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Evidence of the role of the real exchange rate in the growth of the GDP in Argentina (1989–2007)

Mariana Saidón¹

Abstract. This paper analyzes the impact of the real exchange rate on the behavior of the GDP in Argentina in the period that goes from 1989 to 2007. In this paper, an econometric model based on the Vector Error Correction method, which proves the (lack of) relevance of different predictions made by alternate schools of domestic macroeconomic thought is proposed.

The model links four non-stationary and cointegrated variables: the two mentioned variables are: the gross domestic product and the real exchange rate, and a liquid monetary aggregate (excluding time deposits) and the terms of trade.

The responses of GDP to real exchange rate shocks and the terms of trade showed a similar behavior towards both the *generalized impulses* and other impulses arising from a Cholesky decomposition: initially, a real exchange rate shock has a negative impact on the activity that gradually decreases, and after six months it becomes positive, when it begins to gradually recover strength. The terms of trade have a positive impact after the shock and that impact loses strength over the time until it becomes negative and, cumulatively, explosive.

Money- Supply shocks have a positive impact initially but there is no strong evidence regarding medium and long-term effects.

Resumen. Este trabajo analiza la incidencia del tipo de cambio real en el comportamiento del producto interno bruto en la Argentina en el período 1989-2007. Se propone un modelo econométrico basado en la metodología de Vectores con Corrección de Error, que presta evidencia sobre la (falta de) pertinencia de las diferentes predicciones arrojadas por corrientes alternativas de pensamiento macroeconómico local.

En el modelo se vinculan cuatro variables no estacionarias y cointegradas: las dos variables mencionadas -el producto bruto interno y el tipo de cambio real-, los saldos monetarios y los términos del intercambio.

Las respuestas del producto interno bruto ante shocks de tipo de cambio real y de términos del intercambio mostraron un comportamiento similar, tanto ante *impulsos generalizados* como de los otros que surgen de una descomposición de Cholesky: inicialmente, un shock de tipo de cambio real tiene un impacto negativo sobre la actividad que gradualmente se reduce, hasta volverse positivo después de seis meses, momento en que empieza a cobrar fuerza progresivamente. Los términos del intercambio inciden positivamente tras el momento del shock, impacto que pierde fuerza en el tiempo hasta volverse negativo y, acumuladamente, explosivo.

Los shocks de oferta monetaria impactan de manera positiva inicialmente pero no existe evidencia fuerte respecto de los efectos de mediano y largo plazo.

Keywords: real exchange rate, GDP, Gross Domestic Product, VEC, Vector Error Correction, Argentina, generalized impulses.

1. Introduction

The aim of this paper is to prove the role of the exchange rate in the growth of the gross domestic product (GDP) in Argentina in recent decades.

Regarding the literature on the subject, on the one hand, there exists a type of literature that is based on the classic Keynesian vision subsequent to the year 1930, which supports the idea that a high real exchange rate promotes the growth process. However, by the year 1970, a structuralist literature which argued that devaluations are recessive emerged (Diaz Alejandro (1963), Braun and Joy (1968), Diamand (1972), Canitrot (1975) and Porto (1975)). However, another conception regarding the impact of real exchange rate took place in the second quarter of 2002, when economists warned about the production growth, together with the currency devaluation. As a corollary, there exist economists who maintain aligned discourses with many of the premises of the structuralism (Frenkel and Rapetti (2007)) but, however, they recommend " stable and competitive " real exchange rate policies to sustain the activity level.

This kind of arguments followed by counter-arguments have motivated the development of a literature in Argentina which has sought to weigh the arguments of different views. The debate on the real exchange rate as a determining factor of the economic growth still continues. The aim of this paper work is to contribute to that discussion with an econometric application based on the vector error correction model, which serves to

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prove what happened in the economic history of the country between 1989 and 2007, based on quarterly data.

In turn, this analysis includes other variables that, according to the literature, are relevant to shed light on the objectives of this paper work. Particularly, we analysed the impact on the determination of the economic growth, the terms of trade and monetary aggregates.

This paper work is organized as follows: section 2 presents the theoretical framework that contextualizes the study. Section 3 explains the econometric framework with which an empirical application will be carried out. The data that is taken into account in this paper work and their essential features are described in section 4. In section 5, the obtained quantitative results are evaluated and interpreted according to economic terms. Finally, in section 5, conclusions and guidelines for future research are drawn.

2. Theoretical framework

The economic history of Argentina that took place as from the second half of the twentieth century was characterized by a pattern of behavior of economic activity with high volatility in the growth process and with a growth rate lower than that of the so called "developed" countries.

Said instability of the economy and its relatively low growth pushed the development of academic studies that sought to explain, through the behaviour of different relevant variables, the macroeconomic performance in Argentina.

Among the explanations given by the literature, some of them placed particular emphasis on permanent external and fiscal deficits, which triggers *stop and go* cycles or, in more recent times, balance of payments and over-indebtedness crisis.

Also in this framework, explanations based on the real exchange rate as a determining factor of growth process emerged. In particular, since 1930, the keynesianism had a great impact on the economic theory.

However, from the adjustment and stabilization policies implemented in the mid 50s and early 60s of the twentieth century, it became necessary to understand the nature of the of the economic slowdown, which was combined, at the same time, with the currency devaluation. These facts were different from what was expected according to the Keynesian economic theory, that is the reason why the argentinean structuralism sought to explain the behavior of the output growth in the country and, at the same time, to avoid this anomaly.

The structuralism, on the one hand, argued that, since 1870, the trend of prices evolved strongly against the underdeveloped countries specialized in exporting food and raw materials, but it benefited those countries which devoted their activity to manufactured goods and export those products, a phenomenon which was later named as "secular deterioration of terms of trade." However, on the other hand, some people who supported the *structuralism* sought to explain the stylized facts taking into account the features of the relationship between the real exchange rate and the gross domestic product or the employment level.

For example, Díaz Alejandro (1963) stated that the "redistributive effect of devaluation" could threaten the level of the activity, since there exist different marginal tendencies that prone to boost the consumption between capitalists (privileged) and salary earners (underprivileged).

Sidrauski (1968) added as a basis the "monetary effect of devaluation" by which, a rise in the interest rate would cause recession.

Later, Diamand (1972) explained that in the economic structure of Argentina, the relative productivity of the industry is lower than that of the primary sector that exports and fixes the exchange rate. This would result in a higher price of industrial goods than that price set in the international market, rendering them little competitive. In turn, devaluations would tend to increase the price of imports and this would augment the prices of industrial goods. This unbalanced structure of the economy would explain that a devaluation gives rise to "currency inflation"² with recession, rather than acting as an stimulus to industry development jointly with the economy growth process.

Another article that has had great influence on the macroeconomic literature has been the one written by Porto (1975) who, following the same pattern, explained a short-term general model in which, not only did he include the *redistribution effect* and the *monetary effect* of devaluation, but he also included the public sector as actor and an industrial sector whose exports and, thus, the real income were subject to the relationship between wages and exchange rate. Moreover, he incorporated a "substitution effect" in the consumption of wage earners which involved that, if wages grow at a different rate from the exchange rate, the relative price of products would vary, and hence, its relative demand. Consequently, as a result of the static comparisons of the model raised, if nominal wages grow at a higher rate than that of the exchange rate, the redistributive effect would increase the real income, but the substitution effect, the effect of industrial exports and the real value of monetary aggregates would decrease the real income. Therefore, under the assumption that the income effect dominates the substitution effect and that the impact of variations on the relationship between nominal wages and the exchange rate over industrial exports do not offset the income effect or the variations in the real value of the amount of money; a devaluation of the exchange rate would generate a fall in the real income, the same would happen if wages and the exchange rate increase in equal proportion.

Another classical view on the macroeconomic literature has been the one presented by Canitrot (1975), in which he adds the "autonomous demand" to the explanations given by Porto. The "autonomous demand" comprises the autonomous investment, industrial exports and the substitution of imports, which is different from the demand induced by the multiplication process. In this paper work, as it is assumed that agricultural goods are the ones that can be exported and that industrial goods require imported supplies, so the level of industrial activity would determine the need to import. However, as the ability to import would depend, in turn, on export balances and on international prices in relation to wages, the expansion of employment, achieved through the spread of exports, finally, depends on the growth of the production capacity of the tradables sector. In the case of Argentina, the expansion of employment depends on the capacity of the agricultural sector, whose growth process is slow. All this would have meant a restriction on the growth process of the country and would explain that the import-substitution industrialization may have had, unlike other policies, a positive influence on the creation of employment. In addition to this, the exchange rate and international prices would determine the vector of prices and relative demands with regard to the economy and the tariff and fiscal policies also would have an impact on the demand. Likewise, under arguments that are at the same level with those given by Porto (1975), Canitrot also argues that the effects on increasing the real exchange rate are opposed to an increase in nominal wages: when the real exchange rate increases, the level of activity decreases and the trade balance improves. However, the opposite occurs when the nominal wage rises.

This structural view which linked real devaluations to the fall in the level of activity had a considerable impact on the explanation of the economy in Argentina until about 1980, since it is compatible with its development. However, the stylized facts that would be discerned, would question this approach later.

² Phenomenon of structural inflation by external strangulation where the effects of the devaluation are practically eliminated after the increase in all prices.

On the one hand, unemployment rates in double digits that were demonstrated in the '90s, combined with a process of real appreciation promoted the development of new studies that, including the analysis of factors such as the drastic trade opening carried out through tariff reductions and the lack of compensation by the government, suggested the possibility of a negative impact of the real appreciation on determining the employment.

Subsequently, the convertibility regime collapsed between December 2001 and January 2002, generating a slowdown in the activity and a rise in the exchange rate that the government managed to keep steady in the second half of the year 2002. After that, the market began to show a trend of nominal appreciation of the exchange rate, with expectations of appreciation and high interest rates, becoming local assets more attractive and generating a change of portfolio which promoted a systematic decline in interest rates. Thus, the monetary and financial functioning of the economy has also been stabilized and the surplus in fiscal accounts and in the current account of balance of payments was achieved. This, in turn, contributed to the management of monetary and exchange rate policies by the government, which reduced the burden of the Central Bank. Once the financial environment was stabilized, by mid-2003, a political decision designed to preserve a stable and competitive real exchange rate (SCRER) slowed down the process of nominal and real appreciation, based on quantitative money creation targets.

These set of events left aside the old structuralist arguments which related, in terms of a monotonous relation between the two variables, the real devaluation to the economic downturn. In this regard, Keifman (2005) argued: "*A noticeable change is that some economists that are clearly identified with the structuralism have recently proposed a policy of stable and competitive real exchange rate (read it aloud) to promote the employment, reviewing the old structuralist argument*" As one might say that, from the recent economic evidence, the authors associated with the structuralism (Frenkel and Rapetti: 2004 and 2007), pose a sort of relationship opposite to the above mentioned, where the real exchange rate is related to the economic activity with a monotonous increasing regularity.

According to Frenkel and Rapetti (2007), the exchange rate policy consisting of maintaining a SCRER favored the reversal of the current account deficit and played a preponderant role in the rapid GDP growth process by means of stimulating the activity of tradable sectors. According to these authors, other factors that contributed, but to a lesser extent, have been an international context consisting of products that our country exports at high prices and at low interest rates, as well as the import substitution.

The approach that supports the adoption of a SCRER in order to promote the growth, argues that it can be taken as a compatible protection tool with the free trade, which does not threaten the viability of the tradable sector. Moreover, it does not require much administration and it lowers the monetary costs of the exchange rate intervention. Furthermore, it is argued that it lessens external crises and the macroeconomic instability.

According to Frenkel and Rapetti (2007), according to the strategy designed to maintain a SCRER, the short-term exchange rate uncertainty promotes the management of the monetary authority when preventing private massive flows from buying and selling in the foreign exchange market. Therefore, the interventions of the central bank must aim at, on the one hand, preserving the exchange rate stability in the medium and long-term and, on the other hand, allowing a free-floating exchange rate in the short term in order to discourage speculative capital flows. The higher the exchange rate risk, the greater the banda and the greater the independence of monetary policy shall be. Otherwise, the

arguments of the "trilemma" of an open economy³, which do not agree with the SCRER strategy because they implicitly assume situations of massive capital inflow based on speculative reasons, that render foreign exchange interventions unmanageable. Moreover, in Argentina, the preservation of a SCRER strategy had to be sought jointly with the pursuit of another conflict objective: the price stability.

Therefore, to achieve the goal of the SCRER, the consistency of monetary, fiscal and exchange rate policies and the robustness of the external sector accounts are thought to be essential. Therefore, the success of a policy aimed at preserving a SCRER regime and controlling inflation would depend not only on the size of their foreign exchange interventions, the effective limits of sterilization, the international context, but also on the expectations (and the uncertainty) about the future evolution of the exchange rate.

However, the SCRER regime promotes debates on the appropriateness of its implementation in all circumstances and on the possibility of keeping it throughout time in a context of financial and international integration. Keifman (2005), for example, argues that those who have affirmed the need to maintain a SCRER regime in order to contribute to economic growth did so as not to discuss some determinant factors of the relationship between these variables. Keifman warns that a policy that aims at raising the real exchange rate could promote effects contrary to the ones sought, arguing that the employment acting as a function of the relationship between exchange rate and wages could increase low values of that relationship and decrease high values, hence, the link may not be monotonous. In turn, the tariff policy could change the level of employment as a function of that relationship and the sign of the devaluation impact on employment.

Finally, it is worth noticing that, since July 2007, in Argentina, there has been a constant flight of capital, intensified by the agriculture conflict⁴. Along with those events, there has been a scenario of financial isolation that forced to cover the maturing dates of the foreign debt with the outcome of the current account, reserves or multilateral sources. These factors have imposed new restrictions on the management of the economic policy. In this framework, previous theories with some tension regarding what was stated a few years ago have emerged. Those theories argue that although in the country there exists the advantage of flexible exchange rate, a devaluation rather than promoting stabilization expectations and curbing the capital flight in a scenario as the one described causes expectations of further exchange rate hikes, which increases the purchase of foreign currency. This event warns the need of generating a shock of confidence on the part of the government (Frenkel, 2009).

3. Econometric framework

In terms of achieving the objectives proposed in this paper work, studying the impact of real exchange rate on the behavior of gross domestic product in Argentina between the end of the year 1989 and the end of the year 2007, the methodology of vector error correction is applied. The proposed model in its structural form is as follows:

³ According to the trilemma, in a country that is part of the international financial market, the government can not adopt an active monetary policy and, at the same time, control the exchange rate. The linchpin of said inconsistency was reflected in the gradual acceleration of the inflation rate that began in the year 2005. Therefore, the management of the monetary policy under a SCRER regime consists of offsetting its interventions in the foreign exchange market with sterilization transactions (sale of securities of the central bank or of the public sector in furtherance of absorbing the currency issued in exchange interventions).

⁴ Between July 2007 and October 2008, those events resulted in an outflow of \$ 30,000.

$$\begin{aligned}\Delta t_i &= \alpha_{10} + \alpha_{11}(t_{i-1} - \beta_2 e_{i-1} - \beta_3 M_{i-1} - \beta_4 lpib_{i-1} - \beta_5) + \sum \phi_{1i} \Delta t_{i-1} + \sum \delta_{1i} \Delta e_{i-1} + \sum \varphi_{1i} \Delta M_{i-1} + \sum \chi_{1i} \Delta pib_{i-1} + \varepsilon_{1i} \\ \Delta e_i &= \alpha_{20} + \alpha_{21}(t_{i-1} - \beta_2 e_{i-1} - \beta_3 M_{i-1} - \beta_4 lpib_{i-1} - \beta_5) + \sum \phi_{2i} \Delta t_{i-1} + \sum \delta_{2i} \Delta e_{i-1} + \sum \varphi_{2i} \Delta M_{i-1} + \sum \chi_{2i} \Delta pib_{i-1} + \varepsilon_{2i} \\ \Delta M_i &= \alpha_{30} + \alpha_{31}(t_{i-1} - \beta_2 e_{i-1} - \beta_3 M_{i-1} - \beta_4 lpib_{i-1} - \beta_5) + \sum \phi_{3i} \Delta t_{i-1} + \sum \delta_{3i} \Delta e_{i-1} + \sum \varphi_{3i} \Delta M_{i-1} + \sum \chi_{3i} \Delta pib_{i-1} + \varepsilon_{3i} \\ \Delta pib_i &= \alpha_{40} + \alpha_{41}(t_{i-1} - \beta_2 e_{i-1} - \beta_3 M_{i-1} - \beta_4 lpib_{i-1} - \beta_5) + \sum \phi_{4i} \Delta t_{i-1} + \sum \delta_{4i} \Delta e_{i-1} + \sum \varphi_{4i} \Delta M_{i-1} + \sum \chi_{4i} \Delta pib_{i-1} + \varepsilon_{4i}\end{aligned}$$

where $\{ pib_i \}$ is the series of the gross domestic product in Argentina, whose behavior is sought to be explained. The series is expressed in logarithms ($\{ lpib_i \}$) in order to avoid heteroscedasticity problems and, in turn, to facilitate the interpretation of results in percentage terms.

The series $\{ e_i \}$ represents the real exchange rate, which, according to what is stated in the theoretical framework, although structuralism indicated that the real exchange rate, between the years 1950 and 1980, would have a negative impact on the economic growth, the Keynesian model of the years '30s and the authors belonging to the beginning of XXI century identified themselves with the structuralism stated the opposite view. Keifman's assertions (2005) suggest that the activity, as a function of the real exchange rate, could result in an increase in low values of that variable and a decrease in high values.

The series $\{ t_i \}$ represents the index of the terms of trade, that as it is described by the structuralism, has played a fundamental role in determining the growth of the gross domestic product in Argentina. Moreover, international prices (included in this variable) have been one of the factors that explains the growth of Argentina as from the year 2003 (Frenkel and Rapetti, 2007).

Finally, the series (M_i) represents the liquid monetary aggregate. This seeks to incorporate the monetary effect -the ones of real money balances- described by Sidrauski (1968), so that changes in real exchange rate, along with the monetary balances, would determine changes in interest rates and this could hit the growth of the economy. However, according to the assumptions of the main stream, the addition of this variable should not be significant in order to explain economic growth in the long run. This assertion has often been disputed by other schools of thought⁵.

Particularly, in this paper work the methodology VEC was chosen, since it comprises a short-term and a long-term situation, with non-stationary series, but cointegrated. This model allows us to get the dynamic behaviour, without losing information about the relationships of long-term equilibrium. Thus, changes in each series are explained, not only because of variations in each of the series, but also because of the discrepancy between the effective and equilibrium values in the long-term.

According to Sims (1980), if the variables are non-stationary variables, but cointegrated, it is not advisable to present the model in differences because, thus, information related to the co-movements among variables would be rejected, since the purpose is, rather than to estimate parameters, many times, to understand relationships between variables.

⁵ Restrictions on available information limited the incorporation of additional variables to the vector system that, as evidenced in the Theoretical Framework, would have enhanced the analysis (replacing or complementing the variables proposed). There were also restrictions on the length of the series used although it would have been interesting to extend them so as to include in the analysis the evidence about phenomena occurred throughout the country's economic history.

For these reasons, the model described contains a cointegration relationship, $(ti_{t-1} - \beta_{12}e_{t-1} - \beta_{13}M_{t-1} - \beta_{14}lpib_{t-1} - \beta_{15})$, which, in the long-run, is close to zero. This relationship is obtained through the procedure described by Johansen (1988). The parameters α_i ; $i=1, \dots, 4$ are adjustment coefficients that indicate which is the average periodic imbalance correction (Brufman and Urbisaia, 2000).

On the other hand, as $\{\Delta ti_t\}$, $\{\Delta e_t\}$, $\{\Delta M_t\}$ and $\{\Delta lpib_t\}$ are stationary variables, ε_{1t} , ε_{2t} , ε_{3t} and ε_{4t} are White Noise and $\{\varepsilon_{1t}\}$, $\{\varepsilon_{2t}\}$, $\{\varepsilon_{3t}\}$ and $\{\varepsilon_{4t}\}$ are assumed to be non-correlated, such a specification allows us to consider the fluctuations of the variables already mentioned as a function of non autocorrelation orthogonal shocks: the terms of trade shocks $\{\varepsilon_{1t}\}$, the real exchange rate shocks $\{\varepsilon_{2t}\}$, monetary shocks $\{\varepsilon_{3t}\}$ and the activity shocks $\{\varepsilon_{4t}\}$.

Assumptions of orthogonality which imply variations in each variable considered in this paper are not assumed to be systematically correlated, without eliminating the possibility that changes in each of them may affect other variables, since those variations must have different sources in the economy. For example, breakthroughs in the monetary policy which are the result of factors (e.g. the political instability) that do not disrupt the economic activity systematically could be sources of shocks in the real exchange rate. The definition of such a structure incorporates a *feedback* between $\{\Delta ti_t\}$, $\{\Delta e_t\}$, $\{\Delta M_t\}$ and $\{\Delta lpib_t\}$. Hence, the temporal path of each of these series may be affected by current and past variables values of other series.

In connection with the specification of the model, we used Akaike's information criterion for determining the lags of the autoregressive vector, which allows a maximum of 8 lags (since quarterly series were considered). The construction of the VEC model was carried out with a lag less than the one suggested by that criterion, since they are applied to endogenous variables expressed in first differences.

In furtherance of verifying the validity of the model, we considered the presence of unit root in the series $\{ti_t\}$, $\{e_t\}$, $\{M_t\}$ and $\{pib_t\}$, through the Augmented Dickey-Fuller test with Modified Akaike criterion for the selection of lags⁶. In turn, for determining the maximum number of lags to assess (maxlag), the suggestions of Schwert (1989) were considered, where $\max lag = \text{int}(12(\frac{T}{100})^{\frac{1}{4}})$, where *int* means the integral part. In all cases the presence of remaining autocorrelation in the residuals of the test was analyzed.

Moreover, the existence of cointegration among the series considered in this paper was verified through Johansen's method (1988), whereas, with the purpose of considering the robustness of the results both the sequential design trace test and the maximum eigenvalues test were implemented for a specification with linear trend in levels and intercept (no trend) in the cointegration equations. In both cases, a lag less than the number indicated in Akaike's criterion for autoregressive vector was incorporated, due to the fact that the methodology works on first differences.

Furthermore, the LM test for serial autocorrelation in the residuals was utilized in order to test the null hypothesis of the absence of serial self-correlation in different lags.

To interpret the impact of the behavior of certain series on others, we worked with impulse-response functions and with variance decomposition. We analyzed the

⁶ According to Ng-Perron (2001) this approach produces tests with desirable size and characteristics, which domains other criteria, both from the theoretical and numerical point of view.

responses of the variable $lpib_t$ to generalized impulses of ti , e and M , according to the generalized impulse-response functions method raised by Pesaran and Shin (1997), which does not depend on the order of the variables indicated in the model. Generalized impulse-response functions are unique⁷, thus, the method does not impose restrictions a priori on the relative importance of each variable in the transmission process. Precisely for these reasons, the applied economic literature has increasingly used this method.

Additionally, since the identification of results similar to those reached would increase the strength of those results, the results of the generalized impulse-response functions were subsequently contrasted with those results arising from a Cholesky's decomposition.

In order to use the Cholesky's method is necessary to impose an order *a-priori* to the variables of the system. In this case, it is assigned an order that goes from the most exogenous variable- in our case, ti -, to the less exogenous one, and next in rank, the variable $lpib$, the one that we are interested in analyzing (Favero, 2001, pp.165). The order of the variables assigned to the decomposition is: ti , e m and $lpib$. In the same way, we studied the model by means of a variance decomposition analysis to show the relative importance of each random innovation, distributing the variance of the prediction error of each variable regarding its own shocks and innovations in other variables of the model (Enders, 1995). This analysis allows us to separate the variation of one endogenous variable from the shocks that make up the model, reporting on the relative importance of each random innovation as regards their impact on each variable.

4. Data

The period that we analyse ranges from the fourth quarter of 1989 to the fourth quarter of 2007 and the analysis was carried out with a frequency of quarterly data.

The lack of data availability has made impossible the extension of all relevant series to the past. On the other hand, from the academic field, the reliability of certain data provided by the National Institute of Statistics and Censuses, especially, after the year 2007 has been questioned. With regard to this analysis, the questions about the prices indexes published by that institution are taken into account. These were the factors that limited the period of investigation.

In the implementation that was carried out we used a series of Gross Domestic Product $\{pib_t\}$, expressed at market prices (spliced), pesos in millions in 1993, pursuant to information published by the National Institute of Statistics and Censuses (INDEC).

This series is characterized by an upward trend, interrupted in 1995, probably by the so called "Tequila Crisis," which hit from the international arena. Then, a sharp slowdown in the economic activity, followed by the collapse of the convertibility regime in December 2001 and a recovery after the year 2002 is highlighted.

⁷ A structural decomposition according to Blanchard and Quah (1989), would fix, a priori, theoretical concepts, whereas what is intended in this analysis is to provide evidence to support (or not) various macroeconomic schools of thought. For example, in such a decomposition it might be arbitrarily stated that M - being a nominal variable, has no real long-term effects. Additionally, even accepting this concepts, it would be too difficult and arbitrary to put into practice these suppositions to two of the remaining variables involved in this analysis.

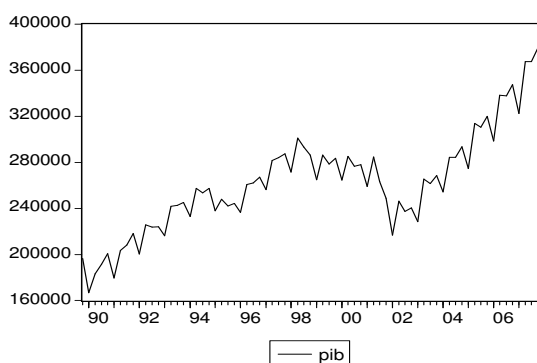
The series of Real Exchange Rate $\{ e_t \}$ was generated as $e_t = \frac{E_t x P_t^*}{P_t}$, where E_t is the nominal exchange rate as regards the dollar, the average of the monthly series that was reported by the International Monetary Fund (IMF), between 1989 and March 2002 and by the Banco Central de la República Argentina (BCRA), from March 2002 until November 2008⁸. P_t^* is the consumer price index of the United States, according to data published by the Bureau of Labor Statistics of that country and P_t is the consumer price index of Argentina⁹ (quarterly average of monthly values), according to data published by the INDEC. Both price indexes are expressed pursuant to the reference year 1989:4 = 100. In graph 2 the behavior of the series $\{ e_t \}$ can be observed.

⁸ We used this variable for simplicity. We hope that results do not change much, if we use the nominal exchange rate with respect to another currency.

⁹ The series P connects base: 1988 to base: 1999 = 100 series.

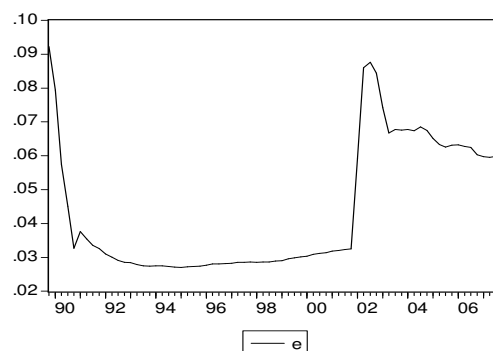
Graph 1: Dynamics of Gross Domestic Product (market prices)

Quarterly data: 1989:4 to 2007:4



Graph 2: Dynamics of Real Exchange Rate

Quarterly data: 1989:4 to 2007:4



Source: Personal Research based on data published by the INDEC, the IMF, the BCRA and the Bureau of Labor Statistics of the United States.

It is worth mentioning the scarcely volatility of the real exchange rate shown in the 90s, as a consequence of the *Convertibility Regime*, where, although local and international prices were subject to market forces, the nominal exchange rate was anchored. Furthermore, there is a rise in the real exchange rate followed by the breakdown of the convertibility regime in December 2001¹⁰. In the second half of 2002, the government succeeded in stabilizing the exchange rate by strengthening the controls on external transactions and by achieving a more systematic intervention policy in the foreign exchange market¹¹. Since then, the market began to show a trend of nominal appreciation of the exchange rate, and once the financial environment was stabilized, as of the middle of the year 2003, a political decision aimed at maintaining a stable and competitive real exchange rate is warned.

Another series included in the analysis is the terms of trade index, $\{ ti_t \}$. This variable arises from the division between the exports price index and the imports price index and it may be understood as variations in relative prices that the economy faces in its foreign trade: the evolution of the purchasing power of an export physical unit in terms of imports. The data taken into account are those published by the INDEC and they have as reference year 1993=100.

Graph 3 shows the evolution of the series $\{ ti_t \}$ in the last two decades, where a growing trend is highlighted during those years.

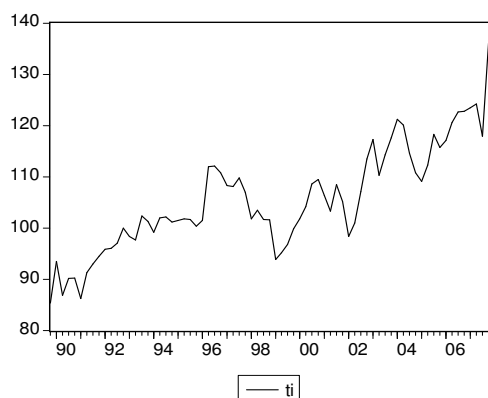
Finally, the analysis included a series of monetary balances $\{ M_t \}$, which represents the value at end of the year in thousands of pesos of the monetary aggregate M2, according to the Ministry of Economy and Public Finance of Argentina (MECON).

¹⁰ The restrictions in data prevented the incorporation of the relationship between real exchange rate and wages in this analysis. It would have been interesting so as to test the predictions of some of the theoretical texts contemplated in this paper. For example, Canitrot (1975), as discussed hereinabove, suggests that the effects of increasing the real exchange rate are opposed to an increase in nominal wages.

¹¹ The BCRA was forced to settle exports superior to one million dollars by encouraging the accumulation of reserves, the drain on bank deposits destined to foreign currencies demand was restricted and an executive order prohibiting the return of deposits by means of amparo proceeding (legal proceeding brought for the protection of a constitutional right other than those protected by the writ of Habeas Corpus that was violated by the Judicial or Executive branch) for a period of 120 days was issued.

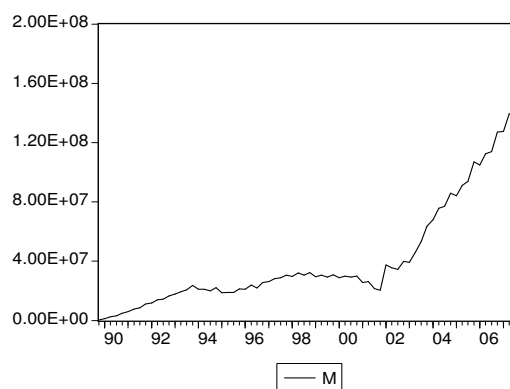
Graph 3: Dynamics of Terms of Trade

Quarterly data: 1989:4 to 2007:4



Graph 4: Dynamics of Monetary Balances (M2)

Quarterly data: 1989:4 to 2007:4



Source: Personal research based on data published by the INDEC and the MECON. Note: Data of ti that correspond to the year 2007 are temporary.

In graph 4, there is a change in the behavior of the series $\{M_t\}$ after a decade of relative stability, followed by the fall in the *Convertibility Regime*, which involved an exit from a system of fixed exchange rate. This change gives the monetary authority more autonomy. Consequently, in the middle of the year 2003, the objective of maintaining a stable and competitive real exchange rate relied on quantitative targets for monetary policy.

5. Assessment results

Even though we sought to provide empirical evidence of the relationship between the selected variables by means of the proposed econometric model, it would be essential to act cautiously when analysing its results. Therefore, it is interesting to consider the following a priori statements given by Keifman (2005, p. 7-8): "*Of course, to demonstrate the possibility of a fact does not mean that it has occurred. (...) We are interested in warning that the formulation of macroeconomic policies must not be based on empirical trends or associations between variables that may be of short duration, and in pointing out the need to further investigate these issues to develop the policies. (...)we should(not) limit ourselves to extrapolate recent trends in employment and exchange rate, but we should try to understand them whithin an analytical framework*".

Once these statements have been made, taking into account the explicit restrictions in terms of interpretation, the results obtained in the stationarity and cointegration analysis of the series are hereinbelow described, as well as the characteristics of the behavior of the model¹².

5.a. Analysis of stationary of times series

¹² It is worth mentioning that, although we took into account the theoretical arguments to specify which variables form part of the selected model, which has been described in the *Econometric Framework*, we also carried out tests on models that included variables- import and export prices indexes and inflation, which could have been a substitute or a complement to those selected variables regarding what has been discussed in the *Theoretical Framework*. Some of these models did not produce significant results. Others were left aside because they generate slightly robust results. In this sense, priority was given to those models that did not reject the null hypothesis of the existence of at least one cointegration relationship, both through the Johansen trace test and through the maximum eigenvalues. Furthermore, the models that when varying the sample size dramatically changed the results of the tests associated with them were left aside.

The results of the unit root test applied to the series $\{ ti_t \}$, $\{ e_t \}$, $\{ M_t \}$ and $\{ pib_t \}$ by the Augmented Dickey-Fuller test with Modified Akaike's criterion for lags selection can be seen in *Table 5.a.1*.

Table 5.a.1: Unit Root Test Augmented Dickey-Fuller. *Quarterly Data: 1989:4 to 2007:4.*

	Series				
	$\{ pib_t \}$	$\{ lpib_t \}$	$\{ e_t \}$	$\{ ti_t \}$	$\{ M_t \}$
Exogenous	Intercept and Linear Trend	Intercept and Linear Trend	Intercept	Intercept and Linear Trend	Intercept and Linear Trend
Lag Length	5	5	6	0	8
ADF t-Statistic	-1.402928	-1.797844	1.047195	-2.971705	-0.012583
5%Critical values	-3.478305	-3.478305	-2.90621	-3.473447	-3.481595
Residual Autocorrelation	No	No	No	no	No

Source: Personal research based on data published by INDEC, the IMF, the BCRA, the Bureau of Labor Statistics of the United States and the MECON.

In none of the series the results suggest to reject the null hypothesis of unit root with a confidence level of 95%, without the presence of correlation remaining in the residuals of the test. Tests of the series $\{ ti_t \}$, $\{ M_t \}$ and $\{ lpib_t \}$ were carried out with intercept and linear trend and the test of $\{ e_t \}$ with intercept. Also, if the number of parameters decreases in the test configuration with the purpose of increasing its power- as the case may be, removing intercept or intercept and linear trend-, the null hypothesis of unit root in none of the series is rejected.

5.b. Cointegration Analysis

In the presence of non-stationary series, we assessed whether it is appropriate to develop a VEC model or not. Therefore, we studied whether there is at least a stationary combination of the series $\{ ti_t \}$, $\{ e_t \}$, $\{ M_t \}$ and $\{ lpib_t \}$, so that there is a long-term stable relationship between them.

For the cointegration analysis a VAR of 8 lags was built, as recommended by the Akaike's criterion, jointly with the series $\{ ti_t \}$, $\{ e_t \}$, $\{ M_t \}$ and $\{ lpib_t \}$. Consequently, Johansen's tests were carried out (1988) on 7 lags in first differences. The specification of the test consisted of linear trend in levels and of intercept (no trend) in the cointegration equations¹³. Test results of the trace test and those of top eigenvalues test are shown in Tables 5.b.1 and 5.b.2, respectively.

¹³ The cointegration test of Engle-Granger is not suitable for working with more than three variables, since in this case that restriction exceeds.

Table 5.b.1: Johansen Trace Test for Unrestricted Cointegration Rank
Quarterly data: 1989:4 to 2007:4

Hip. No. of CE(s)	Eigenvalue	Trace Statistic	5% Critical Value	Prob.**
None *	0.571653	86.83127	47.85613	0.0000
At most 1 *	0.255986	31.72289	29.79707	0.0296
At most 2	0.173804	12.50270	15.49471	0.1344
At most 3	0.001425	0.092692	3.841466	0.7608

The Trace test indicates two cointegration equations at a level of 0.05%.

Table 5.b.2: Johansen Unrestricted Cointegration Maximum Eigenvalue Test
Quarterly data: 1989:4 to 2007:4

Hip. No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5% Critical Value	Prob.**
None *	0.571653	55.10838	27.58434	0.0000
At most 1	0.255986	19.22018	21.13162	0.0906
At most 2	0.173804	12.41001	14.26460	0.0962
At most 3	0.001425	0.092692	3.841466	0.7608

The Maximum Eigenvalues Test indicates a cointegration equation at a level of 0.05%.

Source: Personal research based on data published by the INDEC, the IMF, the BCRA, the Bureau of Labor Statistics of the United States and the MECON. Note: The adapted sample, which includes 65 observations, covers the period between the 4th Qtr of 1991 and the 4th Qtr of 2007.

Notes: * it indicates the rejection of the hypothesis at a level of 0.05. ** MacKinnon-Haug-Michelis (1999) p-values.

There exists cointegration between the series $\{ ti_t \}$, $\{ e_t \}$, $\{ M_t \}$ and $\{ lpib_t \}$, at a confidence level of the 95%, in the period under analysis.

5.c. Model Analysis

In compliance with the objective of this analysis and in order to explain the relationship between the GDP growth and the real exchange rate, we selected a VEC model specification with linear trend in levels and intercept (no trend) in the cointegration equations, which has as endogenous variables ti , e , M and $lpib$, with 7 lags for the variables in differences. They are consistent and efficient since the sample is relatively huge. Furthermore, the LM test for serial correlation in the residuals did not reject the null hypothesis of no serial correlation in residuals.

The selected model showed a value on the Akaike's information criterion of 24,58593, which represents a better adjustment than that of many other specifications. However, it is worth saying that although in some alternative models there were values relatively better in this approach, we decided to highlight those options since they were slightly robust results as regards changes in the sample size and/or the type of test implemented. Anyway, the presence of these specifications with fine adjustment do not generate incompatibility with the selected model ¹⁴.

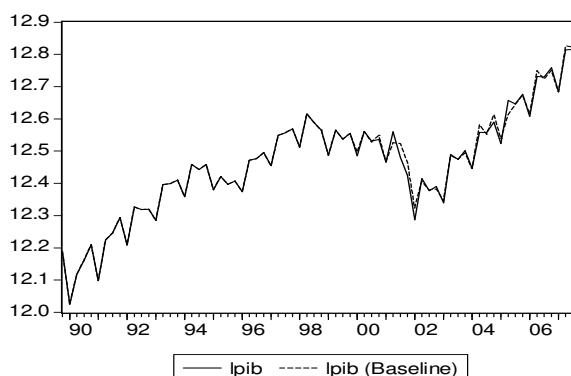
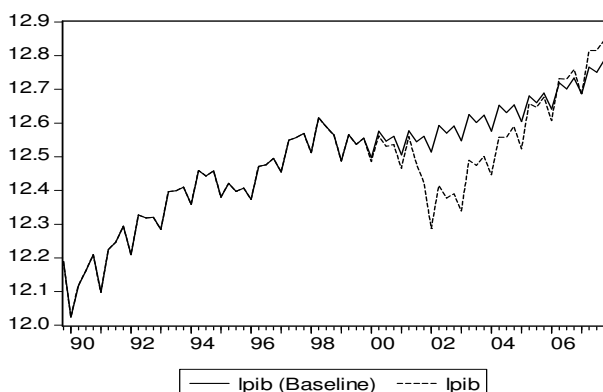
¹⁴ For example, in the selected model, the index ti was incorporated, since one of the models with fine adjustment includes, alternatively, the variables that comprise it (imports and exports prices index).

Furthermore, the ability of the model to predict the behavior of the product is encouraging. This is shown in Graph 5.c.1. In particular, we can say that performance of the model to predict is better upon the basis of a static simulation (Graph 5.c.1.ii) rather than upon the basis of a dynamic simulation (Graph 5.c.1.i) as it is based on historical data, it could be used to anticipate the future behavior of the economic activity in the country.

Graph 5.c.1: Forecasting model for the period 2000-2007

i. Deterministic dynamics simulation

ii. Deterministic static simulation

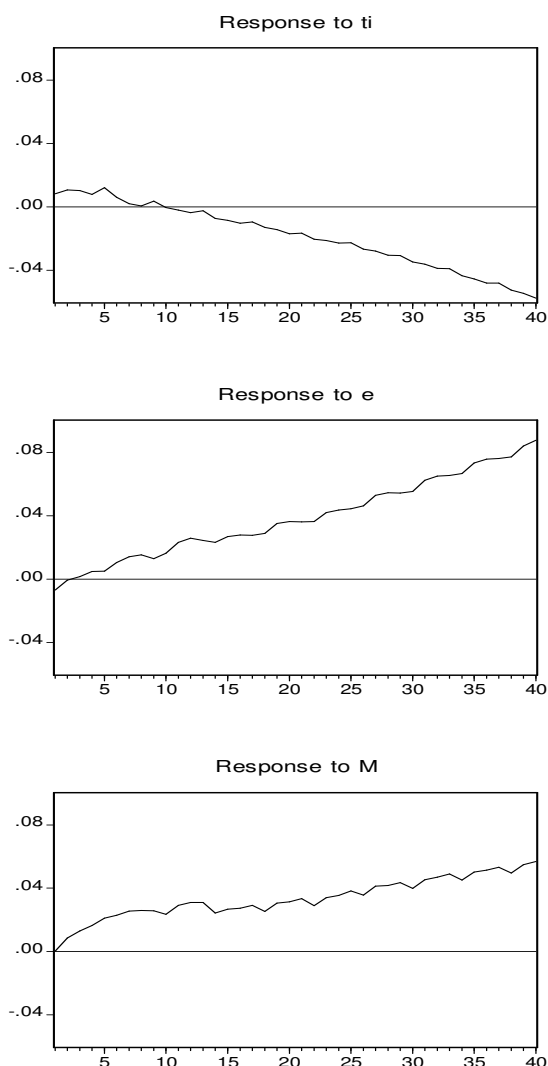


Source: Personal research based on data published by the INDEC, the IMF, the BCRA, the Bureau of Labor Statistics of the United States and the MECON. Note: the Gauss-Seidel method, with a maximum number of iterations of 5000 and convergence: 1e-008.

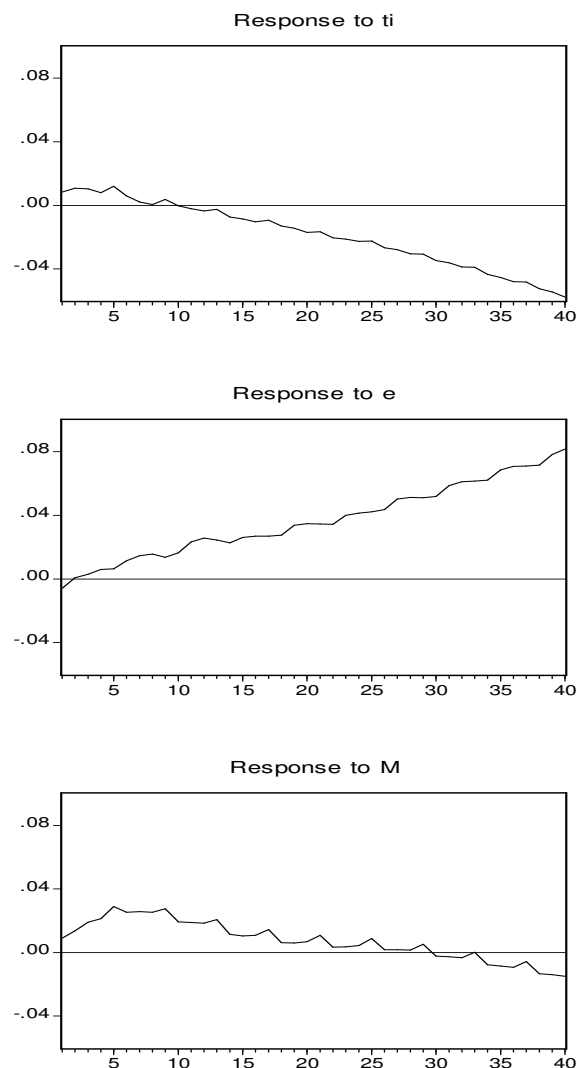
Impulse Response Functions

In Graph 5.c.2.i we can observe current and future responses of *lpib* (over 10 years) to generalized impulses of a standard deviation of the other variables included in the VEC. Hence, a shock in some of the variables (at time t) generates a response to *lpib* over the time, as represented in the graph.

Graph 5.c.2: Response of *lpib* to innovations (one S.D.),
 Quarterly data: 1989:4 to 2007:4
 i. Generalized Innovations



ii. Cholesky Innovations



Source: personal research based on data from INDEC, the IMF, the BCRA, the Bureau of Labor Statistics of the United States and the MECON. Note: Cholesky decomposition (Graph5.c.2) was carried out for an order of the variables: *ti*, *e*, *M*, *lpib*.

Graph 5.c.2.ii shows the (similar) results of the impulse-response functions arising from an adjusted Cholesky decomposition. This decomposition was based on a ranking variable, considering the theoretical framework that goes from the most exogenous *-ti-* to the least exogenous placing ultimately the variable *lpib*, which is the one that we are interested in analyzing¹⁵. The ranking of variables proposed is the following: *ti*, *e*, *M*, *lpib*.

It is highlighted that both graphs show a similar behavior as regards the *lpib*, towards real exchange rate shocks and terms of trade. This demonstrates the robustness of the results described below: a real exchange rate shock has an immediate negative impact

¹⁵ It is not possible to order these four variables in relation to Granger Casualty Test, since results reveal more than a possible order among them. It is important to highlight, however, that the ranking proposal herein formulated is not incompatible with the results obtained from this test.

on *lpib*, that becomes positive after two quarters and gains strength over time. The cumulative effect, from that moment, becomes positive and grows exponentially. An innovation in terms of trade, in turn, has a positive impact that lasts for more than two years. During that period, it is losing strength until it changes the sign of its impact, when the accumulated temporary effect becomes progressively negative until it becomes explosive.

Finally, a money supply shock hits in a positive way at first. This can be proven in generalized impulses, or through Cholesky decomposition which is already stated. However, whereas an innovation of this kind before generalized impulses increases their positive effects on *lpib* over the time; using the Cholesky method, however, the positive effect is losing strength until, after 7 years, it becomes negative and decreases exponentially, albeit at a slower speed than what happened with the terms of trade.

Variance Decomposition

In Table 5.c.1, we can see the variance decomposition of *lpib* among the four variables of the system, arising from the Cholesky decomposition described herein above. In the second column of the table, we can see a prediction error of the variable in an already given horizon. The source of that prediction error is the variance of innovations value of each variable of the VEC. The remaining columns assess a percentage of the prediction error variance corresponding to each innovation, where –by definition– each line adds up 100.

Table 5.c.1: *Variance Decomposition lpib*

Quarterly data: 1989:4 to 2007:4

Period	Standard Error	ti Shock	e Shock	M Shock	lpib Shock
1	3,023896	10,12827	5,214876	11,74239	72,91446
2	3,869454	10,53912	2,067638	15,20312	72,19012
3	4,440447	10,11107	1,549661	21,89095	66,44832
4	4,764066	9,466185	2,120573	29,00808	59,40516
5	4,858621	8,730914	2,106116	33,54967	55,61330
6	5,039271	7,305228	3,397940	34,88183	54,41500
7	5,272682	6,247727	5,349395	37,23024	51,17264
8	5,648919	5,610077	7,307098	40,12771	46,95512
9	6,026105	5,050472	8,109138	42,09737	44,74302
10	6,487862	4,668092	9,757193	41,99840	43,57631
11	6,993401	4,336112	13,18686	41,50725	40,96978
12	7,335194	4,108157	16,94273	40,95732	37,99179
13	7,485689	3,852455	19,70698	40,86742	35,57314
14	7,680921	4,020032	22,09623	39,87160	34,01214
15	7,782218	4,245001	25,05138	38,41145	32,29217
16	7,923910	4,574013	27,52553	36,63630	31,26416
17	8,000509	4,785729	29,82706	35,69641	29,69081
18	8,045672	5,361626	32,04663	33,95190	28,63985
19	8,184903	5,922681	34,92458	31,53882	27,61392
20	8,380891	6,596700	36,80307	28,80396	27,79627

Source: Personal research based on data published by the INDEC, the FMI, the BCRA, the *Bureau of Labor Statistics* of the United States and the MECON. Note: the decomposition was carried out based on the Cholesky method in order to make a ranking of variables: ti, e, M, lpib.

The variance decomposition of $lpib$ indicates that initially, the error prediction variance corresponds mostly (73%) to changes in the values of innovations of its variable. M , ti and e innovations have a participation of the 10%, 5% and 12% respectively. However, over the time, real exchange rate shocks are gaining relative strength, until they go beyond all other shocks in the determination of the prediction error and, in turn, the relative participation of innovations of ti and M increases over the time and its variable, e.i. $lpib$, loses strength.

However, as the variance decomposition analysis was carried out by a factorization that derives from the Cholesky method, the results could be impaired by the ranking of variables proposed by the model. In addition to this, what for the impulse-response functions would be a robust result to the behavior of the variables ti and e would not be the same for variance decomposition. The question is that the results of the innovations effects on monetary supply are not conclusive and, in an analysis of variance decomposition, the behavior of this variable can affect, mainly, the results obtained for the rest of the variables, weakening the results from this analysis.

5. Conclusion

The literature deriving from various macroeconomic schools of thought, related to the role of the real exchange rate in GDP growth in Argentina, has stated that the existence of different types of relationships between variables. Those relationships are based on different foundations and are supported by the evidence of different periods of the economic history of the country. While the classical Keynesian vision, which emerged in the 30s, claimed that a high real exchange rate promotes the growth, as from the 50s, the structuralist literature aimed at explaining the combination of economy slowdowns with the real devaluation of the currency. However, other schools of thought emerged thanks to the stylized facts of the 90s, identified with the structuralism, which argued that a stable and competitive real exchange rate is virtuous for the economy growth. These fundamentals were based on the consideration of the exchange rate expectations as decisive factors of the level and variations in macroeconomic variables. Nevertheless, publications have emerged that question the relevance of applying a policy of stable and competitive real exchange rate in all circumstances and in a context of international financial integration, asserting that it is necessary to discuss some decisive factors of the relationship between relevant variables and emphasizing that a policy which tends to raise the real exchange rate could produce effects contrary to the ones sought, so its relationship with the level of activity could not be monotonous.

Taking into account these assertions, this paper aimed at providing evidence of the impact of the real exchange rate on determining the behavior of the economic activity in Argentina between 1989 and 2007, applying a *Vector Error Correction* to series of quarterly data.

This model includes a short and a long-term component, linking four non-stationary and cointegrated variables: the two variables that we are interested in analyzing are the gross domestic product and the real exchange rate, monetary balances, which could impact on the growth through its effects on interest rates, and terms of trade, one of the favorite arguments of the structuralism in order to explain the macroeconomic performance of non-developed countries. This model has an adjustment superior to other specifications, except for some cases where the results are slightly robust to changes in the sample size or in the type of test implemented. Also the ability to predict of the model with respect to the economic activity is encouraging to anticipate its behavior, particularly, from a static simulation.

With the aim of analysing the impact of the remaining series on the behavior of the GDP, and avoiding setting prescriptions of the relative behavior among the variables that precede the adoption of the method, a method that does not vary from the relative order imposed on the variables in the model was selected. Accordingly, we examined the responses of the economic activity to *generalized terms* of terms of trade, real exchange rate, and monetary balances and we compared those results with the results arising from a Cholesky's decomposition.

The responses of GDP to real exchange rate shocks and terms of trade showed a similar behavior between generalized impulses and those deriving from a Cholesky decomposition, demonstrating the robustness of the following results: a real exchange rate shock has an immediate negative impact on the activity, which is gradually declining until it becomes positive after six months, at that point it gains in strength throughout time. As regards innovations in terms of trade, these have a positive initial impact, which over two years they lose strength and they become negative and, throughout time, explosive.

Moreover, money supply shocks have a positive impact on the economy at first. As time went by, generalized impulses show that such effects would be boosted. However, these latest results are slightly robust, since if we use the Cholesky method according to the

predetermined identification, the positive effect is losing strength until, after 7 years, it becomes negative and decreases exponentially, albeit at a slower speed than the decline of the terms of trade. Therefore, there is no strong evidence regarding such heightened debate related to the real effects of monetary shocks.

Furthermore, the model through an analysis of variance decomposition was studied with the already described Choleski factorization. The results indicate that, initially, the variance of the prediction corresponds mostly to changes in the values of the innovations of its variable and that, throughout the time, real exchange rate shocks are gaining relative strength. However, these results show relative weakness due to the uncertain impact of monetary innovations on the other variables.

With regard to recommendations for future research, it should be noted that, while the reviewed theoretical models are very promising as to their ability to explain and predict the behavior of the economic activity of the country, the restrictions regarding data availability make difficult the possibilities to propose other alternatives and to obtain all the empirical evidence deemed to be relevant to support or contradict the models. This suggests that, in case we have new information available, it would be useful to contrast the behavior of the model with the model of other systems which incorporates additional variables. For example, the availability of a series of wages would allow us to corroborate the predictions of models proposed by Canitrot (1975), Porto (1975) and Keifman (2005)-whether the effects of increasing the real exchange rate are opposed to an increase in nominal wages. Other variables that would enrich the empirical study, demonstrating what the structuralist theoretical models propose are, for example, tariff rates, an indicator of income distribution, employment, the incorporation of the *autonomous demand* -composed by autonomous investment, industrial exports and import substitution-, information about tax policies, based on the strength of the external sector and public sector accounts and some indicator of expectations of exchange rate appreciation. It would be also interesting to develop a model that incorporates an indicator of stable and competitive exchange rate.

The enlargement of the sample of the series considered in this paper –going back to the past- would be useful, for example, to analyse the adoption of the models, at the time for which they were designed. For example, the model proposed by Canitrot (1975), seems to represent the true nature of the Argentine economy since 1930, particularly, he was interested in populist governments, so it would be useful to adopt the model proposed at that period. For the future, the lack of data is not the prevailing concern, but the reliability that institutions deserve.

Finally, as regards the relevance of the results obtained for the decision making in the public field, although the model has shown that as a dominant feature of the Argentine economy, a devaluation of the exchange rate has generated initial recession, followed by an expansion in the medium and long term; the current threat of flight of capital, along with the need to cover foreign the debt maturity in a context of financial isolation, which makes the rise of exchange rate generate further increases expectations and promote the purchase of foreign currency. This reinforces the idea that it is not only the mere presence of data what is needed to corroborate the predictions of analytical models, but the occurrence of actual scenerios. Therefore, while the proposed econometric model sought to provide empirical evidence of the relationship between the selected variables, the results that we obtained can not be generalized. That is to say that the formulation of policies can only rely on those results, taking into account that what is demonstrated in this paper is not the only possible outcome, taking into account the interaction of substantial variables that operate in the economy and that, in every moment, they do it at different levels and with different growth rates. In this sense, it is crucial to complement this analysis with other studies of analytic nature, which may be more encompassing.

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