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Restrictions on the Latin American Economy: The Case of US FDI Profits Repatriation

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ABSTRACT

This paper estimates the long-term effect of the repatriation of US-FDI profits on a set of fourteen Latin American economies, following a methodology of panel cointegration. The period of analysis is 1980-2011. The results suggest that investment in physical capital, employees, public spending on education and repatriation of profits from FDI have an impact on the economic activity in the region. In particular, repatriation shows negative impacts and becomes a barrier to economic growth in the region. Thus, a regulation that encourages reinvestment in competitive economies favors the economic performance in those countries.

Key Words: profits, repatriation, FDI, economic restrictions, living standards

INTRODUCTION

Foreign direct investment (FDI) can generate both benefits and costs for recipient economies. The most dynamic economies encourage the entry of foreign productive capitals by creating a domestic market favorable to increase profits of incumbents. Better conditions in domestic market incentive new investments or reinvestments looking to take advantage of this competitive scenario. For empirical literature, FDI determines

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economic growth in host countries of this investment because it is considered to have potential benefits such as employment, production capacity, trade flows, technological upgrading and development of the domestic market, among others.[1] In this context, several governments of LA countries traditionally recipient of this type of investment, have implemented active policies to attract this capital as an alternative to industrial development and economic growth.

Since the eighties, economic policy in most countries of Latin America (LA), is oriented to opening and strengthening trade as well as attracting more productive flows from abroad, allowing a remarkable American FDI inflows to domestic markets in the region. In 2010, total FDI in LA was 243 billion dollars (equivalent to 6% of Latin American GDP in that year), with average annual growth of 7.52%. This amount is almost nine times higher than in 1980, when it was invested 24.8 billion dollars (bd). Also, given the advantages in LA for MNC, US FDI reached major utilities, with a notable growth (average annual growth rate of 10.7%), from 1.3 bd in 1980 to 31.9 in 2010 (representing 2% public debt of Latin American countries).

These utilities have had two destinations; reinvestment in the Latin American market or repatriation to the US economy. In 1980 repatriated profits were $725 million dollars or 53% of total profits. For 2010 was nine billion dollars, or 28% of total revenue, an increase of 1,151% in those years (annual growth rate of 8.5%). In 2000-2010 repatriated profits of FDI (REPFDI) were, in annual average, of 5 billion dollars, or about 45% of the total profits or 5% of total FDI. In other words, US FDI in Latin American shows a slight tendency to reinvest, presumably having two effects. The first ¬negative¬ effect is over Latin American market, which directly limit the availability of domestic capital and, therefore, saving and investment, which in turn negatively impacts on generation of new jobs, strengthening of productive chains, growth economic and even in future tax revenue. The second ¬positive¬ effect is on US market, similar to the above but of opposite sign (Hines and Hubbard 1990).[2]

Alternatively, if profits are reinvested the effect is positive in the host economy, because capital remains as new investment, thereby fostering its dynamics. In contrast, reinvested earnings have a negative effect on the economy of origin, because these funds are not consolidated as marginal

1 See Fritsch et al. (1991) and Pelegrin (2002).

2 This effect has an additional significance since it means not only that US firms have access to those capitals, but also the government of this country who generally do not rate the profits of US subsidiaries until they are repatriated.

new investment in US, restricting the possibilities in terms of employment growth, consumption, industrial production and per capita income in that economy.

For the case study, during the sample period, 1980-2011, it is seen a connection with major advantages for US. That is, repatriation of FDI profits to that country seems to benefit this economy in terms of GDP, final consumption, GDP per capita (*pcgdp*) and to a lesser extent, employment and industrial production. In contrast, repatriation apparently shows a negative relationship with these same variables, except for *pcgdp*. This raises the hypothesis that the apparent co-movement between repatriation and these variables restrict economic activity in Latin America. That is, the presence of MNC and reinvestment decisions, given the competitiveness of Latin American economies, tends to limit economic growth and development in the region.

However, despite the seeming relationship between return (reinvestment) of profits from FDI and economic activity, the related empirical literature is limited.[3] Brada and Tomsík (2009) found that evolution of profits and its destination have generated large distortions in eight economies of Eastern Europe, reflected in the current account. They accept the hypothesis that FDI maturity in an economy is crucial in this process. Also Altzinger (2008) in a study for 15 EU countries, distinguishes between green FDI and FDI oriented to buy existing assets (mergers and acquisitions, M&A). He finds, that during the first years, M&A are more profitable that new investments and therefore having higher rates of repatriation, with minor contribution to capital stock of the host economy while improving the economic performance of the origin country.

In this sense, the goal of this study is to determine the long-term effect in a set of fourteen Latin American economies of US FDI profits repatriation.[4] The main contribution of this paper is taht allows, considering only the profits of FDI, determining whether FDI has a positive impact on LA economic activity. It is conjectured that the effect of the repatriation

3 Most studies focus on the macroeconomic effects of FDI, both in the home and host country. Many of them highlight the effect in: i) the balance of payments, for example: Mencinger (2003); Blomström and Kokko (2003), Borensztein, et al. (1995), Lipsey (2002), Alfaro et al. (2004), Markusen and Venables (1999), ii) the determinants of FDI ¬macro, micro and specific to industries¬, for example: Love and Lage (2000), Slaughter (2003), Kok and Acikgoz (2009), Chakrabarti (2001), Shantz and Venables (2000), iii) or the effect of tax systems in the host or home country on the decisions of reinvestment or dividend payment, for example Barry (2005), Gropp and Kostial (2000), and Ishii (2006).

4 The countries in the study are Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Honduras, Mexico, Panama, Paraguay, Peru, Uruguay and Venezuela.

is negative for LA and positive for US.

The rest of the paper is organized into four sections. The following section presents a brief account of the determinants of reinvestment or repatriation. Section three provides the econometric model to estimate. Fourth section estimates the model by panel cointegration techniques. Finally conclusions are presented.

REINVESTMENT AND REPATRIATION OF FDI PROFITS: SOME DETERMINANTS

Reinvestment of FDI profits impact on countries growth patterns, since it implies that a country has a level of competitiveness that allows retaining currency for productive investment in its territory. To the extent that the stock of FDI matures, the possibility of new investments (complementary or competitive) occurs in the economy increases. While most MNC operate in an economy, other companies are attracted to invest in the same economy, driven by strategic decisions to compete globally. In other words, the higher the stock of FDI, relative to size of economy, and the higher its profitability, the greater the amount of capital that can be reinvested in the subsidiaries (Brada and Tomšik 2009).

Thus, different elements affect decisions of profits distribution between reinvestment and repatriation. Among the main determinants are alternative investment opportunities. In this regard, profits reached by MNC in different countries of origin have two destinations: reinvestment in subsidiaries which gain these profits or repatriate such funds to finance projects in the parent or other subsidiaries. It is considered that the investment opportunities in the host economy are the main determinant of reinvestment. According to Lehmann (2002), a necessary condition for reinvestment is to obtain positive profit levels in a particular industry, which is interpreted as an investment opportunity in the host economy, given the best conditions of operation, encouraging profits reinvestment as well as entry of new competitors.

The reinvestment also depends on profitability differences between several subsidiaries. In general, differences in productivity and, therefore, profitability, reflect the efficient use of assets and capabilities specific to firms. These differences show the different levels of efficiency in the use of specific assets and capabilities of the arrays as well as specific to subsidiaries (Rugman and Verbeke 2001). Thus, to the extent that profitability results from exploitation of such advantages in the host

economy, it is expected profitability to hold on to capital through reinvestment (Clausing 2001).

Also, a sustained depreciation of the currency of FDI host country tends to discourage repatriation, causing the foreign capital remain in the host economy, increasing reinvestment. Dunning (1993) considers the exchange rate as a variable with growth effect on FDI and not with level effect.

Additionally, different corporative governance systems influence the decisions of repatriation or reinvestment. US companies operating in countries with relatively developed capital markets are geared to short-term financial performance to increase shareholder value (Hall and Soskice 2001), which implies higher levels of repatriation. Finally, a central variable for reinvestment are the income taxes of subsidiaries. A change in taxation over subsidiaries changes the incentives and, therefore, decisions of firms. The income tax treatment on parent and subsidiaries differs between countries. In other words, the income tax rate of MNC that repatriates earnings from its subsidiaries (payment of dividends from subsidiaries to the parent) is different in each country (Lundan 2006).[5] Thus, Desai et al. (2001), indicate that a positive correlation between tax rates and repatriated profits exists, that is, lower tax rates on repatriated profits are associated with higher rates of repatriation.

Empirical evidence shows a relevant role for differences in income tax rates between host and origin countries, by affecting the convenience of reinvesting, subject to economic conditions in parent firms. Thus, in the Latin American economy case, empirical evidence related to the effects of the profits tax rate of MNC is limited. However, some research finds positive evidence regarding this relationship. Agostini y Jalile (2009) highlight, in a study for eleven Latin American countries, that these economies tend to reduce FDI profits tax rates, in order to attract more investment of this kind. They determine that FDI tax elasticity varies between 0.75 and 0.96.

Shah and Slemrod (1990) analyze the effect of effective FDI profits tax rate in Mexican economy in 1965-1990, finding that reinvestment is highly sensitive to taxes (elasticity 1.5), to tax differential between Mexico and US (elasticity 2.8), to MNC credit standing (1.9) and in general to regulations in Mexican economy. They suggest that developing countries with high FDI levels do not need to establish special tax incentives for foreign capital, but to ensure that their tax system is competitive against

5 The tax on subsidiaries has location effects, affecting the way in which MNC choose to repatriate their profits, either through intra-firm dividends, interest payments or royalties.

countries of origin.

Echavarría (2005) studied this relationship for the Colombian case and determines that profit taxes are highly distorting, complex and with hidden effects. It also notes that low tax rates attract FDI, discourage practices of fiscal evasion, and increase tax revenue, while high rates have the opposite effect. The low rates attract new MNC interested in investing, and new MNC interested in paying lower taxes worldwide.

STYLIZED FACTS: US FDI IN LATIN AMERICA

Since the import substitution model was exhausted, which led to the external debt crisis, region economies readjusted industrialization strategies, establishing a model of development oriented to abroad, with the goal of improving economic efficiency, reducing state intervention and integrating into international economy. As a result, commercial intensification processes allowed trade between these economies were in 2010 ten times higher than in 1985; while inflows of productive capital were 9.5 times. In this regard, US is a major source of FDI for AL with a 30% of the total in the whole period. However, this weight decreased from 38% in 1985 to 25% last year. This suggests that US firms have consolidated their production systems in the region and at the same time, they face increased competition, mainly from European and Asian countries that seek to take advantage of scale economies.

The restricted effect of US inward FDI to Latin America economy is due that some restrictions to these capitals have been relaxed only gradually, and without discrimination to other industrialized economies, so this mechanism did not represent a big boost in attracting US firms, compared with FDI inflows from third economies (Morales 2010).[6]

In this context, institutional frameworks of LA countries have been modified, reorienting FDI, labor and tax policies trying to encourage new flows of FDI and to keep them within the individual economies of LA. For instance, Morales et al. (2009), state that in the last twenty years of liberalization and relaxation of the regulatory frameworks in these countries inward FDI notably increased.

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6 Since the second half of the nineties, US define the bilateral investment agreements on terms more favorable to its firms. In this respect, several aspects were established, for instance, restrictions on expropriation and conditions for fair and timely payment, to the rapid transfer resources at the exchange rate market and the right to hire foreign executives.

Additionally, FDI performance, and therefore the reinvestment of its profits, is restricted by the Agreement on Trade-Related Investment to Commerce (ATRIC) which prohibits using trade-related measures such as local content requirements (Mortimore 2009). Thus, foreign investments have flowed mainly as a result of privatization processes, trade liberalization and reduction of restrictions FDI profits repatriation, sectoral restrictions (local content and export requirements) and prior authorization for investments (Blomström and Wolff 1994).

Also, Gligo (2007) notes that Latin America countries have followed an active policy framework, characterized by two elements: promotion policies, particularly by investment promotion agencies (IPA), and incentive policies. Regarding the former, it is highlighted that 30 Latin America countries have some IPA. One activity of IPA that have helped attracting new investment and generating reinvestments are post-investment services (after-care) as a source of information about other companies with investment plans.

Regarding the latter, incentives must be generally grouped into tax (temporary or permanent deduction or removal of taxes) or financial (direct subsidies that reduce the cost of opening or operation of the investment). Also, note that the main incentive is linked to tax rate, aimed to the establishment of firms in free zones with corporate tax exemptions, which seek to increase efficiency and participate in export markets.

In the case of Latin America countries, for Mexico in 1989 it was established a new mechanism to boost FDI (Understanding to Facilitate Trade and Investment) that eliminated or reduced some obstacles (domestic content regulations) (Dussel Peters et al., 2003). Also, the performance requirements of these investments were eliminated from the Direct Foreign Investment Law of 1993, while sectoral restrictions were not established.[7]

In Chile, the regulatory framework of FDI (Act Law 600 or Foreign Investment Statute, DL600) issued in 1974, has undergone some changes for generating certainty in investment. The DL600 is based on the principles of national treatment and non-discrimination as mechanisms to attract and promote domestic and foreign investments, so the DL600 subject FDI to the legal regime applicable to domestic investment. Within this regime, although investors may transfer abroad their capital and the net profits obtained, remittances of capital can only be made after a year of its income to Chilean economy (Rhodes 2005).

7 However, NAFTA have different regulations regarding the rules of origin for specific sectors that promote integration between the three economies belonging to the trade agreement.

Also, Costa Rica changed its strategy to attract foreign capital and created a special regime for FDI linked to export promotion. Incentives are fiscal, established in laws oriented to promote free zones. Thus, this new strategy implies special tax regimes for re-export to firms in the special zones for export processing.

Finally, given the need to attract greater FDI flows, in 1990 Brazil approved the National Privatization Program that focused on sales of strategic state enterprises (steel, petrochemicals and fertilizers). It established a series of constitutional reforms to facilitate the entry of foreign capital, and redefined the concept of Brazilian firm. Thus, this economy has a general law governing the FDI, plus other sector specific regulations. The principles governing FDI are: absence of prior authorization, equal conditions for domestic and foreign capital, free investment through subsidiaries or *joint ventures* ¬without percentage restrictions¬ and free repatriation of capital. The incentives are based on tax benefits, specific funding, and support programs, among others.

Thus, in a closed economy context that characterized Latin America until the eighties, the flow of productive capital from abroad, particularly in from US, remained at relatively stable levels. The regulatory restrictions that rules FDI into productive activities within LA economies generated, accordingly to Dussel (1997), peaceful coexistence between domestic and foreign firms which led subsidiaries to obtain utility rates comparatively low for 1980-1993 of 0.28% of GDP on average (excluding Panama). In this regard, one aspect that encouraged horizontal FDI was the chance to avoid tariff barriers in the region, to supply domestic markets from the inside (Machinea and Vera 2006).

However, in this period a slight tendency to repatriate was observed; profits sent to US economy accounted for 0.17% of GDP, ultimately impacting into net inflow of FDI. In contrast, since the growth of trade with the region, US MNC in Latin America renewed their business strategies leading to higher FDI inflows in the region in recent years (among developing regions, LA countries are the main destination for US investments). In addition, US firms have focused on manufacturing and recently in services (telecommunications and energy). In the case of manufacturing tends to take advantage of some aspects ¬low wages, relative geographic proximity and preferential access to US market¬ to increase their ability to compete in their own market (Hoffmann 2002).

Regulations on such investments were moderated, which include reinvestment of profits. These had as a consequence an increase in profit rate that reached 0.58% of GDP. Although for 1994-2010 repatriation

was intensified, since the ratio repatriation-GDP averaged 0.24%. In this regard, the relationship between FDI or their reinvested profits and economic activity (GDP, consumption, industrial production, or development level) is not evident. On the one hand, there are incentives to retain the funds generated within the Latin American economy associated with vertical FDI, in order to take advantage of scale economies and operate with greater intensity factors of production, so expect a positive link between reinvestment and economic activity in general. On the other hand, horizontal FDI can be negatively related to reinvestment if it mainly searches for a profit serving the domestic or foreign markets (Kose et al. 2004).[8]

Moreover, most papers that analyses the effects of FDI on LA economy since trade intensification in the region, focuses on the effect of FDI on economic growth, productivity, investment, employment, international trade and to a lesser extent in the development, but few studies have analyzed the relationship between reinvestment and economic activity. According to the OECD, there is an initial and direct macroeconomic effect of FDI and an effect on growth and in total productivity (OECD 2002). Aizenman and Noy (2006) find that trade in goods is positively affected by FDI flows, both in industrialized and developing countries.

Mortimore (2004) states that while FDI has promoted the export competitiveness of the region, the impact on production, technology transfer and industrial development has been limited, so export sector dynamism has not spill over the economy. Ramirez (2011) finds that FDI is favorable for economic growth of countries in LA so it should be promoted macroeconomic and institutional reforms for these capitals. Bengoa and Sanchez (2003), examine the relationship between FDI, economic freedom and growth in LA. They find similar results, that is, deregulation attracts FDI and, this in turn, generates higher growth.

Ekanayake and Ledgerwood (2010) indicate a positive relationship between FDI and economic growth in developing countries (Asia, Africa and America). However, they find that this type of investment has negative impact on middle and low income countries. In line with this, Huang et al. (2010) state that FDI flows tend to be associated with greater poverty in Latin American countries through the negative effect on economic

8 In this sense, the Mexico has shown a slightly higher economic growth before NAFTA (in the period 1980-1993 the average annual growth rate was 2%, while for 1994-2008 it was 3%). This performance has been influenced by exports and imports whose contributions to GDP growth increased significantly. The contribution of FDI before 1994 was 0.5 and 1.5% after NAFTA.

growth.

MODEL, DATA AND METHODOLOGY

A time series econometric model is estimated for a set of LA countries that includes, besides the profits of US FDI repatriated from these economies, several macroeconomic variables to consider elasticities in GDP, consumption, industrial production and per capita income in each country. The variables included are:

(i) **ea**: economic activity in each country. It is expected that explanatory variables impact on economies both of the host and origin country of FDI. Several measures are used, so that four different relations are specified, including: *i*) *gdpgr* to determine the effect of *reusfdip* on economic growth, in constant dollars (1990=100), *ii*) *fc*, which represents the growth rate of final consumption, in constant dollars (1990=100), *iii*) *pcgdp* to capture the effect of the repatriation on development of economies, in constant dollars (1990=100), and iv) ipi, the index of industrial production. It is included to establish the effect of FDI profits in manufacturing activity. The latter data are taken from the statistics office of each country and the UN Stats (National Accounts Main Aggregates Database). The series of the first three variables were obtained from UN Stats. It is expected a negative relation between these and *reusfdip*.

(ii) **reusfdip**: repatriation of US FDI profits. Since the economy of a country depends on investment, domestic or foreign, it is expected that the repatriation of these earnings affect both economies, as it means greater availability of capital for productive use. Therefore, the expected sign is negative for AL. The series were obtained from the basis of BEA International Economic Accounts and are in constant dollars (1990=100).

(iii) **gfcf**: physical capital. It assumes a direct relation between capital stock and production reflected in the marginal productivity of this factor. In principle, the greater investment in domestic physical capital, the greater the level of product; so the expected sign is positive. Gross fixed capital formation is used as proxy, in constant dollars (1990=100). The source is the UN Stats.

(iv) **l**: labor, skilled or not. Since marginal productivity of this factor is related to economic growth, it is expected to estimate a positive

sign associated with this variable. The proxy used is the economically active population. The data are taken from the LaborStat of the International Labour Organisation and the respective offices of each LA country.

(v) **bcm**: trade openness that guides countries, particularly the least developed, to import goods of higher quality without producing them locally, with a positive effect on GDP through increased rates of learning, availability of innovations , greater use of advanced capital goods, etc. The proxy used is the manufacturing trade balance in constant dollars (1990=100). The database is the UN Comtrade Data Base of the UN. The expected sign is positive.

(vi) **estpe** and **r&dsgdp**: human capital and technological innovation, respectively. The product is determined increasingly by the access and use of advanced technologies and the availability and quality of human capital, since these factors lead to non-decreasing returns in production. Thus, the larger the stock of technology, knowledge and skilled labor has a country, the higher the growth rate. The expected sign is positive. The proxies used are education spending as a percentage of total public expenditure and R&D spending as a percentage of GDP, for human capital and technological innovation, respectively, both in constant dollars (1990=100). The education series are taken from the UNESCO Institute for Statistics and for R&D from the OECD Stats.

Since the interest of the paper is to determine the effect of repatriation, which ultimately is capital for investment, on economic activity, the underlying economic theory is of endogenous growth. In particular, it is specified a model based on the neoclassical production function derived from the model of endogenous technological change of Romer (1990), that is:

$$Y = K^{\alpha} \cdot (A \cdot H)^{\beta} \cdot T^{\gamma} (A \cdot L)^{1-\alpha-\beta-\gamma} \qquad (1)$$

The idea of incorporates foreign trade, both goods and assets, is that it enhances the accumulation of capital, physical and human, and technological diffusion process. All these elements are growth promoting. Therefore, the specification to be estimated includes the growth rate of set variables considered.

Assuming a log-linear relationship between the "explanatory" variables, repatriation of US FDI profits (*rusfdip*), physical capital (*gfcf*), labor (*l*),

openness (*bcm*), technology (*re?dsgdp*), and human capital (*estpe*), the four model specifications, estimated in the next section following a panel cointegration analysis, can be written as:

$$ae_{it} = \beta_{i1} + \beta_{i2}\, reusfdip_{it} + \beta_{i3}\, gfcf_{it} + \beta_{i4}\, l_{it} + \beta_{i5}\, r\&dsgdp_{it} + \beta_{i6}\, estpe_{it} + \beta_{i7}\, bcm_{it} + u_{it} \quad (2)$$

Where: *i* a LA. All variables are expressed in logs to include the multiplicative effects of time series. If these variables share a common stochastic trend and its first differences are stationary then there is at least one relationship of long-term equilibrium.

ECONOMETRIC METHODOLOGY

This paper uses panel cointegration techniques to estimate the effect of repatriation in economic activity in a set of LA countries, which allows using all available information, which is not detectable through cross section and time series separately. The panel data methodology increases the power of the test when the sample is small.

Thus, the panel cointegration technique combines elements of panel data and time series. As a time series study is required determining the level of integration of the series. Apply tests for panel unit root is essential to avoid spurious regressions. The standard unit root tests like Augmented Dickey-Fuller (ADF) have low power compared to alternative tests. Since panel data increases the power of the test by increasing the size of the series for the cross sections, the results are more reliable. There are two types of unit root tests for panel data. Common unit root process, which occurs when the cross-sectional units share the same parameters (Levin, Lin and Chu test LLC) and individual unit root processes, when the parameters are different between units (Im, Pesaran and Shin, IPS test).

While the LLC test allows heterogeneity both in individual deterministic effects as well as in the serial correlation structure, it assumes the alternative hypothesis of presence of homogeneous autoregressive roots (same coefficient of the autoregressive term), limiting the power of the test. The LLC test evaluates the hypothesis of nonstationarity of each individual series by pooled t statistics.[9]

In contrast, the test IPS overcomes the limitation of the test LLC

9 Hatemi and Irandoust (2005), based on Monte Carlo experiments conducted by Levin et al. (2002), indicate that the power of the test LLC is larger than the individual unit root tests.

assuming that there is heterogeneity autoregressive root. The IPS test calculates the residual serial correlation, allowing for different coefficients of the autoregressive terms, based on the simple average of Dickey-Fuller (DF) statistic of each cross section in the panel, solving the problem of serial correlation in the test LLC.

However, the IPS test is sensitive to the number of lags in the DF regressions. Also, the power of the test is greater the larger the size of the cross-sectional units. Moreover, the interpretation of the results of this test is difficult given the underlying heterogeneity in the alternative hypothesis (Chandra and Sahoo 2007).

An alternative are Fisher tests. First, they prove the existence of unit roots for each panel individually and then combine the resulting p-values to produce a total test. Accordingly to Choi (2001) these tests eliminate the problems in LLC and IPS tests. Thus, this paper used panel unit root LLC, IPS, ADF–and PP–Fisher.[10] The optimal lag length is determined according to Schwarz criterion. See more details in the Annex A.

Thus, if the data generating process is characterized by panel unit root, the next step is to prove the existence of long-term stable relationships from the perspective of the panel. There are two approaches to determine the panel cointegration. The methodology of Pedroni, McCoskey and Kao, and Kao are residual-based tests of Engle and Granger procedure (EG) where the null hypothesis of no cointegration is tested using the residuals of the panel regression.[11] While the test Groen and Kleibergen and Larsson, and Löthgren Lyhagen follow a maximum likelihood approach.[12]

Following Pedroni (1995), it should be used a robust procedure for determining panel cointegration in presence of heterogeneity.[13] In this regard, the test of Pedroni (1999) considers the heterogeneity incorporating

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10 A unit root test for each individual unit (country) in the panel is applied; then the p-values are combined to construct the Fisher statistic to determine whether the series exhibits a unit root. Since the test specification is $\Delta y_{it}=\rho_i y_{it-1}+z'_{it}\gamma_i+v_{it}$; where i=1,..., N, t=1,...,T, v_{it} is the stationary error term of the i-th unit at time t, respectively, y_{it} is the variable of study; z'_{it} represents the control variables (including repatriation), H_0: ρ_i=1 for all i, and the H_a: ρ_i<0 for some i. Choi (2001) proposed four methods of unit root test based on the type of transformation on the p-values: *i*) reverse χ^2 (P), *ii*) normal inverse (Z), *iii*) inverse logit (L) and *iv*) modification of reverse χ^2 used in large sample. Following Breitung (2005), the Z-statistic has better terms of size and strength.

11 See Pedroni (1997; 1999), McCoskey and Kao (1998), O (1999) and Engle and Granger (1987).

12 See and Kleibergen Groen (2003), Larsson et al. (2001).

13 Pedroni (1995) argues that panel unit root tests applied directly to the residuals of the regression consider neither the exogeneity of the regressors nor the link of the residuals with the distribution of the estimated coefficients.

specific parameters that may vary between transversal units in the sample; which represents an advantage, since assuming that all cointegrating vectors are identical for all elements in the panel is unrealistic.

This test extends the residual methodology of two-step of EG, that analysis the residuals of the spurious regression with stationary variables in first differences. It is required that residuals (ε_{it}) are I(0) for existence of cointegration. Formally, the Pedroni test is:

$$y_{it} = \beta_i + \beta_{1i} x_{1it} + \beta_{2i} x_{2it} + \cdots + \beta_{mi} x_{mit} + \varepsilon_{it} \quad (3)$$

where: i=1, ..., N, t=1, ..., T, m=1, ..., M, βi is a country-specific intercept and m the number of regressors. It is assumed that y and x are I(1). For estimating the residual from equation (3), Pedroni (1999) proposes seven statistics, four based on an intra-group dimension (*within*) and three in one dimension between-groups (*between*). All the tests are based on the null hypothesis of no cointegration. Also suggests adjustments on each of the statistics in order to be compared to standard normal distribution. The results reported in this document are set in that way.

Once a panel cointegration is determined equation 3 is estimated for a pool of fourteen countries. Accordingly to Pedroni (2000), the fully modified OLS methodology (FMOLS) generates more robust results when analyzing a hetegoreneous panel with variables I(1). Its distribution is standard, asymptotically unbiased and free of nuisance parameters. The FMOLS estimator produces consistent standard error and therefore consistent t-statistics (Phillpis and Hansen 1990).

RESULTS

Two types of unit root tests for panel are used to check the stationarity of the data. Results of the tests in levels and first differences are shown in Table 1. Clearly, the unit root null hypothesis cannot be rejected for the logarithm of all variables except for *rc*~*dsgdp* and *bcm* for both kinds of test. This implies that these variables are stationary in level, while the remaining variables are stationary in first differences.

Table 1. Unit Root Tests

Variable	LLC	IPS	ADF-F	PP-F
	P-value	P-value	P-value	P-value
gdp	0.9206	1.0000	1.000	0.980
Δgdp	0.0000	0.0000	0.000	0.000
pcgdp	1.0000	1.0000	1.000	0.894
Δpcgdp	0.0000	0.0000	0.000	0.000
fc	0.9974	1.0000	1.000	1.000
Δfc	0.0004	0.0000	0.000	0.000
ipi	0.9887	1.0000	1.000	0.999
Δipi	0.0000	0.0000	0.000	0.000
reusfdip	0.9584	0.9842	0.993	0.997
Δreusfdip	0.0000	0.0000	0.000	0.000
gfcf	0.9448	0.9995	0.999	1.000
Δgfcf	-	0.0000	0.000	0.000
l	0.3006	0.9874	0.842	0.180
Δl	0.0000	0.0000	0.000	0.000
estpe	0.7770	0.9509	0.967	0.900
Δestpe	0.0000	0.0000	0.000	0.000
rc&dsgdp	0.0398	0.0111	0.020	0.008
Δrc&dsgdp	-	-	-	-
Bcm	0.0305	0.0019	0.038	0.042
Δbcm	-	-	-	-

H0: unit root. The LLC test is a common unit root process.
Los test IPS, ADF-F y PP-F are a single unit root process.
1% significance. The Fisher test probabilities are obtained using an asymptotic $\chi 2$ distribution.
Source: own

Given the different orders of integration these two variables are eliminated for cointegration analysis. The variables with the same order, I(1), facilitate the examination of possible long-run relations through cointegration panel tests of Pedroni. The results of these tests are shown in Table 2. The null hypothesis of no cointegration is rejected for most of the tests in all equations. The statistical *panel-ADF* and *group-ADF* are significant at 5%. In addition, *panel* and *group* rho and PP statistics are significant. Thus, the results show that profit repatriation along with other relevant variables, are cointegrated in the long term with *gdp*, *pcgdp*, *fc* and *ipi*.

Table 2. Cointegration Test of Pedroni

Equation	Panel v-Statistic	Panel rho-Statistic	Panel PP-Statistic	Panel ADF-Statistic	Group rho-Statistic	Group PP-Statistic	Group ADF-Statistic
dlgdp dlgdp dlreusfdip dlgfcf dll dlgpepib	-2.321	-2.550	-6.306	-1.947	-1.799	-7.882	-2.032
t	0.990	0.005	0.000	0.044	0.036	0.000	0.021
dlpcgdp dlgdp dlreusfdip dlgfcf dll dlgpepib	-2.357	-2.324	-6.420	-2.225	-2.201	-9.016	-3.002
t	0.991	0.010	0.000	0.013	-0.015	0.000	0.001
dlfc dlgdp dlreusfdip dlgfcf dll dlgpepib	-2.536	-2.939	8-.067	-2.668	-2.450	-9.707	-3.281
t	0.994	0.002	0.000	0.004	0.007	0.000	0.001
dlipi dlgdp dlreusfdip dlgfcf dll dlgpepib	-2.906	-3.323	-9.883	-4.475	-2.468	-15.513	-5.400
t	0.998	0.000	0.000	0.000	0.007	0.000	0.000

H_0: cointegration
Source: own

Since there is evidence of cointegration in the panel, the long-term impact of US-FDI profits repatriation and of control variables in economic activity in a set of LA countries, is estimated. The election of FMOLS methodology, compared with OLS, is based on the former corrects problems of serial correlation and endogeneity that may arise by OLS (Debashis et al. 2009). Table 3 presents FMOLS estimation results for the four equations.

Table 3. Estimates by FMOLS

Variables	Dependents			
Independents	*dlgdp*	*dlpcgdp*	*Dlfc*	*dlipi*
dlreusfdip	-0.028	-0.017	-0.044	-0.035**
t	-2.04	-2.12	-2.11	-1.98
dlfgfcf	0.412	0.384	0.091	0.319
t	15.16	14.22	2.49	10.18
dll	0.183	0.119	0.243	0.165
t	3.1	2.4	3.03	2.43
dlestpe	0.083	0.72	0.073**	0.09
t	2.06	2.33	1.88	1.98**

** and ** significance at 1 and 5% respectivaly.*
Source: own

The expected signs are estimated. Specifically, results indicate that investment in physical capital, labor, and human capital formation have, in the long term, statistically significant positive impact in economic activity (*gdp* and *fc*), productivity (*ipi*) and on development (*pcgdp*). The significance of human capital variable (*estpe*) suggests that the findings support the neo-classical argument that human capital plays a key role in economic growth.

The role of FDI profits repatriation cannot be underestimated since the coefficient of *reusfdip* is statistically significant in all equations. In other words, results suggest that repatriation is an important determinant of economic activity throughout Latin America. In particular, since the sign is negative, it implies that in the long run exit of utilities from LA countries restricts economic activity in them. Then, the positive effects of US FDI in host markets in the region are limited. Moreover, since this perspective, the hypothesis that FDI is beneficial to host economy does not seem to hold.

Furthermore, the coefficient of *reusfdip* is of low magnitude. Final consumption is the variable more affected by repatriation, which implies that capital outflow contracts the money supply in the domestic economies, restricting consumption possibilities. In addition, MNC strategic decisions regarding repatriation restrict production chains affecting aggregate and industrial production. Similarly, although the coefficient is small, in the long term repatriation impacts on living standards in Latin American economies, thus becoming an additional negative element of economic development in the region.

Of the above, three critical points are extracted. First, from an industrial policy view, repatriation should be considered as a factor limiting production in the long run, by constraining the impact of investment on GDP. Second, economic development in LA is conditioned by MNC decisions regarding profits repatriation, given the negative effect of lower reinvestment. Third, despite the positive effect of human capital formation in the economy, the amount and quality of this type of capital does not seem enough to retain increasingly percentages of the profits.

CONCLUSIONS

This paper estimates the long-term effect of US-FDI profits repatriation on a set of Latin America economies. It followed a relatively new methodology of panel cointegration. Theoretical determinants of MNC

decision about reinvestment or repatriation were described. Among them are alternative investment opportunities (internal factor to firms); profitability of subsidiaries, movements in exchange rates and government incentives.

The estimations show that variables are characterized by unit root processes. However, the panel cointegration test show evidence those variables in first difference can be considered as a cointegrated system. The results suggest that investment in physical capital, labor, public spending on education, and US-FDI profits repatriation are statistically significant in the long run and has the expected sign. In particular, *reusfdip* negatively affects economic activity in Latin America. In other words, Latin American countries face an additional restriction to its economies derived from repatriation of FDI profits.

While the estimated elasticities are less than unity, the role of the repatriation is crucial not only for productive activity but to living standards in LA countries. Thus, US-FDI profits repatriation has become a barrier to economic growth and development in the region. These results are relevant for economic policy, since they make evident the need for designing and implementing powerful incentives to effectively influence the economic performance of these countries. For instance, to increase the GDP by one percentage it is required to lower repatriation or, alternatively, increase reinvestment, in 36% in only one year. At the same time, if policymakers seek to stimulate economic development levels, measured by per capita income, they should discourage marginal capital outflows by about 60%.

Therefore, establishing a regulatory framework that encourages reinvestment in domestic economies significantly would favor economic performance in those countries. The regulation of these marginal capitals over the long term should consider that MNC behavior is driven by issues related to profitability, direct government incentives, efficiency of institutions and human capital variables basis for sustained development.

In essence, these economic policy measures aimed to promoting these factors would tend to retain a higher margin of profit in the long term and, thus, underpin the living standards in the region. In this regard, accordingly to Daniels et al. (2004) government promotion of reinvestment would be justified, from MNC approach, by the fact that reinvestment of profits is a major source of funding for US-MNC.

REFERENCES

Agostini, C. and I. Jalile(2009), "Efectos de los impuestos corporativos en la inversión extranjera en América Latina," *Latin American Research Review,* Vol. 44, No. 2, pp. 84-108.

Alfaro, L., A. Chanda, S. Kalemli and S. Sayek(2004), "FDI and Economic Growth: The Role of Local Financial Markets," *Journal of International Economics*, Vol. 64, No. 1, pp. 89-112.

Altzinger, W.(2008), "The Profitability of Austrian Foreign Direct Investment -reinvestment or Repatriation?," FIW Research Reports Series 010, p. 48.

Baltagi, B. and C. Kao(2000), "Nonstationary Panels, Cointegration in Panels and Dynamic Panles: A Survey," *Advances in Econometrics*, Vol. 15, pp. 7-51.

Barry, F.(2005), "FDI, Transfer Pricing and the Measurement of R&D Intensity," *Research Policy*, Vol. 34, No. 5, pp. 673-681.

Bengoa, M. and B. Sanchez(2003), "Foreign Direct Investment, Economic Freedom and Growth: New Evidence from Latin America," *European Journal of Political Economy*, Vol. 19, No. 3, pp. 529-545.

Blomström, M. and A. Kokko(2003), "The Economics of Foreign Direct Investment Incentives," Stockholm School of Economics Working Paper 168, p. 46.

Blomström, M. and E. Wolff(1994), "Multinational Corporations and Productivity Convergence in Mexico," NBER Working Paper 3141, p. 37.

Borensztein, E., J. De Gregorio and J. Lee(1995), "How Does Foreign Direct Investment Affect Economic Growth?," NBER Working Paper 5057, p. 39.

Brada, J. and V. Tomšík(2009), "The Foreign Direct Investment Financial Life Cycle: Evidence of Macroeconomic Effects from Transition Economies," *Emerging Markets Finance and Trade*, Vol. 45, No. 3, pp. 19-34.

Breitung, J.(2005), A Parametric Approach to the Estimation of Cointegration Vectors in Panel Data," *Econometric Reviews*, Vol. 24, No. 2, pp. 151-173.

Clausing, K.(2001), "The Impact of Transfer Pricing on Intra.firm Trade," in J. Hines(ed.), *International Taxation and Multinational Activity*, Chicago: University of Chicago Press.

Chakrabarti, A.(2001), "The Determinants of Foreign Direct Investment: Sensitivity Analyses of Cross-country Regressions," *Kyklos*, Vol. 54, No. 1, pp. 91-102.

Chandra, P. and P. Sahoo(2007), "Export-led Growth in South Asia: A Panel Cointegration Analysis," *International Economic Journal*, Vol. 21, No. 2, pp. 155-175.

Choi, I.(2001), "Unit Root Tests for Panel Data," *Journal of International Money and Finance*, Vol. 20, No. 1, pp. 249-272.

Daniels, J., W. Hejazi and M. Von der Ruhr(2004), "Regional vs Global Financing Strategies for US MNE," in A. Rugman(ed.), *North American Economic and*

Financial Integration: Research in Global Strategic Management, Vol. 10, United Kingdom: Oxford University Press.

Debashis, D., S. Amanulla and S. Joy(2009), "Financial Development and Economic Growth in Indian States: An Examination," *International Research Journal of Finance and Economics*, Vol. 24, No. 2, pp. 117-130.

Desai, M., C. Foley and J. Hines(2001), "Repatriation Taxes and Dividend Distortions," *National Tax Journal*, Vol. 54, No. 4, pp. 829-852.

Dunning, J.(1993), *Multinational Enterprises and the Global Economy*, Wokingham: Addison Wesley.

Dussel, E.(1997), *La economía de la polarización. Teoría y evolución del cambio estructural de las manufacturas mexicanas*, México: JUS-UNAM.

Dussel, E., L. Galindo and E. Loría(2003), *Condiciones y efectos de la inversión extranjera directa y del proceso de integración regional en México durante los años noventa: Una perspectiva microeconómica*, Argentina: BID-UNAM.

Echavarría, J.(2005), "Impuestos a las utilidades e inversión extranjera directa en Colombia," Documento de Trabajo del Banco de la República, 025, p. 37.

Ekanayake, E. and J. Ledgerwood(2010), "How Does Foreign Direct Investment Affect Growth in Developing Countries? An Empirical Investigation," *The International Journal of Business and Finance Research*, Vol. 4, No. 3, pp. 43-53.

Engle, R. and C. Granger(1987), "Co-integration and Error Correction: Representation, Estimation and Testing," *Econometrica*, Vol. 55, No. 2, pp. 251-276.

Fritsch, W., G. Franco, and L. Wolfson(1991), "Inversión extranjera directa y pautas de la industrialización y el comercio exterior en los países en desarrollo: Notas con referencia a la experiencia brasileña," *Revista Desarrollo Económico*, Vol. 30, No. 120, pp. 523-547.

Gligo, N.(2007), "Políticas activas para atraer inversión extranjera directa en América Latina y el Caribe," *Serie Desarrollo Productivo CEPAL*, p. 131.

Groen, J. and F. Kleibergen(2003), "Likelihood-based Cointegration Analysis in Panels of Vector Error Correction Models," *Journal of Business and Economic Statistics*, Vol. 21, No. 1, pp. 295−318.

Gropp, R. and K. Kostial(2000), "The Disappearing Tax Base: Is Foreign Direct Investment Eroding Corporate Income Taxes?" European Central Bank Working Paper 31, p. 75.

Hall, P. and D. Soskice(2001), "An Introduction to Varieties of Capitalism," in P. Hall and D. Soskice(eds.), *Varieties of Capitalism: The Institutional Foundations of Comparative Advantage*, United Kingdom: Oxford University Press.

Hatemi, A. and M. Irandoust(2005), "Energy Consumption and Economic Growth in Sweden: A Leveraged Bootstrap Approach, 1965-2000," *International Journal of Applied Econometrics and Quantitative Studies*, Vol. 2, No. 4, pp. 87-98.

Hines, J. and R. Hubbard(1990), "Coming Home to America: Dividend Repatriations by US Multinationals," in A. Razing and J. Slemrod(eds.),

Taxation in the Global Economy, Chicago: The University of Chicago.
Hoffmann, A.(2002), "La inversión extranjera directa en América Latina y el Caribe: Una evaluación al comienzo del nuevo milenio," en Z. Vodusek(ed.), *Inversión extranjera directa en América Latina. El papel de los inversores europeos*, Argentina: BID.
Huang, C., K. Teng and P. Tsai(2010), "Inward and Outward Foreign Direct Investment and Poverty: East Asia vs Latin America," *The World Economy*, Vol. 146, No. 2, pp. 763-779.
Ishii, Y.(2006), "Multinational Firms and Strategic FDI Subsidies," *Review of International Economics*, Vol. 4, No. 2, pp. 292-305.
Kao, C.(1999), "Spurious Regression and Residual Based Tests for Cointegration in Panel Data," *Journal of Econometrics*, Vol. 90, No. 1, pp. 1-44.
Kok, R. and B. Acikgoz(2009), "Analyses of FDI Determinants in Developing Countries," *International Journal of Social Economics*, Vol. 36, No. 2, pp. 105-123.
Kose, M., G. Meredith and C. Towe(2004), "How Has NAFTA Affected the Mexican Economy? Review and Evidence," IMF Working Paper 04-59, p. 49.
Larsson, R., J. Lyhagen and M. Löthgren(2001), "Likelihood-based Cointegration Tests in Heterogeneous Panels," *Econometrics Journal*, Vol. 4, No. 1, pp. 109-142.
Lehmann, A.(2002), "Foreign Direct Investment in Emerging Markets: Income, Repatriations and Financial Vulnerabilities," IMF Working Paper 02-47, p. 29.
Lipsey, R.(2002), "Home and Host Effects of FDI," NBER Working Paper 9293, p. 58.
Love, J. and F. Lage-Hidalgo(2000), "Analysing the Determinants of US Direct Investment in Mexico," *Applied Economics*, Vol. 32, No. 1, pp. 1259-1267.
Lundan, S.(2006), "Reinvested Profitability as a Component of FDI: An Analytical Review of the Determinants on Reinvestment," *Transnational Corporations*, Vol. 15, No. 3, pp. 33-64.
Machinea, J. and C. Vera(2006), Comercio, inversión directa y políticas productivas," Serie Informes y Estudios Especiales CEPAL 16, p. 68.
Maddala, G. and S. Wu(1999), "A Comparative Study of Unit Root Tests With Panel Data and a New Simple Test," *Oxford Bulletin of Economics and Statistics*, Vol. 61, pp. 631-652.
Markusen, J. and A. Venables(1999), "Foreign Direct Investment as a Catalyst for Industrial Development," *European Economic Review*, Vol. 43, No. 1, pp. 335-356.
McCoskey, S. and C. Kao(1998), "A Residual-based Test of the Null of Cointegration in Panel Data," *Econometric Reviews*, Vol. 17, No. 2, pp. 57-84.
Mencinger, J.(2003), "Does Foreign Direct Investment Always Enhance Economic Growth?," *Kilkos*, Vol. 56, No. 4, pp. 491-508.
Mesa, F. and R. Parra-Peña(2006), "Política tributaria como instrumento

competitivo para captar la inversión extranjera directa: caso de América Latina," *Archivos de Economía* 3340, p. 56.

Morales, J.(2010), "Inversión extranjera directa y desarrollo en América Latina," *Problemas del Desarrollo*, Vol. 41, No. 163, pp. 141-156.

Morales, L., P. Guerrero and M. López(2009), "Una evaluación de las políticas promocionales de inversión extranjera directa en América Latina," *Lecturas de Economía*, Vol. 71, No. 2, pp. 141-168.

Mortimore, M.(2004), "The Impact of TNC Strategies on Development in Latin America and the Caribbean," in D. te Velde(ed.), *Foreign Direct Investment, Inequality and Poverty: Experiences and Policy Implications*, London: Overseas Development Institute.

_____(2009), "Arbitraje internacional basado en cláusulas de solución de controversias entre los inversionistas y el Estado en acuerdos internacionales de inversión: desafíos para América Latina y el Caribe," Serie Desarrollo Productivo CEPAL 188, p. 87.

OECD(2002), *Foreign Direct Investment for Development: Maximising Benefits, Minimising Costs*, París: OECD.

Pedroni, P.(1995), "Panel Cointegration: Asymptotic and Finite Sample Properties of Pooled Time Series Tests, With an Application to the PPP Hypothesis," Indiana University Working Papers in Economics 95-013, p. 48.

_____(1997), "Panel Cointegration: Asymptotic and Finite Sample Properties of Pooled Time Series Tests, With an Application to the PPP Hypothesis. New Results," Indiana University Working Paper 97-04, p. 51.

_____(1999), "Critical Values for Cointegration Tests in Heterogeneous Panels With Multiple Regressors," *Oxford Bulletin of Economics and Statistics*, Vol. 61, No. 1, pp. 653-670.

_____(2000), "Fully Modified OLS for Heterogeneous Cointegrated Panels," in B. Baltagi(ed.), *Nonstationary Panels, Panel Cointegration, and Dynamic Panels*, Amsterdam: Elsevier.

Pelegrín, A.(2002), "Inversión extranjera directa," *Papeles de Economía Española*, Vol. 93, pp. 122-134.

Phillpis, P. and B. Hansen(1990), "Statistical Inference in Instrumental Variables Regressions With I(1) Processes," *Review of Economic Studies*, Vol. 57, No. 2, pp. 99-125.

Ramirez, M.(2011), "Is Foreign Direct Investment Productive in the Latin America Case? A Panel Cointegration Analysis, 1980-2002," *The International Trade Journal*, Vol. 25, No. 1, pp. 35-73.

Rodas, M.(2005), "Los regímenes de la inversión extranjera directa y sus regulaciones ambientales en México y Chile," Series Estudios y Perspectivas CEPAL 27, p. 69.

Romer, P.(1990), "Endogenous Technological Change," *Journal of Political Economy*, Vol. 98, No. 5, pp. 71-102.

Shah, A. and J. Slemrod(1990), "Tax Sensitivity and Foreign Direct Investment: An Empirical Assessment," The World Bank Working Papers 434, p. 49.

Shatz, H. and A. Venables(2000), "The Geography of International Investment," World Bank Policy Research Working Paper 2338, p. 59.

Slaughter, M.(2003), "Host-country Determinants of US Foreign Direct Investment into Europe," in H. Herrmann y R. Lipsey(eds.), *Foreign Direct Investment in the Real and Financial Sector of Industrial Countries*, New York: Springer.

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ANNEX

The starting point of the model Levin, Lin and Chu (LLC) is:

$$y_{it} = \rho_i y_{it-1} + z'_{it}\gamma + u_{it} \quad \text{(A)}$$

With i=1, …, N and t=1, …, T; and where z_{it} is the deterministic component and u_{it} is a stationary process. z_{it} could be zero, one, the fixed effects, μ_i, or fixed effects as well as a time trend, t. The LLC tests assume that $\rho_i = \rho$ for all i, thus, under the homogeneous alternative the first order serial correlation coefficient ρ is required to be identical for all units. Also, the LLC test proves the null hypothesis H_0:ρ=1, while the alternative is H_0:ρ<1. Given $\rho_i = \rho$, the model (A) can be written as:

$$\Delta y_{it} = \delta_i y_{it-1} + z'_{it}\gamma + u_{it} \quad \text{(B)}$$

With i=1,…,N and t=1,…,T; and where . Therefore, the null of is equivalent to $\delta = 1$.

The LLC tests are restrictive since they require ρ be homogeneous across i. In contrast, Im, Pesaran and Shin (IPS) allow for heterogeneous coefficient of y_{it-1}. Thus, essentially the IPS test is a linear trend model of N cross-section units; and, instead of pooling the data, it uses separate unit root tests for the N cross-section units. They also proposed an alternative testing procedure based on the augmented DF tests when u_{it} is serially correlated with different serial correlation properties across cross-sectional units, that is, $u_{it} = \sum_{j=1}^{p_i} \varphi_{ij} u_{it-1} + \varepsilon_{it}$. When u_{it} is substituted, equation (A) can be rewritten as:

$$y_{it} = \rho_i y_{it-1} + \sum_{j=1}^{p_i} \varphi_{ij} \Delta y_{it-1} + z'_{it}\gamma + \varepsilon_{it} \quad \text{(C)}$$

With i=1,…,N and t=1,…,T. The null hypothesis is H_0:ρ=1, for all i, while the alternative is Ha:ρ_i<1, for at least one i. Economic literature that analyzes long run relationships in panel data states IPS has superior test power.

An alternative approach to panel unit root tests was introduced by Maddala and Wu (1999) and modified to the case of infinite N by Choi (2001), relying on the assumption that the individual time series in the panel are cross-sectionally independent. The Fisher type tests combine the p-values from individual unit root tests for each cross-section i. Formally,

the test is:

$$P=-2\sum_{i=1}^{N} lnp_i$$

Which combines the *p*-values from unit root tests for each cross-section *i* to test for unit roots in panel data. *P* is distributed as x^2 with $2N$ degrees of freedom as $T_i \rightarrow \infty$ for finite *N*. Accordingly with Baltagi and Kao (2000), the advantage of this test is that it does not require a balanced panel as in the case of the IPS test. Also, one can use different lag lengths in the individual ADF regression, and can be applied to any other unit root test.