Union of South American Nations: Monetary Synchronization and Economic Asymmetries

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An analysis of the monetary synchronization of the Union of South American Nations (UNASUR) for the decade 2004 through 2013 has been conducted using the optimum currency area (OCA) theories in order to evaluate the economic integration. By applying Bayoumi and Eichengreen's equation, it was found that with a decent adjustment, a high percentage of countries show a tendency to harmonize their currencies in function of the four independent variables: output disturbances, the dissimilarity in exports composition, the trade linkages, and the size of the economies. To extend the model, mobility of labor and level of the integration in good's market were added by modifying Behrens' proposal, founding that the six variables are indeed related to the exchange rate harmonization at different significant levels, with a considerable moderate fitting. Additionally an analysis of variance (ANOVA) has been considered in order to study the following economic indicators: gross domestic product (GDP), population, GDP per capita, exports to group vs. total exports, unemployment, and inflation rates so as to visualize the economic asymmetries of the Union, for the same period. Differences were inferred for all of them but not for their annual speed of change. The least significant differences (LSD) provide further results and Duncan's multiple range tests lead to defining groups of countries with similar characteristics.

Keywords: Union of South American Nations (UNASUR), regional integration, optimum currency area (OCA), multiple comparisons, economic asymmetries

Some Facts Regarding the Integration of Union of South American Nations (UNASUR)

As published in the Union's official web site, the main goal of the Union of South American Nations (UNASUR) is to build integration in the cultural, economic, social, and political areas. The economic agenda is currently set around the competitiveness, the development of science and technology, and the infrastructure building with the aim to increase the integration and to strength connectivity.

One of the 21 specific goals punctually refers to the economic cooperation by promoting the growth and development in order to overcome the asymmetries through the complementation of the economies of the members (Retrieved from <http://unasursg.org/en/node/180>).

Considering this scenario, though the adoption of a single currency is not among its most recent objectives, it is definitively interesting to evaluate the economic degree of integration through the monetary synchronization based on the optimum currency area (OCA) models.

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Additionally, because it is also important to infer the economic asymmetries within UNASUR, a statistical investigation of some economic indicators was performed in order to define groups of members that have similar conditions.

Integration Roots

According to the official web site (Retrieved from <http://unasursg.org/en/node/194>), UNASUR has 12 member states: Argentina, Brazil, Bolivia, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Suriname, Uruguay, and Venezuela. Historically, it has its origins at the Treaty of the UNASUR—approved on May 23rd, 2008, which has later become the South American Community of Nations—created on December 8th, 2004. Other efforts were held in 2005 and 2006 with the strategic plan for a common agenda of the region.

Referring to intraregional trade and economic integration in South America, Behrens (2015) mentioned that the initiatives started in 1960s with the Latin American Free Trade Association and continued in the 1980s with the Latin American Integration Association. She also reported the integration efforts that led to the Andean Community of Nations and to the Southern Common Market Constitution.

It is important to point out that the membership as well as the goals pursued of all of these organizations has been modified with the passage of time and the influence of different periods and stages, that is why an extrapolation of data would not be advisable.

Regional Integration Through Monetary Synchronization and Economic Asymmetries Through Multiple Comparisons

To evaluate the degree of economic integration among “neighborhood countries” in terms of the monetary synchronization, some models have been developed based on the theory proposed by Mundell (1961) according to which the OCA is effectively a region.

Bayoumi and Eichengreen (1997) evaluated the readiness of adopting a single currency in the European Community by developing an equation where the bilateral proximity was the function of four variables: real output differences, dissimilitude in merchandise trade, fraction of exports in gross domestic product (GDP), and size of the economies.

Ramírez (2011) considered this model to evaluate the Latin American integration processes reinforcing the results with deep statistical analysis. Behrens (2015) applied the same equation to determine the prerequisites for creating a monetary union in UNASUR and even added two more variables to complement the model perception: the convergence of unemployment rates and the integration in goods and labor market.

The OCA models have been extensively used as tools to measure the economic integration in other areas of the world. Lee and Azali (2012), Thijsak (2014), and Alvarado (2014a; 2014b) among others used these gravity models to study ASEAN for example and reported several references to other authors whose results in some cases are supplemented with other methods like ordinary least square (OLS), Granger causality, or least significant differences (LSD).

Beyond the endogenous characteristics of the OCA models, economic harmonization and differences among the countries have been evaluated through multiple regression models with or without the combination of other techniques. In the specific case of UNASUR for instance, Bonilla (2014) examined the external vulnerabilities and economic integration of seven of its 10 members performing the Bayesian SVAR model, the correlation analysis of convergence, and the error variance decomposition.

The present research aims to evaluate the integration level of UNASUR, for the period from 2004 to 2013, through the equation proposed by Bayoumi and Eichengreen (1997) and to go further adding the two variables considered by Behrens (2015) with modifications. Additionally, to supplement these bilateral models and to a certain point infer the asymmetries by defining groups of statistically similar countries, the analysis of variance (ANOVA), LSD, and Duncan's multiple range tests (1995) are performed for six indicators.

The results could be useful as far as they may somehow, reflect the situation among the 12 countries that are members of the UNASUR. However, these results do not reach the field of other topics; neither the adoption of a single currency whose sensibility and/or inconvenience was advised by many authors like Bayoumi and Mauro (1999), Alesina and Barro (2002), and recently by Edwards (2011); nor perceiving further differences among the nations beyond the statistically ones at certain level of probability.

Research Methods

OCA Models

The model proposed by Bayoumi and Eichengreen (1997) for the European Community is represented in equation (1) and the coefficients obtained are included in Table 1.

$$SD(e_{ij}) = \alpha + \beta_1 SD(\Delta y_i - \Delta y_j) + \beta_2 DISSIM_{ij} + \beta_3 TRADE_{ij} + \beta_4 SIZE_{ij} \quad (1)$$

where $SD(e_{ij})$ is the standard deviation of the change in the logarithm of the end-year bilateral exchange rate between countries i and j ; $SD(\Delta y_i - \Delta y_j)$ is the standard deviation of the difference in the logarithm of real output between i and j and aims to measure the output disturbances' effect; $DISSIM_{ij}$ is the sum of the absolute differences in the shares of agricultural, mineral and manufacturing trade in total merchandize trade of countries i and j and reflects the external shock influence according to the exports composition; $TRADE_{ij}$ is the mean of the ratio of bilateral exports to domestic GDP for the two countries and it is used to measure intraregional trade linkages; and $SIZE_{ij}$ is the mean of the logarithm of the two GDPs measured in US dollars and shows the influence of the country size.

As can be observed by the results reported in Table 1, Behrens (2015) studying the UNASUR, applied equation (1) and also added two more variables resulting in equation (2):

$$SD(e_{ij}) = \alpha + \beta_1 SD(\Delta y_i - \Delta y_j) + \beta_2 DISSIM_{ij} + \beta_3 TRADE_{ij} + \beta_4 SIZE_{ij} + \beta_5 UNEMP_{ij} + \beta_6 PRICE_{ij} \quad (2)$$

where the variables are the same of the equation (1) except $UNEMP_{ij}$ calculated as the mean of the logarithm of the absolute value of the differences between the unemployment rates between countries i and j and is included as the measure of the integration and flexibility of the countries' labor markets; and $PRICE_{ij}$ calculated as the mean of the logarithm of the absolute value of the differences between the inflation rates of consumer prices between countries i and j and it is a measure of the integration in goods' market.

In the present paper, $UNEMP_{ij}$ and $PRICE_{ij}$ values correspond to the standard deviation for the period, of the logarithm of the absolute bilateral differences between countries i and j ; introducing in this way the measurement of the bilateral variation of these rates through the time, modifying in this way Behrens' proposal (2015) for the labor and goods' markets.

Data sources and calculations are as follows:

- The quarterly exchange rates, for each country in SDR (special drawing rights), reported at the World Favorite Currency Site (Retrieved from <http://www.xe.com/currencytables/?from=ARS&date=2012-02-25>)

were used to determine the annual average, then the bilateral rate expressed in logarithms, and its change; and, finally the standard deviation value of the period $SD(e_{ij})$;

- GDP values retrieved from the World Bank (Retrieved from <http://data.worldbank.org/indicator/SP.POP.TOTL>) were used to calculate the real output of the countries expressed in logarithms, afterwards the bilateral differences were determined and the standard deviation of the period $SD(\Delta_i - \Delta_j)$;

- The shares of agricultural, mineral, and manufacturing trade in total merchandize trade calculated by the World Trade Organization (WTO, Retrieved from https://www.wto.org/english/res_e/statis_e/statis_bis_e.htm?solution=WTO&path=/Dashboards/MAPS&file=Map.wcdf&bookmarkState={%22impl%22:%22client%22,%22params%22:{%22langParam%22:%22en%22}}) were used to establish the absolute bilateral differences as a sum for all the period;

- The bilateral exports values are reported by the Observatory of Economic Complexity (Retrieved from http://atlas.media.mit.edu/en/visualize/tree_map/hs92/export/bra/show/all/2013/) with these and the GDP figures by the World Bank (Retrieved from <http://data.worldbank.org/indicator/SP.POP.TOTL>); $TRADE_{ij}$ was calculated as the period mean of the fraction of total bilateral exports over the total GDP; and only the values 2013 were obtained from COMTRADE web site (Retrieved from <http://comtrade.un.org/data/>);

- For determining $SIZE_{ij}$ data, the GDP values were expressed in logarithms, to calculate the bilateral average of the period;

- $UNEMP_{ij}$ corresponds to the period's mean of the bilateral absolute differences of the unemployment rates that were retrieved from the World Bank web site (Retrieved from <http://data.worldbank.org/indicator/SP.POP.TOTL>). For the present calculation, the absolute values of the bilateral differences are expressed in logarithms, and then the standard deviation of the period is measured;

- $PRICE_{ij}$ is the period's mean of the bilateral absolute differences of the inflation rate for consumer price. Data were retrieved from the World Bank (Retrieved from <http://data.worldbank.org/indicator/SP.POP.TOTL>), the Argentinean Institute of Statistics (INDEC, Retrieved from http://www.indec.gov.ar/ftp/nuevaweb/cuadros/10/sh_ipc_2008.xls), Triami Media BV (Retrieved from <http://www.inflation.eu/inflation-rates/chile/historic-inflation/cpi-inflation-chile.aspx>), and the world fact book of CIA. For this study, the absolute bilateral differences are expressed in logarithms then the standard deviation of the period is determined.

Multiple Comparison Tests

Although simple, these methods are extensively used in agriculture and industrial processes when defining groups of statistically similar characteristics. For the present research, they have been chosen with the purpose of visualising the distribution of the countries in the group and in certain way the asymmetries that could be observed for certain economic indicators.

When applying the ANOVA test with a positive result, meaning that at least one of the groups differs from the others, Saltos (1993) referred to Fisher (1956), who has developed the LSD formula simplified in equation (3) to calculate the smallest significant between two means that enable direct comparisons between them based on the statistic value of t .

$$LSD = t \sqrt{\frac{2MSE}{n}} \quad (3)$$

where, LSD or least significant value is a function of t which is a statistical value at level 0.05 for this study; MSE is mean square error from the ANOVA test; and n is the number of scores used to calculate the means.

According to this method, the first step is to apply the ANOVA for the period to economic indicators of the 12 countries in this case: GDP, population, GDP per capita, exports to UNASUR vs. total exports, unemployment, and inflation rates related to consumer price. If the ANOVA test proves that there is a significant difference, then a bilateral comparison of the average of each country is made with the LSD equation to find the similar and different pairs.

Refining the procedure even more, because the LSD considers only one difference for comparing all the contrasts among the bilateral comparisons, Duncan's multiple range test (1995) is performed, because it considers several critical differences and lets establish sets of similar countries according to each economic indicator based on equation (4) (Saltos, 1993):

$$Y_i - Y_j > d \sqrt{\frac{MSE}{n}} \quad (4)$$

where $Y_i - Y_j$ is the bilateral difference of the averages for each economic indicator; d is critical value proposed by Duncan (1995)—one for each range at 0.05; MSE is the mean square error from the ANOVA test; and n is the number of scores used to calculate the means.

The sources of information are: World Bank for GDP, population, unemployment rates, and inflation rates; INDEC-Argentina for inflation rates for the consumer index price to calculate inflation; Triami Media BV for Chilean inflation data; world fact book of CIA for Venezuelan inflation rates for the period 2004-2008; OEC for the bilateral exports values; COMTRADE for bilateral exports values 2013; and WTO for total exports by country.

Results

OCA

The coefficients and statistic indicators for OCA models with respect to equation (1), equation (2), and modified equation (2) are reported in Table 1.

The OCA coefficients calculated for UNASUR countries, for the period from 2004 to 2013, are reported in Table 2. According to Bayoumi and Eichengreen (1997), the pairs that have an OCA value lower than the standard error of the regression are ready to form a monetary union and are reported in bold characters; the ones that have an OCA value lower than two and a half times the standard error of the regression are converging and are presented in italics; and the rest in regular characters.

Multiple Comparison Tests

According to ANOVA, there are significant differences among the members of the UNASUR when analyzing all the considered variables for the period from 2004 to 2013. But by applying the same technique to the annual speed of change of the indicators, no differences were found; therefore no further calculations were made regarding their annual variations.

The differences and similarities found between the countries according to LSD test are reported in Table 3. The groups of countries that could be defined by performing the Duncan's ranges test (1995) are reported in Table 4, where the members of UNASUR are ordered from the smallest average value to the biggest one of the period, for each indicator.

Table 1

Terms of the Equation for OCA and OCA Modified Model

	Bayoumi & Eichengreen	Ramírez	Behrens	Alvarado	Behrens	Alvarado modifying equation 2
Variable	OCA MODEL			OCA EXTENDED		
	European Union 21 countries	Latin America 17 countries	UNASUR 12 countries			
	1983-1992	1998-2008	1996-2007	2004-2013	1996-2007	2004-2013
Samples	210	136	132	66	132	66
Significance		0.0000	0.262	significant _{0.05}	0.392	significant _{0.05}
R^2	0.51	0.5515	0.040	0.4796	0.048	0.5083
Stand. Err.	0.027	0.064	0.1199	0.0274	0.1204	0.027367
“ α ”	-0.09	-0.0252	-0.168	-0.0900	-0.201	-0.0738
Stand. Err.	0.02	0.0583	0.139		0.143	
Significance		0.6658	0.228		0.164	
“ β_1 ”	1.46	3.2768	-0.283	-0.0349	-0.404	-0.0334
Stand. Err.	0.021	0.2842	0.374	0.0579	0.395	0.0575
Significance		0.0000	0.425	0.0093	0.307	0.0120
“ β_2 ”	0.022	-0.1092	0.055	0.0018	0.051	0.0017
Stand. Err.	0.006	0.0305	0.033	0.7453	0.034	0.7390
Significance		0.0005	0.104	0.0726	0.139	0.0970
“ β_3 ”	-0.054	-3.4649	0.148	-1.1188	0.226	-1.2378
Stand. Err.	0.006	1.4233	0.904	0.0007	0.930	0.0007
Significance		0.0163	0.870	0.3250	0.809	0.2779
“ β_4 ”	0.012	0.0097	0.013	0.0132	0.016	0.0118
Stand. Err.	0.001	0.0054	0.012	0.1256	0.013	0.1193
Significance		0.0762	0.273	0.0313	0.200	0.0645
“ β_5 ”					0.018	0.0172
Stand. Err.					0.018	0.0277
Significance					0.327	0.5273
“ β_6 ”					0.003	-0.01204
Stand. Err.					0.016	0.0902
Significance					0.839	0.1523

OCA Indexes for 12 Countries of UNASUR for the Period 2004-2013

Notes. Symbols: A—Argentina, O—Bolivia, B—Brazil, H—Chile, C—Colombia, G—Guyana, E—Ecuador, Y—Paraguay, P—Peru, S—Surinam, U—Uruguay, and V—Venezuela.

Significant Differences Among the Countries When Applying the LSD Test to Some Economic Indexes at 0.05 Level

[illegible]

Table 3 to be continued

Exports to UNASUR vs. total											Unemployment rate											Inflation rate													
	O	B	H	C	E	G	Y	P	S	U	V		O	B	H	C	E	G	Y	P	S	U	V		O	B	H	C	E	G	Y	P	S	U	V
A	≠	≠	≠	≠	≠	≠	≠	≠	≠	≠	≠	A	≠	≈	≈	≠	≠	≠	≠	≠	≈	≈	≈	A	≈	≈	≠	≠	≠	≠	≈	≠	≈	≈	≠
O		≠	≠	≠	≠	≠	≠	≠	≠	≠	≠	O		≠	≠	≠	≈	≠	≈	≈	≠	≠	≠	O		≈	≈	≈	≈	≈	≈	≈	≈	≈	≠
B			≈	≈	≈	≈	≠	≈	≈	≠	≈	B			≈	≠	≈	≠	≈	≠	≈	≈	≈	B			≈	≈	≈	≈	≈	≈	≈	≈	≠
H				≈	≈	≈	≠	≈	≈	≠	≈	H				≠	≈	≠	≈	≠	≈	≈	≈	H				≈	≈	≈	≈	≈	≠	≠	≠
C					≈	≠	≠	≈	≠	≈	≠	C					≠	≈	≠	≠	≠	≠	≠	C					≈	≈	≈	≈	≠	≠	≠
E						≠	≠	≠	≠	≠	≠	E						≠	≈	≈	≈	≈	≠	E						≈	≈	≈	≠	≈	≠
G							≠	≠	≠	≠	≠	G							≠	≠	≠	≠	≠	G							≈	≈	≈	≈	≠
Y								≠	≠	≠	≠	Y								≈	≈	≈	≠	Y								≈	≈	≈	≠
P									≠	≈	≠	P									≠	≠	≠	P									≠	≠	≠
S										≠	≈	S										≈	≈	S									≈	≠	
U											≠	U										≈	≈	U										≠	

Notes. Symbols: A—Argentina, O—Bolivia, B—Brazil, H—Chile, C—Colombia, G—Guyana, E—Ecuador, Y—Paraguay, P—Peru, S—Surinam, U—Uruguay, and V—Venezuela; similar is “≈”, and different is “≠”.

Table 4

Groups of UNASUR Countries According to Statistical Analysis of Some Economic Indexes by Duncan Range Test at 0.05 Level

GDP		Population		GDP per capita		Exports to region		Unemployment		Inflation	
G	5	S	4	O	5	S	5	O	5	P	4
S	5	G	4	G	4 5	G	5	P	5	C	4
Y	5	U	4	Y	4 5	V	5	E	4 5	H	3 4
O	5	Y	4	E	3 4 5	H	4 5	Y	4 5	E	3 4
U	4 5	O	4	P	3 4 5	B	4 5	B	3 4	G	2 3 4
E	3 4 5	E	3	C	3 4	E	3 4	H	3 4	B	2 3 4
P	2 3 4 5	H	3	S	2 3	P	3 4	U	3 4	Y	2 3 4
H	2 3 4 5	V	3	B	1 2	C	3 4	A	2 3	O	2 3 4
C	2 3 4	P	3	U	1	U	3	S	2 3	U	2 3
V	2 3	A	2	A	1	A	3	V	1 2 3	S	2
A	2	C	2	V	1	Y	2	G	1 2	A	2
B	1	B	1	H	1	O	1	C	1	V	1

Notes. Symbols: A—Argentina, O—Bolivia, B—Brazil, H—Chile, C—Colombia, G—Guyana, E—Ecuador, Y—Paraguay, P—Peru, S—Surinam, U—Uruguay, and V—Venezuela.

It is remarkable that according to ANOVA results, the annual rate of change of all the considered indicators, for all the 12 countries, shows no significant differences at $F_{0.05}$.

Discussion

Currency Harmonization

Analyzing and comparing the data reported in Table 1, it is interesting to observe that in respect of the number of samples, only Behrens (2015) duplicated the amount of bilateral comparisons and reported different magnitude vales. For all the considered authors, the application of the OCA models is statistically significant and the adjustment of data varies with an R^2 that reaches half of the population except for Behrens' (2015). Standard

error also is similar in all cases. The “ α ” values have negative signs and up to a certain point similar magnitude.

The expected positive sign for “ β_1 ” coefficient does not occur for UNASUR either reported by Behrens (2015) or as reported in the present study but with better significant levels. The negative sign of “ β_1 ” means that when the nation outputs move together less contribute to the currency harmonization, and in such scenario, it could be interesting to consider other papers. For instance, Calderón, Chong, and Stein (2002), going beyond the endogenous criteria of OCA, found that developing countries indeed have different patterns that lead to cyclical asymmetries in the period from 1960 to 1999. In fact, when Alvarado (2014b) used equation (1) to evaluate the ASEAN and ASEAN+3 integration, for the period from 2003 to 2012, the sign for “ β_1 ” was positive like found for the European Community. Moreover, recently Bonilla (2014), studying UNASUR proved that seven of its members are considerably influenced by external disturbances with a high level of common reaction and a considerable synchronization where the domestic economies are more vulnerable to external disturbances than to the monetary and the financial ones.

For this paper, the “ β_2 ” coefficients have positive sign as expected, with fine significance. In theory, that occurs because the dissimilarity of commerce composition may reveal the comparative advantages and the asymmetry of the shocks may respond to the same export sectors. Only Ramírez (2011) found an inverse relationship for “ β_2 ” when analyzing Latin America.

Although at less strict levels of acceptance of the null hypothesis, coefficient “ β_3 ” was found significant for both equations in this research, with inverse relationship as also reported by the other authors except Behrens (2015); thus the trade linkages shall favor the common currencies use. The size of the economies, reflected by coefficient “ β_4 ”, reflects good significant and proportionally direct relation to the dependent variable in all cases.

The modified “ β_5 ” has a lower level of significance to the model and the positive sign may indicate that bilateral harmonization in the labor market also results in currency synchronization.

At good acceptance level, coefficient “ β_6 ” reflects an inverse relationship between the bilateral similarity on the inflation of the prices and the tendency to converge in a “single” currency.

Monetary synchronization expressed in terms of the OCA indexes (Table 2) shows that 12.1% of the countries in pairs are ready for monetary union, 80.3% have tendency to converge, and 7.6% are in the way when applying equation (1); and when using modified equation (2) with more variables, the values respectively change to 13.6%, 80.3%, and 6.1%.

Inference of the Differences

The speed of change in the period of analysis is not different for the UNASUR members. However, the differences are evident for all the considered economic indicators as such. Similar results were found by Alvarado (2014a) when evaluating ASEAN. Nevertheless their economic differences, the members of the region tend to have the same rate of variation.

It must be taken into consideration that the chosen level of significance will indeed influence the comparisons. The groups and distribution of the 12 members for the six indicators lead to forming five groups in the case of GDP, GDP per capita, exports to region vs. total and unemployment rate, and four groups in the case of population and inflation rate.

Brazil is definitely different when talking about GDP and population, as Bolivia is referring to the exports to UNASUR and as Venezuela is regarding inflation rate. Apart from that, what the results draw is more like a scale whose interceptions levels are pretty good except for population.

Conclusions

The results are positive in terms of integration because for the period from 2004 to 2013, the members of the UNASUR harmonically varied their exchange rates in function of the output disturbances, the dissimilarity in exports composition the trade linkages, and the size of their economies (equation (1)). When applying modified equation (2), currency synchronization is function of the four previously mentioned variables and also of the introduced ones, related to labor and goods' markets.

The data obtained have similar magnitude to the ones reported by other authors with this kind of models, for this region or others. The outcomes regarding the South American group are also similar to the ones reported by Bonilla (2014), although she used a different approach and techniques, both studies found that the region is advancing at the same rhythm remarking that output disturbances deserve special attention.

Nevertheless the speed of change through the time of the 12 countries was inferred similar, differences indeed appeared when analyzing the six economic indicators which led to defining groups of countries within the Union that formed superposed "stairs", some of them with singletons on the top. Such perceptions of the symmetries and asymmetries may be useful to visualize the direction of the economic cooperation in terms of the economic complementation, which is one of the goals of UNASUR.

Further and periodical investigation is needed about this area of the planet, as it is also concluded by Behrens (2015) and Bonilla (2014). Extrapolation of data is not recommended and political decisions could up to certain point use information like this with the correspondent reserves as also advised by Ramírez (2011) in relation to the moderate adjustment of the models.

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