RESERVED INFORMATION

Status: In Process General Direction of Economic Research Last update: February, 2018

7-th BIS Research Network meeting "Pushing the frontier of central Banks' macro modelling"

General Direction of Economic Research

March 8 and 9, 2018



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2	Description and Model Fit
3	Transmission Mechanism
4	Properties of the Model
5	Final Remarks

Introduction

- The current staff's model used for policy advise serves appropriately for its purposes. The empirical evidence suggests the existence of a significant change in the transmission of external shocks to the Mexican economy, and the relative importance of the transmission mechanisms of monetary policy, thus the staff's model has been adapted somehow to account for this. However, it has become evident the need for reexamining the structure of the Model for Simulating Monetary Policy Rules (MSMPR) exhaustively and systematically, that is, the staff has identified the need to reexamine the model used regularly for policy advice.
- In recognition of this need, Banxico's General Direction of Economic Research decided to update of their MSMPR in its 2017-2018 Annual Work Plan. This presentation shows the advances related to the restructuring and re-estimation of the MSMPR.

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Introduction

- There are five blocks describing the model:
 - 1 <u>Demand Block (IS Curve)</u>. The gaps of tradable and non-tradable goods and services are modeled separately, which allows capturing differentiated dynamics according to the type of good.
 - 2 <u>Inflation and Salary Block (Phillips Curve)</u>. A core inflation measure is used in the model, and due to the recent liberalization of gasoline prices in Mexico, the non-core inflation equation is enriched to take into account this. Also, a measure of formal sector salaries is introduced.
 - 3 <u>External Sector (USA).</u> A macroeconomic model is used which is in line with those proposed in the literature for the US economy. This allows to condition the behavior of external variables based on Blue Chip projections while opening the possibility of doing additional exercises of general equilibrium type in the US and analyze its impact on Mexico.
 - 4 <u>Monetary Block.</u> Monetary policy is modeled as a Taylor Rule.
 - **5** <u>Financial Block.</u> To model the behavior of the exchange rate, the uncovered parity condition is enriched with some financial variables relevant to the country, such as country risk. In addition, the price of oil is incorporated into this block.



Estimation Method

- ✓ The estimation period comprises from 2001Q1 to 2017Q1. The estimation involves 17-time series.
- ✓ To deal with the "forward-looking" nature of the model, it is solved under the assumption of rational expectations with Sims' methodology (2002).
- ✓ The estimation of the model is carried out as a system of equations by Bayesian methods following Herbst and Schorfheide (2015).
 - We use a RWMH with 1.5 million draws to achieve convergence

1 Demand Block (IS Curve)

- One of the qualities of the structure of the MSMPR is the explicit modeling of the gaps of tradable and non-tradable goods and services. The above is due mainly to two factors:
 - 1. The dynamics of the tradable and non-tradable sectors tended to be highly correlated. Thus, it could be argued that the distinction between the two gaps was not necessary. However, recently there has been a divergence in the dynamics of both sectors. In particular, the correlation between the two gaps recently fell from 90 percent to close to zero percent. Additionally, a 7 percent drop in the participation of the tradable sector in GDP was observed.
 - 2. The literature of international business cycles shows that various kinds of standard models cannot predict the high interdependence observed in the international business cycle, i.e. they cannot capture spillover effects from one economy to another.^{1/} The incorporation of the commercial channel through the explicit modeling of the tradeable goods and services gap makes it possible to predict the high correlation observed in the United States.

^{1/} For exemple, standard DSGE models can not predict the observed correlation between Canada and the USA GDP --- Justiniano & Preston (2010)--- o México y Estados Unidos --- Hernandez & Leblebicioglu (2012)---.

1 Demand Block (IS Curve)

Share of the Commercial Sector in the Economy GDP (%)



Correlation between the Growth of the **Tradable Sector and the Non-Tradable Sector** 4-year mobile window

0.8

0.6

0.4

0.2

-0.2

2017.2

0.48

Output, Tradable and Non-Tradable Gaps (%)



- Capturing the external impact on the domestic economy represents a challenge for macroeconomic models in general. For example, Justiniano and Preston (2010) show that a standard model of a small and open economy for the United States and Canada cannot reproduce the correlations between the GDP of both economies. The same occurs in a standard model for Mexico and the United States as shown by Hernández and Leblebicioglu (2012).
- Therefore, a modeling strategy is adopted that captures the commercial and financial links between Mexico and the United States to capture the effect of US shocks on the Mexican economy. Below is the counterfactual graph of Justiniano and Preston (2010), as well as the correlation successfully captured in the model, between the tradable gaps of Mexico and the United States.



1 Demand Block (IS Curve)

IS Curve $x_t^{MX} = \gamma_{1,1} x t_t^{MX} + \gamma_{1,2} x n t_t^{MX}$



 $xt_{t}^{MX} = \gamma_{2,1}xt_{t-1}^{MX} + \gamma_{2,2}E_{t}xt_{t+1}^{MX} + \gamma_{2,3}E_{t}xnt_{t-1}^{MX} - \gamma_{2,4}R_{t}^{MX} - \gamma_{2,5}E_{t}\Delta q_{t+1} + \gamma_{2,6}xt_{t}^{EU} + \varepsilon xt_{t}$

Non-Tradable IS Curve

 $xnt_{t}^{MX} = \gamma_{3,1}xnt_{t-1}^{MX} + \gamma_{3,2}E_{t}xnt_{t+1}^{MX} + \gamma_{3,3}xt_{t-1}^{MX} - \gamma_{3,4}R_{t}^{MX} - \gamma_{3,4}E_{t}\Delta q_{t+1} + \varepsilon xnt_{t}$

Where:

 x^{MX} is the output gap of Mexico.

 R^{MX} is the real ex-ante rates in Mexico.

 x^{EU} is the output gap of the US.

q is the real depreciation rate.

xt^{MX} is the tradable gap.

 xnt^{MX} is the non-tradable gap.

 ext_t , $exnt_t$ are a set of shocks defined in the appendix. a_t^{EU} , at_t^{EU} , ant_t are exogenous shocks.

2 Inflation Block (Phillips Curve)

Headline Inflation

 $\pi_t^{MX} = \gamma_{4,1} \pi_{S,t}^{MX} + \gamma_{4,2} \pi_{NS,t}^{MX}$



$$\pi_{S,t}^{MX} = \gamma_{5,1}\pi_{S,t-1}^{MX} + \gamma_{5,2}E_t\pi_{S,t+1}^{MX} + \gamma_{5,3}x_t^{MX} + \gamma_{5,4}dep_t + \gamma_{5,5}\Delta w_t + \gamma_{5,6}e_t^{NS} + e_t^{S}$$

Non-Core Inflation

$$\pi_{NS,t}^{MX} = \gamma_{6,1}\pi_{NS,t-1}^{MX} + \gamma_{6,2}E_t\pi_{NS,t+1}^{MX} + \gamma_{6,3}x_t^{EU} + \gamma_{6,4}dep_t + \gamma_{6,5}\Delta Pet_t + e_t^{NS}$$

Where:

 e_t^S , e_t^{NS} are exogenous shocks. e_t^W is a e

e^W_t is a exogenous shock.

1/ The most recent empirical evidence suggests that the transfer of the exchange rate to inflation has not changed in recent years and that it remains at reduced levels. In particular, the Technical Chapter of the "Evolution of the Transfer of the Exchange Rate to Inflation" of the April-June 2017 Quarterly Report of the Bank of Mexico, finds that in an environment of low depreciation the transfer of one percent of depreciation increases headline inflation in 0.04 percentage points after 12 months, while in an environment of high depreciation it increases to 0.05 percentage points. For the core inflation it is estimated a threshold between 0.03 and 0.04 percentage points, while for the non-core the transfer interval is 0.09 to 0.10 percentage points.

Modelo MSRM

Model Structure B Financial Block

- Another important part of the structure of the model is the incorporation of oil prices and country risk in the equation that determines the exchange rate. Its introduction is related to the following three observations:
 - 1. First, recent research shows that a simple regression between certain prices of raw materials against the real exchange rate of Mexico shows an adjustment in the sample of around 70%^{1/}. In particular, the correlation between the price of oil and the exchange rate can be exploited to explain the behavior of the real exchange rate.
 - 2. Second, given the simple nature and its special focus on monetary policy issues, the MSMPR does not explicitly consider issues related to public financing. Incorporating the price of oil helps capture the effect of changes in oil revenues on the economy, in the form of a demand shock from government spending. Also, a fall in the price of oil can affect the country risk that investors demand.
 - 3. Third, the academic literature ---for example, Uribe and Yue (2006)--- has identified country risk as an important variable for the dynamics of various macroeconomic variables in emerging countries. Its presence allows incorporating the effect of this risk premium on the dynamics of the yield curve in the future.

1/ See Nicolini, Hevia & Ayres, (2015).

3 Financial Block

Real Exchange Rate

$$q_{t} = \gamma_{7,1}E_{t}q_{t-1} + \gamma_{7,2}E_{t}q_{t+1} + \gamma_{7,3}(R_{t}^{EU} - R_{t}^{MX}) + \gamma_{7,4}embi_{t-1} - \gamma_{7,5}E_{t}Pet_{t+1} + \varepsilon_{et}$$

Country Risk

$$embi_{t} = \gamma_{8,1}embi_{t-1} + \gamma_{8,2}E_{t}embi_{t+1} - \gamma_{8,3}(X_{t}^{MX} - X_{t}^{EU}) - \gamma_{8,4}(\Delta X_{t}^{MX} - \Delta X_{t}^{EU}) - \gamma_{8,5}E_{t}Pet_{t+1} + e_{t}^{EMBI}$$





Taylor Rule

Where:

 Pet_t is the oil price.

 $embi_t$ is the Emerging Market Bond Index. e_t^{EMBI} y e_t^{Pet} are exogenous shocks.

Model Fit

Observed vs. Predicted Dynamics of the Product Gaps



Model Fit

Observed vs. Predicted Dynamics of the Inflations



Observed vs. Predicted Dynamics of the Monetary Policy Rate



Modelo MSRM

Model Fit

Observed vs. Predicted Dynamics of Financial Variables



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3.1.- IRF: Domestic Demand Shock



Modelo MSRM

3.2.- IRF: US Tradable Demand Shock



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3.3.- IRF: Interest Rate Shock



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3.3.- IRF: EMBI Shock

Headline Inflation



$\begin{array}{c} 0.6 \\ 0.4 \\ 0.2 \\ 0.0 \\ -0.2 \\ -0.4 \\ -0.6 \\ -0.8 \\ -1.0 \\ 1 \quad 3 \quad 5 \quad 7 \quad 9 \quad 11 \quad 13 \quad 15 \end{array}$

Nominal Interest Rate

Real Exchange Rate



Nominal Depreciation





Real Interest Rate



Core Inflation



EMBI



3.3.- IRF: Oil Shock



Real Exchange Rate



Nominal Interest Rate



Nominal Depreciation





Real Interest Rate



Core Inflation



Oil



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Historic Output Gap Decomposition

Percentage 8 Output Gap **US Shocks** 6 Non-Tradable Gap Shocks Tradable Gap Shocks 2 -2 **Tequila** Crisis **Dot-com Crisis Financial Crisis** -8 Mar-16 Jun-97 Mar-98 Dec-98 Mar-10 Mar-13 Jun-15 Dec-16 Mar-95 Dec-95 Sep-96 Sep-99 Jun-00 Jun-03 Mar-04 Sep-05 Jun-06 Sep-08 Jun-09 Dec-10 Jun-12 Dec-13 Sep-14 Jun-94 Sep-02 Dec-04 Mar-01 Mar-07 Dec-07 Dec-01 Sep-11

US Shocks Contribution to Mexican Output Gap

The historical decomposition shows that the US shocks played a very important role in the dynamics of the output gap, however, the US shocks did not play an important role during the tequila crisis, but it did during the "dot-com" crisis and the financial crisis. Additionally, it shows that the role of the tradable and nontradable gap was recently acquired.

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Final Remarks

- A new model for monetary policy recommendation has been develop in the Central Bank of Mexico
- At this moment the model is in its implementation stage, the Board of Governors will be presented with the scenarios of the current model and the new model for some time while they gain confidence in the new model---this could take 4 to 6 policy decision meetings.

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