Universidade Federal do Rio de Janeiro
Instituto de Economia

TERMS-OF-TRADE FLUCTUATIONS AND THEIR IMPLICATIONS FOR EXCHANGE-RATE COORDINATION IN MERCOSUR

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Nelson H. Barbosa-Filho

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TERMS-OF-TRADE FLUCTUATIONS AND THEIR IMPLICATIONS FOR EXCHANGE-RATE COORDINATION IN MERCOSUR*

Nelson H. Barbosa-Filho**

Abstract: This paper presents the correlation between the annual fluctuations of the terms of trade of Brazil, Argentina, Uruguay and Paraguay. The period under analysis is 1980-2001 and the main findings are that the four countries have a high to moderate synchronization of their export prices, a moderate to low synchronization of their import prices, and a low synchronization of their terms of trade. The small positive correlation between the growth rates of the terms of trade of Brazil and Argentina (0.24) support exchange rate coordination between the two countries, provided that their bilateral real exchange rate is allowed to fluctuate temporarily to accommodate possible differences between the intensity of shocks across them. For instance, given an adverse shock to Brazil, both the Brazilian and Argentine real exchange rates against the rest of the world (domestic good per unit of foreign good) should increase to avoid a reduction, or smooth the variation, of their trade balances, but the Argentine currency should appreciate against the Brazilian currency in real terms because Argentina tends to be less affected by the shock. The observed correlations indicate that, through a joint and flexible managed float of their currencies, Argentina and Brazil may be able to share the benefits and costs of terms-of-trade shocks without imposing major macroeconomic disruptions on each other. In such an arrangement and also based on the observed correlations, Uruguay may either follow Argentina, when the terms-of-trade shock is more intense to Brazil, or do nothing, when the shock is more intense to Argentina. In contrast, Paraguay should follow Brazil, when the terms-of-trade shock is more intense to Argentina, or do nothing, when the shock is more intense to Brazil. Because of the low correlation between the terms-of-trade fluctuations of Brazil and Argentina, the best form of exchange-rate coordination for the near future seems to be a *Mercosur* version of the European Monetary System of 1979-98, that is, a wide interval of fluctuation for the regional currencies around a common and competitive real exchange rate against the rest of the world.

Keywords: Terms of Trade, Mercosur, Exchange Rate Coordination

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** Institute of Economics, Federal University of Rio de Janeiro. E-mail: nhbarbosa@ie.ufrj.br.

1 – Introduction

The recent currency crises and financial turmoil in Brazil and Argentina clearly indicated how the macroeconomic stability in both countries is interdependent. First, in the wake of the Brazilian 1998-99 crisis, the Argentine exchange-rate system came under a lot of stress. The transmission mechanism was the contagion effect of the Brazilian devaluation on investors' expectation about the sustainability of the Argentine peg to the US dollar, as well as the negative impact of the Brazilian devaluation on the Argentine trade balance. Then, as the Argentine peg crumbled in 2001-02, it was Brazil who experienced a run on its currency because of the contagion effect of the Argentine devaluation and default on investors' confidence on the Brazilian currency. Macroeconomic stability was restored in 2003, after Brazil and Argentina came under new administrations.

Independently of the idiosyncrasies of and differences between Lula's and Kirchner's macroeconomic policies, the lessons from the past and the quick realignment of the Brazilian and Argentine currencies after 2002 gave new strength to the idea of macroeconomic coordination in *Mercosur*, especially exchange-rate coordination between Brazil and Argentina.[1] The logic supporting coordination is straightforward: as two small and liquidity-constrained economies, Brazil and Argentina are subject to booms and busts caused by fluctuations in international financial conditions, especially in international liquidity.[2] In such an environment, a stable bilateral real exchange rate may be useful to cope with common financial shocks from abroad without disrupting trade and financial relations between the two countries. If anything, the recent Brazilian and Argentine currency crises made it clear that a mutually consistent exchange-rate regime in both countries is a necessary condition for the successful economic integration of *Mercosul*.

More specifically, a low volatility of the real exchange rate between Brazil and Argentina can be beneficial for the growth and international competitiveness of both countries through basically two channels. First, it would promote intra regional trade and allow both countries to benefit from the scale and learning economies associated with it. Second, it would foster the integration and deepening of regional financial markets, allowing an increase in risk diversification and capital accumulation in both countries.

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[1] In the Declaration of Buenos Aires, in October 2000, the governments of the two countries agreed to promote macroeconomic convergence and policy coordination. The financial turmoil and exchange-rate misalignment of 2001-02 kept this initiative dormant. The exchange-rate realignment of 2003, together with the inauguration of new administrations in both Brazil and Argentina, raised once again the possibility of macroeconomic coordination. For an earlier analysis of coordination, see, for instance, Eichengreen (1998).

[2] For a structuralist perspective on the operation of liquidity constraints in the balance of payments, see Barbosa-Filho (2004a).

Even though the main reasons for exchange-rate coordination between Brazil and Argentina are based on the common financial shocks experienced by both countries in recent years, it is also important to analyze whether or not such a move also makes sense in relation to their terms of trade. As liquidity constrained economies, Brazil and Argentina tend to adjust their trade balances to the availability of foreign finance.[3] A stable bilateral real exchange rate would therefore be useful only if both countries are subject to common price shocks from the rest of the world. In fact, one of the classic results of the theory of Optimal Currency Areas is that, to stabilize or smooth variations in income, it is optimal for two regions to have a common currency only if they are subject to similar price shocks.[4] For instance, if the export prices of Brazil and Argentina fluctuate together, then a common devaluation of their currencies against the rest of the world may be useful to compensate a reduction in their export prices and, in this way, smooth the adjustment of their trade balances to the new international conditions.

In addition to the above and given the fact that a common exchange-rate policy would also have to be extended to Paraguay and Uruguay to preserve the current structure of *Mercosur*, it is also necessary to investigate whether or not fluctuations of the terms of trade of these two countries support the case for coordination with Brazil and Argentina.

The objective of this paper is to analyze the correlation between the export and import prices of all four *Mercosur* economies and the implications of these correlations for exchange-rate coordination. More formally, the aim is to measure the degree of co-movement between of terms of trade of each pair of *Mercosur* countries and analyze the implications of this for a common exchange-rate policy in face of liquidity constraints. The period under analysis is 1980-2001 and, since we have just 22 annual observations, the statistical analysis is concentrated on the sources of correlation between each pair of *Mercosul* countries.[5] Assuming that export and import prices have many determinants, but that not all of these determinants change at the same time, the analysis will be focused on the fluctuations rather than on the level of these prices.[6]

The text is in five sections in addition to this introduction. Section two analyzes the fluctuations of export prices and section three does the same for import prices. Section four merges export and import prices in the analysis of the terms of trade. Section five discusses the

[3] For the evidence on Brazil, see Barbosa-Filho (2004a).
[4] The basic ideas of the Optimum-Currency-Area literature can be found in Mundell (1961 and 1996). For a more recent empirical study, see Rose and Engel (2000).
[5] For an analysis of the case of Brazil and Argentina, using quarterly data, from 1980 through 2002, see Barbosa-Filho (2004b). The results with quarterly data are qualitatively the same as the ones presented in this paper.
[6] Because the price series tend to be integrated of order one, working with their first difference has the additional advantage of concentrating the analysis on stationary time series.

implications of the empirical findings for exchange-rate coordination and section six concludes with a summary of the main results and recommendations of the paper.

2 – Export Prices

Figure 1 presents the growth rate of the export price index of each *Mercosur* country.[7] To facilitate the visual comparison, we plot the series of each pair of countries in separate graphs. The main stylized facts are the following:

(i) There is a high synchronization between Brazil, Argentina and Uruguay, that is, the direction of change of their export prices is the same during most of the period under analysis.

(ii) Paraguay move practically together with its *Mercosur* partners in the early and mid-1980s, but with a substantially higher volatility. In the mid and late 1990s, the Paraguayan export price showed once again a small synchronization with the other three *Mercosur* countries, especially Brazil

See figure 1.

Table 1 presents the main statistical properties of the series of each country. The main stylized facts are:

(i) The average growth rate of the export price was negative (between zero and minus 1%) for Brazil, Argentina and Uruguay. Only Paraguay had a positive growth rate of its export price during the period under analysis.

(ii) Paraguay had the highest volatility in absolute terms, whereas Argentina had the highest volatility in relative terms.[8]

(iii) Given a shock, the adjustment of the growth rate of the export price to its mean tends to be faster for Argentina than for the other three *Mercosur* economies. In numbers, 99% of the adjustment tends to be completed in approximately 21 months for Argentina, 30 months for Uruguay, 33 months for Paraguay and 35 months for Brazil.[9]

See table 1.

[7] Unless stated otherwise, the growth rates equal the difference of the natural logarithm of the corresponding series.

[8] The standard deviation measures the absolute volatility and the coefficient of variation (standard deviation divided by the absolute value of the mean) measures the relative volatility.

[9] To calculate the duration of the adjustment, all series were specified as a first-order autoregressive AR process and the estimated AR coefficient was used to calculate how long it would take for 99% of a temporary (one-period) shock to die out.

To investigate the degree of co-movement across countries, table 2 presents the lag, contemporaneous and lead correlation between the growth rates of the export price for each pair of countries.[10] Because of the limited number of observations, only correlations with one lead or lag were calculated. In all pairs of countries the contemporaneous correlation is the highest one, that is, the pattern in *Mercosur* seems to be for export prices to fluctuate together rather than one country to lead or lag the other. Overall, the main stylized facts are:

(i) The highest correlation is observed between Brazil and Uruguay (0.74), followed closely by Brazil and Argentina (0.69). The lowest correlation occurs between Brazil and Paraguay (0.42).

(ii) With the exception of Brazil and Paraguay, all correlation coefficients are higher than 0.5, which indicates a high degree of co-movement between the export prices of *Mercosur* economies.[11]

See table 2.

In order to have a benchmark for comparing the correlations within *Mercosur*, table 3 presents the correlation between each *Mercosur* country and the US. Setting 0.5 as the cutoff value between a "low" and a "high" correlation, Brazil and Paraguay also show a high correlation with the US. However, in the case of Brazil, the correlations with Argentina and Uruguay are still higher than with the US, whereas in the case of Paraguay only the correlation with Argentina is higher than with the US. Finally, only for Argentina and Uruguay the correlations with all *Mercosur* countries are higher than with the US.

See table 3.

Based only on the fluctuation of export prices, we can conclude that there is evidence of a strong synchronization of Brazil, Uruguay and Argentina, which in principle tends to support the case for exchange-rate coordination between these countries. Let us now see the evidence on import prices.

3 – Import Prices

[10] In economic terms, the correlation coefficient measures the impact of fluctuations in one variable on the conditional expectation of the other variable. More formally, let $E(A|B)$ be expectation of A given B, by definition $E(A|B)=E(A)+CORR(A,B)x[S(A)/S(B)]x[B-E(B)]$, where $E(A)$ and $E(B)$ are the unconditional expectations of A and B, respectively; $CORR(A,B)$ is the correlation between A and B; and $S(A)$ and $S(B)$ are the standard deviations of A and B respectively.

[11] Formally and based on the previous footnote, assuming that the series in question have the same volatility, S(A)=S(B), a correlation of 0.5 indicates that 50% of the fluctuation in B is transmitted to the expectation of A given B.

Figure 2 presents the growth rates of the import price each *Mercosur* country. As we did in section two, each pair of countries is shown in separate graphs and the main stylized facts are:

(i) There was basically no synchronized fluctuation of import prices between Brazil and Argentina from 1980 up to the creation of *Mercosur*, in 1988. After that the growth rate of the import prices show some joint fluctuations, but around different levels.

(ii) Brazil and Uruguay showed synchronized fluctuations of import prices during most of the period under analysis.

(iii) Argentina and Uruguay had de-synchronized changes of their import prices in the early 1980s. Then, from the mid-1980s onwards, the direction of change was basically the same.

(iv) The fluctuation of the Paraguayan import price showed a high synchronization with Brazil and Uruguay from 1980 up to the mid-1990s. The synchronization with Argentina was low during most of the period under analysis.

See figure 2.

Table 4 presents the main statistical properties of the series of each country. The main stylized facts are:

(i) The average growth of import prices was positive and low for Argentina. The other three *Mercosur* countries registered a negative annual rate between minus 1 and minus 2%.

(ii) The growth rate of Brazilian import prices had the highest volatility in absolute terms, but the lowest volatility in relative terms. Because its mean growth is close to zero, Argentine import prices had the most volatile growth rate in relative terms. The relative volatility for Paraguay and Uruguay was basically the same.

(iii) The persistence of shocks was higher for the growth rate of Argentine import prices, followed closely by Brazil. Given a temporary shock, it took Argentina and Brazil approximately 45 and 43 months to complete 99% the adjustment, respectively. The adjustment periods for Uruguay and Paraguay were 33 and 28 months, respectively.

See table 4.

Moving to cross-country effects, table 5 presents the correlation between the growth rates of the import prices for each pair of countries. As we verified for the export price, the highest correlations occur with no lag or lead. However, with the exception of Brazil and Paraguay, the contemporaneous correlation between the growth rates of import prices is lower than between the growth rates of export prices analyzed earlier. The main stylized facts are:

(i) The lowest correlation occurs between Argentina and Paraguay (0.30), followed closely by the one between Brazil and Argentina (0.34).

(ii) The highest correlation occurs between Uruguay and Paraguay (0.70), followed by Brazil and Paraguay (0.57).

(iii) The correlation between Brazil and Uruguay and between Argentina and Uruguay is approximately the same (0.49).

See table 5.

As we did in the previous section, table 6 shows the contemporaneous correlation between each *Mercosur* country and the US. In contrast to what happens with export prices, the evidence indicates that correlations with the US tends to be higher than with *Mercosur*. For instance, in the case of Brazil, the correlation with the US is higher than with Argentina. In the case of Argentina, fluctuations of the import price are more correlated with the US than with any of its *Mercosur* partners. In the same vein, Uruguay has a higher correlation with the US than with Brazil and Argentina, and only Paraguay shows more synchronization with *Mercosur* (meaning Brazil and Uruguay) than with the US.

See table 6.

So far the pattern between *Mercosur* countries can be summarized as moderate to high correlation between export prices and moderate to low correlation between import prices. When compared with fluctuations of the US prices, the joint fluctuations of the export prices of Brazil, Argentina and Uruguay are higher, which support exchange-rate coordination of these three countries. In contrast, fluctuations of import prices point to coordination of these three countries with the US rather than with each other. The natural solution is therefore a coordination of Brazil, Argentina and Uruguay with each other around a common exchange rate with the US. To complete the analysis, let us now see how the export price of one country impacts on the import prices of another country within *Mercosur*.

4 – Terms of Trade

Figure 3 presents the evolution of the terms of trade of each pair of *Mercosur* countries. The main stylized facts are:

(i) There was little synchronization between the fluctuations of the terms of trade of Brazil and Argentina during the period under analysis. The common changes seem to be a coincidence rather than a regular pattern.

(ii) The Brazilian and Uruguayan terms of trade showed some synchronized fluctuations only in the mid-1980s and late 1990s.

(iii) Argentina and Uruguay had almost no synchronized fluctuation of their terms of trade. In fact, during most of the 1990s, the terms of trade of each country fluctuated in opposite directions.

(iv) Of its three *Mercosur* partners, Paraguay showed some synchronized fluctuation only with Argentina, and only in the mid 1980s.

See figure 3.

Table 7 presents the main descriptive statistics of series of each *Mercosur* economy. The main stylized facts are:

(i) The average growth rate was positive for Brazil, Paraguay, and Uruguay, and negative for Argentina.

(ii) The terms of trade of Paraguay had the most volatile growth rate in absolute terms, whereas Uruguay had the highest volatility in relative terms, followed by Argentina. Brazil and Paraguay had almost the same relative volatility.

(iii) The persistence of shocks was higher for Argentina, followed by Brazil, Paraguay and Uruguay. Given an exogenous shock, 99% of the adjustment tends to be completed in 47 months for Argentina, 40 months for Brazil, 28 months for Paraguay and just 13 months for Uruguay.

See table 7.

Table 8 presents the correlation between each pair of *Mercosur* countries. With the exception of Argentina and Paraguay, and contrary to what happens with export and import prices, all coefficients are below 0.5. In short, the main stylized facts are:

(i) Despite the high correlation between the growth rates of their export prices, there is a low correlation between the growth rate of the terms trade of Brazil and Argentina (0.24). The same holds for Brazil and Uruguay.

(ii) There is a small correlation between the growth rates of the terms of trade of Brazil and Paraguay, with changes for Brazil seeming to lead and be positively related to changes for Paraguay.

(iii) Similarly, changes in the terms of trade of Uruguay seem to lead and be negatively related to changes in the terms of trade of Argentina.

(iv) Uruguay and Paraguay show a small negative correlation, with Uruguay seeming to lead the Paraguay.

See table 8.

Table 9 presents the contemporaneous correlation between the growth rates of the terms of trade of the US and each *Mercosur* country. On the one hand, for Argentina and Paraguay, there is approximately no correlation with the US. On the other hand, for Brazil and Uruguay, there is a small positive correlation with the US. In the case of Brazil, the correlation with the US is actually higher than with Argentina.

See table 9.

The evidence on the terms of trade indicates that there is basically no synchronized fluctuation between Brazil and Paraguay on the one hand, and between Argentina and Uruguay on the other hand. Despite this, the small positive correlation between Brazil and Argentina lend some support to exchange rate coordination between the two largest *Mercosur* economies, although for Brazil the evidence also support exchange-rate coordination with the US. Before we analyze the policy implications of this finding, let us see the sources of the terms-of-trade correlations.

The low contemporaneous correlation coefficients in table 9 indicate that, in addition to the correlation between export prices and import prices, there may be a positive “cross” correlation between the export price of one country and the import price of another country within Mercosur, which is an obvious consequence of intra regional trade. For instance, in the case of Brazil and Argentina, the high correlation between their export prices tends to result in a high correlation between the terms of trade *ceteris paribus*. However, if the export price of Brazil is also highly and positively correlated with the import price of Argentina because of

bilateral trade, a change in the former tends to increase both the export and import prices of Argentina, having only a small impact on the Argentine terms of trade. Thus, despite synchronized fluctuations of export prices, the result may be a low correlation of the terms of trade.

To analyze the import-export price correlation within *Mercosur*, table 10 presents all contemporaneous correlation coefficients between the growth rates of the export and import prices for each pair of countries. In economic terms, the numbers can be interpreted as follows:

- Brazil and Argentina: the low correlation between the terms of trade occurs because the correlation between export prices (0.69) is partially compensated by the correlation between Brazilian export and Argentine import prices (0.44). In the same vein the correlation between import prices (0.34) is partially compensated by the correlation between Brazilian import and Argentine export prices (0.20).

- Brazil and Paraguay: the almost zero correlation between the terms of trade occurs because the correlation between the import price of Brazil and the export price of Paraguay (0.46) compensates the correlation between the export prices (0.42) and between the import prices (0.57) of the two countries.

- Brazil and Uruguay: the small correlation between the growth rates of the terms of trade occurs because the correlation between export prices (0.74) is compensated by the correlation between Brazilian export and Uruguayan import prices (0.54), whereas the correlation between import prices (0.49) is only partially compensated by the low correlation between Brazilian import and Uruguayan export prices (0.17).

- Argentina and Paraguay: the high correlation between the growth rates of the terms of trade occurs basically because of the high correlation between the export prices of the two countries (0.68), which is not compensated by a high correlation between the export price of one country and the import price of the other country.

- Argentina and Uruguay: the almost zero correlation between the growth rates of the terms of trade is a result of the high correlation between the export and import prices of the two countries. In fact the highest correlation is registered between Argentine export and Uruguayan import prices (0.67), which pretty much compensates the correlation between the export prices of the two countries (0.56). Similarly, the correlation between the import prices (0.49) is compensated by the correlation between Argentine import prices and Uruguayan export prices (0.41).

- Uruguay and Paraguay: the low correlation between the growth rates of the terms of trade (0.32) is basically a result of the high correlation between the growth rates of the import prices of the two countries (0.70), which is not compensated by the correlation between the growth rates of the import price of Uruguay and the export price of Paraguay (0.16). The correlation between the growth rates of export prices (0.58) is compensated by the correlation between the growth rates of the export price of Uruguay and the import price of Paraguay (0.53).

See table 10.

Using the fact that the covariance between the growth rates of the terms of trade of any two countries can be decomposed additively into its export-export, import-import, export-import and import-export elements, we can isolate the "contribution" of each coefficient in table 10 to the terms-of-trade correlation.[12] The results are presented in table 11 and, taking the first line as an example, the interpretation is that the 0.24 correlation between Brazilian and Argentine terms of trade can be decomposed as follows: 0.37 from the positive covariance between export prices; 0.14 from the positive covariance between import prices; minus 0.12 from the positive covariance between the Brazilian export price and the Argentine import price; and minus 0.15 from the positive covariance between the Brazilian import price and the Argentine export price. In other words: 0.24=0.37+0.14-0.12-0.15.

See table 11.

Comparing the numbers in table 10 and 11, we can see that the ordering of the contribution of each element to the terms-of-trade correlation does not necessarily correspond to the ordering of its correlation coefficient. For instance, in the case of Brazil and Argentina, the correlations in table 10 indicate that Brazilian export prices tend to have a higher impact on Argentine import prices (0.44) than Argentine exports price on the Brazilian import price (0.20). However, when we calculate the contribution of the covariances, we see that the effective impact of Brazilian export prices on Argentine import prices (0.12) is actually slightly lower than of Argentine export prices on Brazil import prices (0.15). The discrepancy lies on the different volatility (standard deviation) of the series in question and the intuition is that the higher correlation coefficient in one direction (from Brazil to Argentina) is compensated by the higher variation in the other direction (from Argentina to Brazil), resulting in basically the same contribution in both directions.

5 – Implications for exchange-rate coordination

[12] See the appendix for the formal details of this decomposition.

From the previous sections we can conclude that the four *Mercosur* countries tend to have a high positive correlation between the growth rates of their export prices, a moderate positive correlation between the growth rates of their import prices and a low positive correlation between the growth rates of their terms of trade. The latter is basically the result of the high correlation between the growth rates of the export price of one country and the import price of another country caused by intra-regional trade. To analyze the implications of this for exchange-rate coordination, and given the centrality of Brazil and Argentina for *Mercosur*, let us first see what would be the best exchange-rate arrangement between these two countries.

The underlying assumption of this section is that both Brazil and Argentina are liquidity constrained countries in international financial markets, so that causality runs from capital flows today to trade flows tomorrow. In other words, because these countries face incomplete financial markets abroad, they have to adjust their current accounts to the supply of foreign finance in other to keep their international reserves at a level consistent with stable exchange rates. Since variations in the current account of Brazil and Argentina are basically the result of variations in their trade balance,[13] the chain of causality runs from capital flows today to trade flows tomorrow.

What are the implications of terms-of-trade shocks in the above situation? Given a shock to their export or import prices, Brazil and Argentina may promote a compensatory change of their nominal exchange rate to avoid an excessive variation of their trade balances away from the levels consistent with macroeconomic stability. In short, Brazil and Argentina may have to devalue their currencies after adverse changes in their terms of trade and revalue after favorable shocks to keep trade consistent with the liquidity constraint. The price rigidity in the two countries guarantees that, at least in the short run, changes in nominal exchange rates result in changes in their real exchange rates, which in their turn tend to smooth the variations of their trade balances.

Do the two countries need to change their exchange rates against the rest of world in the same direction and proportion? Here enters the importance of the terms-of-trade correlations for Brazil and Argentina. According to the previous section the answer is yes for direction but no for proportion. To see this, consider the situation after an adverse shock to the Brazilian terms of trade. The Argentine terms of trade are likely to fall as well, but proportionally less than for Brazil. The change in relative prices (and the liquidity constraint) calls therefore for devaluation in both countries, but not in the same intensity. In other words, after an adverse

[13] According to the annual data of 1980-2001, the correlation between changes in the trade and changes in current account balance is 0.91 for Brazil and 0.95 for Argentina, that is, adjusting the current account means adjusting the trade balance for both countries.

shock to the Brazilian terms of trade, devaluation should be higher in Brazil than in Argentina because only a small part of the Brazilian shock is transmitted to Argentina. The net effect would thus be an increase in the real exchange rate (unit of domestic output per unit of foreign output) of both countries against the rest of the world, which fully or partially compensates the impact of the new world relative prices on their trade balances. Between the two countries, the Argentine currency will appreciate against the Brazilian currency in real terms, having a negative impact on the Argentine bilateral trade balance with Brazil. The final result is that the costs of the adverse shocks to Brazil are partially financed by Argentina through changes in their bilateral trade balance.

Why would Argentina want to do the above? Because, theoretically, the opposite will happen in case of an adverse shock to Argentina. In short, after a reduction in the Argentine terms of trade, both Argentina and Brazil will devalue, but the Brazilian currency will appreciate against the Argentine currency in real terms. The change in the bilateral exchange rate will then make Brazil finance part of the costs of the adverse shock to Argentina. The reasoning is the same in the case of favorable shocks to the terms of trade, that is, the gains from the changes in the relative prices of one country will be shared with the other country through changes in their bilateral exchange rate.

Overall, the low positive correlation between the growth rates of Brazilian and Argentine terms of trade allows the two countries to diversify and share the risk of shocks by jointly managing the float of their currencies. The next question is what is the best exchange-rate regime to implement the risk sharing. The answer depends on whether the terms of trade of both countries share a common trend.[14] In case they do, both countries should adopt a joint managed (dirty) float of their currencies to stabilize their real bilateral exchange rate. The temporary changes in the bilateral real exchange rate will then depend on which country is most affected by changes in world prices, but they should not depart too much from the pre-specified peg for coordination to be effective.

The same managed float is theoretically possible when the terms of trade of Brazil and Argentina have divergent trends. The difference is that instead of fluctuating around a stable level, the currencies would have to fluctuate around a moving peg. The practical problem with this is that, in the long run, the currency of one country tends to become infinitely cheap in relation to currency of the other country in order to compensate for the divergent trends in their terms of trade. The historical evidence indicates that such situations are not likely to last indefinitely, that is, deteriorating terms of trade are likely to promote structural changes in the

[14] As shown in Barbosa-Filho (2004b), the terms of trade of Brazil and Argentina had different trends in the 1980s and early 1990s. Since then both countries seem to fluctuate around a common trend.

countries affected by it. In the case of Brazil and Argentina, it should also be noted that an increase in bilateral intra-industry trade may also result in a common trend for the terms of trade between the two countries, that is, exchange-rate coordination may promote terms-of-trade synchronicity.[15]

Moving to the implications of a Brazilian-Argentine coordination for Paraguay and Uruguay, the main issue to consider is that the terms of trade of Uruguay fluctuate almost independently of the terms of trade of Argentina, whereas the terms of trade of Paraguay fluctuate almost independently of the terms of trade of Brazil. Because of this, the response of Uruguay and Paraguay to terms-of-trade shocks to Brazil and Argentina depends on which of the later is most affected by the shock.

For instance, consider the case of Uruguay. A reduction in the Brazilian terms of trade is likely to be accompanied by a reduction in the Uruguayan terms of trade, but the shock to Uruguay tends to be smaller than the one to Brazil. The situation is basically the same as between Argentina and Brazil analyzed earlier, that is, the Uruguayan and Brazilian currencies should be devalued against the rest of the world to compensate the changes in relative prices, but the Uruguayan currency should appreciate against the Brazilian currency in real terms. The opposite holds for the case of an increase in the terms of trade of Brazil.

When the shock is to Argentina rather than to Brazil, the terms of trade of Uruguay are likely to remain the same. No compensatory exchange-rate variation is needed to compensate changes in relative prices because of the almost zero contemporaneous correlation between the fluctuations of the terms of trade of Uruguay and Argentina. However, Uruguay may end up following either Brazil or Argentina into devaluation to avoid a reduction in its trade balance with these countries.

In general terms and assuming that Brazil and Argentina coordinate their exchange-rates in the way outlined earlier, Uruguay has three choices after an adverse shock to the Argentine terms of trade: do nothing, follow Brazil or follow Argentina. If Uruguay does nothing, its currency will appreciate against Brazil and Argentina but remain the same against the rest of the world. The result will be neutral for the Uruguayan world trade balance but negative for its trade balance with Brazil and Argentina.

[15] As pointed by Frankel and Rose (1996) and Corsetti and Pesenti (2002), trade integration can be both a pre-condition and a consequence of a successful economic integration. In other words, intra-regional trade usually increases after economic integration. If this results in more inter-industry trade, the trade flows of both countries may become increasingly concentrated on the same goods and, therefore, influenced by the same prices.

If Uruguay follows Brazil, its currency will appreciate against Argentina and depreciate against the rest of the world. The result is neutral for the Uruguay-Brazil trade balance, negative for the Uruguay-Argentina trade balance and positive for Uruguay-world trade balance. Conversely, if Uruguay follows Argentina, its currency will depreciate against both Brazil and the rest of the world. The result will be neutral for Uruguay's trade balance with Argentina, but positive for its trade balance with Brazil and the rest of the world.

Theoretically, the choice of Uruguay should be based on its trade volume with Argentina, Brazil and the rest of the world. Depending on which is more important for macroeconomic stability, the choice of exchange-rate regime varies. However, given that it already makes sense for Uruguay to follow Argentina in face of terms-of-trade shocks to Brazil, it may be simpler and easier for Uruguay to follow Argentina under all circumstances. The situation of Paraguay is basically the same of Uruguay, provided that we substitute Brazil for Argentina as the country to be followed in the exchange-rate coordination of *Mercosur*.

5 – Conclusion

There is a strong synchronization of fluctuations of the export prices of *Mercosur* countries, especially between Brazil, Argentina and Uruguay. There is also a moderate synchronization of the fluctuations of import prices, but when put together, the variations of export an import prices result in a low positive correlation between the fluctuations of the terms of trade. The reason is the export-import correlation across countries, which tends to compensate the joint export-export and import-import correlations.

Based only on the positive correlations between their terms of trade, and assuming that both countries are liquidity constrained in international financial markets, exchange-rate coordination might be useful for Brazil and Argentina to share the costs and benefits of shocks to their export and import prices. However, given the low correlation coefficient between the two countries, the coordination should be flexible enough to allow small and temporary variations in their bilateral real exchange rate, while both countries jointly devalue or revalue against the rest of the world.

Given that their terms of trade change in the same direction but not necessarily in the same proportion, Brazil and Argentina can benefit from a joint flexible managed float of their currencies. Assuming that Brazil and Argentina do stabilize their bilateral exchange rate, it makes sense for Uruguay to follow Argentina, when foreign shocks are more intense to Brazil, or do nothing, when shocks are more intense to Argentina. In contrast, Paraguay should follow

Brazil when foreign shocks are more intense to Argentina and do nothing when the shocks are more intense to Brazil.

Because of the Uruguayan and Paraguayan idiosyncratic situation in relation to Brazil and Argentina, as well as because of the low correlation between the terms-of-trade fluctuations of Brazil and Argentina itself, the best way to start exchange-rate coordination in *Mercosur* is to follow the lessons of the European Monetary System in 1979-98, that is, to specify a wide interval for the fluctuation of all *Mercosur* currencies around a common real or nominal exchange-rate peg against the rest of the world.

Overall, a stabilization of bilateral exchange rates within *Mercosur* and the joint fluctuation of all *Mercosur* currencies against the rest of the world can be important and effective instruments to promote intra-regional trade, deepen intra-regional financial markets and increase the international competitiveness of all countries. However, in order to avoid the errors of the recent past, it is crucial that the joint fluctuation of Brazil and Argentina occurs around a real exchange rate against the rest of the world that is competitive enough to promote the growth and the macroeconomic stability of both countries. If this happens, all *Mercosur* will benefit.

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Appendix A: Correlation Decomposition

Let *TA* and TB be the first difference of the natural logarithms of the terms of trade of Argentina and Brazil. By definition the covariance between *TA* and *TB* can be written as $COV(TA,TB) = COV[(XA - MA),(XB - MB)]$.

where *XA* and *XB* are the growth rates of the export prices of Argentina and Brazil, respectively, and *MA* and *MB* are the growth rates of their import prices. Since $COV(TA,TB) = E(TA \times TB) - E(TA) \times E(TB)$, after some algebraic operations we arrive at

$COV(TA,TB) = COV(XA,XB) + COV(MA,MB) - COV(XA,MB) - COV(MA,XB)$;

which can be used to decompose the observed correlation between *TA* and *TB*.

More formally, the correlation between *TA* and *TB* is given by

$$CORR(TA,TB) = \frac{COV(TA,TB)}{S(TA)S(TB)}$$

where *S()* represents the standard deviation of the variable within the parenthesis.

From the decomposition of the covariance we have

$CORR(TA,TB) = CONT(XA,XB) + CONT(MA,MB) - CONT(XA,MB) - CONT(MA,XB)$;

where

$$CONT(XA,XB) = CORR(TA,TB)\left[\frac{COV(XA,XB)}{COV(TA,TB)}\right]$$

is the “contribution” of the export prices to the terms-of-trade correlation. The same reasoning applies to the other components of $CORR(TA,TB)$.

The relationship between the contribution and the correlation of any two terms is:

$$CONT(XA,XB) = CORR(XA,XB)\left[\frac{S(XA)S(XB)}{S(TA)S(TB)}\right]$$

Finally, the ordering of contributions is not necessarily the same as the ordering of correlations because of the possible different volatility of the terms involved. For instance, take *CORR(XA,MB)* and *CORR(MA,MB)*. From the above results we have:

$$\frac{CONT(XA,MB)}{CONT(MA,XB)} = \frac{CORR(XA,MB)}{CORR(MA,XB)}\left[\frac{S(XA)S(XB)}{S(MA)S(MB)}\right].$$

In words, the ratio of the contributions does not necessarily coincide with the ratio of correlations because of the possible differences between the standard deviations of the series involved.

Figure 1: growth rates of the export price index of each *Mercosur* country in 1980-2001. Source: ECLAC 2002 yearbook.

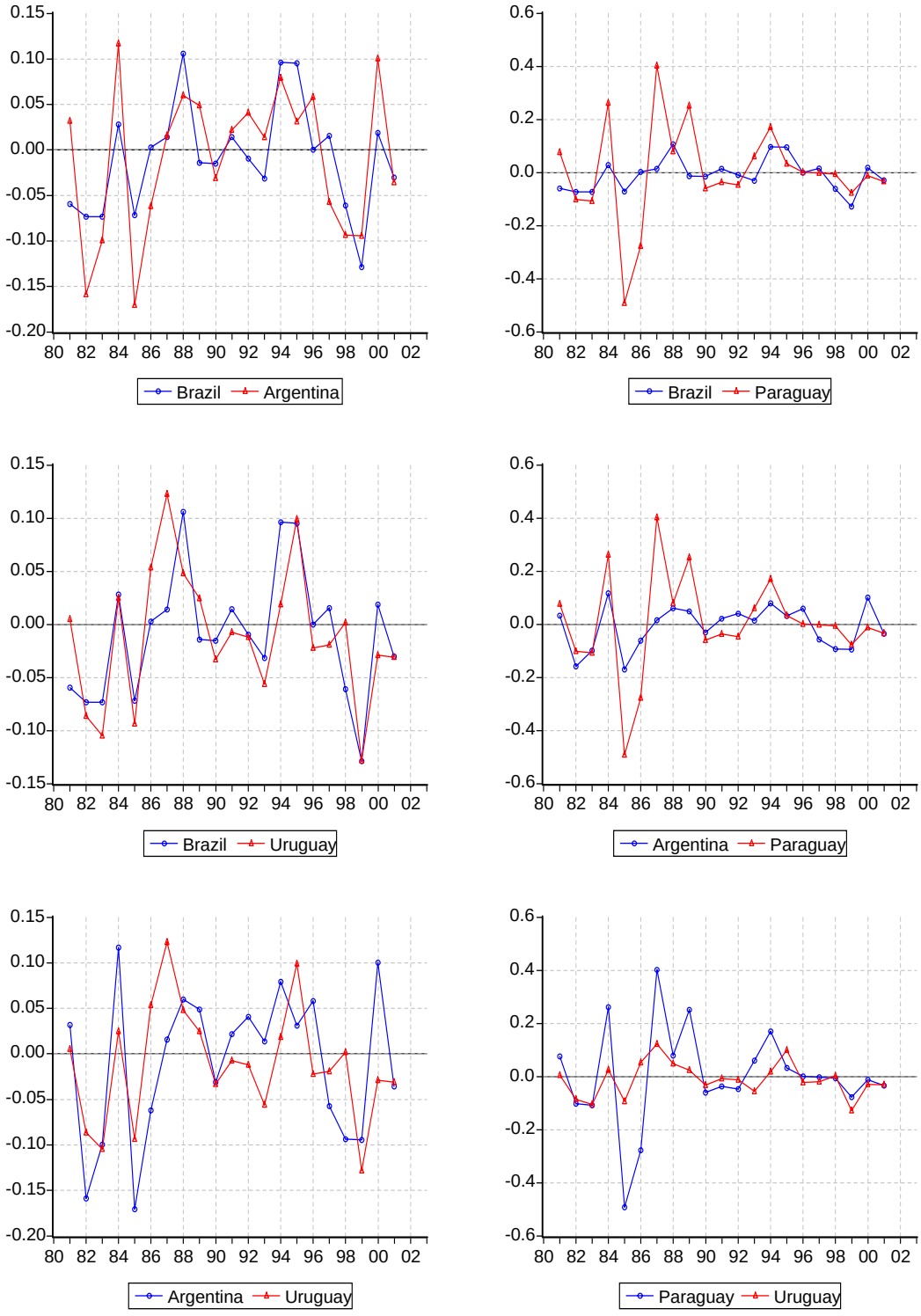

Figure 2: growth rates of the import price index of each *Mercosur* country in 1980-2001. Source: ECLAC 2002 yearbook.

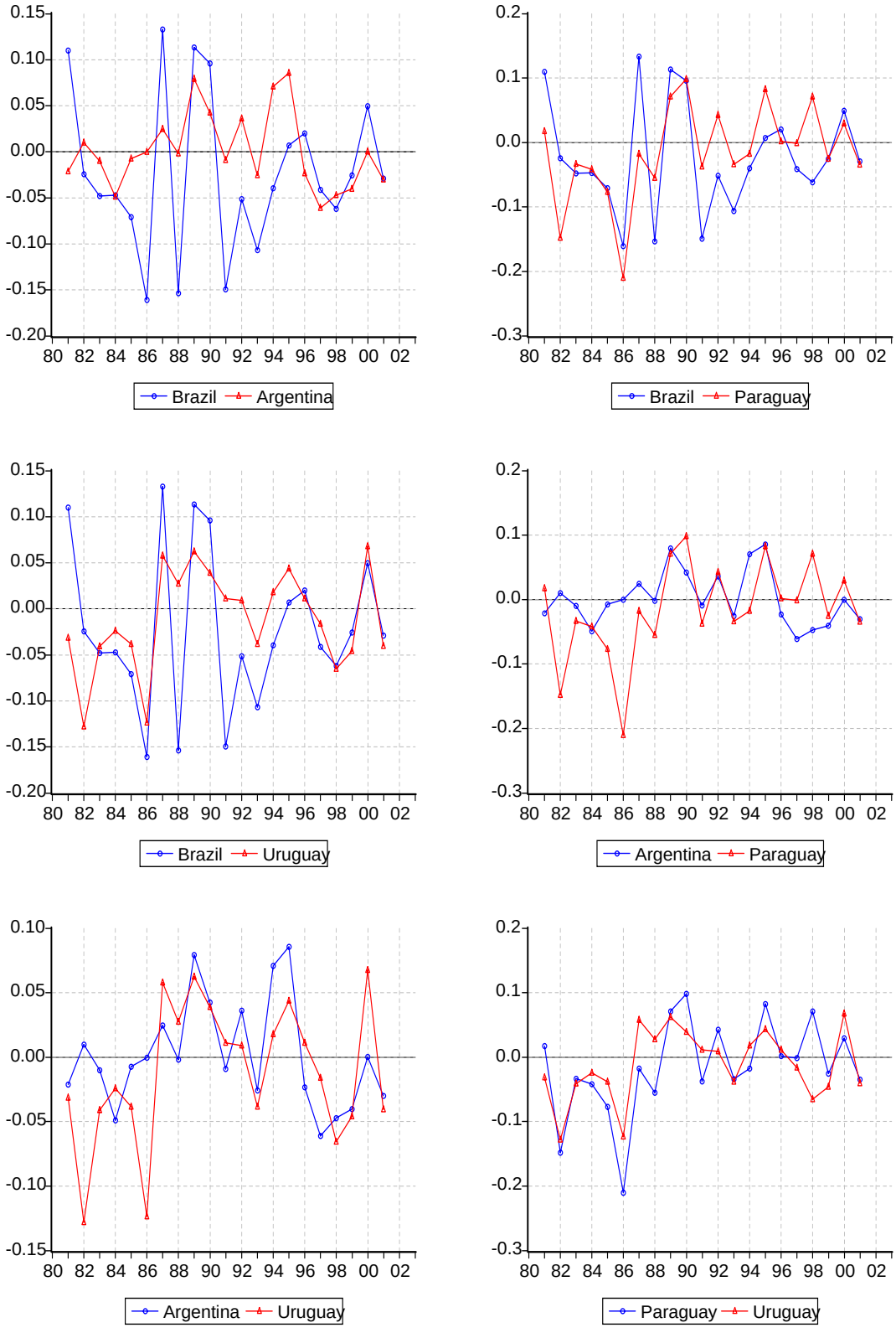

Figure 3: growth rates of the terms-of-trade index of each *Mercosur* country in 1980-2001. Source: ECLAC 2002 yearbook.

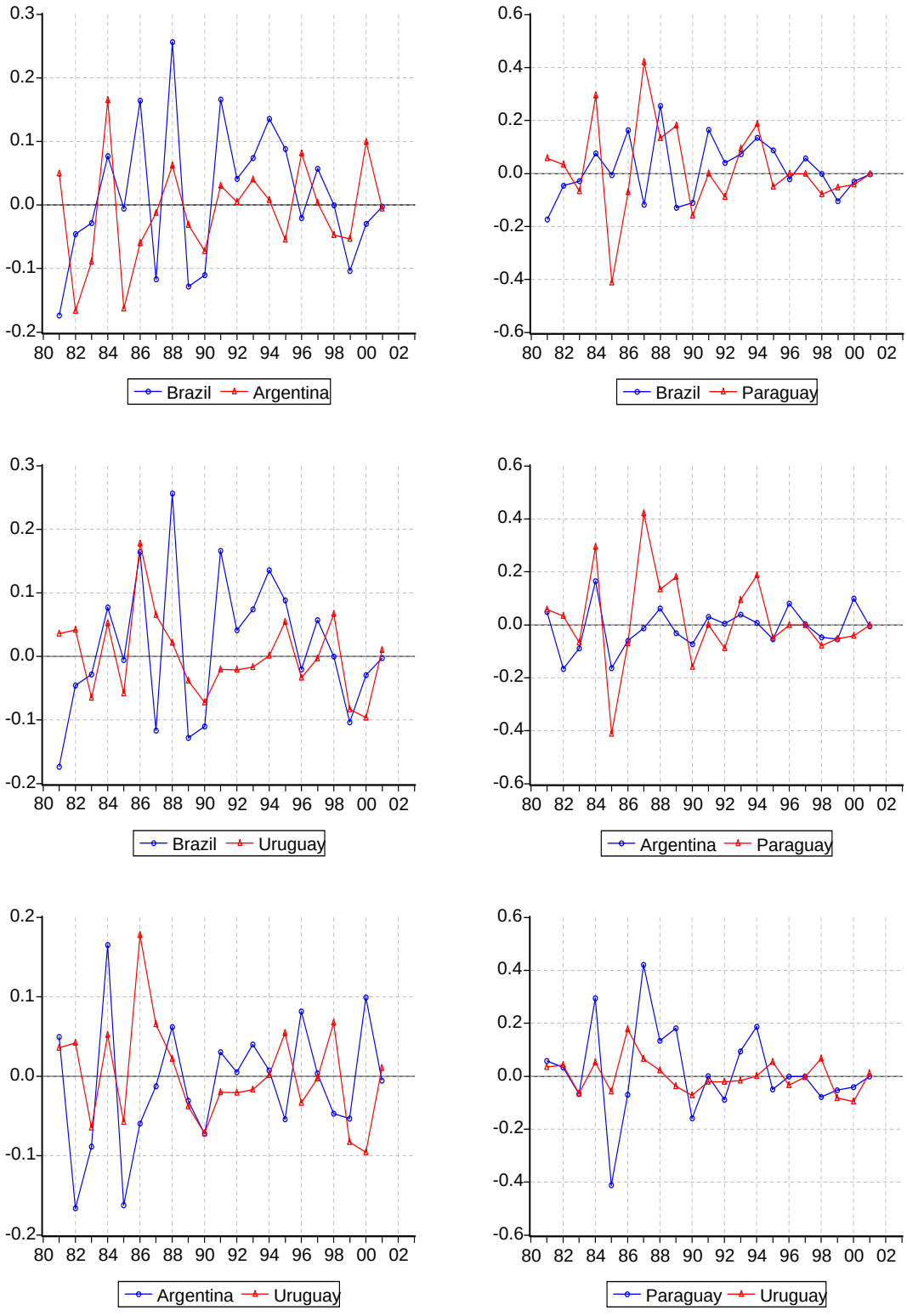

Table 1: descriptive statistics of the growth rate of the export price of *Mercosur* economies. The growth rate is the log difference of the corresponding price. Source: ECLAC 2002 statistical yearbook.

	Mean	Standard Deviation	Coefficient of Variation	1st Order Autocorrelation	Persistence*

Argentina	-0.57	7.98	13.99	-0.07	20.81
Brazil	-0.68	6.01	8.87	0.21	35.31
Paraguay	2.02	18.76	9.31	-0.16	29.82
Uruguay	-0.88	6.30	7.15	0.19	32.98

* Number of months before 99% of a shock is absorbed based on an AR(1) specification of the variable analyzed.

Table 2: lag, contemporaneous and lead correlation between the growth rates of the export price of *Mercosur* countries. Source data: ECLAC 2002 Statistical Yearbook.

Countries	J=-1	J=0	J=1
Brazil at period t+J and Argentina at period t	0.10	**0.69**	0.15
Brazil at period t+J and Paraguay at period t	0.15	**0.42**	0.17
Brazil at period t+J and Uruguay at period t	0.33	**0.74**	0.11
Argentina at period t+J and Paraguay at period t	-0.07	**0.68**	-0.03
Argentina at period t+J and Uruguay at period t	-0.02	**0.56**	-0.03
Uruguay at period t+J and Paraguay at period t	-0.19	**0.58**	0.13

Table 3: contemporaneous correlation between the growth rates of the export price of *Mercosur* and the US. Source data: ECLAC 2002 Statistical Yearbook and the NIPA tables of the US Bureau of Economic Analysis.

	Correlation
US and Brazil	0.58
US and Argentina	0.43
US and Paraguay	0.62
US and Uruguay	0.47

Table 4: descriptive statistics of the growth rate of the import price of *Mercosur* economies. The growth rate is the log difference of the corresponding price. Source: ECLAC 2002 statistical yearbook.

	Mean	Standard Deviation	Coeficient of Variation	1st Order Autocorrelation	Persistence*
Argentina	0.19	4.26	22.37	0.30	45.77
Brazil	-1.92	8.54	4.45	-0.29	42.78
Paraguay	-1.26	7.06	5.60	0.14	27.99
Uruguay	-1.03	5.35	5.20	0.19	33.47

* Number of months before 99% of a shock is absorbed based on an AR(1) specification of the variable analyzed.

Table 5: lagged, contemporaneous and forward correlation between the growth rates of the import price of *Mercosur* countries. Source data: ECLAC 2002 Statistical Yearbook.

Countries	J=-1	J=0	J=1
Brazil at period t+J and Argentina at period t	-0.29	**0.34**	0.12
Brazil at period t+J and Paraguay at period t	-0.16	**0.57**	-0.24
Brazil at period t+J and Uruguay at period t	-0.18	**0.49**	-0.14
Argentina at period t+J and Paraguay at period t	0.24	**0.30**	-0.25
Argentina at period t+J and Uruguay at perido t	0.35	**0.49**	0.08
Uruguay at period t+J and Paraguay at period t	-0.10	**0.70**	0.28

Table 6: contemporaneous correlation between the growth rates of the import price of *Mercosur* and the US. Source data: ECLAC 2002 Statistical Yearbook and the NIPA tables of the US Bureau of Economic Analysis.

	Correlation
US and Brazil	0.46
US and Argentina	0.53
US and Paraguay	0.31
US and Uruguay	0.68

Table 7: descriptive statistics of the growth rate of the terms of trade of *Mercosur* economies. The growth rate is the log difference of the corresponding variable. Source: ECLAC 2002 statistical yearbook.

	Mean	Standard Deviation	Coeficient of Variation	1st Order Autocorrelation	Persistence*
Argentina	-0.68	8.03	11.75	-0.31	46.60
Brazil	2.04	11.51	5.64	-0.27	39.72
Paraguay	3.31	18.03	5.45	-0.14	28.09
Uruguay	0.30	6.59	22.08	-0.01	12.59

* Number of months before 99% of a shock is absorbed based on an AR(1) specification of the variable analyzed.

Table 8: lagged, contemporaneous and forward correlation between the growth rates of the terms of trade of *Mercosur* countries. Source data: ECLAC 2002 Statistical Yearbook.

Countries	J=-1	J=0	J=1
Brazil at period t+J and Argentina at period t	0.00	**0.24**	-0.11
Brazil at period t+J and Paraguay at period t	**0.18**	0.02	0.00
Brazil at period t+J and Uruguay at period t	0.10	**0.34**	**-0.33**
Argentina at period t+J and Paraguay at period t	-0.25	**0.53**	-0.21
Argentina at period t+J and Uruguay at perido t	-0.20	-0.01	**-0.30**
Uruguay at period t+J and Paraguay at period t	**-0.37**	0.32	0.24

Table 9: contemporaneous correlation between the growth rates of the terms of trade of Mercosur countries and the US. Source data: ECLAC 2002 Statistical Yearbook and the NIPA tables of the US Bureau of Economic Analysis.

	Correlation
US and Brazil	0.30
US and Argentina	-0.05
US and Paraguay	-0.04
US and Uruguay	0.20

Table 10: contemporaneous correlation between the terms of trade, export price and import price of *Mercosur* countries. Source data: ECLAC 2002 Statistical Yearbook.

Countries	Terms of trade	Export-Export	Import-Import	Export-Import*	Import-Export**
Brazil and Argentina	0.24	0.69	0.34	0.44	0.20
Brazil and Paraguay	0.02	0.42	0.57	0.13	0.46
Brazil and Uruguay	0.34	0.74	0.49	0.54	0.17
Argentina and Paraguay	0.53	0.68	0.30	0.37	0.21
Argentina and Uruguay	-0.01	0.56	0.49	0.67	0.41
Uruguay and Paraguay	0.32	0.58	0.70	0.53	0.16

* Export price of the first country and import price of the second country in the row name. ** Import price of the first country and export price of the second country in the row name.

Table 11: decomposition of the contemporaneous correlation between the terms of trade of the *Mercosur* countries. Source: ECLAC 2002 Statistical Yearbook.

Countries	Terms of trade*	Export-Export	Import-Import	Export-Import**	Import-Export***
Brazil and Argentina	0.24	0.37	0.14	-0.12	-0.15
Brazil and Paraguay	0.02	0.25	0.19	-0.03	-0.39
Brazil and Uruguay	0.34	0.40	0.33	-0.25	-0.13
Argentina and Paraguay	0.53	0.74	0.07	-0.16	-0.12
Argentina and Uruguay	-0.01	0.56	0.22	-0.58	-0.21
Uruguay and Paraguay	0.32	0.62	0.26	-0.49	-0.07

* The first column equals the sum of the last four columns, provided that we allow small discrepancies due to numerical approximation to two decimal places. ** Export price of the first country and import price of the second country in the row name. *** Import price of the first country and export price of the second country in the row name.