

*Applications of Sudden Stops of  
International Capital to the Mexican Economy*

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The IAFOR North American Conference on the Social Sciences  
Official Conference Proceedings 2014

**Abstract**

There was nothing in the fundamentals of the Mexican economy that would suggest at this point the beginning of a crisis of such magnitude. The 1994 crisis was extremely unexpected for both domestic and foreign firms and households, because there were good economic indicators so far together with the financial stability of the previous years.

The Mexico of 1994 had a jure fixed exchange rate regime, but in practice, it was an intermediate peg, not a serious hard peg. Our goal is to try to find out whether things would have been different if there would have been a floating exchange rate regime in Mexico at the time of the crisis of 1994. In our aim at trying to answer this question, we set up a Dynamic Stochastic General Equilibrium Model (DSGE) that shared the main stylized characteristics of the Mexican economy of that time. We considered a pure exchange, monetary, small open economy with a DSGE framework in discrete time that obtains from micro-foundations.

Keywords: exchange rate regimes, sudden stops of international capital, bank panics, dynamic stochastic general equilibrium, monetary policy, small open economy

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## Extended Summary

Mexico has experienced different economic crises along its history, but the particular characteristics of the local and international environment made the 1994 Mexican crisis the worst crisis occurred in Mexico since 1930.

There was nothing in the fundamentals of the Mexican economy that would suggest at this point the beginning of a crisis of such magnitude. The 1994 crisis was extremely unexpected for both domestic and foreign firms and households, because of all the good economic indicators so far together with the financial stability of the previous years.

The debt issued by the Mexican government took mainly two forms: the Tesobonos and the CETES. Regarding the first debt instrument, the name of Tesobonos was the acronym for “Bonos de la Tesorería de la Federación” (Federal Treasury Bonds); it was a form of debt issued by the Mexican government that was denominated in foreign currency but payable in the national legal tender. With respect to the second debt instrument, CETES was the acronym for “Certificados de la Tesorería de la Federación” (Federal Treasury Certificates) and it was a debt instrument denominated in domestic currency. Aguirre (2002) commented that the debt in the form of Tesobonos reached the level of USD 18,384 billion of dollars, while the foreign reserves reached rock bottom at USD 12,470 billion. By December 19<sup>th</sup> of that year, President Zedillo decided to devalue the Mexican peso by 15%, from \$3.5 to \$4.03 per dollar. According to the INEGI<sup>1</sup>, at the end of 1994 Mexico owed as well 39,701 million pesos in CETES, while the foreign reserves continued to fall until they reached only USD 6,148.2 billion.

This uncertain environment influenced adversely the expectations that both domestic and foreign investors had regarding the performance of the Mexican economy; among other things, the nominal exchange rate increased in 80% between December 20<sup>th</sup> 1994 and February 13<sup>th</sup> 1995. This explained in part why the foreign investors were fearful of investing good money in such an unstable country, all of which led to a sudden stop of international capital. The Mexican government tried to roll over some of its debts, but the foreign investors were unwilling to purchase new debt from Mexico, but especially from the Mexican government, given all the unfavorable events. This sudden stop of capital, plus the devaluation of the Mexican peso were the origin of the terrible crisis that affected millions of Mexican households and firms.

From 1994 to 1995, the Mexican economy experienced a decrease in its GDP; according to the CEF<sup>2</sup>, this reduction was of the order of 6.2%. This contraction of the economic activity represented, in accordance with INEGI, an increase in the unemployment rate from 3.2% to 6.6%, raise that was equivalent to 2,310 thousands of newly unemployed persons. This increase in unemployment was accompanied by an increase in the indicators of poverty: the number of poor people increased to 44 million of persons, almost half of the Mexican population in 1995. Moreover, the

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<sup>1</sup> The INEGI is an institution that is independent from the Mexican government. It is in charge of elaborating the official statistics in Mexico, and of making surveys to the population every ten years. These surveys provide information about the GDP, unemployment, investment, consumption, etc.

<sup>2</sup> CEF is the acronym for “Centro de Estudios de las Finanzas Públicas” (Center for the Study of Public Finance), that is managed by the Chamber of Deputies of Mexico.

Bank of Mexico's Annual Report for 1995 established that during that year the aggregate consumption fell in 11.7%, while the total spending -measured by the aggregate demand- fell in 10.2%. A good approximate indicator of the magnitude of the sudden stop experienced by the Mexican economy was the significant reduction in the share of the foreign direct investment on the GDP: it was reduced from 7.8% of the GDP in 1994 to 0.3% in 1995. Moreover, the balance of payments had a deficit of the order of USD 654 million, thus increasing Mexico's debt with the rest of the world. Those among the Mexican people who had issued debt denominated in USD or had acquired loans from the banking sector were adversely affected by the devaluation of the Mexican peso: according to the statistics of the CEFPE, the interest rates increased abruptly to 89.48% in March of 1995 against an annualized inflation rate of 20.4%.

The impact of this crisis is told in part by the amount of international help needed by the Mexican economy. According to Banda and Chacon (2005), Mexico received USD 17,800 billion from the International Monetary Fund, USD 2,000 billion from the World Bank, USD 500 billion from the United States and USD 83 billion from Canada, among others.

Another characteristic of the crisis of 1994 is that it also spread from Mexico to other Latin American countries, thus hurting the expectations that foreign investors had about them as well. An example was the case of Chile; Marhur, Gleason, Dibooglu and Singh (2002) found that the Mexican crisis affected the Chilean stock market, since Chile and Mexico had a bilateral trade agreement from 1991 to 1994.

We focused our study on the events surrounding this crisis in Mexico because of all the negative effects and repercussions it brought not only to Mexico but to other countries as well; as we mentioned earlier, there were high levels of unemployment which were coupled with reductions in consumption and in savings that contributed to deteriorate the quality of life of the Mexican people.

The Mexico of 1994 had a *de jure* fixed exchange rate regime, but in practice, it was an intermediate peg, not a serious hard peg. Our goal is to try to find out whether things would have been different if there would have been a floating exchange rate regime in place in Mexico at the time of the crisis of 1994 (instead of the fixed exchange rate regime that was actually in place). In our aim at trying to answer this question, we set up a Dynamic Stochastic General Equilibrium Model (DSGE) that shared the main stylized characteristics of the Mexican economy of that time. We followed most of the features of the model by Diamond and Dybvig (1983), since they model banks that can arise endogenously as transformers of maturities and liquidity providers; but we departed from their model significantly, since we introduced two important and nontrivial features: we introduced exchange rate regimes into the environment together with the fact that the domestic country was a small open economy. We chose to model a small open economy because of two reasons: Firstly, Mexico was classified (and still is) as a small open economy and an emerging country; secondly, there was empirical evidence showing that it was the emerging countries the ones that suffer the most in the event of a sudden stop of capital, since their counterparties in more developed countries can always borrow from their respective counterparties. Given the chosen focus on an open economy, we decided to take from the work by Chang and Velasco (2001) as well. However, a

main distinction between our work and theirs is that we do take seriously the fiat component of both the domestic and foreign currency, and we do not introduce fiat money in the utility function as these authors did; we introduced instead nontrivial demands for a domestic and a foreign fiat currency that had no intrinsic value; both currencies may have circulated together and compete with each other. In addition, we modified accordingly the design of the deposit contracts offered by domestic banks to households: our main goal in this respect was to obtain more flexible contracts that would allow us to analyze the potentially negative effects that a sudden stop would have had on this economy.

We must also highlight that, from a technical standpoint, we have introduced some improvements with respect to the work by Diamond and Dybvig (1983) and Chang and Velasco (2001) in at least two ways. In the first place, we embedded the main features of the framework worked by these authors into a truly dynamic framework, in an economy that has an infinite horizon but where agents have finite lives. The second improvement relates with the setting up of a re-optimization algorithm, which is the way in which domestic banks adjust their contingent plans in the presence of unanticipated shocks.

We started our analysis of the problem at hand by focusing on a pure exchange economy based upon the micro-foundations of what would become the general equilibrium model of this economy: we modeled the behavior of the individual domestic households and banks in a very particular environment, where banks could be thought of as coalitions of households that may arise endogenously when it is in the best interest of the domestic households to do so: that is, when their expected utility is maximized. Next, we introduced alternative exchange rate regimes that in each case were coupled with a simple monetary policy rule; we considered two very distinct regimes: floating versus fixed exchange rates. On the one hand, we modeled an economy with floating exchange rates; this policy was coupled with an independent monetary policy that consisted in a constant rate of growth of the money supply. Thus, in the case where the nominal exchange rate was market-determined, the money supply was chosen exogenously by the monetary authority and there was a well-defined monetary rule in place. On the other hand, we also investigated the effects of a policy of fixed exchange rates, where the monetary authority set exogenously the nominal exchange rate; it is common knowledge that a policy of fixing the nominal exchange rate comes also with a cost: the central bank must give up an independent monetary policy, since it has to stand ready to buy or sell foreign exchange in exchange for domestic currency at the fixed price. As a consequence, the money supply is determined endogenously and the monetary authority gives up a valuable policy tool.

The overlapping generations of households in the domestic economy live for only two periods, but the economy itself has an infinite horizon. The latter allowed us to solve the model in the structural form by means of obtaining the equilibrium of this open economy in the form of a nontrivial dynamic system. We analyzed both the stationary and the transitional dynamic equilibria represented by the reduced-form dynamic equations that solved the general equilibrium for this model economy. We must draw attention to the fact that we worked on each exchange rate regime independently from one another, with the goal of comparing the contingent consumption bundles that arose in equilibrium under each of the regimes considered. Our goal was to compare

the relative merits of these two different exchange rate regimes and decide whether a policy of floating exchange rates would have worked better for a model economy that replicated the main features that the Mexican economy had by the end of 1994. There were five stylized facts that we believe the Mexican economy of 1994 shared with the East-Asian countries of 1997-98. We list these characteristics below:

- 1) Increased risky-lending behavior by domestic banks.
- 2) The lack of sound financial structure worsened with the ill-oriented process of financial and capital liberalization.
- 3) The banks' financial assets constituted the majority of their total assets – instead, for instance, of financing in capital markets.
- 4) Borrowing from foreign banks was a significant portion of the domestic debt of the private sector.
- 5) The majority of these countries had intermediate pegs in place.

We have confidence that our model captures all five stylized facts. As we mentioned earlier, we considered a pure exchange, monetary, small open economy with a DSGE framework in discrete time that obtains from micro-foundations. *Ex-ante* identical domestic agents face an uncertainty whose realization is private information. There is a standard problem in coordination that may lead to strategic complementarities and crises of a self-fulfilling type, with a potential for multiple equilibria that may or may not be realized. There is free international mobility of financial capital without any legal restriction on the holdings of foreign currency other than the reserve requirements mentioned earlier, ensuring that the domestic country inherited and took as given the prices and interest rates that were determined in the appropriate world markets. The foreign debt instruments considered may display different maturities and maturity-dates at fixed world interest rates. Moreover, in this economy the private sector is a net debtor of the rest of the world and there is an exogenous upper limit to the amount of long-term debt lending from foreign banks at each point in time. The latter permitted us to obtain equilibrium allocations that were not only determinate but also globally unique.

With the set-up we just described we were able to analyze separately the effects that sudden stops and bank runs might have on the aggregate economy, as well as how these problems relate to each other. As in Hernández-Verme and Wang (2009), domestic investment is subject to multiple reserve requirements that take the form of currency reserves; however, in our model the monetary authority chooses exogenously to pay an interest on these currency reserves. Moreover, the monetary authority chooses to back a fraction of the domestic money supply by holding interest-bearing foreign-reserve assets. We model two such economies that are similar in every respect, except for their choice of exchange rate regimes.

We must mention that the dynamic system that resulted from a regime of floating exchange rates displayed a very convoluted dynamic behavior. In particular, the equilibrium system that results from this regime was a decoupled dynamic system where both the short-term foreign debt position of domestic banks and the contingent consumption bundles inherited their dynamics from what we call a core dynamical sub-system. On the one hand, the core sub-system consisted of five first order difference equations that determined five state variables. A striking characteristic of these state variables was that they were determined independently of the foreign

interest rates, thus adding to their determinacy. On the other hand the caused dynamic sub-system of foreign debt and contingent consumptions consisted each of a nonlinear and second order difference equation, with a potential for very complicated transitional dynamics that may display endogenously-arising volatility.

Now we turn to the small open economy that operates with fixed exchange rates. The resulting dynamic system was also decoupled, with the same structure of causality than the one arising from floating exchange rates. However, since this economy inherited the world inflation rate (which we assumed was exogenous and constant,) the dynamic behavior displayed by the main economic variables of this economy was significantly simpler: all the equations of both dynamic sub-systems were linear and of first order. Moreover, the equilibrium dynamical paths did not reveal any endogenously-arising volatility, and they approached the steady-state equilibria monotonically.

Our analysis proceeded in two stages. First, we solved for the full-information benchmark equilibrium, in the absence of early liquidation, sudden stops or bank panics. Secondly, because we wanted to replicate the main cause of the 1994 Mexican crisis, we introduced the possibility of a sudden stop of capital and we analyzed the consequences of this unexpected event under the two alternative exchange rates regimes mentioned above. In the environment we modeled, we used a very simple definition of a sudden stop: a sudden stop is a cause of intrinsic uncertainty that originates in an unanticipated shock that reduces significantly the inflows of international capital with respect to what would be promised or expected in the standard contingent contracts. The big idea behind all this is that a sudden stop could affect, and possibly even reverse the structure and direction of the international flow of international capital that are commonly associated with this model economy. And the latter could have severe consequences for the economy as a whole. Furthermore, we establish that bank runs in our economy can occur if and only if a bank becomes illiquid and insolvent.

Thus, in the second stage of our inquiry, we analyzed the consequences of having several alternative combinations of the fundamental and policy parameters for these two economies. We worked with domestic banks that formulated contingent plans regarding their choice variables. In particular, a key element of the banks' contingent plan was their need to borrow the quantity of short-term debt that maximized the utility of their depositors under full information. This choice is what domestic banks expected from foreign banks in the absence of a crisis. We find that the amount of short-term debt that is part of banks' contingent contracts is larger for the economy that operates under fixed exchange rates than for floating exchange rate in the event of a sudden stop of capital.

Our results suggest that the fractions of deposits that the domestic banks must hold in form of currency reserves played a key role in most scenarios, regardless of the exchange rate policy in place. Conventional wisdom suggested that the Mexican crisis could be attributed to the decrease in foreign reserves experienced in 1994. We took this premise to be true and we run the thought experiment suggested by it, so that we could compare the consequences for each exchange rate regime. On the one hand, we found that under floating exchange rates, some combinations of parameters would cause a bank run in the case a sudden stop hit the domestic country; and, as one might

expect, the domestic banks subsequently would suffer from illiquidity and insolvency. Regarding the economy that operated with fixed exchange rates -which was the case of the Mexican economy in 1994-, our analysis suggested as well that, for some combinations of deep and policy parameters, the sudden stop of capital would cause a banking crisis, with the associated suspension of convertibility. It would appear that it is more likely for a sudden stop to have caused a bank run when a fixed exchange rate regime is in place<sup>3</sup>.

We found in the existing literature that crises arising in emerging countries, like Mexico, have been attributed to different causes. For example, authors like Aysun and Honig (2011) have found a relationship between the quality of institutions and the possibility of a crisis; they pointed out that a country with a weak institutional framework is more prone to crisis. More recently, Benmelech and Dvir (2011) tried to find out if there was a clear-cut relationship between the short-term debt held by the private sector and how vulnerable the economy as a whole was to financial crises. They explored two channels that could make it so: either the short-term debt increased a country's vulnerability to financial crises or the amount of short-term debt is an effect -rather than a cause- of a forthcoming crisis in emerging countries. They concluded that the short-term debt did not cause crises; they found instead that the short-term debt was more likely a reflection of the weak financial system of the country.

There is also a group of studies that have focused on the potential consequences of that a crisis could have on the economy as a whole. Among them, we found the work by Cooper and Ross (1998) and Ennis and Keister (2006). They studied how banks could adjust the deposit contracts they offered to households in the case a bank run occurred in equilibrium, together with the implied consequences of this change in their decisions. They concluded that it was evident that the probability of a run would affect the level of investment made by banks and that banks would formulate their deposit contracts based upon this level. Thus, they concluded that deposit contracts played a key role, since contracts that were not properly designed could leave banks vulnerable to runs. Following in this line of study we have the work by Furceri and Zdzienicka (2011), who studied the effects that debt crises could have on the Gross Domestic Product. They concluded that, in the case of a sudden stop (which they also call a debt crisis), the reduction that it would cause on the rate of economic growth would be larger in countries where the incidence of public debt is higher. Moreover, they draw attention to the fact that the negative impact that a debt crisis might have on growth would be larger than the effect caused by an increase in the debt of the public sector. Closer to our approach, Edwards (2007) studied the influence that capital inflows could have on external crises; he concluded that there was not sufficient evidence to suggest that high levels of capital mobility could definitely increase the probability of a crisis.

Regarding some of the previous work that has focused on the study of the Mexican crisis, we found that Cole and Kehoe (1996) attributed the Mexican crisis to a self-fulfilling-debt crisis; in particular, they concluded that the main factor causing a crisis was the short maturity of Mexico's domestic debt. Concurrently, the work by Sachs, Tornell and Velasco (1996) tried to explain that the Mexican crisis was not the

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<sup>3</sup> This is an inference, not necessarily a result of the model.

consequence of an overvalued exchange rate or the deficit in the balance of payments experienced by Mexico at the time; instead, they attributed the Mexican crisis to a self-fulfilling panic that was exacerbated by the fixed exchange rate regime in place. However, they also pointed out the caveats of their analysis: as any theoretical model built to improve our understanding of a particular event, they argued that the model they used to evaluate the impact of a debt crisis appears to have some limitations, and that their results should not be taken lightly.

We found a long list of events that could have caused the crises that were experienced by emerging countries; among them we have the following: the short maturity of their debt, the poor quality of their institutions, their degree of international capital mobility, the deficits in their balance of payments, a bad combination between exchange rate regimes and monetary policies, a pessimistic shift in households' expectations, etcetera.

We consider that our contribution to the existing literature does not lie in explaining what caused the crisis of 1994; instead, we explored the consequences that a sudden stop of capital could cause. We found that the underlying exchange rate regime and the monetary policy in place were central to understanding this phenomenon. However, the direction of the effects did not have opposite effects depending on the regime: instead, the exchange rate regimes explain the different incidence of a crisis, not its direction. We have restricted our attention to the line of thought that established that crises in emerging countries arose due to their short-term debt, either because of their short maturity or because of the size of their debt position. In particular, we have focused as well on how a change in the amount of their debt could have increased the likelihood of a run.



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