Trade agreements, specialization and exports in South America: analysis based on cointegration tests and stochastic frontier models

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Abstract

There is a vast body of literature that poses that Economic integration brings benefits that may be appropriate asymmetrically between the actors who carry out that process (Bouzas, 2003; Venables, 2003). The emergence of regional integration agreements has impacts on the level of industrial activity and its location, leaving some countries with obstacles to fully participate as beneficiaries of that process. The aim of the article is to test the Contemporaneity of changes in the specialization and exports of South American countries, after the signing of trade agreements. For this purpose, we performed unit root tests with endogenous breaks, cointegration tests and stochastic frontier models on manufacturing production and exports series by country and type of technology for the period 1985-2008. The most important result observed is that after the signing of trade agreements, changes in countries' export structure or specialization, if there are any, have been weak. Also, the breaks in the series may also have been associated with other factors (e.g. macroeconomic reforms). Moreover, there is no strong contemporaneity between specialization and revealed comparative advantage or between both and the dates of the signing of trade agreements except in the case of Uruguay in the low-tech sector. While other exercises are necessary to test causality between involved series and its direction during breaks and the signing of the agreements, preliminary results indicate that trade agreements have not boosted structural changes in specialization and export intensity in manufacturing in South American countries.

Keywords: regional integration, specialization, manufacturing exports, trade agreements

JEL classification: F15, F13

1. Introduction

There is a vast body of literature on international trade that believes that Economic integration brings benefits that may be appropriate asymmetrically between the actors who carry out that process (Bouzas, 2003; Venables, 2003; among others). The creation of regional Economic agreements (hereinafter, RIAs) has consequences on the behavior of industrial activities (including their location), involving impediments for some countries to fully beneficiate as beneficiaries of that integration process. Some authors argue that asymmetries in Economic structure affect that capacity of appropriation of benefits and may set up an obstacle to further integration (Lo Turco, 2007; Terra 2008; Venables 1999, 2003a and 2003b; Imbs and others 2012; Bouzas, 2003; Bouzas and Da Motta Veiga, 2008).

In the context of symmetric and asymmetric RIAs, Venables (2003a) analyzes the impact on the production and location of activities in member countries. This author poses that in South-South RIAs, the demand relations become more relevant, since intraregional demand becomes the engine of industrialization in those countries. Puga and Venables (1999) found also a slow process of industrialization emerging from such agreements. The central hypothesis of that approach is that a customs union formed by countries that share similar comparative advantages would benefit those with intermediate comparative advantages among its trading partners and the rest of the world, at the expense of those members who have extreme comparative advantages or are highly specialized in few sectors. Therefore, the presence of preferential tariffs or commitments undertaken in RIAs may affect local production, strengthening the role of regional comparative advantages in shaping production patterns.

The objective of this paper is to test econometrically the Contemporaneity of changes between the signing in RIAs and manufacturing specialization in South America. In particular, we aim to check if the potential advantages of each country in a sector have been effectively exploited and, if so, if it occurred as a consequence of trade agreements.

Based on unit root tests that include endogenous breaks we firstly analyze if the series of specialization and revealed comparative advantage faced breaks in their trajectory and whether shocks were Contemporary to the signing of trade agreements. Second, we test cointegration between specialization and effective exports. Finally, in order to assess whether the specialization in the 4 manufacturing sectors have resulted in revealed advantages, we use a stochastic frontier model, that provides the degree of utilization (inefficiency) of those advantages.

2. Data and materials

We analyze the relationship between trade agreements, location and export pattern changes in manufacturing; agricultural production cannot react in the same way to RIAs as location and production decisions are tied to land. The relative ubiquity of manufacturing makes them sensitive to integration processes.

Second, we explore the consequences of trade agreements on specialization and exports in a sample of 10 South American countries (i.e. Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay and Venezuela)[1]. In South America, trade and RIAs began in late 1960s in with the signing of CAN between Bolivia, Chile, Colombia, Ecuador and Peru). The last trade agreement occurred in 2014 between Brazil and Venezuela. RIAs concentrated most during the 1990s, simultaneously with other structural reforms involving macroeconomic management, government financing, public enterprises and openness.

In order to capture specialization we compute the location quotient proposed by Hoover (1936). The index is considered both as location and specialization indicator of a given country/region in a certain sector. The index is computed as:

$$\text{Specialization index } (IE)_j = \frac{\frac{VA_{ij}}{\sum_i VA_{ij}}}{\frac{\sum_j VA_{ij}}{\sum_i \sum_j VA_{ij}}}$$

where VA_{ij} denotes value added in sector *i* in country *j*.

If the ratio is greater than unity the country in question specializes in the production of goods offered by sector *i* and therefore that sector has greater export potential in that country to the rest of the region. If $IE_j < 1$, the country *j* is not specialized in this sector and is likely to be a net importer of products of the sector. When IE_j equals the unit, there is not a clear pattern of specialization in the sector. The source for the added value has been the PADI data base of CEPAL, supplemented in some cases by data from official statistics addresses of each of the member countries.

In turn, effective exports are measured by the revealed comparative advantage index, VCR proposed by Balassa (1965)[2]. Also this indicator has been modified so that it becomes an index of regional comparative advantage. Our index reports the involvement of k's exports from the *i*-th country with respect to the participation of that sector in regional exports; it indicates the relative position of each country of the block in each of the industrial sectors within the region.

VCR index is performed according to the following formula:

[1] We Suriname and Guyana from the analysis as their available series are relatively short and the techniques used have asymptotic properties, a condition that can diminish power to conclusions.

[2] Which is also a variant from Hoover's location quotient.

$$VCR_{ik} = \frac{\left[\frac{\frac{x_{ik}}{\sum_{k=1}^{s} xik}}{\frac{\sum_{i=1}^{r} x_{ik}}{\sum_{i=1}^{r} x_i}} - 1\right]}{\left[\frac{\frac{x_{ik}}{\sum_{k=1}^{s} xik}}{\frac{\sum_{i=1}^{r} x_{ik}}{\sum_{i=1}^{r} x_i}} + 1\right]}$$

The reason $\frac{\frac{x_{ik}}{\sum_{k=1}^{s} xik}}{\frac{\sum_{i=1}^{r} x_{ik}}{\sum_{i=1}^{r} x_i}}$ represents the proportion of exports of the k-th sector in the i-th country, of total exports to South America. While the relationship $\frac{\sum_{i=1}^{r} x_{ik}}{\sum_{i=1}^{r} x_i}$ exhibits the proportion of exports of sector k of total exports of all countries to region. The index is standardized terms in order to be symmetrical, so values are within a range of -1 and 1. Positive index values suggest a revealed comparative advantage in the specific sector negative values indicate a disadvantage. A null value would exhibit an indifference situation.

We employ data from the manufacturing sector (value added and exports) classified according to the international classification system ISIC[3], Revision 2. They have been classified into 4 categories according to their technological content: manufactured products based on high technology, media, low and natural resources. The classification is based on defined by Lall (1998, 2000) and Lall and Mengistae (2005). The figures for intra and extra trade flows were obtained from the base of UN-Comtrade data. All information has been processed and harmonized within the system of international classification ISIC, Revision 2.

3. Variations in specialization index and revealed advantages: analysis based on unit root tests with endogenous breaks

Different approaches agree that the integration processes may cause changes in the geographical distribution of production and trade specialization of the members signing the agreement, as they involve reductions in tariffs and mobility of goods and production factors (Imbs et al, 2012). The approaches differ in terms of the direction of the locational changes: a theoretical line poses that trade integration promotes agglomeration (Krugman and Venables, 1990), another one asserts that trade agreements stimulates locational dispersion (Forslid and Wooton, 2003) and a third one recognizes forces that can simultaneously act in opposite directions (Puga, 1999). These changes may generate costs and benefits difficult to predict, in

[3] International Standard Industrial Classification

terms of how they will be distributed between countries or between the geographical regions involved.

In addition, locational and production changes that arise as a consequence of trade agreements countries usually occur gradually and with a time delay as they involve long-term decisions (Puga, 1999; Venables, 2003a). Therefore, the variations in the patterns of specialization and / or trade patterns between countries cannot be observed until after certain time extent after the agreement.

One way to empirically check the occurrence of such changes is testing the presence of breaks in the series of specialization and revealed regional advantages. The method selected is the unit root test proposed by Zivot and Andrews (1992), ZA; unlike other classical unit root tests, ZA can identify breaks endogenously preventing the analyst an *ad hoc* date choice. That mechanism allows us to identify whether a structural change on a series could be related to a given policy and/or specific event[4].

ZA tests the null hypothesis that the series has a unit root with no breaks, which implies that $\alpha = 0$ against the alternative that $\alpha < 1$. In this context, rejecting the null implies that the series follows a stationary process with a break. In turn, the break is located at the time period for which the ADF test statistic t is at a minimum, usually assuming a negative value. Consequently, the break date is selected when the evidence is less favorable to the null. If rejected, the series would remain stationary but exhibit a break in period t, in the intercept, the trend or both, depending on the selected specification. We examined the 3 specifications in order to assess the robustness of the findings.

Table 1 shows the main results obtained from ZA test, applied to each series and specification. Test statistics and critical values are exhibited in the table A1 in Appendix.

The ZA test shows evidence of breaks in some series, especially VCR. In the IE series, Paraguay and Ecuador have few observations; therefore, they have not been taken into account as they may affect the robustness of results. The test leads to consistent results under any specification, except for some cases in which specifications identify different dates for breaks for the same series (e.g. Argentina and Brazil in the mid technology sector; Peru in high and natural resources based technology and Bolivia in natural resources based sectors). This may be because the series probably have experienced breaks in both years, but by

[4] Lumsdaine and Papell (1997), Perron (1997) and Ohara (1999), among others, developed other variants of unit root tests with endogenous breaks. The choice of test applied in this case was based on the availability of the calculation routine used in the econometric software (Stata).

construction ZA supports only one break[5]. Therefore, in cases where the null is rejected while breaks are located distant from signing agreements, the analysis was complemented with charts of each series by sector and country.

On the other hand, trade agreements are considered contemporary with structural breaks in the series if the identified break matches or it occurred 2 and 3 years from the signing of the agreement (Gonzalez and Delbianco, 2011).

Table 1. Unit root tests and endogenous breaks in location and export pattern in South America

	IE	VCR
Argentina		
High technology		Break in 2002, possibly related with agreement in 2000
Mid technology	Break in 2001possibly related with agreement in 2000	Break in 1991, possibly related with agreement in the same year
Low technology		Break in 2002/2004, possibly related with agreements in 2000 to 2004
Bolivia		
High technology	Break in 1988/1989	Break in 1998/2002, possibly related with agreements in 1996 and 2000
Mid technology	Not related with Contemporary trade agreements	
Low technology	Break in 1993, possibly related with agreement in the same year	
Nat resources based tech	Break in 1995, possibly related with agreement in 1993	Break in 2000, possibly related with agreement in the same year
Brasil		
High technology		Break in 2002, possibly related with agreements de 2000 y 2001
Mid technology	Break in 1999, possibly related with agreements in 1996	Break in 1993/1994, possibly related with agreements in 1991
Chile		
High technology		Break in 1994/1995, possibly related with agreements in 1993
Mid technology	Break in 1996, possibly related with agreements in the same year	
Nat resources based tech	Break in 1989/1990. Not related with Contemporary trade agreements	
Colombia		
Mid technology		Break in 1991. Not related with contemporary trade agreements
Nat resources based tech		Break in 1993. Not related with contemporary trade agreements
Ecuador		
High technology		Break in 1993. Not related with Contemporary trade agreements
Mid technology		Break in 1991. Not related with contemporary trade agreements
Low technology		Break in 1989. Not related with contemporary trade agreements
Paraguay		
High technology		Break in 1998/1999, possibly related with

[5] Actually there are unit root tests that allow for 2 breaks, like Clemente, Montañes and Reyes (1998). They were not applied here due to their asymptotic properties and insufficient temporal coverage of available data.

		agreements de 1996
Mid technology		Break in 1999/2000, possibly related with agreements de 2000
Nat resources based tech		Break in 1995. Not related with contemporary trade agreements
Peru		
High technology	Break in 1995/1999. Not related with contemporary trade agreements	Break in 1996/1998. Not related with contemporary trade agreements
Low technology	Break in 1999/2000, possibly related with agreement in 2000	
Nat resources based tech	Break in 1998/2000, possibly related with agreement in 2000	Break in 1989/1999. Not related with contemporary trade agreements
Uruguay		
High technology		Break in 1994, possibly related with agreement in 1991
Mid technology	Break in 1994, possibly related with agreement in 1991	
Low technology	Break in 1989, possibly related with agreement in 1986	Break in 1989, possibly related with agreement in 1986
Nat resources based tech	Break in 1991, possibly related with agreement in the same year	
Venezuela		
Low technology	Break in 1990. Not related with contemporary trade agreements	
Nat resources based tech	Break in 1988/1989. Not related with contemporary trade agreements	

Source: own

In Argentina, the largest detected breakdowns occurred with revealed advantages series and focused in high, mid and low-tech sectors. Additionally mid technology sector recorded a break in IE in 2001. It is worth noting that the shock in IE occurred after that experienced by the same sector in VCR, which could lead to point that variation in exports pattern of mid tech manufacturing goods did not emerge from significant changes in specialization. In turn, the high and low tech manufacturing sectors experienced substantial changes in VCR without evidence of shocks in IE. Finally, Argentina recorded no evidence of significant breaks in the patterns of specialization or exports based on natural resource sector, a sector in which the country is specialized according to its specialization index.

In Bolivia breaks occurred mainly in IE series in the mid and low tech and natural resource based manufacturing, the latter two related with trade agreements signed by the country. In the VCR series breaks occurred in the high-tech sector and natural resource based manufacturing, also possibly linked to trade agreements. Dates of breaks in IE series are precedent to those identified in VCR series but, as they are associated with different sectors, (they match only in the natural resources based sector), that suggest that changes in the country's exports in those sectors do not emerge from changes in specialization. Only in the manufacturing sector based on natural resources, in which Bolivia is specialized, the break in IE series is precedent to the one faced by VCR and therefore might indicate that trade agreements have led to changes in the production of goods which, in turn, lead to intensify exports to the rest of regional partners.

Brazil exhibits breaks in VCR focused in 2 sectors, high and mid tech manufacturing. In the latter, in both series the ZA points dates for breaks possibly associated with the signing of trade agreements. However, the breakdown dates differ; the process that generate VCR series changed before the one underlying EI.

In the case of Chile, breaks are detected mostly in IE especially in mid tech and natural resource based sectors. EI series shows that Chile also recorded an increasing tendency to specialize in those sectors. Chilean's VCR changed suddenly in 1994/1995. Also, breaks do not coincide by sector so there is no evidence of contemporaneity in the shocks experienced by both series, although that both in high and mid tech breaks could be related with trade agreements. In other words, 2 of the 3 breaks identified by the ZA test may be possibly associated with regional trade agreements, although, as noted above, could not speculate with a sequence of the type: trade agreement → locational change / specialization → exports boost.

In Colombia, EI series exhibited no breaks, only in VCR series breaks were observed in 2 sectors in which the country is specialized (mid tech and natural resources), but they cannot be associated with contemporaneous trade agreements. Therefore, it seems that those breaks do not constitute reactions in sectors in which the country was already facing competitive business alliances. In the low-tech sector, Colombia evolved from not specialized to specialized (as the index grew from < 1 to >1) yet the test did not identify any break in both series for this sector.

In the case of Ecuador and Paraguay, EI series have insufficient observations, so the results lack of robustness. Therefore, we only present results for VCR series. In the case of Ecuador ZA locate breaks not associated with Contemporary trade agreements in the sectors of high, mid and low technology. In these sectors the country either exhibited a downward trend in specialization or no specialization at all. Dates identified by the ZA test correspond to significant decreasing in specialization index or the least level of specialization in the case of mid-tech sector. In the case of Paraguay, the breakdowns in the revealed advantages series were found in the sectors of high, mid and resourced based tech; the latter is the only one in which the country is specialized and the break is hardly related with a trade agreement. In the other 2 sectors, the breaks could be associated with the signing of trade agreements by the country.

In the case of Peru, breaks are detected in 3 of the 4 sectors considered: high, low technology sector and natural resource based activities. In the last 2, in addition, the country reveals as specialized. In IE series breaks were detected under 3 specifications in those sectors while in VCR just high tech and natural resource based activities show significant breaks; also they did not occur near or after the signing of trade agreements. The dates of breakdown identified by the test in the series of specialization are approximate to each other and associated with the signing of trade agreements, except in the high-tech sector in which the break occurred before the trade agreement of 2000.

Uruguay, like Bolivia, recorded breaks in the 4 sectors covered. In this case, breaks were identified in both series (mostly in IE) but in different sectors, they only match in the low tech manufacturing sector; where ZA located the break in the same date which can be associated also to the signing of trade treaties.

Finally, Venezuela faced breaks in IE series in low-tech sectors and natural resource manufacturing that could not be linked to trade pacts although selected dates by the test are close together.

In short, the evidence in favor of trade agreements followed by changes in industrial location and, in turn, variations in export pattern is mixed in South American economies. The most common situation is the presence of instability (unit root processes) in specialization and revealed advantage series. Also, breaks, when located, occurred after the signing of trade alliances but concentrated mainly in exports and less in location/specialization.

The only case where such sequence has some evidence is the low tech in Uruguay.

Taking into account contemporary breaks with trade agreements by sector, IE concentrated ruptures in mid technologies while VCR exhibits more breaks in high tech. Natural resource based manufacturing technologies exhibit the fewer number of breaks after the signing of regional trade acts.

As for the VCR series, a higher concentration of breaks in the periods 1990-2002 is observed, being the 90s de decade of higher occurrence. A total of 20 breaks were identified in that series, 12 of them associated with trade agreements. Meanwhile IE series exhibit a total of 15 breaks in the years 1988, 1989 and 1999, and some individual years during the 90s depending upon the country, 10 of them associated agreements.

The breaks are rarely presented in both series in the same sector; most cases show a break in one series and sector except in 5 cases (Argentina and Brazil in mid-tech sector, Bolivia in natural resourced sector, and Peru in high-tech sector and natural resource based activities). Also, in those cases studied, only 2 follow the expected sequence and dates agree in just one case, otherwise the break in the VCR series is prior to the one in EI series and the rest is difficult to determine because the test identifies 2 different dates in each series as potential ruptures.

Although other exercises are in order to test causality between breaks and the signing of trade agreements, the found result indicates that specialization and revealed advantage figures are not stable but cannot also be univocally associated with trade agreements. Also, when structural changes in their process emerge, the evidence in favor of them as trade acts reactions are mixed; breaks may have multiple origins and do not reproduce a succession of locational change followed by variations in exports intensity.

4. Specialization and effective trade advantages: a cointegration approach

As already mentioned, the agreements may entail changes in specialization and trade of the participating countries, but such changes may occur with a time delay. The index of specialization not only indicates whether a country is specialized in the production of a certain good, but also provides information about the potentiality of becoming a net exporter of such goods to the rest of the countries. If that trade potential is exploited it should be translated into concrete changes in the country´s pattern of trade. Moreover, it could also trigger further changes in the production structure. In econometric terms, this would imply the existence of long-term relationships or cointegration between IE and VCR.

To test the existence of a cointegration relationship between 2 variables, it is necessary first to test if individually series have a unit root or are stationary. In part, this task has been made previously (based on tests of ZA). However, since it is possible to arrange the data in panel form, the presence of unit roots in series may exploit the information provided by a panel data structure. A set of different methods was chosen to test the existence of unit root in each series in a context of panel data, such as Levin Lin Chu (2002), Im-Pesaran Shin (2003), known in the literature as unit root tests first generation panels and CADF Pesaran (2003) and CIPS Pesaran (2007), part of the set of second generation tests. A review of unit root tests for panel data is in Hurlin and Mignon (2007).

The mentioned unit root tests were applied in both IE and VCR series by country. In some cases tests were carried out with 7 countries instead of 10 in order to meet the information requirements of each test. Since the models are based on a panel structure with 2-dimension, cross-section and time, and the problem here contains 3 dimensions (country, period, sector), a variable "sector/country" was created to get just 2 dimensions. The resulting panel Contains cross section observations corresponding to a given sector in a given country each year.

The LLC test applied to the IE series indicates that all panels are stationary, but if applied on a sample of 7 countries, the conclusion is that all panels have unit root. The IPS test concludes that the panels are stationary if a trend is included; otherwise they follow a unit root. In the case of test CADF, EI series has a unit root with different specifications selected. In turn, the CIPS test indicates that some panels are stationary in the sample with 10 countries, with the opposite conclusion (e.g. unit root) when 7 countries are considered.

For the VCR series tests results are more homogeneous. Upon the LLC test, all panels are stationary in both samples. A similar conclusion emerges performing the IPS test, CADF and CIPS; some panels are stationary, so some might follow a unit root process.

In short, the evidence would indicate that the VCR series is panel stable while the evidence for IE series supports the existence of a unit root. As second generation tests indicate some panels are stationary in VCR, we proceed to test cointegration.

Regarding the methods for testing cointegration, the proposals of Pedroni (1999) and Westerlund (2007) were chosen. To do so we select the VCR series as the dependent variable while the IE series would be the explanatory variable.

Table 2. Cointegration: Pedroni test results

Statistic	With trend	Without trend	With trend extraobs [&]	With trend and max lags (hqic)#
Panel v	1,182	1,542**	1,525	1,182
Panel rho	-1,652**	-2,49*	-2,477*	-1,652**
Panel t	3,177*	-3,953*	-4,056*	-3,177*
Panel ADF	0,879	1,099	-0,074	1,493
Group rho	-0,102	-0,313	-0,471	-0,102
Group t	-4,194*	-4,763*	-4,77*	-4,194*
Group ADF	1,235	2,543*	-0,643	2,339*

Source: own

[&] if there is an unbalanced panel with observations missing for some of the variables (at the start or end of the sample) for certain individuals, the estimation includes the available observations from the missing years in the time means used for time demeaning.

[#] number of lags are based on Hannan-Quinn information criteria.

* RH0 AT 1%

** RH0 AT 5%

*** RH0 AT 10%

The results of statistical proposed by Pedroni (op. cit.) suggest cointegration. The statistic *panel t* and *group t* reject the null of no cointegration in each of the selected specifications.

Panel rho statistic with and without trend, including observations available also rejects the null, as well as *group ADF* do, with and without trend or selecting the number of lags.

Like first generation unit root tests, this type of testing can lead to the conclusion that there is cointegration in the series influenced by the existence of cross-dependence between observations. Thus, we perform the proposal made by Westerlund (2007), a second generation test that supports dynamic structures in the relationship between variables. In addition, since the panel covers a relatively long period in which there have been significant macroeconomic and structural reforms, it is possible that EI exerts short and long term effects on VCR. Therefore, an error correction model is appropriate because it allows estimating both effects and the speed of adjustment to equilibrium.

Table 3. Cointegration in a panel of 10 countries, 1985-2008 based on Westerlud (2007) test

Statistics	Lags (1) Leads (0) W(3)*	Lags (1) Leads (0) W(4)*	Lags (1) Bootstrap (100 reps)	Decision
G_τ	-2,571 -5,535 (0.000)	-2,571 -5,535 (0.000)	-2.447 -4.656 (0.330)	RH0, series cointegrate. NRH0 using Bootstrap
G_a	-10,210 -3,511 (0.000)	-10.255 -3,563 (0.000)	-10.424 -3.761 (0.180)	RH0, series cointegrate. NRH0 using Bootstrap
P_τ	-17,650 -8,217 (0.000)	-17.656 -8,223 (0.000)	-15.268 -5.865 (0.150)	RH0, series cointegrate, NRH0 using Bootstrap
P_a	-11,689 -10.108 (0.000)	-12,231 -10,854 (0.000)	-9.368 -6.909 (0.140)	RH0, series cointegrate. NRH0 using Bootstrap

Source: own

* Bartlett Kernel window width used in the estimation of long term semi-parametric variances.

H0: no cointegration, G_τ and G_a check cointegration for each country individually and P_τ and P_a check cointegration in panel globally.

Coefficient, Z and p-values in parenthesis

Other specifications could not be tried as the tests requires a long time horizon in order to consider more lags and or leads

Table 3 shows evidence of cointegration for the panel as a whole and considering each cross section in particular. The speed of adjustment (in cases where the decision suggest that series cointegrate) is near -0.6, which is moderate. Anyway replications decrease the evidence in favor of a long term relationship between location index and export pattern.

5. Comparative advantages and trade: an approach based on stochastic frontier models

The extent to which organizations, regions or countries take advantage from a given capability can be approached by efficiency analysis, which implies comparing effective results with that which should have been obtained from the full utilization of that potential (the frontier). In this case the frontier is constructed from the country´s potential in a given sector.

The analysis of potential trade utilization is based on stochastic frontier technique. This approach, originally proposed for estimating production frontiers in microeconomics, provides estimations of relative efficiency. Here we try to identify if a country or a given technology, is efficient in terms translating its advantages (measured as specialization) into exports. Thus, the dependent variable VCR is specified in terms of IE on a model of the type:

$$VCR_{it} = \alpha + \beta\, IE_{it} + \varepsilon_{it} \qquad\qquad i = 1, \ldots N; t = 1, \ldots, T$$

where $\varepsilon_{it} = v_{it} - u_{it}$. The term ε is composed of 2 components, a symmetrical noise, normally distributed ($v_{it} \sim$ N $[0, \sigma^2_u]$) and a nonnegative term of inefficiency that follows a normal truncated distribution ($u_{it} \sim N+ [\mu, \sigma^2_u]$). Both terms of disturbance are independent of each other. For more details see Kumbhakar and Lovell (2003).

The idea behind the stochastic frontier approach is that IE sets an export potential that could be fully exploited and become in exports, in which case $u_{it} = 0$ or, alternatively, it can also be underexploited, in which case $u_{it} > 0$. Thus, the estimate stochastic frontier involves imposing the restriction that the term associated with inefficiency should invariably take non-negative values[6].

Also, in stochastic frontier models with panel data there are 2 possible parameterizations for the inefficiency term: time variant or invariant. In the former case, an equation must be entered in order to model the temporal sequence for u_{it}. Battese and Coelli (1992) propose a model where u_{it}. is defined as:

$$u_{it} = u_i\, e^{\eta(t-T)}$$

where T represents the last period of the panel, η is a vector of parameters to be estimated and u_i the sample average level of inefficiency or the mean distance to the estimated stochastic

[6] Traditionally in models using cross-section data, the inefficiency term is assumed to follow a mean normal, truncated mean normal, exponential or gamma distribution. Estimates of stochastic frontier in panel data usually assume the truncated normal distribution. In practice outcomes rarely differ depending on the type of distribution used, as cumulative density functions differ only at the extreme.

frontier. If $\eta = 0$, the model does not depend on time and the most appropriate decision is to use a model with static inefficiency. If $\eta > 0$ inefficiency it is increasing and vice versa.

Since the model is based on panel data with 2 dimensions, cross section and time series, and the problem here analyzed contains 3 dimensions (country, type of manufacturing technology and time), the estimate requires setting one of the 2 cross sectional dimensions. Thus, 2 variants were tried: one in which technology is given and the resulting panel contains observations per country per year and another one where the country is given and observations vary by technology and by year.

Table 4 summarizes the results. It should be noted that the results of Paraguay are excluded from the table and in the case of Venezuela the variant that allows for u_{it} variability in time is also omitted because the objective function was not concave and the procedure is unable to find an optimal value.

The results obtained considering a frontier estimation for each country (i.e. where i stands for the sector in the panel) shows that in 4 of the 8 countries analyzed the potential benefits are significant to explain the intra-regional export position. However, the potential of the economies in each sector do not appear to be fully exploited by exports; in most cases, in countries where specialization becomes significant to boost exports the magnitude of β does not exceed 0.3. Additionally, the evidence favors temporal variations in inefficiency; except in Argentina, the other countries face a rising inefficiency over time.

Some explanations are required to clarify some confusing results; the low average value of β must not be interpreted as a sign of country's or sector's inefficiency in translating specialization into exports as that specialization may be transferred to internal or foreign markets other than regional ones. Thus, a given country or sector can exhibit low β with high efficiency scores and some other can display high β with low efficiency.

In particular, Peru is the economy that most exploited its export potential as β is substantially higher (0.63) than the rest of its partners ($\beta < 0.3$) which was significant and although the sign of η indicate that inefficiency is growing, it has the lowest coefficient ($\eta = 0.0349$) in the group.

Values and statistical significance for η allow us to state that Bolivia and Peru increased their efficiency as their β coefficients for 2 possible settings were significant.

Table 4. Comparative advantage and exports: a stochastic frontier estimation

Country	Time invariant	Time variant	No. observations, $N \times T$

	β	β	η	
Argentina	.0412 (0.592)	.2160* (0.000)	-.0281* (0.000)	96
Bolivia	.1634** (0.076)	.3096** (0.044)	.0359* (0.000)	68
Brasil	.1304 (0.308)	.1742 (0.226)	-.0028 (0.440)	92
Chile	.1791** (0.098)	-.0415 (0.645)	.0219* (0.000)	92
Colombia	-.0772 (0.315)	-.0842 (0.272)	.0058 (0.126)	96
Ecuador	-.5629+ (0.000)	-.2866+ (0.035)	.0406* (0.004)	40
Perú	.6455* (0.000)	.6282* (0.000)	.0349* (0.000)	76
Uruguay	.0948 (0.247)	.1662** (0.058)	.0148 (0.124)	68
Venezuela	-.7025+ (0.009)	#	#	56
High technology	4.86e-08 (0.519)	7.62e-08 (0.215)	.0170* (0.004)	181
Mid technology	.0644 (0.375)	.0272 (0.712)	-.0064*** (0.091)	181
Low technology	.1047 (0.291)	.1434** (0.074)	.0343* (0.000)	181
Nat res. Tech	-.0791 (0.195)	-.0828 (0.187)	.0035 (0.138)	181

Source: Own
p-values in brackets, 2 tails
+ Relevant at 1% and 5%, but with sign contrary to expected
# models for Paraguay and Venezuela could not be estimated as objective function was not concave for both specifications
* RH0 AT 1%
** RH0 AT 5%
*** RH0 AT 10%

It is noteworthy the case of Uruguay, in which the model with static inefficiency does not record that IE will impact significantly on VCR, the specification with variant inefficiency does not find η as significant (i.e., the correct specification would be static) but there β is significant and positive. One possible explanation for this contradictory result is the lack sufficient observations in order to set stable results. In particular, the cases of Uruguay and Ecuador (where the parameter that accompanies IE is significant, but its sign is contrary to the expected one) have the least number of observations, condition that could affect the asymptotic properties of the estimators[7].

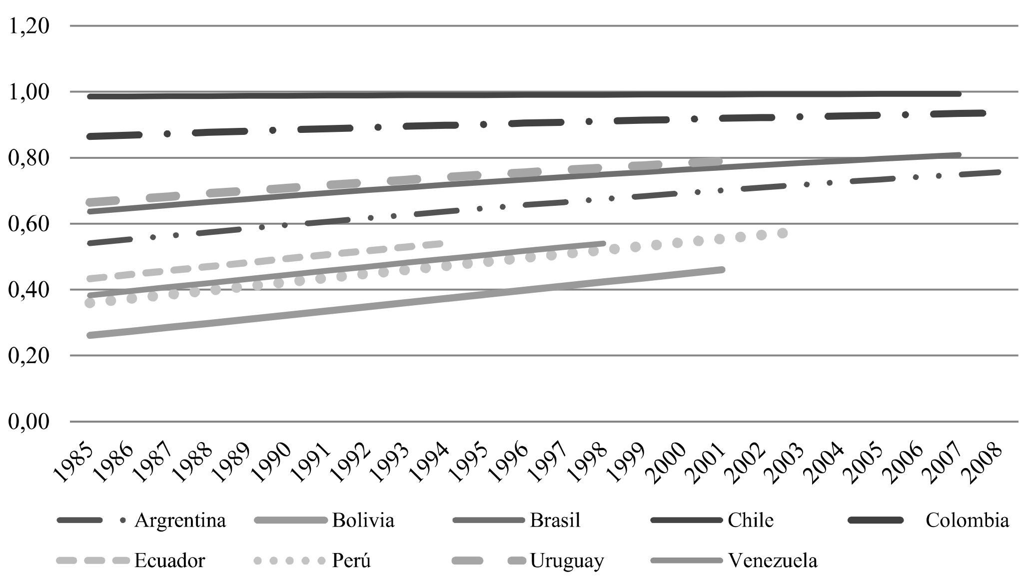
On the other hand, the fact that countries such as Ecuador or Venezuela registered an opposite sign than expected could also be due to several factors not necessarily econometric

[7] In econometrics, a small number of observations is known as a micronumerosity problem, one of whose symptoms is the instability of the coefficients, the lack of individual significance or signs contrary to the expected ones.

ones; including a manufacturing specialization oriented to the domestic market or policies unfavorable to industrial goods´ exports (exchange rate appreciation, etc.).

When the *i-th* dimension of the panel represents countries (for given sector), the results indicate that the coefficient of EI variable is not significant (except in low technology, which is significant at 5%). Again, this suggests that effective trade patterns are not driven by the advantages.

Figure 1. Time inefficiency in low-tech manufacturing industry



Source: Own

In this methodology the error term measures the inefficient in the use of a country´s capability. In the case of low-tech manufacturing, inefficiency has been increasing over time in all countries under study. In this sector there are countries with high inefficiency (e.g. Chile and Colombia) and others where the exploitation of advantages is higher (e.g. Bolivia and Peru). Therefore they exhibit lower values of the error term, close to about 0.3.

Figure 1 show countries with similar inefficiency estimates, exhibiting "inefficiency clubs" with 2 or 3 countries each. Although that there are countries with few data, it is clear in this type of manufacturing the growing and sustained trend over time of the inefficiency in exploiting its potential.

Figure 2 exhibits the variant inefficiency by sector in those countries where the IE´s coefficient was significant. The sectors with higher time variant inefficiency in exploiting their potentials are mid-tech and natural resource based manufacturing. The difference between the estimated values of inefficiency of each country and among themselves is not significant; high values approaching 0.9 and low ones are near 0.5.

Table 5. Time invariant inefficiency by sector and country

Sector/Country	Bolivia	Chile	Peru
High technology	0,579	0,554	0,885
Mid technology	0,926	0,851	0,962
Low technology	0,500	0,966	0,526
Natural res. Based tech	0,955	0,585	0,677

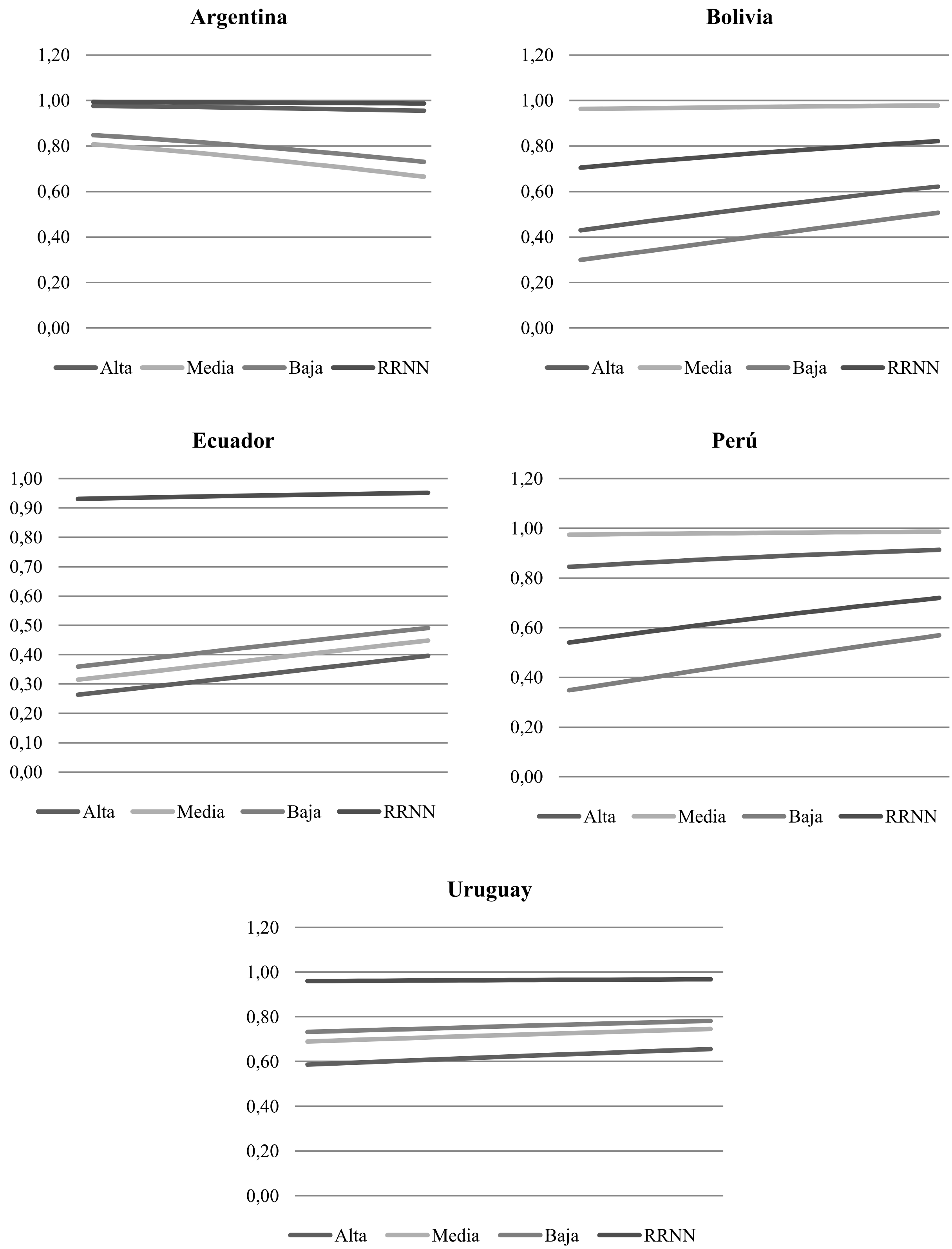
Source: Own

I

In short, in the model of variant inefficiency, Bolivia, Chile and Peru have succeeded in transforming their manufacturing potential in exports to their regional partners. However, they exhibit inefficiency, especially in mid tech and natural resources based activities (Bolivia), mid and low technology (Chile) and mid and high technology (Peru). In turn, Peru is the economy which higher trade exploitation from its specialization.

Additionally, it should be noted that, contrary to expectations, sectors where there was more transformation from specialization to exports do not record a particular specialization. Meanwhile, the sectors with greater inefficiency are those where the specialization index was greater than 1.

Figure 2. Time variant inefficiency by country and sector



Source: Own

The results obtained in the time variant model do not differ substantially from the invariant specification for inefficiency. Also, fixing the model by country, there is an increasing trend in inefficiency in the less efficient sectors and the rest of them form a group with similar trends in inefficiency evolution. Argentina is perhaps an exception as it has 2 sectors with high inefficiency with a favorable evolution.

Finally, the mid tech and natural resource based are the sectors with higher inefficiency in the use of their potential, except again for Argentina, in which the higher inefficiency is located in high-tech manufactured goods.

6. Discussion

In the present study, the results indicate that there is no definitive evidence as to whether the potential of each country/sector to generate trade have been effectively exploited in terms of increased exports to the region. In relation to contemporaneity, it is feasible to associate changes in IE and VCR series with trade agreements, but evidence suggests that it is possible that the dates identified by the tests applied have diverse backgrounds, so that the contemporaneity of shocks in the series with the agreements is still hypothetical; additional information is needed to monitor the effects of external variables on exports[8].

In particular, difficulties in applying this methodology in cases of Paraguay and Venezuela arose because the objective function was not concave and the procedure was unable to find an optimum. Again future further research should be aimed to extend the data time.

Some countries recorded an opposite sign than expected in terms of export potential and revealed advantage. This could be due to several factors, including a manufacturing specialization oriented to the domestic market (specially marked in Venezuela) or policies unfavorable to exports of industrial goods (exchange rate appreciation, etc.).

Some issues could not be analyzed as they exceeded the target of study but highlight a path for future approaches and insights. As no evidence of significant breaks in both series (IE and VCR) is found, it is important to remember that some authors as Nunes et al (1997) and Lee and Strazicich (2004) suggest that one of the weaknesses of the ZA type tests is that the null does not consider breaks. While these authors have proposed unit root tests with breaks, the

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[8] One drawback to be solved in future research is the narrowness of the time horizon of the information available to the economies of Paraguay and Ecuador. Therefore, and given the characteristics of test ZA, they were not analyzed the results of these countries as they would not robust.

commands are still not available in econometric packages commonly used, so its application is still limited.

Another issue that deserves more attention is connected with breaks in series; ZA test endogenously identifies the date of possible cut off but the effective impact of trade agreement should also consider the direction of the break in IE and/or VCR. Future research must complete the picture addressing this point.

In cointegration testing, VCR was taken as the dependent variable and IE as explanatory. Westerlund method assumes that VCR has no effect on EI when it is plausible that they influence each other. There is literature aimed to handle with this situation. An example is the test proposed Blackburne and Frank (2007) that captures dynamic relationships and allows for cross-sectional heterogeneity. Usually it is also used to check bidirectionality, which requires a series of additional tests to check endogeneity and heterogeneity, which requires extensive work time.

Moreover, cointegration tests do not support breaks. Westerlund and Edgerton (2008) and Costantini and Martini (2010) propose a panel co-integration test with breaks but the routine is not yet available in traditional statistical packages so your application becomes limited.

7. Final remarks

Economic integration agreements may generate benefits that cannot be appropriated symmetrically among participants. Regional economic integration has consequences on the behavior of industrial activity and its location, creating obstacles for some countries to participate fully as beneficiaries of that integration process. "*…both the size and wealth of the countries determine their ability to appropriate the benefits of an integration process*" (Terra, 2008: 4). The New Economic Geography emphasizes the importance of market size as agglomeration processes are generated around the markets with larger sizes. On the other hand, the least developed and poor countries are often left behind and are less able to exploit the opportunities offered by integration agreements.

In this paper we study the contemporaneity of the changes in specialization patterns of South American countries with the signing of integration agreements. The aim was to check whether the potential of each country and sector to export (in terms of the specialization index) have been effectively exploited (in terms of higher relative exports) and, if there is a change, it was contemporary or it followed the signing of trade agreements.

Results indicate that in all countries except Venezuela, Colombia and Ecuador could be contemporaneity between the date of break in one of the series and the signing of trade agreements with South American countries.

As for the VCR variable, the occurrence of breaks agglomerates in 1990-2002 is observed, being the 90s the decade with more breaks. A total of 20 breaks were identified in this series, 12 of them associated with trade agreements. While the IE series faced near 15 breaks in the years 1988, 1989 and 1999, and some individual years of 1990s according the country under analysis, 10 of them associated agreements.

Breaks are rarely presented in both series in the same sector, mostly a break series and sector except in 6 cases (Argentina and Brazil in mid-tech sector; Bolivia in the technology sector based on natural resources, Peru in the high tech sector and natural resource based activities and Venezuela in low-tech sector). Also, breaks in the IE series are not always prior to breakdowns in VCR series, so there is no strong evidence in favor of a sequence of changes in specialization followed by changes in trade.

Breaks did not occur in all sectors; some sectors experienced more ruptures than others. The high-tech sector was the highest proportion of breaks in exports associated with agreements while the natural resource based tech was the one that experienced fewer breaks linked to trade agreements in the region. In turn, major breaks in IE occurred in mid manufacturing technologies.

The most important result observed is that after the signing of trade agreements changes in the specialization or export structure of the country, if any, have been weak both in terms of breaks following those acts and sequence of emerging changes (from specialization to effective trade). Moreover, breaks in the series may also have been associated with other factors (e.g. the debt crisis in several countries in Latin America). The only exception to that global picture is the case of low technology sector in Uruguay.

The evidence suggests that VCR series is more stable than IE series as it shows more cases of stationarity. There is some support in favor of cointegration considering both the panel as a whole as for each cross section in particular with a moderate speed of adjustment. But bootstrapping reduces the evidence towards cointegration.

Most of the countries studied exploited moderately their export potential. The ones with higher connection between specialization and export intensity show also high inefficiency. Peru differs slightly from that general picture as its β coefficient (relating export potential with effective one) was substantially higher (0,63) than the rest of its partners ($\beta < 0,3$). Also inefficiency is growing on most countries. Argentina is the only country where inefficiency exploiting its potential decreases over time.

Considering results by sector, the stochastic frontier coefficient is not significant (except in low technology, which is significant at 5%). This suggests that the specialization do not boost trade patterns. Moreover, when significant, inefficiency is increasing steadily over time.

Models that consider variant or invariant inefficiency do not differ substantially from each other. The sectors with greater inefficiency in exploiting their potentials are mid-tech manufacturing and natural resource based technologies. Contrary to expectations, sectors where export exploitation is higher are those where countries do not exhibit specialization. While most inefficient sectors correspond to those which have specialization index values greater than 1.

According to the results, the potential of each country/sector to export certain manufactures have been exploited in some cases although inefficiently. The changes have been weak and although they may be associated with the signing of a regional trade agreement, evidence also suggests that it may be caused by other forces. While the region does not specialize in high-tech products, high tech exports reacted the most to regional trade alliances and have gained proportionally more important in trade among members of South America. Also, changes in location/specialization following trade acts were not frequent but, when occurred, concentrated in mid tech manufacturing.

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Appendix

Table A.1. ZA test statistics

Sector / Series	IE Break in intercept	IE Break in trend	IE Break in both	Decision	VCR Break in intercept	VCR Break in trend	VCR Break in both	Decision	Trade agreement dates
Argentina									
High tech	-1.814	-1.799	-2.050	Has a unit root	-5.764* (2002)	-4.388*** (1999)	-4.940*** (1993)	Stationary with a Break in 2002	1990 1991 1992 1996 1998 2000 2003 2004 2005 2009 2011
Mid tech	-6.949* (2001)	-3.013	-5.922* (2001)	Stationary with a Break in 2001	5.405* (1991)	-4.380*** (1997)	-5.248** (1991)	Stationary with a break in 1991	
Low tech	-3.821	-2.634	-3.697	Has a unit root	-4.477	-5.344* (2004)	-5.615* (2002)	Stationary with a Break between 2002/2004	
Natural res based tech	-3.958	-2.905	-3.168	Has a unit root	-4.205	-3.143	-4.080	Has a unit root	
Bolivia									
High tech	-4.432	-2.278	-3.213	Has a unit root	-4.916** (2002)	-5.338* (2000)	-5.904* (1998)	Stationary with a break between 1998/2002	
Mid tech	6.563* (1988)	-5.936* (1989)	-5.982* (1988)	Stationary with a Break in 1988/1989	-3.330	-2.320	-3.288	Has a unit root	1969 1993 1996 2000 2006 2009 2011
Low tech	-4.158	-2.562	-5.203** (1993)	Has a unit root but could be stationary with a break in 1993 at 5%	-1.434	-2.053	-2.301	Has a unit root	
Natural res based tech	-5.037** (1990)	-7.691* (1995)	-7.079* (1995)	Stationary with a Break in 1995	-7.566* (1992)	-6.617* (1996)	-6.727* (2000)	Stationary with a Break in 2000	
Brasil									

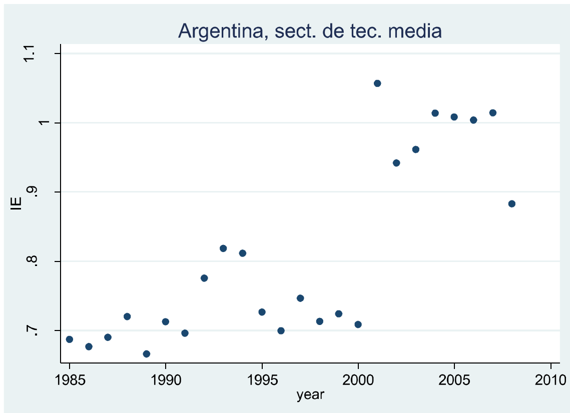
High tech	-3.821	-3.248	-3.741	Has a unit root	-5.435* (1993)	-5.711* (2002)	-5.732* (1998)	Stationary with a break in 2002	1986 1990 1991 1996 2000 2001 2004 2005 2009 2011 2014
Mid tech	-4.335	-4.197*** (1999)	-4.756	Has a unit root but could be stationary with a Break in 1999 at 10%	-5.940* (1993)	-6.662* (1994)	-7.038* (1993)	Stationary with a Break in 1993/1994	
Low tech	-4.256	-2.887	-4.212	Has a unit root	-3.810	-3.847	-3.755	Has a unit root	
Natural res based tech	-4.096	-2.172	-3.294	Has a unit root	-3.158	-3.869	-3.581	Has a unit root	
Chile									
High tech	-1.704	-2.777	-2.777	Has a unit root	-4.806** (1990)	-6.349* (1994)	-6.253* (1995)	Stationary with a Break between 1994/1995	1969 1991 1993 1996 2000 2009 2010 2011
Mid tech	-5.276** (1996)	-3.360	-4.872*** (1996)	Has a unit root but could be stationary with a break in 1996 at 10%	-3.880	-3.478	-3.863	Has a unit root	
Low tech	-2.895	-3.475	-3.164	Has a unit root	-3.611	-3.652	-3.457	Has a unit root	
Natural res based tech	-4.909** (1989)	-5.133* (1990)	-4.791	Stationary with a Break between 1989/1990	-3.781	-4.228*** (1991)	-4.445	Has a unit root	
Colombia									
High tech	-2.728	-1.879	-1.712	Has a unit root	-3.050	-2.980	-3.082	Has a unit root	
Mid tech	-4.334	-2.461	-4.771	Has a unit root	-4.780*** (1991)	-3.043	-4.538	Has a unit root at 5% but could be stationary with a Break in 1991 at 10%	1969 2000 2004 2009 2011
Low tech	-3.863	-2.614	-3.893	Has a unit root	-2.738	-2.397	-2.655	Has a unit root	
Natural res based tech	-2.306	-2.954	-2.484	Has a unit root	-5.971* (1993)	-3.713	-6.277* (1993)	Stationary with a Break in 1993	

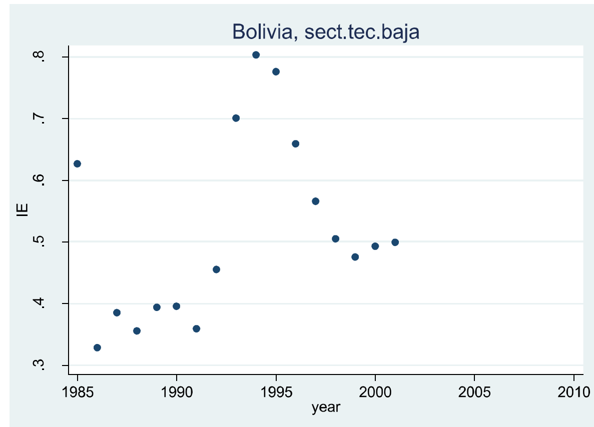
Ecuador									
High tech	-4.738*** (1989)	-4.174*** (1990)	-4.405	Insufficient time horizon. Results are not robust	-4.620*** (1991)	-4.068	-4.629	Has a unit root but could be stationary with a break in 1993 at 10%	1969 2000 2004 2008 2009 2011
Mid tech	-6.400* (1990)	-2.408	-5.188** (1990)	Insufficient time horizon. Results are not robust	-4.325	-4.446** (1999)	-4.344	Has a unit root, could be stationary with a break in 1991 at 5%	
Low tech	-4.085	-2.860	-5.272** (1991)	Insufficient time horizon. Results are not robust	-6.727* (1989)	-4.906** (1993)	-6.526* (1989)	Stationary with a Break in 1989	
Natural res based tech	-4.608*** (1991)	-2.999	-4.118	Insufficient time horizon. Results are not robust	-3.461	-3.657	-4.580	Has a unit root	
Paraguay									
High tech	-1.169	-2.044	-2.198	Insufficient time horizon. Results are not robust	-6.14* (1998)	-5.620* (1999)	-6.597* (1998)	Stationary with a break in 1998/1999	1991 1992 1996 2000 2004 2005 2009 2011
Mid tech	-5.967* (1989)	-4.086	-5.049*** (1989)	Insufficient time horizon. Results are not robust	-6.756* (2000)	-4.861** (1999)	-7.149* (2000)	Stationary with a break in 1999/2000	
Low tech	-5.497* (1992)	-4.033	-4.568	Insufficient time horizon. Results are not robust	-3.881	-3.655	-4.116	Has a unit root	
Natural res based tech	-4.003	-5.257* (1992)	-4.807	Insufficient time horizon. Results are not robust	-6.078* (1998)	-4.820** (1995)	-6.053* (1998)	Stationary with a Break in 1995	
Perú									
High tech	-11.637* (1995)	-8.741* (1999)	-11.311* (1995)	Stationary with a Break between 1995/1999	-5.712* (1992)	-5.293* (1996)	-5.753* (1998)	Stationary with a Break between 1996/1998	1969 2000 2005 2006 2009 2011 2012
Mid tech	-4.190	-3.457	-4.485	Has a unit root	-3.083	-3.948	-4.165	Has a unit root	
Low tech	-5.426* (1996)	-4.827** (2000)	-5.681* (1999)	Stationary with a break between 1999/2000	-4.487	-4.096	-4.159	Has a unit root	
Natural res based tech	-4.932** (2000)	-5.313* (2000)	-6.560* (1998)	Stationary with a Break between 1998/2000	-5.487* (1999)	-7.260* (1989)	-5.515** (1989)	Stationary with a Break in 1989/1999	
Uruguay									

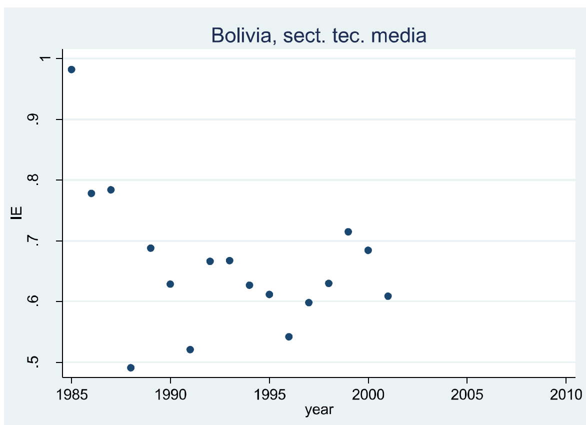
High tech	-4.367	-3.638	-3.831	Has a unit root	-9.066* (1994)	-8.322* (1996)	-8.491* (1998)	Stationary with a break in 1994	1986 1991 1996 2000 2003 2004 2005 2009 2011
Mid tech	-5.315** (1992)	-4.928** (1994)	-4.961*** (1996)	Stationary with a Break in 1994 at 5%	-4.399	-3.787	-4.140	Has a unit root	
Low tech	-5.510* (1989)	-6.030* (1992)	-5.743* (1989)	Stationary with a Break in 1989	-3.214	-4.782** (1989)	-4.185	Has a unit root but could be stationary with a break in 1989 at 5%	
Natural res based tech	-3.236	-4.736** (1991)	-4.077	Has a unit root but could be stationary with a Break in 1991 at 5%	-4.088	-3.865	-4.093	Has a unit root	
Venezuela									
High tech	-4.463	-3.888	-3.974	Has a unit root	-3.925	-3.308	-3.826	Has a unit root	1993 1996 2000 2004 2005 2009 2011 2012 2014
Mid tech	-4.086	-3.422	-4.479	Has a unit root	-3.007	-3.242	-3.385	Has a unit root	
Low tech	-6.684* (1990)	-3.465	-5.211** (1990)	Stationary with a Break in 1990	-3.862	-3.839	-4.005	Has a unit root	
Natural res based tech	-4.939** (1988)	-4.939* (1989)	-6.465* (1989)	Stationary with a Break in 1988/1989	-4.887** (2002)	-3.729	-4.162	Has a unit root	

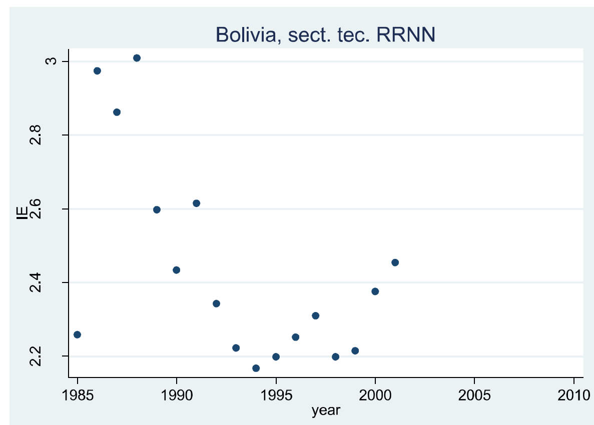
Source: own base d on UN-Comtrade
Analysis was completed with charts of each series.
The selected lags followed Bayes' information criteria
* RH0 AT 1%
** RH0 AT 5%
*** RH0 AT 10%
Critical values, specification 1: 1%: -5.34, 5%: -4.80 y 10%: -4.58
Critical values, specification 2: 1%: -4.93, 5%: -4.42 y 10%: -4.11
Critical values, specification 3: 1%: -5.57, 5%: -5.08 y 10%: -4.82

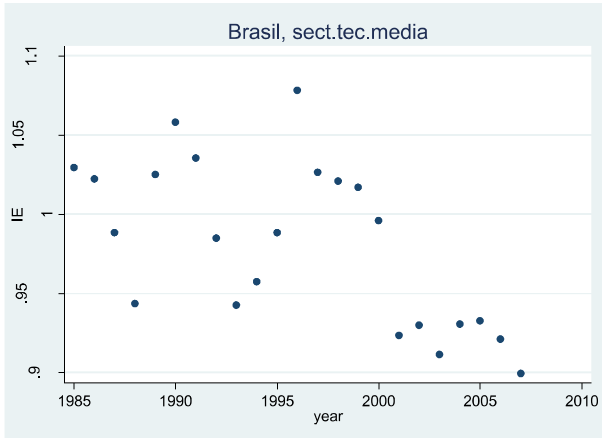
Charts A.1. Series IE.







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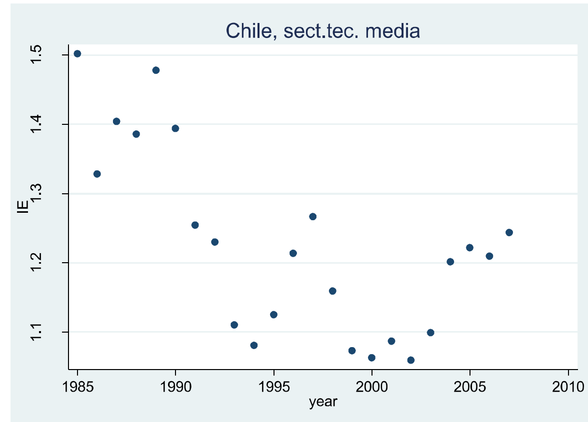
2005
2010
year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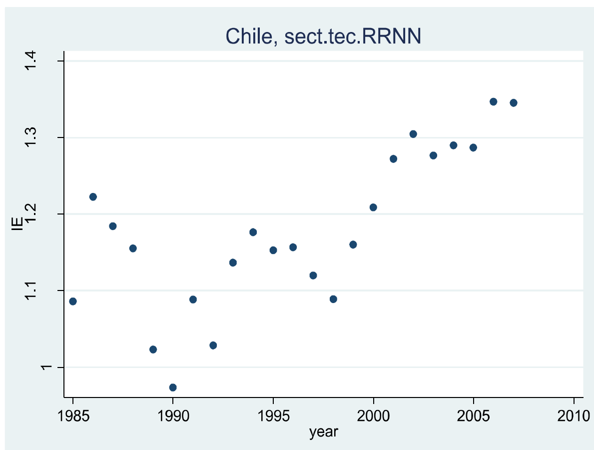
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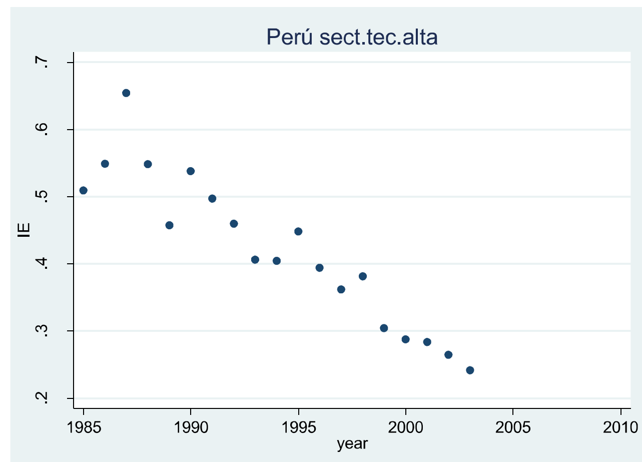
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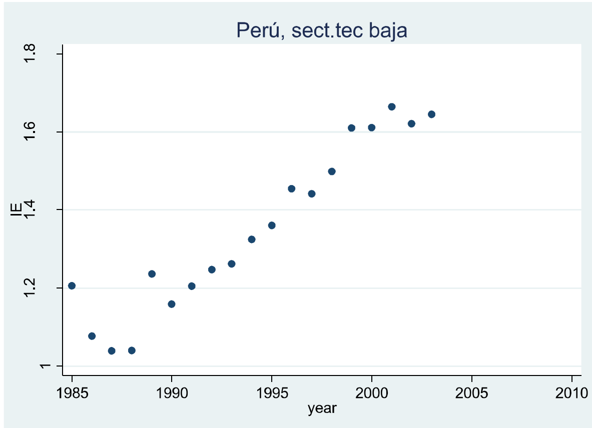

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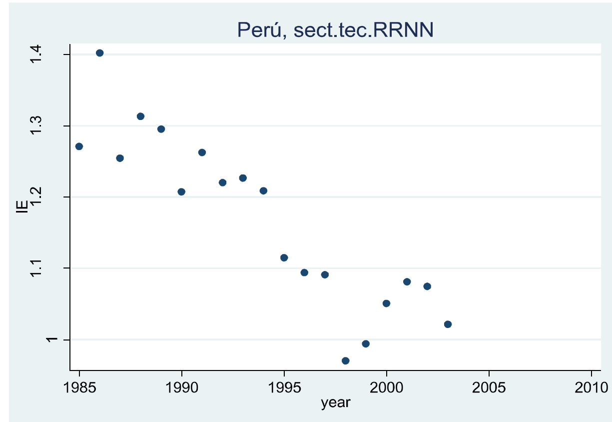

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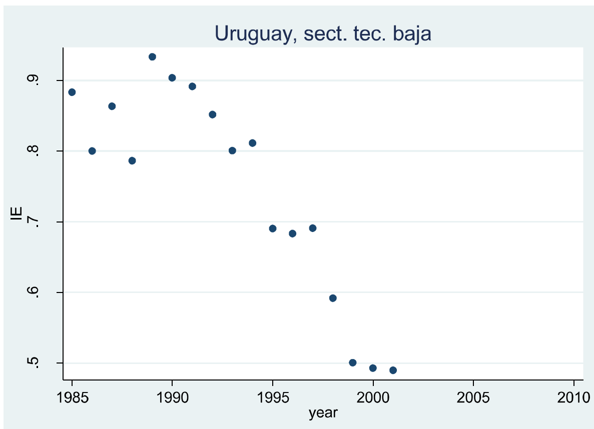

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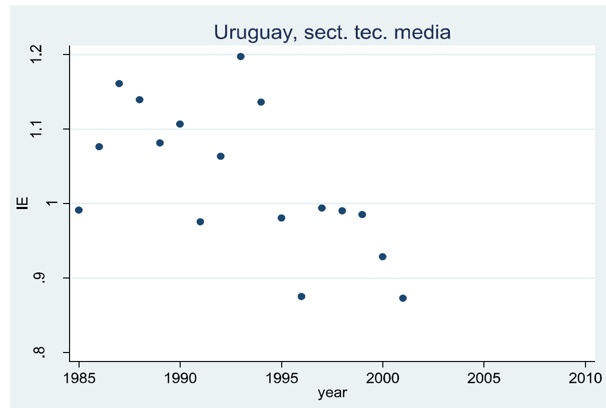

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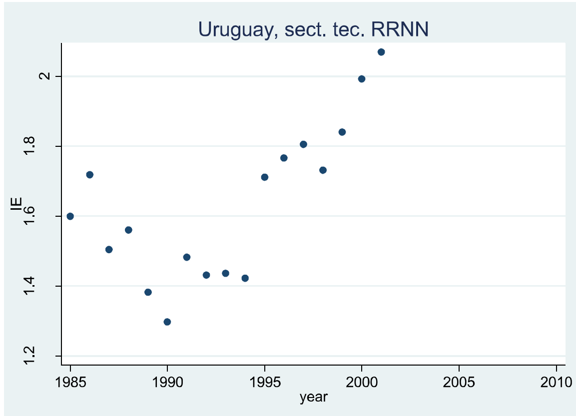
2010
year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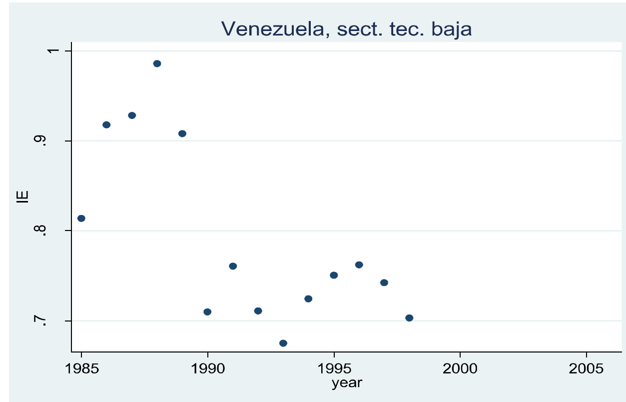
year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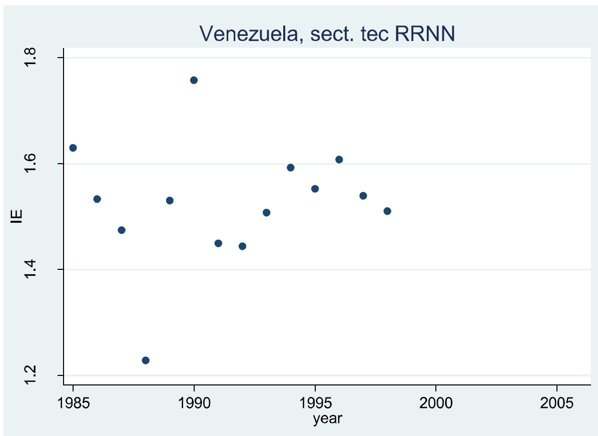
2005
year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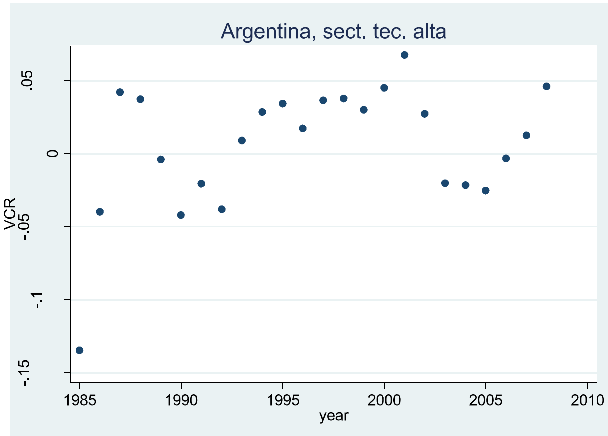
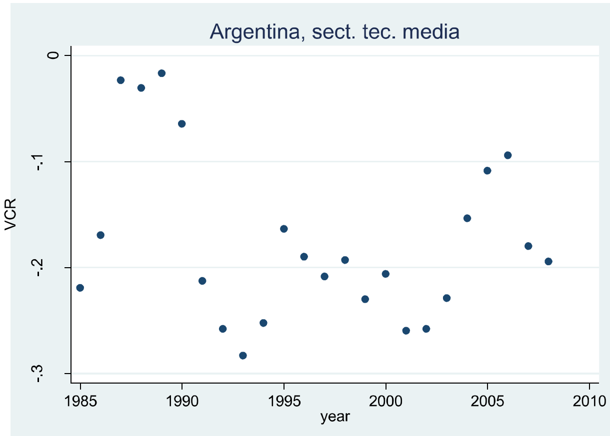
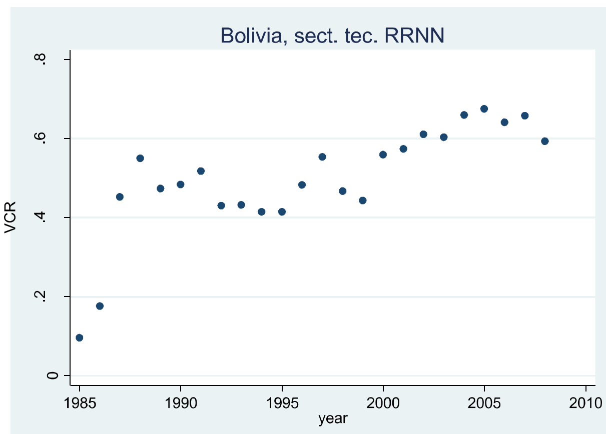
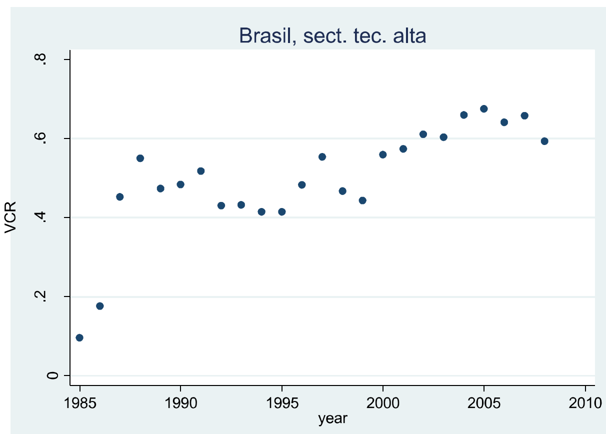
year

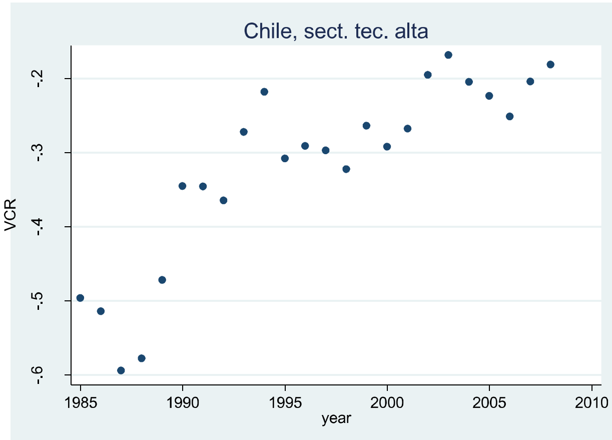
Charts A.2. Series VCR










Chile, sect. tec. alta
VCR
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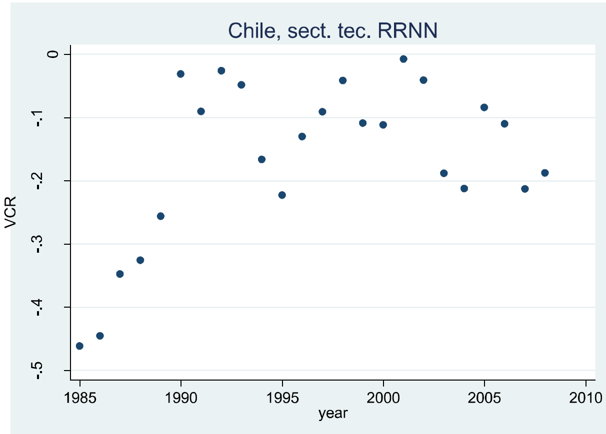
year


Chile, sect. tec. RRNN
VCR
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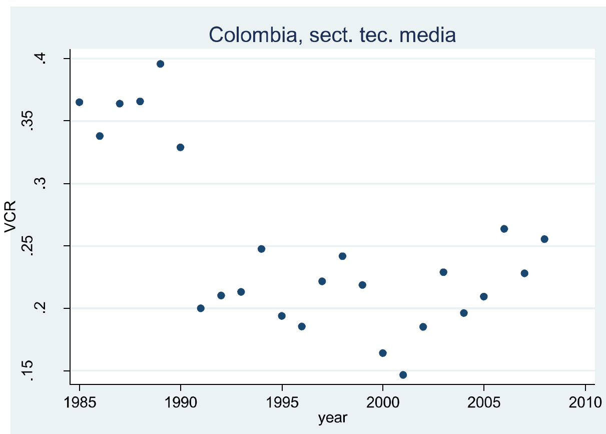
year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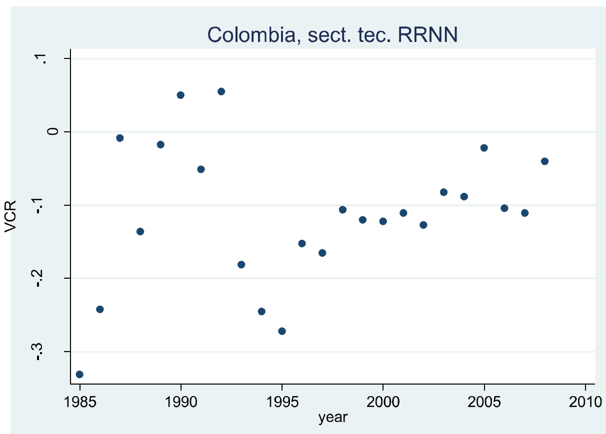
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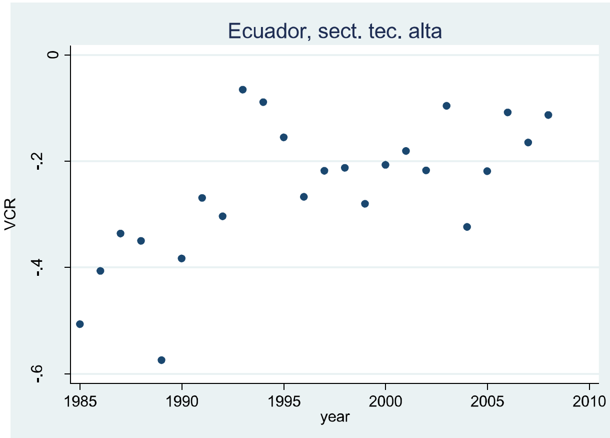
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VCR
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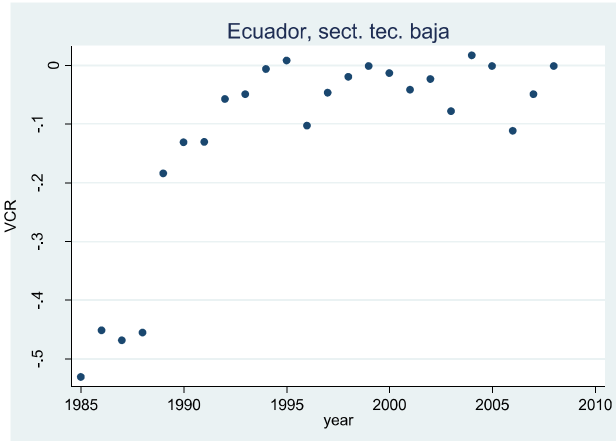
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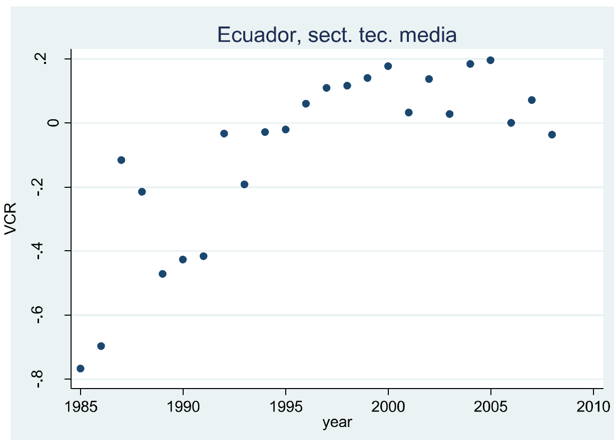
VCR
year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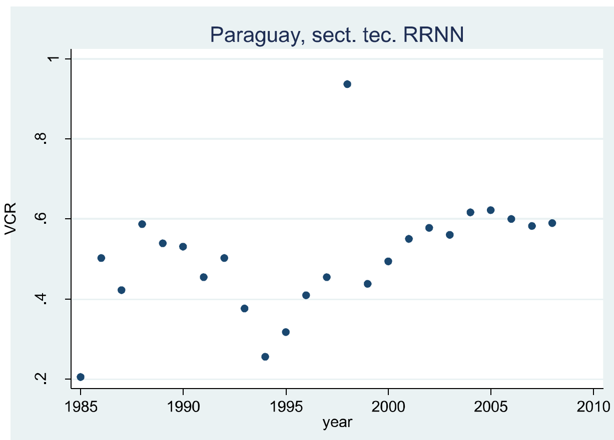
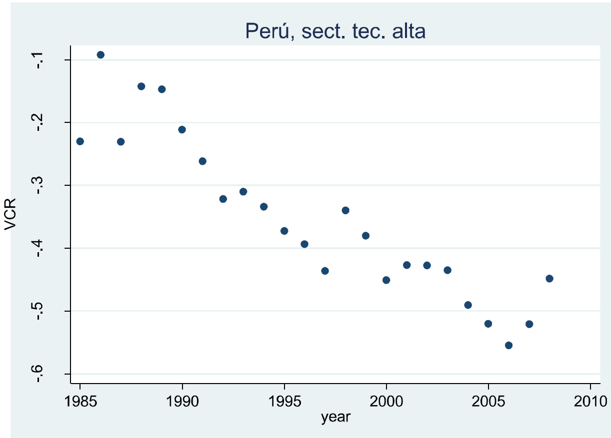
VCR
year


Paraguay, sect. tec. RRNN
VCR
year


Perú, sect. tec. alta
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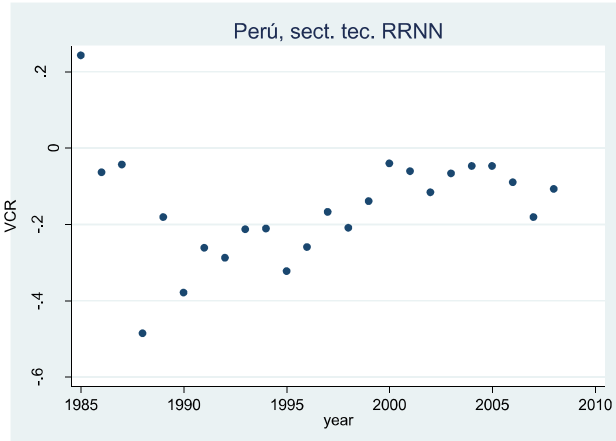
Perú, sect. tec. RRNN
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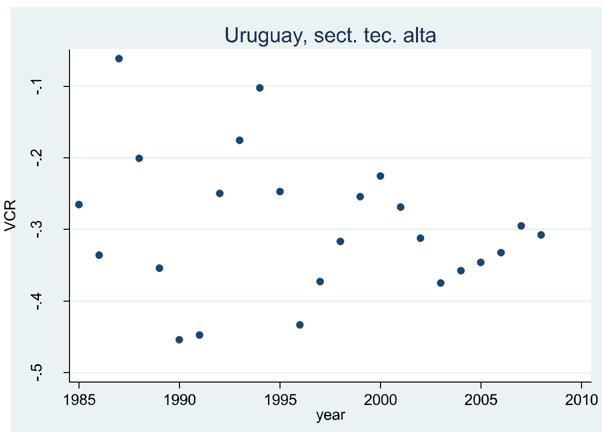
Uruguay, sect. tec. alta
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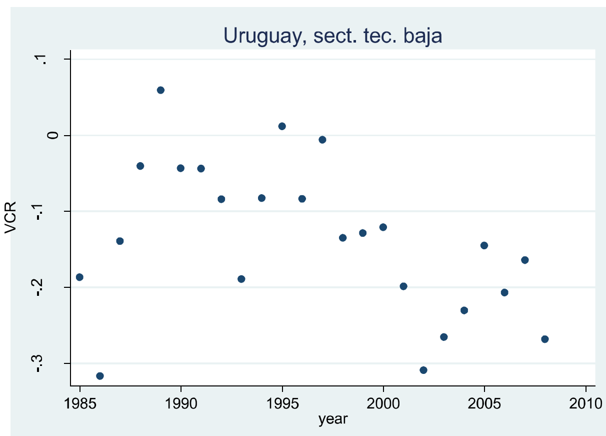
Uruguay, sect. tec. baja
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Table A.2. Panel data unit root tests

Series: IE. Countries: Argentina, Bolivia, Brasil, Chile, Colombia, Ecuador, Paraguay, Perú, Uruguay y Venezuela, 1985-2008.

Test	H0, H1	Statistic (p-value) for 10 countries	Decision	Statistic (p-value) for 7 countries	Decision
Levin Lin Chu (2002), without trend	H0: All panels have unit root H1: All panels are stationary	-6.8651** (0.000)	RH0, All panels are stationary	-1.9509 (0.0255)*	NRH0, all panels have unit root
Levin Lin Chu (2002), with trend	H0: All panels have unit root H1: All panels are stationary	-10.6626** (0.000)	RH0, All panels are stationary	-5.2797 (0.000)*	RH0, All panels are stationary.
Levin Lin Chu (2002), with constant	H0: All panels have unit root H1: All panels are stationary	-0.6045** (0.2728)	NRH0, all panels have unit root	-0.7844 (0.2164)*	NRH0, all panels have unit root
Im-Pesaran Shin (2003), without trend	H0: All panels have unit root H1: Some panels are stationary	-0.5985 (0.2748)	NRH0, all panels have unit root	0.4801 (0.6844)	NRH0, all panels have unit root
Im-Pesaran Shin (2003), with trend	H0: All panels have unit root H1: Some panels are stationary	-5.5998 (0.0000)	RH0 Some panels are stationary	-5.5998 (.0000)	RH0 Some panels are stationary
Im-Pesaran Shin (2003), without trend*	H0: All panels have unit root H1: Some panels are stationary	-0.8800 (0.1894)	NRH0, all panels have unit root	0.0737 (0.5294)	NRH0, all panels have unit root
Im-Pesaran Shin (2003), with trend*	H0: All panels have unit root H1: Some panels are stationary	-5.6814 (0.0000)	RH0 Some panels are stationary	-4.0420 (0.0000)	RH0 Some panels are stationary
Pesaran's CADF, AC(1) without trend	H0: All panels have unit root H1: Some panels are stationary	-1.016 (0.155)	NRH0, all panels have unit root	1.940 (0.974)	NRH0, all panels have unit root
Pesaran's CADF, AC(1) with trend	H0: All panels have unit root H1: Some panels are stationary	-0.139 (0.445)	NRH0, all panels have unit root	0.114 (0.545)	NRH0, all panels have unit root
Pesaran's CADF, AC(1) without trend*	H0: All panels have unit root H1: Some panels are stationary	-1.246 (0.106)*	NRH0, all panels have unit root	-1.686 (0.954)*	NRH0, all panels have unit root
Pesaran's CADF, AC(1) with trend*	H0: All panels have unit root H1: Some panels are stationary	-0.182 (0.428)	NRH0, all panels have unit root	-0.565 (0.286)	NRH0, all panels have unit root
Pesaran's CIPS, maxlags(5) bglags(1)***	H0: All panels have unit root H1: Some panels are stationary	-2.430 (-2.330) **	RH0, Some panels are stationary	-1.484 (-2.200)*	NRH0, all panels have unit root
Pesaran's CIPS, maxlags(5) bglags(1) trend ***	H0: All panels have unit root H1: Some panels are stationary	-3.444** (-2.840)	RH0, Some panels are stationary	-2.317* (-2.720)	NRH0, all panels have unit root
Pesaran's CIPS, maxlags(5) bglags(1) noc ***	H0: All panels have unit root H1: Some panels are stationary	-1.864** (-1.720)	RH0, Some panels are stationary. At 1% NRH0	-1.370* (-1.610)	NRH0, all panels have unit root
Pesaran's CIPS, maxlags(5) bglags(1)***	H0: All panels have unit root H1: Some panels are stationary	Panel no balanceado por eso 1985-1995	RH0, Some panels are stationary	-1.429 (-2.150)	NRH0, all panels have unit root

Pesaran's CIPS, maxlags(5) bglags(1), trend***	H0: All panels have unit root H1: Some panels are stationary	-2.430 (-2.330) ** Panel no balanceado -3.444** (-2.840)	RH0, Some panels are stationary	-2.354 (-2.660)	NRH0, all panels have unit root
Pesaran's CIPS, maxlags(5) bglags(1), noc***	H0: All panels have unit root H1: Some panels are stationary	Panel no balanceado -1.864** (-1.720)	RH0, Some panels are stationary. At 1% NRH0	-1.390 (-1.570)	NRH0, all panels have unit root

* period 1985-2002.
** period 1985-1995
*** Stata does not provide p-values but critical values at 1, 5 y 10%. 5% critical value is reported.

Series: VCR. Countries: Argentina, Bolivia, Brasil, Chile, Colombia, Ecuador, Paraguay, Perú, Uruguay y Venezuela, 1985-2008

Test	**H0, H1**	**Statistic (p-value) for 10 countries**	**Decision**	**Statistic (p-value) for 7 countries**	**Decision**
Levin Lin Chu (2002) llc without trend	H0: All panels have unit root H1: All panels are stationary	-5.4029 (0.000)*	RH0 All panels are stationary	-4.4747 (0.000)*	RH0, All panels are stationary.
Levin Lin Chu (2002) llc With trend	H0: All panels have unit root H1: All panels are stationary	-6.5428 (0.000)*	RH0 All panels are stationary	-6.2482 (0.000)*	RH0, All panels are stationary.
Levin Lin Chu (2002) llc With noWithstant	H0: All panels have unit root H1: All panels are stationary	-3.6010 (0.0002)*	RH0 All panels are stationary	-2.4513 (0.0071)*	RH0, All panels are stationary.
Levin Lin Chu (2002) llc without trend	H0: All panels have unit root H1: All panels are stationary	-5.4029 (0.000)*	RH0 All panels are stationary	-4.7866 (0.000)	RH0, All panels are stationary.
Levin Lin Chu (2002) llc with trend	H0: All panels have unit root H1: All panels are stationary	-6.5428 (0.000)*	RH0 All panels are stationary	-4.9753 (0.000)	RH0, All panels are stationary.
Levin Lin Chu (2002) llc With noWithstant	H0: All panels have unit root H1: All panels are stationary	-3.6010 (0.0002)*	RH0 All panels are stationary	-3.0527 (0.0011)	RH0, All panels are stationary.
Im-Pesaran Shin (2003), without trend	H0: All panels have unit root H1: Some panels are stationary	-5.3720 (0.000)	RH0 Some panels are stationary	-4.0226 (0.000)	RH0, Some panels are stationary.
Im-Pesaran Shin (2003), with trend	H0: All panels have unit root H1: Some panels are stationary	-7.0127 (0.0000)	RH0 Some panels are stationary	-5.4456 (0.000)	RH0, Some panels are stationary.
Im-Pesaran Shin (2003), ips without trend	H0: All panels have unit root H1: Some panels are stationary	-4.8738 (0.0000)	RH0 Some panels are stationary	-3.4856 (0.0002)*	RH0, Some panels are stationary.
Im-Pesaran Shin (2003), ips with trend	H0: All panels have unit root H1: Some panels are stationary	-6.8827 (0.0000)	RH0 Some panels are stationary	-5.6013 (0.000)*	RH0, Some panels are stationary.
Pesaran's CADF, AC(1) without trend	H0: All panels have unit root H1: Some panels are stationary	-2.568 (0.005)	RH0 Some panels are stationary	-2.160 (0.015)	RHO, Some panels are stationary.

Pesaran's CADF, AC(1) with trend	H0: All panels have unit root H1: Some panels are stationary	-3.957 (0.000)	RH0 Some panels are stationary	-2.465 (0.007)	RH0, Some panels are stationary.
Pesaran's CADF, AC(1) without trend	H0: All panels have unit root H1: Some panels are stationary	-2.410 (0.008)*	RH0 Some panels are stationary	-2.275 (0.011)*	RH0, Some panels are stationary.
Pesaran's CADF, AC(1) with trend	H0: All panels have unit root H1: Some panels are stationary	-4.078* (0.000)	RH0 Some panels are stationary	-3.298 (0.000)*	RH0, Some panels are stationary.
Pesaran's CIPS, maxlags(5) bglags(1)***	H0: All panels have unit root H1: Some panels are stationary	-2.187* (-2.160)	RH0, Some panels are stationary. At 1% NRH0	-2.398* (-2.150)	RH0, Some panels are stationary.
Pesaran's CIPS, maxlags(5) bglags(1) noc***	H0: All panels have unit root H1: Some panels are stationary	-1.853* (-1.570)	RH0, Some panels are stationary	-1.788 (-1.570)*	RH0, Some panels are stationary.
Pesaran's CIPS, maxlags(5) bglags(1) trend***	H0: All panels have unit root H1: Some panels are stationary	-2.888* (-2.650)	RH0, Some panels are stationary	-2.852 (-2.660)*	RH0, Some panels are stationary.
Pesaran's CIPS, maxlags(5) bglags(1)***	H0: All panels have unit root H1: Some panels are stationary	-2.187* (-2.160)	RH0, Some panels are stationary. NRH0 at 1%	-2.470 (-2.150)	RH0, Some panels are stationary.
Pesaran's CIPS, maxlags(5) bglags(1) trend***	H0: All panels have unit root H1: Some panels are stationary	-2.888* (-2.650)	RH0, Some panels are stationary	-2.960 (-2.660)	RH0, Some panels are stationary.
Pesaran's CIPS, maxlags(5) bglags(1) noc***	H0: All panels have unit root H1: Some panels are stationary	-1.853* (-1.570)	RH0, Some panels are stationary	-1.855 (-1.570)	RH0, Some panels are stationary.

*** Stata does not provide p-values but critical values at 1, 5 y 10%. 5% critical value is reported.
* the analysis covers the period 1985-2007.