Real Exchange Rate Volatility and Exports: Argentine Perspectives*

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Abstract

The present paper deals with the link between real exchange rate (RER) volatility and exports in the case of Argentina. Extensive theoretical work on this matter is not conclusive. Empirical research may thus contribute to disentangle the existing uncertainties on this topic. The focus and the findings of this trend of literature may be of interest for the conduct of economic policy, whereas in view of questions such as trade integration and export performance, macroeconomic sustainability, or the controversies on the optimal exchange rate regime (fixed or flexible). This is more so in the case of Argentina and Latin America that have shown for long extremely high levels of economic volatility. The empirics of this topic are discussed in view of the twofold dimension of trade relations: the impact of intra-regional (with Brazil) and extra-regional (with the rest of the world) RER volatility on intra and extra-regional exports. Volatility matters for exports in Argentina: reducing RER volatility (intra-region or extra-region) has a positive impact on exports to Brazil but a negative impact on sales to the rest of the world. This trade-off increases when the reduction in volatility falls on the intra-regional RER volatility. Indeed, if Argentina is committed to deepen commercial integration with Brazil the coordination of exchange rate policies should not be excluded.

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1 Introduction and motivation

Argentina, like many Latin American countries, is a highly volatile economy, with most macroeconomic variables (inflation, nominal exchange rates, GDP, etc.) exhibiting significant fluctuations in the last decades. However, it is only recently that researchers became interested in the economic consequences of volatility for developing countries. Economic instability may lead to perverse and dysfunctional effects on the economic performance of these nations. Aizenman and Marion (1999) study the incidence of government consumption and monetary growth volatility on private investment, showing a negative impact. Serven (2002) studies the impact of real exchange rate (RER) volatility on private investment, and finds a negative relationship. Lensink and Morrissey (2002) discuss the role of FDI volatility in developing countries detecting a detrimental effect on growth. This line of research is extended by studing the relation between RER volatility and intra-regional (Mercosur) as well as extra-regional exports of Argentina, a subject hardly explored in the empirical literature of this country.

The theoretical literature on the impact of unexpected movements in the exchange rate on trade and the resulting demand for stable anchors (exchange rate fixing) have long been a highly debated topic among economists. Traditional models examined the exchange rate volatility effect on trade based on the producer theory of the firm under uncertainty, where firm profitability is related to the movements of the exchange rate. Some theoretical models point to a positive relationship. Baron (1976) shows how an increase in exchange rate volatility may not necessarily lead to an adverse effect on the level of trade when hedging opportunities exist. Furthermore, some authors have shown that an increase in exchange rate volatility may be beneficial for trade (De Grauwe, 1988; Franke, 1988). The most obvious case it that in which exporters are risk-lovers. But De Grauwe (1988) showed that, when exporters are sufficiently risk-averse, a positive relationship may still arise. Very risk-averse firms will worry about the worst possible scenario. When risk increases, the way to avoid a drastic decline in export revenues is by increasing the export volume. Franke (1988) highlights that volatility may increase exports if it also associated with an increase in the real exchange rate level.

In contrast, other studies show that unexpected changes in the RER may have a negative impact upon decisions made by risk-averse exporters (Baron, 1976). De Grauwe (1988) highlights a political-economy argument: sizable RER volatility may trigger trade restrictions, raising the costs of trading and damaging trade. In the case of a trade agreement, a devaluation of the currency of a member country may be perceived as opportunistic behavior and may trigger protectionist responses and potentially negative political dynamics for the integration process may thus arise.[1]

Apart from these direct effects of volatility, it is also relevant to account for the possibility of *third country effects* (Cushman, 1986). Exports to one region are not only affected by its bilateral *RER* level and volatility (direct effects), but also, by those of other countries or regions (indirect or substitution effects). Dell'Ariccia (1998) in a simple set up assumes that a country is exporting to two regions j and k and that exchange rate variability increases with both of them. If there is a larger increase in volatility with country k, there is a reduction in the relative risk of trading with country j, that may imply a reallocation or substitution of exports from country k to country j. Cushman thus argues that not only absolute but also relative volatility matters.

The study of the relative benefits of fixing the local currency -and the choice of anchor- deserves attention in the decision making process leading to the adoption of an appropriate exchange rate system. So far, the costs and benefits of currency coordination and common currencies have been discussed on the basis of the theories of Optimal Currency Areas (OCAs) and Credibility Gains. The first strand of literature (OCA) stresses the conditions under which it would be beneficial for a country to abandon its exchange rate policy (monetary policy) as an instrument for economic adjustment. The second approach (credibility), holds that it could be beneficial for a country to peg its currency to a low inflation country in order to absorb credibility. But the empirics of *third country effects* in the case of Argentina (Mercosur) may also contribute to the debate on the optimal exchange rate regime

Accounting for intra and extra Mercosur *RER* volatility seems to be a key factor to consider since it was seen that they have opposite effects on intra and extra regional exports.[2] As such, only considering the direct negative effects with one region may erroneously lead to an overestimation of the potential benefits of a strategy directed to reduce the *RER* volatility.

[1] In the case of Argentina and Brazil, examples abound of sharp changes in the *RER*, triggering protectionist activity. In the 1990s the real appreciation of the peso led to a ten per cent (statistics) import tax in Argentina. In the face of rising current account imbalances in 1997, Brazil imposed restrictions and barriers on imports from the Mercosur partners. And once again in 1999, when Brazil suffered a speculative attack and a sharp devaluation, protectionist responses emerged in the other partner countries.

[2] Intra regional RER volatility is expected to affect negatively exports to Brazil but positively exports to the rest of the world. The inverse is true for RER volatility with the rest of the world.

Under this scenario, fixing the local currency (either to the Real or to third currencies) would boost both intra and extra regional exports. When third country (indirect) effects are included in the analysis, the global effects of a RER volatility reduction would be cut down because of the counterbalancing impact of the positive cross-country effects.

Also, depending on the correlation between intra and extra-regional RER volatility and on the relative magnitudes of the direct and cross-country (indirect) effects, volatility may positively or negatively affect both type of exports and may also trigger trade-offs (exports to one region are boosted while the others are hurted). Also, trade-offs may be present at the level of each RER volatility, or at the level of volatility as a whole. As such, it is possible that reducing only the RER volatility with Brazil or both types of volatility simultaneously (if they are positively related) will boost intra-regional exports while hurting exports to the rest of the world. Of course, the final scenario in which the economy will be is an empirical question, which we will try to disantagle in the following pages. By focusing on the trade effects of volatility, these issues can contribute to the debate on fixed vs flexible exchange rates or to the choice of the appropriate anchor (intra or extra-regional).[3] The contribution seems to be particularly relevant, since Mercosur countries have been evaluating the relative benefits of monetary and exchange rate cooperation or the future adoption of a common currency.

As aforementioned, the interest of this topic is greater when account is made for the economic history of the club of countries involved: Mercosur economies have suffered from excessive RER volatility due to unsustainable fiscal and monetary policies, leading to high and variable inflation rates. Erratic exchange rate management and failed stabilization programs with frequent (corrective) sharp devaluations also played an important role. In a study performed by Eichengreen (1998) it is shown that Mercosur countries exhibit 60% more RER volatility than other comparable economies, even when controlling for its macro determinants.[4]

This paper differs from previous studies on the topic in three issues. First, special attention is paid to the specification of the volatility estimator. The estimators usually found in the literature are unsatisfactory and recent papers focus on more appropriate techniques. The family of the au-

[3] In the case of Mercosur a regional domestic currency (the brazilian Real) or an extra-regional currency (the Dollar, the Euro or a basket of currencies) should be considered as likely alternatives.

[4] These include differences in country size, disparities in production, and trade structures (agriculture, manufactures, minerals, etc.), the degree of asymmetry of the shocks and trade interdependence between countries.

toregressive conditional heteroskedastic ($ARCH$) models are now used to obtain the conditional second moment of the relevant information (in contrast to the unconditional moments used until now). This paper follows this line of research and uses an extension of this family of models, the Markov Swithching $ARCH$ ($SARCH$). These indicators are then employed as independent variables in the export equations of Argentina.

Second, a careful analysis of the stationary properties of the variables is performed prior to the econometric estimations. In particular, appropriate econometric techniques are applied in order to distinguish difference-stationary with drift processes from those being trend - stationary. This distinction has important implications also on the analysis of cointegration: if the explained variable does not contain a unit root, testing for cointegration with that variable is nonsense, as well as including an error correction term in the estimated equation. Finally, the third distinctive element of the paper is the analysis of the role of *third country effects*, ignored in most papers of the literature on the topic. Here, the latter issue is discussed, since export equations are estimated, including simultaneously the real exchange rate with Brazil, the RER with the rest of the world and the volatilities of RERs.

The remainder of the paper is organized as follows. The Section 2 presents the empirical evidence (and the methodology) on the impact of RER volatility on international trade. Section 3 introduces the data needed to test for the significance of RER volatility on Argentina's exports (real exports, the RER and the industrial production index). Sections 4 and 5 develop a careful analysis of the stationarity and cointegration properties of the variables to decide the specific econometric specification to be used. Then, in Section 6 we obtain estimates of the implicit RER volatility making use of the Markov Swithching $ARCH$ ($SWARCH$) model. The results concerning the econometric estimations on the impact of intra (with Brazil) and extra (with the rest of the world) RER volatility are presented in Section 7. Section 8 contains the conclusions.

2 Methodology and current evidence

To study the effect of exchange rate volatility on Argentina's exports to Brazil and to the rest of the world, monthly data spanning the period 1980:1-2004:8 is used. The framework applied in this study relies on the determinants of trade advanced by most of the papers on the subject (see next): exports are a function of domestic and foreign real income, the level of the real exchange rate and its volatility. National income captures local conditions affecting exports, foreign income stands for the purchasing power of the trading partner, while relative price variables (the real exchange rate) try to capture the price power on shaping market behavior. The role of exchange rate volatility is to consider the currency movement effect through uncertainty on trade decisions. However, this study deviates from previous ones in that the so called "3rd country effect" is taken into account. Exports to one region are not only affected by its bilateral RER level and volatility, but also, by those of other countries or regions. Hence, when estimating for example an export equation to Brazil, not only the level and volatility of the bilateral RER should be included, but also, the same measures for the rest of the world. The idea is that not only the "absolute" but also the "relative" volatility matters (the volatility with the other's country partners). Not taking these variables into account would lead to an "omitted variables problem", possibly biasing the estimated coefficients.

The most general export equations to be estimated take then the following form:

$$X_t^B = f\left[Y_t^B, Y_t^A, V_t^B, V_t^A, RER_t^B, RER_t^{ROW}, V_t^B, V_t^{ROW}, Dum\right] \quad (1)$$

$$X_t^{ROW} = f\left[Y_t^{ROW}, Y_t^A, V_t^{ROW}, V_t^A, RER_t^B, RER_t^{ROW}, V_t^B, V_t^{ROW}, Dum\right] \quad (2)$$

Where X_t^B and X_t^{ROW} represent real exports from Argentina to Brazil and to the rest of the world (ROW), respectively; Y_t^B, Y_t^A and Y_t^{ROW} represent real economic activity in Brazil, Argentina and the rest of the world, respectively; V_t^B, V_t^A and V_t^{ROW} represent volatility in real economic activity in Brazil, Argentina and the rest of the world, respectively; RER_t^B and V_t^B, and RER_t^{ROW} and V_t^{ROW} are the RER level and volatility with Brazil and the rest of the world, respectively; and Dum are dummy variables capturing variations in exports not accounted for by the explanatory variables.

One would expect exports to Brazil to increase *pari-passu* with real income in that country (higher demand) and with a bilateral RER depreciation (positive relative price effect). An increase in the RER with the rest of the world would lead to a reduction of exports, showing that higher relative prices with the rest of the world would make, *ceteris paribus*, more profitable the exports to that region, then reducing exports to Brazil. National income may have a positive or negative impact on exports to Brazil. In the first case, it would be indicating the presence of positive supply side effects, while in the second, a higher level of economic activity may be reflecting either a higher "capacity utilization" or a higher level of domestic demand.[5] In both cases, an increase in the level of local economic activity would "crowd out" exports to Brazil. As stated before, the impact of RER volatility is ambiguous. Although, in the more traditional case, it is expected that the direct effects of volatility will be negative while the cross effects will be postive.

Under *third country effects,* both exports may be jointly positively or negatively affected and there may be trade-offs coming from reductions in RER volatility. The result depends on the sign of the correlation between volatilities, and when positive, it will depend on the relative magnitudes of the direct and cross-regions effect. Assuming the expected signs for the coefficients and a zero correlation, a trade-off arises from a reduction in the bilateral RER volatility (commercial relations with Brazil are boosted while those with the rest of the world are hurted). The inverse is true when it is the multilateral volatility that is reduced. If the correlation is negative, the same trade-offs as before are obtained, but the impacts are magnified given that the direct and cross-region effects have opposing signs. For example, a reduction of RER volatility with Brazil will entail an increase in that with the rest of the world, which will boost intra-regional exports both through the direct and inderect effects. The same is true for the extra-regional RER volatility and exports. Then,with a zero or negative correlation, there will allways be trade-offs, the direction of which being a function of the type of volatility affected.

Assume now a postive correlation and that the direct (negative) effects dominate, in the sense that they are higher in absolute value. Under this set up, a trade-inn between both types of exports is very likely to arise, with volatility being bad for exports as a whole. When the indirect (positve) effects dominate, a trade-inn is also very likely, but now volatility will be beneficial for exports. But trade-offs can not be excluded under a postive correlation. Assume that the effects coming from the bilateral RER volatility are sizeble (in absolute value) in each equation, compared to those coming from volatiliy in the multilateral RER. Then it is very likely that

[5] In the last case, national income would be reflecting that the country behaves as a net consumer of exportable goods. Also, a point can be made that economic activity in Argentina may be endogenous to exports. For the period 1990-2002 exports to Brazil amounted only to aproximately 2% of GDP while extra Mercosur exports represented almost 8% of GDP. As such, economic activity in Argentina shouldn' t show a strong dependence on either type of exports. In any case, export equations without the domestic economic activity are also estimated.

a trade-off will emerge, with a reduction in any RER volatility boosting intra-regional exports and hurting the commercial relations with the rest of the world. The opposite is valid when the coefficients for the extra-regional RER volatility dominate. Summing up, when the correlation is positive, both trade-inns and trade-offs may show up depending on the relative values of the coefficients. Now the direction of the trade-off is settled-up at the level of the RER volatility as a whole (since they are both positively), and not at the individual level.

Empirical studies conducted so far have estimated a variety of forms of equations (1) and (2) for many countries and using different econometric techniques.[6] Reflecting in part the theoretical ambiguity on the subject, the conclusions of the empirical arena are similarly inconclusive. As such, Kroner and Lastrapes (1993), McKenzie (1998) and Aristotelous (2001) find no firm evidence for the relationship between exchange rate volatility and trade. Kumar and Dhawan (1991), Caporale and Doroodian (1994), Dell'Ariccia (1998) and Vergil (2002), provide, on the other hand, evidence in support of the view that the volatility of exchange rates reduces the volume of international trade. Finally, Grobar (1993), McKenzie and Brooks (1997) and Devlin et al. (2001) are of those who find some evidence for a positive effect of exchange rate volatility on trade flows. In the case of Argentina, and to the best of the knowledge of the authors of this paper, only Heymann and Navajas (1992) studied the subject in a bilateral exports setting with Brazil, finding no relations between exports to Brazil and volatility.

3 Data construction: exports, the real exchange rate and the industrial production index

Seasonally-adjusted monthly nominal exports (in millions of USD) for the period January 1980 - August 2004, are calculated using the unseasonally adjusted series from the International Monetary Fund (2005). Exports to Brazil were deflated by a price index constructed using two independent indices. The first was constructed by Heymann and Navajas (1992) and the second was constructed especially for this paper: it is a weighted average of Argentina's export prices (in terms of Fuels, Industrial Manufacturs, Agricultural Manufacturs and Primary Products).[7] Annual weights are the

[6] These include standard OLS estimation, vector auto regressor and multivariate GARCH-in-mean models.

[7] A "regression method" was applied to expand to the future the Heymann and Navajas' series.

shares of every type of these exports to total exports to Brazil.[8] Seasonally adjusted monthly nominal exports to Brazil are deflated by the seasonally adjusted price index just presented.

For exports to the rest of the world, there is the issue of deciding which countries should be considered. Partners are considered to be countries that, at least, represented 1% of total exports on a monthly basis from January 1980 to August 2004.[9] Of these, only those countries that had the relevant macroeconomic variables were retained, which gave a total of 24 countries.[10] These exports were deflated using a general export price index, which is a chaining of Heymann and Navajas' (1992) with that of the National Institute of Statistics and Censuses of Argentina (INDEC). The finally constructed export series (expressed in January 1980 US dollars) are presented in Figures 1 and 2, at the end of the paper.

To construct the real exchange rates, seasonally adjusted data on nominal exchange rates and the wholesale price indices are used.[11] [12] The intra RER is calculated just as a bilateral real exchange rate: $RER_t^B = \left(e_t WPI_t^B / WPI_t^A\right)$, e_t being the nominal exchange rate between Argentina and Brazil (pesos per reais) and WPI_t being the wholesale price index. To have a measure of the RER with the rest of the world, the bilateral exchange rate between Argentina and each of its 24 partners is computed, the same way as done for Brazil. Then, following Ellis (2001), a multilateral RER is calculated as:

[8] The source of the exports price indices is the National Institute of Statistics and Censuses of Argentina (INDEC).

[9] The exception to this general rule is the case of the United Kingdom, a country with which economic relations were stopped during the 1982 military conflict.

[10] These are Canada, Chile, Denmark, Finland, France, Germany, Greece, India, Israel, Italy, Japan, Korea, Malaysia, Mexico, Netherlands, Norway, Peru, Portugal, Saudi Arabia, South Africa, Spain, Sweden, United Kingdom and the United States. All the data comes from the International Monetary Fund Financial Statistics.

[11] When the wholesale price index is not available, the consumer price index is used instead, as is the case for Portugal, South Africa and Norway.

[12] A relevant question is which exchange rate is more appropriate for these types of studies. Nominal exchange rates are accused of overestimating the existing exchange rate uncertainty, the reason being that price movements partly offset the real effects of fluctuations in the nominal exchange rates. These offsetting movements are considered in the real exchange rates. Of course, an argument can be made that prices are not flexible in the short term, so that the nominal exchange rate would be preferable. The real exchange rate would gain importance in the medium and long run. In an inflation-prone country such as Argentina, it is expected that the pass-through from nominal exchange rates to prices would be faster than in more inflationary stable economies, indicating that prices are more flexible. As such, the real exchange rate will be kept in the present case.

$$RER_t^{ROW} = RER_{t-1}^{ROW} \frac{\prod_i (BRER_{i,t})^{w(i,t)}}{\prod_i (BRER_{i,t-1})^{w(i,t)}}$$

Where $BRER_{i,t}$ is the bilateral real exchange rate with country i at time t and $w(i,t)$ is a weight computed as the share of exports to country i over total exports to those countries, also at time t. Three things are worth noting about the way the real exchange rate with the rest of the world is computed. First, note that weights can change over time in order to account for the possibility that some country may become a more important export destiny. Otherwise, if actual shares move significantly and this is not taken into account, the exchange rate index would be giving a misleading picture of the net effect of movements in particular bilateral rates. Second, as changing weights are being used, it is important that the index be spliced together with the previous observations. Otherwise, in periods in which the weights change, one would not know whether the RER index is changing because of a change in the weights or in the bilateral exchange rates.[13] Finally, note that geometrically weighted bilateral real exchange rates are used. As such, the percentage change in the index is the weighted average of the percentage change in each of the bilateral exchange rates. This property is lost when one uses arithmetic averages.[14] Figures 3 and 4 at the end present the calculated bilateral and multilateral real exchange rates (the scale of the variables is January 1980 = 1).

Finally, the measure of economic activity in Argentina (Y_t^A) is an industrial production index, which is an extension of FIEL's (Fundacion de Investigaciones Economicas Latinoamericanas), using the index of the National Institute of Statistics and Censuses of Argentina (INDEC). For Brazil (Y_t^B), the index comes from the Instituto de Pesquisa Econômica Aplicada (IPEA). Both series, which were seasonally adjusted, are presented in Figures 5 and 6 (the scale of the variable is January 1980 = 1).

The economic activity of the rest of the world is estimated using the seasonally adjusted industrial production indices of the selected countries and the same methodology as before used to compute the multilateral RER.[15] In particular:

[13] These small errors may have a tendency to amplify rather than to offset each other. For example, assume that the bilateral real exchange rate with a certain country is rising. Then, the export share will be rising too and a depreciation bias will be imparted to the index.

[14] On arithmetic and geometric exchange rates see Belongia (1986) and Ott (1987).

[15] All the data comes from the International Monetary Fund Financial Statistics.

$$Y_t^{ROW} = Y_{t-1}^{ROW} \frac{\prod_i Y_{i,t}^{w(i,t)}}{\prod_i Y_{i,t-1}^{w(i,t)}}$$

Where $Y_{i,t}$ is the seasonally adjusted industrial production index of country i at time t and Y_t^{ROW} is the measure of real economic activity for the rest of the world. Figure 7 at the end of the paper present the constructed series (the scale of the variable is also January 1980 = 1).

4 Testing for unit roots

Using integrated variables in econometric regressions may lead to spurious results, meaning that the regression may appear to be satisfactory when in fact it is economically meaningless. To avoid this, exports and their determinants should be tested for unit roots, and where necessary, they should be made stationary by applying an appropriate correction. Also, it is very important to test for cointegration between the variables that contain a unit root. Missing this step would result in the loss of very valuable information ("omitted variables" problem) and may bias the estimated coefficients. A more appropriate representation would, in this case, be an Error Correction Model. Surprisingly, many papers on the subject neglect one, two or both of the aforementioned points; this, in principle, negates the possible conclusions derived from them.

As the model will be estimated in logs, unit root tests will be applied to the logs of the variables. In particular, since the series presented in Figures 1 to 7 may have some degree of heteroscedasticity, the Phillips - Perron (PP) test is used for the series that do not seem to contain a trend and the Schmidt-Phillips (SP) test for those that do.[16] Based on a visual inspection of Figures 1 to 7, the PP test was applied to the intra and extra (with Brazil and with the rest of the world, respectively) $RERs$. The SP test was applied to intra and extra regional exports, and to the industrial production indices of Argentina, Brazil and the rest of the world.[17] Results are presented in

[16] Even though these tests are less powerful than other more recent tests, they are applied here because they are robust to the presence of heteroscedasticity in the error term, which is a feature usually found in developing country data. Also, the SP test is appropriate when the series exhibits a trend because it allows testing directly the null hypothesis that the series is difference stationary with drift, against the alternative that it is trend - stationary.

[17] The PP test is performed on the demeaned series without a constant term or time trend in the estimated equation; so, under the null hypothesis the series behaves as dif-

Table 1.[18]

The PP test shows that the null hypothesis of a unit root can not be rejected for the intra and extra $RERs$; the same is true for the exports to Brazil and the industrial production index for the rest of the world (using the SP test). In contrast, Argentina's and Brazil's industrial production indices and the extra region exports are found to be trend - stationary based on the SP test. After taking the first difference of the variables that have a unit root and de-trending the trend stationary variables, the series are tested again for unit roots. For the series that are detrended, the HP trend is first computed for the variables in levels, and then the difference between the log of the variable and the log of the HP trend is computed. As such, the detrended series represent percentage deviations with respect to trend. The resulting variables are presented in Figures 8 to 14 at the end and the tests are exposed in Table 2. In that table, Δ represents the first difference operator and small latters represent the difference between the log level of the variable and the log of its HP trend. Now, only the PP test is used since there is no apparent trend in any of the resulting series.[19] Results show that the null hypothesis of a unit root can be rejected in all of the cases. For the variables that were differentiated this means that they are $I(1)$ which will be important when testing for cointegration among them.

	RER_t^B	RER_t^{ROW}	X_t^B	X_t^{ROW}	Y_t^A	Y_t^B	Y_t^{ROW}
PP_ρ	-0.55	-4.05	−−	−−	−−	−−	−−
PP_τ	-0.30	-1.25	−−	−−	−−	−−	−−
SP_ρ	−−	−−	-10.69	-115.70***	-20.17**	-36.48***	-6.37
SP_τ	−−	−−	-2.35	-8.43***	-3.24**	-4.43***	-1.79

Notes: All variables are in logs. "***", "**" and "*" indicates a significant statistic at the 1%, 5% and 10% level, respectively.
The asymptotic critical values for the PP_ρ (PP_τ) test are -13.8 (-2.58) at the 1% level, -8.1 (-1.95) at the 5% level and -5.7 (-1.62) at the 10% level; while those for $SP_\rho(SP_\tau)$ are -25.2 (-3.56) at the 1% level, -18.1 (-3.02) at the 5% level and -15.0 (-2.75) at the 10% level.

Table 1: Phillips - Perron and Schmidt-Phillips unit roots tests (log level variables)

ference stationary, while under the alternative, it acts as a stationary stochastic process around zero.

[18] The Newey-West automatic truncation lag selection was invoked for every variable, which is five in this case.

[19] As before, the PP test is applied to the demeaned variables.

	ΔRER_t^B	ΔRER_t^{ROW}	ΔX_t^B	x_t^{ROW}	y_t^A	y_t^B	ΔY_t^{ROW}
PP_ρ	-291.02***	-322.50***	-370.74***	-171.89***	-77.87***	-143.56***	-436.50***
PP_τ	-17.91***	-20.22***	-29.87***	-10.91***	-6.63***	-9.47***	25.31***

Notes: All variables are in logs. "***", "**" and "*" indicates a significant statistic at the 1%, 5% and 10% level, respectively.
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Table 2: Phillips - Perron unit roots tests (differenced and detrended variables)

A point can be made that a special care should be paid to the presence of structural breaks that could potentially bias the results of the unit root tests. This is of particular importance when dealing with data for developing countries which is more likely to suffer from this problem.[20] The recently developed one and two-break LM unit root test of Lee and Strazicich (2004) and Lee and Strazicich (2003), respectively, are implemented (Tables 3 and 4).[21] In general, the previous results using the PP and the SP tests are confirmed [22] The outcome concerning the industrial production indices of

[20]For example, it is possible to see from Graph 1 that there was a break in trend for exports to Brazil around the end of 1998. Additionally, from Figures 5 and 6 it is also possible to see that the industrial production indices of both countries exhibited a decided positive trend since the beginning of the 90s, but the trend was less obvious before that date.

[21]The methodology consists of endogenously determining the presence of one or two breakes in intercept and one or two breakes in intercept and trend. The method allows for the possibility of structural breaks under the unit root null. This is in contrast to previous endogenous-break unit root tests, such us Zivot and Andrews (1992) and Lumsdaine and Papell (1997).

[22]For exports to Brazil the specification in which there are changes in intercepts and trends is preferred to that in which there is only a change in intercept, since the variable definitely seems to present a break in trend (Figure 1). Exports to the rest of the world do not seem to contain a change in trend (Figure 2), so the model which only includes a break in intercept is chosen. For the economic activity of Argentina and Brazil, both breakes in intercepts and trends are likely to be present (Figures 5 and 6). In the case of the industrial production index of the rest of the world (Figure 7), since the variable presents a negative trend at the beginning of the sample, results for the specification with a change in intercept and trend are presented. Regarding the intra and extra real exchange rates (Figures 3 and 4), both specifications are estimated to allow for the possibility that, even if the series do not seem to contain a general trend, they may exhibit one in sub periods.

Argentina and Brazil are in contrast to previous results. Once breaks are taken into account, the presence of unit roots can not be rejected or, when it can, it is only at the 10% level. Since these results are in sharp contrast with those obtained before, the analysis will be continued assuming that both variables can either be trend stationary or difference stationary. The difference will matter not only for the appropriate transformation to apply in order for them to become stationary, but also regarding the testing of cointegration. Figures 15 and 16 present the difference of the log of the industrial production indices of Argentina and Brazil, respectively.

		1 Break	
Variable	Model	Date of Break	Test Stat.
X_t^B	Change in Intercept and Trend	1985:9	-2.67
X_t^{ROW}	Change in Intercept	1999:3	-3.79**
Y_t^A	Change in Intercept and Trend	1992:12	-4.25*
Y_t^B	Change in Intercept and Trend	1994:9	-3.69
Y_t^{ROW}	Change in Intercept and Trend	1985:10	-4.01
RER_t^B	Change in Intercept	1982:6	-3.20
	Change in Intercept and Trend	1990:7	-4.70*
RER_t^{ROW}	Change in Intercept	1990:2	-2.28
	Change in Intercept and Trend	1990:3	-3.92

Notes: All variables are in logs. "***", "**" and "*" indicates a significant statistic at the 1%, 5% and 10% level, respectively. Critical values come from Lee and Strazicich (2004).

Table 3: Testing for unit roots with one break

Variable	Model	2 Breaks: Dates of Breaks	Test Stat.
X_t^B	Change in Intercept and Trend	1990:12; 1999:3	-4.24*
X_t^{ROW}	Change in Intercept	1989:4; 1999:2	-4.62***
Y_t^A	Change in Intercept and Trend	1992:10; 1999:12	-5.09
Y_t^B	Change in Intercept and Trend	1985:5; 1990:6	-5.38*
Y_t^{ROW}	Change in Intercept and Trend	1984:12; 1998:6	-4.41
RER_t^B	Change in Intercept	1982:6; 1990:2	-3.51*
	Change in Intercept and Trend	1990:7; 2002:1	-5.10
RER_t^{ROW}	Change in Intercept	1982:6; 1989:12	-2.97
	Change in Intercept and Trend	1989:11; 2002:2	-6.03**

Notes: All variables are in logs. "***", "**" and "*" indicates a significant statistic at the 1%, 5% and 10% level, respectively. Critical values come from Lee and Strazicich (2003).

Table 4: Testing for unit roots with two breaks

5 Testing for cointegration

The last section has shown that exports to Brazil (X_t^B), the industrial production index of the rest of the world (Y_t^{ROW}), and the real exchange rates (RER_t^B and RER_t^{ROW}) can be considered difference stationary (integrated of order one), while exports to the rest of the world (X_t^{ROW}) can be considered trend stationary. The industrial production indices of Argentina and Brazil (Y_t^A and Y_t^B) could be either trend or difference stationary (Table 5). The next step consists of testing for cointegration among the integrated variables. For the extra model (equation (2)), one does not need to perform this task since the dependent variable (exports to the rest of the world) is trend stationary, and as such, it can not be co-integrated with the others. For both equations two model specifications will be estimated (with and without the economic activity of Argentina) since in Heymann and Navajas (1992) the economic activity of Argentina was not found to be significant. For exports to Brazil (model equation (1)), the implication is that three cointegrating equations should be tested (given that Y_t^A and Y_t^B could be either DS or TS). In particular, if it is considered that the industrial production indices are TS, they won't be co-integrated with the other variables. In this case it is necessary to check for cointegration between exports to Brazil and the intra and extra real exchange rates only. If the indices are taken to be DS, and given that models with and without the economic activity of Argentina

(Y_t^A) will be estimated, two extra cointegrating vectors should be estimated. A summary of the different groups of variables to be tested for cointegration is shown in Table 6.

	X_t^B	X_t^{ROW}	Y_t^A	Y_t^B	Y_t^{ROW}	RER_t^B	RER_t^{ROW}
Without breaks	DS	Trend stationary	TS	TS	DS	DS	DS
With breaks	DS	Trend stationary	DS	DS	DS	DS	DS
Conclusion	DS	Trend stationary	TS or DS	TS or DS	DS	DS	DS

Note: DS = difference stationary; TS = trend stationary.

Table 5: Results of unit root tests

	With Y_t^A	Without Y_t^A
Y_t^A and Y_t^B TS	$X_t^B, RER^B, RER_t^{ROW}$	
Y_t^A and Y_t^B DS	$X_t^B, RER_t^B, RER_t^{ROW}, Y_t^A, Y_t^B$	$X_t^B, RER_t^B, RER_t^{ROW}, Y_t^B$

Table 6: Summary of variables to be tested for cointegration

Cointegration tests are performed using the Johansen and Joselius methodology.[23] When testing for cointegration using this methodology the results may depend crucially on the number of lags included in the model as weel as on the specification of the deterministic component of the VECM. The number of lags is selected by applying two different multivariate lag selection criteria: the Schwarz Bayesian Criterion (SBC) and the Akaike Information Criterion (AIC).[24] Regarding the deterministic component, the specification in which the $VECM$ contains a constant (not restricted to lie in the cointegration space) and the error correction term contains a linear trend is chosen. This choice is based on the stochastic properties of the variables obtained in the previous section.[25]

[23] A main advantage of this methodology over univariate tests is that, when more than two variables are being tested, the results do not depend on which variable is chosen as the dependent variable.

[24] Up to 24 lags were included in the model.

[25] The inclusion of the constant term in the VECM is justified by the fact that exports to Brazil behave as difference stationary with drift. This means that, at least, the equation for this variable in levels contains a deterministic trend; which justifies the inclusion of a constant in the equation in differences. On the other hand, that both exchange rates behave as difference stationary without drifts was not rejected. Consequently, a cointegrating equation between these variables and the exports to Brazil will necessarily contain a deterministic linear trend. Also, when testing for cointegration between exports

Results in Table 7 for the variables $X_t^B, RER_t^B, RER_t^{ROW}$ point to the existence of a cointegrating equation (three tests out of four) between these variables. The normalized cointegrating vector (with respect to the real exports to Brazil) is presented in Table 10. As expected, the bilateral real exchange rate (RER_t^B) is positively related to real exports (X_t^B) while the opposite is true for the exchange rate with the rest of the world (RER_t^{ROW}). With reference to the set of variables $X_t^B, RER_t^B, RER_t^{ROW}, Y_t^A$ and Y_t^B, from Table 8 it can be seen that there is strong evidence in favor of three cointegrating relations. The cointegrating vector associated with the highest eigenvalue is the one who has signs and elasticity magnitudes completely in accordance with economic priors. This long run relation will be kept in the analysis.[26] The normalized cointegrating vector is again presented in Table 10. The elasticities with respect to the real exchange rates are maintained (in signs and magnitudes) and the industrial production indices have a positive impact on exports to Brazil. When the industrial production index of Argentina is excluded from the set of variables, the cointegration test results (Table 9) show that there is strong evidence of two cointegrating equations. The normalized cointegrating equation for the highest eigenvalue is again presented in Table 10. All the signs are completely in accordance with economic priors and the magnitudes of the elasticities are very similar to those just obtained.[27]

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to Brazil, the real exchange rates and the industrial production indices, a linear trend will be included to allow for the possibility that the trendy variables (exports and the indices) do not contain the same trend. In all of the cases, the null hypothesis that the deterministic components can be included in the cointegrating vectors are not rejected via a likelihood ratio test even at the 10% level.

[26] Other studies that follow the same strategy, even for other types of economic studies are Muscatelli, and Hurn (1992) and Drake and Chrystal (1994).

[27] Heymann and Navajas (1998) found a similar value for the elasticity with respect to the economic activity in Brazil. Their value is 2.54 and was obtained using quarterly data starting in the 70s and going to the middle of the 90s.

	MAX Statistics			*TRACE Statistics*		
H_0	$r = 0$	$r = 1$	$r = 2$	$r = 0$	$r \leq 1$	$r \leq 2$
H_1	$r = 1$	$r = 2$	$r = 3$	$r \geq 1$	$r \geq 2$	$r \geq 3$
AIC suggests 23 lags.						
Statistics	25.06	13.85	3.37	42.28	17.21	3.37
CV (5 %)	25.54	18.96	12.25	42.20	25.47	12.39
SBC suggests 1 lag.						
Statistics	39.93	15.57	4.48	59.98	20.05	4.48
CV (5 %)	25.54	18.96	12.25	42.20	25.47	12.39

Note: *CV* = critical value.

Table 7: Johansen cointegration test results for exports to Brazil and the real exchange rates

	MAX Statistics					*TRACE Statistics*				
H_0	$r = 0$	$r = 1$	$r = 2$	$r = 3$	$r = 4$	$r = 0$	$r \leq 1$	$r \leq 2$	$r \leq 3$	$r \leq 4$
H_1	$r = 1$	$r = 2$	$r = 3$	$r = 4$	$r = 5$	$r \geq 1$	$r \geq 2$	$r \geq 3$	$r \geq 4$	$r \geq 5$
AIC suggests 24 lags.										
Statistics	62.20	43.89	27.19	12.52	3.55	149.44	87.16	43.26	16.07	3.55
CV (5 %)	37.52	31.46	25.54	18.96	12.25	86.96	62.61	42.20	25.47	12.39
SBC suggests 1 lag.										
Statistics	66.62	34.07	25.78	11.02	6.08	143.59	76.96	42.89	17.10	6.08
CV (5 %)	37.52	31.46	25.54	18.96	12.25	86.96	62.61	42.2	25.47	12.39

Note: *CV* = critical value.

Table 8: Johansen cointegration test results for exports to Brazil, the real exchange rates and the IPIs

	MAX Statistics				*TRACE Statistics*			
H_0	$r = 0$	$r = 1$	$r = 2$	$r = 3$	$r = 0$	$r \leq 1$	$r \leq 2$	$r \leq 3$
H_1	$r = 1$	$r = 2$	$r = 3$	$r = 4$	$r \geq 1$	$r \geq 2$	$r \geq 3$	$r \geq 4$
AIC suggests 24 lags.								
Statistics	51.00	34.00	13.22	2.70	100.89	49.90	15.92	2.70
CV (5 %)	31.46	25.54	18.96	12.25	62.61	42.2	25.47	12.39
SBC suggests 2 lag.								
Statistics	21.03	17.78	15.66	6.27	60.74	39.71	21.93	6.27
CV (5 %)	31.46	25.54	18.96	12.25	62.61	42.2	25.47	12.39

Note: *CV* = critical value.

Table 9: Johansen cointegration test results for exports to Brazil, the real exchange rates and the IPI of Brazil

Normalized cointegrating relation for $X_t^B, RER_t^B, RER_t^{ROW}$:
$X_t^B = 1.82 * RER_t^B - 2.60 * RER_t^{ROW} + 0.008 * t$
Normalized cointegrating relation for $X_t^B, RER_t^B, RER_t^{ROW}, Y_t^A, Y_t^B$:
$X_t^B = 1.72 * RER_t^B - 2.45 * RER_t^{ROW} + 0.39 * Y_t^A + 2.11 * Y_t^B + 0.005 * t$
Normalized cointegrating relation for $X_t^B, RER_t^B, RER_t^{ROW}, Y_t^B$:
$X_t^B = 1.67 * RER_t^B - 2.52 * RER_t^{ROW} + 2.20 * Y_t^B + 0.006 * t$

Note: All variables are in logs.
Cointegrating equations are calculated for the number of lags suggested by the SBC.

Table 10: Normalized cointegrating relations

6 Volatility estimation of the real exchange rates

Measuring unexpected fluctuations in the real exchange rates to be included in equations (1) and (2) is one of the main difficulties in these types of studies. Most of the previous literature has focused on the degree of dispersion of the exchange rate around a mean or central value, or on the residuals of an econometric regression to obtain an indicator of exchange rate volatility.[28] As signaled by McKenzie (1998 and 1999) and Cheong (2004), the use of these measures may not be appropriate. On the one hand, many of them are completely ad-hoc in the sense that the definition of the window of time over which the relevant measure is computed is completely arbitrary. On the other hand, they fail to capture the uncertainty embodied in exchange rate changes, not considering the fact that higher moments of the RER can be characterized as non - constantly varied with clustering. Finally, when the error term of an estimated regression is used, the associated coefficient in the exports equation will not be consistent. The $ARCH$ model of Engle (1982) and generalized by Bollerslev (1986), and the switching $ARCH$ model ($SWARCH$) of Hamilton and Susmel (1994), in contrast, allow testing for the presence of $ARCH$ effects, they consistently parameterize the time-varying conditional variance of the exchange rate (generating volatility

[28] Some of the indicators usually found in the literature are rolling statistical variances or standard deviations, coefficients of variation, average of absolute changes, difference between previous forward and current spot rates, deviations from trend, error terms of ARMA models, etc. See, among others, Kumar and Dhawan (1991), Aristotelous (2001) and Vergil (2002).

clustering) and produce consistent estimates of the associated coefficient in the exports equation.[29]

As such, the square root of the conditional variance generated from the Markov Switching $ARCH$ model ($SWARCH$) proposed by Hamilton and Susmel (1994) will be used as the proxy for volatility. The estimation period runs from January 1980 to August 2004.[30] The $AR-SWARCH(K,q)$ model estimated for the RER with the rest of the world has the following form:

$$(1-L)\ln RER_t^{ROW} = c + \sum_{j=1}^{J} d_j DUM_j + \varphi(L)(1-L)\ln RER_t^{ROW} + \varepsilon_t \quad (3)$$

$$\varepsilon_t = \sqrt{g_{S_t}}\tilde{e}_t \quad (4)$$

$$\tilde{e}_t = \sigma_t \eta_t \quad (5)$$

$$\sigma_t^2 = w + \alpha(L)\tilde{e}_t^2 \quad (6)$$

Where $\tilde{e}_t$ is a standard $ARCH$ process, with $\alpha(L)\tilde{e}_t^2 = \sum_{i=1}^{q}\tilde{e}_{t-i}^2$. g_{S_t} is a scale parameter that captures the change in regime; S_t is an unobserved random variable that can take on the values $1, ..., K$, each of these being the state (or regimes) in which the economy can be in; and $\eta_{i,t}$ is an $i.i.d.(0,1)$ stochastic process. The error term $\tilde{e}_t$ is multiplied by the constant $\sqrt{g_1}$ when the process in the regime $S_t = 1$, multiplied by $\sqrt{g_2}$ when the process in the regime $S_t = 2$, and so on.[31] Then, the $SWARCH(K,q)$ model is a process with K states and q autoregressive terms in the $ARCH$ process. This model requires a formulation of the probability law that causes the economy to switch among regimes. A simple specification is that the regime is the outcome of a $K-state$ Markov Switching chain that is independent of $(1-L)\ln RER_t^{ROW}$ and all of of it's past:

[29] Another way of obtaining a proxy for volatility is converting high into low frequency data. This is the case, for instance, when computing the variance of the daily nominal exchange rate to produce a proxy for the volatility over a month. In such a case, the associated coefficients in the exports equation will not be consistent (See McKenzie, 1999).

[30] Other papers that use $ARCH$ estimates of volatility are Kroner and Lastrapes (1993), Caporale and Doroodian (1994), McKenzie and Brooks (1997), McKenzie (1998), Doroodian (1999) and Cheong (2004).

[31] One of the g_{S_t} is unidentified and, hence, g_1 is set equal to 1. See Hamilton and Susmel (1994).

$$\text{Prob}\ (S_t = j/S_{t-1} = i, S_{t-2} = k, ..., (1-L)\ln RER^{ROW}_{t-1}, (1-L)\ln RER^{ROW}_{t-2}, ...) =$$

$$= \text{Prob}\ (S_t = j/S_{t-1} = i) = p_{ij}$$

for $i, j = 1, ..., K$. Under this specification, the transition probabilities (the p_{ij}'s) are constant.

Several $SWARCH$ models were estimated to find a stationary representation of the data to derive a measure of extra-regional RER volatility. Results in Table 11 show that the only model found to be second order stationary is the $SWARCH(3,1) - N$ (for the other models the $ARCH$ coefficient implies an explosive process). This model proves to be a very good representation of the data, since no autocorrelation or conditional heteroscedasticity were found in the standardized residuals (results not reported). The predicted conditional variance (the square root of which will be the measure of extra regional exchange rate volatility) is presented in Figure 17. For the bilateral RER (Table 12), two models are stationary ($SWARCH(2,1) - N$ and $SWARCH(3,1) - N$). The $ARCH$ effect being insignificant in the latter (result not reported), the former will be kept as the model from which to generate the measure of volatility. No autocorrelation or conditional heteroscedasticity were found in the standardized residuals neither. The predicted conditional variance of this estimation is presented in Figure 18 and the final complete estimations of both (intra and extra) RER models are presented in Table 13.[32] [33] As expected, there is a strong correlation between RER volatility and the major macroeconomic events in Argentina and Brazil. For example, the bilateral RER volatility was very high when both countries were running through hyperinflationary processes. It then reached the lowest values ever in the period the peso and the real were fixed to the US dollar. It then increased when Brazil first let its currency float in 1999, and latter on when Argentina did so in 2002. Regarding multilateral volatility, it reached the highest levels during the hyperinfla-

[32] In the case of the RER^{ROW}, traditional $GARCH$ models were originally estimated, without finding a second order stationary representation. For the RER^{B}, stationary representations were found and the relative performance of the $ARCH$ and $SWARCH$ models was compared using the criteria discribed in Pagan and Schwert (1990). The results pointed to the superiority of the $SWARCH$ estimations.

[33] To check for robustness, the CPIs instead of the WPIs were used to construct measures of $RERs$. Second order stationary representations couldn't been found using $GARCH$ and $SWARCH$ techniques.

tionary period of the end of the 80s and begenning of 90s. Since then, it stayed at very low levels during the Convertibility plan.

Model	ARCH Coefficient
$AR(1)-SWARCH(2,1)-N$	1.22
$AR(1)-SWARCH(2,1)-t$	1.89
$AR(1)-SWARCH(2,2)-N$	1.37
$AR(1)-SWARCH(3,1)-N$	0.47

Table 11: SWARCH models for the RER of the ROW

Model	ARCH Coefficient
$AR(1)-SWARCH(2,1)-N$	0.40
$AR(1)-SWARCH(2,1)-t$	1.25
$AR(1)-SWARCH(2,2)-N$	1.02
$AR(1)-SWARCH(3,1)-N$	0.04

Table 12: SWARCH models for the bilateral RER

$AR(1)-SWARCH(3,1)-N$ for RER_t^{ROW}						
$(1-L)\ln RER_t^{ROW}=$	-0.0004	+	0.14	$(1-L)\ln RER_{t-1}^{ROW}$	+	ε_t
	(-0.34)		(1.78)			
$\varepsilon_t=\sqrt{g_{S_t}}\mathbf{e}_t$						
$\mathbf{e}_t=\sigma_t\eta_t$						
$\sigma_t^2=$	0.0001	+	0.47	$\mathbf{e}_{t-1}^2$		
	(4.25)		(2.43)			
	$g_1=1$		$g_2=5.63$	$g_3=51.9$		
			(2.32)	(2.67)		
$AR(1)-SWARCH(2,1)-N$ for RER_t^B						
$(1-L)\ln RER_t^B=$	-0.0002	+	0.23	$(1-L)\ln RER_{t-1}^B$	+	ε_t
	(-0.12)		(3.32)			
$\varepsilon_t=\sqrt{g_{S_t}}\mathbf{e}_t$						
$\mathbf{e}_t=\sigma_t\eta_t$						
$\sigma_t^2=$	0.0002	+	0.40	$\mathbf{e}_{t-1}^2$		
	(3.34)		(2.45)			
	$g_1=1$		$g_2=14.88$			
			(4.13)			

Note: t statistics in parenthesis. For g_1 and g_2, t statistics test the H_0 that $g_1=1$ and $g_2=1$.

Table 13: SWARCH Models - Final estimations results

7 Empirical results

7.1 Econometric estimation: preliminaries

Starting with dynamic linear versions of equations (1) and (2) in levels and taking into account the results concerning the unit roots properties of the variables, the following models can be obtained:[34]

$$(1-L)\,X_t^B = a+\varphi(L)\,(1-L)\,X_t^B+\phi(L)y_t^B+\delta(L)y_t^A+\theta(L)(1-L)RER_t^B+\lambda(L)(1-L)RER_t^{ROW}+$$

$$+\pi(L)V_t^B+\mu(L)V_t^{ROW}+\epsilon(L)V_t^A+bECT_{t-1}+\sum_{i=1}^{I} d_i DUM_i+\varepsilon_t^B \quad (7)$$

$$x_t^{ROW} = b+\beta(L)X_t^{ROW}+\varpi(L)Y_t^{ROW}+\tau(L)y_t^A+\psi(L)RER_t^B+\varkappa(L)RER_t^{ROW}$$

$$+\varrho(L)V_t^B+\upsilon(L)V_t^{ROW}+\alpha(L)V_t^A+\varepsilon_t^{ROW} \quad (8)$$

For the case in which Y_t^B and Y_t^A are considered TS variables, $y_t^B = \ln Y_t^B - \ln Y_t^{BHP}$ and $y_t^A = \ln Y_t^A - \ln Y_t^{AHP}$; for the case in which they are DS, $y_t^B = \Delta \ln Y_t^B$ and $y_t^A = \Delta \ln Y_t^A$; RER_t^B and V_t^B and RER_t^{ROW} and V_t^{ROW} are the real exchange rate and the indicator of its volatility, for Brazil and the rest of the world, respectively;[35] ECT_t is the error correction term generated from the residuals of the co-integration vectors estimated previously;[36] Dum_i are I dummy variables; and ε_t^B and ε_t^{ROW} are error terms. Also, $\phi(L)$, $\delta(L)$, $\theta(L)$, $\lambda(L)$, $\pi(L)$, $\mu(L)$ and $\epsilon(L)$ in equation (7), and $\varpi(L)$, $\tau(L)$, $\psi(L)$, $\varkappa(L)$, $\varrho(L)$, $\upsilon(L)$ and $\alpha(L)$ in equation (8) are lag polynomials of 12th degree of the general form $\sum_{j=0}^{12} a_j L^j$; $\varphi(L)$ and $\beta(L)$

[34] All variables are in logs, except the volatility indicators.

[35] A claime can be made that the exchange rate may be endogenous to exports. As signaled by Ahumada (1994), higher exports may imply a larger supply of foreign currency which may induce a downward pressure in the real exchange rate. Also, authorities may be trying to affect the export performance of the country by trying to increase the nominal exchange rate. She applies an IV technique (using as instruments the log of imports, the trade balance and the terms of trade) to the estimation of an export equation for Argentina, finding no distinctive results than when using directly the real exchange rate.

[36] The ECT accounts for the fact that actual exports do not adjust instantaneously to their long run determinants.

are also a lag polynomials of 12th degree but of the form $\sum_{j=1}^{12} b_j L^j$. For the second equation, $x_t^{ROW} = \ln X_t^{ROW} - \ln X_t^{ROWHP}$, where X_t^{ROW} and X_t^{ROWHP} are real exports to the rest of the world and it's Hodrick and Prescott trend, respectively; and Y_t^{ROW} is the industrial production index of the rest of the world.

Note that in equation (7) and (8), only V_t^A (the volatility of y_t^A) was included as an explanatory variable. As seen previously, the economic activity in Argentina could be modeled as either trend stationary or as difference stationary. From Figures 12 and 15 it is evident that the log deviation (with respect to trend) and the log difference of the industrial production index of Argentina appear to exhibit conditional volatility at the beginning of the sample. As such, it is necessary to adjust $ARMA-GARCH$ models to both variables in order to obtain a measure of their implicit volatility (V_t^A).[37] In the case of Brazil and the rest of world, from Figures 13, 14 and 16 it can be seen that they do not present conditional heteroscedasticity.

For the intra regional model, four equations will be estimated. In models 1 and 2, the variables Y_t^B and Y_t^A are considered TS. Of course, as the variables are not supposed to contain a unit root, they were not tested for cointegration and not included in the cointegrating vector, as seen before. In models 3 and 4, Y_t^B and Y_t^A are considered to be DS. This affects the estimated model in two ways: first, through the way the variables enter the model (in differences instead of trend adjusted, which in turn affects the volatility measure for Argentina); second, through the cointegrating vector, since it was seen before that these variables are co-integrated with exports to Brazil and with the $RERs$. Models with and without the economic activity of Argentina will be considered.[38]

For exports to the rest of the world (extra regional model), three equations will be estimated. In model 1, Y_t^A is considered to be TS. As before, the only effect of Y_t^A being considered TS is the way it is included in the model ($y_t^A = \ln Y_t^A - \ln Y_t^{AHP}$) and the usage of its derived volatility measure. In model 2, the economic activity of Argentina and its volatility are eliminated. Finally, in model 3, Y_t^A is considered to be DS (the variables are included in differences).

[37] A final $ARMA(3,13;1,2) - GARCH(0;2,8,12)$ was selected for the log deviation with respect to trend and an $ARMA(1,4,9,13;0) - GARCH(0;1)$ for the log difference of the industrial production index. These models are stationary and do not exhibit neither autocorrelation nor heteroscedastiticy in the standardized residuals.

[38] In model 3, the error correction term is that between all of the variables ($X_t^B, RER_t^B, RER_t^{ROW}$, Y_t^A and Y_t^B) while in model 4 it is that which excludes the industrial index of Argentina ($X_t^B, RER_t^B, RER_t^{ROW}$ and Y_t^B).

Models were estimated by OLS in a general to particular fashion, using a 10% significance level. Before proceeding, it is important to note that although the two step procedure applied here (first estimating the volatility and then including it into an exports equation) leads to consistent estimators, the estimated parameters may not be efficient (Pagan, 1984). In order to have parameters from which a reliable statistical inference could be made, the covariance matrix estimated in the second step is adjusted by accounting for heteroscedasticity in the error term.[39]

7.2 Econometric estimation: intra regional exports

Results for the four intra regional models are presented in columns two to five in Table 14. The table shows the steady state elasticities for each variable, based on the coefficients that proved to be significant in the general to particular analysis.[40] Then, the R^2, the F statistics for the joint significance of the model, and tests for autocorrelation and conditional heteroscedasticity in the residuals are presented. The overall results in terms of signs and the quality of the adjustment are very encouraging.

It can be seen that the economic activity of Argentina (measured either as a log deviation with respect to trend or in first differences) has a positive impact on the rate of growth of exports to Brazil. A 1% deviation of the industrial production index with respect to trend increases the rate of growth of intra regional exports by 0.34 percentage points. When Y_t^A is considered DS, a 1% increase in the rate of growth of the IPI increases the rate of growth of intra-regional exports by 0.15 points. This finding may be indicating that increases in the economic activity of Argentina may be capturing the presence of positive supply side shocks. Volatility of the economic activity also has a positive sign in both specifications, indicating maybe that a higher volatility induces producers to search for safer markets in which to sell their products. As expected, real demand in Brazil has a positive impact on exports in all of the estimated models, with the impact

[39] An alternative to the two stage procedure would have been to estimate a multivariate $GARCH$ in mean model ($MGARCH$). This would have allowed to model jointly the behaviour of both the exchange rates and exports (Kroner and Lastrapes, 1993). This strategy proved not to be succesful given the number of lags needed to capture the dynamics of the data with monthly observations. The presence of breaks for the RERs seen before, not accounted for in $MGARCH$ models, also played against a successful estimation.

[40] For example, in a regression of the form $y_t = a + by_{t-1} + cx_t + dx_{t-1} + e_t$, the elasticities are obtained for the steady state relation between the variables ($y_t = y_{t-1}$ and $x_t = x_{t-1}$): $y_t = \frac{a}{1-b} + \frac{(c+d)}{1-b}x_t$.

being somewhat weaker when the economic activity of Argentina and its volatility are not included in the estimations. For the case in which Y_t^B is considered TS, a 1% deviation with respect to trend increases the rate of growth of exports by 0.80 and 1.18 percentage points. While in the case in which Y_t^B is considered DS, a 1% increase in the rate of growth of the IPI of Brazil increases the rate of growth of intra regional exports by 2.05 and 2.57 percentage points.

While the correct signs were found for both the intra and extra $RERs$ at the moment of estimating the long run relationships between the integrated variables, these results are not maintained in the short run estimations. Remember that the RER_t^B is expected to have a positive impact on intra regional exports and the RER_t^{ROW} a negative one (the higher the RER_t^{ROW}, the lower the benefits of exporting to Brazil). However, when the error correction term was excluded from the short run estimation, the correct signs appeared for both $RERs$. This indicates that the short term adjustment in exports to Brazil is being absorbed mainly through the error correction term.

In the case of the focus variables, the volatility of the intra regional RER has the expected negative sign in all of the estimations.A one standard deviation increase in V_t^B reduces the rate of growth of intra regional exports between 1.37 and 4.10 percentage points. For the volatility of RER_t^{ROW}, the positive expected sign is found in three out of four estimations. A one standard deviation increase in V_t^{ROW} raises the rate of growth of exports between 2.32 and 2.63 percentage points.

Last but not least, all the error-correction terms have the expected negative sign, in the sense that a positive deviation from the long run relationship induces a reduction in the rate of growth of exports, guaranteeing convergence to the long run equilibrium.[41] Concerning the overall fitting quality, the econometric regressions do not present autocorrelation nor conditional heteroscedasticity.

7.3 Econometric estimation: exports to the rest of the world

The estimated results for equation (8) are presented in columns six to eight of Table 14. A higher real economic activity in Argentina leads now to a higher capacity utilization or to a higher local demand that ends crowding out exports to the rest of the world (negative sign). This result stands in contrast with the estimations for exports to Brazil. For the volatility of the

[41] Remember that this coefficient represents the partial short run adjustment that corrects deviation from long run equilibrium.

internal economic activity, in one case the efect is positive (inducing the search for safer markets), while in the other a negative sign appears. This suggests that instead of being an incentive to look for markets abroad, this type of volatility becomes an impediment to exports.

The economic activity of the rest of the world, which should act as an indicator of the level of demand for the goods produced in the country, has the expected positive impact on exports in only one up to three of the estimations.[42] The extra RER raises exports in two of the three estimations while the intra RER reduces it in all of them, as expected. Where a positive impact is found for RER_t^{ROW}, a 1% increase in the devaluation rate produces a deviation of exports from trend which amounts to 0.38 to 0.75 percentage points. In the case of RER_t^B, the negative impact ranges from -0.21 to -1.44 percentage points.

The focus variables (volatility in RER_t^B and RER_t^{ROW}) have the expected signs in almost all of the estimations. Evidence seems to suggest that, *ceteris paribus*, a one standard deviation increase in intra regional RER volatility makes extra regional exports deviate positively from the long run trend in magnitudes that go between 1.73 and 2.89 percentage points. For the extra regional RER volatility, findings seem to support that a one standard deviation increase has a negative impact going from 1.72 to 2.48 percentage points (in one case the RER_t^{ROW} is not significant). It is also worth noting that estimations do not exhibit autocorrelation or conditional heteroscedasticity.

To sum up, the estimated models of this section give support to the argument that the RER volatility affects exports in the Argentinean case.[43] Instead of considering only the direct impact of RER volatility with one region, third country effects were also considered in the analysis. The importance of accounting for this third country effect becomes apparent when evaluating the impact on exports of a potential strategy directed to reduce the RER volatility. Just accounting for the direct negative impact of real exchange rate volatility with one region may erroneously lead to an overestimation of the potential benefits of a volatility reduction. It is then important to weight the positive and negative effects on intra and extra regional exports of both types of RER volatility. This is the goal of the next section.

[42] This may be due to the fact that the stochastic properties of the variables made the trends not be included in the analyses.

[43] Heymann and Navajas (1992) found no evidence that RER volatility affects exports to Brazil using quarterly data for the period 1970 - 1991. This may be due to the fact that, when lower frequency data is used, the chances of finding a statistically significant relationship are reduced, since the volatility effect is diluted.

	Intra-regional exports				Extra-regional exports		
Variable	(1)	(2)	(3)	(4)	(1)	(2)	(3)
Intercept	0.71	0.50	0.25	0.52	0.02	-0.03	-0.01
$y_t^A = \ln Y_t^A - \ln Y_t^{AHP}$	0.34	–	–	–	-0.35	–	–
V_t^A for y_t^A	1.05	–	–	–	-1.83	–	–
$\Delta \ln Y_t^A$	–	–	0.15	–	–	–	-0.78
V_t^A for $\Delta \ln Y_t^A$	–	–	1.58	–	–	–	0.15
$y_t^B = \ln Y_t^B - \ln Y_t^{BHP}$	1.18	0.80	–	–	–	–	–
$\Delta \ln Y_t^B$	–	–	2.57	2.05	–	–	–
$(1-L)Y_t^{ROW}$	–	–	–	–	0.89	-1.96	-6.52
$(1-L)RER_t^{ROW}$	1.37	0.90	0.22	0.93	0.75	0.38	-0.40
$(1-L)RER_t^B$	-1.14	-0.82	-0.28	-0.81	-1.44	-1.23	-0.21
V_t^{ROW}	0.50	-0.08	0.56	0.25	0	-0.53	-0.08
V_t^B	-1.43	-0.48	-1.16	-0.79	0.60	0.97	0.34
ECT_{t-1}	-0.20	-0.14	-0.07	-0.13	–	–	–
R^2	0.72	0.68	0.74	0.68	0.41	0.43	0.59
F Value	15.81***	16.96**	14.66***	15.53***	8.49***	6.27***	9.84***
$LB(6)$	2.52	6.03	3.24	5.68	2.18	0.75	2.38
$LB(12)$	5.45	11.38	7.63	9.81	6.26	5.28	5.29
$ARCH(6)$	10.89	7.50	5.81	6.05	13.13	4.49	6.10
$ARCH(12)$	21.56*	17.64	16.53	14.58	18.65**	6.14	9.36

Notes: Dummies not reported. All the variables were significant at the 10% level. The t statistics were corrected for heteroscedasticity. The F statistic tests the overall significance of the model; $LB(X)$ is the Ljung-Box test for absence of autocorrelation of order X; $ARCH(X)$ is the LM test of absence of $ARCH$ disturbances of order X. "***", "**" and "*" denote significance at the 1%, 5% and 10% level.

Table 14: Regression results for intra and extra-regional exports

7.4 The effect of exchange rate volatility on exports

The *ceteris paribus* analysis conducted in the last subsection is not appropriate to quantify the impact on exports coming from a volatility reduction. While in this kind of analysis it is assumed that one volatility can be affected without altering the level of the other, in practice it is expected that they will not be independent. In particular, by fixing the Argentinean peso to the USD (for example), Argentina may not only be reducing directly the extra-regional exchange rate volatility, but it will also be affecting the intra-regional volatility. Now, the intra-regional exchange rate volatility will be explained by the volatility between the R$ and the USD, whereas before it was also due to the volatility between the $ and the USD (and the correlation between them).[44] Of course, it is not possible to say a priori weather one volatility will be reduced or rised and to what extent, when reducing the other. The final relation between both being an empirical question, a $VAR(P)$ model linking both volatilities was estimated.[45] The steady state relation between the variables are given by: $V_t^B = 0.04 + 0.41V_t^{ROW}$ and $V_t^{ROW} = 0.00 + 0.82V_t^B$. It is possible to see that a reduction in one volatility will entail a reduction in the other. Combining these results with the econometric estimations of the last subsection, a quantitative impact on exports (both intra and extra) of a reduction of both types of RER volatility will be computed.

Table 15 presents the results for the intra-regional and extra-regional models. First (rows two to four), the impact on exports of a one standard deviation reduction in V_t^{ROW} and the subsequent reduction in V_t^B, is analyzed. Then (rows five to eight), the effect of a one standard deviation reduction in V_t^B and the subsequent reduction in V_t^{ROW}, is studied. As V_t^B and V_t^{ROW} have usually opposing effects on X_t^B and X_t^{ROW}, a row with the net impact is added at the end in each case.

From columns two to five, it can be seen that in general, a reduction in

[44] The (log) exchange rate between the Argentinean peso ($) and the Brazilian Real (R$) can be decomposed as: $\ln(\$/R\$) = \ln(\$/USD) + \ln(USD/R\$)$. Taking the variance gives $V(\ln(\$/R\$)) = V(\ln(\$/USD)) + V(\ln(USD/R\$)) + 2Cov(\ln(\$/USD), \ln(USD/R\$))$. When fixing the exchange rate between the $ and the USD $V(\ln(\$/USD)) = Cov(\ln(\$/USD), \ln(USD/R\$)) = 0$. Also assume that $V(\ln(USD/R\$))$ is not affected by the fixing between the $ and the USD. Then, if $Cov(\ln(\$/USD), \ln(USD/R\$)) > 0$ before fixing, the result will be a reduction in the intra regional exchange rate volatility - $V(\ln(\$/R\$))$. If the covariance is negative, then the result will depend on the relation between $V(\ln(\$/USD))$ and $2Cov(\ln(\$/USD), \ln(USD/R\$))$. If $V(\ln(\$/USD)) + 2Cov(\ln(\$/USD), \ln(USD/R\$)) > 0$, then there will be a reduction in $V(\ln(\$/USD))$, while the opposite is true if $V(\ln(\$/USD)) + 2Cov(\ln(\$/USD), \ln(USD/R\$)) < 0$.

[45] The lag length was selected by the Schwartz Bayesian Criterion (SBC).

both types of RER volatilities (regardless of the origin of this reduction) has a positive impact on intra-regional exports. As such, the rate of growth of X_t^B is raised between 0.33 and 2.93 percentage points in the steady state. The impact is higher in the case of one standard deviation reduction in V_t^B (and the subsequent impact in V_t^{ROW}). Columns six to eight show that a volatility reduction (whatever its origin) has a negative impact on exports to the rest of the world, the negative deviation from trend being of the order of 0.18-2.02 percentage points. As before, the impact is higher (in absolute value) for the case in which the volatility reduction runs through the bilateral RER volatility.

To sum up, the quantitative results give support to the argument that the RER volatility affects exports in the Argentinean case.[46] Instead of focusing only the direct impact of RER volatility with one region, *third country effects* were also considered in the analysis. As such, reducing the intra and extra regional RER volatility has a positive impact on exports to Brazil while the effect on exports to the rest of the world tends to be negative. Additionally, the effect is magnified when the reduction takes place directly on the intra regional RER volatility.

The importance of accounting for *third country effects* becomes apparent when evaluating the impact on exports of a potential strategy directed to reduce the RER volatility. Forgetting its presence and just accounting for the direct negative impact of real exchange rate volatility with one region may erroneously lead to an overestimation of the potential benefits of a strategy directed to reduce the RER volatility. Also, the relative magnitudes of the direct and cross-country (indirect) effects and the correlation between intra and extra-regional RER volatility is such that a trade-off exists at the level of volatility as a whole. As such, reducing any of the RER volatilities boosts intra-regional exports while hurts exports to the rest of the world. The effect is magnified when the reduction runs directly through the bilateral RERvolatility.

[46] As aforementioned, Heymann and Navajas (1992) found no relation between RER volatility and exports to Brazil, using quarterly data for the period 1970 - 1991. This may be due to the fact that low frequency data dilutes the measure of volatility and reduces the chances of finding a statistically significant coeficient. It can also be explained by the volatility estimator used (a rolling standard deviation), that generates biased coefficients in the export equation.

	Intra-regional exports				Extra-regional exports		
	(1)	(2)	(3)	(4)	(1)	(2)	(3)
Impact on exports of one STD reduction in V_t^{ROW} and subsecuent reduction in V_t^B							
Intra Regional Volatility (V_t^B)	2.70	0.90	2.19	1.49	-1.14	-1.84	-1.90
Extra Regional Volatility (V_t^{ROW})	-2.32	0.38	-2.63	-1.16	0.00	2.48	1.72
Net Effect	**0.38**	**1.28**	**-0.44**	**0.33**	**-1.14**	**0.64**	**-0.18**
Impact on exports of one STD reduction in V_t^B and subsecuent reduction in V_t^{ROW}							
Intra Regional Volatility (V_t^B)	4.10	1.37	3.33	2.27	-1.73	-2.79	-2.89
Extra Regional Volatility (V_t^{ROW})	-1.17	0.19	-1.33	-0.58	0.00	1.25	0.86
Net Effect	**2.93**	**1.56**	**2.00**	**1.68**	**-1.73**	**-1.55**	**-2.02**

Table 15: Impact on intra and extra-regional exports

8 Conclusion

The present paper deals with the link between RER volatility and intra and extra-regional exports in the case of Argentina, in an attempt to give some useful clues for the debate on the optimal choice of the exchange rate regime for that country. Up to now, the evaluation of the costs and benefits of fixing the national currency have only been discussed on the grounds of the Optimal Currency Areas (OCAs) criteria and on the theory of Credibility Gains. But another key element not accounted for in the previously mentioned theories is the volatility in $RERs$.

Depending on the correlation between intra and extra-regional RER volatility and on the relative magnitudes of the direct and cross-country (indirect) effects, volatility may positively or negatively affect both type of exports and may also trigger trade-offs (exports to one region are boosted while the others are hurted). The final scenario in which the economy is in is the empirical question adressed in this paper. To uncover this effect, the family of $SWARCH$ econometric models was used to obtain the implicit magnitudes of RER volatility and then included in export equations to asses their significance for Argentina. Econometric results show that direct effects are negative.[47] But concentrating only on the direct negative effects with one region may erroneously lead to an overestimation of the potential benefits of a strategy directed to reduce volatility. It also says nothing about the relative benefits of fixing to intra or extra regional currencies. The inclusion in the analysis of third country (indirect) effects points, as expected, to a positive effect of extra and intra regional volatility on exports to Brazil and to the rest of the world, respectively.

More importantly, the quantitative results show that a reduction in volatility (whatever its origin) produces a trade-off between intra and extra-regional exports. Reducing volatility has a positive impact on exports to Brazil but a detrimental effect on exports to the rest of the world. Indeed, the results obtained here highlight that the debate of fixed vs flexible exchange rates in Argentina also involves the political dimension on to which region is prioritized regarding commercial integration. This seems then to

[47] Other papers also point to a negative direct effect of bilateral real exchange rate volatility in the case of developing countries (see among others, Grobar 1993; Kroner and Lastrapes, 1993; Caporal and Doroodian, 1994; Doroodian, 1999, Arize et al., 2004). It is argued, that in developing economies were financial markets and hedging instruments (to insure against exchange variations) are less developed, the effect of exchange rate volatility on trade should be more important (negative) than in richer economies (Devlin et al, 2001).

be a factor that policy makers should take into account when evaluating the relative advantages of fixing the local currency. Even more, evidence highlights that the trade-off is magnified when the reduction takes place directly on the intra regional volatility. This means that a pegging between the Argentinean Peso and the Brazilian Real would have a sizable positive impact on exports to Brazil but a negative one on exports to the rest of the world. Indeed, if Argentina is committed to deepen commercial integration with Brazil the possibility of coordinating exchange rate policies should not be excluded.[48]

A very fruitful extension of the paper would be to run a similar econometric exercise for the rest of the Mercosur member countries in order to see weather similar trade-offs are also taking place in those cases. This would give a broader picture on which to discuss the scope and relative benefits of deepening the actual integration process and to discuss potential strategies directed to coordinate the exchange rates in the region.

[48] Of course, an argument can be made that in terms of policy analysis this would mean to fix the nominal exchange rate, while the calculations performed here relate to the real exchange rate. In any case, it is expected that a fixing of the nominal exchange rate will bring a huge reduction in the real exchange rate volatility.


Fig 1
Exports to Brazil (in USD of January 1980)
Fig 2
Exports to the ROW (in USD of January 1980)
Fig 3
Bilateral RER with Brazil
Fig 4
RER with the ROW
Fig 5
IPI of Argentina
Fig 6
IPI of Brazil
Fig 7
IPI of the ROW
date

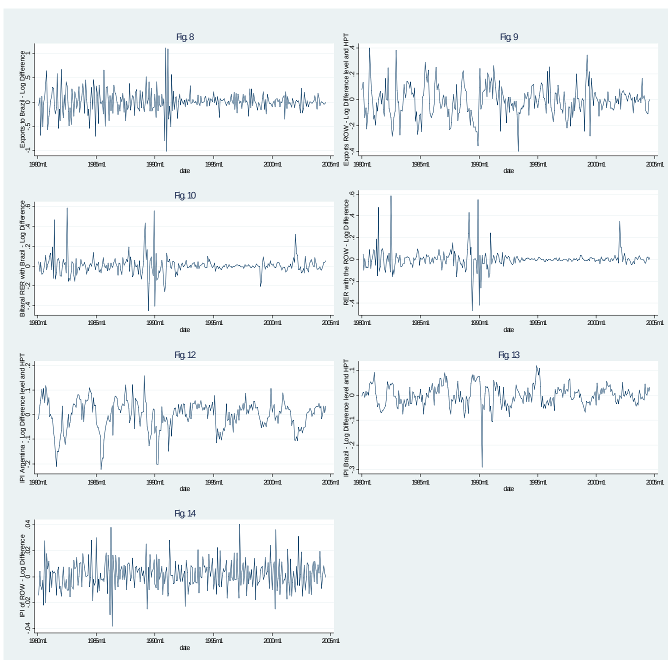


Fig 8
Exports to Brazil - Log Difference
Fig 9
Exports ROW - Log Difference level and HPT
Fig 10
Bilateral RER with Brazil - Log Difference
Fig 11
RER with the ROW - Log Difference
Fig 12
IPI Argentina - Log Difference level and HPT
Fig 13
IPI Brazil - Log Difference level and HPT
Fig 14
IPI of ROW - Log Difference
date

Fig. 15

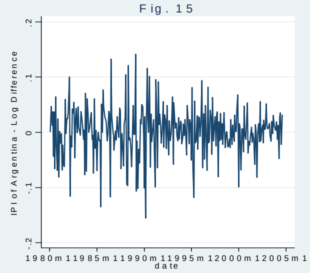


Fig. 16

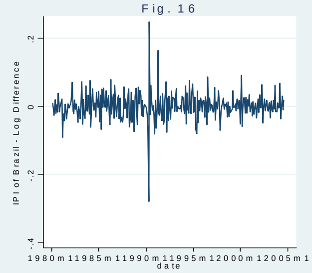


Fig. 17

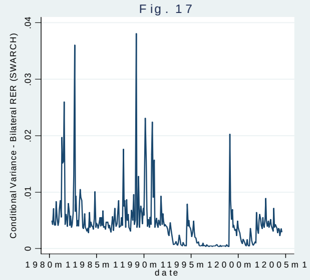
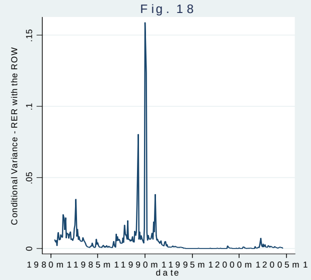


Fig. 18



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