



INSTITUTO TECNOLÓGICO Y DE ESTUDIOS SUPERIORES  
DE MONTERREY  
EGADE BUSINESS SCHOOL

**MXN: TECHNICALS OVER FUNDAMENTALS, THE  
AFTERMATH OF THE GREAT RECESSION**

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## Abstract

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The purpose of the current essay is to elaborate on how the Mexican currency has evolved since the recent financial crisis, what have been the main drivers of the exchange rate in order to identify if we can say that there has been a structural change in the Mexican currency dynamics after the last global recession. Hence the study elaborates on how the macroeconomic stability achieved over the past decades has provided support to developed deep financial markets, particularly the FX market. Once stated what does macroeconomic stability in Mexico stand for, global financial conditions around the Mexican peso are assessed. In this context, the study implements an empirical approach to identify if there was a structural change in the Mexican peso dynamics after the global crisis, in which macroeconomic fundamental may have become less relevant vis-avis financial market conditions. Results show the hypothesis of a structural change after the ‘Lehman Brothers’ event can not be rejected and complementary it is shown that fundamentals lost explicative ground relative to financial technicals. It is concluded that this has been the case given the peso has become a relevant assets in the international markets front, and hence it is now subjected to global financial headwinds. However, current financial conditions are not likely to linger forever, which in turn suggest fundamental are likely to gain traction as financial stress dissipates.

## I. Introduction

The global financial crisis in 2008-09 and its aftermath have unfolded a new economic scenario in which growth is likely to shift from developed to emerging economies. Economic growth over the past century was typically guided by business cycles in the main developed economies (i.e. US and Europe). However, in a global context of sluggish growth and an imminent fiscal tightening in the US and the European Union, growth is likely to come from emerging economies going forward. Under this new 'global growth outlook' amid huge fiscal challenges, Mexico looks well poised to emerge as a leader among emerging economies. Against this backdrop, the purpose of the current essay is to elaborate on how the Mexican currency has evolved since the crisis, what have been the main drivers in order to identify if we can say that there has been a structural change in the Mexican currency dynamics after the last global recession.

While macroeconomic conditions in Mexico have been quite benign for the past couple of years, recovering firmly after the Great Recession, dynamics in the FX market have not reflected the sustained improvement in domestic and external accounts, and instead the peso has remained subject to global market conditions, responding favorably to positive headlines, while suffering on the back of risk-aversion episodes.

The Mexican economy was able to bounce-back from the most recent crisis in a reinvigorated fashion, supported by the manufacturing V-shape recovery, with no significant imbalances between output supply and demand, and a solid macro framework that enhances the credibility of economic policy. Furthermore, after three years of above-trend growth and increasing appetite for Mexican assets, the economy looks set to take-off on the back of the long-awaited structural reforms, the most important trigger to increase the country's long-run potential growth. The new administration has set an ambitious agenda, and President Enrique Peña appears to count with robust political capital, while the willingness for political agreements has been evidenced with the signing of the 'Pact for Mexico'.

That said, the object of the current paper is to elaborate on the recent dichotomy between sound fundamentals that should have translated into a stronger currency, reflecting both idiosyncratic and external factors. However, part of the dissertation will elaborate on how the aftermath of the recent financial crisis evidences that the technicals in financial markets, where the very nature of the peso as a free-float, top-traded emerging market currency with strong correlation with other global assets has derived the MXN to be mainly driven by global conditions, instead of its fundamentals.

Section I starts describing how Mexico has been able to develop strong macroeconomic fundamental over the last two decades, particularly after the 1994 Tequila crisis. In this context, the first section elaborates on Mexico's strong recovery after the sharp growth contraction due to the financial shock, as well as on how fiscal and monetary policy has supported macroeconomic stability over the last two decades. In order to do this, I will provide a brief view on the bright recovery story from the export-driven manufacturing sector that underpinned the economic comeback after the huge collapse in global activity in 2009, as well as an overview on fiscal and monetary policy over the last years.

Section II will focus on how the Mexican currency has become a global asset that is link to the headwinds of global financial conditions and markets' animal spirits. It describes FX market recent dynamic and how market technicals also play a crucial role in the currency performance, regardless of what sound fundamental would suggest.

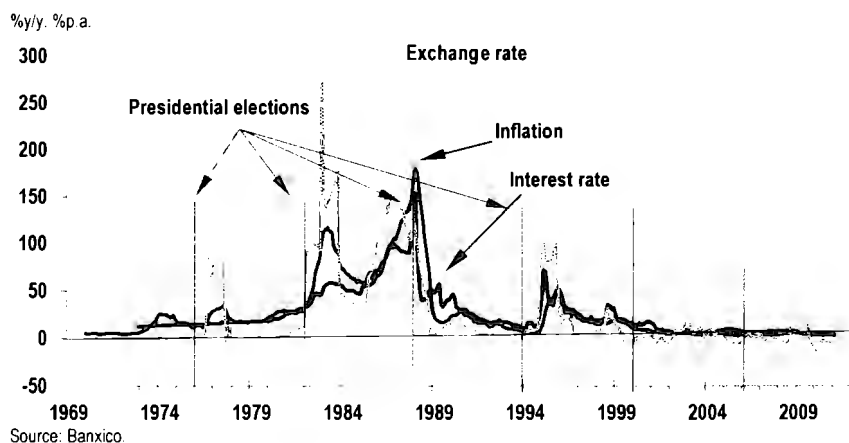
After differentiating between fundamentals and technicals, as main drivers of the currency performance, Section III proposes an empirical approach to elaborate on how both currency-drivers have influenced the Mexican peso ex-ante and ex-post of the 2008-09 crisis, in a twofold fashion. The first empirical approach introduces two econometric OLS models to explain the MXN dynamics with both fundamental and financial variables. We would expect to see that the explicative power of fundamentals is relatively stronger prior to the 2008-09 financial shock, and vice versa. Lastly, in order to validate the previous unorthodox empirical approach a third economic OLS model is presented. This model incorporates both fundamental and financial variables to explain the Mexican currency. While the model is expected to improve explicative power relative to the other two previous models, the object is to run a 'Chow Test' in order to formally prove that a structural change took place during the 2008-09 financial crisis.

## II. Macroeconomic fundamentals: Mexico has done its homework

Over the last 10 years policymakers in Mexico, as well as analysts from the private sector have highlighted the important achievements the country has reached in terms of macroeconomic stability. Political and economic progress over the past two decades in Mexico has been gradual but sustained. Politically speaking Mexico is a 'young democracy' and its biggest challenge is to create consensus amid a split Congress while, economically speaking, the macroeconomic stability achieved over the past decade is a necessary pillar to support economic growth and a stable currency, but not sufficient.

Macroeconomic stability relies basically on the responsible management of the two main forces of the economy, fiscal and monetary policy. In this context, Mexico has been able to avoid the self-inflicted economic crisis historically known as 'crisis sexenal'. Note that during the second half of the last century, the last year of the public administration was very well known as 'El año de Hidalgo', in which irresponsible fiscal policy and the lack of transparency, typically translated into BoP crises with strong capital outflows, huge exchange rate depreciations, and ridiculously high inflation and interest rates (chart below). Nowadays, this is not the case anymore as the sharp depreciation observed during the 2008-09 financial crisis, was driven by an external liquidity crunch and not a domestic inflicted imbalance. Consistent with that inflation and interest rates were well contained despite the abovementioned depreciation of the currency.

Exchange rate, inflation and short-term interest rates

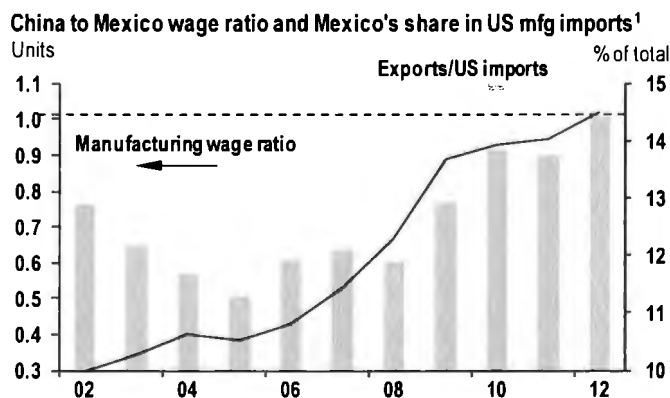


### *A CONSTRUCTIVE MANUFACTURING RECOVERY*

The aftermath of the latest financial crisis not only poised the Mexican manufacturing sector in a sweet spot to emerge in a reinvigorated fashion on the back of considerable gains in competitiveness, but it also confirmed that sound macroeconomic fundamentals remain in place. Mexico's manufacturing sector has become increasingly more competitive over the past few years, regaining some of the ground lost to China in the early years of the last decade. Over the past few years, Mexico has been able to increase its share in US total manufacturing imports to nearly 15% from a 10-year low of 11.2% in 2005. Several factors have allowed manufacturers to regain competitiveness, among which are increasing transportation costs, which have turned Mexico into an attractive destination for manufacturers aiming to sell their goods in the US market, and the growing domestic markets in Central and South America.

The most important factor behind this increase has been the relatively subdued labor costs that have prevailed in the country over the past 10 years. Mexican manufacturing wages have barely increased since 2000, and the mild increase that has been observed has been more than offset by the sharp depreciation of the peso following the Great Recession (2008-09). In fact, when measured in dollar terms, Mexican manufacturing wages have remained virtually unchanged since 2007 (wages stood at US\$2.01 per hour last year).

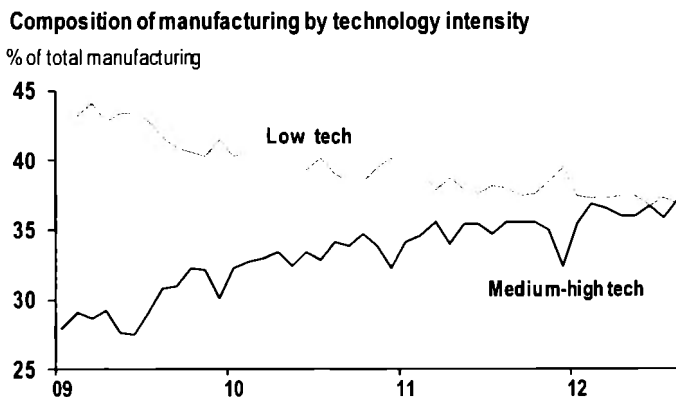
In contrast, the gradual economic and demographic transformation of the Chinese economy has resulted in a sustained increase of manufacturing wages, exacerbated by the appreciation of the renminbi. These two opposing trends, increasing manufacturing wages in China and stagnant wages in Mexico, have reduced the wage gap between these countries—which stood around 300% in 2004—to practically zero (chart below). These contrasting trends have explained much of the increased attractiveness of Mexico's manufacturing sector.



Source: J.P. Morgan and INEGI. 1. Estimates for Chinese wages in 2011-12

One of the sectors benefiting most has been the automotive sector (accounting for around 18% of total manufacturing), which has seen a broad range of automakers shifting their production to Mexico, taking advantage of both lower labor and transportation costs. On the back of this shift, auto production has grown at a double-digit pace over the past three years, reaching yearly production of around 2.6 million units, of which around 80% goes into the external market (J.P.Morgan, 2012).

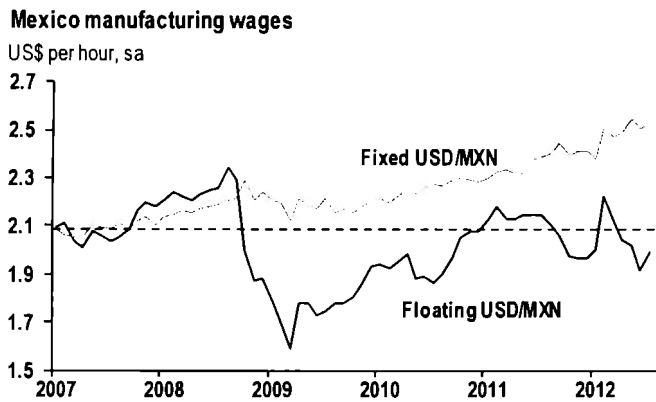
Besides fostering an increase in the share of US total manufacturing imports, the increase in competitiveness is seemingly leading to a structural change in Mexico's manufacturing composition, in terms of both technology intensity and destination markets. Mexico has begun to gradually shift its factory production from low- and medium-low-technology-intensive products to medium-high-technology intensive ones (chart below). While the share of low-tech products fell to 36% from 44% between 2009 and 2012, the share of med-high-tech output increased to 37% from 26% over the same period, allowing manufacturers to move further up in the production chain of value. On the other hand, although remaining heavily dependent on US imports, the ratio of manufacturing exports to the US to total manufacturing exports has dropped to 78% after peaking at around 88% in 1998, helping the country become less vulnerable to the US economic cycle by diversifying to the rest of America, Europe and Asia.



Source: J.P. Morgan and INEGI

However, while allowing the manufacturing industry to expand and enhance its structure to some extent, the factors behind the gain in competitiveness have been more cyclical than structural. Controlling for the sharp depreciation of the peso, let alone the appreciation of the renminbi, manufacturing wages in Mexico would have increased by around 25% between 2007 and 2012 (chart below), rather than remaining flat as has been the case. Gains in competitiveness, resulting from higher oil prices, and therefore higher transportation costs, have also followed cyclical factors.

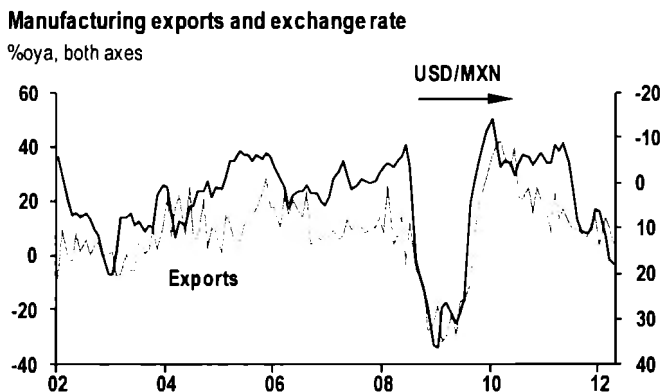




Source: J.P. Morgan

In contrast, structural developments such as an increase in the sector’s productivity have remained modest and have only recently started to show signs of improvement. Productivity has increased around 3.5% over the past five years, implying a meager 0.7% annual increase. Nevertheless, it is worth noting that most of the poor performance of productivity is explained by the sharp drop observed during the Great Recession. In fact, after remaining subdued since 2007, manufacturing productivity has increased above pre-crisis levels.

The correlation between manufacturing exports and yearly changes in USD/MXN over the past 10 years has been -0.76, and since the outburst of the 2008-09 financial crisis has increased to -0.84. (J.P.Morgan, 2012) The high beta of manufacturing exports to exchange rate changes makes them quite vulnerable to an appreciation of the peso as it eventually could wipe out much of the competitiveness gain achieved (chart below).

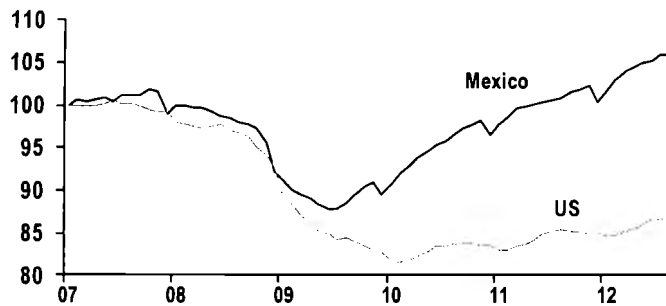


Source: J.P. Morgan and INEGI

In addition, the gradual fall in unemployment and the relatively fast increase in manufacturing jobs are likely to push up wages ahead. In contrast with the US, where manufacturing employment has recovered only in a mild and gradual fashion, manufacturing jobs in Mexico have risen sharply since the beginning of the recovery, and currently stand above pre-crisis levels (chart below).

### US and Mexico manufacturing employment

Index (2007=100)

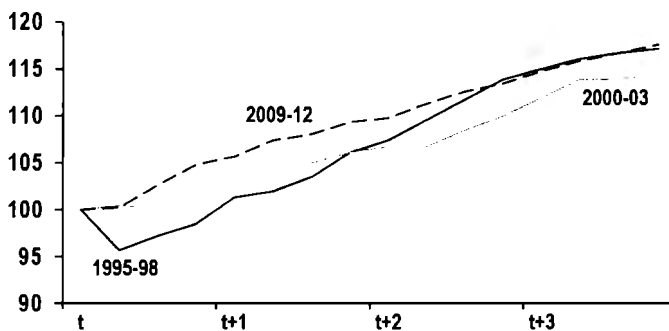


Source: J.P. Morgan

Overall, Mexico has benefited from an increase in competitiveness that has triggered a strong expansion in the manufacturing sector, particularly in the automotive industry. Even though the performance of the manufacturing sector in the aftermath of the Great Recession has been impressive, on the back of the factors noted above, GDP growth as a whole has experienced a similar path to the one observed in previous recovery periods, such as the Tequila hangover and the 2001 recession (chart below).

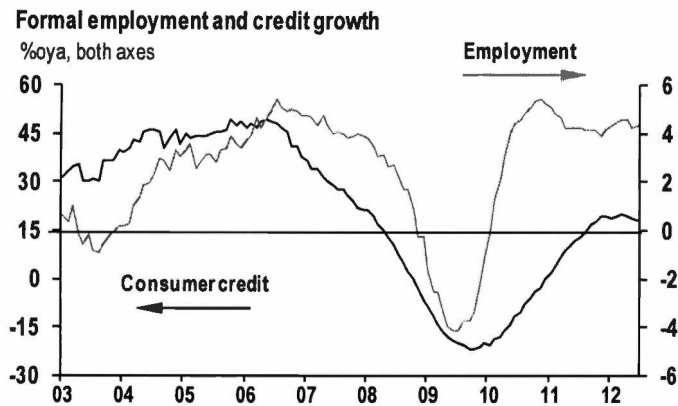
### GDP growth during the last three expansion cycles

Index (trough=100)

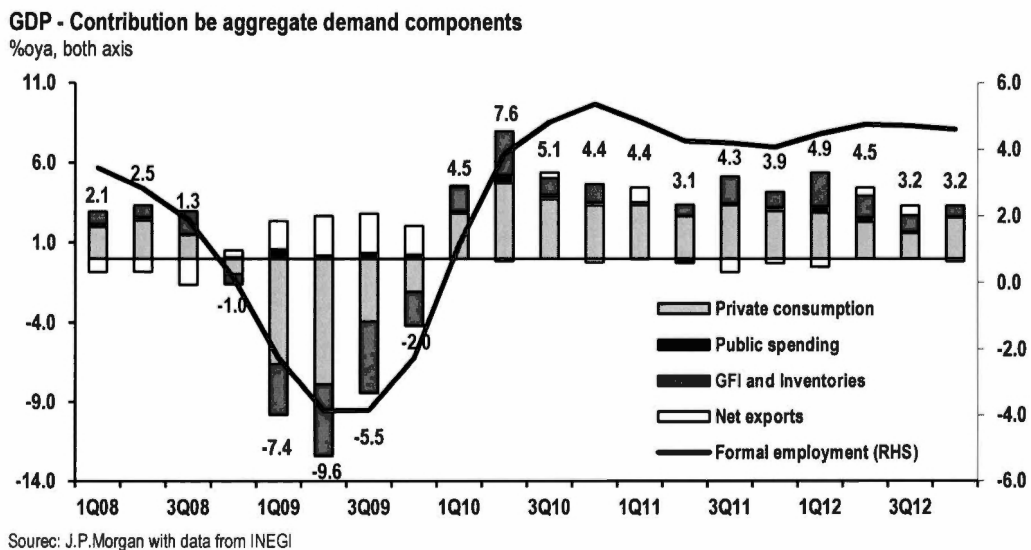


Source: J.P. Morgan

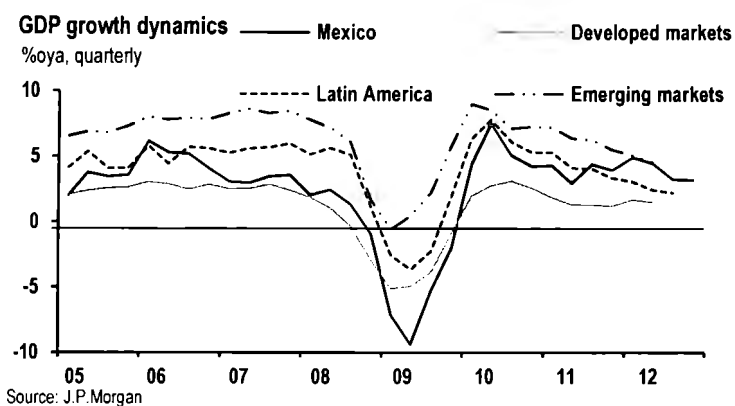
While the externally driven boom in manufacturing led to a V-shape recovery in the sector, domestic demand dynamics have been relatively more moderate but sustained. There have been considerable recoveries on domestic consumption on the back of higher employment and credit (chart below), and nowadays domestic consumption is expanding at a healthy pace.



As it is shown in the chart below, during the worst episode of the economic contraction investment and consumption collapsed, while net exports contributed to positive growth. After the manufacturing boom, the recovery observed in employment supported higher levels of consumption, while the comeback of investment has been relatively gradual. In this context, growth is now supported by healthy consumption and relatively stable investment (chart below).

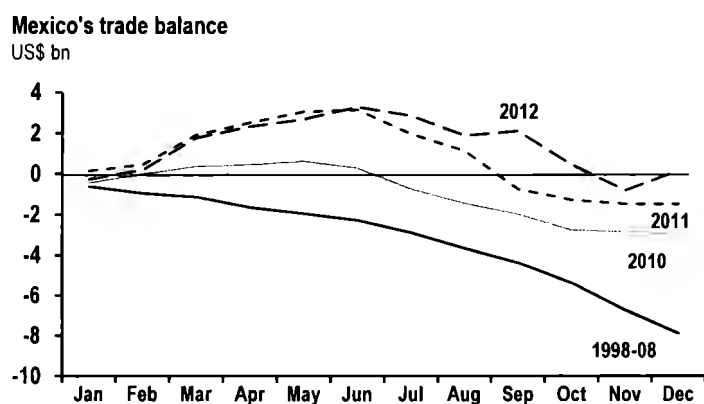


In sum, Mexico has managed to pull a bright recovery story after the sharp recession experienced back in 2008-09. In fact, given the sluggish economic recovery observed among developed economies, Mexico's current growth pace outstands in a global context (chart below).



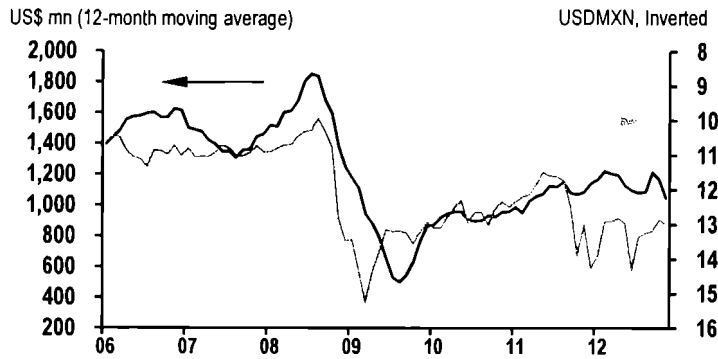
### ***FISCAL RESPONSIBILITY AND HEALTHY EXTERNAL ACCOUNTS***

Healthy and well-financed external accounts, robust capital inflows and an aggressive strategy to accumulate central bank reserves amid prudent fiscal and monetary policy conduction have underpinned macroeconomic stability over the last few years. External accounts have indeed remained well behaved, with a moderate current account deficit supported by a gradual shift in the country's trade balance. In this context, trade deficits have shown an important correction relative to pre-crisis levels, while main sources of capital flows have remained in place.



While the peso is not considered a commodity currency *per se*, it is worth stressing that it keeps a close direct relationship with oil exports, appreciating in line with an improving oil trade balance, and weakening as oil receipts decline. The decoupling observed between the peso and net oil exports since mid-2011 (see next chart) only confirm the increasing sensitivity of the local currency to global risk-aversion, and away from the sound economic fundamentals.

**Oil trade balance and USD/MXN spot**

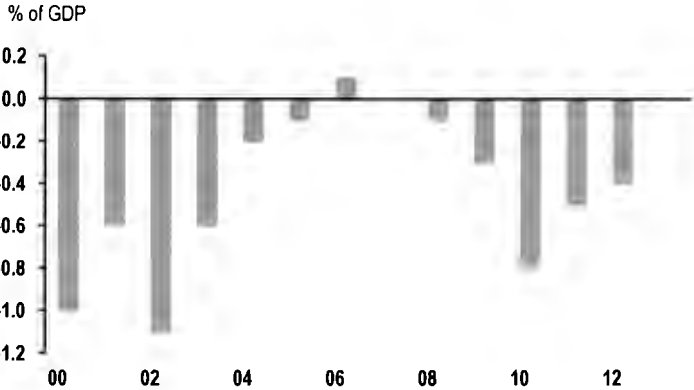


Source: INEGI and Bloomberg.

Furthermore, Mexico enjoys healthy public finances in a global context of fiscal imbalances. In fact, the Mexican government experienced a fiscal tightening back in 2010, when the rest of the world was running countercyclical policies to offset the impact of the 2008-2009 *liquidity crunch*. In a global context of debt-related concerns, Mexico has managed to keep both a relatively low debt-to-GDP ratio as well as a prudent fiscal balance.

This, along with a global search for yield has pushed government financial costs to a historical low. Moreover, the recently approved 2013 zero-deficit budget supports the prudent fiscal stance the Mexican government has adopted over the past years.

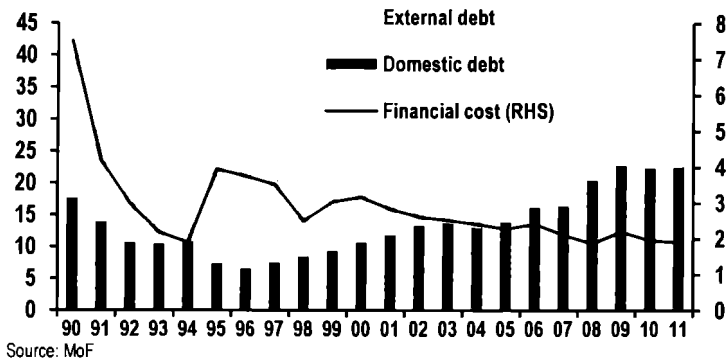
**Federal government fiscal balance**



Source: MoF. The government projected a balance budget for 2013.

Indeed, Mexico’s budget-responsible attitude and a prudent fiscal stance have allowed the country to maintain a healthy indebtedness level of around 34% of its GDP, in a global context where major countries are suffering from serious sovereign debt troubles. In fact, the Mexican Government has been able to gradually shift the composition of its total sovereign debt from a strong dependence on external liabilities to a more internally-biased debt composition (chart below). This would have been impossible without healthy and deep development of local financial markets.

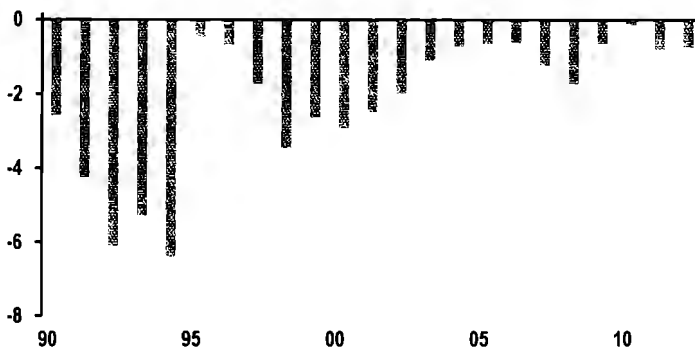
**Debt composition and debt's financial cost**  
 % of GDP, both axis



Source: MoF

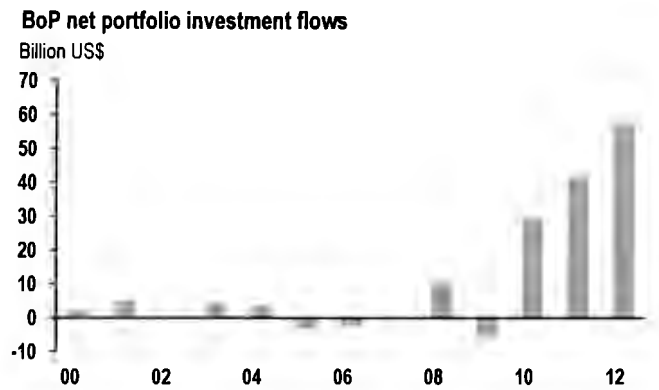
On the other hand, Mexico's external accounts have gradually improved since the Tequila crisis back in 1994. Current account deficit have remain moderate over the last two decades (chart below) and well financed by robust capital inflows in the years after the crisis.

**Current account deficit**  
 % of GDP

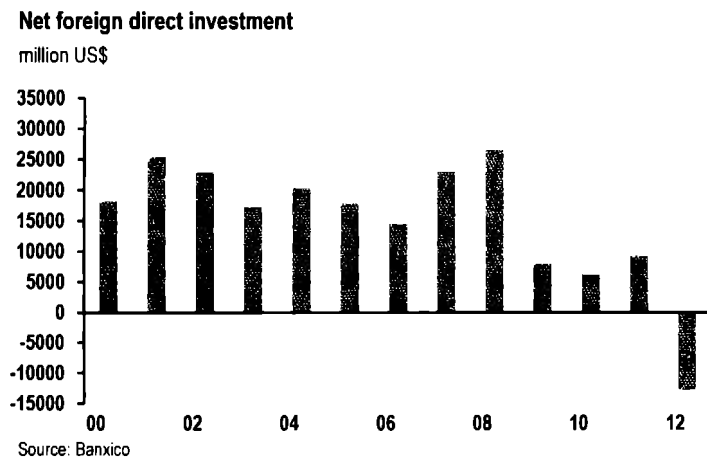


Source: Banxico

Consequently, Mexico has moved away from currency mismatches and refinancing risks that had limited its creditworthiness in the past. Hence, Mexico's fundamentals have continued to grow strong since the last decade, which coupled with steady growth, has attracted foreign investors into local markets (chart below), and particularly into the peso-denominated fixed-rate bond market.



While the gradual improvement in external accounts and portfolio flows into the financial accounts of the balance of payments is peso-supportive by itself, the expected improvement in foreign direct investment (FDI) should confirm the much needed boost to the local currency. FDI represented close to 3.0% of GDP last decade but it has flattened to less than 1.0% between 2010 and 2011. Moreover, net FDI surprised in 2012 posting a negative balance of 1.1% of GDP, in sharp contrast to the 6.2% of GDP in portfolio investments and the moderate deficit in the current account, which stood at 0.8% in 2012.

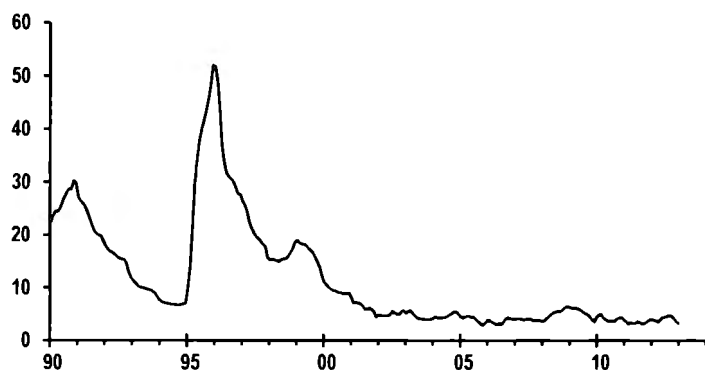


### *A CREDIBLE MONETARY AND EXCHANGE RATE POLICY*

After the independence of the central bank in 1994, Banxico has been able to handle a credible and effective monetary policy pushing inflation down to a one digit figure. In this context, Banxico is fully committed to reach the 3% inflation target and has conducted a prudent monetary policy over the last decade, evidencing it is a solid Institution in Mexico.

**Consumer prices - all items, nsa - Mexico**

%ch over 12 months



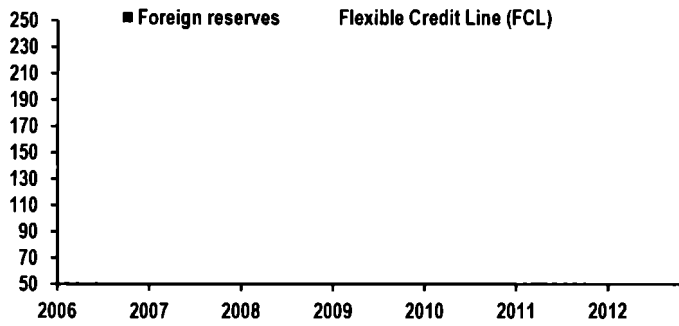
One of the biggest lessons of the last crisis was that the level of international reserves could represent a source of vulnerability, particularly against a speculative attack in the foreign exchange market. Against this backdrop, FX policy over the recent years has been to gradually accumulated central bank's reserves in a successful way. Foreign exchange reserves reached US\$237 billion by the end of 2012 taking into account the IMF's Flexible Credit Line (FCL), which currently accounts for US\$ 73 billion over a two-year horizon<sup>1</sup>. More over the fact that the International Monetary Fund (IMF) has been renewing this flexible credit line is another sing that international financial institutions recognize Mexico's strong fundamentals.

<sup>1</sup> Reserve accumulation increased sharply after the onset of the financial crisis in 2008, reaching a 40% annual pace in 2010. By the end of 2012, the pace of growth declined to 15%, still above the average of accumulation registered since the year 2000, which stands at 14%.



**Banco de México's foreign reserves and IMF's flexible credit line**

US\$ billion

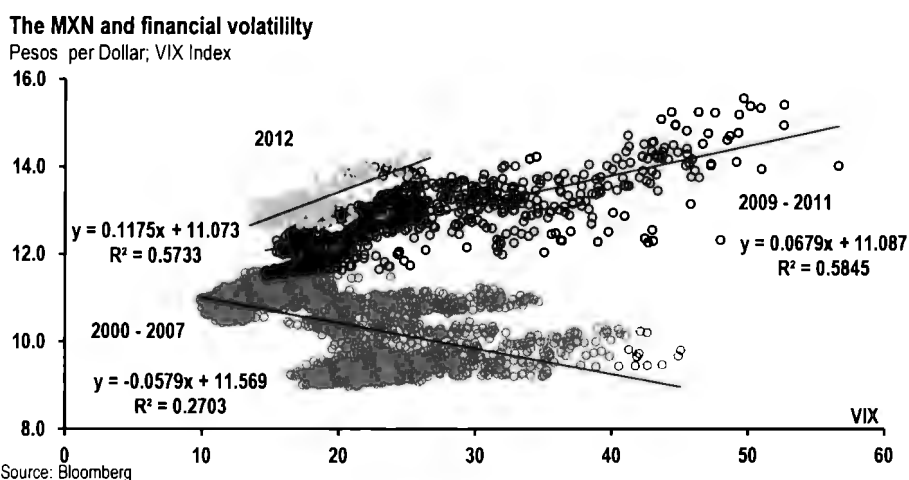


Source: Banco de México

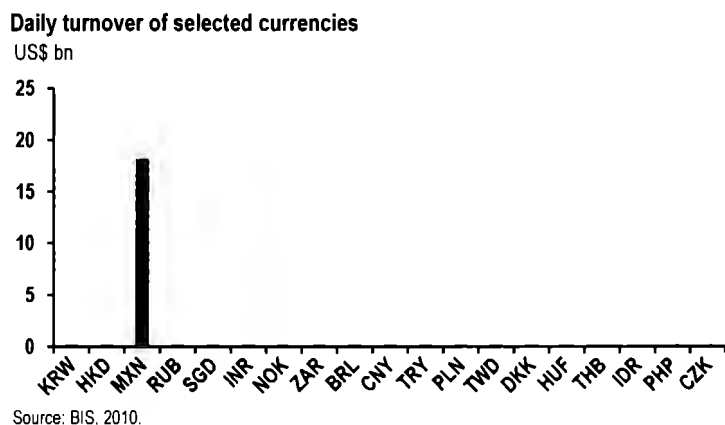
Overall, we have tried to build a strong case to validate that Mexico macroeconomic framework is in better shape than ever, on the back of responsible fiscal and monetary policy in sync with healthy growth, small current account deficits and robust capital surpluses. However, such sound fundamentals were not necessarily reflected in a stronger currency over the recent past, as global financial markets have also take a toll on the Mexican currency.

### III. The other side of the coin: Market risk aversion

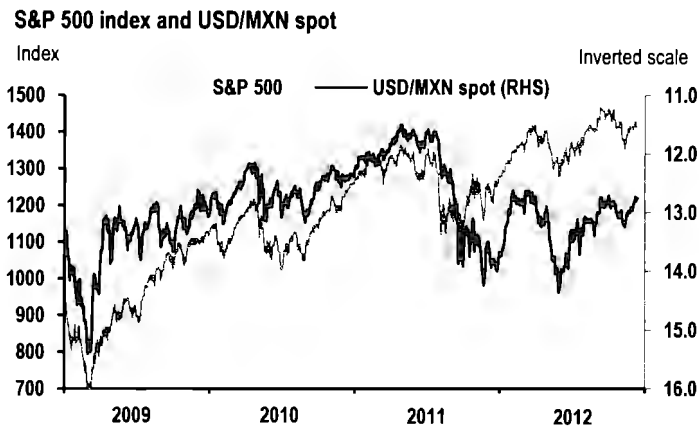
It is hard to refute that in spite of the sound macroeconomic fundamentals observed over the past few years; global risk aversion and high volatility have driven the peso since the aftermath of the Great Recession. In this context is worth to highlight that the relationship between the MXN and some key volatility measures has reversed, turning positive from 2009 onwards. Note that, before 2008, for any VIX (volatility index on the S&P 500) reading the peso remained easily below the MXN\$12.00 “barrier”, in sharp contrast with the post-2008 relationship, with the peso averaging MXN\$12.93 per dollar and the VIX at 24 points on average. In the “old” times the latter reading was consistent with the peso below MXN\$11.00 per dollar (chart below).



The abovementioned shift in the Mexican currency correlation may have a lot to do with the fact that the MXN enjoys one of the most liquid, deep and fully accessible market among emerging markets. According to the 2010 Bank of International Settlements (BIS) report on global foreign exchange market activity, the Mexican peso is the third most trade currency in the EM world (chart below), while almost two thirds of the daily traded volume occurs off-shore.



Hence, given that the peso is at present one of the most liquid free-float<sup>2</sup> emerging market currencies (BIS, 2010) and holds an important correlation with US equities, it has become an important hedging vehicle for investors in the global risk aversion episodes observed so often in recent years. As it is depicted in the chart below, the Mexican currency holds a positive correlation of about 70%, with the S&P 500 US equity index. In this context, given that the peso is a 24/7 full convertible currency and the central banks has historically respect a free-float FX regime, it has become relatively easier to get in and out from the peso market than from most of EM currencies. As it is also shown in the table below, note that in contrast to the South Korean Won (SKW) –which is in fact the most liquid EM currency in the spot market (table below)—the Mexican Peso (MXN) is now mostly traded off-shores making easier for global investors to get in and out at anytime.



Source: Bloomberg.

#### OTC Foreign exchange turnover by instrument and counterparty

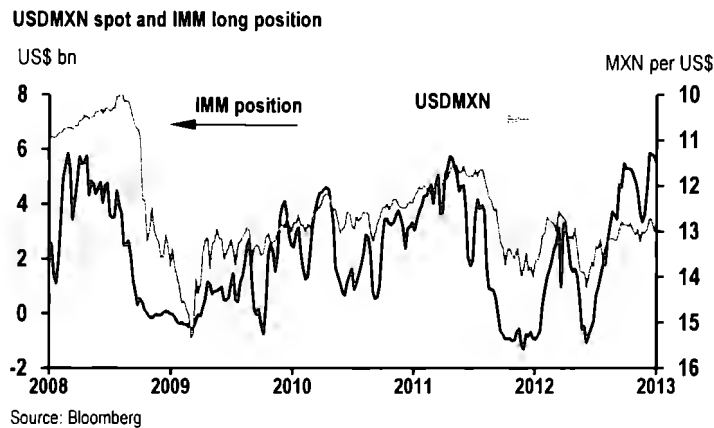
Daily average, in million US\$

|                                   | SKW           | MXN           |
|-----------------------------------|---------------|---------------|
| <b>Spot</b>                       | <b>21,144</b> | <b>18,158</b> |
| With reporting dealers            | 12,821        | 6,925         |
| Local                             | 9,769         | 2,125         |
| Cross-border                      | 3,052         | 4,800         |
| With other financial institutions | 6,229         | 8,360         |
| Local                             | 3,183         | 2,812         |
| Cross-border                      | 3,046         | 5,555         |
| With non-financial customers      | 2,094         | 2,867         |
| Local                             | 1,714         | 1,599         |
| Cross-border                      | 380           | 1,268         |

Source: BIS, data as of April 2010.

<sup>2</sup> The Foreign Exchange Commission (FEC) is in charge of exchange-rate policy in Mexico, and historically has followed a hands-off approach via rules-based interventions intended to reduce volatility and/or accumulate reserves. The FEC has been clear in that it does not target any exchange rate levels. Discretionary interventions have been limited in the past to extreme volatility episodes in 1998 and 2008.

Moreover, the peso is also a very liquid asset on the Chicago Mercantile Exchange (CME), in which the International Monetary Market of future contracts has become an important reference on the peso performance. As it is depicted in the chart below, the net long or short position of market participants in the Mexican currency has also a strong correlation with the performance of the currency.



Given the recent analysis, it appears that having a full deliverable and open FX regime is a two-hand-tool in which the currency can play a very important role as the main buffer through which external shocks can be absorbed, but on the other hand, it can also provides leeway for international investors to use the peso as a hedging vehicle against risk off scenarios. Note that such has been the case in the aftermath of the liquidity crunch after the 'Lehman Brothers collapse' due to the assets bubble experienced in the subprime mortgage back securities (MBS) market in the US. Such event not only triggered a risk-off mode in which global investor have remained relatively skeptical and uncertain on future conditions, but unfolded a global recession that continues to dent on global growth dynamics. Moreover, it also evidence the weak fiscal stance of many countries in the Euro zone, which in turn, increased the risk of a financial 'tail event' feed even further already high volatility, exacerbating global risk aversion. Given such environment, it is not hard to believe that now that the peso has become a more 'global' currency, as it has been more subject to the headwinds of global conditions, and hence relying on financial conditions.

## **IV. The econometric models**

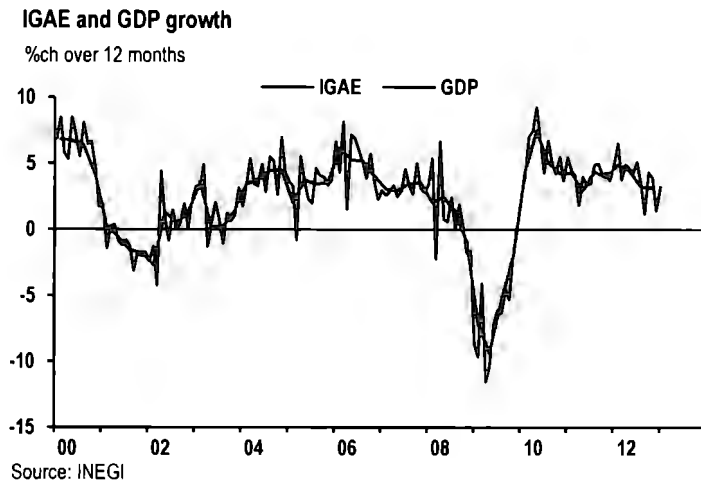
### *AN UNORTHODOX APPROACH: TECHNICALS VS. FUNDAMENTALS*

In order to sustain the thesis that a structural change took place during the Great Recession, in which fundamentals lost explicative power on the peso performance vis-à-vis market technicals, it is proposed to make a twofold empirical approach to explain the peso dynamics over the last decade. In this context, the ‘Fundamental Model’ will contain fundamental indicators as independent variables in an OLS model, while the ‘Market model’ will try to explain the peso performance with the use of global financial assets as independent variables.

The sample for both models will be divided in two periods, prior and after the financial crisis. The threshold was set at September 2008, as the Lehmann Brothers event is considered the main trigger of the global financial turmoil. In this context, the pre-crisis sample goes from July 2000 to September 2008, while the post-crisis period goes from September 2008 to January 2013. Results are expected to show that fundamental variables lose explicative power at the margin when testing in the post-Lehman episode relative to the pre-crisis period, while financial variables are expected to show the opposite outcome. Hence, we can conclude that fundamental drivers behind the Mexican peso became less relevant relative to financial conditions after the financial crisis.

### *THE FUNDAMENTAL MODEL*

The proposed OLS model under a fundamental approach incorporates the INEGI's economic activity indicator (IGAE) as a GDP monthly proxy for economic growth. Note that correlation between IGAE index and GDP is almost 1 (chart below).



The other two independent variables are the 5-year Credit Default Swap (CDS) and the Consumer Price Index (CPI). The CDS is expected to reflect the sovereign risk of Mexico, as these swaps are actually a hedging tool in case the Federal Government defaults on its debt. Lastly, CPI inflation represents a key fundamental indicator for a strong macroeconomic framework, as prices stability is crucial to support real growth and purchasing power. It is worth noticing that in order to avoid stationary in data series, the model is built using monthly variations of the abovementioned variables.

As it is shown in the OLS estimated model (table below), the explicative power (R-squared) for the pre-crisis period stands close to 22%, while all independent variables hold a significance level above 90%. Note that the purpose of the model is not to find the best OLS model to explain the peso performance, but to detect if the explicative power of fundamental variables loses significance after the financial crisis. In this context, beta estimators are consistent with economic theory as the economic activity indicator (IGAE) present a negative correlation of 57% with the peso (MXN), meaning the peso tends to appreciate (decline) when growth accelerates. In contrast, but also consistent with economic theory, the beta estimator for inflation (CPI) shows a positive correlation close to 81% in which higher inflation levels are associated to a depreciated peso, given the so-called pass-through that feeds inflation through the tradable goods basket. In other words, a depreciated peso makes imports relatively more expensive, which in turn translates into higher consumer prices of imported goods in the consumer price index (CPI).

### Fundamental Model (pre-crisis)

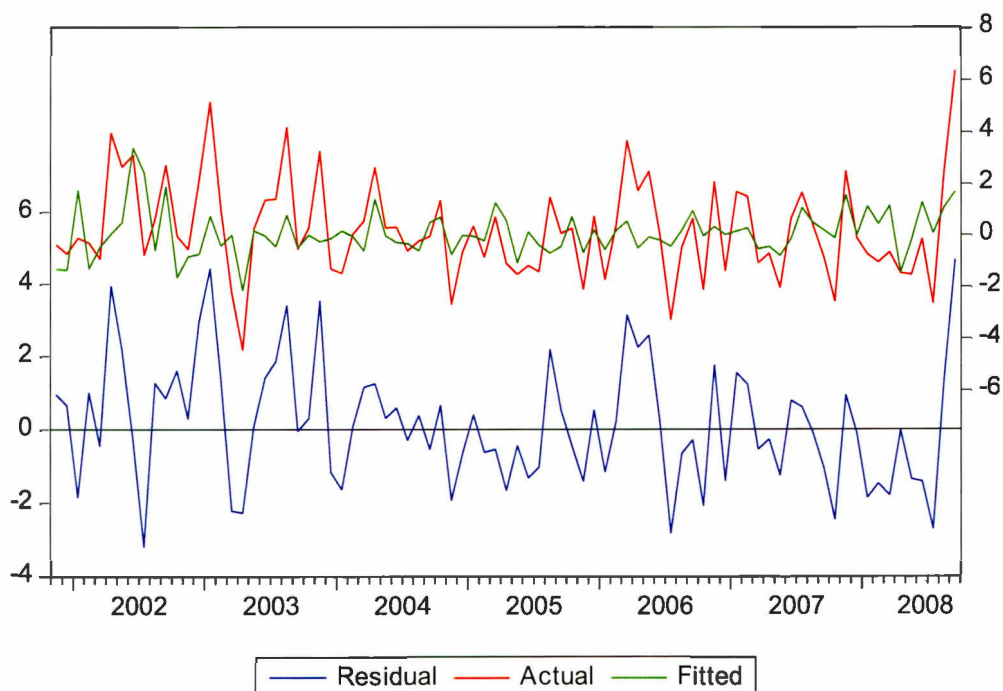
Dependent Variable: MXN\_MM  
 Method: Least Squares  
 Date: 04/01/13 Time: 16:56  
 Sample (adjusted): 2001M11 2008M09  
 Included observations: 83 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob.  |
|----------|-------------|------------|-------------|--------|
| IGAE_MM  | -0.574799   | 0.317355   | -1.811218   | 0.0739 |
| CPI_MM   | 0.811111    | 0.413035   | 1.963785    | 0.0530 |
| CDS_MM   | 0.301041    | 0.073973   | 4.069621    | 0.0001 |

|                    |           |                       |          |
|--------------------|-----------|-----------------------|----------|
| R-squared          | 0.211868  | Mean dependent var    | 0.219050 |
| Adjusted R-squared | 0.192164  | S.D. dependent var    | 1.921438 |
| S.E. of regression | 1.726982  | Akaike info criterion | 3.966103 |
| Sum squared resid  | 238.5974  | Schwarz criterion     | 4.053531 |
| Log likelihood     | -161.5933 | Hannan-Quinn criter.  | 4.001227 |
| Durbin-Watson stat | 1.416066  |                       |          |

On the other hand, the beta for Mexico’s sovereign risk shows a 30% correlation with the currency, while it is the most statistically significant variable of the model. Such robust results validate economic theory in which higher country risk reflects is associated with depreciation of the currency, and vice versa. Overall, the fitted model looks statistically robust, while residuals remain well distributed with in a range around +/- 1 standard error (chart below).



It is worth highlighting that the Durbin Watson statistic suggest that there could be a bit of autocorrelation in the residuals, and hence, this model could be adjusted incorporating an AR(1). In fact when, adjusting with an autoregressive process of order 1 (AR) the statistic increases to 1.8, from 1.4. However, given the object of the study is to compare the same variables across different episodes and not to achieve a robustly fitted model to explain the dependent variable (MXN), the model was left unchanged.

Method: Least Squares

Date: 04/10/13 Time: 18:44

Sample (adjusted): 2001M12 2008M09

Included observations: 82 after adjustments

Convergence achieved after 8 iterations

| Variable           | Coefficient | Std. Error            | t-Statistic | Prob.    |
|--------------------|-------------|-----------------------|-------------|----------|
| IGAE_MM            | -0.679284   | 0.291607              | -2.329449   | 0.0224   |
| CPI_MM             | 0.638818    | 0.474556              | 1.346139    | 0.1822   |
| CDS_MM             | 0.310065    | 0.076514              | 4.052418    | 0.0001   |
| AR(1)              | 0.284304    | 0.115743              | 2.456333    | 0.0163   |
| R-squared          | 0.268828    | Mean dependent var    |             | 0.226331 |
| Adjusted R-squared | 0.240706    | S.D. dependent var    |             | 1.932110 |
| S.E. of regression | 1.683592    | Akaike info criterion |             | 3.927287 |
| Sum squared resid  | 221.0896    | Schwarz criterion     |             | 4.044688 |
| Log likelihood     | -157.0188   | Hannan-Quinn criter.  |             | 3.974422 |
| Durbin-Watson stat | 1.837371    |                       |             |          |
| Inverted AR Roots  | .28         |                       |             |          |

Looking at the same model, but through the post-crisis period, the fitted model confirms consistency in the beta estimators as they all maintain the same correlation (in terms of direction) and it actually shows that the explicative power (R-squared) of the model increase considerably to 63%, from 22% when running for the pre-crisis period. However, the CDS appears to be the only independent variable that remains statistically significant, as the model suggests that inflation and growth dynamics became irrelevant (see P-values in the table below). Hence, despite the R-squared of the post-crisis model improved, the beta estimators reflect the model is not statistically robust as two variables lost significance, which support the hypothesis that fundamental variables los explicative power after the financial crisis.



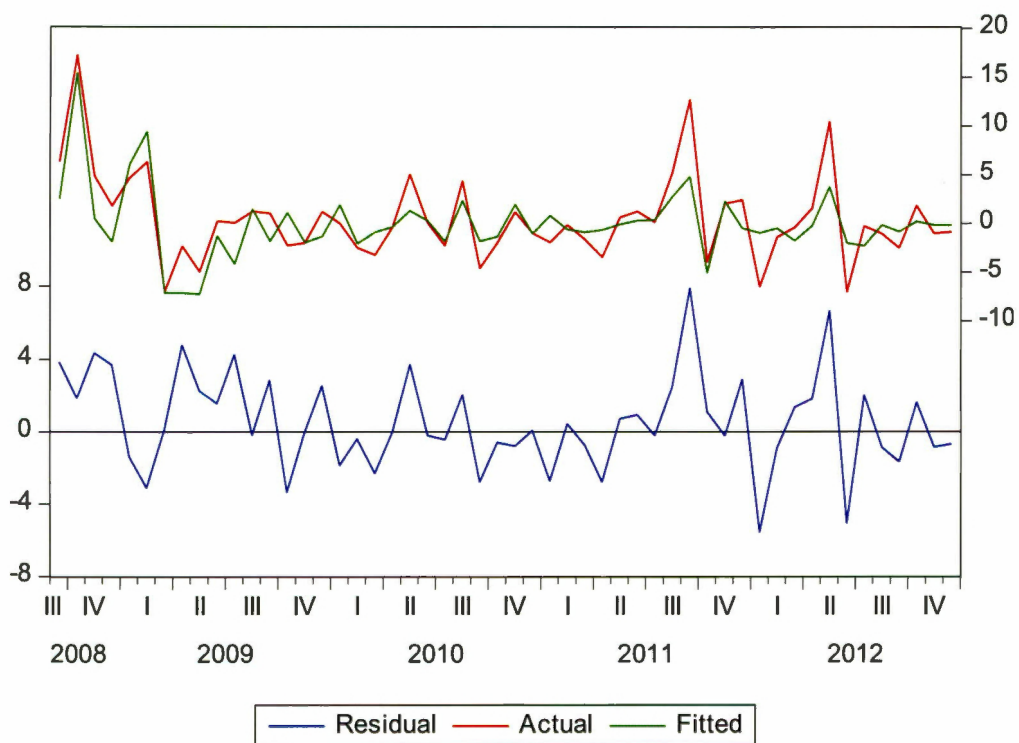
### Fundamental Model (post-crisis)

Dependent Variable: MXN\_MM  
 Method: Least Squares  
 Date: 04/01/13 Time: 17:11  
 Sample (adjusted): 2008M09 2012M12  
 Included observations: 52 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob.  |
|----------|-------------|------------|-------------|--------|
| IGAE_MM  | -0.089084   | 0.386089   | -0.230733   | 0.8185 |
| CPI_MM   | 0.358307    | 0.737189   | 0.486046    | 0.6291 |
| CDS_MM   | 0.890432    | 0.096580   | 9.219621    | 0.0000 |

|                    |           |                       |          |
|--------------------|-----------|-----------------------|----------|
| R-squared          | 0.633011  | Mean dependent var    | 0.526819 |
| Adjusted R-squared | 0.618032  | S.D. dependent var    | 4.541181 |
| S.E. of regression | 2.806611  | Akaike info criterion | 4.957794 |
| Sum squared resid  | 385.9761  | Schwarz criterion     | 5.070365 |
| Log likelihood     | -125.9026 | Hannan-Quinn criter.  | 5.000951 |
| Durbin-Watson stat | 1.898510  |                       |          |



## *THE MARKET MODEL*

The proposed OLS model under a financial market approach incorporates the VIX (volatility index on the S&P 500) as a proxy for global risk aversion sentiment given that relatively high global risk aversion is typically associated with higher volatility and vice versa. Secondly, the 10-year interest rate differential between Mexican interest rate swaps (IRS) and US swaps is introduced as a proxy to reflect capital flows. Note that a wider spread between Mexican rates and US rates should be associated with stronger capital inflows in the Mexican economy as yield differential make Mexican rates look relatively more attractive at the margin, and vice versa. Lastly, an Asian currencies index (ADXY<sup>3</sup>) is introduced in order to capture global financial conditions in the foreign exchange market among other comparable emerging markets. It is worth highlighting that many of these Asian emerging markets are also manufacturing-driven economies, and hence relatively comparable with the Mexican economy. It is worth highlighting that, in order to avoid any stationary issues with the financial time series, the model is run using monthly changes on the financial assets.

As it is shown in the OLS estimated model (table below), the explicative power (R-squared) for the pre-crisis period stands close to 33%, while all independent variables hold a significance level above 95%. Moreover, beta estimators are consistent with economic theory as the S&P 500 volatility index (VIX) shows a positive correlation with the peso (MXN), meaning the peso tends to depreciate (increase) when volatility spikes, consistent with global higher risk aversion scenarios. Likewise, the positive correlation between US and Mexican 10-year interest rate spread (USMX10Y) and the peso is also consistent, as a wider interest rate spread reflects capital outflows, which in turn translate into a weaker currency. Lastly, the negative correlation between the peso and the Asian currency index (ADXY) is due to the fact that the index is a composite basket where drops in the level actually represent depreciation and vice versa, hence we can infer that the correlation is actually positive and consistent with global market dynamics. Overall, the fitted model looks statistically robust, while residuals remain well distributed within a range around +/- 1 standard error (chart below).

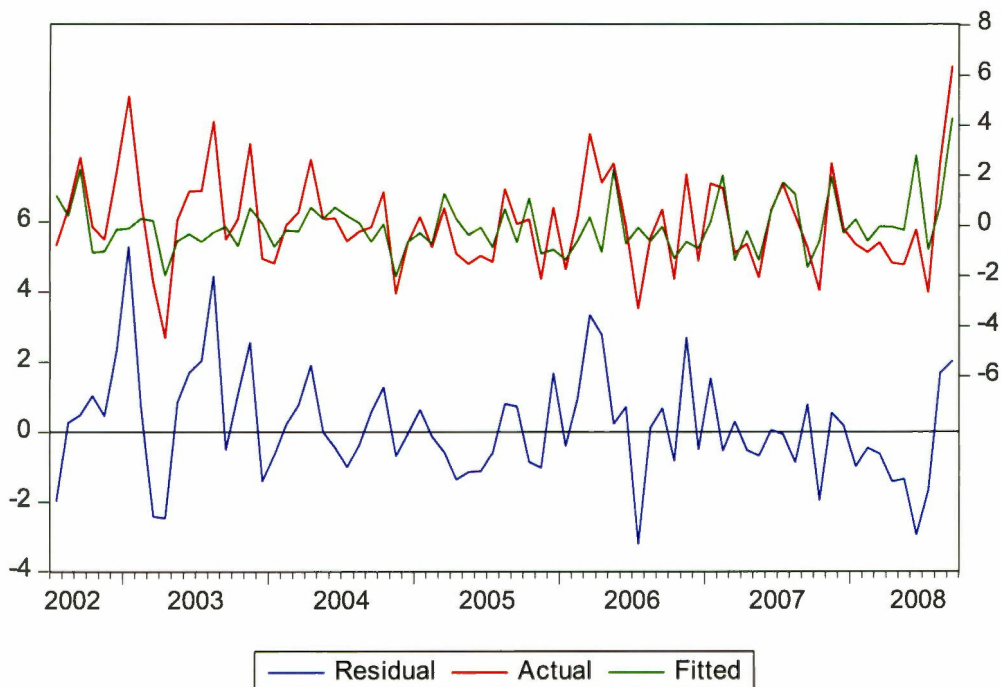
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<sup>3</sup> The ADXY creates a benchmark for monitoring Asia's currency markets on an aggregate basis. The ADXY is a spot index of emerging Asia's most actively traded currency pairs valued against the U.S. dollar. The index's composition is based primarily on trade weights, with an added filter for liquidity that keeps the index updated with macro and market trends. The countries included are: China, Hong Kong, India, Indonesia, South Korea, Malaysia, Philippines, Singapore, Taiwan and Thailand.

## Market Model (pre-crisis)

Dependent Variable: MXN\_MM  
 Method: Least Squares  
 Date: 02/21/13 Time: 08:49  
 Sample (adjusted): 2002M07 2008M09  
 Included observations: 75 after adjustments

| Variable           | Coefficient | Std. Error            | t-Statistic | Prob.    |
|--------------------|-------------|-----------------------|-------------|----------|
| VIX_MM             | 0.030961    | 0.010534              | 2.939070    | 0.0044   |
| USMX10Y_MM         | 0.051197    | 0.022666              | 2.258747    | 0.0269   |
| ADXY_MM            | -0.627130   | 0.229023              | -2.738285   | 0.0078   |
| R-squared          | 0.328088    | Mean dependent var    |             | 0.144674 |
| Adjusted R-squared | 0.309423    | S.D. dependent var    |             | 1.912977 |
| S.E. of regression | 1.589702    | Akaike info criterion |             | 3.804148 |
| Sum squared resid  | 181.9549    | Schwarz criterion     |             | 3.896847 |
| Log likelihood     | -139.6555   | Hannan-Quinn criter.  |             | 3.841162 |
| Durbin-Watson stat | 1.406602    |                       |             |          |



Similar to what we observed in the 'Fundamental Model', post-crisis regression confirms consistency in the beta estimators as they all maintain the same correlation (in terms of direction), but in this case they all remain statistically robust (table below). Consequently, this time the explicative power (R-squared) of the post-crisis model is considerably higher than in pre-crisis period (68% vs. 33%), while both are statistically robust. Hence, we can say that financial indicators can explain better the peso performance after the financial crisis, than before.

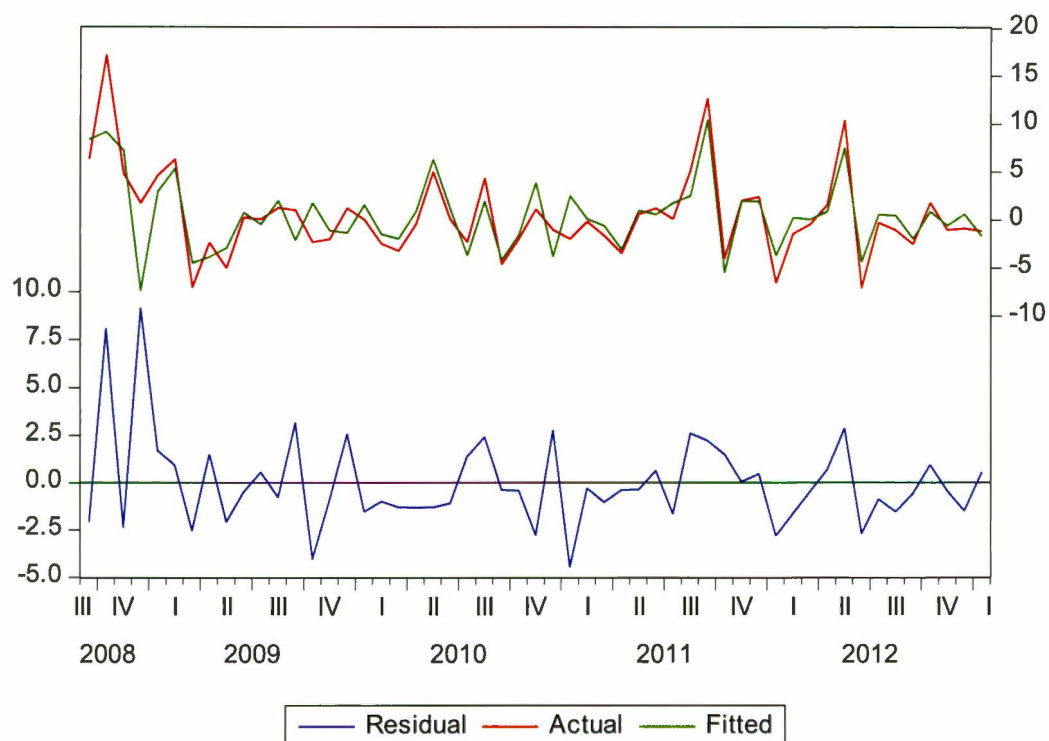
## Market Model (post-crisis)

Dependent Variable: MXN\_MM  
 Method: Least Squares  
 Date: 02/21/13 Time: 08:52  
 Sample: 2008M09 2013M01  
 Included observations: 53

| Variable   | Coefficient | Std. Error | t-Statistic | Prob.  |
|------------|-------------|------------|-------------|--------|
| VIX_MM     | 0.055430    | 0.018323   | 3.025242    | 0.0039 |
| USMX10Y_MM | 0.141253    | 0.061736   | 2.288018    | 0.0264 |
| ADXY_MM    | -1.263396   | 0.326762   | -3.866406   | 0.0003 |

|                    |           |                       |          |
|--------------------|-----------|-----------------------|----------|
| R-squared          | 0.683790  | Mean dependent var    | 0.495463 |
| Adjusted R-squared | 0.671142  | S.D. dependent var    | 4.503094 |
| S.E. of regression | 2.582351  | Akaike info criterion | 4.790216 |
| Sum squared resid  | 333.4268  | Schwarz criterion     | 4.901742 |
| Log likelihood     | -123.9407 | Hannan-Quinn criter.  | 4.833103 |
| Durbin-Watson stat | 2.292489  |                       |          |



Furthermore, both the 'Fundamental' and 'Market' model independently suggest a structural change in the peso performance took place during the 2008-09 financial crisis, and both independently confirmed the sustain thesis that fundamentals were considerably more relevant prior to the crisis, while technicals gain explicative power in the post-crisis period. Lastly, in order to formally prove a structural change took

place in the peso dynamics and evidence that eventually the interaction of both fundamental and technical variables have an even better explicative power than both models abovementioned, a third model is proposed.

### ***THE COMPLETED MODEL***

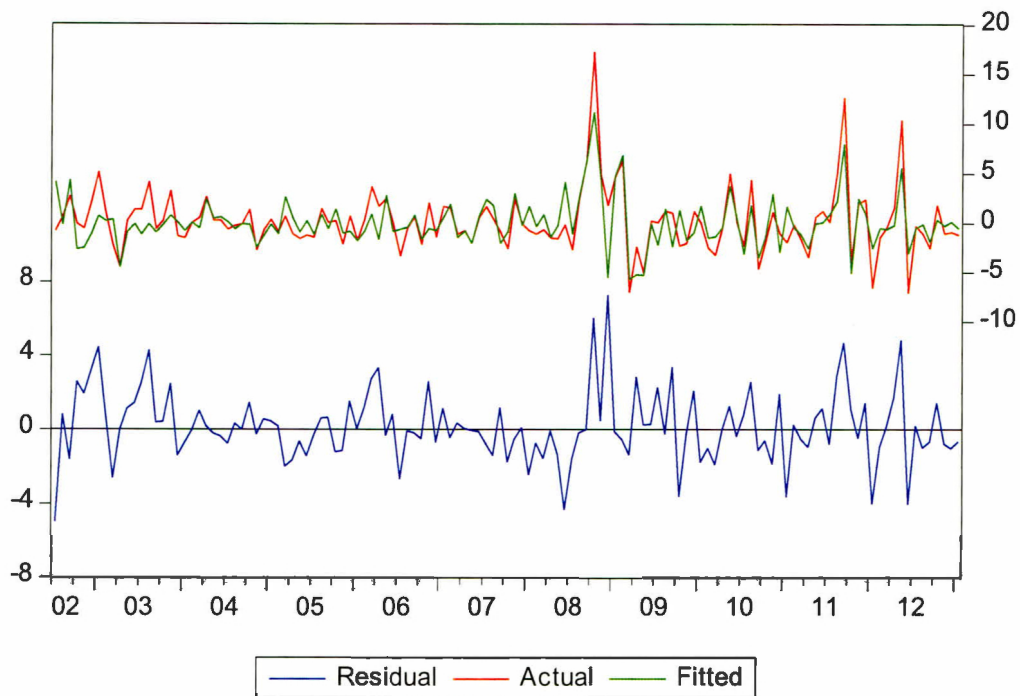
As a complementary way to validate the original thesis of the current essay, a third model is proposed, in which both, fundamental and technical variables are included. Consequently, instead of breaking the sample in two episodes determined by the financial shock, the object of this final approach is to determine if a structural change took place during the financial crisis, regardless of what variables gain or lose significance in the process, as these have been addressed above.

The OLS estimation for the 'Complete Model' shows that explicative power was virtually flat as the R-squared stands at 63%, with all estimators showing a 90% level of significance. This model was run for the full sample, from June 2002 to January 2013. Furthermore, previously shown correlations of the estimators are consistent for all the variables, validating economic theory (table below). Note that the IGAE was excluded from the model as it turned out to be statistically insignificant when including the rest of the variables for the full sample.

### **Complete Model (post-crisis)**

Dependent Variable: MXN\_MM  
 Method: Least Squares  
 Date: 04/01/13 Time: 18:28  
 Sample (adjusted): 2002M07 2013M01  
 Included observations: 127 after adjustments

| Variable           | Coefficient | Std. Error            | t-Statistic | Prob.    |
|--------------------|-------------|-----------------------|-------------|----------|
| CPI_MM             | 0.719314    | 0.365167              | 1.969821    | 0.0511   |
| CDS_MM             | 0.337397    | 0.078127              | 4.318552    | 0.0000   |
| VIX_MM             | 0.028240    | 0.011045              | 2.556890    | 0.0118   |
| ADXY_MM            | -1.009223   | 0.190523              | -5.297112   | 0.0000   |
| USMX10Y_MM         | 0.044450    | 0.025064              | 1.773457    | 0.0786   |
| R-squared          | 0.623992    | Mean dependent var    |             | 0.242197 |
| Adjusted R-squared | 0.611664    | S.D. dependent var    |             | 3.202236 |
| S.E. of regression | 1.995525    | Akaike info criterion |             | 4.258265 |
| Sum squared resid  | 485.8185    | Schwarz criterion     |             | 4.370241 |
| Log likelihood     | -265.3998   | Hannan-Quinn criter.  |             | 4.303760 |
| Durbin-Watson stat | 1.791251    |                       |             |          |



While all variables appear to be significant, in terms of *p-values*, the *betas* for the VIX and the interest rate differential might look relatively low. In this context, the same model was run with the exclusion of both independent variables, showing the following results:

Dependent Variable: MXN\_MM  
 Method: Least Squares  
 Date: 04/11/13 Time: 12:31  
 Sample: 2002M02 2013M01  
 Included observations: 132

| Variable           | Coefficient | Std. Error            | t-Statistic | Prob.    |
|--------------------|-------------|-----------------------|-------------|----------|
| CPI_MM             | 0.864638    | 0.379913              | 2.275884    | 0.0245   |
| CDS_MM             | 0.473229    | 0.067773              | 6.982567    | 0.0000   |
| ADXY_MM            | -1.061140   | 0.187583              | -5.656897   | 0.0000   |
| R-squared          | 0.565836    | Mean dependent var    |             | 0.297710 |
| Adjusted R-squared | 0.559104    | S.D. dependent var    |             | 3.176090 |
| S.E. of regression | 2.108923    | Akaike info criterion |             | 4.352697 |
| Sum squared resid  | 573.7347    | Schwarz criterion     |             | 4.418215 |
| Log likelihood     | -284.2780   | Hannan-Quinn criter.  |             | 4.379320 |
| Durbin-Watson stat | 1.758797    |                       |             |          |

As it is shown in the table above, when excluding both variable (VIX and USMX10y) the explicative power of the model (R-squared ) was considerably reduce to 56%, from 62%. Hence, even when betas for these variables are relatively low, the model was left as originally presented. Given the last piece of the puzzle is to determine if a structural change took place in the Mexican currency performance after the financial crisis, a Chow Test is proposed. Note that the Chow Test is used to fit

### ***THE CHOW TEST***

Given the last piece of the puzzle is to determine if a structural change took place in the Mexican currency performance after the financial crisis, a Chow Test is proposed. Note that the Chow Test is used to fit the equation separately for each subsample and to see whether there are significant differences in the estimated equations. In other words, the test compares if there is a significant change when estimating the residuals before and after a given date or breaking point. Therefore, the Chow breakpoint test tests whether there is a structural change in all of the equation parameters. The test compares the sum of squared residuals obtained by fitting a single equation to the entire sample with the sum of squared residuals obtained when separate equations are fit to each subsample of the data. A significant difference indicates a structural change in the relationship took place. For further elaboration on Chow Test please see Davidson and MacKinnon (2004), pg. 145-147. Algebraically, this condition can be expressed as followed:

$$F = \frac{(\tilde{u}'\tilde{u} - (u_1'u_1 + u_2'u_2))/k}{(u_1'u_1 + u_2'u_2)/(T - 2k)},$$

Where  $\tilde{u}'\tilde{u}$  is the restricted sum of squared residuals,  $u_i'u_i$  is the sum of squared residuals from subsample  $i$ ,  $T$  is the total number of observations, and  $k$  is the number of parameters. The *F-statistic is based on* the comparison of the restricted and unrestricted sum of squared residuals and in this case involving a single breakpoint.

Alternatively, instead of using a *F-distribution*, the log likelihood ratio (LR) statistic can be used to determine a break point. The log likelihood is based on the comparison of the restricted and unrestricted maximum of the (Gaussian) log likelihood function. The LR test statistic has an asymptotic  $\chi^2$  distribution with degrees of freedom equal to  $(m - 1)k$  under the null hypothesis of no structural change, where  $m$  is the number of subsamples.

Lastly, the Wald statistic can also be used to determine if a structural change took place. This statistic is computed from a standard Wald test of the restriction that the coefficients on the equation parameters are the same in all subsamples. As with the log likelihood ratio statistic, the Wald statistic has an asymptotic distribution with  $(m - 1)k$  degrees of freedom, where  $m$  is the number of subsamples. For further elaboration on Wald statistic please see Davidson and MacKinnon (2004), pg. 189-191. Like in the previous models, the breaking point will be settled at the ‘Lehman Brothers event’, in September 2008. The results of the Chow Test are the following:

Chow Breakpoint Test: 2008M09

Null Hypothesis: No breaks at specified breakpoints

Varying regressors: All equation variables

Equation Sample: 2002M07 2013M01

|                      |          |                     |        |
|----------------------|----------|---------------------|--------|
| F-statistic          | 3.768243 | Prob. F(5,117)      | 0.0034 |
| Log likelihood ratio | 18.96272 | Prob. Chi-Square(5) | 0.0020 |
| Wald Statistic       | 18.84121 | Prob. Chi-Square(5) | 0.0021 |

As it is shown in the table above, results show that under any statistical reference, the null hypothesis for no break at the specified breakpoint (September 2008) can be rejected with 95% of confidence, hence the test proves a structural change took place during the financial crisis. Note that while this test confirms the ‘Lehman Brothers’ event can be considered as a breakpoint for the Mexican currency performance, this test can not distinguish among which variables gain or loss explicative power after the breakpoint. This test is only a complementary empirical way to validate that a structural change took place, after assessing the impact of both fundamental and market variables in the previous section.



## V. Conclusions

Over the current essay it was evidenced that the Mexican peso has emerged from the Great Recession with a more protagonist role among emerging markets currencies. The fact that the Mexican peso market enjoys of deep liquidity domestically and abroad, making the USD MXN available at anytime, is a positive consequence of macroeconomic improvements. However, having a currency that becomes a global financial asset also implies to be subject to global financial headwinds, which could be not desirable, particularly during financial turmoil. In this context, we tried to provide empirical evidence that macroeconomic fundamental as drivers for the Mexican peso, become less relevant during global risk aversion episodes, as dynamics of the exchange rate under global stressed scenarios appears to be mainly led by market technical, rather than fundamentals of the economy. The proposed model proved that fundamental variable such as growth and inflation become statistically insignificant over the post-crisis episode, after being statistically robust in the pre-crisis period. On the other hand, financial variables gained significance and explicative power over the peso dynamics after the crisis.

It is worth highlighting that the results found in the current study are valid for the sample from 2002 through 2012. Note that the post-crisis period has been associated with high volatility and financial stress as the 'sub-prime' asset bubble that triggered the financial turmoil back in 2008, was followed by fiscal and financial stress in the Euro area which fueled the risk of a double-dip global recovery and the possibility of a tail event in Europe. That said, clearly the post-crisis sample differs from regular financial conditions, and the fact that global financial conditions became more relevant for the Mexican currency may come as no surprise. This is particularly the case as monetary policy stances in the developed world have maintained unprecedented levels of easing for a prolonged period of time. This has provided a global excess of liquidity in an environment of still fragile business confidence and relatively higher risk aversion. Hence, it is not hard to believe that high level of liquidity coupled with low conviction and high uncertainty explained the sharp volatility observed in the Mexican currency. Against this backdrop, it could be estimated that as the sequels of the Great Recession dissipate, liquidity would gradually dry and global financial markets should 'normalize'. In such scenario it is likely that the peso should go back to pre-crisis dynamics in which fundamental should gain relevance again. In other words, the post-crisis sample is not a good reference for the long run.

In sum, it was stated how building a robust macroeconomic framework provides support for a stronger currency. Building macroeconomic stability takes time and gaining credibility takes even longer. The performance of the currency has a lot to do with the development of financial markets in the economy and the capacity to absorb financial shocks. In this context, the Mexican economy has been able to build sound fundamentals and developed a deep domestic financial market. While this is positive to attract foreign investment, when the currency becomes liquid enough to be considered a global financial asset, its performance is subject to global headwinds and not only fundamentals. This was the case of the Mexican peso over the financial turmoil, when macroeconomic fundamental played a secondary role in FX dynamics given the market technicals behind a global currency. However, this doesn't mean macroeconomic fundamentals will become irrelevant. On the contrary, as global financial conditions 'normalize' and risk aversion dissipates sound fundamental should help to support a stronger currency ahead.

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