Indicadores de Alerta Precoce para a América Latina

Fernando Tenjo
Martha López*

* Os autores trabalham, respectivamente: Como Co-diretor da Junta Diretiva do Banco da República da Colômbia e no Departamento de Modelos Macroeconômicos do Banco da República da Colômbia. Agradecemos a Hernando Vargas e Andrés González pelos comentários a versões anteriores. Agradecemos também a Norberto Rodríguez pelo apoio estatístico. As opiniões manifestadas neste documento são responsabilidade exclusiva dos autores e não comprometem o Banco da República da Colômbia nem sua Junta Diretiva.

Correio electrônico: ftenjoga@banrep.gov.co ; mlopezpi@banrep.gov.co

Documento recebido no dia Maio 20, 2010; versão final aceita no dia Septembro 22, 2010.

Exploramos o desempenho de um conjunto de indicadores de alerta precoce para um grupo de economias da América Latina desde a perspectiva do ciclo endógeno. Para este grupo de países, o artigo confirma os resultados obtidos em trabalhos anteriores sobre países industrializados, os quais indicam que uma combinação dos preços dos ativos e do crédito proporciona informação valiosa sobre as prováveis crises financeiras futuras. No entanto, fazemos uma análise mais detalhada das economias emergentes e encontramos que uma combinação dos fluxos de capitais provenientes do exterior e do crédito é um indicador de resultados futuros, superior inclusive para este tipo de eventos.

Classificação JEL: E30, E52, F30, F41.

Palavras chave: estabilidade/instabilidade financeira, indicadores de alerta precoce, acelerador financeiro.

Indicadores de Alerta Temprana para América Latina

Fernando Tenjo
Martha López*

Exploramos el desempeño de un conjunto de indicadores de alerta temprana para un grupo de economías de América Latina desde la perspectiva del ciclo endógeno. Para este grupo de países, el artículo confirma los resultados obtenidos en trabajos anteriores sobre países industrializados, los cuales indican que una combinación de precios de los activos y crédito proporciona información valiosa acerca de probables crisis financieras futuras. Sin embargo, hacemos un análisis más detallado de las economías emergentes y encontramos que una combinación de flujos de capitales provenientes del exterior y crédito es un indicador de resultados futuros incluso superior para este tipo de eventos.

Clasificación JEL: E30, E52, F30, F41.

Palabras clave: (in)estabilidad financiera, indicadores de alerta temprana, acelerador financiero.

*Los autores trabajan, respectivamente: como Codirector de la Junta Directiva del Banco de la República de Colombia y en el Departamento de Modelos Macroeconómicos del Banco de la República de Colombia.

Agradecemos a Hernando Vargas y Andrés González por sus comentarios a versiones anteriores. Agradecemos también a Norberto Rodríguez por el apoyo estadístico. Las opiniones expresadas en este documento son responsabilidad exclusiva de los autores y no comprometen al Banco de la República de Colombia ni a su Junta Directiva.
Correos electrónicos: ftenjoga@banrep.gov.co, mlopezpi@banrep.gov.co;
Documento recibido el 20 de mayo de 2010; versión final aceptada el 22 de septiembre de 2010.

Early Warning Indicators for Latin America

Fernando Tenjo
Martha López*

* The authors work, respectively: as Codirector of the Board of Directors of the Banco de la República de Colombia and at the Department of Macroeconomic Models of the Banco de la República de Colombia.

We would like to thank Hernando Vargas and Andres González for comments on earlier drafts. We also thank Norberto Rodriguez for statistical support. The views expressed in this paper are those of the authors and do not necessarily represent those of the Banco de la República de Colombia or its Board of Directors.
E-mails: ftenjoga@banrep.gov.co, mlopezpi@banrep.gov.co;
Document received: 20 May 2010; final version accepted: 22 September 2010.

We explore the performance of a set of early warning indicators for a group of Latin American economies under the endogenous cycle perspective. For this group of countries, the paper confirms the results of previous work on industrialized countries, which indicate that a combination of asset prices and credit provides valuable information of probable future financial crises. However, we go a step further in the analysis of emerging economies and find that a combination of capital flows from abroad and credit is an even superior leading indicator of such events.

JEL Classification: E30, E52, F30, F41.

Keywords: financial (in)stability, early warning indicators, financial accelerator.

I. INTRODUCTION

The recent global crisis brought to the forefront the need to confront the existence of instances of financial instability and episodes of systemic risk. While some renowned economists insist that these events cannot be predicted and that the most sensible attitude on the part of economic authorities is to deal with their consequences (Greenspan, 2010), there is, on the other hand, a long-standing tradition that contends that it is both possible and advisable to set up a framework that enhances the ability of the authorities to predict the occurrence of such episodes (Borio and Drehmann, 2009b). Such framework may very well consist of a battery of early warning indicators, stress tests, and early warning systems, among other things.

The state of the art in this sort of exercises is summarized by Borio and Drehmann (2009a), who underscore the importance of simple early warning indicators as the basis for these operational frameworks. From an endogenous cycle perspective, the authors also stress the importance of equity prices and credit variables as elements that can be reliably used to signal the buildup of financial imbalances that could eventually lead to financial distress.

Drawing from related works, the authors also advance a methodology for selecting the best early warning indicators among various alternatives. Unfortunately, most of these works focus on developed countries, for which there is a substantial amount of available data.

The present work is an attempt to apply this methodology to a group of Latin American countries in order to verify the extent to which equity prices and credit are reliable

early warning indicators of future situations of risk taking and financial imbalances. At the same time, the paper studies how these indicators perform in emerging economies which cycles, while retaining an endogenous nature, are affected by external variables, in particular the flows of capital from abroad. The results in both fronts are positive: equity prices and credit provide valuable information about the buildup of systemic or macroeconomic risk in emerging economies, but credit and capital flows perform better as leading indicators of this process in such economies.

The remainder of the paper is divided into five sections. Section II presents some background for our work. Section III provides a motivation about the relationship between asset prices and financial instability. Section IV presents the rationale underlying the early warning indicators. Section V presents the methodology used to construct the indicators and the results of their performance. Section VI concludes.

II. BACKGROUND AND ANALYTICAL FRAMEWORK

As already mentioned, a good deal of effort has been allocated to developing frameworks or strategies to identify the buildup of financial imbalances that could eventually lead to episodes of financial instability or distress. These efforts have drawn on the results of numerous research exercises that have identified recurrent patterns of key variables in economic cycles and previous to banking or financial crises. To mention just a few of these works, Reinhart and Rogoff (2008), for example, find that "systemic banking crises are typically preceded by asset price bubbles, large capital inflows and credit booms, in rich and poor countries alike." In International Monetary Fund (2009) it is found that "credit, shares of investment in GDP, current account deficits, and asset prices typically rise, providing useful leading indicators of asset price busts." Finally, Claessens *et al.* (2008) conclude that the "analysis of the interactions between macroeconomic and financial variables around various episodes of business and financial cycles suggests that these interactions play key roles in determining the severity and duration of recessions. In particular, recessions associated with credit crunches and house price busts appear to be deeper and last longer than other recessions do." These works are particularly relevant for Latin America, where swings in asset prices, credit, and investment have traditionally been closely related to banking crises and frequently to recessions.

The background for this analysis on leading indicators are López *et al.* (2008) and Tenjo *et al.* (2007), where the relationship between asset prices and economic activity is

tested through evidence of the existence of a financial accelerator mechanism in Colombia. From this point of view, our analytical approach to the modeling of financial instability is closer to what is known in the literature as "endogenous financial cycles." Under this tradition, financial distress is perceived as the result of the buildup in risk taking over time, owing to feedback mechanisms both inside the financial system and between this system and the rest of the economy. In this kind of models, there exists a mutually reinforcing link between credit and asset prices that arises from the use of collateral valued at market prices (Kiyotaky and Moore, 1997; Bernanke *et al.*, 1999).

For the construction of leading indicators our work relies on Borio and Lowe (2002) and Borio and Drehmann (2009a) (2009b). There is a wide variety of approaches to construct this type of indicators that ranges from traditional balance sheet variables to system-wide multi-module measurement models. However, as pointed out by Borio and Drehmann (2009a), *ex-ante* measures of financial instability perform rather poorly, and while potentially promising, macro stress tests may mislead policymakers with a false appearance of security. By contrast, simple leading indicators rooted in the "endogenous cycle" view of financial instability appear better suited to identify risks of financial distress.

Along these lines, Borio and Lowe (2002) found that focusing on the behavior of asset prices and credit is a promising line of enquiry to develop simple and transparent leading indicators of banking system distress. More recently, Borio and Drehmann (2009a) conclude that the combination of "unusually strong" increases in credit and asset prices constitute a simple indicator to assess the buildup of risks of banking distress.

In this paper we investigate the performance of a set of indicators as a tool of macroprudential analysis for a group of Latin American countries. As mentioned above, recent studies regarding early leading indicators have centered their attention on the behavior of two key variables of the endogenous cycle in industrialized economies: asset prices and credit. Nonetheless, it is an amply studied fact that, especially since the financial liberalization of the early 1990s, foreign financial conditions have played an important role in the business cycle of emerging economies. In particular, it is now recognized that capital flows tend to be a component of the endogenous cycles in these economies. It is then important to explore the extent to which these flows may also play a role in the search for leading indicators of financial distress in emerging market economies.

We conduct a preliminary investigation of the usefulness of credit, asset prices, capital flows, and investment as predictors of future imbalances in the financial system of these economies. We are interested in two aspects: first, determining the performance of various indicators using information available to the policymaker at the time that the policy decision is made. And second, verifying how this performance improves when we consider asset prices, credit, investment, and capital flows jointly.

The terminology used in our study closely follows Borio and Drehmann (2009a). Along these lines, a financial crisis is an event in which "substantial losses at financial institutions and/or the failure of these institutions cause, or threaten to cause, serious dislocations to the real economy." Correspondingly, financial instability is defined as a set of conditions that is sufficient to result in the emergence of financial crises in response to normal-sized shocks.

III. ASSET PRICES AND FINANCIAL INSTABILITY IN LATIN AMERICA: STYLIZED FACTS

The quantitative analysis in this paper is based on a data set of five Latin American economies (Argentina, Brazil, Colombia, Mexico, and Peru) with information about asset prices (equity and, in a few cases, housing prices), credit, investment, capital flows, and private investment for the period 1980–2008. All series are deflated by consumer price indices to account for inflation (a detailed description of the data set is presented in Appendix 1).

The evolution of stock prices in the five countries can be divided into three subperiods (Graph 1):

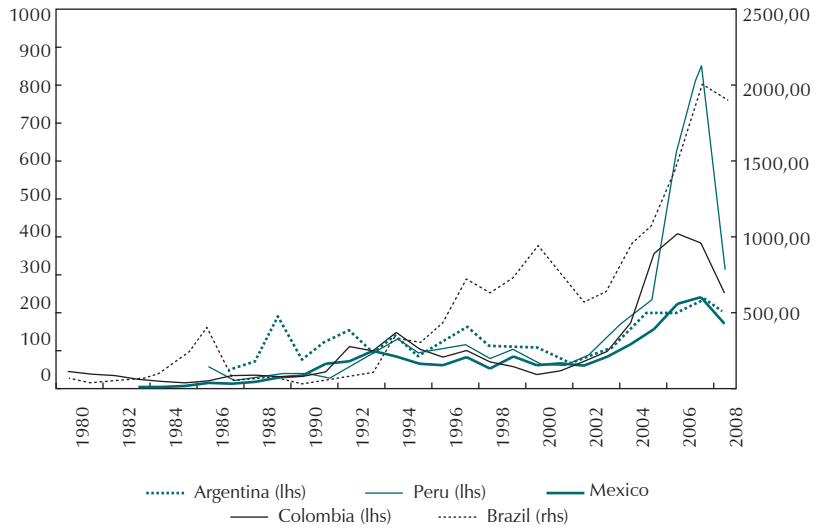
- In the eighties, real equity prices showed no clear trend with some spikes in Brazil and Argentina.

- In the nineties, a synchronized boom and bust episode was evident for all the countries in the sample, except Brazil, where the rising trend continued during the entire decade.

- During the two-thousands, there was a substantial increase in amplitude in asset price movements until 2006 and a reversal afterwards. However, equity prices remained high in all the countries.

It is worth noting that, with time, the cycles appear to be growing in amplitude.

Graph 1
Real Equity Prices 1993=100



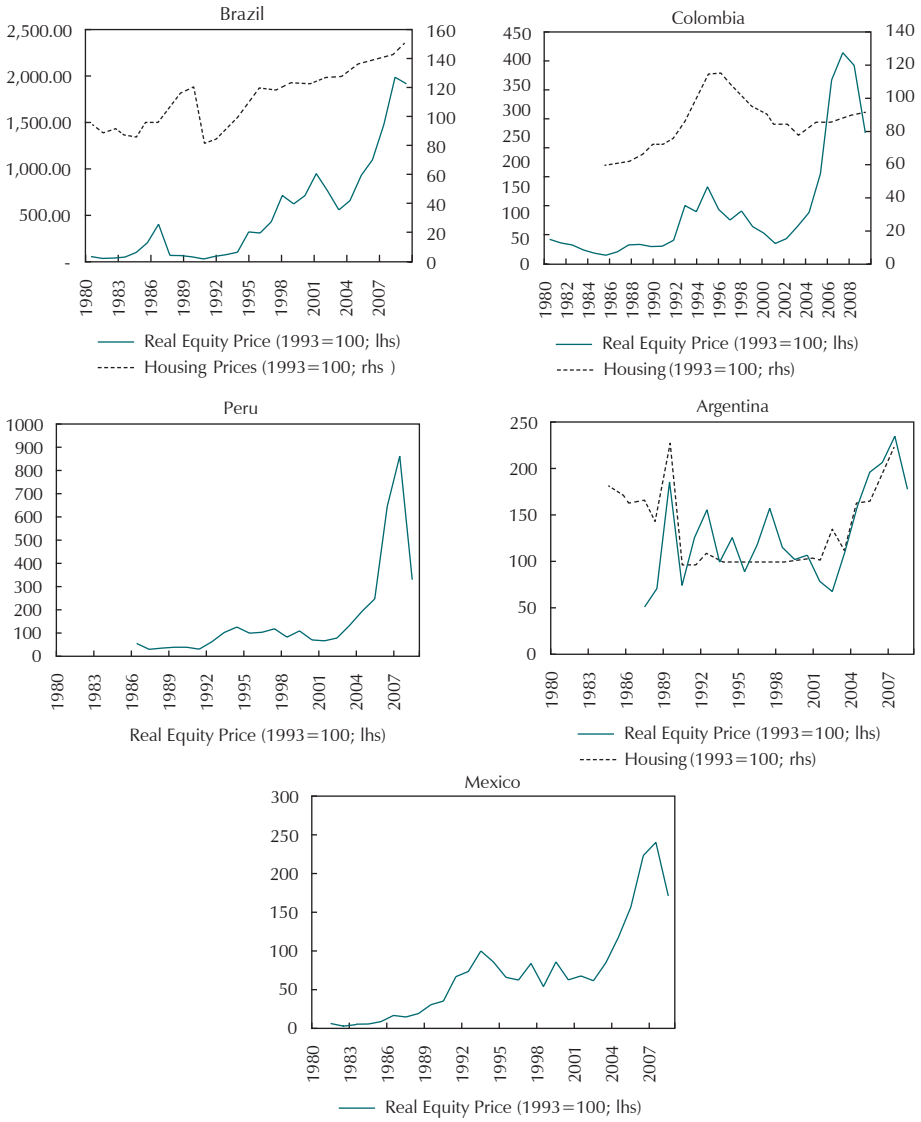
It can be observed (Graph 2) that although housing prices are less volatile than equity prices, the two follow the same time pattern. However, movements in equity prices tend to lead those of housing prices by one to two years. In the current upswing, equity markets have been particularly strong. With the exception of Argentina, housing prices have remained more subdued.

Movements in asset prices tend to go hand in hand with movements in credit and investment, (Graph 3), with asset prices preceding both credit and investment. However, the volatility of asset (equity) prices is higher than the volatility of the other two variables (the correlations between equity prices and the aggregate variables are presented in Appendix 2).

There is a positive association between equity prices and capital flows (Graph 4). Both variables tend to move together, although with brief periods of divergence. In general, for almost all the countries in the sample, movements in capital flows are followed by movements in equity prices and credit. The association between these three variables during the nineties was remarkable and the decade ended with a sudden stop in capital flows and

a banking crisis in almost all the countries.[1] Moreover, significant falls in capital flows and busts in asset prices have been associated with subsequent banking crises and recessions. This was true for a number of countries in the eighties (Brazil, Peru, and México) and again in the nineties (*e.g.* Colombia, Peru, and Argentina) (Graph 4).

Graph 2
Real Asset Prices: Equity and Housing



1 Our source to identify banking crises is Kaminsky and Reinhart (1999) for the period 1980-1995 and others, following the criteria suggested by Borio and Drehmann (2009b) for the period 1995-2008 (see Appendix 3).

IV. THE ENDOGENOUS CYCLE VIEW: THE FINANCIAL ACCELERATOR

The analysis of the role of asset prices and their interaction with the real economy builds on the idea that the economy is exposed to financial frictions and that this interaction can be amplified by a financial accelerator mechanism. According to this mechanism, an increase (decrease) in asset prices improves a firm's (or household's) net worth, lowering (raising) the external finance premium, which, in turn, enhances (reduces) its capacity to borrow, invest, and spend (Bernanke, Gertler and Gilchrist, 1999).

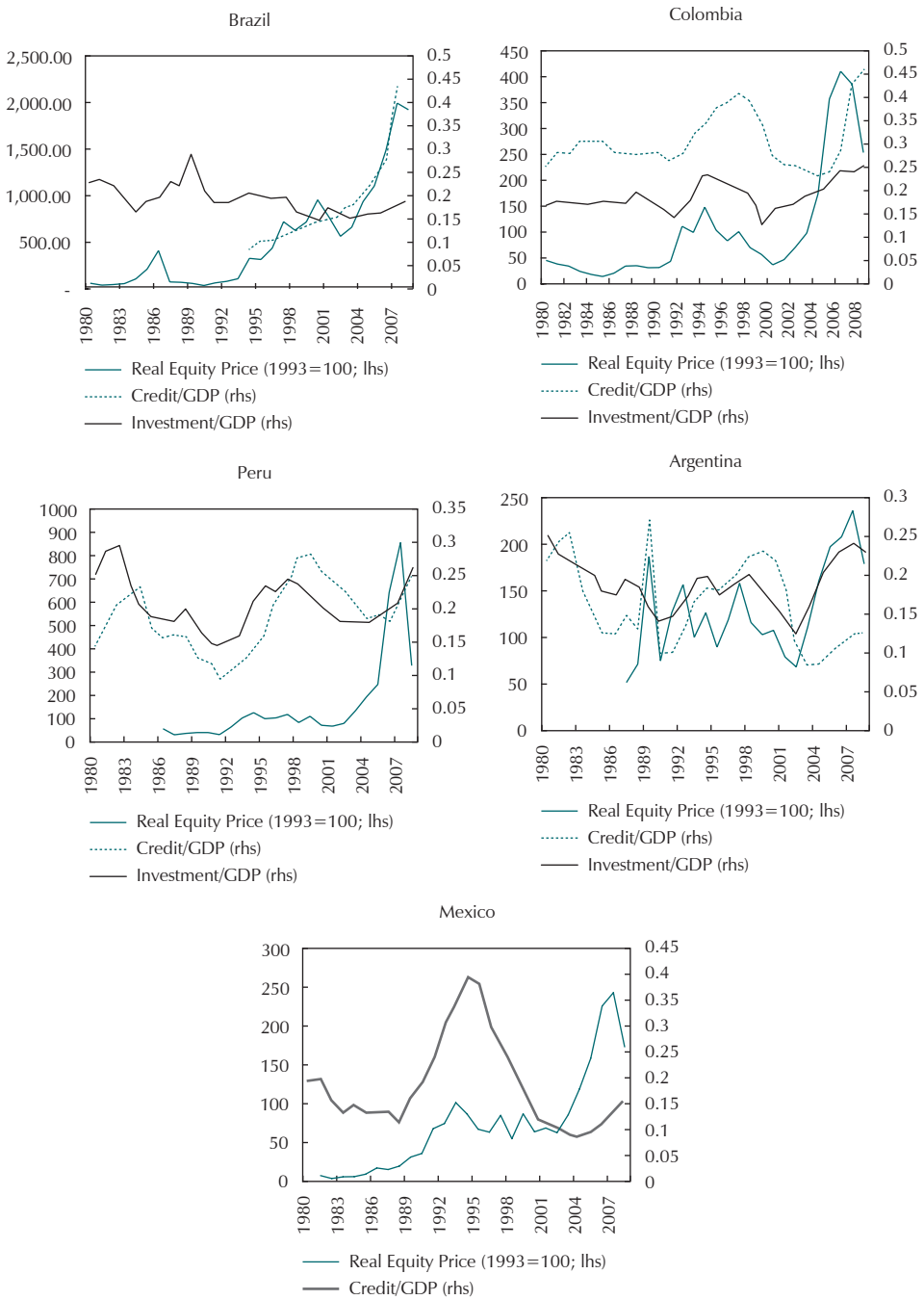
There is empirical evidence in support of the existence of this mechanism in both industrialized and developing countries. For advanced economies, some empirical investigations analyze the dynamics of asset prices, credit cycles, and real activity. Worth mentioning are, for example, the works by Dib and Christensen (2006) and by Borio, Furfino and Lowe (2001). For developing countries, notable examples are the works by Tovar (2006) and by López *et al.* (2008).

Cycles in emerging economies are influenced by movements in capital flows. These movements feed into the functioning of the accelerator and may contribute to the dynamics of asset prices, credit, and investment. This, in turn, makes the countries more vulnerable to financial distress and to abrupt changes in the direction of those flows. Capital inflows appreciate asset prices and create booms in credit that subsequently reverse when there is a sudden outflow of capital. In this sense we can think of capital inflows as a trigger of the "endogenous cycle" process.

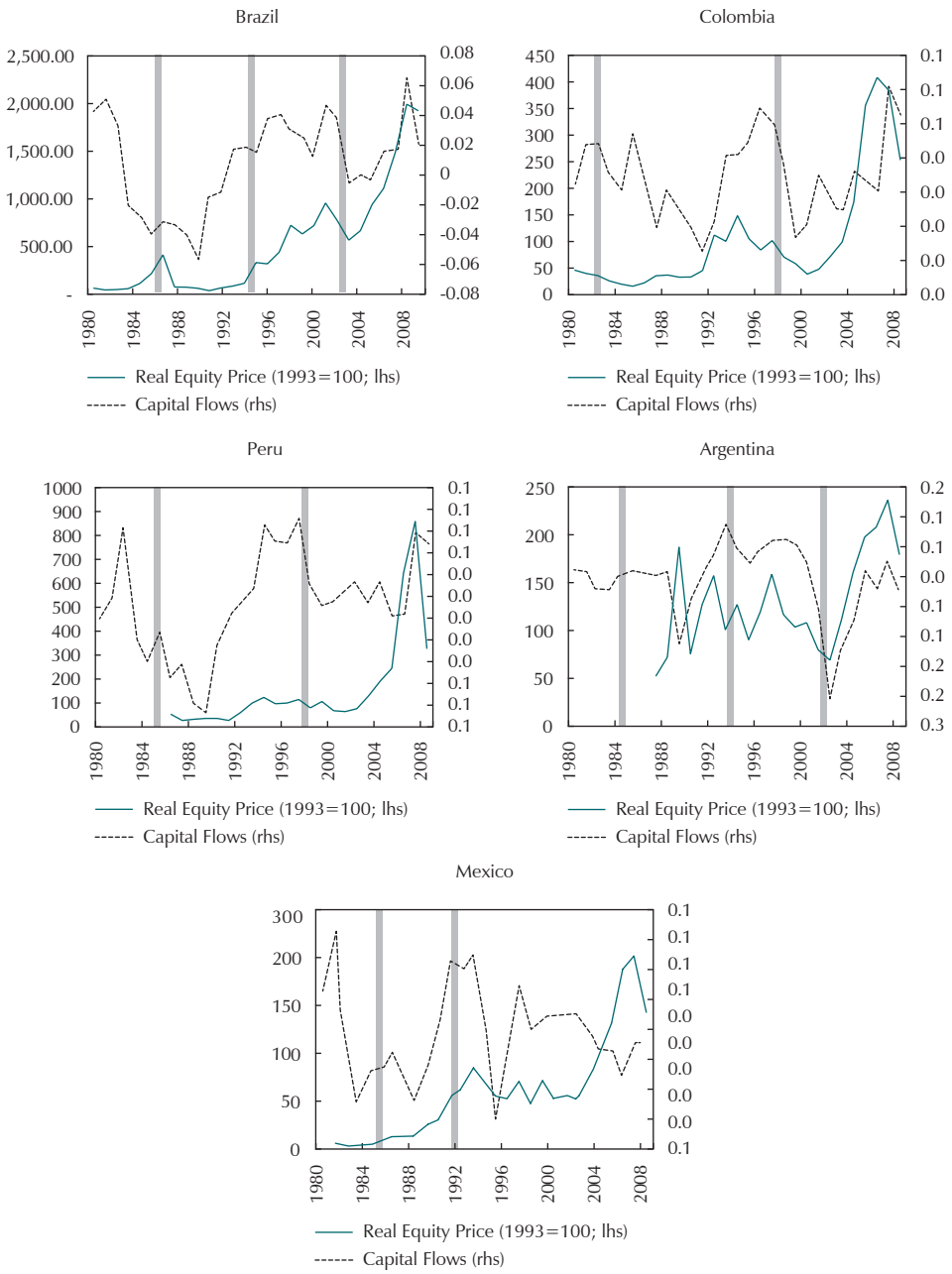
At the empirical level, Mendoza and Terrones (2008) show that the frequency of credit booms in emerging markets is higher when preceded by periods of large capital inflows but not when preceded by domestic financial reforms or gains in total factor productivity. Industrialized countries exhibit the opposite pattern. In addition, Herrera and Perry (2003) found evidence that capital flows are one of the key determinants of asset price bubbles in Latin America.

The exchange rate regime can exacerbate this mechanism. An illustration of this for the case of Korea can be seen in Gertler, Gilchrist and Natalucci (2007) and for the case of Colombia in López *et al.* (2008). In these papers, the combination of a financial accelerator mechanism and the exchange rate regime explains the severity of the crises at the end of the nineties in the two mentioned countries. In the face of a negative risk premium shock that produces capital outflows, if the monetary

Graph 3
Real Equity Prices, Credit and Investment



Graph 4
Equity Prices, Capital Flows and Banking Crises (solid vertical lines)



authority tries to defend a fixed exchange rate, it will have to increase the domestic interest rate to very high level. This will cause asset prices, net worth, investment, consumption, and output to fall in great proportion. On the other hand, if the monetary policy follows a conventional Taylor rule and the exchange regime is flexible, when the negative shock occurs the capital outflows cause exchange rate devaluation and, therefore, inflation of imported goods. The monetary authority raises the domestic interest rate to fight inflation but this increase is much lower than in the case of the fixed exchange rate.

V. VARIABLES AND LEADING INDICATORS

According to the previous sections, the relationship among the variables that describe the endogenous cycle view in emerging market economies and the subsequent financial crises presented in the area can provide us with a set of early warning indicators. Next, we describe the methodology that we used to construct them.

A. METHODOLOGY

The exercise is based on a signal extraction method, one of the most common approaches for the estimation of early warning indicators (Kaminsky and Reinhart, 1999). However, our approach incorporates some features suggested by Borio and Lowe (2002), in particular:

- We focus on cumulative processes rather than growth rates calculated over just one year. We identify a credit boom as a period in which the ratio of credit to GDP deviates from its trend by some specific percentage. Similarly, we define equity prices, housing prices, capital flows, and investment booms as periods in which real equity and housing prices, the ratio of capital flows to GDP, and investment to GDP deviate from their trends by specific amounts. We refer to these deviations as *credit gap*, *equity prices gap*, *housing prices gaps*, *capital flows gap*, and *investment gap*, respectively.

- In determining whether a boom exists or not, we use only *ex-ante* information. The individual indicators are all measured as deviations from one-sided Hodrick-Prescott trends (gaps), calculated recursively up to time *t*. In order to capture the gradual and cumulative buildup of imbalances, a high degree of smoothing is used (*lambda*=1600).

- We consider combinations of indicators. Rapid credit growth, by itself, may pose little threat to the stability of the financial system. However, the combination of events —the simultaneous occurrence of rapid growth of credit and asset prices, capital flows or investment, in particular— may increase the probability of crises.

- Because the sequence of events takes time, we also consider multiple horizons. Specifically, a signal that points to a crisis is judged to be correct if a crisis occurs any time within one, two, and three years ahead.

For each period *t*, a signal is calculated. The signal takes the value of 1 if indicator variables exceed critical thresholds or 0 otherwise. Ideally, the vector of thresholds would be chosen so that the indicator variables would always exceed the critical thresholds ahead of crisis and never during non-crisis periods.

However, choosing the optimal threshold involves a trade-off between the occurrence of type 1 errors (no signal is issued and crisis occurs) and type 2 errors (a signal is issued but no crisis occurs). In general, lower thresholds predict higher percentage of crisis, but at the cost of predicting more crises that do not occur (false positives). Our criteria follows Borio and Lowe (2002) and Borio and Drehmann (2009a-b), where minimizing the signal-to-noise ratio subject to at least two thirds of the crises being correctly predicted appears to provide a good compromise[2].

To establish the dates of occurrence of banking crises we use the dates from Kaminsky and Reinhanrt (1999). For the period 1996–2008 we resort to one of the criteria suggested by Borio and Drehmann (2009b), that a country is in crisis when its government had to inject capital in more than one large bank and/or when more than one large bank failed. Given that gaps are calculated if at least 10 years of data are available before any prediction is made, we identified a total of seven banking crises for the whole sample of countries and for the period 1990–2008 (Appendix 3).

B. RESULTS

We analyze two kinds of results. First, we present results for individual indicators; second, we present the results for combinations of the best indicators. In Table 1,

2 The signal-to-noise ratio corresponds to the ratio of type 2 errors to one minus type 1 errors.

we show the results for individual indicators for different thresholds with the corresponding level of percentage of crises predicted at each threshold and the type 2 errors and the signal-to-noise ratios.

Taking into account only the individual indicators (Table 1), we can observe the following results:

- Of the five indicators individually considered, the best one is the capital flows gap: it has the lowest signal-to-noise ratio and one of the highest percentages of crises predicted. A threshold of around 4% produces the best results: nearly 60% of the crises are predicted at one-year horizon, while false positive signals are issued around 16% of the time.

- The second best single-variable indicator is the credit gap. A threshold between 3 and 5 percentage points produces the best results. With a threshold of 3 percentage points, 60% of the crises are predicted at one-year horizon, while false positive signals are issued around 25% of the time.

- The asset prices indicator provides relatively noisy signals at the one-year horizon. With a threshold of 30–40 percentage points, 60% of the crises are predicted and false positive signals are issued 50% of the time. The performance of the indicator improves considerably when the time horizon is extended to three years, in which case 86% of the crises are predicted and false positive signals are issued 33% of the time.

- The housing prices gap indicator has a very poor performance given its very high signal-to-noise ratio. Its performance improves substantially when the horizon considered is lengthened to 3 years.

- The investment gap indicator is not as noisy as the equity and housing prices gaps, but the percentage of crises predicted is not as high as that predicted with the capital flows gap or the credit gap indicators.

- The performance of all the indicators improves considerably as the time horizon is lengthened. This is true especially in the case of asset (equity) prices and capital flows gaps. The percentage of crises predicted improves in about 25% and the false positive signals drop 32%.

In order to take into account that it may be the simultaneous occurrence of events which causes financial imbalances, we consider the following combinations of indicators: equity prices and credit gaps; investment and credit gaps; credit gap and capital flows gap; and capital flows and equity prices gaps. We use these combinations because these individual indicators were the ones with best performance in terms of minimizing the signal-to-noise ratio subject to a percentage of crises predicted of at least 60 percent[3].

We report the results for the case of one-year horizon of certain combinations of thresholds in Table 2. It can be observed that:

- Only in those cases where credit is combined with equity prices or capital flows the signal-to-noise ratio is lower than when we consider the indicators separately.

- For a credit gap of 4% and an asset prices gap of 10%, the signal-to-noise ratio is almost 50% lower than when the signal is activated by the credit gap alone.

- For a credit gap of 3% and a capital flows gap of 4%, the signal-to-noise ratio drops in about 70%.

- In addition, the signal-to-noise ratio of the joint indicators falls further when the time horizon is lengthened to 3 years as can be seen in Table 3. The performance of the joint indicator of credit gap and capital flows gap at a 3 year horizon is remarkable, with 100 % of crises predicted and 3% of false signals. This might be the result of a cumulative imbalances process.

These results are in line with the findings by Borio and Lowe (2002) and Borio and Drehmann (2009b). Indicators of vulnerability should take into account cumulative processes and pay particular attention to joint indicators. In our case the interaction of asset prices or credit with capital flows produces superior results that taking the indicator separately. The relevance of capital flows as early warning indicator in this kind of economies is a step forward in the analysis for emerging market economies.

The same results can be used to interpret what the leading indicators would have said about financial vulnerabilities in the set of countries here considered at the time of eruption of the global financial crisis. Interestingly, despite the fact that these countries

3 However, we present different combinations of thresholds in order to show that the results do not depend on the threshold.

were ultimately not seriously hit by the crisis, there is evidence of financial fragility at that time. The asset prices gaps (by itself a noisy indicator) (Graph 5)[4] show, for the five countries, signals of financial vulnerability for the period 2006–2008. However, when considered jointly with the credit gap indicator (graphs 6-5), only for Colombia would they point in the direction of financial imbalances. The same can be said when credit and capital flows (graphs 6-7) are pooled together.

Table 1
Performance of Indicators

Credit gap

Horizon= 1 year				Horizon= 2 year				Horizon= 3 year			
Threshold	Pred. %	Type 2 error %	Noise/ Signal	Threshold	Pred. %	Type 2 error %	Noise/ Signal	Threshold	Pred. %	Type 2 error %	Noise/ Signal
2	80	36	0.45	2	100	28	0.28	2	100	22	0.22
3	80	30	0.37	3	80	24	0.30	3	100	19	0.19
4	60	25	0.42	4	60	19	0.32	4	80	15	0.19
5	20	7	0.37	5	20	7	0.37	5	40	6	0.15
6	40	12	0.30	6	40	9	0.22	6	60	7	0.12
7	20	12	0.60	7	20	9	0.45	7	40	7	0.19
8	20	7	0.37	8	20	7	0.37	8	40	6	0.15

Equity price gap

Horizon= 1 year				Horizon= 2 year				Horizon= 3 year			
Threshold	Pred. %	Type 2 error %	Noise/ Signal	Threshold	Pred. %	Type 2 error %	Noise/ Signal	Threshold	Pred. %	Type 2 error %	Noise/ Signal
7	57	49	0.86	7	71	39	0.54	7	86	33	0.38
10	57	48	0.84	10	71	39	0.54	10	86	33	0.38
20	43	39	0.90	20	43	30	0.70	20	43	24	0.56
30	43	34	0.79	30	43	25	0.59	30	43	19	0.45
40	29	24	0.84	40	29	17	0.59	40	29	13	0.46
50	29	19	0.67	50	29	14	0.51	50	29	11	0.38
60	29	13	0.46	60	29	10	0.34	60	29	6	0.21
70	29	11	0.38	70	29	7	0.25	70	43	5	0.11
80	29	8	0.30	80	29	6	0.21	80	29	4	0.13
90	14	5	0.34	90	14	4	0.25	90	14	2	0.17

4 The bands shown correspond to the threshold founded for the individual indicators, where at least 60% of crises are predicted at the same time that the noise-to-signal ratio is minimized.

Table 1
Performance of Indicators (continued)

Real estate price gap

Horizon= 1 year				Horizon= 2 year				Horizon= 3 year			
Threshold	Pred. %	Type 2 error %	Noise/ Signal	Threshold	Pred. %	Type 2 error %	Noise/ Signal	Threshold	Pred. %	Type 2 error %	Noise/ Signal
2	60	49	0.82	2	60	43	0.71	2	80	35	0.43
4	40	45	1.12	4	40	39	0.97	4	60	31	0.51
6	20	43	2.14	6	40	37	0.92	6	60	29	0.48
8	20	37	1.84	8	20	33	1.63	8	60	24	0.41
10	20	35	1.73	10	20	31	1.53	10	40	24	0.61

Investment gap

Horizon= 1 year				Horizon= 2 year				Horizon= 3 year			
Threshold	Pred. %	Type 2 error %	Noise/ Signal	Threshold	Pred. %	Type 2 error %	Noise/ Signal	Threshold	Pred. %	Type 2 error %	Noise/ Signal
2	40	28	0.71	2	40	21	0.52	2	60	15	0.25
3	40	19	0.49	3	40	15	0.37	3	40	10	0.26
4	40	13	0.34	4	40	10	0.26	4	40	6	0.15
5	20	6	0.30	5	20	4	0.22	5	20	1	0.07

Capital flows gap

Horizon= 1 year				Horizon= 2 year				Horizon= 3 year			
Threshold	Pred. %	Type 2 error %	Noise/ Signal	Threshold	Pred. %	Type 2 error %	Noise/ Signal	Threshold	Pred. %	Type 2 error %	Noise/ Signal
2	71	28	0.39	2	100	17	0.17	2	100	17	0.17
3	57	23	0.40	3	100	13	0.13	3	100	13	0.13
4	57	16	0.27	4	71	11	0.15	4	100	11	0.11
5	29	8	0.30	5	43	6	0.14	5	57	6	0.11
6	29	1	0.04	6	29	1	0.04	6	29	1	0.04

All variables are measured as gaps, ie as percentage point(credit-to-GDP and investment-GDP ratios) or as percentage deviations (equity price and real estate indices) from exante (one-sided), recursively calculated Hodrick-Prescott with lambda set to 1600.

Table 2
Performance of Joint Indicators - One Year Horizon

Credit and Equity Prices					Credit and Capital Flows				
Threshold for		Pred. %	Type 2 error %	Noise/ Signal	Threshold for		Pred. %	Type 2 error %	Noise/ Signal
Capital flows	Equity gap				Credit gap	Capital flows			
3	10	40	9	0.22	3	2	80	15	0.19
3	20	20	4	0.22	3	3	60	10	0.17
3	30	20	3	0.15	3	4	60	7	0.12
3	40	0	1	-	3	5	40	1	0.04
4	10	40	9	0.22	4	2	60	15	0.25
4	20	20	4	0.22	4	3	40	10	0.26
4	30	20	3	0.15	4	4	40	7	0.19
4	40	0	1	-	4	5	20	1	0.07
5	10	40	6	0.15	5	2	60	10	0.17
5	20	20	4	0.22	5	3	40	7	0.19
5	30	20	3	0.15	5	4	40	4	0.11
5	40	0	1	-	5	5	20	0	0.00

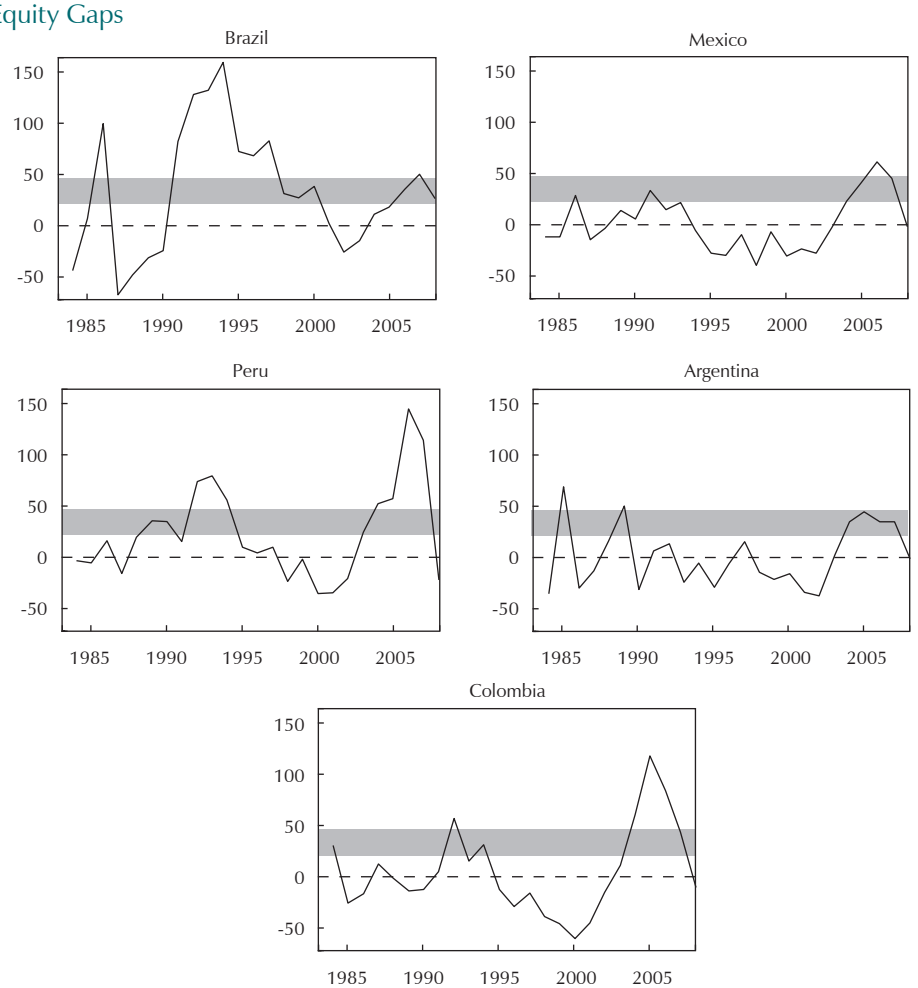
Capital Flows and Equity Prices					Credit and Investment				
Threshold for		Pred. %	Type 2 error %	Noise/ Signal	Threshold for		Pred. %	Type 2 error %	Noise/ Signal
Credit gap	Equity gap				Credit gap	Investment gap			
2	10	40	22	0.56	3	2	25	22	0.88
2	20	20	15	0.75	3	3	25	20	0.80
2	30	20	13	0.67	3	4	25	18	0.72
2	40	0	9	-	3	5	25	16	0.64
3	10	40	21	0.52	4	2	25	18	0.72
3	20	20	13	0.67	4	3	25	16	0.64
3	30	20	12	0.60	4	4	25	14	0.56
3	40	0	9	-	4	5	25	12	0.48
4	10	40	18	0.45	5	2	25	14	0.56
4	20	20	12	0.60	5	3	25	12	0.48
4	30	20	10	0.52	5	4	25	10	0.40
4	40	0	7	-	5	5	25	8	0.32

All variables are measured as gaps, ie as percentage point (credit-to-GDP and investment-GDP ratios) or as percentage deviations (equity price and real estate indices) from exante (one-sided), recursively calculated Hodrick-Prescott with lambda set to 1600.

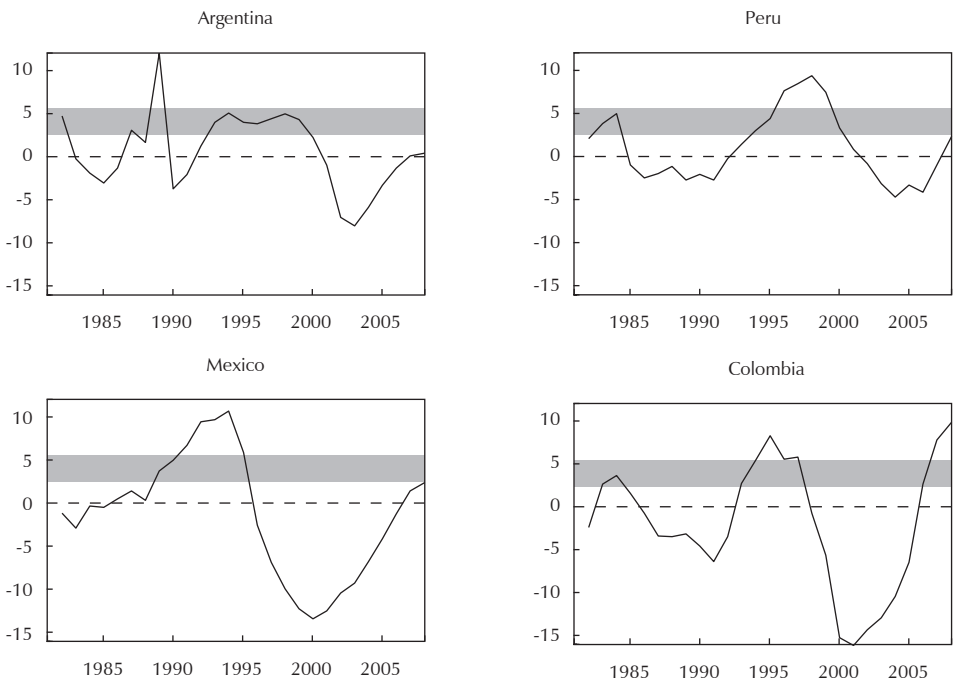
Table 3
Performance of Joint Indicators at Different Horizons

	Threshold: Credit gap = 3% points			Threshold: Credit gap = 3% points Equity Price gap = 10% points			Threshold: Credit gap = 3% points Capital flows gap = 4% points		
Horizont years	Pred. %	Type 2 error %	Noise/ Signal	Pred. %	Type 2 error %	Noise/ Signal	Pred. %	Type 2 error %	Noise/ Signal
1	80	30	0.37	60	7	0.12	40	9	0.22
2	80	24	0.30	80	4	0.06	40	7	0.19
3	100	19	0.19	100	3	0.03	60	6	0.10

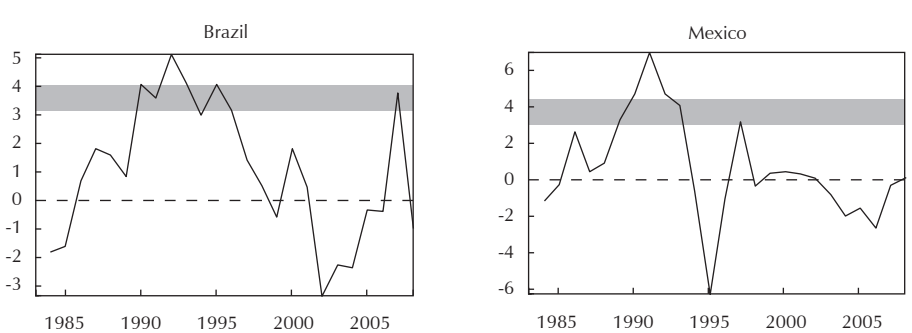
Graph 5
Equity Gaps



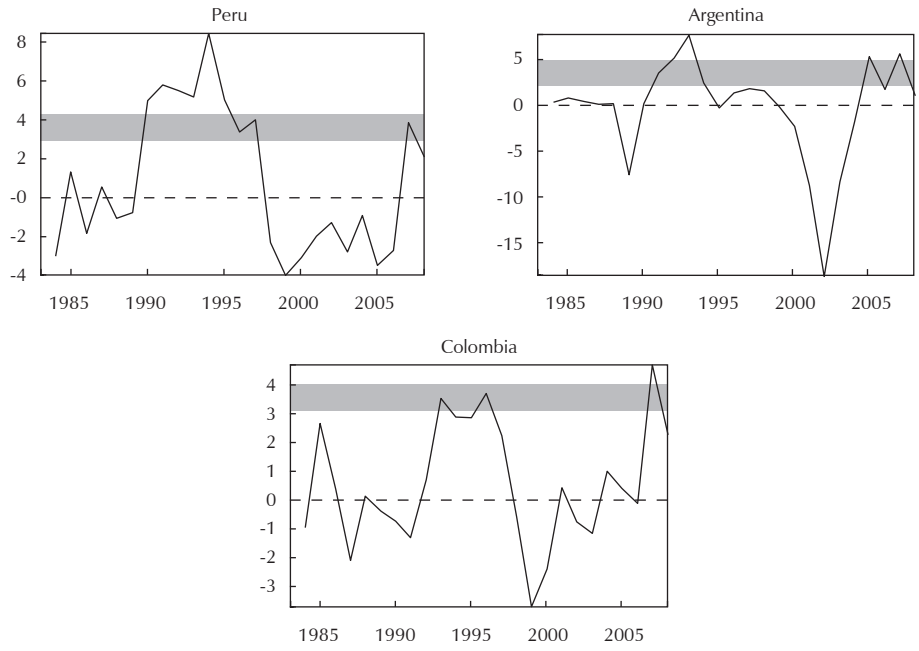
Graph 6
Credit Gaps



Graph 7
Capital Flows Gap



Graph 7
Capital Flows Gap (continued)



VI. FINAL REMARKS

This paper has ratified the conclusion derived from other works (Borio and Drehmann 2009a, among others) that it is possible to advance in the construction of simple leading indicators that can be used to monitor the buildup of risk taking in an economy. Along the lines of these works, the paper also underlines the importance of variables such as credit and asset (equity) prices as components of those leading indicators.

However, a further step is taken here by showing that, given the particular characteristics of emerging economies, the flows of capital from abroad should play a crucial role in any attempt to construct a framework for financial stability in these countries.

These findings give rise to at least two implications.

From the analytical point of view, the fact that capital flows can be regarded as an exogenous element or a trigger of boom and bust cycles in emerging economies does

not contradict the "endogenous cycle view" behind the design of leading indicators. What proponents of this view stress is the cumulative and feedback mechanisms that lead to risk taking and, therefore, to the buildup of financial imbalances that may eventually lead to financial distress.

From a policy perspective, this paper widens the scope of the macroprudential orientation of financial regulation and supervision when considerations of financial stability are taken into account.

REFERENCES

1. Bernanke, B.; Gertler, M.; Gilchrist, S. "The Financial Accelerator in a Quantitative Business Cycle Framework", in M. Woodford and J. Taylor (eds.) *Handbook of Macroeconomics*, Amsterdam, North Holland, pp. 1341-1393, 1999.

2. Borio, C.; Furfine, C.; Lowe, P. "Procyclicality of Financial Systems and Financial Stability", BIS Working Papers, no.1, Bank for International Settlements, 2001.

3. Borio, C.; Lowe, P. "Asset Prices, Financial and Monetary Stability: Exploring the Nexus", Working Paper, BIS Working Papers, no. 114, Bank for International Settlements, 2002.

4. Borio, C.; Drehmann, M. "Towards an Operational Framework for Financial Stability: "Fuzzy" Measurement and its Consequences", Working Paper, BIS Working Papers, no. 284, Bank for International Settlements, 2009a.

5. Borio, C.; Drehmann, M. "Assessing the Risk of Banking Crises – Revisited", *BIS Quarterly Review*, marzo, Bank for International Settlements, pp. 29-46, 2009b.

6. Céspedes, L. F.; Chang, R.; Velasco, A. "Balance Sheets and Exchange Rate Policy", *American Economic Review*, vol. 94, no. 4, American Economic Association, pp. 1183-1193, 2004.

7. Claessens, S.; Kose, A.; Terrones, M. "What Happens During Recessions, Crunches and Busts?", Discussion Paper, CEPR Discussion Papers, no. 7085, C.E.P.R. Discussion Papers, 2008.

8. Dib, A.; Christensen, I. "The Financial Accelerator in an Estimated New Keynesian Model", *Review of Economic Dynamics*, vol. 11, no. 1, Elsevier, pp. 155-178, 2008.

9. Gertler, M.; Gilchrist, S.; Natalucci, F. "External Constraints on Monetary Policy and the Financial Accelerator", *Journal of Money, Credit and Banking,* vol.39, no.2-3, Blackwell Publishing, pp. 295-330, 2007.

10. Greenspan, A. "The Crisis", Brookings International Institute, 2010.

11. Gruben, W.; Welch, J. "Banking and Currency Crisis Recovery: Brazil's Turnaround of 1999", *Economic and Financial Policy Review,* fourth quarter, pp. 12-23, 2001.

12. Herrera, S.; Perry, G. "Tropical Bubbles: Asset Prices in Latin America, 1980-2001", in W. Hunter; G. Kaufman and M. Pomerlano (eds.) *Asset Price Bubbles: The Implications for Monetary, Regulatory and International Policies,* Cambridge, MIT Press, pp. 127-162, 2003.

13. International Monetary Fund, "Lessons from Asset Price Fluctuations for Monetary Policy", *World Economic Outlook*, no. octubre, pp. 93-120, 2009.

14. Kamisnky, G.; Reinhart, C. "The Twin Crises: The Causes of Banking and Balance-of-Payments Problems", *American Economic Review*, vol. 89, no. 3, American Economic Association, pp. 473-500, 1999.

15. Kiyotaki, N.; Moore, J. "Credit Cycles", *Journal of Political Economy*, vol. 105, no. 2, University of Chicago Press, pp. 211-248, 1997.

16. López, M.; Prada, J. D.; N. Rodríguez, N. "Financial Accelerator Mechanism in a Small Open Economy", Borradores de Economía, no. 525, Bogotá, Banco de la República de Colombia, 2008.

17. Mendoza E.; Terrones, M. "An Anatomy of Credit Booms: Evidence from Macro Aggregates and Micro Data", Working Paper, NBER Working Papers, no. 14049, National Bureau of Economic Research, 2008,

18. Reinhart, C.; Rogoff, K. "Banking Crises: An Equal Opportunity Menace", Working Paper, NBER Working Papers, no. 14587, National Bureau of Economic Research, 2008.

19. Rojas J.; Costa, E. "Movilidad de capitales y crisis bancarias en el Perú, 1990-2000", Mimeo, CIES, 2002.

20. Tenjo, F.; Charry, L.; López, M.; Ramírez, J.M. "Acelerador financiero y ciclos económicos en Colombia: un ejercicio exploratorio", Borradores de Economía, no. 451, Bogotá, Banco de la República de Colombia, 2007.

21. Tovar, C. "Devaluations, Output and The Balance Sheet Effect: A Structural Econometric Analysis", Working Paper, BIS Working Papers, no. 215, Bank for International Settlements, 2006.

Appendix 1
Description of Variables and Sources

Country	Description	Source
Equity Prices Indices		
Argentina	Merval index	Banco Central de la República Argentina
Brazil	Iboespa index	Central Bank of Brazil
Peru	Stock market index	Banco Central de Reserva del Perú
Colombia	Stock market index	Banco de la República
Mexico	Stock market index	Banco de México
Housing Prices Indices		
Argentina	New Apartments	Banco Central de la República Argentina
Brazil	INCC - Total Average	Central Bank of Brazil
Colombia	New Housing	Banco de la República
Credit as pertcentage of GDP		
All Countries	Credit to private sector/nomial GDP	Central Banks
Capital Flows		
All countries	Capital and financial account, net	CEPAL 1980-2005, Central Banks 2005-2008

Appendix 2
Correlations of Equity Prices with Aggregate Variables

	EP(t-2)	EP(t-1)	EP	EP(t+1)	EP(t+2)
Colombia					
Investment/GDP	0.63	0.74	0.59	0.37	0.10
Credit/GDP	0.76	0.56	0.14	-0.27	-0.53
CapitalFlows/GDP	0.61	0.50	0.19	0.04	-0.12
Argentina					
Investment/GDP	0.31	0.34	0.36	0.24	0.00
Credit/GDP	0.09	0.03	0.03	-0.46	-0.37
CapitalFlows/GDP	0.34	0.36	0.25	0.25	0.07
Brazil					
Investment/GDP	-0.09	-0.09	-0.27	-0.40	-0.23
Credit/GDP	n.a	n.a	n.a	n.a	n.a
CapitalFlows/GDP	0.17	0.45	0.54	0.47	0.45
Peru					
Investment/GDP	0.59	0.46	0.07	-0.18	-0.37
Credit/GDP	0.19	-0.08	-0.43	-0.59	-0.65
CapitalFlows/GDP	0.46	0.49	0.26	0.00	0.05
Mexico					
Investment/GDP	n.a	n.a	n.a	n.a	n.a
Credit/GDP	0.61	0.59	0.39	0.14	-0.07
CapitalFlows/GDP	-0.03	0.03	0.23	0.03	0.00

Source: author´s calculations

Appendix 3
Year of Banking Crises

Country	BankingCrises
Brazil	
	1985
	1994
	1998
Argentina	
	1980
	1985
	1994
	2002
Peru	
	1983
	1998
Mexico	
	1982
	1992
Colombia	
	1982
	1998

Sources: Kaminsky and Reinhart (1999)
Gruben and Welch (1999),
Informe al congreso-BCRA and BR various issues.
Rojas and Costa (2002).