Dynamic Interactions between Currency Regimes and Economic Activity in the Presence of Crises

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Rough draft, not to be quoted

March 14, 2010

Abstract

The paper addresses two established empirical puzzles in International Macro: (a) The lack of evidence for systematic differences in the macroeconomic performance across exchange rate regimes, and (b) The absence of a clear cut relationship between macroeconomic performance and capital-account liberalization. We explore the dynamic interactions between currency regimes and business cycles , controlling for predicted crisis probability which in turn depends on the currency regimes, for Argentina and Mexico in the period 1970-2007. We characterize the effects of productivity shocks, liquidity shocks and policy regime shocks on the business cycle.

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1 Introduction

We address two established empirical puzzles in International Macro: (a) The lack of evidence for systematic differences in the macroeconomic performance across exchange rate regimes, and (b) The absence of a clear cut relationship between macroeconomic performance and capital-account liberalization.

Our point of departure from the literature is the recognition that currency regimes affect economic activity not only directly. It also impact on financial stability and thereby, indirectly, on output. In general there are conflicting effects of currency regimes on economic activity in the presence of currency crises. While a currency peg may provide a stable environment for exporters , thereby raising economic activity, it may also increase the likelihood of capital flow reversals. thereby depressing economic activity.

Analogously, capital-account liberalization regimes have conflicting effects on macroeconomic outcomes. While improving risk sharing and efficiency of the allocation of capital across industries, capital-account liberalization could also increase the risk of sudden stops to capital inflows, triggering financial and currency crises, which are accompanied by a sharp fall in output.

Emerging economies in the last decades provide a useful testing ground: they often peg their currency to some major currencies (the dollar, the euro, or the yen); they are subject to currency crises, and they have volatile growth rates.

In this paper we examine two emerging economies, Argentina and Mexico, over the period 1970 to 2007. We extend the international cross section analysis of Razin and Rubinstein (2006), who allow the currency and capital-account liberalization regimes to have both a direct and an indirect effect on growth, to a dynamic panel data analysis.

The organization of the paper is as follows. Section 2 discusses the empirical puzzles in the literature. Section 3 presents summary statistics. Section 4 presents the analytical framework. Section 5 presents findings. Section 6 provides analysis of panel data. Section 7 concludes.

2 Empirical Puzzles

Strikingly, the empirical literature has failed to identify clear-cut real effects of exchange-rate regimes on the open economy. Indeed, Marianne Baxter and Alan Stockman (1989) and Robert Flood and Andy Rose (1995) find that there are no significant differences in business cycles across exchange rate regimes. Frankel and Wei (2004) explores how output lost in crises is determined by various controls, including the degree of exchange rate flexibility, currency mismatch, FDI, etc, and they also find that the exchange rate flexibility variable is not statistically significant. Another trend of literature, such as Rose (2000), uses the existing evidence to estimate the effect of currency unions on international trade. A currency union, an extreme form of a pegged exchange-rate regime, is found to expand bilateral trade between two average member countries by 200%. This analysis is later challenged by Persson (2001), which finds significant but modest effects of currency unions. [1]

Similarly, no definitive view emerges as to the aggregate effects of capital account liberalization. Rodrik (1998) finds no significant statistical association between capital-account openness and growth. A more recent study by Prasad et al (2005) finds that it is difficult to establish a robust causal relationship between the degrees of financial integration and the growth performance for developing countries. Kristin Forbes (2005) surveys the inconclusive macroeconomic evidence on capital controls like this: "of the 14 recent papers they [that is, Prasad et al., 2005] examine, three find a positive effect of financial integration on growth, four find no effect, and seven find mixed results." In fact, Eichengreen (2001) which overviews the literature, argues that the explanation for such ambiguities lies in the rather complex role played by capital account liberalization.

A more definite view concerning positive effects of capital account liberalization on output, which is advanced by Fischer (1998), is supported by some evidence provided by Quinn (1997). The role of pre-existing policies and of trade-account versus capital-account sequenc-

[1] Anderson and van Wincoop (2003) demonstrate the importance of including country fixed effects in gravity models. Although commonly estimated gravity equations generally fit the data well, they show that they are not theoretically grounded and prone to biased estimation. They applied the method to solve the border puzzle. They find specifically that borders reduce bilateral national trade levels by plausible though substantial magnitudes.

ing in determining the effects of capital control liberalization on growth and investment is also examined, most notably by Arteta at al. (2001), Chinn and Ito (2002), and Tornell et al. (2004, 2007). Another evaluation of this literature by Prasad et al. (2005), however, yields somewhat inconclusive results. It shows no significant relationship between financial openness and growth in real per capita income across countries, even after controlling for a series of standard explanatory variables (initial income, initial schooling, investment-GDP ratio, political instability, and regional dummies.) See also Ariyoshi et al.(2000), Bhagwati (1998), Edwards (1999, 2000) and Kaplan and Rodrik (2000).

Conventional wisdom tries to explain this inconclusiveness by focusing on either inaccurate measurement of capital account openness or the possibly distinctive effects of different types of capital flows on economic growth. Measurement of capital account openness has always been difficult and controversial. Most of the studies use rough numerical indices of different policies and regulations, so called *de jury* measure. Other studies use *de facto* measures of integration, such as capital flows within a certain time period or foreign asset holdings which are usually determined jointly with the macroeconomic performance they are supposed to explain. Some recent work argues that a more positive effect on growth could be identified if we focus just on the less volatile flows of foreign direct investment. By spreading technological and management know-how and being less vulnerable to sudden stops, foreign direct investment has greater growth effects compared with other forms of capital flows. This is the point made by Razin (2004).

As previous mentioned, Razin and Rubinstein (2006) is yet another attempt to reconcile this inconsistency of theory and data. It proposes that policy regimes have both positive and negative channels to affect macroeconomic performance. Unless we could successfully disentangle the different channels, it may well be the case that some mixed results are obtained. More specifically, they find that the influence on the overall macroeconomic performance of currency regimes depends on the likelihood of sudden stops to capital flows. In various specifications, if the probability of sudden stops is excluded from the growth equation, they find that the instrumented peg and the financial liberalization regime indicators are insignificant in the growth equation; thereby tracing the literature "puzzles" in their sample. However, the instrumented peg has a positive and highly significant effect on growth after the inclusion

of the crisis probability in the growth equations, and with the instrumented peg. The instruments that they use are: the past spell of the peg, country fixed effects, lagged crises, lagged policy regime switches, and time dummies. The external debt serves as the exclusion restriction variable. In addition, capital controls (both in levels and changes) have a negative, and highly significant, effect on growth after the inclusion of the crisis probability in the growth equations. The projected probability of an international financial crisis increases with the imposition of an exchange rate peg, and falls with the imposition of capital controls (both in level and change forms); The spell of the peg, country fixed effects, lagged crises, time dummies, as instruments, and the external debt serves as the exclusion restriction variable.

Our paper, based on the previous work by Razin and Rubinstein (2006), follows them in constructing a latent state variable which measures the potential severity of a balance-of-payment crisis. This variable captures the negative effects on business cycles of fixed exchange-rate arrangements and free capital markets. However, unlike their paper, we carry out a dynamic analysis instead of a static one, which naturally allows us to explore the dynamic effects of policy regimes on macroeconomic outcomes. While a static analysis has to address the endogeneity issue to find a causal effect, a dynamic VAR analysis allows us to examine the interactions of policy regimes and economic performance over time through impulse response functions.

3 Data and Summary Statistics

We have assembled country level annual data for Argentina and Mexico in the period 1970 to 2007. All the macro economic data series are from World Development Indicators provided by World Bank Group. The per capita GDP growth rate is cyclically unadjusted, while the current account balance is represented as percentage of GDP. It is widely held that short term debt are more susceptible to sudden stops than long term debt, thus it is also included as a standard control when estimating crisis severity. Here it is in the form of percentage of total external debt.

Although both World Development Indicators and International Financial Statistics by IMF have real exchange rate series, a lot of data points are missing. Thus to improve data

availability, we construct our own series of real exchange rate. It is based on the annual average nominal exchange rate with US dollars, the domestic GDP deflator and the US GDP deflator as price indices. A real exchange rate depreciation is hence represented by a positive annual change.

We implement a binary index based on the multiple categories of the Reinhart and Rogoff classification of exchange rate regimes.[2]

It is always a controversial issue to measure the degree of openness of capital accounts. There are many measures available, some de facto, some de jury, but each one of them have its own pitfalls. In this paper we choose Chinn-Ito financial openness index, which addresses both intensity and efficacy of the controls with a dataset covering 182 countries over the period 1970 to 2006, such superior to some de jury indices in a sense. Note that larger values of the index represent higher level of capital account liberalization.

Table 1 presents some stylized facts for exchange-rate regimes, GDP annual growth rate, potential crisis severity, financial openness index, current account balance and short term debt for Argentina and Mexico over the period of 1970 to 2007. Except for the first one, all the rows show the mean level of the corresponding variable with standard deviation in brackets. For exchange rate regimes, out of 38 annual observations, 18 of them are classified as flexible for Argentina, while 20 of them are flexible for Mexico. The average level of potential crisis severity for Argentina using real exchange rate is very low because Argentina has suffered from hyperinflation in the past, leading to some prolonged periods of very negative value for real exchange rate change. Judged by sample mean, Mexico is relatively more open in

[2]Reinhart and Rogoff undated the IMF official classification of exchange rate prior to 1997, as described in the various issues of the IMF's Annual Report on Exchange Rate Arrangements and Exchange Rate Restrictions. The most recently updated dataset in Ilzetzki, Reinhart and Rogoff (2008) has data for 227 countries spanning from 1940 to 2007. Although the IMF empirical definition of exchange rate regimes is based on formal government statements, the Reinhart-Rogoff classification is based on empirical algorithm, factoring in ex-post behavior. Ilzetzki, Reinhart and Rogoff (2008) contains exchange rate regime index under both coarse and fine classification. The coarse classification we use here divides exchange rage arrangement into six classes: from 1 being de facto peg to 6 being dual market in which parallel market data is missing. In constructing a binary index, we code class 1 to 2 as 1, representing a peg, and code class 3 to 6 as2, representing a fixed exchange rate regime.

terms of capital market liberalization during the sample period, while Argentina has larger proportion of external debt as short term debt.

Variable	Argentina	Mexico
Exchange-rate regime indicator	18 (out of 38)	20 (out of 38)
GDP annual growth	1.120 (5.984)	1.702 (3.331)
Potential crisis severity	-217.029 (232.635)	-17.675 (16.146)
Financial openness index	-0.281 (1.265)	0.916 (1.380)
Current account balance	-0.892 (3.484)	-2.180 (2.710)
Short term debt	19.163 (8.647)	14.441 (7.856)

Table 1. Sample averages and standard deviations.

	ERR	GRG	PCS	FOI
Argentina				
ERR	1			
GGR	-0.4200***	1		
PCS	-0.5592***	0.1585	1	
FOI	-0.6388***	0.1428	0.6158***	1
Mexico				
ERR	1			
GRG	-0.4326***	1		
PCS	-0.3642**	0.3844**	1	
FOI	-0.5259***	0.5471***	0.7955***	1

Table 2. Correlations between exchange-rate regime indicator, GDP growth rate, potential crisis severity and financial crisis openness indicator.
** :significant at 15%; ** :significant at 5%; *** :significant at1 %.*

In Table 2 we present simple correlations between exchange-rate regime indicator, GDP growth rate, potential crisis severity and financial openness indicator. More flexible exchange rate regimes tend to be associated with lower annual GDP growth rate, showing the dominant effects of trade adjustment channel for a peg. The negative correlation between crisis severity

and exchange-rate regime indicator seems to be consistent with the notion of crisis channel: a fixed exchange-rate arrangement is more likely to incur sudden stops. Similarly, more liberalized capital markets increase the likelihood of crises, partly shown in the positive correlation between potential crisis severity and financial openness indicator. The correlation between GDP growth rate and financial openness for Argentina is slightly positive and insignificant, while that for Mexico is significantly positive.

It is helpful to juxtapose the GDP growth rate together with exchange rate regime indicators and potential crisis severity. Figure 1 contrasts the movements of GDP growth rate and exchange rate regime indicator for Argentina. Although no robust pattern emerges from this graph, it is striking how volatile the growth rate of GDP for Argentina has been. Figure 2 compares GDP growth rate with potential crisis index severity for Argentina, which shows that higher potential crisis severity is not necessarily associated with poor economic performance. Some episodes in the sample have good GDP growth while the economy will be hit hard if a crisis ever occurred. However, if a crisis does occur, like in year 2000, the potential crisis severity is indeed very high. Figure 3 compares the movements of GDP growth rate and exchange-rate regime for Mexico. At least before 1995, a better growth experience seems to come along with a peg. This also explains the strong correlation between the two variables as we record in Table 2. Figure 4 again confirms that higher potential severity in case of a sudden stop does not mean a real crisis, while a real sudden stop crisis always leads to high predicted severity, as Mexico in 1994. Note that other than sudden stop crises, these two countries have suffered from other types of crises in the past, such as hyperinflation and currency depreciation.

4 Empirical Framework

We use changes in the real exchange rate as the measure of crisis. As pointed out in Razin and Rubinstein (2006), a free fall in the nominal exchange rate does not distinguish between domestic price crises and balance-of-payments crises, but it is the latter we are interested in. Crisis episodes involving bouts of high inflation and currency depreciation, which lead to stable, or even appreciating real exchange rate, do not qualify as a balance-of-payment

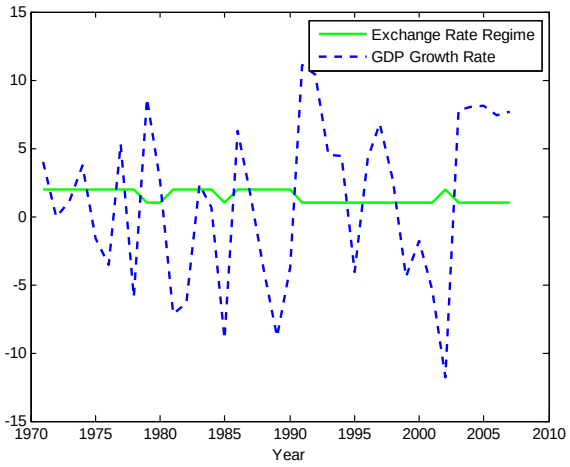

Figure 1: This figures compares the movements of GDP growth rate and exchange rate regime indicator for Argentina.

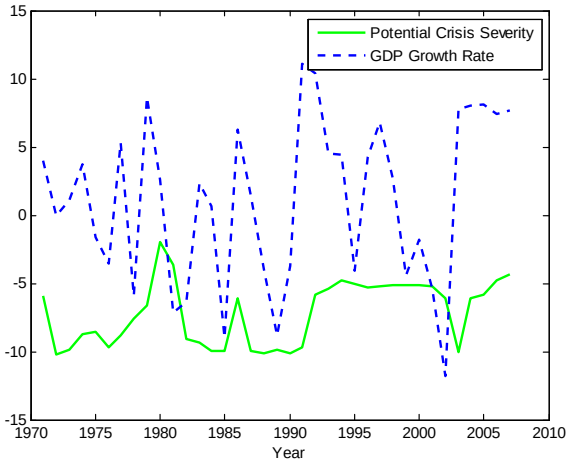

Figure 2: This figure contrasts the movements of GDP growth rate and potential crisis severity. Potential crisis severity has been scaled down by 100 and then moved down by 5 units to make it comparable with GDP growth rate.

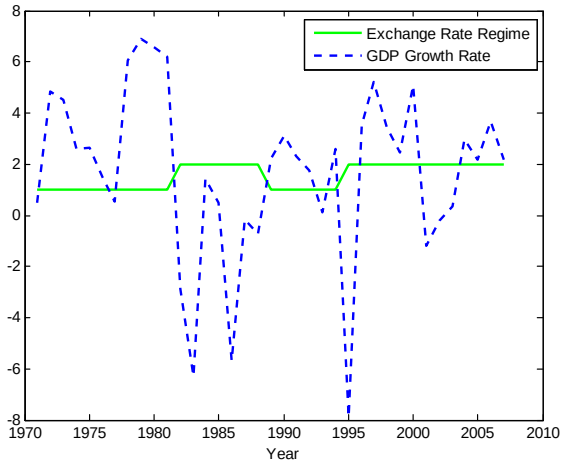

Figure 3: This figures compares the movements of GDP growth rate and exchange rate regime indicator for Mexico.

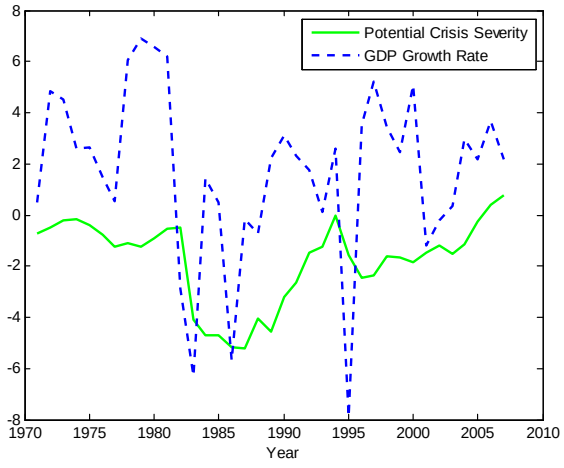

Figure 4: This figure compares the movements of GDP growth rate and potential crisis severity for Mexico. Potential crisis severity has been scaled by 10 for better comparison.

crises[3]. Large real depreciation, however, captures the effects of international financial crises on the domestic financial side as well as the real side. Typically, large depreciation of the real exchange rate is likely to have significant balance-sheet effects, leading to bankruptcies and economic slowdown.

Our empirical methodology relies on the conjecture that a currency regime and capital control policies have conflicting effects on economic activity in the presence of crises. To dynamically separate the growth promoting effect from the crisis-prone effect on activity, we adopt a two stage estimation strategy. A common difficulty in panel VAR studies is that it is hard to justify all the countries in the panel are evolving according to the same dynamic rule even after controlling for country fixed effects, especially considering that these are developing countries with diverse economic and political background. To isolate country specific dynamics we focus in this draft on time series analysis of a specific country.

In the first stage, we use multinomial logit to explain the variations in the crisis-prone severity variable, measured by the expected future depreciation of the real exchange rate. The explanatory variables are policy regimes and standard controls, such as current account balance and short term debt. Currency peg is expected to raise crisis severity, for a given set of country specific and world economy shocks. Likewise, capital-market liberalization tends to raise the crisis severity variable because such policy facilitates capital flow reversals. The likelihood severity of sudden stops is obtained by fitting a linear model to the annual depreciation of real exchange rate, depending on the exchange rate regime indicator, the capital control indicator and some controls. Policy regime indicators are modeled in levels and taken one lag, capturing pre-existing policy regimes right before the crisis. Pre-existing levels of capital account balance as a percentage of GDP and short term debt as a percentage of total external debt are used as controls.

In the second stage, we estimate a dynamic VAR system comprising three variables: policy regime indicator, annual growth rate of GDP and estimated crisis severity, where

[3]Calvo et al. (2004) finds that in their sample of 32 developing countries, real exchange rate fluctuations come hand in hand with sudden stops, which is a unique feature for emerging countries. Also, the real exchange rate measure for crisis is strongly correlated with sharp reversals in the current-account balance. See Milesi-Ferretti and Razin (2000).

annual growth of GDP is taken as an indicator of macroeconomic performance.

The state vector is composed of three variables: the exchange rate regime indicator, the annual GDP growth rate, and the predicted crisis severity. It is worth noting that since the exchange rate regime indicator comes as categorical data with order (ranging from strict pegged to completely flexible), this VAR system is non-linear because the first-stage equation includes an ordinal dependent variable.

A consequence of the nonlinearity is we can no longer use the traditional method of computing the impulse response functions. The the impulse response functions are no longer independent of the starting point from which the system evolves. We use the mean of each series as the starting point. The impulse response function is the difference of the system's evolutions, with and without a shock, at the given starting point.

Specifically, we estimate the following system:

$$\begin{bmatrix} ERR_t \\ GGR_t \\ PCS_t \end{bmatrix} = \begin{bmatrix} \mathbf{E}_{t-1}(ERR_t) \\ b_{20} + b_{21}ERR_{t-1} + b_{22}GGR_{t-1} + b_{23}PCS_{t-1} \\ b_{30} + b_{31}ERR_{t-1} + b_{32}GGR_{t-1} + b_{33}PCS_{t-1} \end{bmatrix} + \begin{bmatrix} u_{1t} \\ u_{2t} \\ u_{3t} \end{bmatrix}$$

where ERR_t is the exchange-rate regime indicator at period t, GGR_t is the growth rate of GDP at period t, and PCS_t is the estimated potential crisis severity at period t. [4] At period $t-1$, ERR_t is expected to take two possible values: 1 (fixed) or 2 (flexible). Thus the expected value of ERR_t one period ahead under multinomial logit model is

$$\begin{aligned} \mathbf{E}_{t-1}(ERR_t) &= 1 * \mathbf{P}_{t-1}(ERR_t = 1) + 2 * \mathbf{P}_{t-1}(ERR_t = 2) \\ &= 1 * \frac{e^{b_{10}+b_{11}ERR_{t-1}+b_{12}GGR_{t-1}+b_{13}PCS_{t-1}}}{e^{b_{10}+b_{11}ERR_{t-1}+b_{12}GGR_{t-1}+b_{13}PCS_{t-1}}+1} \\ & \quad 2 * \frac{1}{e^{b_{10}+b_{11}ERR_{t-1}+b_{12}GGR_{t-1}+b_{13}PCS_{t-1}}+1}. \end{aligned}$$

We identify the shock as follows. The vector e_t includes three shocks: policy-regime shock , productivity shock, and liquidity shock. The short-run restrictions are as follows. The liquidity shock raises predicted crisis severity, but has no contemporaneous impact on the exchange rate regime, and on GDP growth. Its effects on the latter are shown up in later periods, via the crisis severity effect. Similarly, we don't allow the productivity shock to contemporaneous affect the exchange rate regime.

[4] For ease of presentation, lag length of 1 is assumed here.

In other words, if $u_t = [u_{1t}, u_{1t}, u_{1t}]$ is the vector of estimation residuals in the VAR system and $u_t = De_t$, D is a lower triangular matrix. This identification strategy allows us to explore the impact of the shocks on policy regimes and output growth.

5 Estimation Findings

Table 3 presents the estimation results of the stage one model. The dependent variable is the annual depreciation of real exchange rate. The coefficients of exchange rate regime indicators are negative and significant for both countries. The coefficients on financial openness indicators are positive, also consistent with the prediction of our previous argument, although none of them is significant. One might expect a negative sign from current account balance, measured as a percentage of total GDP here. However, we get positive coefficients here and the coefficient is significant in the case of Mexico. In fact, right before the 1994 crisis in Mexico, the current account deficit is about 7 percent of GDP, the highest record of deficit throughout our sample period. Thus one potential explanation for this positive sign could be the strong predictive power of exchange-rate regime indicators and the high correlation of exchange-rate regimes with current account balance. Other standard controls have also been tried, such as total reserves and total debts, but they are not included here.

Another way to approach this problem is to construct a binary crisis indicator, which takes value 1 if the real exchange rate has depreciated more than some standard level, say, 15%, and 0 otherwise. This indicator can then be used as the dependent variable for the first stage estimation; we could call the estimated value as "crisis probability" as in Razin and Rubinstein (2006). But they use panel data and we use country time series data. As a result, this approach is not implementable in our case since we don't have enough observations of crises which have actually happened during the sample period.

6 Impulse Response Functions

Benchmark results are shown in Fig. 5 and Fig. 6, showing the impulse responses from a short run identification strategy described before. That is, there is no instantaneous reactions

in response to a liquidity shock for exchange rate regimes and GDP growth, and there is no instantaneous responses for exchange rate regimes to a GDP shock. In estimating the system, we have adopted the multinomial logit setup describe before and chosen the lag length of the system to be 1. [5]

The results can be described as follows:

1. In Argentina, there is a significant drop of 2.5 percent of GDP growth rate right after the exchange-rate arrangement becomes more flexible, then after two years, then course is reversed, eventually GDP is raised by 0.5 percent after 4 years. In Mexico, the initial drop in GDP growth rate is also sizable, typically by 1.75 percent. Then the effect disappears after 2 years.

2. The potential crisis severity reacts rather swiftly to a policy regime change, reaching the bottom of the decrease after 1 year.

3. In Argentina, a GDP shock which is large enough to move annual GDP growth rate by 5% can only shift exchange rate regime index between 0 and 0.1 with a 2/3 probability. Considering the fact that exchange-rate index is coded to take the value of 1 and 2, this shows the policy regimes are rather irresponsive of the business cycle movement. The same conclusion also holds for Mexico. A GDP shock which might initially increase GDP growth rate by 1.5 to 4, could only move exchange rate regime index slightly within the range of -0.02 to 0.05.

4. In both countries the potential crisis severity variables increase after a positive GDP shock, a rather unconventional result.

5. A liquidity shock which moves the potential crisis severity by a reasonable size might have ambiguous effects on GDP in the case of Mexico. While in Argentina, GDP annual growth rate will drop quickly after such a shock. Again, such shocks do not have much effects on exchange rate regimes. Note that we have forbidden instantaneous responses of exchange rate regimes and GDP to a liquidity shock.

[5] Constrained by the sample length, we could only choose from the lag length of 1, 2, or 3. All the three criteria AIC, SIC, and HQ point to the lag length of 1.

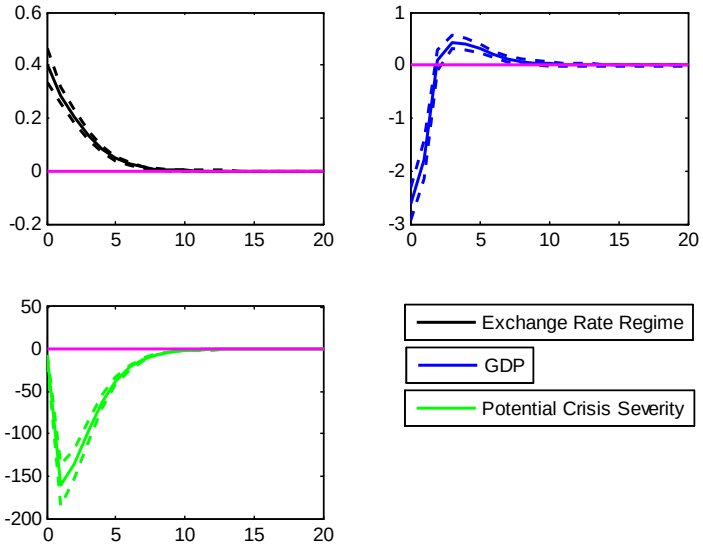

Figure 5: Impulse responses to a one unit exchange regime shock for Argentina, with one standard deviation error bands.

Dependent Variable: Annual Real Exchange Rate Depreciation Rate		
	Argentina	Mexico
Financial openness indicator	3.383 (93.837)	5.672 (2.482)
Exchange rate regime indicator	-366.980*(236.705)	-12.577**(7.232)
Current account balance	8.323 (9.432)	1.070** (0.299)
Short term debt	1.408 (12.184)	0.407*** (0.423)
R-square	0.175	0.552
DW statistics	1.291	1.487

Table. 3 *Note: The first stage estimation for Argentina and Mexico. Standard errors in parentheses. *: significant at 15%; **: significant at 5%; ***: significant at 1%.*

7 Panel Data Analysis

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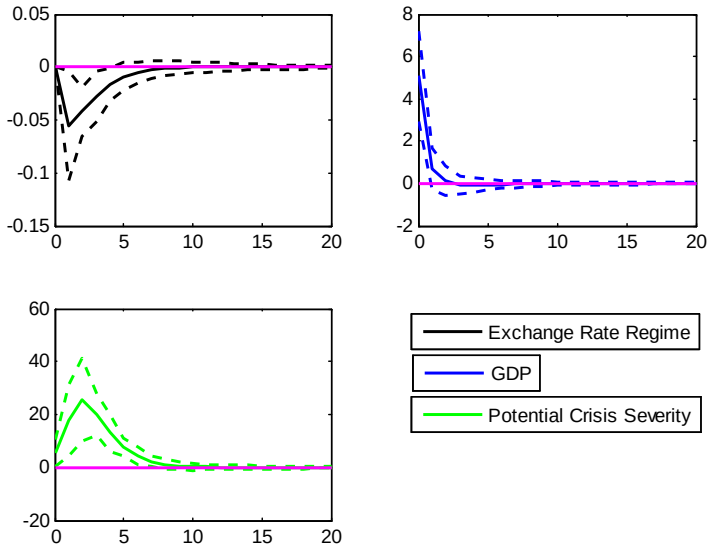

Figure 6: Impulse responses to a one unit GDP shock for Argentina, with one standard deviation error bands.

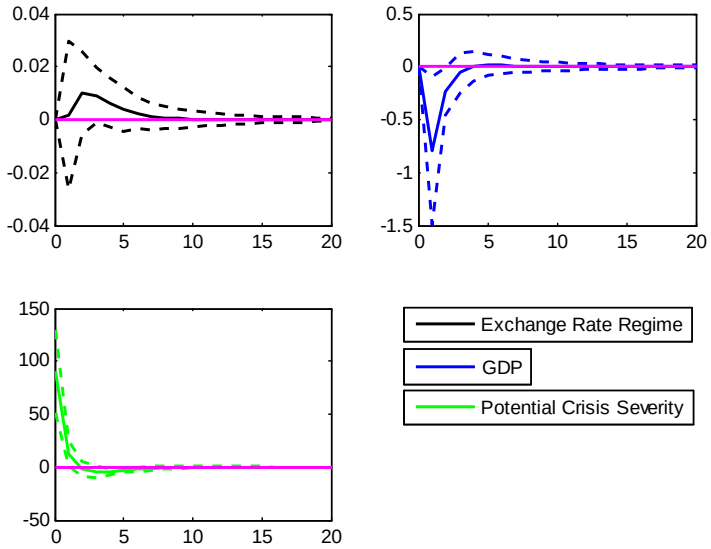

Figure 7: Impulse responses to a one unit liquidity shock for Argentina, with one standard deviation error bands.

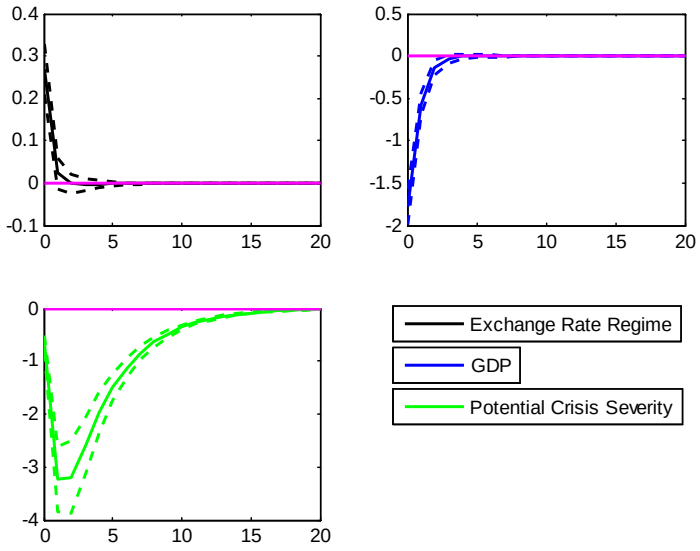

Figure 8: Impulse responses to a one unit exchange regime shock for Mexico, with one standard deviation error bands.

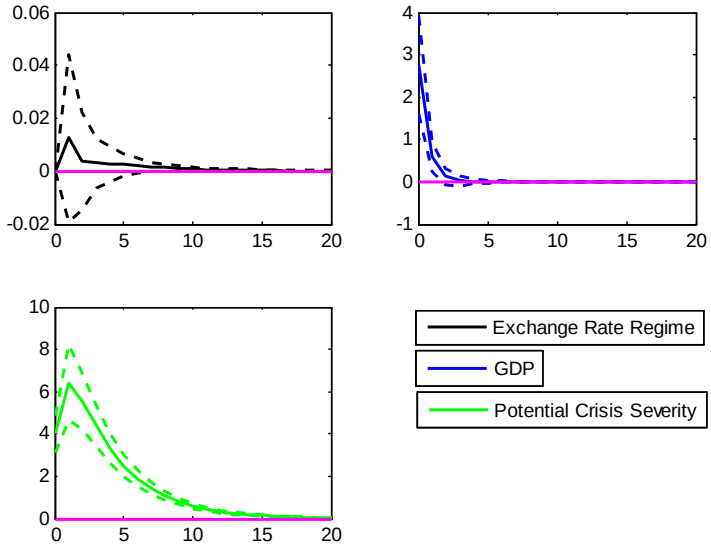

Figure 9: Impulse responses to a one unit GDP shock for Mexico, with one standard deviation error bands.

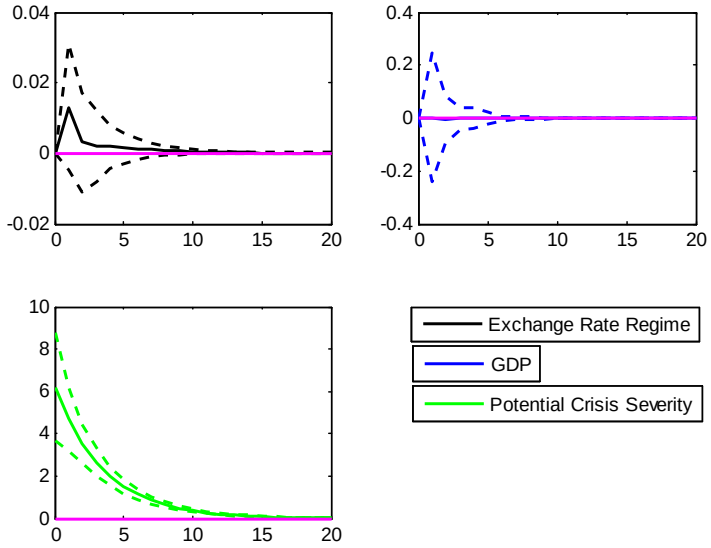

Figure 10: Impulse responses to a one unit liquidity shock for Mexico, with one standard deviation error bands.

8 Conclusions

In this paper we explore the dynamic interactions between currency regimes and business cycles , controlling for predicted crisis probability which in turn depends on the currency regimes. We characterize the effects of productivity shocks, liquidity shocks and policy regime shocks on the business cycle.

To be completed ...

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