Beyond Bubbles: The role of asset prices in *early-warning* indicators

Esteban Gómez
Sandra Rozo·

I, Introduction

Asset price bubbles are amongst the most talked-about yet misunderstood topics in economics. Theoretical researchers debate between rational, nonrational or even non-existent bubbles, while empiricists tackle the issue with state-of-the-art econometric tools yielding mixed results.

A bubble is usually defined as the component of asset prices that cannot be accounted for by fundamentals[1]. A rational bubble arises when agents are willing to pay a higher price than the \fundamental price" because they believe that they can sell the asset at an even higher price in the future (Gurkaynak (2005)). A nonrational bubble is defined as a rapid upward price movement, based on exaggerated beliefs about future outcomes (e.g. company earnings or the impact of a new technology), followed by a collapse (Meltzer (2003)).

Some theorists have also developed behavioral models with rational expectations which allow for explaining price behavior without bubble components. In a nut-shell, these models assume expectations are based on imperfect knowledge of future fundamentals, so that investors may overestimate potential income flows (i.e. earnings) and hence asset prices. As agents acquire new information, they correct their initial forecasts, altering their investment/consumption decisions and changing asset prices (Meltzer (2003)).

· Economist of the Financial Stability Department of Banco de la República and Economist of Fedesarrollo, respectively. The views expressed in this document do not reflect the opinion of Banco de la República or its Board of Governors or those of Fedesarrollo. We thank Dairo Estrada and the rest of the Financial Stability Staff for their insightful comments on a prior version of this paper. All errors and omissions are the sole responsibility of the authors.

[1] Fundamentals are the discounted value of expected future income flows.

On the empirical side, tests are usually constructed for rational bubbles, given the relative knowledge of researchers on testing the present value model of asset prices. Nonetheless, results vary and there does not appear to be a general consensus regarding a specific empirical test of bubbles. In fact, there is not even a common agreement on the interpretation of a rejection of the no-bubbles hypothesis; while some argue this is proof of the existence of bubbles others attribute this to a failure of the model in another dimension (e.g. misspecified fundamentals). In the end, the choice between bubble solutions and a misspecified model of price behavior remains a matter of belief.

The bottom-line is that even if there is no scientific proof of the existence of bubbles, the current volatility in asset prices worldwide has sprang a newfound interest in the subject.

The typical questions found in the literature usually read something like: How should bubbles be measured? Can they be measured? Are they rational or nonrational bubbles? Do bubbles *exist*? Are these the most relevant questions for decision-makers? Probably not. Financial instability usually arises from a combination of economic imbalances and not a single event. That is, large increases in asset prices by themselves do not necessarily lead to widespread instability in the financial system. Rather, an increase in asset prices, rapid credit expansions and high levels of investment, occurring *simultaneously*, could lead to potential problems (Borio and Lowe (2002, 2003)). Thus, the relevant question for policymakers is not whether bubbles *exist*, but rather if the observed behavior in asset prices, along with other financial and real variables, is indicative of possible future imbalances.

In such spirit, we use information on the most relevant asset prices, credit and investment to construct *early-warning* indicators of financial distress, as suggested by Borio and Lowe (2002, 2003). The idea behind these indicators is simply to observe the deviation of each series to its long-term trend, and determine whether imbalances occur after such deviations overcome a specific threshold. Although analyzing the deviation of a variable to its trend is by no means revolutionary (the loans to GDP ratio being one of the most common), analyzing real and financial variables *jointly* as early warning indicators of financial distress has only become popular more recently. This is mainly due to the fact that although asset prices have made several appearances on historical accounts of financial instability, their empirical relationship with credit and aggregate demand has been less studied.

However, there have been various attempts in identifying the link between asset prices, financial stability and monetary policy. Some authors argue that a responsible monetary policy leads to low inflation, induces stable asset prices and efficient levels of liquidity, reduces investors' uncertainty (by promoting a sounder macro environment) thus allowing for optimum consumption and investment decisions.

On the other hand, some economists have began to realize that financial instability (and large asset price swings) can develop in periods of low inflation. A credible monetary policy results in low inflation expectations, meaning it takes longer for higher demand to translate into prices. As agents' expenditure increases, there is a higher demand for loans and banks increase their lending. Debt-financed spending may lead to a faster rise in asset prices, which does not immediately translate to higher inflation. The inverse is also true. There could be high inflation under a stable financial environment. Under this scenario, a rise in interest rates, consistent with the inflation goal, could lead to financial instability by increasing the burden of outstanding floating-rate debt and most importantly creating significant wealth effects through portfolio-valuation losses caused by the fall in the price of tradable assets (this is especially relevant in markets where balance sheets are *marked-to-market*), thus altering investment/consumption decisions. In other words, there is room for important *trade-offs* between monetary and financial stability.

The above does not mean that policymakers are thus left with their hands tied. In the first place, it would be foolish to overlook that asset prices contain a large amount of information from which policymakers can reap incredible benefits[2]. On second place, even if there is no consensus on the exact link between financial and monetary stability there does seem to be a convergence on some of the actions that should be undertaken by policymakers to reduce large asset-price swings. In short, these are aimed towards reducing information asymmetries in the market, promoting the long-term structure of certain specific institutional investors' portfolio (e.g. pension funds) as well as the diversification and sophistication of risk management tools. Additionally, they should promote deeper and wider capital markets to increase the universe of financial assets available to investors and encourage a closer monitoring of financial markets.

Both the retrieval of information embedded in asset prices as well as possible policy actions to help move financial markets into a stronger form of market effciency (i.e. more shock-resistant) are crucial to policymakers worldwide. This is even more so in a country like Colombia, because emerging markets which are moving towards a model of financial integration are more vulnerable to the adverse effects that speculative capital flows have on the financial cycle. When there are waves of optimism on the real sector, credit grows spectacularly, there is a tendency to overinvest in physical capital, asset prices hike and consumption soars as well. All this factors lead to higher economic growth and a valorization of domestic assets, increasing foreign investors appetite for the latter. This leads to higher

[2] Developments in asset prices and credit may have an impact on in°ation and are therefore important for central banks when they set interest rates. Additionally, asset prices may be indicative of future developments in output and demand.

capital inflows, which in Colombia are highly (and positively) correlated with credit (see Villar *et al*. (2005)), thus exacerbating the business cycle. When expectations change (e.g. due to new information on future fundamentals) and agents correct their initial forecasts, the wave of optimism crumbles, imbalances are corrected abruptly and there are perverse effects both on financial markets and the real economy (Collyns and Senhadji (2003)).

This paper is organized as follows. Section I presented a quick introduction to the subject at hand and its relevance to policymakers. Section II presents an overview of the implications of the latter on monetary policy. Empirical exercises with Colombian data on asset prices, credit and investment as *early-warning* indicators are carried out in section III. Section IVconcludes.

II. Implications of Bubbles on Monetary Policy

A. To intervene or not to intervene

Although there seems to be an agreement regarding the relevance that asset price developments have over financial stability and economic growth, the debate concerning the optimum intervention of economic authorities to prevent strong swings in these prices prevails.

One branch of the literature supports the hypothesis that expansive policies may compensate the recessive effects of large swings in asset prices. As Meltzer (2003) notes, asset price declines need not be followed by output or consumption recessions. By analyzing several bubble episodes, the author states that the different effects that high asset prices have on an economy are explained by the policy actions implemented by the relevant authorities. Moreover, Cecchetti *et al.* (2003) suggest that even though asset prices should not belong to the objective function of the Central Bank, misalignments in these prices must be taken into account. The main reason is that asset price bubbles lead to increases in real output and inflation, followed by sharp falls. The authors suggest these effects can be offset with modest movements on the interest rates by policymakers. There are three channels distinguished in this literature through which monetary policy can affect asset valuations: through changes in individual expectations about future behavior of economic growth, altering agents' set of discount factors and causing portfolio shifts that affect assets' relative prices.

On the other hand, a branch of the literature states that central banks should not react to changes in asset prices. They support their position by arguing that it would be harmful for economic stability to introduce such a volatile indicator into

policy decisions. Another important argument to remain extremely cautious about monetary policy intervention is moral hazard problems: if individuals expect intervention they may take riskier projects in order to magnify their expected returns because they internalize that their losses are limited.

Moreover, Goodfriend (2003) advices that monetary policy should not react directly to asset prices because there can be no theoretical presumption on the correlation between interest rates and equity price movements, and hence on the overall *effectiveness* of the intervention.

B. What can Monetary Authorities Do?

Although the debate concerning intervention seems endless, there are certain points in which researchers and academics have reached an agreement. For instance, there is consensus regarding the reasons that explain the abnormal behavior of asset prices in the last years. Three facts can be clearly distinguished. First, agents have increased their interest in short-term results. This has magnified price volatility by amplifying the impact of any new information. Second, markets have developed mimetic or herding behavior. That is, agents prefer to be wrong along with everybody else rather than taking the risk of being right alone. This type of conduct leads to massive earnings or losses. Finally, converging risk management techniques have led to contemporaneous homogeneous responses by different market players, increasing the size of trading volumes and magnifying initial shocks.

The above implies that monetary authorities must safeguard financial stability by promoting diversity in financial markets, which in turn may prevent asset price swings. In order to achieve this objective, monetary policy should focus on *i)* strengthening market transparency, *ii)* preserving the long term perspective of some investors (e.g. pension funds), and *iii)* promoting the diversification of risk management tools of financial institutions.

- Market transparency reduces incomplete information and uncertainty, which boosters investors' confidence regarding their own decisions.
- Transparency also allows for a better differentiation between good and bad borrowers.
- Preserving the long-term perspective of pension funds and insurance companies they compensate for the "short-termism" of other agents, thus reducing the impact of new information in the price formation process.
- Authorities must promote diversification in the risk management tools of financial institutions, in order to help reduce the mimetic behavior observed in markets.

Monetary authorities may also openly promote the deepening of existing capital markets and the creation of new ones. For example, in Colombia few firms are listed in the Colombian Stock Exchange[3], and even fewer issue corporate bonds as means of obtaining financial resources. Policy maker's must strive to create the necessary conditions (i.e. a sound macroeconomic environment, low and stable interest rates, low inflation, quicker and more reliable information systems, efficient legal systems, tax incentives) for firms to effectively consider exploring these new markets. The former would allow for a larger universe of financial assets available to investors, thus reducing the high concentration and homogeneity present today in local investors' portfolios, which increases systemic risk.

Other policies that authorities may apply to promote financial diversity are[4]:

- Require companies to disclose periodical information necessary to assess a company's value (that does not compromise competitive secrets). The periodicity of the disclosures could vary depending on the market.
- Each investor should have prompt access to critical information.
- Chief Executive Officers who clearly abused their power should lose their right to serve in any corporate leadership position.
- Enhancing the accountability of corporate leaders to restore trust in the system.

Moreover, there is consensus over the idea that asset prices offer useful information to monetary authorities in the short-run (Goodfriend (2003)), especially because they have important consequences over financial markets. This idea is central to the core of this paper, because it implies that observing financial series may give policy makers vital information regarding the future development of certain segments (or in some cases the whole) of the financial system. This means that a central bank should use the information that these variables contain in order to ensure and promote the stability of financial markets.

III. Empirical Exercises

A. What can be done

Following the spirit of Borio and Lowe (2002, 2003), the central question in this analysis is not whether bubbles exist or not, but rather how much information can be derived from asset prices and other real and financial variables concerning

[3] As of July 2006, there are 8980 listed firms of a total of over 20,000 firms who actively report their balance sheet to the relevant authorities.

[4] These policies are part of President Bush's 10 Point plan on financial disclosure. For more information see Kroszner (2003).

financial instability[5]. From a policymaker's perspective, this is probably the relevant issue anyway; even if the bubble question is interesting in its own right, knowing what *combination* of events in the real and financial sectors increase the probability of possible risks materializing is even more so.

Historical experience has taught us that financial distress generally arises as a *combination* of economic imbalances which unwind simultaneously. In this sense, hikes and declines in asset prices, along with rapid credit expansion[6] and —in some cases— above-average capital accumulation, rather than any of these alone, are the most common symptoms of such scenarios. Accordingly, they are an indication of an increase in the likelihood of possible imbalances.

Therefore, in what follows we seek to construct what can be called an *Early-Warning Financial Imbalance Indicator* using *ex ante* Colombian data on credit, investment and asset prices[7]. To build this indicator, we utilize quarterly data that covers the period between December 1994 and December 2006[8]. The idea behind these indicators is to measure the deviation of each variable from its long-term trend, and then determine if an imbalance was effectively observed after such deviations overcome a specific threshold value[9]. If the above occurs, then the deviations of the variables from their long-run tendencies (which we refer to as the *gap* in what follows) can be seen as an *ex ante* indicator of possible financial distress.

B. Calculating the Early-Warning Indicators

Following Borio and Lowe (2002, 2003) we calculate the ratio of loans[10] to gross domestic product (GDP)[11], as well as the ratio of investments to GDP[12].

---

5 This approach was first proposed by Kaminsky and Reinhart (1999).

6 Much debate exists concerning the criteria that defines adverse credit growth. In this paper, when we refer to *rapid* credit growth we do not think of a higher equilibrium growth level, but rather an expansion related to increased market liquidity, a relaxation in risk assessment and monitoring standards, and indebtment decisions above actual repayment capacities. Hilbers *et al*. (2005) identify an expansion above 20% in real terms as worrying for countries with low credit to GDP ratios (i.e. below 30%). Credit in Colombia grew 26.5% in real terms during 2006, and the credit/GDP ratio was slightly above 30% for the first time in over 5 years.

7 Intuitively, we want to calculate the various indicators using only information that would have been available to the policymaker when determining whether or not a "boom" existed.

8 The information was obtained from the Superintendencia Financiera (Financial Superintendency), DANE(Department of National Statistics), DNP (Department of National Planning) and the Bolsa de Valores de Colombia (Colombian Stock Exchange). The Superintendencia Financiera is in charge of financial regulation and supervision in Colombia.

9 Following Borio and Lowe (2002, 2003), we utilize various threshold levels in our indicators. The idea is to try and find the threshold value that best identifies actual imbalance periods whilst minimizing the number of *false alarms* i.e. the number of wrongly predicted crises.

10 The loan series includes mortgage, consumer and commercial loans.

11 This ratio is also suggested by Kaminsky and Reinhart (1999), Gourinchas et al. (2001), and Sopanha (2006), among others.

12 All the variables here used are in real terms.

Additionally, we use three asset price indexes: the general equity index, the new housing price index and an aggregate price index (IGBC, IPVN for their Spanish initials and API, respectively)[13].

Afterwards, we employ a Hodrick and Prescott ¯lter to obtain the long-run trend of these variables. Subsequently, we calculate the deviation of each series with respect to its trend. We shall from this point on refer to these deviations as the *credit gap*, *investment gap*, *equity gap*, *housing gap* and *API gap*. Figure 1 plots the percentage *gap* for each of the series considered[14]. The shaded region corresponds to the crisis period (i.e. 98-99).

IV. Results

As Figure 1 reveals, the credit, investment, equity and API *gap* present high deviations from their long-term trend for the year prior to and/or during the financial crisis of 1998-1999[15]. However, the same is not true for the *housing gap* which does not show a high *gap* for the year before or during the crisis, but rather 3 years earlier (i.e. 1995). This could mean one of two things. Either that housing prices are not a good *early-warning* indicator, or on the contrary, they are the best *early-warning* indicator, because they predict the imbalance first.

Additionally, it is interesting to note that the *credit gap*, *equity gap* and *API gap* showed somewhat similar deviations during the pre-crisis period and the first quarter of 2006. However, they diverge significantly starting the second quarter and up until the end of the year, with the loans to GDP ratio registering its highest deviations (over 10%) with respect to its trend, while both equity prices and the API presented important reductions in theirs (around 20 percentage points). This is not surprising if one keeps in mind that credit grew over 20% in real terms during 2006 (GDP grew 6.8%), a level that has already began to worry supervisory authorities as well as the Central Bank. This has led to important monetary measures to slow-down the rapid credit expansion (interest rate hikes, marginal reserve requirements, among others) and the implementation of a new credit-risk model to enhance the current risk measures[16]. The fall in the API and

---

[13] IGBC is constructed by the Bolsa de Valores de Colombia (www.bvc.com.co) and IPVN is constructed by DNP (www.dnp.gov.co). Appendix B carefully explains the construction of the aggregate price index, calculated at Banco de la República (Central Bank of Colombia).

[14] A *gap* of 1.2 implies a deviation of 20% between the series and its trend. In other words, the series' value is 20% greater than the long-run trend value.

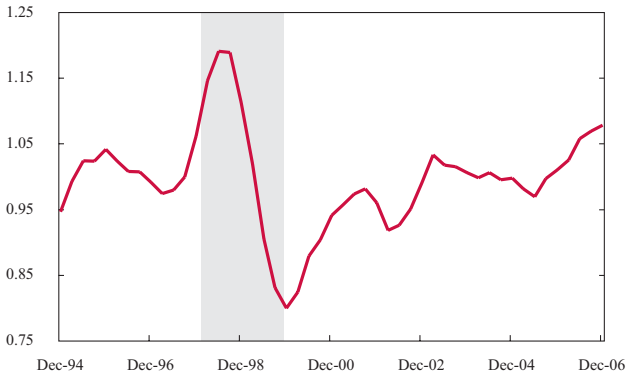
[15] This crisis was the must pronounced *shock* the Colombian economy has su®ered in the last century, and is actually the only crisis in our data set.

[16] The new model is called SARC (for its spanish initials) and is currently operating only for commercial loans. The idea is to extend it to consumption loans by 2008. The central idea behind the model is for banks to have higher provisioning levels during the ascending part of the economic cycle so as to create a reserve fund for the "bad" times. More on this model can be found at www.superfinanciera.gov.co

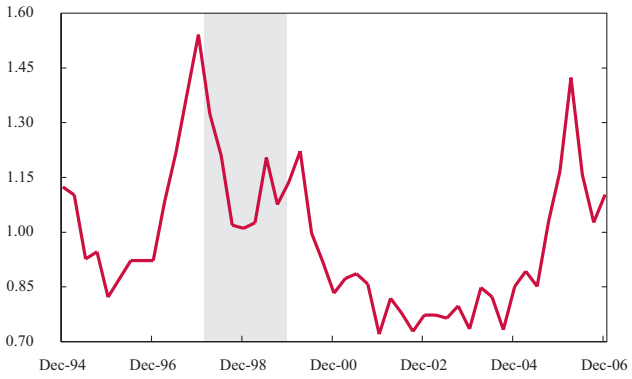
DEVIATION FROM THE ANALYZED SERIES TO THEIR LONG-TERM TREND (GAP)

A. CREDIT GAP

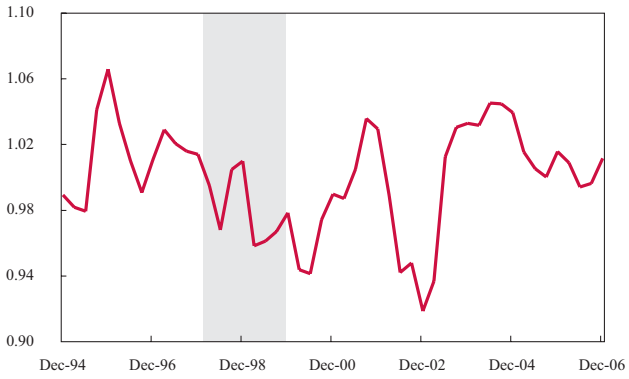
B. INVESTMENT GAP



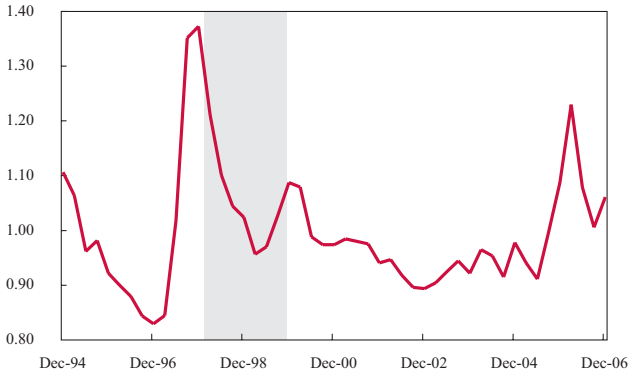
C. GENERAL EQUITY GAP



D. HOUSING GAP



E. API GAP



Source: National Office of the Superintendent of Financial Institutions , BVC, DANE, DNP, authors´ calculations,

equity prices is explained by the high volatility experienced in local markets during the second quarter of 2006, which increased certain investors' risk aversion and adversely affected their portfolio position in these assets (e.g. pension funds, stock brokers, investment funds, among others).

The *indicators* that we intend to build must give an alert signal when the estimated gaps overcome certain threshold values. In this way, we use a trial-and-error methodology to verify the efficiency of these indicators by checking whether they were able to predict the 1998-1999 economic crisis, how many *false alarms* are detected and whether each indicator identifies a financial imbalance as of December 2006. Obviously, the information may vary depending on the threshold values that are chosen. We construct information tables for the alert signals that the various indicators give for different threshold values and time horizons, we also use *combinations* of indicators. Results are presented in Figure 2.

In the tables presented, an imbalance is defined as a period in which two or more quarters present deviations above the chosen threshold level[17] at the respective time horizon. A 1 year horizon means that the predictive capacity of the indicator is validated only if an imbalance is present the year immediately prior to the crisis; a 2 year horizon means it is validated if the imbalance is present either the year before or two years before, and so on. For the *joint* indicators, all the chosen variables must exhibit an imbalance in order for the signal to be on.

The results from the individual indicators show no apparent surprises. All indicators correctly predict the 98-99 crisis at all horizons for the threshold values chosen, except housing prices. The latter only identifies the crisis when a 3 year horizon is considered. Additionally, only the credit indicator identifies an imbalance *today*, for all threshold values and horizons. The investment, equity and API indicators identify it as well, but only with the lowest threshold values considered. However, the equity and API indicators both give *false signals* when such a threshold is chosen, which is certainly not a desired feature in these type of indicators.

The fact that both the API and equity indicators *fail* to predict an imbalance as of December 2006 is directly related to the volatility period during the second quarter of 2006, which reduced the deviation of each series to its respective trend[18]. However, it is interesting to note that the deviations present during the latter half of 2005 and the first quarter of 2006 did effectively reflect a possible imbalance in those markets; one which corrected abruptly before the end of the first semester.

---

[17] This is done in order to eliminate possible "noisy-signals" which arise due to high volatilities under very specific conjunctures in the market.

[18] Assuming that the deviation would have continued to increase had there been no such volatility in the market.

EARLY-WARNING INDICATORS

Housing Gap

Threshold Value		Horizon		
		1 year	2 years	3 years
4	No. of correctly predicted	0	0	1
	No. of false alarms	2	2	0
	Predicts imbalance today	No	No	No
5	No. of correctly predicted	0	0	0
	No. of false alarms	0	0	0
	Predicts imbalance today	No	No	No
6	No. of correctly predicted	0	0	0
	No. of false alarms	0	0	0
	Predicts imbalance today	No	No	No

Credit Gap

Threshold Value		Horizon		
		1 year	2 years	3 years
4	No. of correctly predicted	1	1	1
	No. of false alarms	0	0	0
	Predicts imbalance today	Yes	Yes	Yes
6	No. of correctly predicted	1	1	1
	No. of false alarms	0	0	0
	Predicts imbalance today	Yes	Yes	Yes
7	No. of correctly predicted	1	1	1
	No. of false alarms	0	0	0
	Predicts imbalance today	Yes	Yes	Yes

Investment Gap

Threshold Value		Horizon		
		1 year	2 years	3 years
5	No. of correctly predicted	1	1	1
	No. of false alarms	0	0	0
	Predicts imbalance today	Yes	Yes	Yes
9	No. of correctly predicted	1	1	1
	No. of false alarms	0	0	0
	Predicts imbalance today	No	No	No
10	No. of correctly predicted	1	1	1
	No. of false alarms	0	0	0
	Predicts imbalance today	No	No	No

Equity Gap

Threshold Value		Horizon		
		1 year	2 years	3 years
10	No. of correctly predicted	1	1	1
	No. of false alarms	1	1	1
	Predicts imbalance today	Yes	Yes	Yes
20	No. of correctly predicted	1	1	1
	No. of false alarms	0	0	0
	Predicts imbalance today	No	No	No
30	No. of correctly predicted	1	1	1
	No. of false alarms	0	0	0
	Predicts imbalance today	No	No	No

Aggregate Price Index (API) Gap

Threshold Value		Horizon		
		1 year	2 years	3 years
5	No. of correctly predicted	1	1	1
	No. of false alarms	1	1	1
	Predicts imbalance today	Yes	Yes	Yes
15	No. of correctly predicted	1	1	1
	No. of false alarms	0	0	0
	Predicts imbalance today	No	No	No
25	No. of correctly predicted	1	1	1
	No. of false alarms	0	0	0
	Predicts imbalance today	No	No	No

Note: The threshold values are expressed as percentage deviations from the trend. The horizon is the number of years, prior to the imbalance period, considered to test the predictive power of the indicator. An indicator is on if the deviation form the trend is above the chosen threshold level for two or more consecutive quarters at the respective horizon.

TABLE 1

EARLY-WARNING INDICATORS (CONTINUED)

Joint Indicator (Credit-Investment-Equity-Housing)

Threshold Value					Horizon		
Credit	Invest.	Equity	Housing		1 year	2 years	3 years
4	5	30	4	No. of correctly predicted	0	0	1
				No. of false alarms	0	0	0
				Predicts imbalance today	No	No	No
4	10	30	4	No. of correctly predicted	0	0	1
				No. of false alarms	0	0	0
				Predicts imbalance today	No	No	No

Joint Indicator (Credit-Investment-Equity)

Threshold Value				Horizon		
Credit	Invest.	Equity		1 year	2 years	3 years
4	5	30	No. of correctly predicted	1	1	1
			No. of false alarms	0	0	0
			Predicts imbalance today	No	No	No
4	5	10	No. of correctly predicted	1	1	1
			No. of false alarms	0	0	0
			Predicts imbalance today	Yes	Yes	Yes

Joint Indicator (Credit-Investment-API)

Threshold Value				Horizon		
Credit	Invest.	IPA		1 year	2 years	3 years
4	5	15	No. of correctly predicted	1	1	1
			No. of false alarms	0	0	0
			Predicts imbalance today	No	No	No
4	5	5	No. of correctly predicted	1	1	1
			No. of false alarms	0	0	0
			Predicts imbalance today	Yes	Yes	Yes
4	10	5	No. of correctly predicted	1	1	1
			No. of false alarms	0	0	0
			Predicts imbalance today	No	No	No

Note: The threshold values are expressed as percentage deviations from the trend. The horizon is the number of years, prior to the imbalance period, considered to test the predictive power of the indicator. An indicator is on if the deviation form the trend is above the chosen threshold level for two or more consecutive quarters at the respective horizon.

The *joint* indicators give diverse results. Not surprisingly, when an indicator involves housing prices (Credit-Investment-Equity-Housing), it does not predict a financial imbalance *today* and only correctly predicts the 98-99 crisis when a 3 year horizon is chosen. The second *joint* indicator (Credit-Investment-Equity), correctly predicts the crisis period for the threshold values and horizons considered. Moreover, including real variables along with equity prices eliminates the *false alarms* present when the latter was taken individually. Whether the indicator predicts

an imbalance *today* remains a matter of choice between the two sets of threshold values, and given uncertainty as to whether the next years will effectively feature a financial imbalance, a definite choice cannot be made between the two. The same conclusion holds for the Credit-Investment-API indicator, which is expected given the relative importance of equity price movements in the behavior of this index.

Overall, a definite conclusion cannot be made as to which indicator is *best*. However, there is enough evidence in these indicators regarding the information that financial prices (at least equity prices), among with other key variables, have in identifying possible future imbalances (i.e. almost all indicators were on before the 98-99 crisis). Preliminary results tend to favor both the Credit indicator and the *joint* indicators Credit-Investment-Equity and Credit-Investment-API, as they all correctly predict the crisis period and make no *false alarms*. The strong appeal of the latter lies in that they take into account financial and real variables and theoretically include more market information. The future behavior of the market (i.e. the occurrence or not of a financial imbalance) will more specifically tell us which threshold values work *best*; However, note that the realization of a future imbalance will make a strong case for the Credit indicator, since it is the only *early-warning* signal that is on regardless of the threshold value chosen. In this more than in any other case, only time will tell.

V. Concluding Remarks

Asset prices have recently began to experience an academic *boom*, by becoming a common topic in economic debate. However, much time has been spent in determining whether asset prices effectively exhibit a bubble component, a question which although being theoretically appealing deviates from the policy makers needs. For the latter, the fact that asset prices may contain relevant information concerning future market developments is central, and should therefore be exploited.

This paper is a first effort in this direction, aimed towards the construction of *early-warning* indicators using financial (including asset prices) and real variables, both individually and *jointly*. Results show evidence to support that there is relevant information embedded in these series, as all indicators (except the new housing price indicator) reveal a significant deviation for the year(s) prior to the 98-99 crisis (i.e. they are on). Additionally, the exercises here conducted show that the performance of asset price indicators is enhanced by including credit and investment, thus considering a wider range of market information. A definite conclusion regarding the *best* indicator (along with the *best* forecast horizon and threshold level) will unfortunately depend on future market events. They will be the ultimate judge on the predictive power of each indicator.

In terms of policy action, these indicators serve two purposes. Firstly, the individual indicators help identify specific markets where signs of possible imbalances are present. Secondly, the *joint* indicators help to identify specific moments when the promotion of a sounder financial system is most necessary (although by no means unique). When the *early-warning* indicators are on, the role of the policy maker should be *more* active in the market. Not necessarily in the traditional sense (i.e. altering interest rates), but in communicating with market participants, promoting portfolio diversification, preserving the long-term perspective of institutional investors (e.g. pension funds) and urging financial agents to make the best use of the information (i.e. credit data bases and/or firms balance sheets) and risk management tools that are available to them[19].

However, as mentioned above, these actions should not be the sole responsibility of the *imbalance* periods, and should be regularly practiced by local authorities (i.e. prudential regulation). Additionally, promoting the creation and deepening of capital markets to increase portfolio diversification is a task that must not be left aside, because the future development of a more shock-resistant financial system will largely depend on the level of maturity of the system as a whole.

In this respect, the Banco de la República has done an immense effort, by openly collaborating with the Superintendencia Financiera in the sophistication and implementation of risk management tools to better face market, credit and liquidity risk. Additionally, by emphasizing in its periodical publications the need to advance in better credit-information data bases for the financial system, alerting banks to keep a close watch on the level of non-performing loans and analyzing asset prices in an effort to identify possible imbalances.

Future research in this field is more than necessary, especially since this is only a first approach to obtaining all the relevant information for policy makers from asset prices. A possible next step would be to follow Coudert and Gex (2006) in utilizing risk aversion indicators (which are constructed using principal component analysis on financial price series) to anticipate financial imbalances[20]. The important issue at hand is that all such efforts, no matter how sophisticated or practical, by being aimed towards granting monetary authorities new tools to prevent pronounced periods of recession, are welcome.

---

[19] An excellent review of the prudential and supervisory measures that can and have been used by policy-makers worldwide to undermine possible future financial imbalances is found in Hilbers *et al*. (2005).

[20] The authors use probability models to test this hypothesis.

References

Borio, C. and Lowe, P. (2002). Asset Prices, Financial and Monetary Stability: Exploring the Nexus. Paper presented at the BIS Conference on "Changes in Risk Through Time: Measurement and Policy Options", *BIS Working Papers*, No 114 (July), Basel.

Borio, C. and Lowe, P. (2002). Imbalances or "Bubbles?" Implications for Monetary and Financial Stability. In C. Hunter, G. Kaufman and M. Pomerleano (Eds) (2003), *Asset Price Bubbles: The Implications for Monetary, Regulatory and International Policies*. Cambridge, MA: MIT Press, pp. 247-270.

Cecchetti, S., Genberg, H. and Wadhwani, S.(2003). Asset Prices in a Flexible In°ation Targeting Framework. In C. Hunter, G. Kaufman and M. Pomerleano (Eds) (2003), *Asset Price Bubbles: The Implications for Monetary, Regulatory and International Policies*. Cambridge, MA: MIT Press, pp. 227-444.

Cochrane, J. (1992). Explaining the Variance of Price Dividend Ratios. *Review of Financial Studies* 5(2), pp. 243-280.

Collyns, C. and Senhadjy, A. (2003). Lending Booms, Real Estate Bubbles, and the Asian Crisis. In C. Hunter, G. Kaufman and M. Pomerleano (Eds) (2003), *Asset Price Bubbles: The Implications for Monetary, Regulatory and International Policies*. Cambridge, MA: MIT Press, pp. 101-125.

Coudert, V. and Gex, M. (2006). Can Risk Aversion Indicators Anticipate Financial Crises? *Financial Stability Review* Banque de France, No. 9. December. pp. 67-87.

Dezbakhsh, H. and Demirguc-Kunt, A. (1990). On the Presence of Speculative Bubbles in Stock Prices. *The Journal of Financial and Quantitative Analysis* 25, pp. 101-112.

Diba, B. and Grossman, H. (1988a). Explosive Rational Bubbles in Stock Prices? *American Economic Review* 78(June), pp. 520-530.

Diba, B. and Grossman, H. (1988b). The Theory of Rational Bubbles in Stock Prices. *The Economic Journal* 98(September), pp. 746-754.

Dowd, K. (2005). *Measuring Market Risk*. Chichester: John Wiley & Sons Ltd.

Driffill, J. and Sola, M. (1998). Intrinsic Bubbles and Regime Switching. *Journal of Monetary Economics* 42(July), pp. 357-373.

Evans, G. (1991). Pitfalls in Testing for Explosive Bubbles in Asset Prices. *American Economic Review* 31(September), pp. 922-930.

Friedman, M.(2003). Comments on Implications of Bubbles for Monetary Policy. In C. Hunter, G. Kaufman and M. Pomerleano (Eds) (2003), *Asset Price Bubbles: The Implications for Monetary, Regulatory and International Policies*. Cambridge, MA: MIT Press, pp. 459-463.

Flood, R., Hodrick, R. and Kaplan P. (1994). An Evaluation of Recent Evidence on Stock Price Bubbles. In Robert Flood and Peter Garber (Eds) *Speculative Bubbles, Speculative Attacks, and Policy Switching*. Cambridge, MA: MIT Press, pp. 105-133.

Froot, K. and Obstfeld, M. (1991). Intrinsic Bubbles: The Case of Stock Prices. *American Economic Review* 81(December), pp. 1189-1214.

Goodfriend, M.(2003). Interest Rate Policy Should Not React Directly to Asset Prices. In C. Hunter, G. Kaufman and M. Pomerleano (Eds) (2003), *Asset Price Bubbles: The Implications for Monetary, Regulatory and International Policies*. Cambridge, MA: MIT Press, pp. 444-457.

Gourinchas, P., Valdes, R. and Landerretche, O. (2001). Lending booms: Latin America and the world. *NBER Working Paper*, No. 8249.

Gurkaynak, R.S. (2005). Econometric Tests of Asset Price Bubbles: Taking Stock. *FEDS Working Paper* 2005-04. Available at SSRN:http://ssrn.com/abstract=658244

Hilbers, P., Otker-Robe, I., Pazarbasioglu, C. and Johnsen, G. (2005). Assessing and Managing Rapid Credit Growth and the Role of Supervisory and Prudential Policies. *IMF Working Paper*, WP/05/151.

Kaminsky, G. and Reinhart, C. (1999). The twin crises: the causes of banking and balance-of-payments problems. *American Economic Review*. Vol 89, No 3, June, pp 473-500.

Kroszner, R.S. (2003). Asset Price Bubbles, Information, and Public Policy. In C. Hunter, G. Kaufman and M. Pomerleano (Eds) (2003), *Asset Price Bubbles: The Implications for Monetary, Regulatory and International Policies*. Cambridge, MA: MIT Press, pp. 3-12.

McGrattan, E.R. and Prescott, E. (2003). Testing for Stock Market Overvaluation/Undervaluation. In C. Hunter, G. Kaufman and M. Pomerleano (Eds) (2003), *Asset Price Bubbles: The Implications for Monetary, Regulatory and International Policies*. Cambridge, MA: MIT Press, pp. 271-276.

Meltzer, A.H. (2003). Rational and Nonrational Bubbles. In C. Hunter, G. Kaufman and M. Pomerleano (Eds) (2003), *Asset Price Bubbles: The Implications for Monetary, Regulatory and International Policies*. Cambridge, MA: MIT Press, pp. 23-33.

Shiller, R. (1981). Do Stock Prices Move Too Much to be Justi¯ed by Subsequent Changes in Dividends?. *American Economic Review* 71(June), pp. 421-436.

Sopanha, S. (2006). Capital Flows and Credit Booms in Emerging Market Economies. *Financial Stability Review* Banque de France, No. 9. December. pp. 49-66.

Tirole, J. (1985). Asset Bubbles and Overlapping Generations. *Econometrica* 53, pp. 1499-1528.

Trichet, J.-C. (2003). Asset Price Bubbles and Their Implications for Monteray Policy and Financial Stability. In C. Hunter, G. Kaufman and M. Pomerleano (Eds) (2003), *Asset Price Bubbles: The Implications for Monetary, Regulatory and International Policies*. Cambridge, MA: MIT Press, pp. 15-22.

Van Norden, S. and Vigfusson, S. (1998). Avoiding the Pitfalls: Can Regime-Switching Tests Reliably Detect Bubbles? *Studies in Nonlinear Dynamics and Econometrics* 3, pp. 1-22.

Villar, L., Salamanca, D. and Murcia, A. (2005). Crédito, Represión Financiera y Flujos de Capitales en Colombia *Borradores de Economía, Banco de la República* No. 322.

West, K.(1987). A Specification Test for Speculative Bubbles. *The Quarterly Journal of Economics* 102(August), pp. 553-580.

Wu, Y. (1997). Rational Bubbles in the Stock Market: Accounting for the U.S. Stock-Price Volatility. *Economic Inquiry* 35(April), pp. 309-319. MIT Press. pp, 444-457,