Are Macroprudential Indicators Leading Indicators of Economic and Financial Distress in The Bahamas

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Abstract

Since the start of the 2008 global economic recession, policy makers have placed increased emphasis on macroprudential regulations and instruments to mitigate the effects of and where possible prevent financial crises. Moreover the importance of monitoring macroprudentuial indicators in providing early warning signs of an impending crisis has intensified. This paper therefore seeks to analyse the relevance of macroprudential variables in predicting economic crises in The Bahamas, and to compare their performance against traditional leading economic indicators. Two series of tests were performed, using the Signals Approach and Probit models and the results showed that macorprudential indicators were more effective at predicting oncoming economic crises than traditional macroeconomic variables; however the predictive ability of the model was enhanced when the two sets of variables were combined.

Keywords: Macroprudential indicators, Signal Approach, Probit Models,

[1] The views expressed in this paper are those of the authors and do not necessarily represent The Central Bank of The Bahamas. This paper should be considered a work in progress and as such the authors would welcome any comments on the written text.

Introduction

The current recession has made visible the vulnerabilities in the global financial system worldwide. It has shown that the present policies are insufficient are completely and effectively handle the financial system. This is clearly seen in the Caribbean, where prior to the global recession, the ratio of total non-performing loans in the banking system to total loans averaged 6.0%, but rose sharply to an estimated 10% by end-2011.

Consequently, the recession emphasised the need to create a more robust early warning indicator framework. With such a framework, policy makers would have the ability to access conditions in the macro-economy and banking sector and thereby, undertake measures to minimize the impact of shocks on their economies. Traditionally, Caribbean economies have placed emphasis on macroeconomic indicators such as global real gross domestic product, employment, credit, and external reserves; however, given the respective negative effect which adverse developments in the banking sector may have on the wider economy, is important to have indicators which monitor the performance of the banking sector in order to detect potential challenges that may affect the wider economy in the future.

This paper therefore seeks to create early warning indicators for the banking system called macroprudential indicators and tests the suitability of the early warning indicators in detecting potential economic and financial crises and compares the performance of these variables against traditional leading economic indicators.

The remainder of the paper is organized as follows: section two provided an overview of a few countries experiences developing macroprudential frameworks and their impact on the banking sector. The following section provides a brief overview of the literature on macroprudential

indicators. Section four explains the methodology of the paper and outlines the two specific models used. Section five presents the results of the two utilised and compares the performance of the macroprudential versus the macroeconomic variables, while the final section summarises the findings and prevents the limitations of the study.

Review of Macroprudential Policy: Country Studies

During the recent financial crisis, most countries sought to implement macroprudential policies because of the financial vulnerabilities exposed in their banking sectors. As traditional financial regulations were not all-encompassing of financial risk, most governments began exploring more systemic approaches, which addressed the entire financial system rather than its individual institutions. These measures formed the latest series of macroprudential policies, which countries have implemented over the last two decades.

The United States of America

In the 1980s, the United States experienced mass bank failures while larger banks increased their leveraging positions, putting them at increased risk. Prior to 1991, the United States had no interagency capital standards and as a result of the above concerns, a leverage ratio was implemented. This ratio was administered to both the bank holding company and individual banks.

The leverage ratio (capital to assets ratio) monitors all bank risk by constraining how much a bank is able to leverage its equity. This macroprudential instrument's sole purpose was to contain the steady increase in leverage build up. It was implemented mainly because of its ease of use and the simplicity. The ratio was set at different rates depending on the strength of the institution, which was determined by its supervisory body. The ratio was immediately applied to

all banking institutions, however it did not work in conjunction with other polices nor was the rate ever adjusted in response to an evolving financial climate.

The ratio kept leverage at both commercial and investment banks low over the period until 2004 when investment banks chose to have consolidated oversight, which allowed their leverage to increase. As a result, leverage increased from 15:1 to 40:1 in investment banks (Lim et al 2011) but remained lower in commercial banks.

In 2010, the US created a macroprudential policy supervisory council, the Financial Stability Oversight Council (FSOC). This Committee was given the mandate to protect the US economy from future financial crises. In this regard, the FSOC liaises with various US regulatory bodies to ensure no miscommunication and to recommend any developed prudential supervisory standards, especially in the event any individual institution may cause a disruption in financial stability (Kern, 2012).

Most recently, the FSOC enacted the "*Volcker Rule,"* which restricts the composition of certain bank assets through applying limits on proprietary trading (Viñals 2011). The purpose is to limit bank's exposure to excessive risks.

Spain

Prior to 2000, Spain saw the need to protect its banks against excessive and rapid credit growth, while assessing the true value of risk due to the fluctuations in the lending cycle (Repullo & Saurina, 2011). As a result, dynamic provisioning (DP) was introduced in 2000 by the Banco de España, shortly following the implementation of the Single Monetary Policy of the European Union. DP was seen as a transparent tool that would reduce procyclicality, as it is a macroprudential tool that requires banks to build reserves in the event of sudden loan losses,

based on the average of these losses within a full economic cycle, average specific provisions and specific provisions in the most recent period. In 2005, DP was changed in compliance with the International Financial Reporting Standards (IFRS). DP helped to build a buffer during upturns and the reserves were used during recessions. It was meant to deal with the sharp increase in credit risk on banks' balance sheets. It was also meant as an incentive for more prudent lending that would curb credit growth, as moral suasion proved too weak and ineffective in this regard. Additionally, this instrument was proven to be relatively effective for the Spanish economy, due to research and various studies on the history of lending within the country.

The DP tool was used exclusively by the Bank, as no other macroprudential tools were introduced and it proved to be somewhat effective in dealing with credit losses in Spain during the financial crisis, as the losses due to the increase in non-performing loans were only partially absorbed by the DP, because actual losses were much higher than anticipated. Another challenge occurred with the size of provisioning for each bank. Some banks had larger reserves than others, because the DP formula was homogenized with no differentiation between banks. Lim at al suggests that rates be distinguished between loan categories and banks to curb this problem. Alberola et al (2011) explains that due to the complexities of the lending cycle DP is not a "macroprudential panacea," as macroprudential polices must work simultaneously with monetary policy. Having an overarching monetary policy at the European Union level, while introducing macroprudential policy at the domestic level, gave Spain the opportunity to use policies that worked for its own economic environment.

South Korea

South Korea, introduced macroprudential measures in the aftermath of the 2008 financial crisis to mitigate volatile capital flows. Unlike the US and Spain, the South Korean regulatory authorities introduced its policies in the form of packages, differentiated between domestic and foreign banks and adjusted these measures from time to time. Additionally, the macroprudential polices were to work alongside fiscal policy tools.

South Korea used a number of tools to alleviate the instabilities of foreign capital flows. They increased long-term foreign currency denominated borrowing by 10% to 90% of their long-term leading. Banks were required to hold at minimum 2% of their foreign assets in liquid investments rated "A" or higher, as at November 2009.

The regulatory authorities introduced a withholding tax on foreign purchases on domestic bonds. In December 2009, the Korean supervisory authority reintroduced new regulation for a loan-to-deposit policy that puts a cap on lending growth, so that it does not exceed the same pace of deposit growth. In reference to the real estate market, South Korea placed a limit on their Loan-to-Value ratios (LTV) and placed a cap on Debt-to-Income ratios (DTI).

In accordance with recommendations made by the IMF through its Financial Stability Contribution (Bruno et al 2012), the South Korean regulatory authorities began work on a macroprudential levy in December 2010 that was initiated in August 2011. The levy is placed on banks' non-deposit foreign exchange-denominated liabilities with a 20 basis point rate for short-term liabilities. The main purpose of this tool is for financial stability especially with the vulnerabilities of open emerging economies.

As a result of the macroprudential policies, South Korea has seen limited growth in banks' external borrowing as their short-term external borrowing remain 30% below the pre-crisis levels of 2012. However, the policies have not been proven to stem portfolio inflows into both debt and equity markets (Lim et al). Additionally, the impact of the withholding tax has been curtailed due to the existence of a double taxation agreement. The effects of the LTV and DTI have been somewhat effective, as Igan and Kang (2011) found that they assisted in controlling real estate booms and their risks. Also, limits on LTV appear to have greater effect than limits on

Latin America and the Caribbean (LAC)

Macroprudential polices are relatively new and still under development in the region. Historically, in LAC credit and equity price booms are common occurrences, while credit cycles are more prolonged and volatile. Additionally, de la Tovar et al (2012) explains that during downturns, fluctuations with bank leverage, housing prices and real exchange rates have been more amplified, which accounts for the ongoing threat of macroeconomic volatility.

As a result of this history of financial instability in the LAC region, the macroprudential suggested changes have been to augment policies already in place by contracting regulation during an upturn and relaxing it during a downturn. Several LAC countries targeting lower inflation rates, including Brazil, Colombia, and Peru, sought to implement changes to the banks' reserve requirement in an attempt to restrain credit cycles. In addition, several LAC countries such as Colombia, Mexico and Uruguay, have used countercyclical dynamic provisioning with some degree of success to contain leverage and credit growth (Jácome et al 2012).

Similar to the United States, Chile, Mexico, and Uruguay have taken major steps towards creating effective macroprudential polices through the formation of financial stability

committees. These committees have been established to make recommendations on what macroprudential instruments can be most effective in any given situation; however, they are not able to make a final decision on which instruments are used. Of the three countries, only Mexico produces a report detailing the current state of financial stability in the country.

Macroprudential policies are used in the Caribbean to a far less extent than in Latin America. In the most recent Financial Stability Reports (FSR) published by several Caribbean nations, it was noted that they are working towards macroprudential policymaking. In this regard, Jamaica had the most rigorous and thorough analysis of macroprudential conditions, as it utilised an overall macroprudential index. Trinidad and Tobago's FSR contained references to macroprudential indicators, but only within a discussion on the macroeconomic environment, while Belize and Suriname mentioned only select macroprudential indicators. On the other hand, Barbados did not include a macroprudential index.

The countries and regions evaluated are all on a path to eventual macroprudential policy integration within their economies. Macroprudential policies are still undergoing development and refinement in the region; however, there appears to be consensus among researchers that these policies are in no way a "magic bullet." For the policies to remain effective, they must work alongside other existing policies. Although the research on the use of macroprudential indicators is sparse, a few authors have utilised a variety of techniques to determine the efficiency of macroprudential indicators in predicting financial and economic crises.

Literature Review

Juselius and Drehmann (2012) construct and test a variety of early warning indicators (EWIs). The main properties that are identified as being essential in assessing EWIs with respect to

policy requirements are an analysis of the costs-benefits of macroprudential interventions (cost of crisis vs. cost of intervention) as well as the timing and consistency of the EWI in signalling crises. The receiver operating characteristic (ROC) curve technique was employed to summarize the trade-offs between type I and type II errors. For the assessment, a sample of 27 economies was used which included a total of 25 crises covering a quarterly time series dating back 1980 for most of the countries. The macroprudential indicators used in the analysis included the credit-to-GDP gap, property-price gap, the debt service ratio and GDP growth.

The main findings were that the area under the ROC curve (AUROC) was high for all indicators (at least 75%) in the 5 year flexible horizon forecasts with the debt service ratio. However, the ROC curves for fixed horizon forecasts reveal that the debt service ratio and the credit-to-GDP gap to be the strongest indicators in predicting crises with the debt service ratio strongest in the shorter horizons and credit-to-GDP gap dominant in the longer horizons. According to Juselius and Drehmann, the remaining two indicators, property-price gap and GDP growth were found to have "less stable" temporal performance.

In a 2012 study, Jahn and Kick develop a forward-looking indicator for banking sector stability in Germany and analyzed the impact of leading macroprudential indicators on banking sector stability. The study was done against the backdrop of occasional periods of banking sector instability rather than full-blown banking sector crises. To develop a forward-looking indicator for financial institutions, the following indicators were used: the institutions' individual standardised probability of default, credit spread, and stock market index for the banking sector. In analysing the impact of macroprudential indicators the set of explanatory variables included macroeconomic variables (asset price indicators and leading indicators of the business cycle),

financial variables (lending and monetary indicators), and structural variables (regional spillovers, counterparty exposures, risk aversion and bank size).

The study was based on data from approximately 3,300 financial institutions in Germany over the period from 1995 to 2010. Panel regression techniques were employed which led to the conclusion that asset price indicators, leading indicators of the business cycle and monetary indicators were the most reliable early warning indicators. Further, international spillover effects were found to have significantly influenced banking sector stability across all sectors with regional spillover effects, and the credit-to-GDP ratio having a significant effect on credit cooperatives but less so for commercial banks.

Bhattacharayay (2003) proposed a macroprudential framework for monitoring financial sector vulnerability in the wake of the 1997 Asian financial crisis. A core set of 22 leading indicators gathered from a broader set of 67 identified by the Asian Development Bank were used. The types of commonly agreed indicators included external debt and financial flows, money and credit, banking indicators, interest rates, stock markets and bonds, trade exchange and international reserves and business survey data. To test the relationship between the indicators, the author preformed a time series analysis on the leading indicators for Thailand, in order to provide a framework for "early warning/vulnerability" rather than predictive power. Based on the results, the author concluded that each country needed to perform its own simulation analysis in order to arrive at the most appropriate core set of indicators.

Methodology

This section seeks to analyze the performance of variables over time to determine their suitability first individually, as early warning indicators of an economic and financial crisis and then in two

separate groups of macroprudential and macroeconomic indicators. This process allowed the researchers to determine whether or not macroprudential variables are useful in predicting an impending financial or economic crisis and to gauge their performance vis-à-vis other macroeconomic indicators in predicting an impending crisis.

Two separate tests were performed using the following techniques:

- The Signals Approach
- Probit Models

In order to execute each approach, a crisis period was first identified. In the case of The Bahamas, there have not been any instances of financial crisis, hence the definition of a crisis focussed on periods of economic downturn. Initially, several definitions of economic crisis were modelled, based on studies by Jeanne and Ranciére (2006) and Calvo et al (2004), who defined a crisis in terms of a sharp decline in capital inflows. Other authors such as Frankel and Cavello (2004), include a contraction in real output and capital flows in their definitions of economic crisis. Unfortunately, neither of these definitions led to the identification of more than one crisis period over the entire sample period, which would severely limit the results of the tests; the authors then utilised the standard definition of an economic recession, namely that an economic crisis is determined to have occurred when the economy, namely a contraction in real output over the two consecutive quarters for quarter data or over a one year period in the case of annual data, and the crisis end when the economy returns to growth. Using this approach, three separate crisis periods were identified, namely 2003, 2008 and 2009.

A total of thirteen indicators were chosen based on available data and Table 1 (Appendix I) details the names and the expected sign of each indicator. All of the data was obtained from

various published and unpublished Central Bank sources. The macroprudential indicators utilised were based on several studies conducted by authors such as Lim et al and Tovar et al (2012). In terms of the integration of the signs of the variables, it is assured that an increase or decrease in any of the variables is expected to lead to an increase or a decrease in the probability of a crisis happening within the next eight quarters. For example, an increase in air arrivals (AIR_ARRIVALS) would lead to a decrease in the probability of a crisis happening or an increase in National debt to GDP (N_DEBT_GDP) would cause an increase in the probability of a crisis occurring within the next eight quarters.

All of the variables were available on a quarterly basis, with the exception of Nominal and Real GDP, which were available only on an annual basis. As a consequence, in order to obtain quarterly data, the annual series needed to be disaggregated, this was accomplished by utilizing the Chow and Lin procedure developed in 1971[2].

The Signals Approach

In applying the "Signals" methodology, it is important to note that there are several key characteristics of the Signals approach; firstly, each variable issues a warning or signal when the variable deviates from its normal level beyond a particular threshold value. An arbitrary threshold must be identified in order to ascertain a particular crisis. Once the crisis index exceeds the threshold level, this is classified as a positive signal i.e. a signal is expected to occur within a two year period. For the purposes of this testing, a threshold of the 20th percentile was used as it appeared to strike an adequate balance between the good and bad signals given the limitations of the data. In order to establish an evaluation criterion, an indicator was considered to emit a good

[2] See Appendix II for an overview of the Chow-Lin technique.

signal, if it was followed by a crisis within 24 months (eight quarters), while a signal not followed by a crisis within 24 months is considered to be a bad signal (noise). This criteria is consistent with other studies such as Reinhart et al, (1998).

In order to examine the usefulness of the individual variables, the following matrix was used. A is the number of quarters in which the indicator issued a good signal. B is the number of quarters in which the indicator issued a bad signal (noise). C is the number of quarters in which the indicator failed to issue a signal and a crisis occurred (8-A). D is the number of quarters in which the indicator failed to issue a signal and a crisis did not occur (Residual). A perfect indicator would only produce observations in the northwest (A) or southeast (D) cells of the matrix. The variable would issue a signal in every quarter that is to be followed by a crisis (within 8 quarters), so that A>0 and C=0, and no signal would be issued in every quarter that is not to be followed by a crisis (within 8 quarters), so that B=0 and D>0. Through our testing, none of the variables were ideal; however, the effectiveness of this matrix is determined by the proximity of each indicator to this profile[4].

Probit Models

The next step involved modelling of the factors which signalled an impending crisis within the next two years (8 quarters), as shown in Equation one:

[4] See Table 2 Appendix I.

$$C_t = \alpha + \gamma X_t \quad (1)$$

where:

$C_t = 1$ *if crisis occurrs within eight quarters*

$= 0$ *otherwise*

$\alpha =$ *Intercept term*

$X =$ *Matrix of signal variables*

Three separate regressions were conducted, the first featured only the macroeconomic variables, the second model was comprised solely of the macroprudential variables and the third equation featured a combination of macroeconomic and macroprudential variables.

A probit model was utilised in the regression analysis. In this model the probability that y = 1 is given by:

$$\Pr(yi = 1 \mid xi, \beta) = 1 - \Phi(-xi'\beta) = \Phi(xi'\beta) \quad (2)$$

where Φ is the cumulative distribution function of the standard normal distribution,

and has a standard normal distribution function given by

$$\Phi(w) = \int_{-\infty}^{w} \frac{1}{\sqrt{2\pi}} \exp\left\{-\frac{1}{2}t^2\right\} dt \quad (3)$$

The models were estimated using the method of maximum likelihood.

Results

Signals Approach

The results for the variables can be found in Table 3 (Appendix I). Column 2 indicates the number of good signals issued by the indicator expressed as a percentage of the number of quarters in which good signals could have been issued (A/[A+C]). The 3rd Column indicates the number of bad signals issued by the variables expressed as a percentage of the number of quarters in which bad signals could have been issued (B/[B+D]). Column 4 looks at the nosiness of the indicator or how well it works in indicating a crisis ([B/(B+D)]/[A/(A+C)]). *Ceteris paribus*, the lower the number in this column the better the indicator. The last two columns use probabilities to determine the noisiness of the variables. It is a comparative look where the probability of a crisis conditional on a signal from the indicator (A/[A+B]) is likened to that of the unconditional probability [A/(A+B) -(A+C)/(A+B+C+D)]of a crisis in terms of the matrix. The usefulness of the variable is seen whenever the conditional probability is higher than the unconditional one.

Air arrivals (AIR_ARRIVALS) indicate roughly 38% of good signals and only 16% of bad signals and change in US real GDP (US_GDP) exhibits 25% good signals and only 16.1% bad signals. These two signals were perhaps the best indicators in determining a crisis. This is to be expected as the small, open economy of The Bahamas is heavily driven by tourism, especially American tourists. In addition, the positive difference between the conditional and unconditional probabilities further explains the usefulness of both variables.

On the other hand, external reserves to demand liabilities (RES_DEM) indicated approximately 88% good signals and 80% bad signals. This shows that while the variable may indicate good

signals, they also exhibit significant noise; therefore, it would not be useful in predicting a crisis. Ratio of nonperforming loans to total private sector loans (NPL_RATIO) proved to be an ineffective indicator as it exhibits only 20% good signals but gave roughly 97% bad signals. Another interesting result was reflected in the growth in credit to private sector indicator (C_CREDIT) where it gave 100% good signals but emitted about 73% bad signals.

Overall, the findings were fairly consistent with stated norms. If there is a steady decline in tourist arrivals, particularly, air arrivals, it will reflect problems arising in neighbouring countries or in The Bahamas. Furthermore, an increase in tourist arrivals will be a positive indicator that a crisis will not occur. Similarly, a rise in US real GDP will indicate positive growth in the United States which could positively affect tourism in The Bahamas. All the variables tested exhibited a positive difference between the conditional and unconditional probabilities, showing that they are all useful. However, many produced significant noise and bad signals.

Probit Models

The results of the best macroeconomic indicators model, as shown by the McFadden R-Squared in model 1 (Appendix I) show that most of the variables had the correct signs with the exception of the National Debt to GDP variable (N_DEBT_GDP), where the requisite sign of the coefficient indicated that the probability of a crisis decreased as the ratio increased. The McFadden R-Squared statistic shows that the model performs 28.0% better than a model which specifies that probability of predicting a recession is constant. An alternative measure, the expectation prediction evaluation for binary specification for a standard cut-off success rate of 50%, showed that when compared to a constant probability model, the gain was 8.42 points or 26.3%.

In terms of the optimal macroprudential indicators model (Model 2 Appendix I), all of the variables had a prior signs, with the exception of the credit to GDP (CREDIT_GDP) variable, which had a positive sign. In addition, both the McFadden-R Squared and expectation evaluation statistics were superior to the macroeconomics indicators model, as they showed relative to a constant probability model, a gain of 21.04 points (65.74%)[5]. The combined model, which included variables with the current signs from models 1 and 2 performed the best, based on the 81.2% goodness of fit measure and the total gain of 26.01 points or 81.29%[6].

The crisis probability graphs also produced similar results, as the time profile for model 1 showed that the crisis probability trended upwards and breached the 50% initial threshold in 2001, one year before the 2003 recession (Chart 1 Appendix I); however, the crisis probability failed to break the 50% threshold before the 2008 – 2009 recession. The macroprudential indicators model accurately predicts the 2003 and 2008 recessions, two years before they occur, unfortunately the model also briefly predicts a recession would occur in the following two years in 1998. However, the combined indicators model accurately predicts the two recessions and remains well below the 50% crisis probability threshold for the remaining periods.

Conclusion

This study sought to analyze the usefulness of macroprudential and macroeconomic indicators in determining a crisis. The analysis showed that indicators that are macroprudential in nature are in fact, good indicators in predicting economic crises in The Bahamas. However, it was found that their performance is best when combined with current macroeconomic indicators. This finding is consistent with other researchers. It also suggests that tracking these indicators can be

[5] It should be noted that the NPL_RATIO variable was not used in the regression, due to the fact that the data was only available from 2002, which would have significantly limited the time period utilized in the test.
[6] See Model 3 Appendix I.

effective for policy makers in implementing macroprudential policies to mitigate the effects of a crisis.

However, as macroprudential indicators are a relatively new development, there is limited research on the subject area. Moreover, the tests were limited by the short timeframe used in the analysis, and the fact that real and nominal GDP were not available on a quarterly basis, but had to be derived from the Chow-Lin interpolation procedure.

Although the results appeared to be relatively conclusive, in reality the majority of indicators are generated with a considerable lag e.g. Nominal GDP, hence further research could examine issues such as the average lead time and the persistence of indicators.

Overall, the study showed the importance of analysing macroprudential indicators in policy making, given their apparent predictive ability. This development is likely to increase in the Caribbean and our economies' financial sectors deepen and the linkages between this sector and other aspects of the economy intensifies.

References

Abeysinghe T., and G. Rajaguru (2004), "Quarterly Real GDP Estimates for China and ASEAN4 with a Forecast Evaluation", Journal of Forecasting, vol. 23, pp. 431-447.

Alberola, E., Trucharte C. and Vega, J.L., (2011), "*Central banks and Macroprudential Policy, Some Reflections from the Spanish Experience"*, Banco de Espana, mimeo.

Bhattacharayay B., (2003), *"Towards a Macro-prudential Leading Indicators Framework for Monitoring Financial Vulnerability",* Asian Development Bank, mimeo.

Bruno, V. & Shin, H.S., (2012), "*Assessing Macroprudential Policies: Case of Korea"*, Prepared for the symposium issue of the Scandinavian Journal of Economics on capital flows, Sep.

Calvo, A.G. and Izquierdo, A., (2004), "On The Empirics of Sudden Stops: The Relevance of Balance-Sheet Effects", Inter-Ameican Development Bank, University of Maryland and National Bureau of Economic Research, Working Paper #509, July.

Frankel, F., & Cavallo, D., (2004), "*Does Openness to Trade Make Countries More Vulnerable to Sudden Stops, or Less? Using Gravity to Establish Casualty",* Havard University, Faculty Research Working Paper Series, RWP04-038, August.

Igan, D. and Kang, H., (2011), *"Do Loan-to-Value and Debt-to-Income Limits Work? Evidence from Korea",* IMF Working Paper, WP/11/297, December.

Jácome, L.I., Nier, W.E., and Patrick, I., (2012), *"Building blocks for Effective Macroprudential Polices in Latin America: Institutional Considerations"*, IMF Working Paper WP/12/183, July.

Jahn N., and Kick T.,(21012), "Early Warning Indicators for the German Banking System: A Macroprudential Analysis", Deutsche Bundesbank, Working Paper No. 27/2012.

Jeanne, O., & Ranciére, R., (2006), "The Optimal Level of International Reserves for Emerging Market Countries Formulas and Applications", IMF Working Paper, WP 06/229, October.

Jordan, A., Skeete, R., and Coppin, K., "*Are Persistent Current Account Deficits in Barbados Sustainable?"*, Journal of Eastern Caribbean Studies, Vol. 30, No. 3, Sept. 2005, pp. 44-72.

Juselius M. and Drehmann M., (2012), *"Improving EWIS for Banking Crises- Satisfying Policy Requirements",* Bank for International Settlements, August, mimeo.

Kerns. S., Lantz, S. and Stiftung, R.B., (2012), *"Macroprudential Financial Supervision in the US"*, Deutsche Bank Research, April.

Lim, C.F., Columba, A. Costa, P. Kongsamut, A. Otani, M. Saiyid, T. Wezel, and Wu, X. (2011), *"Macropruential Policy : What Instruments and How to Use Them?"*, IMF Working Paper WP/11/238, October .

Reinhart, C., Kaminsky G., and Lizondo S. (1998), "*Leading Indicators of Currency Crises"*, IMF Staff Papers, Vol. 45 No.1, March

Repullo, R., and Saurina, J., (2011), *"The Countercyclical Capital Buffer of Basel III, A Critical Assessment"*, Banco de Espana, mimeo.

Tovar, C.E., Garcia-Escribano, M., and Vera Martin, M., (2012), *"Credit Growth and the Effectiveness of Reserve Requirements and Other Macroprudential Instruments in Latin America"*, International Monetary Fund Working Paper, WP/12/142, June.

Viñals, J., (2011), **"***The Do's and Don'ts of Macroprudential Policy",* European Commission and ECB Conference on Financial Integration and Stability.

Appendix I

Table 1 Variable Names and Expected Signs		
Exogenous Variables	**Regressors**	**Expected Signs**
Total Arrivals	TOTAL_ARRIVALS	-
Air Arrivals	AIR_ARRIVALS	-
Credit to the Private Sector/GDP	CREDIT_GDP	+/-
Growth in Credit to Private Sector	CREDIT_GDP	+/-
National Debt/GDP	N_DEBT_GDP	-
Central Government External Debt/GDP	EXT_DEBT_GDP	+
Fiscal Deficit/GDP	DEFICIT_GDP	-
FDI/GDP	FDI_GDP	-
Ratio of Nonperforming Loans/Total Private Sector Loans	NPL_RATIO	N/A
External Reserves/Demand Liabilities	RES_DEM	-
US Real GDP	US_GDP	-
Ratio of Liquid Assets/Total Assets	LIQ_ASSETS	-
Ratio of Private Sector Credit to Bank Deposits	CREDIT_DEPOSITS	+/-
Source: Author's estimates		

Table 2		
	Crisis (within 8 quarters)	**No Crisis (within 8 quarters)**
Signal was issued	A	B
No signal was issued	C	D

Source: Kaminsky et al, (1998)

Table 3
Results of Signals Approach for Indicators

Variable	Good signals as a percent of possible good signals	Bad signals as a percent of possible bad signals	Noise/Signal (adjusted)	P(Crisis/signals)	P(Crisis/signal)-P(Crisis)
MACROECONOMIC INDICATORS					
AIR_ARRIVALS	37.5	15.6	0.4	37.5	37.3
TOTAL_ARRIVALS	18.8	20.3	1.1	18.8	18.6
US_GDP	25.0	16.2	0.7	35.3	35.0
EXT_DEBT_GDP	50.0	80.0	1.6	13.3	13.1
N_DEBT_GDP	50.0	87.7	1.8	12.3	12.1
RES_DEM	87.5	79.7	0.9	21.5	21.3
MACROPRUDENTIAL INDICATORS					
NPL_RATIO	20.0	96.9	4.8	6.1	5.8
C_CREDIT	100.0	73.4	0.7	25.4	25.2
CREDIT_GDP	100.0	75.0	0.8	25.0	24.8
CREDIT_DEPOSITS	80.0	79.7	1.0	23.8	23.6
LIQ_ASSETS	50.0	92.7	1.9	16.0	15.7

Source: Authors' Estimates

Model 1

Macroeconomic Indicators

Variable	Coefficient	Probability Statistic
AIR_ARRIVALS	-0.015134	0.5111
EXT_DEBT_GDP	0.138222	0.5712
N_DEBT_GDP	-0.281970	0.0113
US_GDP	-0.100880	0.1553
RES_DEM	-0.011935	0.1518
C	10.21483	0.0112
McFadden R-squared = 0.290122 Total Gain 8.42 (26.3%)		

Model 2

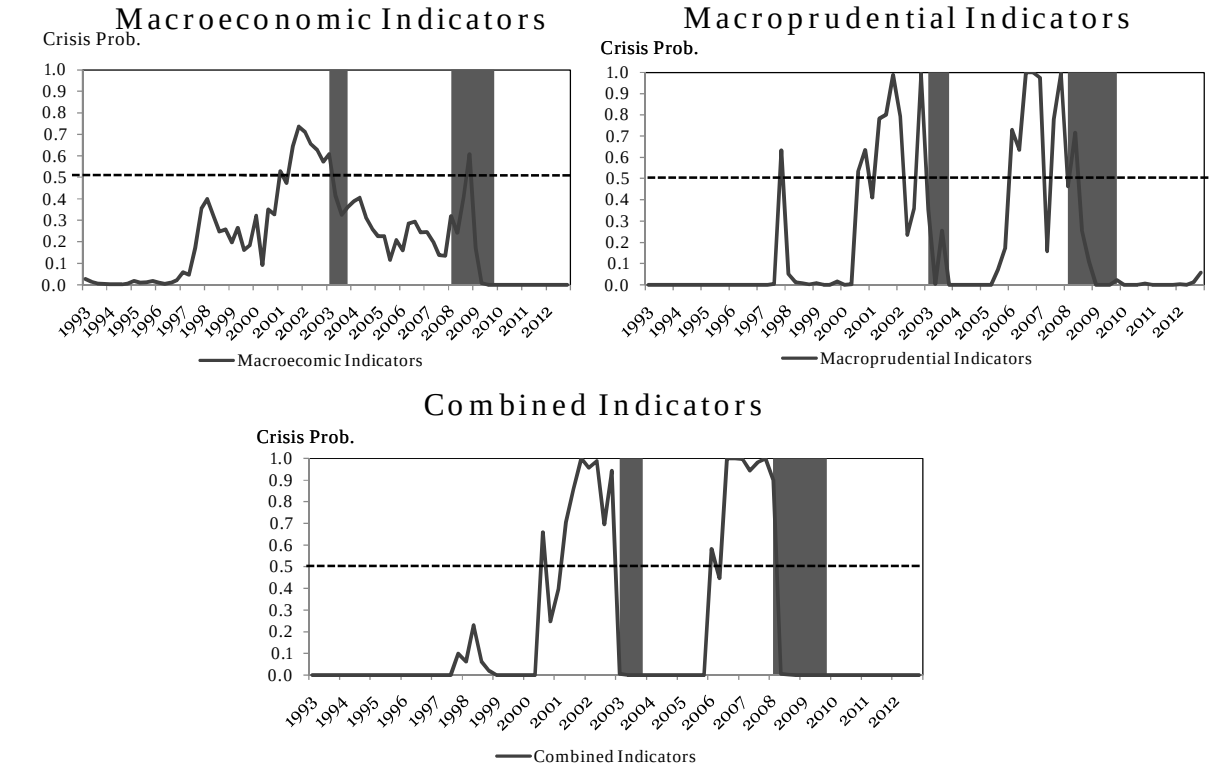
Macroprudential Indicators

Variable	Coefficient	Probability Statistic
C_CREDIT	0.238809	0.0213
CREDIT_GDP	-0.49873	0.0093
CREDIT_DEPOSITS	1.357003	0.0078
LIQ_ASSETS	1.23668	0.0551
C	-136.014	0.0101
McFadden R-squared = 0.669134 Total Gain 21.04 (65.74%)		

Model 3
Combined Indicators

Variable	Coefficient	Probability Statistic
AIR_ARRIVALS	-0.0754	0.3468
EXT_DEBT_GDP	-5.19995	0.078
RES_DEM	-0.04383	0.1747
C_CREDIT	0.958963	0.1066
CREDIT_DEPOSITS	1.634949	0.0424
LIQ_ASSETS	2.547925	0.0921
C	-205.407	0.0457
McFadden R-squared = 0.812089		
Total Gain 26.01 (81.29%)		

Chart 1



Appendix II

As Abeysinghe and Rajaguru (2004) outline, the fundamental equation for Chow-Lin disaggregation of *n* annual GDP figures to *4n* quarterly figures is:

$$\hat{y} = X\hat{\beta}_a + VC'(CVC')^{-1}\hat{u}_a \tag{4}$$

$$\hat{\beta}_a = [X'C'(CVC')^{-1}CX]^{-1}\,\mathrm{X'C'}(CVC')^{-1}y_a$$

$$\mathrm{C}=\begin{bmatrix} 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & \dots & . & . & . & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 & \dots & . & . & . & 0 \\ . & . & . & . & . & . & . & . & \dots & . & . & . & . \\ 0 & . & . & . & . & . & . & . & \dots & 1 & 1 & 1 & 1 \end{bmatrix} \tag{5}$$

$\hat{y}$ is the vector of disaggregated quarterly GDP figures, y_a is the observed $n \times 1$ vector of annual GDP figures, *X* is a $4n \times k$ matrix of *k* predictor variables, *V* is a $4n \times 4n$ covariance matrix of quarterly error terms, u_t , $\hat{u}_a = y_a - X_a\hat{\beta}_a$ is an $n \times 1$ vector of residuals from an annual regression of GDP on predictor variables, $(X_a = CX)$, where C is an $(n \times 4n)$ aggregation matrix, (or an averaging matrix if multiplied by 0.25)and $\hat{\beta}_a$ is a k× 1 vector of GLS estimates of regression coefficients derived from an annual regression.

C- L presented two forms of the vector *V*. The simpler one is the case where u_t is white noise in which case *V* is diagonal and the Generalised Least Squares (GLS) estimator reduces to OLS. In this case, the second term on the RHS of (1) amounts to allocating 1/4 of the annual residual to each quarter of the year. The second form is to assume that u_t follows an AR(1) process of the form: $u_t = \rho u_{t-1} + \varepsilon_t |\rho| < 1$ and $\varepsilon_t \sim iid(0, \sigma_\varepsilon^2)$, in which case *V* has the form:

$$V = \sigma_\varepsilon^2 \begin{bmatrix} 1 & \rho & \rho^2 & \dots & \rho^{4n-1} \\ \rho & 1 & \rho & \dots & \rho^{4n-2} \\ . & . & . & \dots & . \\ \rho^{4n-1} & . & . & \dots & 1 \end{bmatrix} \tag{6}$$

By extending the monthly-quarterly case considered by C-L to the quarterly-annual case equation 8 can be used to estimate ρ from the annual estimate $\hat{\rho}_a$:

$$(\rho^7 + 2\rho^6 + 3\rho^5 + 4\rho^4 + 3\rho^3 + 2\rho^2 + \rho) \div (2\rho^3 + 4\rho^2 + 6\rho + 4) = \hat{\rho}_a \tag{8}$$