Estimating Risk and Excessive Risk-Taking in Colombia's Commercial Banks

Estimando el riesgo y el exceso de riesgo tomado por los bancos comerciales colombianos

Diego Ramos Toro*

Abstract

The document estimates the risk embraced by Colombian commercial banks, and establishes a measurement of excessive risk-taking that is consistent with such estimation. The construction of the excessive-risk measurement follows the basic efficient-portfolio framework, in which the variance of an aggregate portfolio is minimized subject to an observed return. Return and risk-taking in Colombia's banking industry appear to decrease between December 2007 and May 2011. In spite of this, the excess-risk exhibits an upward trend, and denotes an increasing suboptimality when considered as a proportion of the observed risk. Hence, a reduction in the risk embraced by Colombian banks paradoxically coincides with an increase in their instability.

Key words: Financial stability, risk attitudes, risk, excessive risk-taking, bank.

JEL classification: E44, G11, G21.

---

* Universidad de los Andes, Bogotá, Colombia. E-mail: d.ramos61@uniandes.edu.co. I would like to thank Marc Hofstetter, Catherine Rodriguez, and an anonymous referee for their valuable comments and suggestions. I would also like to thank Büllent Aybar and Juan Pablo Uribe for their advice and aide with methodological issues.

Este artículo fue recibido el 31 de enero de 2012; modificado el 23 de agosto de 2012 y, finalmente, aceptado el 26 de octubre de 2012.

Resumen

El artículo estima el riesgo tomado por la banca comercial colombiana y establece una medida de toma excesiva de riesgo que es consistente con tal estimación. La construcción de la toma excesiva de riesgo sigue el modelo del portafolio eficiente, según el cual la varianza de un portafolio agregado es minimizada sujeta a un retorno observado. El retorno y el riesgo tomado por la banca colombiana exhiben una tendencia decreciente entre diciembre de 2007 y mayo de 2011. Pese a esto, la toma excesiva de riesgo exhibe una tendencia creciente y denota una creciente suboptimalidad cuando se considera como proporción del riesgo observado. Por tanto, una reducción en el riesgo tomado por los bancos colombianos paradójicamente coincide con un aumento en su inestabilidad.

Palabras clave: estabilidad financiera, actitudes de riesgo, riesgo, toma excesiva de riesgo, banco.

Casificación JEL: E44, G11, G21.

Introduction

The financial stability of an economy is crucial for its performance and sustainability. The events of the recent financial crisis provide a clear example of the consequences that may arise from an unstable financial sector. A prime element of this stability is the performance and sustainability of the banking industry. Demirgüç-Kunt, Detragiache and Gupta (2006) demonstrate that a banking crisis is accompanied by a decline of 2-4% in the output's growth. Furthermore, such crises may have long-term consequences on the performance of an economy. According to Abiad et al. (2009), a banking crisis may imply that an economy -in spite of recuperating its pre-crisis growth- may not rebound to its pre-crisis trend. The banking industry's sustainability is directly related to the extent to which the banks embrace risk. Following Bustamante and Favilukis (2010), the easing of lending standards and the decline in loan denial rates were at the core of the roots of the subprime crises. Dell'Ariccia, Deniz and Laeven (2008) show that prior to the financial crisis the rates of credit repayment were lower precisely in the areas that had larger increases in number and volume of loans. This indicates that the genesis and outbreak of the recent financial crises was associated with a deterioration of financial stability, and with the worsening of banking risk-taking.

Following the basic premise established by Markowitz (1952), there is an indissoluble relationship between risk and return, for an agent is obliged to take on risk whenever her goal is to obtain a level of return greater than that of the risk free asset. If an industry takes on more risk than what is *required* in order to obtain certain return, then there is an *excessive-risk taking* in such industry. The mentioned evidence regarding banking crises points to the relevance of knowing and assessing the extent to which commercial banks embrace risk. Moreover, it is of prime importance to determine whether such industry is incurring in *excessive-risk taking*, and to calculate such magnitude.

This paper utilizes a measurement proposed by Podpiera and Weill (2010) in which *risk-taking* is measured as the variance of an aggregate portfolio of the banking industry. The construction of the excessive-risk measurement follows the basic efficient-portfolio framework, in which the variance of the mentioned portfolio is minimized subject to an observed return. The document thus introduces the first quantification of the excess-risk embraced by Colombian commercial banks. Risk-taking in Colombia's banking industry appears to decrease between December 2007 and May 2011. In spite of this, *excess-risk* exhibits a clear upward trend. This implies that, although the risk embraced by banks has decreased in the near past, such tendency coincides with an increasing suboptimality of Colombian banks.

The remaining of the document is structured as follows: Section I delves into the concept of *risk-taking* and *excessive risk-taking*, and reviews the common procedures used to measure such concepts for the banking industry. Section II explains in detail the framework and methodology upon which this document will measure *risk-taking* and *excessive risk-taking*. Section III examines the database that will be used in order to obtain such estimations. Section IV presents the main results and its implications. Section V discusses potential explanations for the observed results. Section VI concludes and points to further research avenues.

I. Risk and Excessive Risk-Taking

A discussion and a definition of the concept of *risk* are prerequisites to an adequate assessment of the exercise that will be performed in this article. This document follows the definition given by Ackert and Deaves (2009), according

to which a *risk-attitude* is the predisposition of an agent to choose between alternatives with equal expected return, but different variability. A *risk-neutral* agent would be indifferent between the alternatives as long as they offer equal expected return. Analogously, a *risk-averse* agent would prefer a prospect with less variable outcomes, while a *risk-seeking* agent would prefer the prospect with more variable outcomes. Hence, when an agent takes a decision regarding risk, she is assumed to know[1] the probabilistic distribution of the outcomes to which she is exposed.

Theoretical approaches to agents' risk attitudes in an economy have taken into consideration the different degrees of aversion towards risk. Within the neoclassical framework of economics there are two different interpretations regarding agents' attitudes towards risk. According to the *expected utility theory*, the rationality of agents implies that they decide upon the sole criterion of maximizing their expected wealth, disregarding the variability of the prospect that they select (Von Neumann and Morgenstern, 1947). The *expected utility framework* thus assumes that the economies are constituted by risk-neutral agents. The second neoclassical interpretation of risk assumes that agents are risk-averse, reason for why they demand a compensation for embracing risk (Ackert and Deaves, 2009). This implies a positive relationship between risk-taking and return (Ackert and Deaves, 2009). An explanation for the risk-attitude of agents that competes with the traditional approach is Kahneman and Tversky's *prospect theory.* According to such interpretation, agents do not consider outcomes in terms of wealth magnitudes –as neoclassical interpretation would suggest- but rather as gains or losses. In such fashion, an agent's risk-taking attitude is endogenous, for it depends on whether the agent considers herself on the domains of gains or on the domains of losses (Kahneman and Tversky, 1979).

The concept of *excess risk-taking* goes hand in hand with that of *risk-taking,* with one further crucial assumption: the existence of an optimal level for such concept in the economy (Agur and Demertzis, 2010). This implies that if banks –on the aggregate level- embrace risk to an extent above the optimal level, the banking system as a whole could benefit from less *risk-taking* with-

1 Or at least to think that she knows. This establishes a stark difference with the concept of decision under uncertainty, which occurs when agents have no information about the prospects outcomes and/or probabilistic distribution (Ackert and Deaves, 2009).

out sacrificing its levels of profitability. Although several authors recognize the existence of *excess risk-taking*, there is a gap in the literature in terms of explaining the determinants of such element. Furthermore, the empirical connection between these two elements remains unexplored. The main reason for the referred absence is the absenteeism of a comprehensive measurement of *excessive risk-taking* that is consistent with an estimation of *risk-taking*. The following section proceeds in such direction.

The body of literature that analyzes the determinants of banks' *risk-taking* uses several techniques in order to estimate such element. The most frequently used is a *Z-score* consistent with the Basel II environment. Such score estimates a bank's likelihood of becoming financially distressed, using several financial coefficients such as the return-on-assets, its dispersion, along with equity-to-total-assets ratio (Altman, 2002). This measurement of risk-taking is given at an observation level, shedding a coefficient for each bank. Another popular technique to assess a bank's level of risk, particularly on a practical level, is the non-performing-loans ratio. Given that a non-performing loan is defined as the loan for which the debtor has a delay of up to 90 days in making her scheduled payments, this ratio denotes the percentage of low quality borrowers to which a bank is exposed. An alternative way of determining a bank's exposure to risk could be a ratio of liquid-to-total-assets. This estimation would be consistent with the basic bank-run set-up of Diamond and Dybvig (1983), in which a bank is obliged to forego potential financial returns given its need to have liquid loans that enables it to face an early liquidation. Hence, a high liquid-to-total-assets ratio would denote a low level of risk embraced by the bank, given the danger of a costly early liquidation. The referred estimations, however, do not assess the crucial element of *optimal risk*. By foregoing such element, there is an impediment to evaluate *excessive* (suboptimal) risk, and to examine the empirical determinants of such suboptimality, along with an empirical scrutiny of the relationship between *risk* and financial (economical) performance.

II. Measuring *Risk* and *Excessive Risk-Taking*

In order to evaluate the risk embedded in the assets of a bank and to examine the optimality of such risk, Podpiera and Weill (2010) propose a methodology in which an aggregate portfolio for the banking industry is generated.

In order to generate an aggregate portfolio the authors divide the assets into the types of loans granted by the banks in a determinate period. If the types of loans in the industry are denoted by *i*, then the aggregate share of the loan *i* in the period *t* is given by

$$\delta_{i,t} = \frac{total\ value\ of\ loans\ i\ in\ period\ t}{total\ value\ of\ loans\ \ in\ \ period\ t} \tag{1}$$

The Podpiera-Weil framework assumes that the actual return earned by a bank for a given loan is equivalent to the rate it charges. This assumption is problematic, for the rates charged by banks deviate from actual returns earned by them. This is proved by the fact that there are loans for which the lenders receive no payment from their debtors. The fact that lenders are aware of this potential loss prior to any disbursement implies that the appropriate *ex-ante* returns used to calculate effective risk-taking must incorporate the portion of loans that are not repaid by borrowers. In such fashion, the measure of return that will be used henceforth is given by

$$R_{i,n,t} = \left(r_{i,n,t}\right)\rho_{\overline{i,n,t}} \tag{2}$$

Where $r_{i,n,t}$ is the rate charged at period *t* for the loan *i* issued by bank *n*, and $\rho_{\overline{i,n,t}}$ is a yearly-based discount given by

$$\rho_{\overline{i,n,t}} = 1 - \left(\frac{write\ \ offs + past\ \ due\ \ loans}{total\ \ loans\ \ granted}\right)_{\overline{i,n,t}} \tag{3}$$

In such discount, the *write offs* correspond to the total write offs acknowledged by the bank during the year corresponding to month *t*, whilst the past due loans correspond to the total value of loans during that same year that were not repaid in the stipulated period. Analogously, the *total loans granted* correspond to the total value of the loans granted by the bank *n* during the year corresponding to month *t.*

The reason for why the discount is set on a yearly basis is best explained by the procedure through which a bank accepts a write off. The decision to accept such loss is an accounting -rather than financial- choice, for it is when a bank decides to change an unpaid loan from an expected income to an accepted loss

in the profit-and-loss statement. Hence, the financial decision upon which a loan is issued comes several months prior to the accounting decision to recognize an unpaid loan as a write off. Setting the discount on a monthly basis would thus augment the volatility in a given month without any consistency with the risk-return choice taken within the bank for such month. Additionally, a monthly measure of such variable could result in erroneous rates of discount, for if several unpaid loans that were granted in different months are accepted as write-offs in the same month, equation (3) could assume a negative value. Such erratic result would imply a negative return, leading to a erroneous conclusions regarding the financial decisions taken by the bank in such period. On the contrary, calculating a yearly discount avoids adding unfair variability to the *return*, whilst approaching more accurately to the actual *ex-ante* decision through which a bank calculates the average return they will receive for the loans they grant.

The aggregate return for the loan *i* would be given by the simple average of the returns earned by banks for each loan category:

$$g_{i,t} = \frac{\sum_n R_{i,n,t}}{n} \tag{4}$$

where *n* is the total number of banks in the sample. Therefore, the return of the aggregate portfolio would be given by

$$G_t = \sum_i \delta_{i,t} g_{i,t} \tag{5}$$

The risk embraced by the banking sector in period *t* is given by the volatility of the loans issued by the banks:

$$\sigma_t = \sqrt{\sum_i \sum_j \delta_{i,t} \delta_{j,t} \omega_{i,j,t}} \tag{6}$$

where *j* -as *i*- denotes the set of loan-types granted by Colombia's commercial banks, and $\omega_{i,j}$ is the covariance between the loan categories *i* and *j* –which in turn would equal to the variance of loan *i* whenever *i* equals *j* –.

A calculation of the optimal level of *risk-taking* is achieved by conjugating the referred elements with those proposed by Markowitz (1952) in his efficient-portfolio theory. Assuming that agents in the economy are *risk-averse*, the optimal level of *risk-taking* would be the minimal risk required to obtain the observed return, i.e.

$$\begin{aligned} &\min_{\delta_{i,t}} \sqrt{\sum_i \sum_j \delta_{i,t}\delta_{j,t}}\,\omega_{i,j,t} \\ &s.\ t. \\ &\sum_i \delta_i g_i = G_t \end{aligned} \tag{7}$$

Given a solution of σ_t^* to the referred optimization problem, the excessive risk embraced by the banking industry in period *t* would be given by

$$e\sigma_t = \sigma_t - \sigma_t^* \tag{8}$$

III. The Database

The information on Colombian banking industry can be obtained from the *Superintendencia Financiera* (Superfinanciera for short), Colombia's public entity in charge of the supervision and inspection of the financial institutions operating in such economy. The records kept by Superfinanciera contain monthly information regarding the value of each type of loan for all the banks, along with the monthly rates charged for each type of loan. Additionally, it contains end-of-the-year information regarding the total value of loans, the past due loans, and the write offs corresponding to every year. The information is categorized according to four groups of loans: commercial, consumption, microcredit, and real estate. The commercial loans correspond to those granted to firms with the purpose of acquiring machinery, transporting equipment, computational equipment, and to firms that need liquidity for their basic working capital. The consumption loans correspond to the credit granted to individuals who pursue to acquire equipment, cars, furniture, among others. Real estate loans refer to those that were granted with the purpose of acquiring and/or creating housing. These types of loans are divided into those that are of prime social interest –for low income economical groups-, and those that are not. Finally, the microcredit loans correspond to those loans granted to illiquid entrepreneurs who wish to start a business or who currently own

a small-starting business. The data is available on a monthly basis between December 2007 and May 2011, which implies a total of 42 months. Before December 2007 the needed data is given only for December of each year, starting from December 2002.

The information used in this document comes from all the banks that complied with the following two criteria: (1) that appeared in the whole period of analysis, and (2) that granted loans to at least 2 of the 4 categories. According to such standards, the sample of banks excludes a total of 10 banks[2], and boils down to the 14 banks contained in Table 1. Based on the information reported by such banks, an aggregate portfolio for the banking industry was constructed for each month between December 2007 and May 2011, and for each of the Decembers between 2002 and 2010. A key assumption was needed in order to obtain a balanced panel for the period of interest: for those banks that did not report a loan type in certain month, it was assumed that the bank would have lent at the mean rate of such category of loan in such month. This assumption allows a balanced panel containing a rate and a loan value for each bank at all months. It is worth mentioning that by following an alternative procedure –eliminating all the banks that did not report the four types of loans- valuable information is lost, and the general results –discussed in the following section- still hold[3]. The database entails two basic limitations. First, the gross loan-categorization implies that valuable information –in terms of risk and return optimality- may be lost due to the lack of data refinement. Second, the sample of banks is somehow small, limiting the results that will be presented later on.

Table 1. Banks Used in the Calculation of Risk and Excess Risk

Popular	Bogotá
Santander	Bancolombia
Citybank	Sudameris
HSBC	BBVA
BCSC	Occidente
Davivienda	Colpatria
Agrario	AV Villas

2 Granbanco, Procredit, WWB, Bancamia, Coomeva, Banco Fallabella, Banco Finandina, Banco Pichincha, Helm Bank, and Scotia Bank.

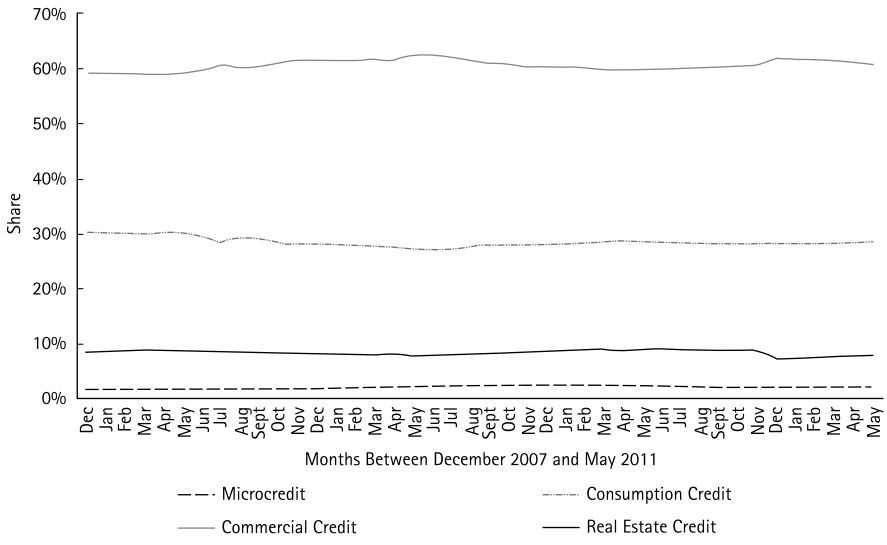
3 Results of the alternative exercise will be sent upon request.

Table 2. Summary Statistics of Loan Shares Relative to Total Loans Granted

	Micro	Commercial	Consumption	Real Estate
Min	1.8%	59.1%	27.2%	7.4%
Max	2.5%	62.5%	30.4%	9.1%
Mean	2.2%	60.7%	28.6%	8.5%
Median	2.3%	60.6%	28.4%	8.6%
Std.	0.2%	1.0%	0.8%	0.4%

Before delving into the calculations, it is worth examining the general trends contained in the information. Figure 1 illustrates the behavior of the share of each loan category throughout the analyzed period, whereas Figure 2 elucidates the behavior of the average return of each category.

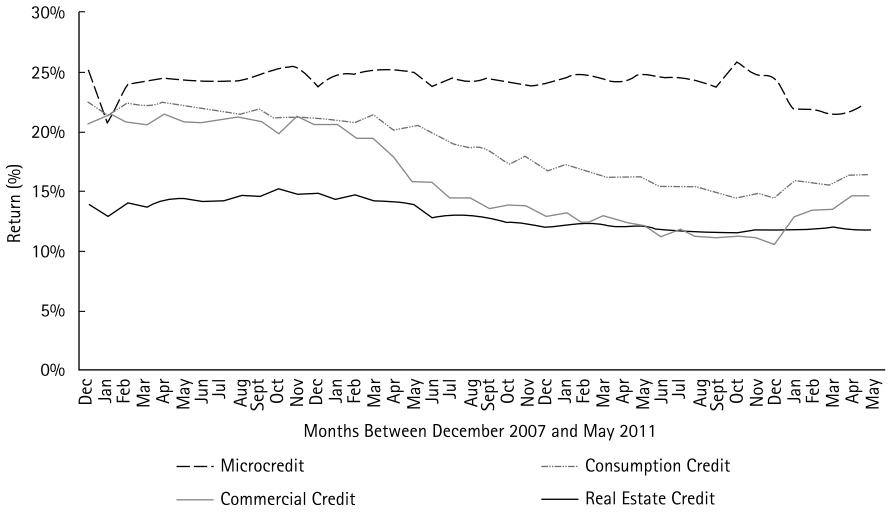
Figure 1. Corresponding Share of each Category of Loan Relative to the Total Value of Loans Granted



When examining Figure 2 one notices that the microcredit receives the higher return throughout the period, which —following the basic Stiglitz and Weiss (1981) setup— implies that such loan entails the highest *ex ante* risk compensation. This is true regardless of Colombian financial regulation, which stipulates a ceiling for the rates charged for microcredit loans (the ceiling is nowadays near 45.9%, which is way above the maximum rate of 30% charged in the

period under scrutiny). Contrarily, the real estate loans are associated with the lowest return, a result that may derive from Colombian financial regulation which stipulates that the rates charged for such credit category must be the lowest. The earned returns for these types of loans are somehow stable, whereas the earned returns for consumption and commercial credit vary significantly throughout the analyzed period. This may be in part explained by Colombian financial regulation, which impedes the microcredit rate to rise above a certain level, and ensures that the real state rate is the lowest of the rates. As illustrated by Figure 2, there is a considerate decline in the returns earned for the commercial and credit categories of loans. These assertions are supported by the information shown in Table 3: the dispersion between the minimum and the maximum earned returns for commercial and consumption credits are well above the dispersion exhibited by microcredit and real estate. Analogously, the standard deviation of microcredit and real estate is lower than the standard deviation of consumption and commercial credit.

Figure 2. Loan Return for each Category of Loan



Although there is a notable variation in the earned returns, Figure 1 illustrates how the shares of such loans exhibit almost no variability. The majority of credit is always allocated on commercial loans, followed by a significant allocation on consumption loans. As shown in table 2, allocations on real estate and microcredit are much less significant, with a maximum of 9.11% and 2.5%

respectively allocated to such loans. This implies a lack of dynamism and a reduced reconfiguration of the portfolio selection with respect to the returns achieved by the assets. An estimation and analysis of the effects of such lack of dynamism may be achieved by calculating the *excessive risk* and *suboptimality* of the aggregate portfolio of Colombian commercial banks.

Table 3. Summary Statistics of Returns Earned for each Category of Loan

	Micro	Commercial	Consumption	Real Estate
Min	21%	11%	14%	12%
Max	26%	21%	22%	15%
Mean	24%	16%	19%	13%
Median	24%	15%	19%	13%
Std.	1%	4%	3%	1%

IV. Results

Table 4 contains all the results derived from the exercise performed at a monthly basis between December 2007 and May 2011. The analysis and interpretations of these results are contained in the following subsections.

Table 4. Results

Year	Month	Return	Observed Risk	Observed Risk (Base Dec 2007)	Non Performing Loans Ratio	Optimal Risk	Excess Risk	Excess Risk (as a share of Obs. Risk)
2007	Dec	0.206	0.034	100%	0.032	0.013	0.021	63
2008	Jan	0.207	0.035	103%	0.034	0.019	0.015	44
2008	Feb	0.208	0.033	99%	0.035	0.022	0.011	34
2008	Mar	0.206	0.033	99%	0.037	0.022	0.011	34
2008	Apr	0.212	0.033	100%	0.038	0.022	0.011	34
2008	May	0.208	0.033	99%	0.039	0.020	0.013	39
2008	Jun	0.206	0.034	102%	0.037	0.021	0.014	40
2008	Jul	0.207	0.034	101%	0.037	0.020	0.014	40
2008	Aug	0.208	0.034	103%	0.039	0.021	0.013	38
2008	Sept	0.207	0.032	96%	0.039	0.020	0.013	39
2008	Oct	0.199	0.032	95%	0.038	0.017	0.015	46
2008	Nov	0.209	0.033	99%	0.041	0.017	0.016	48

(*Continued*)

Table 4. Results

Year	Month	Return	Observed Risk	Observed Risk (Base Dec 2007)	Non Performing Loans Ratio	Optimal Risk	Excess Risk	Excess Risk (as a share of Obs. Risk)
2008	Dec	0.204	0.031	93%	0.038	0.024	0.007	22
2009	Jan	0.204	0.026	77%	0.041	0.017	0.009	33
2009	Feb	0.196	0.029	88%	0.042	0.016	0.014	47
2009	Mar	0.197	0.031	92%	0.043	0.014	0.017	55
2009	Apr	0.184	0.035	103%	0.044	0.012	0.023	65
2009	May	0.172	0.032	97%	0.044	0.011	0.021	66
2009	Jun	0.169	0.035	105%	0.043	0.012	0.023	66
2009	Jul	0.158	0.033	98%	0.043	0.010	0.023	70
2009	Aug	0.158	0.032	96%	0.045	0.009	0.023	71
2009	Sept	0.152	0.032	95%	0.043	0.009	0.023	71
2009	Oct	0.149	0.032	96%	0.043	0.008	0.024	74
2009	Nov	0.151	0.035	105%	0.043	0.008	0.027	78
2009	Dec	0.142	0.035	106%	0.039	0.009	0.027	75
2010	Jan	0.145	0.036	107%	0.041	0.008	0.028	78
2010	Feb	0.138	0.032	96%	0.042	0.007	0.025	78
2010	Mar	0.141	0.028	83%	0.043	0.007	0.021	76
2010	Apr	0.138	0.028	85%	0.042	0.006	0.022	79
2010	May	0.136	0.030	88%	0.040	0.008	0.022	74
2010	Jun	0.128	0.026	78%	0.037	0.006	0.020	76
2010	Jul	0.131	0.026	78%	0.037	0.007	0.019	73
2010	Aug	0.128	0.025	73%	0.036	0.007	0.018	72
2010	Sept	0.125	0.026	77%	0.033	0.007	0.019	71
2010	Oct	0.126	0.024	71%	0.032	0.007	0.017	70
2010	Nov	0.126	0.024	72%	0.031	0.007	0.017	71
2010	Dec	0.121	0.027	79%	0.027	0.007	0.019	72
2011	Jan	0.139	0.025	73%	0.029	0.008	0.017	68
2011	Feb	0.141	0.026	77%	0.029	0.009	0.016	64
2011	Mar	0.142	0.029	87%	0.029	0.009	0.020	67
2011	Apr	0.151	0.034	103%	0.029	0.012	0.022	65
2011	May	0.151	0.032	95%	0.027	0.013	0.019	58

A. Returns

Consistent with the tendencies exhibited in Figure 2, the aggregate return of the banking industry is characterized by its declining tendency between December 2007 and May 2011. This follows from the fact that the returns for commercial and consumption loans declined steadily. This, combined with the fact that those two categories of loans represent the majority of the aggregate portfolio, implies that the earned returns fell significantly from its 2007 levels of nearly 21% to a 15% level in May 2011, as illustrated by figure 3.

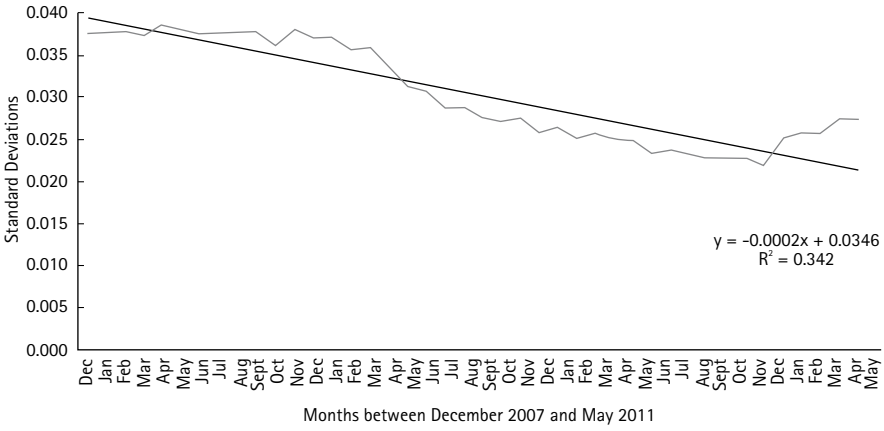
Figure 3. Return Earned by Colombia's Banking Industry

B. Risk-taking

The calculation of equation (6) yields the observed risk taking for Colombia's banking industry for each of the months of the period under scrutiny. The results are in terms of standard deviations, which represent the volatility to which the aggregate return of the industry is exposed. In other words, such number is a statistical measurement denoting how far off could the return lie from the mean return of the banking industry. If two portfolios have equal expected return, but one of these has a greater standard deviation than the other, then it holds that such return could have been potentially lower or higher, implying a greater risk of such bank's assets. An increase (decrease) in the standard deviation thus implies an augment (decline) of the risk embraced

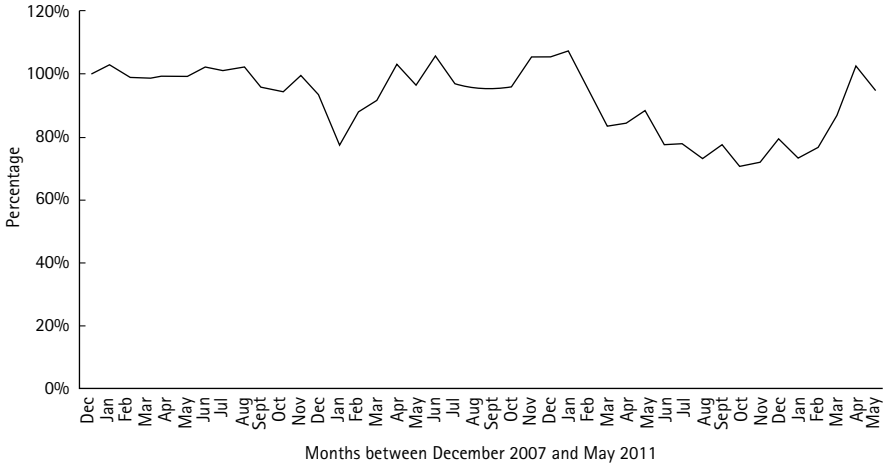
by the industry. Figure 4 exhibits the risk-taking trend for the banking industry in Colombia. Such figure shows that, in spite of the sharp increase in the last months, the risk-taking is characterized by a downward trend, which implies that banks reduced the risk embraced by them in the analyzed period. One can corroborate this by observing the percent-change of risk-taking. Figure 5 shows that, with respect to the first month under scrutiny, the observed risk-taking is always smaller than that of the initial month, exhibiting a decline of nearly 30% in some of the months (such as October 2010). Again, in spite of the sharp increase in the last months, risk-taking rarely rises to its original level of December 2007, which is a clear indication of the declining trend of risk-taking in the period under scrutiny. It is important to note, however, that this general trend cannot be extrapolated to the near future, for the risk-increase observed in the last months may imply a reversal in the tendency.

Figure 4. Equation 6. Risk Taking (In Standard Deviations)



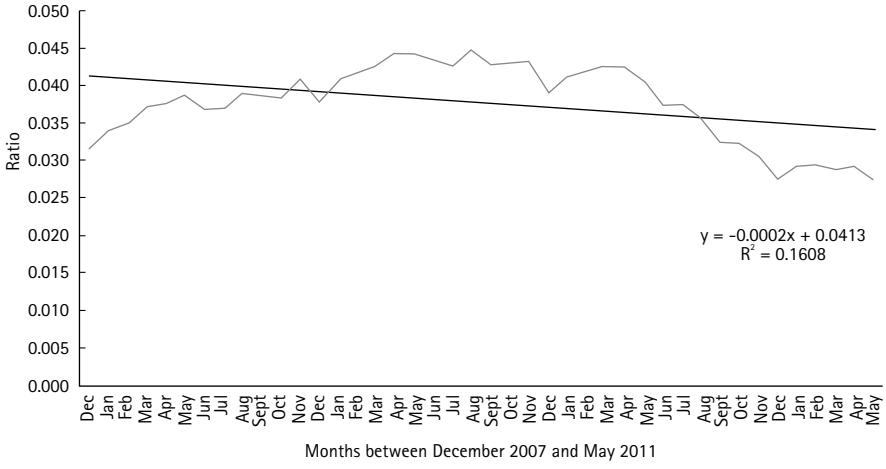
An important exercise is to compare the measure of risk-taking performed in this document with other possible measures for the banking industry as a whole. Table 4 contains the monthly non-performing-loans ratio for the banking industry, and Figure 6 depicts the tendency of such alternative measure of risk. Although the general declining tendency holds —and although the fitted values exhibit an equal decline in risk per period of month— it is clear that there is not a perfect relationship between these two measures of risk. This can be easily identified by noting that in the last months the portfolio-measure of risk yields an increase in risk, while the non-performing loans ratio

Figure 5. Equation 6. Risk Taking (As a Percentage of Risk-Taking in December 2007)



yields a risk-decline. Furthermore, an observed correlation of 0.40 between the two measures of risk implies that, although they tend to move in equal directions, the two measures of risk may result in contradictory results for some particular months.

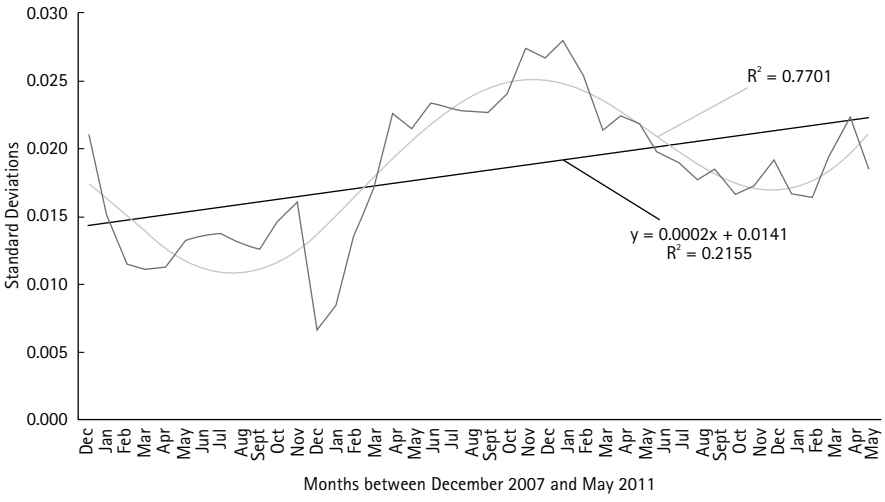
Figure 6. Non Performing Loans Ratio



C. Excessive Risk Taking

The data of excessive risk-taking comes from the calculation of equation (8) at a monthly basis. This implies that, as with risk, the measure of excess risk is given in standard deviations. An excess risk of *x* implies that the industry incurred in *x* additional standard deviations than what it needed in order to obtain the observed return. In other words, the industry could have exhibited *x* less levels of volatility in order to obtain the same return *r* in period *t*, if it had allocated its portfolio in an optimal manner. Figure 7 depicts the observed tendency for the excess-risk measured in standard deviations. The general conclusion is that there is a clear upward trend, implying that Colombian banking industry increasingly embraced unnecessary risk between December of 2007 and May of 2011. However, it could be the case that the excess-risk exhibits some degree of seasonality (Figure 8 depicts a polynomial tendency of sixth degree with an R^2 of 0.77). Alas, the limited dataset impedes a deeper scrutiny into such matter, for a more extended dataset would be needed in order to assess if such series is an ARMA, and –should it be- of its order.

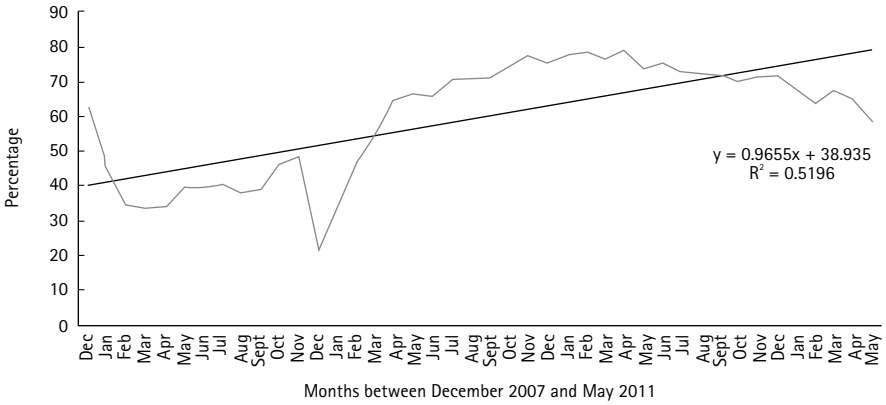
Figure 7. Equation 8. Excessive Risk-Taking in Standard Deviations



An alternative reading of this result sheds light to other important features contained in the measure of excess-risk. Figure 8 illustrates how much of the total risk-taking does the excess-risk represent. If the excess risk corresponds

to *y*% of the observed risk, then it is the case that the banking industry -in optimality- could have attained the same return by reducing its risk-exposure by *y*%. This alternative reading of the data thus leads to a result regarding the level of suboptimality. Figure 8 shows an increasing tendency of suboptimality regarding risk-taking decisions. Although this measure also exhibits some form of seasonality, the fact that a linear fit yields an increase of 0.97% per month with an R^2 of 0.52 implies that in the period under scrutiny the banking industry experienced a rise in the risk suboptimality. This increase could be related with the financial stability of the banking industry, for an increasing margin of suboptimality implies ineffectiveness regarding the banks' financial allocations and decisions.

Figure 8. Equation 8. Excessive Risk Taking (As a Percentage of Observed Risk Taking)



The results depicted in Figures 7 and 8 are consistent with the findings of other authors such as Morales (2011), who constructs and index of financial instability for Colombian banking industry by using different financial indicators, and finds that such index increases in the period 2007-2009. The percentage increase of suboptimality responds to the fact that, although observed risk exhibits a downward trend, the ´optimal risk´ (i.e., the minimum risk required to attain the observed level of return) exhibits a faster decline. As mentioned earlier, this may derive from the fact that the shares of each category of loan remain somehow static through time, while the average return for some of these categories do vary widely. Accordingly, the lack of adjustments in the

portfolio to assess this changing scenario may lead to an increasing suboptimality.

The analyses performed in this and the previous subsection point to a crucial result: a reduction in the observed risk-taking may have no real effect on the stability and optimality of the banking industry. It may very well be the case that a decrease in risk occurs while there is an increase in excessive risk and in its share relative to the observed risk. This result thus contradicts the general intuition portrayed in the analysis of some authors who implicitly assume a direct relation between risk-taking and financial instability; a banking system may be reducing the level of risk it takes while augmenting its instability by exhibiting an increased deviation from portfolio optimality.

D. Yearly December Results

Although an extended set of results covering several years would be desirable, the results of this document are limited by the available dataset in the Superfinanciera. However, as mentioned previously, the data available at Superfinanciera contains the needed information for each December between 2002 and 2010. Although this is not the same as an extended dataset, it allows for comparable yearly results. The general results are contained in Table 5.

Table 5. Results for each December between 2002 and 2010

Year	Return	Observed Risk	Observed Risk (Base Dec 2002)	Optimal Risk	Excess-Risk	Excess-Risk (as a Share of Obs. Risk)
2002	0.181	0.040	100%	0.016	0.024	60
2003	0.182	0.041	103%	0.016	0.025	61
2004	0.191	0.044	110%	0.011	0.034	76
2005	0.175	0.036	90%	0.007	0.029	80
2006	0.157	0.024	61%	0.006	0.019	77
2007	0.206	0.034	84%	0.013	0.021	63
2008	0.204	0.031	78%	0.024	0.007	22
2009	0.142	0.035	88%	0.009	0.027	75
2010	0.121	0.027	66%	0.007	0.019	72

Figure 9 shows that the banking industry exhibits a downward trend in risk taking from 2002 to 2010, with the important exception of the years of inter-

national financial turmoil (2007-2009) which correspond to an upsurge of risk-taking. Figure 10 shows that the level of excess-risk (measured in standard deviations) experiences a decline, with the sole exception of 2009. Although the excess risk –i.e., the additional amount of risk that was taken due to assets allocations- declines, its share with respect to the observed risk tend to hold near 65% through time, with the important exception of 2008.

Figure 9. Risk Taking (in Standard Deviations) of Each December Between 2002 and 2010

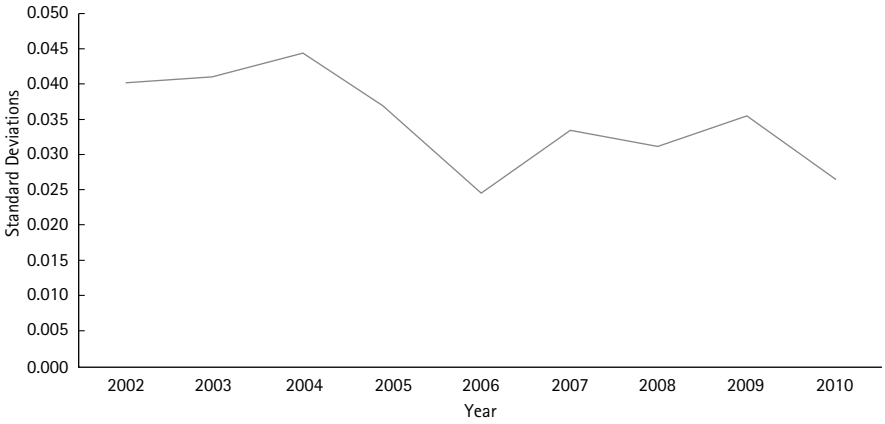
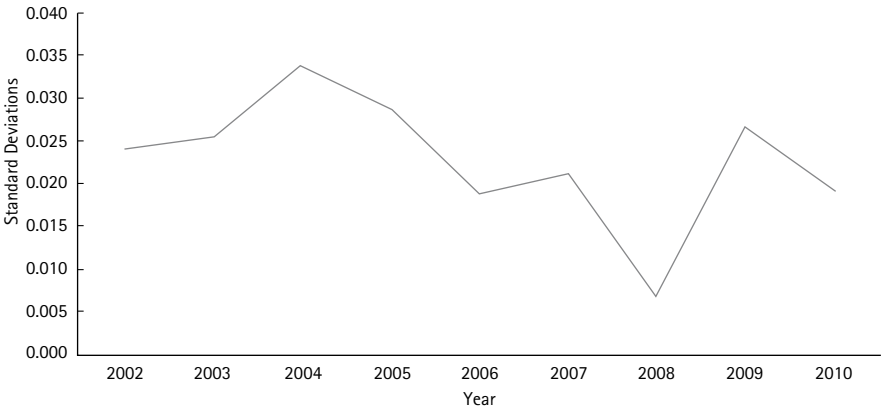


Figure 10. Excessive Risk Taking (in Standard Deviations) of each December between 2002 and 2010



V. Understanding Risk-Taking and its Relationship with Excess-Risk

Explanations of the reasons behind the degree of risk embraced by commercial banks have been made from different perspectives. Among the factors cited as the elements that mainly drive the risk-taking attitude in such industry one finds monetary policy, leverage, corporate governance and regulation, the degree of competition in the industry, and prospect theory. The following subsections explore the mechanisms through which these variables may affect risk-taking, and analyze the tendencies followed by such variables in Colombian financial system between December of 2007 and May of 2011.

A. Monetary Policy

There is a general consensus that a monetary easing is related to an increase in banks' risk taking (Nicoló, Dell'ariccia, Laeven and Valencia, 2010). Particularly, the nowadays popular thesis that blames monetary policy for the recent financial crisis implicitly assumes that this relationship is true. This, given that it is grounded on the idea that the extended period of low interest rates gave an incentive to financial institutions to embrace more risk, in detriment of financial (and economical) sustainability (Nicoló et al. 2010). The most commonly cited mechanisms through which monetary policy affects risk-taking is captured by the *yield-search* theory. Following Rajan (2005), whenever there is a prolonged period of low interest rates, banks are unable to meet their long term obligations by possessing safe assets. This, in turn, implies that banks are compelled to *search for a higher yield* by acquiring riskier assets, which in turn leads to a higher aggregate level of risk-taking in banking industry. Another commonly cited mechanism through which monetary policy is related to bank risk-taking is referred to as "The Greenspan (or Bernanke) put". According to the proponents of such increasingly popular mechanism, a low policy rate would generate the perverse expectations that central banks will always strongly react -by easing monetary policy- to adverse economic prospects (Nicoló et al., 2010). This, in turn, would incentivize a higher degree of risk-taking from banking industry.

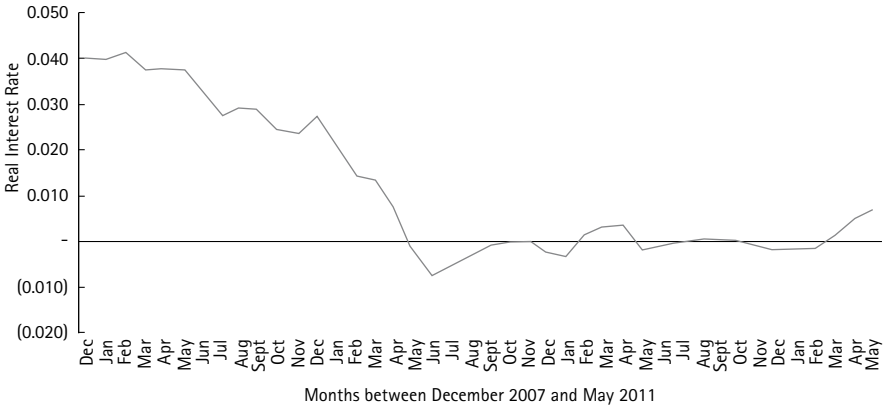
There is ample theoretical and empirical research supporting an inverse relationship between monetary policy and risk-taking. Investigating Bolivian banking system, Ioannidou, Ongena and Peydro (2009) demonstrate that

lower short-term rates –prime instrument of monetary authorities- imply an increase of credit to borrowers of lower quality. Analogously, Jiménez et al. (2008) arrive at a similar conclusion by examining Spanish banking system. Dell'Ariccia, Laeven and Marquez (2010) use data from the U.S. terms of Business Lending Survey to show a negative relation between short rates and the augmentation of risky loans.

The pointed evidence contradicts the relationship between monetary policy and risk-taking that could arise via *adverse selection* and *moral hazard*. These mechanisms suggest that an increase of short term rates would lead to an increase of commercial bank's risk-taking, given the upsurge of credit risk. This theoretical mechanism ignores the fact that commercial banks incur in credit rationing and in a tightening of lending standards when exposed to adverse selection and moral hazard. Banks thus avoid an increase of risk-taking derived from a potential augment of credit risk by limiting the credits granted, and by ensuring a higher quality of borrowers.

Colombian monetary policy between December of 2007 and May of 2011 was a period of strong response from the monetary authorities towards the international financial crisis. Particularly, a period of sustained decline in the nominal rates, combined with a lagged decline in inflation levels resulted in a sharp decrease of real interest rates. Figure 11 shows the trend followed by Colombian real interest rates in such period. It is notable how the rate follows

Figure 11. Colombian Monetary Policy (Central Bank´s Real Interest Rates)



a dramatic decline during 2008, reaching its minimum level in June 2009 and stabilizing around the zero-level thereafter. Such tendency, according to the evidence about financial stability from other parts of the world, would imply an increase in the levels of risk and excess risk. If such relationship were to hold for Colombian case, then the short and medium term monetary stimuli to the economy would have come at the price of increasing financial instability.

B. Leverage

Leverage may present a dual effect on banks' risk-taking, depending on the interaction of this and other variables. The commonly cited effect of leverage is known as *risk-shifting*. According to Bustamante and Favilukis (2010), when a bank's leverage ratio increases it has greater incentives to conform a riskier portfolio given its limited liability. In such scenarios the bank's payoff resembles that of a call-option, which increases in value whenever the outcomes are more volatile. Given the mentioned incentive, this implies a positive relationship between leverage and bank risk-taking via a riskier composition of a bank's assets. Considering leverage in the context of an eased monetary policy, however, sheds the converse result. Following Dell'Ariccia et al. (2010) and Nicoló et al (2010), a poorly capitalized (highly levered) bank experiences a decrease in the cost of its liabilities whenever an economy's short term rates decrease[4]. This implies that, everything else equal, the bank's profits will increase, generating an incentive to reduce the risk embedded in its portfolio.

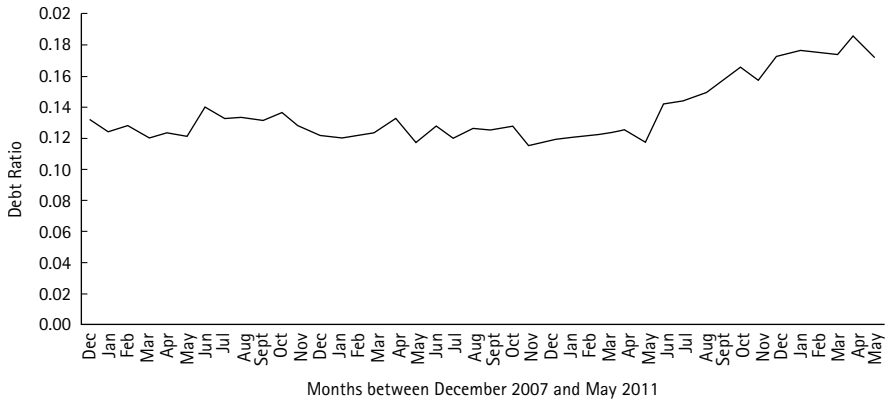
The debt ratio –that is, the total value of the banking system's debt relative to the total value of the system's assets- serves as an accurate measure of the amount of leverage embraced by an industry. Figure 12 illustrates the leverage-dynamic followed by Colombian banking industry according to such ratio.

Such figure denotes a trend of slight increase in the observed leverage between December of 2007 and May 2011. The impact of such dynamic is not clear; according to the cited discussion this tendency could imply either an increase or a decrease in financial instability.

---

4 This could also be seen as a determinant of a potential positive relation between bank risk-taking and an eased monetary policy, which would imply an opposing force to the mechanisms cited above.

Figure 12. Leverage. Debt Ratio Exhibited by Colombian Banking Industry



C. Market Concentration

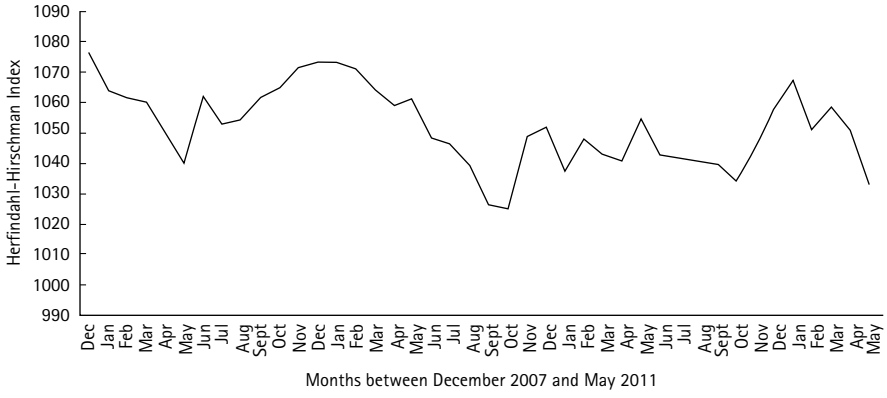
As with leverage, there is no univocal relationship between competition and the degree of risk taking in banking industry. Following Keeley (1990), a high degree of competition in the industry is associated to higher levels of risk-taking given the erosion of the bank's franchise value -that is, the value of the bank above and beyond its tangible assets-. Given this erosion, banks have an incentive to take on more risk in its assets in order to attain a higher level of return, thus maintaining its profitability levels. An opposing theory, however, argues that an increase of competition could lead to a decreasing degree of risk-taking whenever there are informational asymmetries at work. This, given that –everything else equal- an industry with concentrated market power can lead to higher rates charged to borrowers, which could derive in an augmentation of credit risk via *moral hazard* and *adverse selection* (Boyd and Nicoló, 2005). However, the same argument used against a positive relationship between monetary policy and risk-taking could serve against this mechanism; there is no evident reason for why banks in a less competitive industry with informational asymmetries would not incur in credit rationing and in a tightening of lending standards in order to avoid taking on more risk for the higher rates that it charges.

Although the argument for an inverse relationship between market concentration and risk-taking sounds less compelling than the argument supporting a

positive relationship, there is empirical evidence supporting both views. Using a dataset of Spanish banking system and after controlling for several macroeconomic conditions and bank characteristics, Jiménez and López (2007) find that there is evidence of a negative relationship between market concentration and bank risk. On the contrary Boyd, Nicoló and Jalal (2006) examine a panel of 2700 banks from 134 countries and a cross section of small banks operating on only one market within the U.S to conclude, using several measures of risk-taking, that there is a positive relationship between market concentration and bank risk-taking. Martínez-Miera and Repullo (2008) integrate both frameworks by asserting that there is a nonlinear relation between competition and bank risk-taking, which allows competition to increase risk-taking in some domains and to decrease it in others. Both mechanisms seem thusly to be working, and the observed correlation of market power and risk taking depends on the specification of the model and the used dataset.

The level of concentration of Colombian banking industry can be captured by the Herfindahl-Hirscham index. Figure 13 shows that such concentration follows no clear trend in the period under scrutiny, but rather a slight seasonality. In spite of its fluctuating nature, the fact that the index remains above 1000 and below 1800 throughout the analyzed period implies that Colombian banking system was moderately concentrated between 2007 and 2011 (Morales, 2011).

Figure 13. Market Concentration. The Herfindahl-Hirscham Index for Colombian Banking Industry



D. Other Mechanisms: Corporate Governance and Prospect Theory

It is worth mentioning that there are two other known mechanisms that may explain the level of risk-taking and, potentially, the level of excess-risk and forewent return: Corporate governance and prospect theory. Laeven and Levine (2008) analyze the impact that corporate governance may have on bank risk-taking. Examining a database constituted of 300 banks from 48 different countries, the authors analyze the impact that ownership structure, cash-flow, capital requirements and supervisory oversight of banks have on the degree of risk-taking. They arrive at the conclusion that the confluence of large ownership and significant free cash-flow leads to an increase in risk-taking, whereas capital requirements and the existence of supervisory oversight seem to have an insignificant effect. This finding is consistent with the *free cash-flow* problem pointed by the corporate finance literature, where excess cash can lead to suboptimal financial decision-making (Shefrin, 2007).

Few attempts have been made to explain the degree of bank risk-taking from a behavioral approach. Studying a sample of 894 commercial banks in the emerging economies for the period 1996-2001, Godlewski (2004) intends to scrutinize such relationship. Following the above explained Khaneman and Tversky's framework, the author examines the effect that *point-referencing* –that is, the risk attitude adopted by the bank depending on whether it considers itself on the psychological domains of losses or the domain of gains- has on the degree of risk-taking in banks. Godlewski establishes several measures that could serve as benchmarks upon which the banks' managements base their risk-taking decisions. Observing past return-on-equity (ROE), return-on-assets (ROA), and equity-to-total-assets rates –among others- as benchmarks, the author finds evidence that banks embrace more risk when below past-performance of the mentioned benchmarks. This way, if a bank's ROE is below prior measurements of ROE, such bank is more likely to embrace more risk than it did before. Such evidence is hard to reconcile with the traditional neoclassical approach to risk-taking attitudes, and points to the importance of further research examining the impact of behavioral aspects on a bank's risk-taking. The methodology presented thus far bears an important limitation in this aspect. The fact that it assumes a risk-averse attitude for the industry implies that the possible behavioral explanations pointed by Godlewski cannot be tested.

E. Understanding Risk and Excess-Risk

A first step towards understanding the relationship between the variables constructed hereby would be to assess the manner in which classical variables influence risk, excess-risk, and return. The idea would be to perform a *cointegration test* to determine whether the series are stationary or not, and to modify them accordingly in order to attain such stationarity. Such methodology, unfortunately, is unattainable in this document due to the few observations available in the used dataset. In spite of such limitation, Table 6 contains the results of the following regression:

$$x_t = \alpha + \beta MP_t + \zeta MC_t + \theta L_t + \gamma U_t + t + \varepsilon_t \tag{9}$$

Where X_t is the variable of interest in period t –i.e. risk, return, excessive risk, and excessive risk as a share of observed risk-, MP_tcorresponds to the real interest rate of the Central Bank, MC_t is the Herfindahl-Hirschman index of market concentration, L_t is the debt-to-total-assets ratio, U_t is the unemployment rate in period t, and t is a time-variable. As mentioned in prior subsections, MP_t MC_t and L_t are pointed in the literature as determinants of risk-taking. On the other hand U_t serves as a proxy variable for the pace of the economic activity (which may affect the variables), and t is included as a variable that captures the tendency and that partially solves the problem derived from the fact that a cointegration test is not attainable for the analyzed dataset. If the regression were to yield a positive value of β, the evidence would suggest a relationship between monetary stimulus and financial instability in Colombia. The value of ζ would point to the mechanism that is more likely to act in the Colombian case between that proposed by Keely (1990) and that proposed by Boyd and Nicoló (2005). Finally, the θ parameter would also point to whether leverage increases financial instability as proposed by Bustamante and Favilukis (2010), or if instead it leads to an increase in stability as proposed by Dell'Ariccia et al. (2010) and Nicoló et al. (2010).

The results of the regressions are exhibited in Table 6. Such table shows that the time-tendencies followed by return and risk between December 2007 and May 2011 are significant. As expected, the rate of return has a strong positive relation with both the degree of market concentration and the central bank's real interest rate. When measured either as standard deviations or as a share of the observed risk, excess risk exhibits a strong negative relation

Table 6. Equation 9. Regressions' Results

Variables	(1) Return	(2) Risk	(3) Excess Risk (In Std)	(4) Excess Risk (As a Share)
Real Interest Rate	0.461*	-0.0704	-0.285***	-731.7***
	(0.268)	(0.0755)	(0.0849)	(208.4)
Debt Ratio	0.230	0,00091	-0.0426	-107.9
	(0.169)	(0.0478)	(0.0537)	(132.0)
Herfindahl-Hirschman Index	0.00038**	0.00	0.00	-0.169
	(0.000157)	(4.42e-05)	(4.97e-05)	(0.122)
t	-0.00199***	-0.000271**	-9.52e-05	0.221
	(0.00047)	(0.00013)	(0.00015)	(0.362)
u	0.156	-0.0111	-0.0313	-112.3
	(0.176)	(0.0496)	(0.0557)	(136.9)
Constant	-0.248	0.0822*	0.102*	269.0**
	(0.161)	(0.0455)	(0.0512)	(125.6)
Observations	42	42	42	42
R-squared	0.905	0.397	0.613	0.772

Standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

with monetary policy as well. This implies that the monetary ease experienced between 2008 and 2011 in Colombia could have derived in an augmentation of financial instability. Although not significant, both measures of excess risk show a negative relation with the amount of leverage in the industry, suggesting that the inverse mechanism between financial stability and leverage proposed by Dell'Ariccia et al. (2010) and Nicoló et al. (2010) could hold in the Colombian case. In spite of the fact that these regressions corroborate to some extent the expected mechanisms, it is important to stress their limitations: they show no causality –merely a relationship between the variables- and they are subject to the stationarity problem, along with some omitted variable-problems. The fact that some of the explicative variables show no level of significance could come from problems associated with the econometric specification, along with the fact that there is a limited dataset that impedes further econometric refinement.

VI. Concluding Remarks

Using a database provided by Superfinanciera and a methodology developed by Podpiera and Weill (2010), the document calculates risk-taking and excessive risk-taking for Colombia's commercial banks. Based on the portfolio theory developed by Markowitz (1952) and on a dataset available for each month between December 2007 and May 2011, this methodology yields an aggregate coefficient in standard deviations for both concepts. Although the measure of excess-risk allows for an interpretation of the suboptimality of the banking system, such calculation rests upon a risk-averseness assumption. The general results are: (i) risk and return have shown a general declining tendency (ii) excess-risk (measured in standard deviations) fluctuates over time, and that it follows an increasing tendency, and (iii) excess-risk denotes an increasing suboptimality of the banking industry when interpreted as a share of the observed risk. These findings are consistent with (i) a study performed by *Standard & Poor's* and cited in *Portafolio* ("Indicadores de Solidez Mejoran en Bancos del País", published the 27th of September, 2011), a Colombian financial Newspaper, which asserts that risk in Colombian commercial banks has declined in the near past, and (ii) the results of Morales (2011), who finds an increasing instability in Colombian banking system in the same period of time. Hence, a decrease in risk-taking does not necessarily coincide with an improvement in the financial stability of the banking system.

It is the goal of future research to construct an extended dataset that enables econometric refinement, and that allows a deeper scrutiny of the relationship between the variables hereby constructed and other variables. Furthermore, it is important to reproduce the calculations of *risk* and *excessive-risk taking* performed in this document for other financial economies, in order to enable a cross-country study. Such studies would allow for a deeper understanding of the concept of risk-taking and excessive-risk taking, along with their relationship.

References

1. ABIAT, A., BALAKRISHNAN, R., BROOKS, P. K., LEIGH, D. y TYTELL, I. (2009). What's the damage? Medium-term output dynamics after banking crises (Working Paper 09/245). IMF.

2. ACKERT, L. F. y DEAVES, R. (2009). *Behavioral finance: Psychology, decision-making, and markets*. South-Western Cengage Learning, Mason.

3. AGUR, I. y DEMERTZIS, M. (2010). Monetary policy and excessive bank risk taking (Working Paper 271). Ducth Central Bank.

4. ALTMAN, E. I. (2002). *Revisiting credit scoring models in a basel II Environment*. Prepared for "Credit Rating: Methodologies, Rationale, and Default Risk". Londres, Risk Books.

5. BOYD, J. H. y DE NICOLÓ, G. (2005). "The theory of bank risk taking and competition revisited", *Journal of Finance*, 60:1329-1343.

6. BOYD, J. H., DE NICOLÓ, G. y AL JALAL, A. (2006). Bank risk taking and competition revisited: New theory and new evidence (Working Paper 06/297). IMF.

7. BUSTAMANTE, M. C. y FAVILUKIS, J. (2010). *Advanced corporate finance*. Londres, London School of Economics and Political Science.

8. DELL'ARICCIA, G., LAEVEN, L. y MARQUEZ, R. (2010). Monetary policy, leverage, and bank risk taking (Working Paper 10/276). IMF.

9. DELL'ARICCIA, G., DENIZ, I. y LAEVEN, L. (2008). Credit booms and lending standards: Evidence from the subprime mortgage market (Working Paper 08/106). IMF.

10. DEMIRGÜÇ-KUNT, A., DETRAGIACHE, E. y GUPTA, P. (2006). "Inside the crisis: An empirical analysis of banking system in distress", *Journal of International Money and Finance*, 25:702-718.

11. DIAMOND, D. W. y DYBVIG, P. H. (1983). "Bank runs, deposit insurance, and liquidity", *Journal of Political Economy*, 91(3):401-419.

12. GODLEWSKI, C. (2004). *Bank risk-taking in a prospect theory framework: Empirical investigation in the emerging markets' case*. Strasbourg, Université Robert Schuman -Institut d'Etudes Politiques.

13. IOANNIDU, V., ONGENA, S. y PEYDRO, J. L. (2009). Monetary policy, risk-taking and pricing: Evidence from a quasi-natural experiment (Working Paper 2009-31). Tilburg University-Center for Economic Research.

14. JIMÉNEZ, G. y LÓPEZ, J. A. (2007). Does competition impact bank risk-taking? (Working Paper 2007-23). Federal Reserve of San Francisco.

15. JIMÉNEZ, G., ONGENA, S. y PEYDRO-ALCALDE, J. L. y SAURINA, J. (2009). Hazardous times for monetary policy: What do twenty-three million bank loans say about the effects of monetary policy on credit risk-taking? (Documento de Trabajo 0833). Banco de España.

16. KAHNEMAN, D. y TVERSKY, A. (1979). "Prospect theory: An analysis of decision under risk", *Econometrica*, 47(2):263-291.

17. KEELEY, M. C. (1990). "Deposit insurance, risk and market power in banking", *American Economic Review*, 80:1183-1200.

18. LAEVEN, L. y LEVINE, R. (2008). Bank governance, regulation and bank risk-taking (Working Paper 14113). National Bureu of Economic Research.

19. MARKOWITZ, H. (1952). "Portfolio selection", *Journal of Finance*, 7(1): 77-91.

20. MARTÍNEZ-MIERA, D. y REPULLO R. (2008). Does competition reduce the risk of bank failure? (Working Paper 0801). Cemfi.

21. MORALES, M. Á. (2011). Concentración y estabilidad financiera: el caso del sistema bancario colombiano (Documento CEDE 2011-43). Universidad de los Andes.

22. NEUMANN, J. V. y MORGENSTERN, O. (1947). *Theory of games and economic behavior.* Princeton, Nueva Jersey, Princeton University Press.

23. NICOLÓ, G., DELL'ARICCIA, G., LAEVEN, L. y VALENCIA, F. (2010). Monetary policy and bank risk taking (Note 09/10). IMF Staff Position.

24. PODPIERA, J. y WEILL, L. (2010). "Measuring excessive risk taking in banking", *Czech Journal of Economics and Finance*, 60(4):294-306.

25. RAJAN, R. (2005). Has financial development made the world riskier? (Working Paper 11728). NBER.

26. SHEFRIN, H. (2007). *Behavioral corporate finance: Decisions that create value*. Nueva York, McGraw-Hill Irwin.

27. STIGLITZ, J. y WEISS, A. (1981). "Credit rationing with imperfect information", *American Economic Review*, 71:393-410.