp (2005) obtained θ_g and θ_b from default rates on US speculative grade bonds given the unavailability of default data for emerging markets bond. The probability of a state transition λ was obtained using world GDP from the Penn World tables. The largest potential number of independent observable signals N was intelligently overcame measuring the speed of price adjustments in US. Parameters r and w only affect the scale of the lending rate and skewness is invariant in scale[12]. The same numbers can be used as benchmark in this exercise, even when trying to match a greater number and diversity of countries, given the parameters are obtained either from US or from the whole world.

Ten thousand repeated simulations, each with 10,000 periods, produce average skewness estimates depending on monitoring costs. Monte Carlo standard errors are also reported for each case. Because of the assumption that the value of the assets for each venture is 1, a monitoring or bankruptcy cost given, for example, by $c = 0.3$ means a cost of 30% of total assets values. Table 14 shows the asymmetry implied by the model for different monitoring costs possibilities.

Table 14
Montecarlo results

Monitoring Costs (c)	**0**	**0.1**	**0.2**	**0.3**	**0.4**
Skewness of $(ln(\rho_t) - ln(\rho_{t-1}))$	1.60	1.79	2.08	2.56	3.49
MonteCarlo S.E.	0.05	0.06	0.07	0.09	0.12

As shown formally before, the greater the monitoring costs in this simulated economy the greater the skewness of changes in lending rates. Even more, Monte Carlo standard errors show that differences in asymmetry caused by different monitoring costs are statistically significant.

The result without monitoring costs (skewness=1.60) is the same as in Veldkamp (2005) when using uniformly distributed investment payoffs. One of the drawbacks in that paper is the difficulty to match successfully the data about asymmetry on lending rates for 13 emerging markets (skewness=2.9).

At this point Veldkamp experimented with different parameters to match the data. For example, decreasing the probability of state switching (by reducing λ), generating clearer signals (by increasing $\theta_g - \theta_b$) or changing the assumed distribution of ν_i she was able to increase the simulated skewness. But this would mean countries with a very stable state or those with clearer signals are those with higher asymmetry. Considering these characteristics are more

[12] Skewness is independent on r and w because the support for the distribution of v_i is $[\underline{v}, \overline{v}]$, where $\underline{v} = \frac{1+w+r}{\overline{\theta}}$ and $\overline{v} = \frac{1+w+r}{\underline{\theta}}$, where $\overline{\theta}$ is the most optimistic probability of success and $\underline{\theta}$ the most pesimistic one.

common in developed countries than in developing ones, Veldkamp results are contradictory with the data.

Introducing monitoring costs, and without modifying the parameters calibrated from real information, the skewness based on Veldkamp's 13 emerging markets (2.9) is consistent with bankruptcy costs of 35% over total assets.

Now we can face, as shown by Figure 1 and 2, the relation between these results and the fact that less developed countries can present either high or low skewness levels. Introducing monitoring costs is like introducing a compensating force to more volatile states or noisy signals in developing countries, which tend to reduce the asymmetry. Considering the high dispersion of parameters (λ, θ_g and θ_b) among emerging markets in comparison with developed ones, developing countries with high monitoring costs, but also with very unstable states and very noisy signals, can in fact present low relative skewness.

This is exactly why in Table 2 and figures 3 and 4 we controlled skewness by the volatility of GDP per capita, lending rates and consumer prices, raw estimations for λ in each country.

An interesting exercise is to estimate from the results of the simulation what is the magnitude of monitoring costs consistent with skewness differences reported in Section 2. The idea is to obtain from this very basic and rustic model an idea of differences in agency costs across countries. This is a straightforward application of the model to offer a, surprisingly missing, information about the magnitude of monitoring costs differentials.

Table 15 shows the results. Monitoring cost consistent with skewness in each classification group and the range within two Montecarlo standard deviations are reported. Estimations are significant since ranges do not intersect.

Table 15

Implied monitoring costs to match real data on lending rates asymmetry

Countries classification	**Real Skewness**	**Cost of Bankrupt**	**Consistent c (in %)**	
			Point	**Range**
Income Group 1	1.72	7.1	7	$2-11$
Income Group 2	2.29	18.5	25	$22-28$
Income Group 3	2.60	18.6	31	$28-33$
Income Group 4	3.31	23.6	39	$37-41$
OECD	1.73	9.0	7	$2-11$
non-OECD	2.76	20.1	33	$30-36$
High contract enforcement	1.37	6.5	0	0
Low contract enforcement	2.35	16.8	26	$24-30$
Private Bureau	1.96	11.6	15	$12-18$
non-Private Bureau	2.79	20.3	34	$32-36$

Countries classification and Real Skewness columns are taken from columns 1 and 5 of Table 3. Bankruptcy costs are taken from Djankov et al. (2005). Consistent c refers to monitoring costs that, given the parameters, allows to match real skewness. The range is determined using two Montecarlo standard deviation at each side of the point estimation.

Table 15 also presents bankruptcy costs indicators used in section 2. The reason to include them is to compare the monitoring costs implied by the model with the subjective measure of foreclosure costs offered by Djankov et al. (2005).

As can be seen, even when bankruptcy costs obtained from surveys by Djankov et al (2005) (column 3) and consistent c obtained from a simulation of our model (column 4) are two imprecise measures of monitoring costs, it's impressive the high correlation between them. In fact monitoring costs delivered by the calibration are consistently higher than bankruptcy costs. This can be due to two reasons.

First, consistent c replicate skewness for the period 1960-2004 while cost of bankruptcy is measured for 2004. As discussed in section 2.2.1 technologic improvements rationalize that modern measures of bankruptcy costs be lower than older ones. Doing the same exercise for the period 1990-2004 closes the gap between columns 3 and 4 for poorer countries but delivers zero monitoring costs for richer ones.

Second, bankruptcy costs as measured by Djankov et al. (2005) exclude bribes that can raise monitoring costs considerably. Even more, this will be true fundamentally for poorer countries with low contract enforcement. This may be the reason why the gap between monitoring costs implied by the model are bankruptcy costs by Djankov et al. is not only positive but also increasing as countries become less financially developed.

It is important to put these results into context with a brief discussion about the literature on monitoring technology and bankruptcy costs, where a great debate exists about the correct way to measure them. One of the first attempts to estimate bankruptcy costs was done by Warner (1977) who, considering only direct costs of bankruptcies, and using data on the railroad industry, found a cost around 4% of total firm assets.

Altman (1984) included also indirect costs, raising the estimation at about 20% of total firm assets. Indirect costs include financial distress, such as lost sales and lost profits. Another way bankruptcy costs were estimated in the literature is due to Alderson and Betker (1995), by comparing the value of the firm as a going concern with the liquidation value of the firm. This calculation of liquidation costs are approximately 36% of firm assets.

As can be seen, the possible range for bankruptcy costs given by the literature is very wide and imprecise. Furthermore, the few available estimations are typically based on the US or another developed country. This controversy lies fundamentally on differences in definitions. The interpretation most closely related to the concept of bankruptcy costs used here is the one that only considers direct costs, as Warner did. This is because no indirect cost can arise in the environment described by the model and no liquidation value of the firm can be obtained.

The model seems very successful in matching the magnitude of asymmetry from the data not only with previous estimations of monitoring technology but also with new subjective indicators across countries. Even when the model is very basic and simple, it can offer common-sense consistent bankruptcy costs, with sensible differences among various countries' classifications. This is particularly important given the inexistence of direct estimations of this type in developing countries.

All in all, this exercise can offer an idea of monitoring costs in developing countries. Even when the method to obtain them is very indirect and based on a very limited and simple model, the results in fact make a lot of sense and seem to be very robust.

4.1 What about levels?

A natural question at this point is whether monitoring costs are able to explain the important differences we observe in levels of lending rates across countries. This is not an easy task for this simple model considering that, as the first column in Table 16 shows, lending rates in countries with poor financial systems almost double those existing in developed markets.

In our model, levels on lending rates depend exclusively on free risk interest rates, default rates and monitoring costs. In fact equation (4), can be re-written as,

$$\rho_t = r + \frac{(1-\theta_t)}{\theta_t}(1+r) + \frac{(1-\theta_t)}{\theta_t}c \tag{15}$$

This means lending rates can be expressed as the sum of three terms: A free risk interest rate, a risk prime (which depends on the free risk interest rate adjusted by default rates) and costs that arise from financial frictions and costly state verifications.

From this formula, our model can explain big differences on lending rates only by a combination of big differences on free risk interest rates, on probabilities of success and on monitoring costs. In this subsection we show that most of the differences in levels in fact comes from differences in "free risk interest rates" (as typically measured by the literature), affecting levels but not skewness.

Up to this point, to make skewness simulations we just considered the US free risk interest rate, we used the default rates of the riskiest speculative-grade US bonds to obtain probabilities of success and, from there, we estimated monitoring costs. Now it's important to discuss the role of each one of these components before simulating levels.

First, in the previous calibration we used as a free risk interest rate (r) the average of 3-month US Treasury Bills Yields from 1990 to 2005. Since in our model skewness is invariant in scale, the specific number used did not matter for skewness comparisons and for the determination of consistent monitoring costs. However, to simulate levels we need to obtain free risk interest rates for other economies as well, also using 3-month Treasury Bills Yields for the countries in the sample[13]. We find surprising disparities among them, as shown in column 3 of Table 16, which suggests government bonds in developing countries are

[13] This information was obtained from the Global Financial Dataset, taking averages per country between 1990 and 2005 when available.

not really "free risk" since they include default risks, country risks, exchange volatility risks, etc.

Second, default rates are obtained from Moody's bonds information from 1970-2000. In skewness simulations, probabilities of success were obtained using US speculative-grade bonds and not "all corporate" figures, since emerging markets bonds (whose default rates are not available) are likely to be riskier than typical US corporate bonds. Hence, to simulate skewness we used a 5% probability of default in recession years ($\theta_b = 0.95$) and 3% in non-recession years ($\theta_g = 0.97$). Even when this may be a good assumption for developing countries, this is not necessarily true for developed ones. Hence to apply in levels simulations for developed countries we obtain default rates from US "all corporate" bonds ($\theta_b = 0.97$ and $\theta_g = 0.98$)[14].

Finally, to simulate levels we use the monitoring costs obtained in the previous exercise. Results from the simulations as well as the three components of lending rates from equation (15) are shown in Table 16.

Table 16

Real vs. Estimated lending rates

Countries classification	**Real lending rates**	**Estimated lending rates**			
		Total	*Components*		
			r	$\frac{(1-\theta)(1+r)}{\theta}$	$\frac{(1-\theta)}{\theta}c$
Income Group 1	**9.6**	**9.4**	6.6	2.7	0.1
Income Group 2	**18.5**	**19.2**	13.5	4.7	1.0
Income Group 3	**18.5**	**18.0**	12.0	4.7	1.3
Income Group 4	**24.4**	**23.4**	16.8	4.9	1.7
OECD	**10.8**	**11.2**	8.4	2.7	0.1
non-OECD	**20.9**	**20.4**	14.3	4.7	1.4
High contract enforcement	**8.4**	**8.8**	6.0	2.0	0.0
Low contract enforcement	**20.7**	**22.3**	16.3	4.9	1.1
Private Bureau	**14.3**	**16.9**	11.6	4.7	0.6
non-Private Bureau	**23.2**	**21.4**	15.2	5.8	1.4

As can be seen, the importance of monitoring costs on levels of lending rates are low when compared with the importance of differences in free risk interest rates and the multiplicative effects of default rates (through θ). However, it's important to recognize that monitoring costs accounts for more than 20% of lending rates spread in developing countries (1.7/7.6 for income group 4) and less than 5% in developed ones (0.1/3.0 for income group 1).

All in all, even when it seems monitoring costs are not very important to explain differences on lending rates levels, their importance to explain the spread decreases as financial systems become more developed.

[14] Naturally these numbers reduce the estimation of monitoring costs for developed countries in the previous exercises. In any case this reduction is not very important since monitoring costs were already low.

5 Conclusion

A well documented characteristic of financial markets is their asymmetry in changes over cycles. While booms are slow and gradual, crashes are sudden and sharp. This feature represents a non trivial fact to countries since it may generate economic problems such as financial distress, banking crisis and costly reallocation of resources.

But, aside from the existence of asymmetry in a country along time, an interesting characteristic that surges from the data is that less financially developed systems, with high monitoring and bankruptcy costs, show in average higher levels of asymmetry.

While a diverse and rich literature tries to explain why asymmetry exists, this is the first attempt to understand why asymmetry differs across countries.

We introduce agency costs into an endogenous information model (which has the property of generating unconditional asymmetry) to replicate differences observed in the data. The idea of a model with endogenous flow of information is that, in good times there is more economic activity than in bad times, generating a greater number of signals and more information. The asymmetry in the rate of transmission of information across states is the origin of the asymmetry on lending rates. Booms and recoveries are gradual because agents learn slowly about better conditions when few signals are available. Contrarily, crashes are sharp because agents learn quickly that worse conditions arose since a lot of information is available.

Agency costs introduced in this environment are able to generate even more asymmetry. The main reason is that agency costs reduce investment (the number of signals), but their impact is not constant across states. These costs are more restrictive in bad times since an agency problem is more likely to arise. After a crises high monitoring costs prevent a fast renew of economic activity, making harder for agents to learn about the new conditions and slowing down recoveries.

Even when strikingly simple, the simulation of this model delivers an estimation of cross-country differences in monitoring costs that match observed skewness differences.

Direct monitoring costs of around 5% match the data for developed countries while monitoring costs of around 30% match the data for underdeveloped countries. These figures are consistent with new "survey-based" evidence of differences in bankruptcy costs across economies. Furthermore the model matches differences on levels and volatility of lending spreads across countries.

References

[1] Alderson, M. and B. Betker [1995]: "Liquidation costs and capital structure". *Journal of Financial Economics.* **39**, 45-69.

[2] Allen, F., S. Morris and H. Shin [2003]: "Beauty contests, bubbles and iterated expectations in asset markets". *Wharton Working Papers* ***03-06***.

[3] Altman, E. [1984]: "A further investigation of the bankruptcy cost question". *Journal of Finance*, **39**, 1067-1089.

[4] Banerjee, A. [1992]: "A simple model of herd behavior". *The Quarterly Journal of Economics*, **107**, 797-817.

[5] Banerjee, A. [1993]: "The economics of rumors". *The Review of Economic Studies*, **60**, 309-327.

[6] Bergoeing, R., N. Loayza and A. Repetto [2004]: "Slow recoveries". *Journal of Development Economics*, **75**, 473-506.

[7] Carlstrom, C..and T. Fuerst [1997]: "Agency costs, net worth and business fluctuations: A computable general equilibrium analysis". *The American Economic Review*, **87**, 893-910.

[8] Chamley, C. and D. Gale [1994]: "Information revelation and strategic delay in a model of investment". *Econometrica*, **62**, 1065-1085.

[9] Djankov, S., C. McLiesh and A. Shleifer [2004]: "Private credit in 129 countries". *mimeo. Harvard University.*

[10] Djankov, S., O. Hart, T. Nenova and A. Shleifer [2005]: "Efficiency in bankruptcy". *Doing Business. Closing a Business. World Bank.*

[11] Gale, D. and M. Hellwig [1985]: "Incentive-compatible debt contracts: The one-period problem". *The Review of Economic Studies*, **52**, 647-663.

[12] Glosten, L. and P. Milgrom [1985]: "Bid, ask and transaction prices in a specialist market with heterogeneously informed traders". *Journal of Financial Economics*, **14**, 71-100.

[13] Jacklin, C., A. Kleidon and P. Pfleiderer [1992]: "Underestimation of portfolio insurance and the crash of October 1987". *The Review of Financial Studies*, **5**, 35-63.

[14] Jovanovic, B. [2005]: "Asymmetric cycles". *mimeo. New York University.*

[15] Kaminsky, G., S. Schmukler [2001]: "On booms and crashes: Financial liberalization and stock market cycles". *mimeo. World Bank.*

[16] La Porta, R., F. Lopez de Silanes, A. Shleifer and R. Vishny [1998]: "Law and finance". *Journal of Political Economy*, **106**, 1113-1155.

[17] Levine, R. [1997]: "Financial intermediation and economic growth: Views and agenda". *Journal of Economic Literature*, **35**, 688-726.

[18] Levine, R., N. Loayza and T. Beck [2000]: "Financial intermediation and growth: causality and causes". *Journal of Monetary Economics*, **46**, 31-77.

[19] Merton, R. [1987]: "A simple model of capital market equilibrium with incomplete information". *Journal of Finance*, **42**, 483-510.

[20] Townsend, R. [1979]: "Optimal contracts and competitive markets with costly state verification". *Journal of Economic Theory*, **21**, 265-293.

[21] Van Nieuwerburgh, S. and L. Veldkamp [2005]: "Learning asymmetries in real business cycles". *mimeo. New York University.*

[22] Veldkamp L. [2005]: "Slow boom, sudden crash". *Journal of Economic Theory. Forthcoming.*

[23] Warner, J. [1977]: "Bankruptcy costs: Some evidence ". *Journal of Finance*, **32**, 337-348.

[24] Welch, I. [1992]: "Sequential sales, learning and cascades". *Journal of Finance*, **47**, 695-732.

[25] Zeira, J. [1994]: "Informational cycles". *The Review of Economic Studies*, **61**, 31-44.

[26] Zeira, J. [1999]: "Informational overshooting, booms and crashes". *Journal of Monetary Economics*, **43**, 237-257.