A Study on the Elasticity of Argentine Imports Between 1993 and 2013

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Abstract

This work examines the behavior of income and price elasticity of aggregate imports in Argentine economy for the period between 1993 and 2013, addressing the two main problems in this kind of assessment, namely: the existence of structural breaks in the time series and the problems of endogeneity. Both topics have not been properly discussed in previous works. The empirical analysis carried out consists in the implementation of a VEC model following the general-to-specific methodology and a Markov process model. The results of our investigation suggest that the effects of variations in income are stronger than the effects of variations in relative prices. In other words, evidence seems to indicate that the impact on domestic demand in the trade balance cannot be easily compensated by a depreciation of the real exchange rate in the long term. Our analyses suggest that a relatively simple but solid explanation for this phenomenon is that, given the internal difficulties to produce imported products of high added value, real exchange rate would not be incentive enough by itself to restrain imports.

I. Introduction

In some economic literature, a competitive real exchange rate is seen as a crucial factor to reduce imports (Ros and Skott (1998), Rodrik (2008), Razmi, Rapetti and Skott, 2011-8; Rapetti 2011-9; Razmi, Rapetti, Skott, 2012). However, for the Argentina's case, at least from 1995 with Reinhart's work followed by the works of Senhadji (1998); Catão and Falcetti (2002); Heymann and Ramos (2003); Bus and Nicolini Llosa (2007); Duarte, Nicolini-Llosa and Paya (2007); Berrettoni and Castresana (2008), empirical evidence of imports low relative response to alterations in the real exchange rate can be found. This has led some economists to start questioning the effectiveness of using only depreciated rate exchanges to reduce imports and promote the development of the national production (Zack and Dalle, 2014).

The objective of this thesis is to deepen previous works on income and price elasticity of Argentine aggregate imports through the introduction of a new estimation method known as "general-to-specific".

This work differs from the above mentioned because it follows the "London School of Economics-LSE" approach. That is to say, although economic literature suggests relevant functional methods, LSE method, also known as "general-to-specific", assumes that the correct method of the data generator process is *a priori* unknown. The objective of the econometric

theory is to discover this specific method or suggest approaches that are not rejected by the available data (Hendry 1995, p.8).

This paper presents further evidence on the effect of RER over imports in Argentina, that is the variations on the imports when devaluation occurs, using a new estimation methodology on the time series available. Following a sequence of tests suggested by the LSE method. These other tests take into account several variations of the previous models with the idea of avoiding certain biases or undesirable properties that the former modelling may feature.

The method developed by the LSE proposes an alternative to relate dynamic models, containing lags and trends, with static theories. This method does not attempt to impose a theory to the data. In other words, it takes into account the regularities in the data without ignoring relevant information of the theory (Hendry 2009, 56-57). That is, econometric models built with this methodology allow taking into account possible regularities in the information used.

Short and long term dynamics will be modeled together by a VECM since through this methodology short-term fluctuations are not ignored. Thus, the method allows taking into account general dynamics and its extension may be determined by the data. In short, we introduce a method of inference and a modeling alternative strategy that allows learning from data.

Specifically, this work is different from the current literature because it puts emphasis on estimators' statistics properties and aims at addressing the problems resulting from series non-stationarity. Then, it would be possible to lay out the critique of Lucas (Favero, 2001), through exogeneity tests.

Being a classical topic in international trade studies, our work seeks to strengthen the long term results obtained in the previously mentioned works, showing how these results remain the same when changing the econometric methodology. As it will be seen below, our methodology takes into account the presence of future structural breaks and endogeneity of regressors to estimate the before mentioned parameters.

Firstly, the elasticity of imports subject to variations in the real exchange rates (or from now on, price elasticity) is going to be analyzed. The latter is a synthetic measure of the price competitiveness of goods and services produced by a country with regard to those produced by the rest of the world. That is why it should be included as a relevant variable of the imports demand (see Houthakker-Magee (1969), Thirlwall (1979), Krugman (1988)).

Secondly, there will be an analysis on the imports elasticity subject to changes in the national income (or from now on, income elasticity). This is because, given the price relation between domestic and imported goods (see Houthakker-Magee (1969), Thirlwall (1979), Krugman (1988)), the greater the national product (GDP), the greater the demand of imported goods.

In order to study both issues, the empirical analysis carried out in this work consists on the implementation of a VEC model and a Markov process model for Argentina between 1993 and 2013. The period under analysis as well as the frequency of chosen data were determined on the basis of their availability in the statistical data bases of the Ministry of Economy of the Nation (MECON by its Spanish acronym) and the National Institute of Statistics and Census (INDEC by its Spanish acronym).

There is evidence about the strong variability of imports before changes in the product and a reduced response of said imports to alterations in the real exchange rate in Argentina between 1993 and 2013. Particularly for the VEC model, with two explanatory variables (GDP and real exchange rate), we obtain that between 1993 and 2013 the elasticity resulting from imports was of 1.69, while price elasticity was of -0.38.

We found a comparatively simple but solid explanation for this phenomenon: real exchange rate is not incentive enough by itself to restrain imports, given the internal difficulties to produce imported products of high aggregate value. Our investigation suggests that the low elasticity of change of imports obtained is a result of the fuel areas, intermediate goods (vehicle assembly, fertilizers, chemical and petrochemical components and electronic components mainly) and some kind of services (transportation, rental of equipment, payment of royalties), that make up for more than 50% of country imports. Due to their nature or when they are part of the global value chains it is difficult to produce such goods domestically. Therefore, in light of the increase of the exchange rate, unless sectorial or specific industrial policies are established to address domestic difficulties in production, these goods and services will be continually imported in the long term.

Antecedents of empirical literature on the dynamics of Argentine imports

These results contribute to the literature focused on the empirical evidence of price and income elasticity of Argentine imports. Carmen Reinhart (1995) estimated, through Johansen's cointegration methodology for 12 developing countries, Argentina among them, the income and the price elasticities, respectively, between the years 1970 and 1992. She obtained result values of 1.09 and -0.467.

Taking into account the possible non-stationarity of the macroeconomic series used. Abdelhak Senhadji (1998) estimated the price and income elasticities for a series of countries, Argentina among them, between 1960 and 1983. Obtaining a of result 0.8 and -0.64, respectively for the estimation by ordinary least squares, 0.70 for the income elasticity and 0.68 for price elasticity using an estimator modified by the Monte Carlo method.

Catão and Falcetti (2002) also found stationarity of the series using the Johansen's cointegration method; they obtained an income elasticity of 2.42 and elasticity to the exchange rate of -0.79 for the period between 1980 and 1997.

Heymann and Ramos (2003), following Engle and Gragner's methodology and through the estimation of a regression of cointegration, obtained an income elasticity of imports of 3.68 and a price elasticity of -0.61, for the period 1975-200.

Similar results are provided by Bus and Nicolini Llosa (2007). The authors described the demand of aggregate imports for different periods of the Argentine economy between the years 1970 and 2007, applying Engle & Granger's ordinary least squares and Johansen & Juselius' Maximum Verisimilitude together with the Error Correction model, to obtain price and income elasticities for the long and short term. They obtained that price elasticity varies between -0.37 and -0.44 and income elasticity between 1.46 and 3.81.

Duarte, Nicolini-Llosa and Paya (2007) used ordinary least squares with the procedure of Engle-Granger, for the period 1970-2005, and they obtained an income elasticity of 3.52 and a price elasticity of -0.36. On the other hand, using Johansen-Juselius' maximum verisimilitude method, they obtained income and price elasticities of 3.29 and -0.56, respectively.

Through an Error Correction Model (ECM), Berrettoni and Castresana (2008) determined that an increase of 1% of the exchange rate produces a drop of 0.34% in aggregate imports, while an increase of the level of activity of 1% produces a rise in imports of 2.76%, for the period 1993-2008.

The rest of the work is organized as follows. Section IIA describes data used. Section III deals with the endogeneity problem. Section IIIB describes the empirical strategy used: a recursive estimation of price and income elasticities of imports. Section IV presents an analysis of the VEC model. Section V presents a recursive estimation and finally, in section VI we present our conclusions.

Table 1: Empirical bibliography for Argentina

Work	Explanatory variables	Sample	Conclusions (price elasticity and income elasticity)
Carmen Reinhart (1995)	Real Exchange Rate, Gross Domestic Product	1970-1992	(1.09 ; -0.467)
Abdelhak Senhadji (1998)	Real Exchange Rate, Gross Domestic Product	1960-1983	(0.8; -0.64)
Catão and Falcetti (2002)	Real Exchange Rate, Gross Domestic Product	1980-1997	(2.42; -0.79)
Heymann and Ramos (2003)	Real Exchange Rate, Gross Domestic Product	1975-2001	(3.68; -0.61)
Bus and Nicolini Llosa (2007)	Real Exchange Rate, Gross Domestic Product	1970-2007	(1.46 y 3.81;-0.37 y --0.44)
Duarte, Nicolini-Llosa and Paya (2007)	Real Exchange Rate, Gross Domestic Product	1970-2005	(3.52; -0.36)
Berrettoni and Castresana (2008)	Real Exchange Rate, Gross Domestic Product	1993-2008	(2.76; -0.34)

Source: Own elaboration.

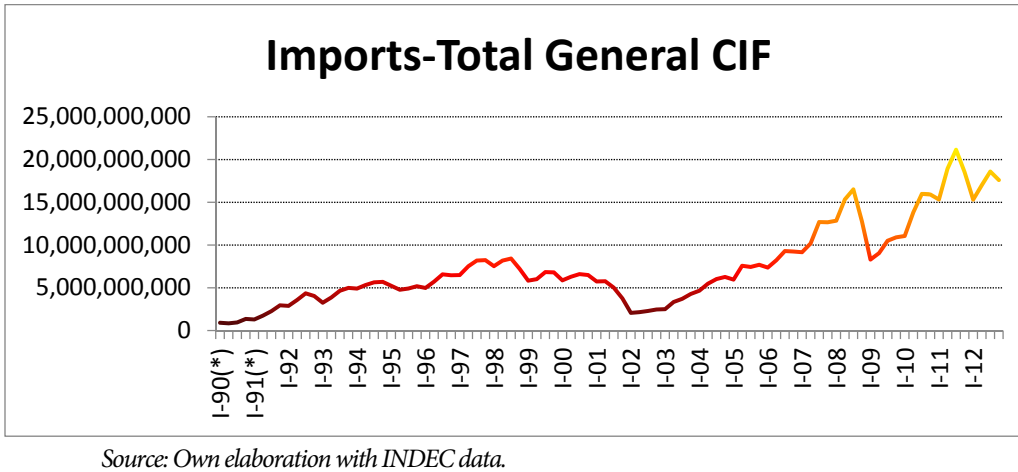
IIA. Data and specification

This section analyzes price and income elasticities of imports in Argentina and their evolution throughout time.

In this research we use quarterly aggregate imports and disaggregated imports per economic use, namely: Capital Goods, Intermediate Goods, Fuels, Parts and Accesories of Capital Goods, Consumer Goods and Motor Vehicles for passengers, from INDEC. All data shown is in millions of dollars at CIF prices.

Figure 1 shows the historic series of aggregate imports taken from INDEC, in millions of dollars at CIF prices.

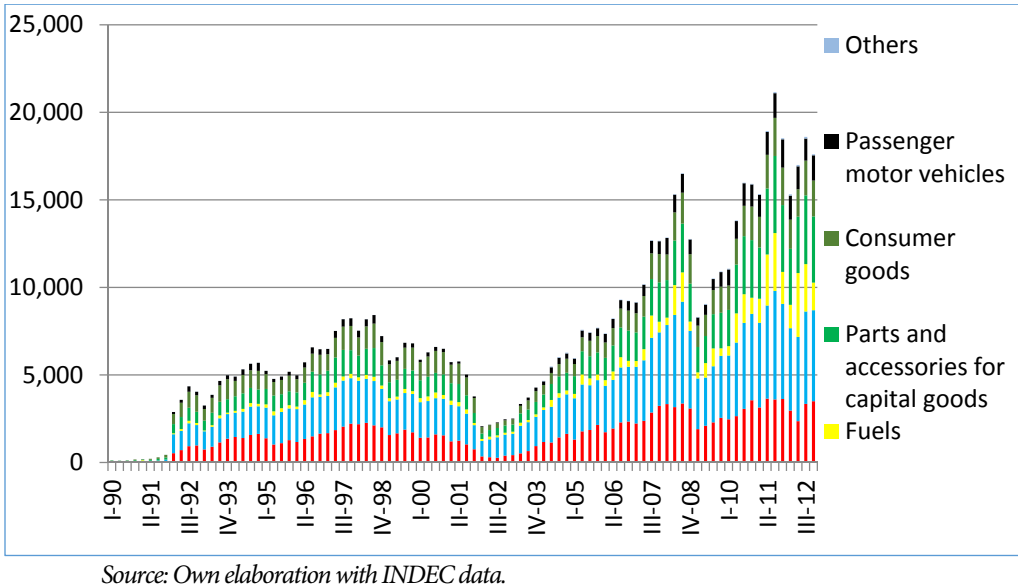
Figure 1: Evolution of imports at CIF prices 1990: I-2013:I



Source: Own elaboration with INDEC data.

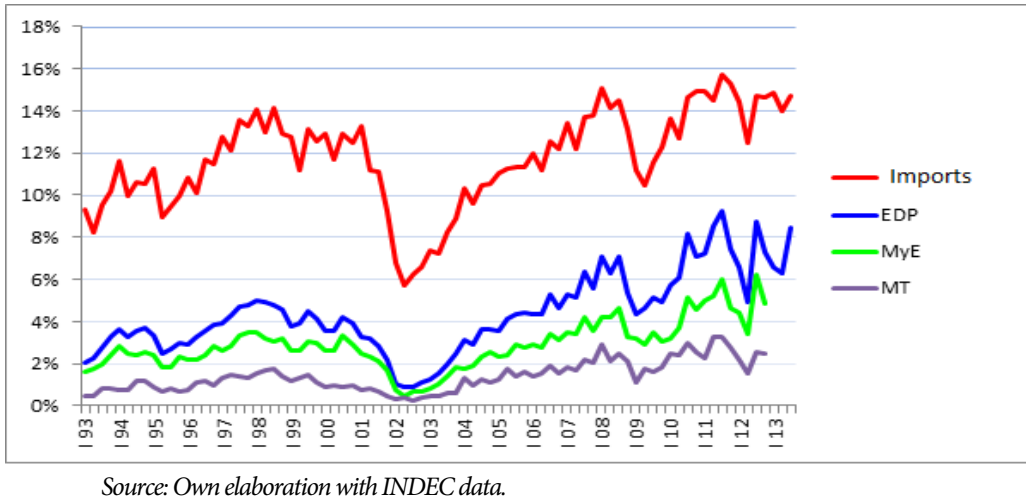
Figure 2 presents the composition of imports by economic use for the period 1993-2013. From the Figure it can be observed there are not many variations through the period, except for the case of fuels, which have increased their proportion in the total imports during the last years. Particularly, the relative participation in total imports of each component is: Intermediate Goods 30%, Capital Goods 20%, Parts and Accesories of Capital Goods 21%, Consumer Goods 21%, Fuels 9% and Motor Vehicles for passengers 8%.

Figure 2: Composition of imports 1990: I-2013: I



Source: Own elaboration with INDEC data.

Figure 3: Evolution of imports between 1993: I-2013: I



Source: Own elaboration with INDEC data.

Figure 3 shows imports by component from INDEC and total imports in the GDP, in millions of pesos at purchaser prices for the year 1993. Total imports (M), Durable Production Equipment (EDP), Machinery and Equipment (MyE) and Transport Material (MT). It can be observed that the relative participation of each component in the GDP has constantly increased since the

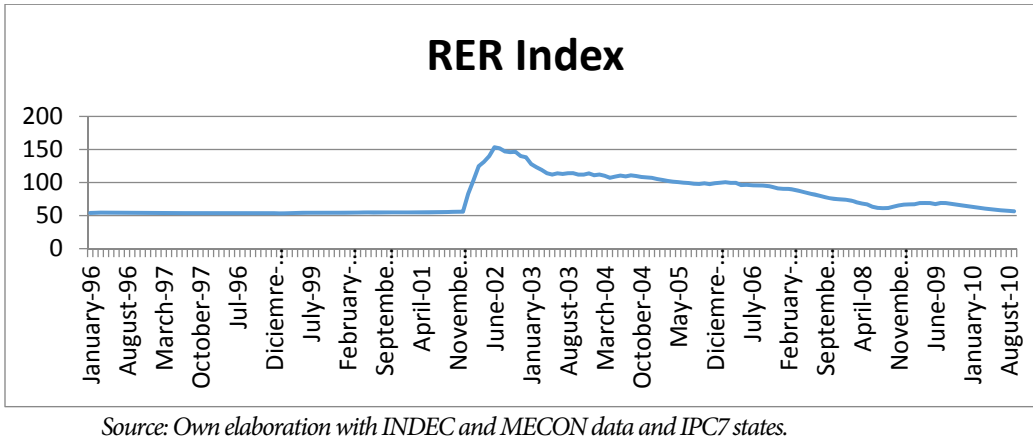
devaluation of 2002. Its participation went from 7%, 1%, 1% and 0.42% in the fourth quarter of 2002 to 15%, 7%, 5% and 2% respectively in the fourth quarter of 2012.

So far, all the variables at constant prices have been used. The variables of the econometric series used in this work will also be used at constant prices.

On the other hand, in all the estimated equations the same variable will be used as proxy of imports demand, that is to say, the series of the gross domestic product at 1993 constant prices, from INDEC.

Additionally, series of nominal exchange rate from INDEC were used as proxy of variation of relative prices, deflated by the price index of 7 provinces. That is to say, we built a series of real exchange rates between 1993 and 2003. Figure 4 shows the real exchange rate index for imports between 1993 and 2013.

Figure 4: Evolution of Real Exchange Rate 1991: I-2013: III



Source: Own elaboration with INDEC and MECON data and IPC7 states.

Summary of the data used can be seen in table 2.

Table 2: Summary of the data.

Variable	Initials	Description	Source
Aggregate Demand	GDP	Natural logarithm of the gross domestic product from 1993 to 2013	National Institute of Statistics and Census (INDEC)
Aggregate Imports	M	Natural logarithm of the domestic aggregate imports from series from 1993 to 2013	National Institute of Statistics and Census (INDEC)
Real Exchange Rate 1993-2013	RER	Natural logarithm of the nominal exchange rate deflated by the CPI seven provinces from 1995 to IV-2012.	National Center for International Economy (CIS) and CPI seven provinces.

Source: Own elaboration.

III. The problem of endogeneity

In this section, we detail the identification strategy. Said strategy is defined as the way in which the data observed in certain variables will be used to approximate an experiment (Angriest and Krueger (1999)), as well as the way to achieve statistical inference (Rubin (1991)).

According to the simplest traditional economic theory, the quantity of foreign goods demanded in an open economy depends on income and real exchange rate (Houthakker-Magee (1969), Thirlwall (1979), Krugman (1988)). Firstly, as product and income remain the same in an open economy, the higher the level of the product, the higher will be the demand of imports. In other words, there is a positive income effect on the imports demand of a country, even when relative prices between national and imported goods remain constant.

Secondly, the demand of imports depends on the real exchange rate. Keeping in mind that real exchange rate is defined as the price of foreign goods in terms of domestic currency, then, a greater real exchange rate implies a rise in prices of foreign goods as related to domestic ones, discouraging demand of the first and encouraging demand of the second ones. This means that there is an inverse effect (substitution effect) between variations of real exchange rate and demand of imports. (Catao y Falcetti (1999) and Jaime Márquez (1995))

The previous macroeconomic relations can easily be expressed in mathematical terms. In fact, we have a function of imports that depends, on the one hand, positively on income, and on the other hand, negatively on the ratio of the relative prices mentioned:

$$M = f\left(Y, \frac{P_i}{P_j}\right) \qquad (1)$$

Where M are imports; Y gross domestic product (GDP), Pi is the price of the imported good, and Pj is the price of the national substitute good.

To avoid the problem of identification, it can be supposed that the demand curve has a constant elasticity through all its points (see Murray and Ginman (1976)); the equation (1) can be rewritten as:

$$M = A\left(\frac{P_i}{P_j}\right)^{\alpha 1} Y^{\beta 1} \qquad (1.2)$$

Where α1 is the price elasticity of the demand of imports and β1 is the income elasticity.

Historically, the price elasticity (the parameter α1) was more empirically studied, but given the importance of the first one (income elasticity) for imports demand, it cannot be ignored, as a great number of works on income elasticity has already proved (Neisser and Modigliani (1953); Polak (1954); Johnson (1958); Houthakker and Magee (1969); Leamer and Sterm (1970); Murray and Ginmam (1976), Goldstein and Kahn (1985); Dornbusch (1988); Hopper and Marquez (1993); Carone (1996); Muinhos y Alves (2003); Sapienza (2007)).

Empirical studies of said elasticities have a double significance. On the one hand, to find empirical evidence for the economic theory, particularly for the function of imports demand previously shown. On the other hand, the behavior of trade flows, among them the imports flows, before income variation and relative prices, is relevant to policy makers.

This being said, it is important to analyze the functional form of the demand of imports and not only the variables and the restrictions that must be included.

Therefore, equation (1.2) succeeds in capturing the two main effects that influence the demand of imports, income and relative prices. When using logarithmic variables to estimate (1.2), β1 and α1 represent the elasticities of imports before changes in income and relative prices respectively. As there will be analyses of structural change, in the case variables must be differentiated, β1 and α1 will represent proportional changes.

Finally, as it was previously mentioned, β1 is expected to be positive and α1 negative.

In the second place, the simultaneous reaction between the variables that form the equation (1.2) cannot be discarded *a priori*. For one thing, the Argentinian productive structure is highly dependent on imports. This is not only a particular structural characteristic of the Argentinian economy, but of every capitalist economy, the ones that do not possess the necessary goods for the development of the productive process. Besides, the traditional economic theory affirms that prices variations of domestic and imported goods may affect the levels of the product.

In other words, the imports and the relative prices may have significant explanatory effects on variations observed in the GDP. That is, *a priori*, GDP may also be an endogenous variable, and not an exogenous one.

In this case, the equation (1.2) can be rewritten as:

$$y_t = a_2 + \beta_2 * m_t + \alpha_2 * \left(\frac{P_{it}}{P_{jt}}\right) + u_{1t} \qquad (2)$$

Where u1t is a stochastic process of the white noise kind, with medium and constant variance.

In the third place, as in the traditional theory, relative prices are jointly determined with the levels of the product, said prices can be considered as an endogenous variable influenced by the national supply and foreign imports. Therefore, equation (1.2) can also be rewritten as:

$$\frac{P_{it}}{P_{jt}} = a_3 + \beta_3 * y_t + \alpha_3 * m_t + u_{2t} \qquad (3)$$

Where u2t is a stochastic process of the white noise kind, with medium and constant variance.

We can conclude saying that, *a priori*, there are endogenous variables to both sides of the equation (1.2). Therefore, as there is more than one causal relation of interest derived from simultaneity, the experiment that will be conducted to capture the mentioned causal effects consists in estimating a VAR model with the following reduced form:

$$X_t = 1X_{t-1} + 2X_{t-2} + \cdots + kX_{t-k} + BZ_t + u_t \quad (4)$$

Where Xt, is a column vector that contains the three variables mentioned (imports, exports and ratio of relative prices), Xt-i is a column vector with the three mentioned lagged variables, for i=1,2,…,k; Zt is a vector of exogenous deterministic variables; βi, B are the matrices of regression coefficients to estimate, for i=1,2,…,k and ut is the vector of innovations of the white noise kind, which are not serially correlated.1

From said vector model we can derive a structural dynamic model. In this way, we have a model of simultaneous equations with the only peculiarity that its three variables are endogenous. A random shock in pit/pjt through a value different from zero in u2t affects directly pit/pjt, but also influences on yt and mt through the presence of pit/pjt as explanatory variable in the first and in the second equation. Additionally, we have an effect that propagates through time due to the presence of lagged values as explanatory variables.

The previous model presents two difficulties for its estimations by Ordinary Least Squares (OLS). Firstly, as all the variables appear in every equation (simultaneity) the estimator would be inconsistent. Even when assuming that the error terms are not correlated, estimation by OLS remains inconsistent as we are dealing with a dynamic model (Novales, 2013). To avoid difficulties, a transformation of the VAR kind can be performed to estimate in a consistent way by OLS (Hamilton, 1994; Novales, 2013)1.

To summarize, when using a VAR model every variable is treated symmetrically as well as explained by the past value of every one of them. That is to say, there are as many equations as number of variables in the model, and lagged values of each of them are included as explanatory variables. Thus, not only specification errors and subsequent restrictions resulting from the empirical model can be avoided, but also the problem of identifying variables as exogenous, that form a model of simultaneous equations, can be solved. (Novales, 2013).

IIIB. Empirical strategy

To carry out an empirical analysis on the relation between real exchange rate (RER) and gross domestic product (GDP) with imports (M), we use the series of said variables for Argentina between 1993 and 2003, controlling the existence of unit roots and structural change. Thus, it is possible to capture the marginal impact of variations in RER and GDP in the imported quantities in a robust way (Engel and Granger, 1987; Lee and Strazicich, 2003).

The first regression strategy used is based on the approach followed by Reinhart (1995) and the recommendations from Novales (2013) when simultaneity occurs in a group of variables. In order to avoid specifications problems of the VAR model that may cause spurious regressions, before the possible existence of unit roots (and cointegration relations), we employ the Engel and Granger Theorem (1987) and incorporate a cointegration analysis (Johansen, 1988).

Particularly, Figures 1, 3 and 4, suggest that there are structural breaks resulting from the devaluation of 2002. Therefore, we need to explore the existence or non-existence of unit roots in the series of imports, gross domestic product and real exchange rate through an Augmented Dickey-Fuller test (ADF). Results of ADF test can be seen in table 3.

Table 3: Augmented Dickey-Fuller test

	Y	M	MRER
Augmented Dickey-Fuller test statistic	0.93	-1.44	-1.18
Test Critical Value 1%	-3.51	-3.51	-3.51

Source: Own elaboration with Eviews.

Additionally, in order to control possible structural breaks in the series, we decided to examine the existence of unit roots through Lee and Strazicich's test (LS) and Zivot and Andrews' (ZA). They explicitly consider the possibility of structural breaks in the series, unlike the ADF test that disregards said breaks. In this way, biased results from the unit root test can be avoided (Lee and Strazicich, 2003).

Results from LS and ZA tests are shown in table 3b and 3c.

In brief, using Johansen's methodology, the annual growth rate of imports will be expressed as a function of the growth rate of the real exchange rate and of the quarterly growth rate of GDP, from MECON, INDEC and the IPC7 provinces data.

The equation for the estimation has the following structure:

$$m_t = a + \beta_1 * y_t + \alpha_1 * (rer_t) + u_t \qquad (5)$$

Table 3b: LS test

	Change in intercept		Change in intercept and trend		
Variable	Statistical t and date	Decision	Statistical t and date	Decision	Result
M	-3.0785 2001-IV	I(0)	-1.1844 2001-III	I(0)	Acceptance H0
Y	2.6276 2010-I	I(0)	-4.5748** 2001-IV	I(1)	Rejection H0
RER	6.1257*** 2002-I	I(1)	6.4327*** 2001-IV	I(0)	Rejection H0

Source: Own elaboration with Winrat.

	Change in intercept		Change in intercept and trend		
Variable	Statistical t and date	Decision	Statistical t and date	Decision	Result
M	-3.1787* 2001-IV	I(1)	0.3720 2001-III	I(0)	Rejection H0
Y	2.7444 2010-I	I(0)	-0.1115 2001-IV	I(0)	Acceptance H0
RER	6.4677*** 2002-I	I(1)	7.6942*** 2002-I	I(0)	Rejection H0

Source: Own elaboration with Winrat.

Table 3c: ZA Test

RER (RER)		
	Critical Value	Date
Zivot-Andrews Break in Trend Model	-3.08847	2005-III
Zivot-Andrews Break in Intercept	-5.60276***	2002-II
Zivot-Andrews Break in Intercept and Trend Model	-9.52272***	2002-II
GDP (PBI)		
	Critical Value	Date
Zivot-Andrews Break in Trend Model	-3.83296	1999-I
Zivot-Andrews Break in Intercept	-2.66513	2002-III
Zivot-Andrews Break in Intercept and Trend Model	-5.48358**	20014-IV
Total Imports (M)		
	Critical Value	Date
Zivot-Andrews Break in Trend Model	-3.26563	2003-II
Zivot-Andrews Break in Intercept	-3.62645	2001-II
Zivot-Andrews Break in Intercept and Trend Model	-4.78134	2001-IV

Source: Own elaboration with Winrat.

Where (m_t) expresses the real growth of imports for Argentina in period t, (y_t) is growth of the gross domestic product of Argentina in period t and (rer_t) is growth of the real exchange rate for Argentina in period t. The coefficient (β_1) expresses the effect of a variation in the GDP in the imported quantities, when the real exchange rate is left constant. While the coefficient (α_1)

expresses the effect of a variation of the real exchange rate over the imported quantities, when the GDP remains constant.

When the Johansen test (1988, 1991) is used to obtain homoscedastic and non-correlated errors, we will need to employ Dummies in the VAR models.

Finally, the VAR model is complemented by using an alternation of Markovian schemes as classic non-cointegration test results are not valid in the presence of structural breaks in the relation of cointegration (Gregory y Hansen 1996) and so biased results are obtained. This means that the probability of rejecting the non-existence of cointegration increases in the presence of structural breaks in the series (Leybourne e Newbold, 2003; Cook, 2004).

The second strategy of regression consists in identifying factors that could affect the price elasticity of Argentine imports. If evidence of non-linearities and structural breaks were found in the data used, results from VAR would not be robust; so in order to solve this issue the same function can be estimated allowing the alternation of Markovian regimes.

There is a considerable body of literature about Markovian regimes discussing the alternation of regimes (Goldfeld and Quandt, 1973, 1976; Maddala, 1986; Hamilton, 1994; Frühwirth-Schnatter, 2006).

Supposing that the random variable of interest "y" follows a process that, in turn, depends on the value of a variable of a non-observed discrete state variable. It is supposed that there are M possible regimes, and it is said that, it is in the state or regime "m" in period "t" when $s_t = m$ for $m = 1, \dots, M$. The commutation model assumes that there is a different regression model associated to each regime.

In other words, many variables present series whose behavior may stressfully vary. For example, Figure 4, shows how the series of real exchange rate presents a break in the year 2002. According to Hamilton (1994), it is possible to affirm that similar breaks can be found in the time series of other macroeconomic and/or financial variables, if they are observed for a long period of time. Said changes may be the result of political decisions, wars, financial panic, and the like.

Briefly, the advantage of using Markov processes to explain changes in the data generating process is twofold. In the first place, having in mind a change of regime as the one observed in the series of real exchange rate, and considering that it could be an absorbing state, meaning that the change of regime may be permanent, the Markov processes will allow generating significant forecasts prior to the change of state (Hamilton, 1994).

In the second place, the required model of temporal series will allow accounting for unusual events of short duration as early affidavits, temporal restrictions to imports, changes of economic policies, changes in consumers' tastes, among others.

In concluding, the analysis through Markov processes complements the analysis through the Johansen's methodology, and adds flexibility. Meaning that it is consistent with a wide range of results, estimating parameters based solely on data (Hamilton 1994).

IV. VEC and parameters in the long term

A VAR model is estimated with the same variables. In order to determine the optimal lag length of VAR that allows ensuring that errors are white noise (WN), the statistical of likelihood ratios (LR) based on the Akaike Information criterion (AIC), Schwarz Information Criterion (SC), Hannan Quinn Information Criterion (HQ) and Final Prediction Error (FPE). (Johansen, 1988)

Observing the roots of the characteristic polynomial where endogenous variables are "y" and "rer", the exogenous variables are "a" (constant) and dummy variables (Di) (for the second, third and fourth quarter of the year 2002, fourth quarter of 2008 and first quarter of 2009), it follows that all the eigenvalues are minor than 1, that is to say, all of them fall inside the unit circle, and therefore, the system is stable and stationary. (Johansen, 1988)

An alternative scheme to the VAR formulation is that in which, imports of a period would not only depend on the explanatory variables values for the same period, but also for past ones. According to the Wald test, the first two lags have a significant impact on the VAR system. Thus, the null hypothesis is rejected for Lag 1 and Lag 2, which affirms that coefficients of delays are jointly non-significant (different from zero) and the alternative hypothesis is accepted. That is to say, the delays coefficients are jointly and significantly different from zero.

Then, different criteria were calculated: LR, FPE, AIC, SC, HQ to select the optimum length of the delay that will be used in the cointegration test. The best model is that which minimizes the criterion of information, or that maximizes the statistical LR. According to the AIC and the LR (Johansen, 1988), the lag quantities that must be included are 4.

The multivariate statistical Q of Box-Pierce/Ljung-Box is calculated where the null hypothesis indicates absence of autocorrelation up to delay h. The likelihood values indicate that remnants are white noise after the fourth delay.

The Lagrange Multiplier test (LM) is used to determine if there is correlation in remnants up to certain order. That is to say, the null hypothesis poses the absence of autocorrelations up to the delay of order h. The LM test indicates that there is correlation up to lag number 3. See table 4.

Table 4: Autocorrelation test in residuals

Lags	LM statiscal	P-value
1	29.018	0.023
2	21.610	0.156
3	24.153	0.086
4	15.412	0.494
5	11.488	0.778
6	10.997	0.809
7	25.407	0.062
8	17.436	0.357

Source: Own elaboration with Eviews.

On the other hand, as previously seen, evidence of the existence of structural breaks were found through LS and ZA unit root tests in the series of imports, for the years 2001 and 2002, and in 2008 and 2009, as well.

Johansen's method considers the following tests to determine the number of vectors of cointegrations: the trace test and the maximum eigenvalue test. The null hypothesis for these two tests is that there are no cointegration vectors. According with the trace test, the null hypothesis (of non-integration) is rejected in favor of a cointegration relation at a 5% level. The eigenvalue test indicates the existence of a cointegrated equation at 5%. Therefore, with the results of the trace test and the eigenvalue test, it is concluded that there are two vectors or relations of cointegration. See table 5.

Additionally, structural breaks of cointegration were found in the cointegration relation through the Gregory-Hansen test. Therefore, we reached a model with 4 lags, including dummy variables

(for the second, third and fourth quarter of the year 2002, fourth quarter of 2008 and first quarter of 2009), to incorporate the structural break in the series and the cointegration relation.

Table 5: Cointegration Test

λ_i	*Ho:r=p*	Λ_{max}	95%	Λ_{traza}	95%
0.417	p = = 0	43.746	28.588***	76.972	54.079***
0.246	p <= 1	22.897	22.299**	33.225	35.192
0.083	p <= 2	7.0732	15.892	10.327	20.261
0.039	p <= 3	3.2545	9.1645	3.2545	9.164

Source: Own elaboration with Eviews.

Then, we obtained the aggregate cointegration relations, estimating the following model for the period 1993-2013:

$$Mt = a + \Theta * log\, Yt + \varrho * logRERt + \Pi * Di + et \qquad (6)$$

Mt is the growth rate of imports in period t, Yt is the growth rate of product in period t, RERt is the growth rate of real exchange rate in period t, Θ is the income elasticity of imports and ϱ is the price elasticity correspondent. Finally Di contains the Dummy variables previously mentioned.

Using data from MECON without adjusting, it is seasonally adjusted with X12 ARIMA filter for imports (M), the GDP (Y) and the RER. The logarithm is applied to work with growth rates and to analyze the correspondent elasticities.

As it is shown in Table 6, the cointegration relations found, as in the already mentioned literature, present high income elasticity (1.69) and low price elasticity (-0.29) of imports.

Table 6: Cointegration Test

Variable	Coefficient	Standard Errors
GDP	1.69***	0.08348
RER	-0.29***	0.04801

D2002-2	0.194***	0.31286
D2008-4	0.20967	0.11080

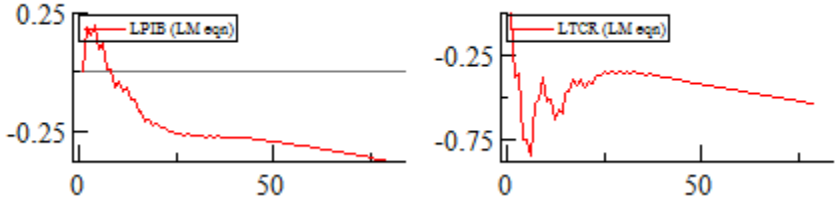
Source: Own elaboration with PC-Give.

From here arises the option of examining biases of endogeneity of the specifications, based on the existence of a unique cointegration vector through the analysis of the structural VAR impulse-response function.

In the following Figure it is observed the impulse-response function, which shows the reaction (response) of the explained variables in the system in front of changes in the explained variables. A change (shock) in a variable in the period i will affect directly the variable and it will be transferred to the rest of the explained variables through the dynamic structure that represents the VAR model.

The impulse-response function of VAR corroborates the previous results and indicates a negative impact of the real exchange rate over imports and a positive impact of the income that decreases in the long term as it can be seen below:

Figure 5: Response of imports to the impulses of the exchange rate and gross domestic product.



Source: own elaboration with PC-Give.

V. Recursive estimation

As follows it is observed the recursive estimation, which consists in the sequential estimation of different parameters of the specified model for different sizes. It is used to analyze the stability of a model when the moment in which the structural break occurs is not known.

In each estimation, we obtain a vector of estimated parameters that at the same time allow the calculation of the prediction of the endogenous variable for the next period.

In this way, with the successive estimations, the series of the "recursive coefficients" is generated. If there is no structural breack, it is expected that the estimations of the parameters are kept essentially constant when increasing the sample in a sequential way.

The estimation of coefficients θ and ϱ can be performed in a recursive way. This allows the analysis of the evolution of the estimated coefficients through time and the observation of increases or decreases suffered through the same period of time. In these estimations, if no structural shock occurs, estimations of the parameters remain constant.

Figure 6 presents recursive estimations, where LGDP is income elasticity of imports (coefficient θ in the equation 6) through time and LRER is price elasticity of imports (coefficient ϱ in equation 6).

Figure 6: Recursive Estimation

Source: Own elaboration with PC-Give.

The coefficient of income elasticity (LGDP(sm)) shows a decreasing tendency before 2002 and a constant tendency through all the remaining period. While the coefficient of price elasticity LRER showed a negative tendency after 2002 and before the 2008 crisis, it reversed its tendency from 2009 onwards.

Results of Markovian Regimes

In order to control the existence of more complex non-linearities, besides the already mentioned structural breaks in the data obtained by the EG and GH, a Markovian model for regimes alternation is estimated. Said models allow the existence of more than one structural break in the relations among variables. This means that possible structural changes in the parameters through time are taken into account. Therefore, said estimation adds robustness to the results obtained through the cointegration analysis.

Particularly, the existence of structural breaks in cointegration relations affects the application of conventional exogeneity tests, obtained from the specification of a well behaved error-correction model and a constant cointegration vector(s) obtained from Johansen's conventional analysis.

In Table 9 it can be observed how the elasticity of imports to the real exchange rate has significantly changed between the considered regimes. That is to say, observing Figure 7, price elasticity increases in the period going from the 2002 devaluations to the year 2009. It is a result that goes in the same direction that the one found with the recursive analysis of the coefficients previously performed.

There was a real devaluation between the regimes considered. In this sense, according to the approach of Markovian regimes, we can suggest that structural changes previously found can have affected price elasticity of imports.

The likelihood of transition can be observed in table 10.

Table 10: Transition probabilities

p_{0|0}	0.958
p_{0|1}	0.035

Source: Own elaboration with PC-Give.

All the previous models, therefore, reach the same conclusion, namely, that both demand and exchange rate are significant when determining total imports, but the latter has little effect in relation to the former.

VI. Conclusions

As was analyzed in this work, identification of shocks of exchange rate and GDP on imports has been dealt with from different approaches, although no consensus has been reached yet regarding

the data generator process to be estimated. In this thesis, we carried out a methodology developed by the London School of Economics, which can account for the exogeneity problems, structural breaks and model specifications.

As there exists the possibility of finding simultaneity and long-term relationships between imports, real exchange rate and gross domestic products, a model of auto-regressive vectors (VAR) was used to characterize de simultaneous relationships of said variables. A VAR is a model of simultaneous equations consisting of an equation system in a reduced form (in each of them there appears the same explanatory variables) without restricting where the group of explanatory variables of each equation is given by the lag of all the variables in the model. Furthermore, dummy variables were included for the quarters where a structural break was detected.

Using this methodology, we avoided two problems. On the one hand, by not imposing restrictions in the structural form of the model, specification errors that may have resulted from empirical exercises were avoided. On the other hand, the problem of identification was solved regarding the difficulty of identifying variables as exogenous variables.

Likewise, the problem of getting no solid results from VAR model estimations, using series with structural breaks, was resolved using alternation models of markovian schemes. In this way, the analysis of the VAR model was complemented, which allowed us to get more solid results.

In such a way, the methodology used throughout this work allows us to examine these problems in a more reliable way as compared to how they were examined in the already mentioned literature for Argentina, and thus obtain consistent estimations.

The strategy was applied to the Argentinian economy for the period 1993-2013 and it resulted in the estimations presented in section 5 that corroborate the central hypothesis of this article: that is, considering the fact that in Argentina income *elasticity of imports* is high and exchange rate *elasticity of imports* is low, the elasticity of imports is explained because the imported goods are not easily replaceable when the real exchange rate is depreciated.

The conclusion is that the dynamic characteristics of the estimated model are diversely supported by the conventional economic theory. Therefore, results from the estimation help us to contrast theoretical models with reality, and shed light on the impact of foreign trade policies on the external account.

We can enumerate, not exclusively nor exhaustively, three possible explanations for the low elasticity of imports in front of variation of real exchange rate.

Firstly, low price elasticity of imports may be due to the slowdown of the international trade expansion. While trade expanded during the 90s, as a consequence of the fragmentation of the international production in global value chains, it diminished in the year 2000 once said process started to slow down (Constantinescu, 2015).

Secondly, the trade policy can have become more sensitive to variations in the exchange rate of other trade partners. Bown and Crowley (2012) found evidence in the temporary barriers to trade as the anti-dumping measures and compensatory rights that can be fixed before said movements in the exchange rate.

Thirdly, pass-through may have been reduced in the last years. That is to say, movements in the exchange rate can be absorbed by importer companies through variations in its mark-ups (see for example (2012), Amiti (2014) and Chen and Juvenal, (2014)). Additionally, if the importer company is increasingly important in the global trade, the international trade will be less insensitive to variations of exchange rate.

We conclude that the dynamic features of the estimated model are diversely supported by the conventional economic theory. Therefore, results of estimation help to contrast theoretical models with reality and shed light on the impact of foreign trade policies on the balance of payments.

Anyhow, results presented in this work suggest that aggregate imports in Argentina represent a structural problem that will be hardly corrected in the short term relying exclusively on real exchange rate variations.

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Appendix A

Table 1: Abstract of data

Variable	Abbreviation	Description	Source
Aggregate demand	GDP	Natural logarithm of the series of the gross output from 1993 to 2013	INDEC (National Statistics and Censuses Institute)
Aggregate imports	M	Natural logarithm of the series of domestic aggregate imports from 1993 to 2013	INDEC (National Statistics and Censuses Institute)
Real exchange rate 93-13	RER	Natural logarithm of the nominal exchange rate deflated by ipc 7 provinces from 1993 to 2013.	DNCEI (National Directorate Centre for International Economy) and IPC7 provinces.

Source: Own elaboration.

Table 4: Autocorrelation test in residuals

Lags	LM statiscal	P-value
1	29.018	0.023
2	21.610	0.156
3	24.153	0.086
4	15.412	0.494
5	11.488	0.778
6	10.997	0.809
7	25.407	0.062
8	17.436	0.357

Source: Own elaboration with Eviews.

Table 8: Tests

LR Linearity test	84.23***
Normality test	4.76
Portmanteau test	30.06
ARCH test	0.55

Source: Own elaboration with Eviews.

Table 9: Markovian schemes

	Scheme 1		Scheme 2	
Variable	Coefficient	Std.Error	Coefficient	Std.Error
GDP	2.045	0.028	1.984	0.030
RER	-0.240	0.017	-0.314	0.017
D2002-1	-0.071	0.042	-0.1192	0.042

Source: Own elaboration with PC-Give.

Table 10: Transition probabilities

p_{0|0}	0.958
p_{0|1}	0.035

Source: Own elaboration with PC-Give.