Income terms of trade and economic convergence: Evidence from Latin America

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Abstract

The paper considers the effects of income terms of trade (ToT) on GDP per capita in Latin American economies and examines whether improvement in the income ToT (in absolute and relative terms) contributes to the stochastic convergence between respective economies and the US. It is shown that in the majority of the economies, income ToT had positive effects on the level of GDP per capita. The stochastic convergence was documented in Chile, Dominican Republic, and Uruguay. The positive effects of income ToT increase on GDP per capita convergence were documented only in Chile and Uruguay. The growth of the volume of exports played a key role in the process, while the effects on the part of net barter ToT were insignificant. In both economies, the improvement in the income ToT relative to the US level played a positive role in convergence.

Keywords: terms of trade, convergence, Prebisch-Singer thesis

JEL Classification: C22; F02; F14; N76

Introduction

The role of international economic factors in income (GDP per capita) convergence has been a topical issue in development economics and in growth literature and has been subject to extensive research. A number of diverse arguments have been put forward, principally pertaining to 'free trade-income convergence' link (Ben-David, Loewy, 1997: 1). On one hand, the factor price equalization theorem (Helpman, Krugman, 1985) states that free trade leads to commodity price equalization and subsequently to factor price equalization. On the other hand, Slaughter (1997) counters that factor price equalization is not the same as per capita income equalization, and hence convergence may be absent even with free trade. Razin and Yuen (1997) argue that factor mobility will only result in interest rate convergence, but foreign direct investment will cause positive human capital externalities and be instrumental in income convergence. Grossman and Helpman (1995) likewise argue that income convergence will take place when free trade assists dissemination of knowledge, technologies, and ideas to less developed economies.

The empirical analysis of international determinants of convergence also delivers contradictory results. The positive effects of trade on per capita income level and growth are identified by Choi (2009), the positive effects of trade on the speed of income convergence are noted by Ben-David (1996) and Ben-David and Kimhi (2001). On the other hand, Slaughter (2001) and Hallet and Piscitelli (2002) argue that trade liberalization, increase in trade flows, and a higher degree of economic integration tend to cause divergence rather than convergence. With regard to effects of greater foreign direct investment, the positive effects on income are identified by Choi (2004).

This paper focuses on the effects of ToT on GDP per capita level and GDP per capita convergence, a process that has received less consideration in the literature. Arguably, it is an equally relevant international economic determinant, given that structure and quality of exports and the gains from trade may be as salient for income level and income convergence as the overall level of bilateral trade and investment, and given that in the developing economies ToT changes contribute substantially to output volatility (Mendoza, 1997; Kose, 2002).

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The theoretical debate on the issue points to two possible outcomes. The ToT may deteriorate and thereby contribute to the decline/stagnation of per capita income and income divergence across developed and developing economies (so-called Prebisch-Singer thesis, PST, formulated by Prebisch, 1950, Singer, 1950, but having earlier origins in the work of Kindleberger, 1943). In contrast, as argued by classical economists (Mills, Ricardo, Malthus), ToT of primary commodities vis-a-vis manufacturers may improve (due to diminishing returns in primary production and increasing returns in manufacturing) and bring in convergence and income growth. Importantly the classical view was that convergence may happen in the absence of industrialization, with technological progress gains being transferred to the developing economies via favourable ToT (Sarkar, 2001: 310-311).

In this regard, the purpose of the paper is to answer three related questions. Does improvement in the ToT in Latin American economies have a positive effect on GDP per capita of these economies? If ToT in these economies have a positive contribution to GDP per capita, do they also bring in convergence in income between individual Latin American economies and the USA? Finally, does relative improvement in the ToT (i.e., ToT in the Latin American economy relative to the US ToT) bring in convergence between individual Latin American economies and the USA?

The paper is novel is three respects. Firstly, it goes beyond the question of whether ToT affect GDP per capita levels, and considers the effects of ToT (and the gap between ToT in developed and developing economies) on GDP per capita convergence. Secondly, it uses income ToT (ITT) as a better indicator of gains from trade and a measure of 'trade as engine of growth' (in fact, as stated by Singer, 1999, the PST was originally formulated as the analysis of ITT, rather than net barter ToT, NBTT). Thirdly, in contrast to previous contributions, it considers the most recent changes in ToT in the past three decades and their effects.

The analysis is likely to be important given seminal changes that took place in international and Latin American foreign trade in the past three decades: a complex interplay of globalization and de-globalisation tendencies, trade liberalization and protectionism, economic integration and disintegration, as well as (in the Latin American context) the growing trade flows between China and Latin America, the demise of import-substitution policies, and partial return to a primary-exporting role for Latin America (Thorp, 1998; Vianna, 2016).

The rest of the paper is organized as follows. The next section discusses the relevant literature pertaining to the role of ToT in economic growth and convergence. Section 3 provides an econometric model for the analysis of the ToT-convergence issue and discusses data sources and other methodological problems. Section 4 presents empirical results and considers them in light of the economic history of Latin American economies in the 1980-2000s. Concluding remarks are contained in Section 5.

Literature review

The classical hypothesis of no deterioration in the primary commodity ToT (due to decreasing returns in agriculture and increasing returns in manufacturing) dominated economic theory from the days of R. Malthus to the early works of J. M. Keynes (Toye, Toye, 2003). It found some empirical support in the late 19^{th} and early 20^{th} century, at times when primary commodity prices were on rise (Sarkar, 2001: 310-11) and in recent years, during the commodity boom of the 2000s. Contemporary models of international trade in a classical (and neoclassical) vein likewise purport that commodity prices and ToT are likely to be sustained (theory of dualism by Jorgenson, 1961, and open economy model of Zarembka, 1972) or that economic growth is invariant to ToT movements and specifically to their deterioration (Brecher, Choudhri, 1982).

PST (Prebisch, 1950; Singer, 1950; Myrdal, 1957) was formulated against these views and rested on the following assumptions. Developing economies specialize in the production of primary commodities, while developed economies specialize in the production of manufactured goods. The organized labour in the manufacturing sector of the developed economies prevents wage falls during recessions, but manages to secure wage increases during upswings, resulting in growing costs and prices of manufactured products. The wage repression and weak organized labour in developing economies results in the opposite tendencies – the cost and price of primary commodities do not rise sufficiently, and thus the ToT (the ratio of primary export prices to the prices of manufacturing imports) experienced by developing economies falls. In addition, the monopoly power of the manufacturing sector and the growing mark-up maintains manufactured goods' prices; while in the primary commodities sector, low income elasticity dampens demand and prices, in line with Engel's Law. Finally, the technical progress in many instances triggers substitution from raw materials and commodity inputs in production towards manufactured substitutes (e.g., synthetic versus natural rubber), thereby reducing demand for and prices of primary products. Overall, the prices of primary exports by the developing economies deteriorate vis-à-vis the prices of manufacturing exports from the developed economies, leading to the secular decline in the developing countries' ToT.

The Prebisch-Singer thesis (PST) is conventionally seen as a hypothesis of economic divergence between developed and developing nations, driven by deteriorating ToT. As Singer (1999) states, 'Falling terms of trade for poorer countries and improving terms of trade for richer countries would mean greater international inequality between countries' (p. 912). However, R. Prebisch and H. Singer also acknowledge the possibility of the opposing tendency (albeit stated that it was unlikely in the international economic environment of the 1950-60s). Convergence of GDP per capita would ensue (1) if the fall in net barter ToT (NBTT) is more than offset by the increase in exports volume and income ToT (ITT) improves, or (2) if the downward trend in NBTT reverses and NBTT stabilizes, while export volume continues to grow (p. 912). The convergence necessarily implies improvement in ITT rather than mere ITT stabilization (as the latter would mean divergence, i.e., economy uses more resources to in increase exports in order to offset falling NBTT), as well as relative improvement in ITTs (i.e., ITTs in the developing economy grow faster than ITTs in the developed economy, or ITTs in the former grow while ITTs in the latter decline). The tendency that dominates is clearly a matter of empirical verification.

The empirical work conducted since the 1950s can be classified into two categories.

Firstly, the dynamics and statistical patterns of the ToT series have been examined. To this end, the construction on sufficiently extensive and inclusive ToT series for the empirical analysis has been performed: Grilli and Yang (1988) constructed commodity ToT series covering the 1900-1986 period, Harvey et al. (2010) obtained the longest ToT series covering the 1650-2005 period, while other authors considered ToT in the 19th century (De La Encosura, 1994) and in the pre-WWII period (Hadass, Williamson, 2003).

In terms of scope and composition of ToT, a number of aspects were considered: trends in primary commodity prices (Kellard, Wohar, 2006); primary commodity prices versus prices of manufactured goods (Powell, 1991); prices of manufacturing exports and imports (Sarkar, Singer, 1991; Athukorala, 1993; Lucke, 1993); prices of the country's total exports and imports, i.e., country ToT (Erten, 2011; Bleaney, Greenaway, 1993; Razzaque et al., 2007). Alternative econometric methodologies were tried: linear trend models (Sarkar, Singer, 1991); Augmented Dickey-Fuller test (Athukorala, 1993; Erten, 2011); Johansen-Juselius cointegration (Powell, 1991); panel data stationarity tests with breaks (Arezki et al., 2012); and Zivot-Andrews, Lumsdaine-Papell and Lee-Strazicich unit root tests with break (Leon, Soto, 1997; Zanias, 2005; Ghoshray, 2011).

Overall, the empirical support for the PSH is mixed. The early studies by Spraos (1980), Sapsford (1985), Thirwall and Bergevin (1985), Grilli and Yang (1988), Powell (1991), Sarkar, Singer (1991), and Reinhart and Wickham (1994), as well as the more recent studies by Harvey et al. (2010), and Arezki et al (2013) suggest secular deterioration of the commodity ToT along the deterministic trend. Other authors

(Ocampo and Parra, 2003; Serrano and Pinilla, 2011; Zanias, 2005) employ the unit root tests with structural breaks and demonstrate that while ToT deterioration took place, it was not continuous, with major declines experienced around the structural breaks. On the other hand, Cuddington and Urzua (1989) and Marcal (2006) argue that ToT fluctuated around a mean, while Kim et al. (2003) suggested that ToT were characterized by unit root processes. Certain historical periods witnessed improvement in the ToT (the case of Spain in 1714-1913, as evidenced by De La Encosura, 1994; and the case of the majority of developed and developing economies in 1870-1940, as demonstrated by Hadass and Williamson, 2003). In addition, the ToT patterns were not uniform, with increases in some of the commodity prices being accompanied by decreases and stability in the others (Cuddington, 1992; Newbold et al., 2005).

Secondly, the empirical work considered the relationships between ToT and economic growth and income, and also examined the effects of ToT's volatility on growth. This aspect is salient, given that PSH itself does not imply that ToT is the major (the only, or the most significant) determinant of GDP per capita and economic convergence. In addition to capital accumulation, technological change, enhancement of human capital, and institutional factors, other variables pertaining to international economic interactions may be important in convergence process (trade openness, trade liberalization, or international investment).

Positive effects of ToT improvement were reported in several instances. Basu and McLeod (1992) confirm a positive growth impact of ToT hypothesis for 12 developing economies (principally in Latin America). Similar type effects are indicated by Mendoza (1997) in panel data estimation for the 40 developed and developing economies in the 1971-1991 period. Bleaney and Greenaway (2001) examine 14 sub-Saharan African economies in the 1980-1995 period and (using panel methods) likewise establish positive contributions of ToT to economic growth. Ekholm and Sodersten (2002) establish a very strong correlation between growth in income ToT and growth in per capita income in the newly industrialised economies of East Asia, as well as in selected economies of Western Europe and USA in 1970-1995. The effect and the positive trend in ITT were more strongly pronounced in East Asia. A similarly strong correlation was experienced in the early industrializing economies of Europe in the 19th century (Sodersten, 1991). The studies of individual economies include Jawaid and Raza (2013), who used ARDL bounds test approach and data covering the 1980-2010 period to demonstrate the positive effects of ToT in India, Wong (2004) who establishes the positive effects of ToT on income in Malaysia using 1965-2002 time series data, and Misztal (2012), who shows the positive effect in Poland (using VAR model and data from 1980-2009 period). Other studies with similar results include Cakir (2009) and Jawaid and Waheed (2011), both considering a large number of economies in recent years (the former using generalized method of moments technique, the latter using OLS estimation). As argued by Fosu (2011) and Misztal (2012), the likely explanations of the positive effects of ToT improvement include expansion of purchases of production inputs, adoption of more technologically efficient processes, growth of capital productivity, and increase in government spending, consumption, and savings.

On the other hand, the negative effects of ToT on economic growth are identified by Blattman et al. (2003) in 35 developed and developing economies in 1870-1938 (with the negative effects being most salient in the developing economies); by Wong (2010) in Korea and Japan in 1971-2006 and 1996-2003, respectively; by Kalumbu and Shafeeni (2014) in Namibia in 1980-2012; Jawaid, Raza (2015) in China in 1980-2010; and by Jebran et al. (2018) in Pakistan in 1980-2013. The possible explanations for the negative effects are a decrease in the social costs of imports (e.g., due to rent-seeking) following ToT decline and resulting increase in economic growth (Anam, 1988); ToT deterioration in economies with significant differentiation of inter-sectoral wage rates (Batra, Pattanaik, 1971), high urban unemployment (Chao, Yu, 1990), or when capital is internationally mobile (Bhagwati, Brecher, 1980); movement of resources to non-traded import competing sectors following ToT deterioration, and decrease in prices of differentiated imported goods (Sen, 1998).

We also note the study by Hadass and Willaimson (2003) that considers ToT in 17 economies in the period of 1870-1940 and shows that while ToT improved both in the 'core' and the 'periphery', they did not affect economic growth in most economies (except in Korea, where the effect was negative, and Germany, the UK, and the USA, where it was positive).

The effects of ToT volatility on economic growth were as important as the effects of the levels of ToT. Mendoza (1997) and Kose (2002) show that ToT volatility explains up to 50% of GDP volatility of the respective economies, while Blattman et al. (2003) argue that the negative effects of ToT volatility are more than twice the size of the negative effects of the downward trend in ToT. Importantly, the negative effects of the ToT volatility were most pronounced in the developing economies (due to their commodity specialization and generally higher degree of openness), as demonstrated by Baxter and Kouparitsas (2000) and Broda and Tille (2003).

The review of the existing empirical literature suggests the following methodological innovations could be made to advance the empirical work.

Firstly, the empirical research progressively shifted the focus away from PSH as it was originally formulated. It tended to focus on the dynamics of NBTT as the ratio of unit value of exports to the unit value of imports (or as a ratio of export price index to the import price index). This approach may be unwarranted, since NBTT and commodity ToT do not account for gains from increased volume of trade and instead consider gains from a unit volume of trade, i.e., look at relative, not absolute gains from trade that matter for convergence (Baldwin, 1955). ITT is therefore a more accurate measure of 'trade as an engine of growth'. The few works that examined dynamics of ITT (as a product of NBTT and the export volume index) or interactions between ITT and growth were rare and included Wilson et al. (1969), Ekholm and Sodersten (2002), Athukorala (2000), and Wong (2004).

Secondly, the link between economic growth and ToT was examined extensively. This, by itself, does not indicate convergence or divergence tendencies; hence, it is instructive to consider the relationship between the ITTs of the developing economies and the GDP per capita gap (the gap between GDP per capita in developed and developing economies). It is also necessary to consider whether GDP per capita gap becomes smaller as the ITTs of the developing economies improve and whether such gap becomes larger, as the ITTs of the developing economies deteriorate (i.e., to examine the relationship between ITT gap and GDP per capita gap).

Methodology

Model

We propose a sequential modelling approach that

1) Considers whether ITTs affect the level of GDP per capita in a particular economy

2) Looks at the convergence (divergence) trends in those economies where ITTs affect GDP per capita levels

3) For those economies where convergence took place, examines whether changes in ITT contribute to convergence (i.e., GDP per apita gap narrows down as ITTs improve) and whether the diminishing gap in the ITTs (the improvement of ITTs in the developing economies relative to ITTs of the developed economies) affects the convergence process.

Firstly, the possibility of cointegration between ITT and GDP per capita is examined using the Pesaran-Shin-Smith (PSS) bounds test of cointegration proposed by Pesaran and Shin (1999) and Pesaran et al. (2001), provided that none of the variables is integrated of order 2 (i.e., is I(2)) and that the independent variable is not stationary in levels (i.e., is I(0)).

The relationship between the variables is considered on a bivariate basis (Model 1), as well as within the aggregate production function framework (Model 2).[i] The former model includes ITT as independent variable, the latter includes ITT, gross fixed capital formation, and gross secondary enrolment ratio and human capital index as independent variables:

$$GDPCAP = f(ITT) \tag{1}$$

$$GDPCAP = f(GFCF, LF, HC, ITT) \tag{2}$$

where all variables are represented in the natural logarithms. $GDPCAP$ is GDP per capita, $GFCF$ is gross fixed capital formation, HC is the human capital variable (either gross enrolment ratio at the secondary level or, in the case of Bolivia and Brazil, index of human capital per person), ITT is income ToT.

Per PSS, cointegration is present when bounds test statistic exceeds the upper bound critical value; i.e., the variable is integrated of order 1, I(1). Cointegration is absent when bounds test statistic is below the lower bound critical value; i.e., is I(0). In the cases, when the bounds test does not deliver definite conclusions, the significance of the error correction term (ECT) is considered to determine cointegration, in line with recommendations by Kremers et al. (1992).

In the presence of cointegration (as confirmed by PSS bounds test), the long- and short-run relationships are estimated using the autoregressive distributed lag (ARDL) model below:

$$\Delta GDPCAP_t = \varphi_0 + \varphi_1 GDPCAP_{t-i} + \varphi_2 GFCF_{t-i} + \varphi_3 HC_{t-i} + \varphi_4 ITT_{t-i} + \varepsilon_t \tag{3}$$

$$\Delta GDPCAP_t = \psi_0 + \psi_1 \sum_{i=1}^{p} \Delta GDPCAP_{t-i} + \psi_2 \sum_{j=1}^{q} \Delta GFCF_{t-j} + \psi_3 \sum_{l=1}^{q} \Delta HC_{t-l} +$$

$$+\psi_4 \sum_{m=1}^{q} \Delta ITT_{t-m} + \upsilon EC_{t-i} + \varepsilon_t \tag{4}$$

where φ_0, φ_1, φ_2, φ_3, φ_4 are long-run coefficients, ψ_0, ψ_1, ψ_2, ψ_3, ψ_4 are short-run coefficients, υ is the coefficient of the error-correction term , and ε_t is an error term. For each individual case, a number of specifications are tried (unrestricted constant, restricted constant, and restricted linear trend), and the one that ensures significance of all variables (including deterministic one) is selected.

Given that the presence of cointegration is sensitive to the lag selection, and that the study sample is limited to 36 observations, the ARDL lags are selected from a maximum of 1, 2, and 4 lags using automatic selection algorithm, based on Akaike information criterion (or using fixed lags, when serial correlation problem is present). The advantages of ARDL are noted: higher power in small samples, a single-equation reduced form, invariance to the different order of integration of the variable, as well as flexible lag structure.

If no cointegration is detected, the ordinary least squares (OLS) model in first differences is estimated and elasticities are obtained accordingly.

In the absence of cointegration, an OLS model in first differences is estimated:

$$DGDPCAP_t = \beta_0 + \beta_1 DGFCF_t + \beta_2 DHC_t + \beta_3 DITT_t + \varepsilon_t \tag{5}$$

where $DGDPCAP_t$, $DGFCF_t$, DHC_t, $DITT_t$ are differenced variables, and ε_t is an error term.

Secondly, the convergence in the GDP per capita between respective Latin American economies and the USA is considered. The objective of the paper is to examine ITTs in relation to GDP per capita, in particular to establish whether ITT changes contribute positively to GDP per capita convergence (reduction of GDP per capita gap). This, in turn, requires testing whether convergence actually takes place.

To this end, the ratio of the GDP per capita in Latin American economy to the GDP per capita in the USA (the former representing developing economy, the latter standing for developed economy) is defined to represent the GDP per capita gap.

In contrast to σ-convergence test that examines whether cross-sectional dispersion in the GDP per capita increases or decreases over time, and β-convergence test that examines whether growth rates of the economies with low GDP per capita exceed rates in the economies with high GDP per capita (Barro, Sala-i-Martin, 1991), this paper conceptualizes convergence as a stochastic convergence (Bernard, Durlauf, 1995; Carlino, Mills, 1996). We consider specifically whether the GDP per capita ratio contain trends, is mean reverting or follows stochastic process. Four tests are employed: the linear trend, the Augmented Dickey Fuller (ADF) test regression, and the Lee-Strazicich LM unit root tests with one or two structural breaks.

The presence of the statistically significant trend with (or without) breaks in the GDP per capita ratio under all or the majority of the tests would indicate that GDP per capita gap narrows down (the positive sign of the trend) or widens (negative sign), the former case representing stochastic convergence. The absence of a significant trend would, in contrast, show that GDP per capita gap is mean reverting or follows random walk, and therefore no definite convergence or divergence tendencies are present.

The linear trend model is specified as

$$GDPCAP_{ij} = \alpha_t + \beta_t TREND + \varepsilon_t \tag{6}$$

where $GDPCAP_{ij}$ is the natural logarithms of the ratio of the GDP per capita in a respective Latin American economy to the US GDP per capita, expressed in percentage terms (representing GDP per capita gap), β_t is the coefficient of the trend term, and ε_t is an error term. AR(1) and AR(2) are added the in cases, when serial correlation is present. Decrease in GDP per capita gap is indicated when $\beta_t > 0$; i.e., when GDP per capita in a respective Latin American economy increases relative to the US GDP per capita, the gap increases when $\beta_t < 0$.

The ADF test is conducted using following equation:

$$\Delta(GDPCAP_{ij})_t = \alpha + \beta t + \psi(GDPCAP_{ij})_{t-1} + \sum_{i=1}^{m} \delta\Delta(GDPCAP_{ij})_{t-1} + \nu_t \tag{7}$$

where α is the intercept term, β is the coefficient of trend term of t, ψ is the coefficient of the error-correction term, δ is the coefficient of the augmenting term, Δ is difference operator, ν is the error term, error-correction term is negative and falls within $-1 < \psi < 0$ range, the long-run trend in the GDP per capita gap is $b = -\beta\psi^{-1}$, $\psi = -\left(I - \sum_{i=1}^{m} \delta\right)$. Deterministic trend is present when $\beta < 0, \psi < 0$ or $\beta > 0, \psi < 0$, reversion to historical mean occurs when $\beta = 0, \psi < 0$, random walk with drift are observed when $\beta < 0, \psi = 0$ or $\beta > 0, \psi = 0$ and random walk without drift is indicated when $\beta = 0, \psi = 0$ (Bleaney, Greenaway, 1993: 351).

The Lee-Strazicich LM test (Lee, Strazicich, 2003, 2004) statistic was estimated using following equation:

$$\Delta LS_t = d^{'} \Delta Z_t + \phi \tilde{S}_{t-1} + \sum \delta_i \Delta \tilde{S}_{t-i} + \varepsilon_t \quad (8)$$

where $\tilde{S}_t$ is de-trended series, ε_t is an independently and identically distributed error term, Z_t is a vector of exogenous variables, ϕ is a relevant estimator used in calculating minimum LM statistic. The latter is defined as $LM = \inf_{\lambda} \tau(\lambda)$, where λ is break location, and τ is a ratio of estimator ϕ to its standard deviation. The number of augmenting terms ΔS_t was obtained through a general-to-specific procedure, with $k_{\max} = 8$. The test was conducted using Model C, including up to two breaks in trend and intercept. The test was conducted sequentially: first with two breaks, and if only one trend break were significant (irrespective of the acceptance or rejection of the null hypothesis), the test with one break was performed. If in the latter case, the trend break were insignificant, the test was considered inconclusive and no results reported.

Thirdly, for those economies where significant and positive trend in GDP per capita ratio ($GDPCAP_{ij}$) is identified, the relationship between this ratio and the level of ITT is considered. Prebisch-Singer hypothesis, as originally formulated, does not dictate necessary convergence or divergence (Singer, 1999). Hence both positive and negative effects of ITT on the GDP per capita gap are considered. Both bivariate and multivariate models are estimated (as per Equations 1 and 2), where $GDPCAP_{ij}$ is a dependent variable, while $GFCF$, HC, and ITT are independent variables. The significant positive coefficient of the ITT variable would point to the fact that ITT changes contribute to reduction of GDP per capita gap and thereby convergence. The significant negative coefficient would point to the widening of GDP per capita gap and divergence.

Given that changes in ITT are driven by changes in NBTT and in the value of exports, we look at which of these ITT components ($NBTT$ and EXP) were more salient in explaining GDP per capita gap changes. In addition, for those economies where ITT was instrumental in GDP gap reduction, we looked at the relationship between ITT gap and GDP per capita gap (ITT_{ij} and $GDPCAP_{ij}$). As mentioned by Prebisch and Singer, the convergence process may be driven by the improvement of ITT in the developing economy accompanied by the deterioration of the ITT in the developed economy. Also, as argued by Sarkar (1986), a faster growth in the ITT in the developing economy may be paralleled by a slower ITT growth in the developed economy; i.e., both economies may experience absolute gains from trade (albeit the size of the gains will differ). We define the ITT gap as the ratio of ITT index in respective Latin American economy to the ITT index in the US (with both indexes having same base in 2005).

Data sources

The sample includes 18 Latin American economies (Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Paraguay, Peru, Panama, and Uruguay) and the USA. The study covers the period of 1980-2014.

GDP per capita data is obtained from UNCTAD database (available at http://unctadstat.unctad.org) and is measured in US dollars at constant 2005 prices. Gross fixed capital formation data is taken from the UN

Statistics Division, National Accounts Main Aggregates Database (available at https://unstats.un.org/unsd/snaama/dnlList.asp). It is measured in US dollars at constant 2005 prices and includes acquisitions and excludes disposal of valuables. Several studies include capital per worker in the aggregate production function (e.g., Musila, Yiheyis, 2015). In this paper we follow the approach by Shaikh (2016: 65-68): instead of considering that all vintages of capital are equally productive (and profitable), it is advantageous to include only the recent (and the more productive) investment in the equation. Income ToT (ITT) index is sourced from UNCTAD database under the name of purchasing power index of exports. ITT index pertains to international merchandise trade (i.e., excludes trade in services) and is defined as the product of net barter ToT index and the volume index of exports, or equivalently as ratio of the value index of exports to the import unit value index. Gross enrolment ratio series are obtained from the World Bank database (available at https://data.worldbank.org/indicator/SE.SEC.ENRR, indicator code – SE.SEC.ENRR). It is defined as the ratio of total enrolment at secondary school level, for both sexes, to population in the official age group corresponding to this level of education. In two cases when enrolment data were not available (Bolivia and Brazil), the human capital index was used instead. The index of human capital per person is retrieved from Penn World Table 9.0 (PWT 9.0) and is based on the average years of schooling and returns to education (Psacharopoulos, 1994; Barro, Lee, 2013).

The missing data were filled in using linear interpolation method in Eviews software. The natural logarithm was taken of all variables in question to ensure scale invariance and to assist interpretation of the effects of independent variables, with estimated coefficients being estimated percentage changes in the dependent variable for a percentage change in the independent variable.

Empirical results

The results of the bounds test are presented in Table 1 (for Models 1 and 2 respectively). For Model 1, the F-statistic indicated cointegration in all economies, except Argentina, Brazil, Dominican Republic, El Salvador, and Paraguay. For Model 2, F-statistic indicates cointegration in all cases, except Ecuador and Venezuela. For several borderline cases when F-statistic fell within I(0) and I(1) bounds (Brazil, Nicaragua, Peru, Panama, USA, Uruguay in Model 2), the error correction terms (ECT) from associated ARDL equations were considered. The value of ECT was within $(0;-1)$ range and was significant, with the t-statistic of the term exceeding the relevant critical values. It was concluded that cointegrating relations were thus present in these cases.

For those economies where cointegration was detected, the ARDL model was estimated (Tables 2 and 3). The requisite diagnostic tests (Jarque-Bera normality test, White or Breusch-Pagan hereoskedasticity tests, Breusch-Godfrey serial correlation LM test, ARCH, RESET, and CUSUM tests) have been passed in both Models 1 and 2. In Model 1, positive and statistically significant coefficients for ITT were present in all cases except El Salvador, where coefficient was positive but insignificant. In Model 2, positive and significant coefficients for ITT were obtained for Argentina, Bolivia, Colombia, Peru, Panama, USA, and Uruguay. A significant negative sign of ITT was present in the case of Brazil, Chile, El Salvador, and Mexico. In all economies, the sign of gross fixed capital formation (investment) variable was positive, while the sign of the education variable (as represented by the human capital index or gross secondary enrolment ratio) was positive in all economies except Argentina and Uruguay, where it was significant and negative. This latter result is not uncommon and may be attributed to a number of factors: measurement errors in human capital (including quality composition and aggregation of human capital), varying patterns of technical change as well as structural change from labour- to capital-intensive production, qualitative deficiencies in educational systems, acceleration of enrolments and of human capital accumulation during the periods of productivity slowdown, and the types of channels through which human capital affects the economy (Dessus, 1999; De La Fuente, Domenech, 2006; Arcand, D'Hombres, 2007; Sunde, Vischer, 2015).

Table 1: Bounds test results (GDP per capita as dependent variable)

Country	Model 1				Model 2			
	F-test	ECM t-test	ARDL model	Result	F-test	ECM t-test	ARDL model	Result
Argentina	3.273	-3.038	(2,0) A RLT	NC	4.945	-5.195	(1,2,0,1) A URC	C
Bolivia	10.772	-5.247	(2,0) A RLT	C	5.085	-5.626	(2,2,0,0) A RC	C
Brazil	3.531	-3.602	(1,0) A RLT	NC	4.003	-4.419	(4,1,0,4) A URC	C
Chile	8.551	-5.301	(4,4) A RC	C	8.954	-7.274	(2,1,1,2) A RLT	C
Colombia	8.650	-3.071	(2,0) A RC	C	4.235	-8.851	(1,1,1,0) RC	C
Costa Rica	5.191	-4.095	(3,1) A RC	C	8.462	-6.144	(1,1,1,1) URC	C
Dominican Rep.	3.870	-4.614	(3,0) A RLT	NC	4.577	-4.327	(1,1,0,0) A RC	C
Ecuador	10.029	-6.390	(1,0) A RC	C	2.131	-3.479	(1,1,0,2) A RLT	NC
El Salvador	1.690	-2.793	(2,0) A RLT	NC	9.321	-6.654	(1,4,2,4) A URC	C
Guatemala	4.946	-4.016	(4,2) A RC	C	13.795	-8.407	(1,1,0,0) A RLT	C
Honduras	5.752	-4.277	(1,0) A RC	C	7.365	-6.575	(1,1,2,2) A RC	C
Mexico	6.563	-7.592	(2,1) A RC	C	5.871	-6.098	(4,4,2,1) A RLT	C
Nicaragua	5.951	-5.950	(2,2) A RC	C	3.973	-4.126	(4,1,1,1) F URC	C
Paraguay	2.604	-2.333	(4,3) F URC	NC	6.791	-5.653	(1,2,4,3) A URC	C
Peru	13.583	-4.247	(3,0) F RC	C	4.776	-5.147	(2,2,0,2) A RLT	C
Panama	11.634	-3.846	(4,4) F RLT	C	4.049	-4.465	(4,3,3,3) F URC	C
USA	8.107	-2.674	(2,2) A RC	C	4.272	-5.001	(3,0,0,0) F URC	C
Uruguay	6.158	-4.449	(2,1) A RC	C	3.529	-5.140	(1,2,0,0) A RC	C
Venezuela	20.582	-5.637	(2,1) A RC	C	3.488	-3.812	(2,1,1,1) A RLT	NC

Note: C and NC indicate the presence of or the absence of cointegration, A indicates selection of lags using Akaike Information Criterion, F represents selection of the fixed lags. ECT represents t-statistic of the error-correction term in PSS and ARDL model. F-stat represents F-statistic in PSS bounds test.

Specification	k = 1		k = 3	
	I(0)	I(1)	I(0)	I(1)
RC	3.96	4.53	3.16	4.19
URC	5.29	6.18	3.62	4.91
RLT	5.23	5.78	3.94	4.92

The critical values for the bounds test are taken from Narayan (2005) and presented for models with restricted constant and no trend, RC (Case II in Narayan's paper); unrestricted constant and no trend, URC (Case III); and restricted linear trend and unrestricted constant, RLT (Case IV). The critical values correspond to the 5% significance level, n=35, and k = 1 or k=3 (where n is the number of observations, and k is the number of regressors). I(0) and I(1) are lower and upper bounds respectively.

The negative sign of the ITT in Brazil, Mexico, and El Salvador is probably indicating that improvement in ToT does not translate to increase in GDP per capita. In the former two economies, the exports of primary resources (petroleum in Mexico, and minerals and agricultural commodities in Brazil) have negative effects on growth through rent seeking and corrosive effects on institutions (Baland, Francois, 2000; Isham et al., 2003), or through real exchange rate appreciation and decrease in non-resource exports ('Dutch Disease' channel, van Wijnbergen, 1984). These effects have been documented in Mexico by Usui (1997) and Farfan-Mares (2010); and in Brazil by Bresser-Pereira and Marconi (2009). In El Salvador, despite improving ITTs and increase in the volume and value of exports, the negative effects of ITTs on growth were likely attributed to the influx of foreign exchange from remittances as well as aid, leading to currency appreciation and decrease in exports competitiveness ('Dutch Disease driven by remittances and aid', Paus, 1995).

Table 2: ARDL and OLS estimates (GDP per capita as dependent variable, Model 1)

	ITT	Model	F-stat	ECT	JB	BG LM	R^2_{adj}	Het	ARCH	RESET
Argentina	**0.018**	OLS			1.675	0.127	0.295	0.156 W	0.934	0.414
	3.849				0.432					
Bolivia	**0.092**	(2,0) A RLT	10.772	-5.247	0.759	0.921	0.993	0.437 W	0.905	0.062
	2.146				0.684					
Brazil	**0.010**	OLS			1.456	0.266	0.318	0.361 W	0.984	0.367
	4.008				0.483					
Chile	**0.337**	(4,4) A RC	8.551	-5.301	0.796	0.117	0.997	0.550 BP	0.375	0.429
	4.745				0.672					
Colombia	**0.285**	(2,0) A RC	8.650	-3.071	1.491	0.751	0.995	0.333 W	0.620	0.998
	9.724				0.475					
Costa Rica	**0.515**	(3,1) A RC	5.191	-4.095	0.403	0.694	0.994	0.948 W	0.878	0.505
	1.752				0.817					
Dominican Rep.	**0.030**	OLS			1.970	0.662	0.214	0.446 W	0.312	0.108
	5.314				0.373					
Ecuador	**0.293**	(1,0) A RC	10.029	-6.390	0.206	0.392	0.977	0.949 W	0.226	0.093
	4.119				0.902					
El Salvador	0.036	OLS			2.829	0.924	0.431	0.232 W	0.907	0.348
	1.541				0.243					
Guatemala	**0.164**	(4,2) A RC	4.946	-4.016	1.715	0.363	0.992	0.689 BP	0.250	0.431
	13.544				0.424					
Honduras	**0.480**	(1,0) A RC	5.752	-4.277	2.348	0.669	0.974	HW	0.887	0.080
	4.801				0.309					
Mexico	**0.139**	(2,1) A RC	6.563	-7.592	1.656	0.786	0.982	0.147 W	0.345	0.024
	9.600				0.437					
Nicaragua	**0.383**	(2,2) A RC	5.951	-5.950	2.629	0.125	0.990	0.431 BP	0.379	0.577
	5.410				0.269					
Paraguay	**0.076**	OLS			4.469	0.943	0.299	0.841 W	0.811	0.147
	2.887				0.107					
Peru	**0.406**	(3,0) F RC	13.583	-4.247	1.602	0.454	0.981	0.256 W	0.919	0.054
	9.749				0.449					
Panama	**0.196**	(4,4) F RLT	11.634	-3.846	0.502	0.375	0.997	0.740 BP	0.260	0.093
	8.135				0.778					
USA	**0.331**	(2,2) A RC	8.107	-2.674	1.024	0.212	0.996	0.553 W	0.924	0.229
	11.585				0.599					
Uruguay	**0.473**	(2,1) A RC	6.158	-4.449	0.398	0.140	0.986	0.635 W	0.425	0.054
	13.781				0.820					
Venezuela	**0.101**	(2,1) A RC	20.582	-5.637	2.293	0.854	0.851	0.812 W	0.631	0.989
	4.682				0.318					

Note: RC and RLT represent ARDL model specifications; A and F indicate selection of lags using Akaike Information Criterion or the fixed lags; W and BP stand for White and Breusch Pagan LM tests of heteroscedasticity; HW indicates Huber-White robust standard errors; BG LM indicates Breusch-Godfrey serial correlation LM test; JB indicates Jarque-Bera test for normality.

ECT represents t-statistic of the error-correction term in PSS and ARDL model. F-stat represents F-statistic in PSS bounds test. Significant (at 10% level) and positive coefficients of ITT are highlighted in bold.

In the case of Chile, the presence of both positive and negative signs of the ITT coefficient (Models 1 and 2) attests to two concurrent developments: on one hand, copper exports continue to be important, constituting 9% of GDP in the late 1990s (Caballero, 2000: 13) and resulting in the positive sign coefficient; on the other, the ToT shocks are effectively cushioned and a decrease in ToT does not decrease GDP per capita and growth (negative sign coefficient). In Chile, the 'Dutch Disease' symptoms are effectively curtailed by taxing copper export revenues (Bresser-Pereira, 2010: 161), as well as by flexible exchange rate policies (Adler et al., 2017) and less pro-cyclical fiscal policies (Roch, 2017).

For the economies with no cointegration detected, the OLS model in the first differences was estimated (Tables 2 and 3). The OLS model was also estimated when cointegration was identified, but none of the coefficients were significant (Dominican Republic). In the case of El Salvador (Model 1), the lagged difference of the GDP per capita was added to address serial correlation problem. The coefficient of the differenced ITT was positive and significant in Brazil, Dominican Republic, and Paraguay (Model 1). In Model 2, the significant positive coefficients of the first difference of ITT were indicated in the Dominican Republic and Ecuador. The negative coefficient of the differenced gross secondary enrolment was shown for Venezuela.

Overall, when two models are compared and ARDL and OLS results are summarised, we conclude that in each economy except El Salvador there was at least one positive and significant coefficient of the ITT in levels or in the first difference; i.e., in these economies the growth of ITT had a positive effect on growth of GDP per capita (or, for OLS models in first differences, the change in the growth of ITT and growth change in GDP per capita). The 17 economies excluding El Salvador were considered in the next stage of the analysis.

Table 3: ARDL and OLS estimates (GDP per capita as dependent variable, Model 2)

	INV	HC/EN	ITT	Model	F-stat	ECT	JB	BG LM	R^2_{adj}	Het	ARCH	RESET
Argentina	0.353	-0.328	**0.119**	(1,2,0,1) A URC	4.945	-5.195	0.331	0.582	0.993	0.1033 BP	0.079	0.260
	7.715	-1.688	1.834				0.847					
Bolivia	0.179	0.008	**0.134**	(2,2,0,0) A RC	5.085	-5.626	1.998	0.403	0.996	0.2711 BP	0.908	0.650
	6.618	1.452	8.559				0.368					
Brazil	0.027	1.759	-0.276	(4,1,0,4) A URC	4.003	-4.419	0.995	0.253	0.992	0.1539 BP	0.224	0.010
	0.286	5.514	-4.943				0.608					
Chile	0.440	0.081	-0.163	(2,1,1,2) A RLT	8.954	-7.274	0.401	0.225	0.999	0.3767 BP	0.848	0.093
	6.356	0.920	-3.307				0.818					
Colombia	0.221	0.054	**0.127**	(1,1,1,0) A RC	4.235	-8.851	1.618	0.660	0.998	0.7447 BP	0.120	0.081
	6.470	0.424	2.409				0.445					
Costa Rica	0.262	0.379	-0.015	(1,1,1,1) A URC	8.462	-6.144	0.023	0.421	0.998	0.1856 BP	0.475	0.075
	6.618	11.774	-0.636				0.989					
Dominican Rep.	0.198	0.065	**0.016**	OLS			1.297	0.614	0.505	0.9101 W	0.505	0.440
	5.996	0.626	3.096				0.523					
Ecuador	0.193	0.073	**0.053**	OLS			1.082	0.635	0.526	0.6832 W	0.823	0.182
	5.776	0.969	2.230				0.582					
El Salvador	0.601	0.326	-0.352	(1,4,2,4) A URC	9.321	-6.654	1.137	0.288	0.998	0.2789 BP	0.531	0.168
	3.075	1.919	-2.150				0.566					
Guatemala	0.194	0.032	-0.088	(1,1,0,0) A RLT	13.795	-8.407	0.021	0.141	0.993	0.5542	0.785	0.120
	3.069	0.256	-0.938				0.989					
Honduras	0.057	0.362	0.052	(1,1,2,2) A RC	7.365	-6.575	2.093	0.548	0.988	0.1766 BP	0.788	0.218
	1.356	6.302	0.668				0.351					
Mexico	0.373	0.384	-0.068	(4,4,2,1) A RLT	5.871	-6.098	0.043	0.152	0.996	0.4339 BP	0.661	0.327
	5.722	4.483	-2.461				0.978					
Nicaragua	0.399	-0.138	0.144	(4,1,1,1) A URC	3.973	-4.126	0.994	0.119	0.995	0.9485	0.385	0.363
	3.139	-1.075	1.450				0.608					
Paraguay	0.652	0.074	0.064	(1,2,4,3) A URC	6.791	-5.653	0.196	0.899	0.970	0.1645 BP	0.483	0.352
	7.145	0.674	0.660				0.907					

Peru	0.150	0.089	**0.366**	(2,2,0,2) A RLT	4.776	-5.147	0.856	0.331	0.993	0.1407 BP	0.787	0.116
	1.844	0.254	5.568				0.652					
Panama	0.053	1.717	**0.164**	(4,3,3,3) F URC	4.049	-4.465	1.058	0.219	0.996	0.8192 BP	0.352	0.050
	0.689	1.864	2.855				0.589					
USA	0.337	0.035	**0.131**	(3,0,0,0) F URC	4.272	-5.001	0.371	0.549	0.998	0.2723 W	0.748	0.183
	10.624	0.198	5.529				0.831					
Uruguay	0.038	-0.534	**0.575**	(1,2,0,0) A RC	3.529	-5.140	0.264	0.632	0.993	0.2545 W	0.169	0.647
	0.406	-2.280	4.087				0.876					
Venezuela	0.268	-0.178	0.026	OLS			0.427	0.307	0.822	0.4463 W	0.967	0.442
	12.186	-1.228	1.289				0.808					

Note: As in Table 2. RC, URC and RLT represent ARDL model specifications.

The results of the time series analysis of the GDP per capita gap are presented in Table 4. The linear trend model was estimated with the relevant dummy variables (representing structural breaks in the data), as well as up to three AR terms to correct serial correlation. Significant positive trends were identified for Chile and the Dominican Republic, while significant negative trends were identified for Argentina, Brazil, Guatemala, Mexico, and Venezuela. The results of the ADF regression model suggest that positive deterministic trends in the GDP per capita gap were present in Bolivia, Chile, Costa Rica, Dominican Republic, Honduras, Nicaragua, and Uruguay. Mean reversion was indicated in Argentina, Guatemala, Mexico, and Venezuela. Random walk with drift was shown in Colombia, Ecuador, and Panama. Random walk without drift was present in Brazil, Paraguay, and Peru. According to the Lee-Strazicich LM test with one or two breaks, trend stationarity with two breaks was identified in Argentina, Brazil, Chile, Ecuador, Honduras, Peru, Uruguay, and Venezuela, and trend stationarity with a single break was found in Bolivia, Colombia, and Panama. Unit root with break(s) was present in Costa Rica, the Dominican Republic, Mexico, and Paraguay. No break coefficients were significant in Guatemala and Honduras, and hence the Lee-Strazicich LM test was considered inapplicable in these cases. In addition, the trend model with quadratic terms (estimated as part of the robustness check, but not reported to conserve space) suggest that non-linearities were present in all cases except Chile and Uruguay, where the signs of the trend and quadratic trend terms were same (i.e., there was a continuous increase in the GDP per capita gap series). These results are in line with the findings of Benavides et al. (2014: 271), who establishes GDP per capita divergence between the Latin American countries and the USA in 1951-1990 (principally due to the debt crisis in the 1980s and the oil shocks of the 1970s), but convergence in 1990-2010.

The conclusion, based on the four tests, is that the GDP per capita gap narrows down in those cases when the linear trend, ADF, and Lee-Strazicich LM tests (or linear trend and one of the tests) indicate trend stationarity with or without breaks, and when the sign of the trend coefficient is positive (i.e., GDP per capita of the country as a percentage of US GDP per capita increases). The narrowing down of GDP per capita is shown in Chile and the Dominican Republic. The widening of the GDP per capita gap is indicated in Argentina, Brazil, and Venezuela. Bolivia, Honduras and Uruguay are considered special cases: despite the absence of significant trend coefficient, both ADF and Lee-Strazicich LM tests point to trend stationarity (in addition, in the case of Uruguay, the trend model with quadratic terms indicates linearity). In all other cases, the four tests deliver contradictory results and no firm conclusion is possible regarding the increase or reduction of the GDP per capita gap.

Overall, the results of the above tests suggest that there is a limited evidence of convergence of GDP per capita in Latin American economies with the US GDP per capita. This is in line with previous studies that consider stochastic convergence in the Americas: Maeso-Fernandez (2003) who do not identify the narrowing down of the gap, attributing this development to the debt crisis and the oil crisis in the late 1970s; Benavides et al. (2012), who likewise do not discover (based on unit root tests and panel cointegration) any evidence of convergence during the 1970-2010 period; Cermeño and Llamosas (2007), who (using the Bernard-Durlauf type cointegration test) find weak evidence of convergence in the Chile-USA case during the 1950-2010 period; and Ranjbar et al. (2016), who (using a panel of unit root tests) point to convergence tendencies in Chile-USA and the Dominican Republic-USA pairs in 1969-2011.

As a next step, the cointegration between ITT and GDP per capita gap is examined using PSS bounds test and the elasticities are estimated using ARDL or OLS models (both bivariate Model 1 and multivariate Model 2). The respective results are indicated in Tables 5 and 6. It is shown that changes in ITT are important for explaining the GDP per capita gap in Bolivia and Uruguay (in both Models 1 and 2). The ITT coefficients are significant in Chile in Model 1, and in Honduras and Brazil in Model 2. In all other cases (Argentina, the Dominican Republic, and Venezuela), there is no significant relationship between ITT and GDP per capita gap.

Table 4: Trend model and unit root tests results (GDP per capita gap)

Country	Trend	AR	Breaks	ADF regression β	ψ	Model	LM test		Breaks	Model
Argentina	-0.008	AR(2)		0.000	-0.182		-6.343	7	1990	TSB
	-1.790			-0.058	-2.172				2000	
Bolivia	-0.007	AR(1)		0.001	-0.095	DT	-5.282	8	1990	TSB
	-0.964			1.833	-2.516					
Brazil	-0.008	AR(1)		0.001	-0.073		-5.683	3	1998	TSB
	-1.760			0.644	-1.048				2006	
Chile	0.015	AR(1)		0.007	-0.335	DT	-6.324	8	1994	TSB
	2.584			5.239	-5.057				1999	
Colombia	0.002	AR(1)	1999	0.001	-0.049	RWD	-6.676	8	1997	TSB
	0.383			2.413	-1.064					
Costa Rica	0.001	AR(1)		0.002	-0.156	DT	-5.410	6	1990	URB
	0.261			3.319	-2.838				2004	
Dominican Rep.	0.010	AR(2)		0.004	-0.144	DT	-4.706	1	1992	URB
	1.817			5.491	-3.211				2006	
Ecuador	-0.006	AR(1)		0.001	-0.041	RWD	-6.985	7	1997	TSB
	-1.014			1.874	-0.850				2009	
Guatemala	-0.011	AR(2)		0.000	-0.130		-2.848	5	1990	NA
	-3.074			-0.475	-3.540					
Honduras	-0.007	AR(3)	1999	0.001	-0.101	DT	-6.570	7	1992	TSB
	-1.266			2.000	-2.317				2012	
Mexico	-0.010	AR(1)	1995	-0.001	-0.198		-5.269	7	1996	URB
	-2.295			-1.061	-3.458				2001	
Nicaragua	-0.015	AR(1)	1988-9	0.001	-0.040	DT	-2.938	6	1992	NA
	-1.569			2.009	-1.876					
Paraguay	-0.004	AR(1)		0.002	-0.054		-4.109	8	1997	URB
	-0.637			1.535	-0.666					
Peru	-0.004	AR(1)	1983	0.001	0.000		-9.678	8	1991	TSB
	0.748		1989	0.727	0.011				1996	
Panama	0.010	AR(1)	1989	0.003	-0.059	RWD	-5.715	1	2002	TSB
	1.140			3.816	-1.441					
Uruguay	0.002	AR(1)		0.001	-0.152	DT	-7.445	5	1990	TSB
	0.301			1.774	-2.665				2000	
Venezuela	-0.018	AR(1)		-0.002	-0.200		-6.033	7	1991	TSB
	-2.886			-1.054	-2.115				2004	

Note: TSB and URB indicate trend-stationarity with break and unit root with break, NA stands for cases, when no breaks are identified by Lee-Strazicich LM test. DT, ST, MR and RWD represent deterministic trend, stochastic trend, mean reversion and random walk with drift.

In particular, in those economies, where cointegration between ITT and GDP per capita gap is identified, the conventional view of the Prebisch-Singer hypothesis (economic divergence due to deterioration in the

ToT) is not supported (with the exception of Bolivia, where some support was found in the earlier period). Brazil and Honduras exhibit economic divergence: GDP per capita as a percentage of the US GDP per capita declined. However, the sign of the ITT coefficient is negative (Model 2); i.e., an increase in the ITT came together with a decrease in the countries' GDP per capita as a percentage of the US GDP per capita. The ITTs and GDP per capita gap thus move asynchronous and the improvement in the ITTs accompanies economic divergence, the latter being likely driven by factors unrelated to ToT.

In Bolivia, GDP per capita as a percentage of the US GDP per capita likewise exhibits negative trends. The effect of ITTs on GDP per capita gap is positive, suggesting that the decline in the GDP per capita gap is explained by ITT deterioration. This effect, however, is observed only in the earlier parts of the sample (1980-90s), while in the 2000s both ITT and GDP per capita (as a percentage of the US GDP per capita) were improving. The results would therefore vary if sub-periods are considered; implying that the conclusion that ITT drove the divergence process during the 1980-2014 period would be unwarranted. In Chile and Uruguay, GDP per capita as a percentage of US GDP increased, and the ITT coefficient is positive, convergence processes assisted by the improvement in the ITT. The relevant patterns in GDP per capita gap, ITT, NBTT, and export volume are presented in Figure 1.

Table 5: ARDL and OLS estimates (GDP per capita gap as dependent variable, Model 1)

	ITT	Model	F-stat	ECT	JB	BG LM	R^2_{adj}	Het	ARCH	RESET
Argentina	-0.031	(2,4) A RC	4.208	-3.704	1.199	0.105	0.785	0.404 BP	0.863	0.841
	-0.429				0.549					
Bolivia	**0.228**	(4,1) A RLT	6.116	-4.466	2.385	0.793	0.936	0.118 BP	0.522	0.950
	4.718				0.303					
Brazil	0.147	(1,0) A RC	3.962	-3.441	1.101	0.286	0.908	HW	0.465	0.243
	0.686				0.577					
Chile	**0.204**	(4,3) A RC	4.278	-3.742	0.41	0.159	0.990	0.423 BP	0.092	0.328
	6.398				0.815					
Dominican Rep.	0.071	(4,3) F RLT	6.298	-5.953	0.158	0.118	0.978	0.384 BP	0.964	0.076
	0.379				0.924					
Honduras	0.129	(1,1) A RC	18.121	-9.050	0.388	0.772	0.979	0.749 W	0.213	0.444
	1.316				0.824					
Uruguay	**0.197**	(2,1) A RC	3.947	-3.562	1.511	0.436	0.931	0.699 W	0.372	0.649
	1.826				0.47					
Venezuela	0.000	OLS			1.261	0.206	0.270	0.637 W	0.980	0.818
	0.274				0.532					

Note: As in Tables 1-3.

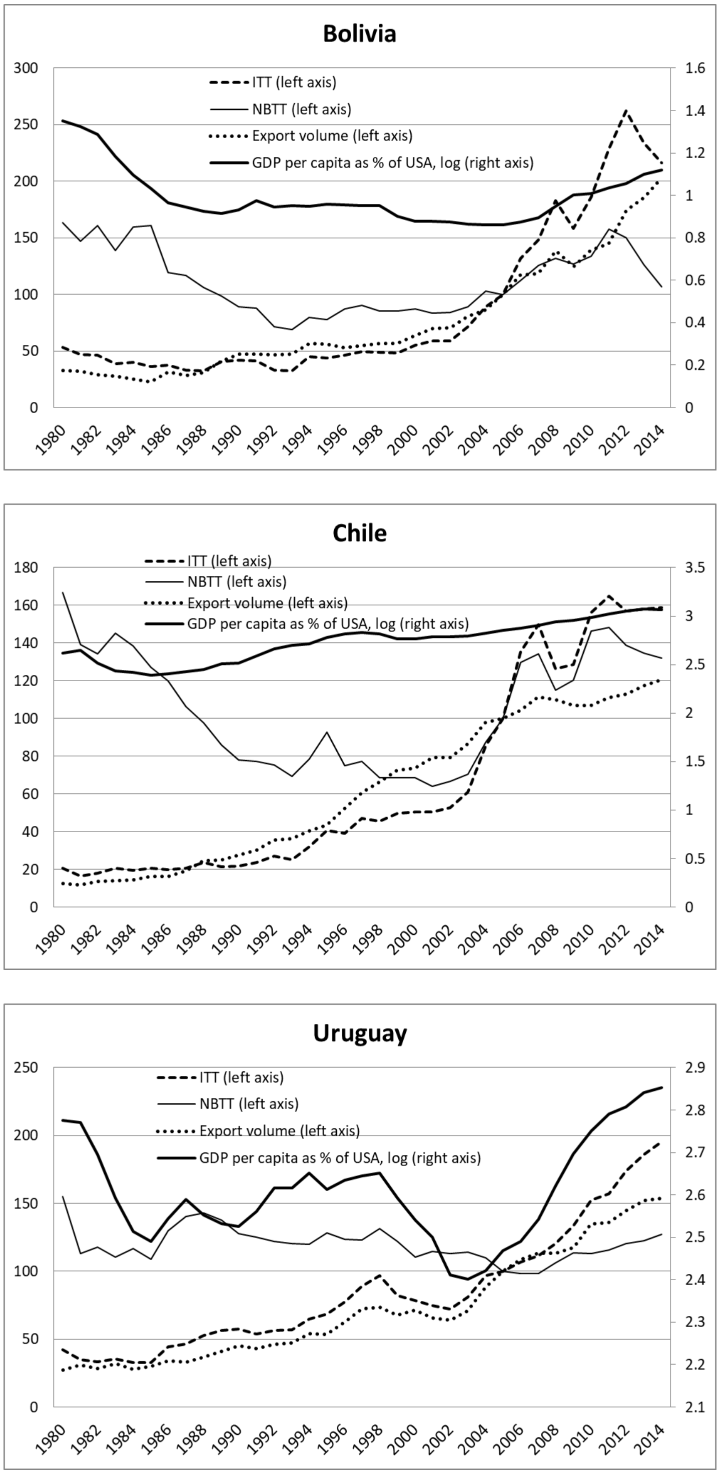
Table 6: ARDL and OLS estimates (GDP per capita gap as dependent variable, Model 2)

	INV	HC/EN	ITT	Model	F-stat	ECT	JB	BG LM	R^2_{adj}	Het	ARCH	RESET
Argentina	0.302	-1.599	0.271	(1,2,0,1) A URC	3.772	-5.831	1.144	0.485	0.972	0.455 BP	0.273	0.847
	2.587	-3.354	1.557				0.564					
Bolivia	0.219	0.010	**0.267**	(2,0,0,0) A RLT	4.754	-4.299	0.128	0.116	0.961	0.211 W	0.741	0.254
	2.510	0.749	5.422				0.938					
Brazil	-0.045	2.064	-0.561	(4,1,0,2) A RC	8.049	-5.839	0.569	0.572	0.980	0.756 BP	0.116	0.317
	-0.355	4.646	-7.051				0.753					
Chile	0.317	1.466	-0.243	(3,1,4,0) A RC	3.580	-5.011	0.500	0.547	0.996	0.418 BP	0.421	0.669
	3.080	1.083	-1.152				0.778					
Dominican Rep.	0.001	0.001	-0.001	OLS			2.416	0.950	0.431	0.494 W	0.119	0.874
	2.981	0.711	-1.467				0.299					
Honduras	0.166	0.204	-0.249	(1,1,1,1) F URC	16.497	-9.600	0.874	0.332	0.983	0.206 BP	0.547	0.499
	1.588	1.636	-1.857				0.646					
Uruguay	0.132	-1.522	**0.453**	(4,1) F RC	5.077	-5.309	0.719	0.140	0.973	0.297 BP	0.391	0.095
	1.252	-4.787	2.788				0.698					
Venezuela	0.003	-0.005	0.000	OLS			1.340	0.427	0.647	0.481 W	0.676	0.018
	8.333	-2.429	-0.607				0.512					

Table 7: ARDL and OLS estimates (NBTT, export volume, and ITT gap as independent variables)

	Chile					Uruguay				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
INV	0.340	0.233				0.033	0.045			
	15.141	2.599				8.642	0.349			
HC	-0.340	0.130				-0.025	-2.967			
	-3.361	0.678				-1.905	-2.300			
NBTT	0.044		-0.087			0.001		0.014		
	1.611		-1.536			0.189		0.877		
EXP		-0.008		**0.290**			0.021		**0.022**	
		-0.116		11.801			0.103		2.686	
ITTGAP					**1.485**					**0.845**
					3.772					2.896
JB	1.808	0.415	0.460	0.351	0.291	0.964	1.452	3.374	1.670	3.583
	0.405	0.813	0.794	0.839	0.865	0.618	0.484	0.185	0.434	0.167
Model	(1,1,0,0) A RC	(3,3,3,1) A RC	(2,2) F RLT	(2,0) A RC	(4,3) F RC	OLS	(4,4,4,3) A RLT	OLS	OLS	OLS
F-statistic	12.077	4.181	9.482	8.622	4.689		15.688			
ECT	-8.174	-5.055	-5.535	-5.017	-3.917		-10.342			
BG LM	0.387	0.461	0.182	0.103	0.196	0.381	0.211	0.434	0.714	0.727
R^2_{adj}	0.996	0.996	0.985	0.982	0.990	0.753	0.992	0.407	0.526	0.545
Het	0.120 W	0.717 BP	0.231 W	HW	0.304 BP	0.945 W	0.699 BP	0.663 W	0.405 W	0.622 W
ARCH	0.877	0.792	0.361	0.374	0.154	0.315	0.269	0.883	0.253	0.153
RESET	0.279	0.130	0.728	0.147	0.373	0.038	0.247	0.961	0.616	0.377

Figure 1: Dynamics of NBTT, export volume, ITT gap, and GDP per capita gap in selected economies



For the two countries, where ITT played positive role in bringing in economic convergence (Chile and Uruguay), we examine the effect of ITT constituent parts on GDP per capita gap, and also consider whether reduction in the GDP per capita gap was driven by the reduction in the ITT gap. Based on the results from bivariate and multivariate models, Table 7 shows that reduction of GDP per capita gap (increase in countries' GDP per capita as a percentage of US GDP per capita) was not due to the improvement in NBTT, but due to the growth of the volume index of exports. This is consistent with the visual representation of the time series in Figure 1. The export volume exhibits continuous increase in both economies, while NBTTs were discontinuous. Specifically, an upward trend was pronounced in the 2000s. This development may be attributed to growing trade between Latin American economies and China, in turn improving the ToT of the former. Such improvement was particularly pronounced for economies exporting primary and agricultural products, while in economies with a strong manufacturing sector (Mexico and Argentina) the positive effects were limited due to more intense competition with China's exports in international markets, in particular in the US market (Ros, 2013). This paper's results, while covering a longer period, likely confirm this hypothesis: both Chile and Uruguay are primary exporters (albeit to a smaller extent than in 1950-70s), while the size of their basic manufacturing production and exports has reduced over recent decades (see Agosin, 1999, for a discussion of the Chilean diversification process).

Both Chile and Uruguay benefited from their status of small open economies with growing exports (the major factor behind ITT improvement, despite fluctuating NBTT). In Uruguay, NBTT was stable around the mean for most of the period, with minor improvement in the mid-1990s. However, the growth in export volume was continuous and accelerating from the early 2000s and the economy benefited substantially from Mercosur, as well as from intra-industry trade with Argentina in the earlier years. The further diversification of the exports (textiles, manufactured leather, electrical machinery, and transport equipment), the growth of the services sector, as well as modernization and technological upgrading of agriculture (and foreign investment therein) also had positive effects on ITTs and the convergence process (Bertola, 2008; Van Rompaey, 2007; Sandonato, Willebald, 2018; Bertola et al., 2014). The likelihood of the onset of income convergence between Uruguay and the developed economies in the 2000s is mentioned by Paolino et al. (2014).

In Chile, NBTT deteriorated until the early 2000s, while export volume grew continuously over the whole period. ITT therefore experienced moderate growth until 2001, and accelerated growth afterwards. As argued by Agosin (1999), Chile was an epitome of an economy with 'export-led growth' from the early 1980s. While Chile's endowment and exports of copper continue to be substantial in absolute terms (Desormeaux et al., 2009), and while the large windfall gains from an increase in copper prices were experienced in the 2000s (Adler, Magud, 2013), the diversification of exports into higher value added products (such as seafood, wood pulp, wine, automotive parts) has been taking place. The process was greatly assisted by sustainable macroeconomic policies, competitive and floating exchange rates, trade policies, such as simplified drawback of duties for non-traditional exports, export subsidies, state-assisted export marketing, and debt conversion plans to stimulate export-oriented production, as well as polices to enhance technological capabilities and improve the quality of the labour force (Ffrench-Davis, 2002; Desormeaux et al., 2009; Agosin, 1999).

In addition, the reduction of the ITT gap (the improvement of the countries' ITTs relative to the ITT of the US, the developed economy) played a positive role in fostering economic convergence in both economies, as attested by the positive sign and significance of the coefficient representing the ratio of the respective Latin American economy ITT index to US ITT index.

Conclusion

Overall, when looking across a sample of 18 Latin American economies, the paper's findings yield little support to PST. Firstly, in contrast to predictions by Prebisch and Singer and in line with the evidence provided by Ekholm and Sodersten (2002), the ITTs had a positive effect on GDP per capita in all but a few economies, with both variables increasing during the 1980-2014 period. Secondly, the stochastic convergence in GDP per capita between Latin American countries and the USA was limited over the period, witnessed in Chile, Dominican Republic and Uruguay, the economies that according to the UN data experienced GDP per capita growth rates above the regional average in 1980-2014 (growth factors of 2.81, 2.45, and 1.92, respectively).[ii] Thirdly, in two economies where statistically significant divergence was identified (Brazil and Honduras) and where PST could hold, the movement in ITTs did not explain the divergence process. In Bolivia, the divergence was present, explained by the movement in the ITTs; however, such regularity was witnessed only in the earlier years, while in the 2000s, the ITTs and GDP per capita (as a percentage of the US GDP per capita) were both on rise. In Chile and Uruguay, the improvement in ITTs contributed to economic convergence with the USA; however, given that both economies have been undergoing broad based economic policy and structural transformations (economic and trade liberalization for Chile, regional economic integration for Uruguay), other salient factors could have been instrumental in the convergence process. Fourthly, both economies exhibited swings in NBTT over the period, and growth in ITTs was driven by increase in the value of exports. In both economies, ITTs grew strong not only in absolute, but also in a relative sense: the gap between ITT index in Chile and Uruguay on one hand and the ITT index in the USA on the other became smaller. Following Singer (1999: 912), we note that ITT increase that offsets falling or stable NBTT is not a genuinely positive development: economies (specifically those that exhibited ITT increase but also divergence) were mobilizing 'greater resources for the increase in export volume. These increased resources would have to be diverted from domestic consumption or investment'.

This study probably had a number of limitations that should be addressed in future empirical work.

Firstly, ITT (as opposed to NBTT) was used as a better indicator of export capacity and export-driven growth, accounting for changes in both unit values and export quantities. Despite this, ITT did not consider the effects of productivity advances (and decline in prices and costs) of exported and imported goods (the effect captured by single and double factorial ToT).

Secondly, in a related vein, a more in-depth theoretical analysis of the driving forces of ToT is needed, in line with previous work by Araujo (2016) and Mollick et al. (2008): specifically, a more detailed analysis of price determination in developed and developing economies; structural change and modified composition of exports; as well as complex interplay of sectoral and economy-wide productivity, technological advance (and its spillovers), and export demand conditions. This would supposedly help to explain a number of country-specific developments identified in this paper (e.g., convergence driven by ITT improvement in Uruguay, but not in Argentina, when both economies have strong economic relationships; or the absence of ITT effects on growth in El Salvador or on GDP per capita gap in Venezuela). Likewise, it appears prima facie that ITT has improved in a number of economies without NBTT improvement: further analysis of sluggish NBTTs may be needed (e.g., in terms of specialization in export sectors with unfavourable price dynamics, or inability to improve quality and climb the product ladder).

Thirdly, the paper considered the 1980-2015 period, which included a number of developments propitious for export growth and improvement in ITTs (the shift from import substitution and inward-looking development towards export-push development, national currency devaluations, the trade liberalization in GATT/WTO, regional trade liberalization, as well as exceptionally high commodity prices in the 2000s). It remains to be seen whether these propitious factors will exercise a positive effect on ITTs in the future.

Finally, during the study period (with the exception of most recent years), the USA remained the major trading partner of the Latin America. The role of China as a trading partner will undoubtedly rise in the decades to come. It would be therefore instructive to examine PSH in a China-Latin America setting, such as a situation when China export manufactured goods to Latin America, while the latter exports primary products to China.

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[i] While omitted-variable problem may be typical to bivariate cointegration, its use may be justified by three factors. Firstly, the comparison of the evidence from the two alternative formulations will be instrumental in ensuring the robustness of results. Secondly, the theoretical arguments against using aggregate production functions are advanced: it is argued that aggregate production functions cannot be derived in general (Cambridge Capital Theory controversies); that many assumptions behind the approach are unjustified, such as aggregation of heterogeneous labour and capital, the process of re-assigning labour, capital and output to firms to maximize efficiency (particularly in the short-run); that the use of the value data instead of physical data and accounting identity basis give rise to spurious significance; among others (Fisher, 1993; Felipe, McCombie, 2010). Thirdly, bivariate cointegration would be the only realistic approach to estimate the effects of the converging ITTs on the GDP per capita convergence for a pair of economies (Latin American economy and the US).

[ii] The estimates are based on GDP per capita at constant 2010 prices in US dollars (UN National Accounts Main Aggregates Database (https://unstats.un.org/unsd/snaama/dnlList.asp).