

INNOVATION-FUELLED, SUSTAINABLE, INCLUSIVE GROWTH

Working Paper

Industrial and Technological Policy (ITP) and Divergence in Comparative Perspective: Latin America and Asia

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Abstract

This report revisits the industrial and technological policy of two Latin American Economies (Argentina and Brazil) and two Asian economies (China and Korea) and discusses their implications for long run growth. To link the role of these policies to growth in a more rigorous way, it develops a North-South technology gap model which combines the Schumpeterian approach to technical and structural change with the Keynesian perspective on effective demand and the Balance-of-Payments (BOP) constraint. It is argued that differences in these policies drive the evolution of relative productivity and relative wage, giving rise to different paths of convergence or divergence between South and North. Formally, differences in policies are reflected in different values of the structural parameters of the model. Convergence in Asia and divergence in Latin America have been extensively debated topics in the literature on comparative economic development. This literature highlights the crucial role of the industrial and technological policy (ITP). It is argued that the results of the technology gap model are consistent with the findings of this literature and helps understand the forces behind convergence and divergence.

1 Introduction

Industrial and scientific & technological policies are crucial for long run growth. The critical challenge for developing economies is to build a National System of Innovation that allows for catching up in technological capabilities and for redefining the patterns of specialization. In Latin America, these policies have been almost absent since the mid-eighties. The impact of the debt crisis brought about a major fiscal crisis that severely compromised public policy and public investment. This weakened the mechanisms and tools that gave support to science and technology in the region. In the 1990s, most Latin American countries adhered to a wave of neoliberal reforms which sought to reduce state intervention and regulations in the markets. It was then considered that the best

industrial policy is not having industrial policy at all. The lack of resources for science and technology was compounded by trade and financial liberalization, leading to a situation in which tradables lost competitiveness. The Latin American countries began to lose the manufacturing sector they had built in the previous thirty years. The commodity boom that the region experienced from 2004 further weakened diversification. The new science & technology policy overlapped with the old one as in "geological strata" and was highly ineffectual. Inversely, Countries like Korea and China sustained active industrial and technological policies throughout the post-war period. Such policies were combined with a management of the RER that emphasized diversification and international competitiveness.

The different paths followed by the two regions produced very different outcomes, as seen in the two graphs below. Latin America clearly falls behind Asia in terms of R&D, particularly private R&D. Ina addition, Latin America received much less foreign direct investment in R&D activities than the Asian countries. This evidence is an expression of the weaknesses of the policies for enhancing learning of Latin America as compared to Asia (more details on these policies can be found in section 3).



Rate of growth of the share of GDP devoted to research and development (R&D), 2004-2013

Expenditure on research and development (R&D) by financing sector, 2012 (Percentages)



Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of information from United Nations Educational, Scientific and Cultural Organization (UNESCO); Organization for Economic Cooperation and Development (OECD) and Ibero-American Network of Science and Technology Indicators (RICYT).

Foreign direct investment (FDI) received in



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Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of Financial Times, *fDi Markets*, and United Nations Conference on Trade and Development (UNCTAD), *World Investment Report 2016*.

^a The figures refer to amounts announced for new investment projects or the expansion of existing ones.

Key: United States; France, Germany and United Kingdom; Japan, Rep. of Korea and Singapore; Canada, Australia and New Zealand; Latin America and the Caribbean.

The model is built on two different traditions of growth models. From one hand, technology gap models explain long-run differences in growth rates across countries based on leads and lags in innovation and technical change. These models are of Schumpeterian inspiration and already have a long lineage in growth and trade theory¹. They are especially useful to study an international economy in which competition is increasingly driven by innovation, and in which the North-South technological divide widens. On the other hand, Keynesian growth models focus on the role of effective demand, whose expansion in open economies is subject to the Balance-of-Payments constraint, especially in developing countries². These models highlight the crucial link that exists between the pattern of specialization, external unbalances and effective demand.

Several authors have sought to build bridges between these two traditions³. Cimoli (1988), Fagerberg (1988), Dosi (1990), Verspagen (1993) and Cimoli and Porcile (2013), among others, are examples of works in which the technology gap determines the growth of exports and the balance-of-payments constraint. This paper takes these models as a point of departure and extends their findings in three ways.

First, it develops a North-South model with a focus on the interaction between supply-side and demand-side variables. At variance with the technology gap models cited above, the model presented in this paper sets forth a dynamic system with three state variables —the technology gap, relative wages and the pattern of specialization. Working with a higher dimension system allows us to analyze a broader scope of growth trajectories, which is the second contribution of the paper. Different combinations of the parameters of the model and initial conditions (which represent different institutional and technological settings) give rise to different growth paths. The model is then used to discuss the impact of different types of policies—in particular industrial policies that foster investments in R&D and diversification—on growth and convergence. Policy changes are associated to changes in the parameters, which trigger a transition towards a new equilibrium or towards an unstable pattern of divergence or convergence. Finally, the predicted patterns of structural change that emerges out of these changes are compared to the actual trajectories generated by policy shocks in specific historical events. The case that helps illustrate the model is the abandonment of industrial policy in Argentina in the mid-seventies and in Brazil in the 1980s as opposed to the continuity of the industrialization policy in Korea.

¹ A pioneer contribution is Posner (1961).

² For a review of BOP-constrained growth models see Thirlwall (2011) and Blecker (2013).

³ Dosi et al (2007) have argued in favor of "Keynes meets Schumpeter" models, in which the emphasis on technical change is complemented by the analysis of the behavior of aggregate demand in the economy.

Why do we choose these cases to illustrate the usefulness of the model? The divergent patterns observed in Asia and Latin America is a problem that has attracted a lot of attention from researchers and policy makers. There is a large body of literature comparing these two regions that begins in the early seventies and continues today⁴. Most contributions to the analysis of the growth miracle in Asia highlight the crucial role that industrial policy played in catching up (a classical work is Amsden, 1989; see also Rodrik, 1997 and more recently Chang, 2006 and Wade, 2012). In the same vein, the literature on Latin America has stressed the failure of industrial policy as a major determinant of the region's lagging behind after 1980 (Bertola and Ocmapo, French-Davis, 2005; Peres, 2011; Schneider, 2015; Khan, 2000). The analytical framework of this paper can help explain the economic dynamics which is behind the patterns identified by these studies on industrial policy and economic growth.

Historical illustrations are not intended to represent rigorous empirical tests of the model, but to show that it can be useful understand the different paths described in the literature. They are also intended to highlight the importance of acknowledging—from the very beginning—the strong asymmetries in capabilities and institutions that exist in the real world, as well as the crucial role of policy decisions. These asymmetries and policies constrain and inform the evolution of the economic system.

The paper consists of three sections besides the introduction and the concluding remarks. Section 2 presents a formal technology gap model which allows for analyzing the evolution and equilibrium positions in the long run of four variables—the technology gap, relative productivity, the production structure, and relative South-North growth. Section 3 applies the model to the analysis of divergent trends in productivity and structural change in Korea, Argentina and Brazil between 1970 and 2013, using different indicators of the technological intensity of the production structure.

2 Technological asymmetries and the macrodynamics of growth and specialization

We start with a conventional technology gap model with a very large number of goods. These goods are produced combining homogenous labor and technology. The variables of the model and their interrelations are presented in figure 1. Technical details are presented in the following subsections.

There is an initial asymmetry in technological capabilities (technology gap) between the advanced economy (North or "rest of the world") and the laggard economy (South), as shown in box **A** of figure (1), defined as $G = \ln(T_R/T_S)$, where T_R represents technological capabilities in the

⁴ Early works see Little et al, Haggard, Brisard et al)

North and T_s technological capabilities in the South. Tj, with j = R,S is an aggregate (countryspecific) variable that captures the effective ability of economic actors to advance knowledge and apply it to production. G is constrained to be positive (i.e., $T_R > T_s$) and evolves as a function of the efforts of the North to innovate and the efforts of the South for absorbing, adapting and improving foreign technology (Fagerberg, 1995; Fagerberg et al, 2001; Fagerberg and Verspagen, 2002). Such efforts are embedded in National Systems of Innovation, a set of institutions that structure interactions among heterogeneous actors (firms, universities, research agencies) to spur innovation and the diffusion of technology⁵.





Asymmetries in technological capabilities give rise to asymmetries in labor productivity, defined as $\pi_i = (Y_i/L_i)$, where Y_i are units of the good *i* and L_i is labor employed in the production of *i* (box **B**). Goods differ in terms of their technological intensity. It is assumed that he higher the technological intensity of the good, the higher the impact of technological capabilities on labor productivity. This implies that the difference in labor productivity between North and South increases with the technological intensity of the good.

⁵ For a discussion of the concept of National System of Innovation, see Freeman (1995) and Metcalfe (2001).

The combination of relative productivity with relative wage determines relative unitary costs and hence the set of goods in which the South is competitive. This set of goods defines the pattern of specialization of the South (box C; see also below the discussion of the variable N). The South specializes in goods for which unitary costs are lower than in the North, which are those less technology-intensive (Castellacci, 2002).

In open economies, exports and imports must grow at similar rates. Countries that are more technologically advanced can compete and increase their market shares in sectors whose demand (external and domestic) grows faster. This implies that they have a higher income elasticity of exports with respect to the income elasticity of imports than technological laggards. As a result, they can grow faster without experiencing a Balance-of-Payments (BOP) constraint. This idea is summarized in Thirlwall's Law: growth is BOP constrained in countries that do not issue the international reserve currency, and their relative rate of growth equals the income elasticity ratio in the long run (the income elasticity ratio in box \mathbf{D}).

There is empirical evidence of a positive association between the technological intensity of the production structure and the income elasticity ratio (see for instance Araujo and Lima, 2007; Gouvea and Lima, 2010; Cimoli et al, 2010; Pacheco-López and Thirlwall, 2006; ECLAC, 2007, 2012; Abdon et al, 2010; Storm and Naastepad, 2015). There are exceptions to this general rule, of which good luck in the commodity lottery is the most apparent. However—as the recent collapse of commodity prices suggests after the so-called "super-cycle of the commodities"—, the dynamism of exports mostly reflects and evolves with technological capabilities.

Positive and negative feedbacks emerge from structural change and technical change. Higher relative growth gives rise to a positive feedback on learning, arising from increasing returns à la Kaldor-Verdoorn (represented by the arrow from Box **E** to Box **F**). Learning by doing increases with the rate of growth, and therefore it has a negative effect on the North-South technology gap. On the other hand, growth increases the demand for labor (arrow from Box **E** to Box **G**) which, given the supply of labor (Box **H**), raises the relative South-North wage (Box **J**; see also subsection 2.3).

In sum: a reduction of the North-South technology gap allows the developing economy to increase the technological intensity of its pattern of specialization, which in turn raises the income elasticity ratio, and hence the equilibrium rate of economic growth, which fosters learning by doing and a rise in the South-North relative wage. Virtuous or vicious cumulative processes may emerge from this dynamics.

2.1 The (Schumpeterian) supply side

This and next subsections formalizes the dynamic system suggested in figure 1. The evolution of *G* is driven by two variables, the technology gap itself and increasing returns to the relative South-North income growth, $y = (y_s / y_R)^6$, where the subscript *S* indicates country South and the subscript *R* indicates country North and $y_j = \hat{Y} = (\dot{Y}_j / Y_j)$ is the rate of growth of country j = R, *S*.

$$\dot{G} = \mathcal{G}(G, y(N)), \qquad \qquad \mathcal{G}_G < 0, \ \mathcal{G}_y < 0 \ \text{and} \ y_N > 0 \tag{1}$$

The assumption $G_G < 0$ implies that the higher the technology gap, the higher the opportunities for learning from the leading economy, and the higher the potential for technological spillovers and catching up in the South. This specification recognizes that the technology gap offers the possibility of using existing foreign technology to build up indigenous capabilities (Bell, 2006). However, technological spillovers are not automatic. For a country to be able to learn from the technological leader it must invest in developing National System of Innovation, which shapes its absorptive capacity (NSI; see Nelson 1994 and Narula 2004). Education of the labor force is also a key variable in explaining the capacity of the country to absorb foreign technology. Note that if the country does not develop its NSI and is unable to learn from the gap, then $G_G > 0$ and a vicious circle may emerge that compromises the stability of the system.

The second variable in the argument of equation (1)—the relative South-North rate of income growth (y)—represents Kaldor-Verdoorn Law, in particular learning by doing, learning by using and investment in new capital vintages (León-Ledesma, 2002; Rada, 2007). The partial derivative $G_y < 0$ implies that technological diffusion in the South (and the rate at which the North-South technology gap falls) increases with relative growth in the South. The intensity of learning (and hence the value of the parameters of equation 1) depends, as mentioned, on the National System of Innovation.

Prices are defined by applying a mark-up factor z > 1 on unitary production costs. The price of good *i* in the South is $P_S^i = z_S^i W_S / (\pi_S^i)$ and the price of the same good in the North is $P_R^i = z_R^i W_R e / (\pi_R^i)$, where W_R is the nominal wage in the North, W_S the nominal wage in the South (in units of the Southern currency), *e* the nominal exchange rate (units of Southern currency per unit of Northern currency), π_S^i labor productivity in the production of *i* in the South, and π_R^i labor productivity in the production of *i* in the North. The good is produced in the country in which the price is lower. Assume that the mark up factor is the same in the two countries in all sectors. The good is produced in the South if:

 $^{^{6}}$ This relationship is represented in figure (1) by the effect from box (F) to box (A).

$$\frac{W_R e}{\pi_R^i} \ge \frac{W_S}{\pi_S^i} \tag{2}$$

There are neither trade barriers nor transport costs, and therefore prices are the same in the two countries. Assume, in addition, that Southern and Northern workers have the same consumption basket. This set of assumptions taken together implies that the relative nominal wage has a univocal relation with relative real wages.

Define relative productivity as $\pi^i \equiv \ln(\pi_s^i/\pi_R^i)$ and relative wage as $W \equiv \ln(W_s/W_R e)$. Rearranging terms gives

$$\pi^i \ge W \tag{3}$$

If the relative South-North productivity in the production of a good i is equal or higher than the relative South-North wage, the unitary cost will be equal or lower in the South and the good i will be produced in the South.

As mentioned, the higher the technological intensity of the good, the more difficult to master, and the higher the productivity advantage of the North (lower South-North relative productivity) for a given technology gap *G*. The good with the highest relative labor productivity in the South is ranked N = 1, which is at the same time the good with the lowest technological intensity. The rank of the good (the number *N*) increases with its technological intensity, and hence the curve $\pi(N)$ —that plots labor relative productivity against *N*—is negatively slopped⁷. For this reason, *N* can be seen as a proxy for both, the degree of diversification of the economy and the technological intensity of the good (Krugman, 1979).

South-North relative wage is a positive function of N: a more diversified economy demands more labor and this boosts wage (more on this below). The South-North relative productivity, in turn, depends on the technology gap along with the technological intensity of the good produced. The higher is the gap, the lower the relative productivity of the South for a given N.

Formally:

$$\pi = \mathcal{P}(G, N), \qquad \mathcal{P}_G < 0 \quad \text{and} \quad \mathcal{P}_N < 0 \tag{4}$$

where $\mathcal{P}_G < 0$ is the technology gap-effect country-specific) and $\mathcal{P}_N < 0$ is the technological intensity-effect (good-specific) on relative labor productivity.⁸

Figure 2 shows specialization in the South. On the horizontal axis there is the number of goods produced in the international economy normalized so that $0 < N \le 1$. On the vertical axis are

⁷ In other words: to rank the goods in terms of increasing technological intensity from N = 1...n is the same as ranking these goods in terms of decreasing technological intensity from N = 1...n.

⁸ This implies that the productivity of each good is a function on the technological capabilities applied to the production process, $\pi_{ij} = f(T_j, N_i), j = R, S; N = 1 \dots M$, where *M* is the total number of goods produced in the international economy.

represented the South-North productivity gap and relative wages. The intersection of these curves define the number of goods (N^*) the South produce for both the domestic and international markets.



Figure 2. Specialization, Productivity and Relative Wages

An acceleration of technical change leading to a reduction in the technology gap shifts the π curve to the right and a new equilibrium emerges, with higher diversification and a higher relative wage (higher N^* and W^*). A change in the labor market reducing the response of real wages to an increase in employment, or a change in the exchange policy that depreciates de domestic currency, shifts the *W* curve to the right. The result is a lower relative wage with higher diversification (higher N^* , lower W^*). These changes are analyzed in more detail in section 3.

2.2 The (Keynesian) demand side

So far, the focus has been on the technological and productivity regimes. But demand forces play an important role in North-South interactions as well. The demand regime is defined by the demand of exports and imports as external equilibrium requires the stability of the current account deficit as a percentage of the GDP (Moreno-Brid, 2003). To attain such stability, the value of exports should grow at the same rate as the value of imports. With a stable real exchange rate in equilibrium, the rate of growth of exports and imports should be approximately the same, *i.e.* $y_s \varepsilon_M = y_R \varepsilon_X$, where ε_X is the income elasticity of the demand for exports and ε_M is the income elasticity of the demand for imports in the South. Defining the income elasticity ratio as $\varepsilon \equiv \varepsilon_X / \varepsilon_M$ and recalling that relative growth is $y \equiv y_S / y_R$ (where y_j is the proportional rate of growth of country *j*) then: The validity of equation (5) —the BOP-constrained rate of growth— depends on a set of assumptions. In particular, autonomous expenditure (private and/or public) should always expand or contract to avoid the accumulation of reserves or an explosive deficit in current account, respectively, as suggested by Blecker (2011). Note that $\varepsilon < 1$ implies divergence ($y_s < y_R$ and y < 1). As set forth by Joan Robinson (1966): "the most important benefit of a surplus on income account, which affects the whole economy, is that, provided that there are energetic enterprises and thrifty capitalist to take advantage of it, it permits home investments to go full steam while a deficit country is nervously pulling on the brake for fear of excessive imports".

The income elasticity ratio is a function of the specialization pattern of the South described by the number N^* , which represents at the same time the number of goods the South produces (diversification) and the technological intensity of the production structure. High-tech goods are assumed to have a higher income elasticity ratio and therefore the higher is N, the higher the income elasticity ratio ε . A country may experience fast growth, at least during some time, if it happens to be specialized in the "right commodities" (those that enjoy a boom in global demand), even in the absence of strong technological capabilities. But these exceptions are generally valid for short periods of time; in the long run what defines the elasticities is the ability of remaining competitive on technology-intensive sectors.

Equation (5) can be rewritten as:

$$y = \mathcal{Y}(N), \qquad \qquad \mathcal{Y}_N > 0 \tag{6}$$

Diversification responds to changes in competitiveness.

$$\widehat{N} = \mathcal{N}(\pi - W), \qquad \qquad \mathcal{N}_{\pi}, \ \mathcal{N}_{W} > 0$$
(7)

When the price of a good in the South is lower than in the North, the South begins its production. Investment endogenously comes forth to expand production when international competitiveness increases⁹.

2.3 The labor market

The relative wage (*W*) depend on the relative employment rate (Γ) in the South as compared to the North, defined as $\Gamma = \ln[(L_s / Z_s)/(L_R / Z_R)]$, where L_j are employed workers and Z_j the total supply of workers in country *j*. Dynamically, the rate of growth of Γ (which is $\dot{\Gamma} = (\hat{L}_s - \hat{L}_R) - (\hat{Z}_s - \hat{Z}_R)$, where as usual dots represents time derivatives and hats proportional rates

⁹ The assumption behind a diversification-driven investment function is that investment follows "as a shadow" (to paraphrase Joseph Steindl) the opportunities opened by international competitiveness. In other words, investment is endogenous to technological learning and to the behavior of effective demand.

of growth), determines the growth of the relative wage. This rate is the difference between the rate of growth of wages in the South and that in the North (assuming a fixed nominal exchange rate). Hence: $\dot{W} = d[\ln(W_s/W_R e)]/dt = \hat{W}_s - \hat{W}_R$.

The relative growth of employment, $\hat{L}_s - \hat{L}_R$, equals the difference between South and North in the proportional rate of GDP growth, $\hat{y}_s - \hat{y}_R$, and the proportional rate of growth of labor productivity, $\dot{\pi} = d[\ln(\pi_s/\pi_R)]/dt = \hat{\pi}_s - \hat{\pi}_R$. Using this equation, normalizing $y_R = 1$ and recalling that $y \equiv y_s/y_R$, we obtain:

$$\hat{L}_{s} - \hat{L}_{R} = y_{s} - y_{R} - \hat{\pi}_{s} + \hat{\pi}_{R} = y - 1 - \dot{\pi}$$
(8)

As regards relative labor supply $(\dot{Z} = d[\ln(Z_s/Z_R)]/dt = \hat{Z}_s - \hat{Z}_R)$, it is assumed to be a function of the relative South-North wage, $\dot{Z} = \xi(W)$ with $\xi_W > 0$. A higher relative wage attracts workers out of the subsistence sector, informality, or even from other countries. The function $\xi(W)$ represents the elasticity of labor supply to a rise in the relative wage. This allows us to write a motion equation for the relative wage in which the function $\omega(y - \dot{\pi})$ captures the effect of the demand for labor and $\xi(W)$ that of the supply of labor on the relative wage.

$$\hat{W} \ ext{i} = \omega(y - \dot{\pi}) - \xi(W), \qquad \psi \omega_W, \ \xi_W > 0 \tag{9}$$

Equations (1), (7) and (9) form a 3x3 dynamic system, which determines the co-evolution of diversification, the technology gap and the relative wage. In the next sections the dynamics of the system is discussed assuming that the functions described by (1)-(9) are linear.

2.4 A Dynamic Linear Model

The co-evolution of the technology gap (\dot{G}) , the pattern of specialization (\hat{N}) and the relative wage (\dot{W}) is described by the following system of linear differential equations:

$$\dot{G}(t) = u - vG(t) - gy(t) \tag{L1}$$

$$\widehat{N}(t) = \eta + \phi[\pi(t) - W(t)] \tag{L2}$$

$$\dot{W}(t) = \psi + \omega[y(t) - \dot{\pi}(t)] - \xi W(t) \tag{L3}$$

where G(t), N(t), y(t), π (*t*) and W (*t*) are the endogenous variables, while all the other letters are parameters. The following equations complete the system:

$$\pi(t) = \alpha - kG(t) - bN(t) \tag{L4}$$

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$$\dot{\pi}(t) = -k\dot{G}(t) - b\dot{N}(t) \tag{L5}$$

$$y(t) = hN(t) \tag{L6}$$

Using (L6) into (L1) renders:

$$\dot{G}(t) = u - vG(t) - ghN(t) \tag{L7}$$

which is our first dynamic equation. Using (L4) into (L2) gives the second dynamic equation of the system:

$$\widehat{N}(t) = \eta + \phi[\alpha - kG(t) - bN(t) - W(t)]$$
(L8)

Finally, using from (L5) to (L8) into (L3) renders the third differential equation:

$$\dot{W}(t) = \Theta + \omega k \Omega G(t) + \omega \Sigma N(t) - (\omega b \phi + \xi) W(t)$$
(L9)

where:

$$\Theta = \psi + \omega ku + \omega b(\eta + \phi \alpha) > 0$$

$$\Omega = (v - b\phi) \gtrless 0$$

$$\Sigma = \omega[(1 - gk)h + \phi b^{2}] > 0$$

The linear system formed by equations (L7), (L8) and (L9) is therefore:

$$\dot{G}(t) = u - vG(t) - ghN(t)$$

$$\hat{N}(t) = \eta + \phi[\alpha - kG(t) - bN(t) - W(t)]$$

$$\dot{W}(t) = \Theta - \omega k\Omega G(t) + \omega \Sigma N(t) - (\omega b\phi + \xi) W(t)$$

(L10)

Table 1 presents the key parameters of the model, discusses their economic meaning and points out the technological factors and policies that affect the parameter values.

Parameter	Economic intuition and type of effect	Eactors that affect the value of the
1 arameter	Economic municipation and type of effect	parameter
u > 0	Autonomous rate of technological innovation (shift in	It chiefly depends on the velocity at
	the international technological frontier). It reflects	which the international technological
	investments in innovation in the North and in the South	frontier moves, which is an exogenous
	(not related to the imitation of existing technology in	variable for the South. This parameter
	the North). If this rate is very low in the South, then <i>u</i>	is high in periods of transformation of
	mainly represents the velocity at which the	the technological paradigm.
	international technological frontier moves as a result of	
	innovations in the North.	
1 > v > 0	Absorptive capacity in the South (effective spillover	The value of the parameter depends on
	effect). The higher <i>v</i> , the more the South is able to learn	the strength of the NSI and the supply
	from the existing stock of knowledge in the North.	of human capital in the South.
1 > g > 0	Learning by doing (Kaldor-Verdoorn effect): the higher	Like the absorptive capacity, learning
	is <i>g</i> , the higher is learning from the experience in	by doing is not automatic, but depends
	production. This parameter gives rise to increasing	on the NSI.
	returns and cumulativeness in technical change.	
$1 > \phi > 0$	<i>Competitiveness effect</i> : represents the velocity with	If there are barriers to (international or
	which a country which has a cost advantage diversifies	domestic) competition, a fall in unitary
	its exports and conquers new domestic and external	costs of production in the South entails
	markets.	a small impact on diversification.
$1 > \omega > 0$	Response of the relative wage to the tightening of the	A policy that strengths labor unions
	labor market in the South. The higher is ω , the higher	and legislation protecting workers
	the increase in relative wage due to an increase in the	(minimum wages, unemployment
٤ > 0	Elasticity of labor supply with respect to the relative	A policy simed at training workers and
$\zeta > 0$	<i>Liasticity of tabor supply</i> with respect to the reallocation of	A policy anned at training workers and anaouraging (internal and avternal)
	workers from informality and subsistence sectors to the	migration increases E
	modern sector and by international migration	$\frac{1}{1}$
k > 0	Effect of the technology gap on relative productivity	Different technologies have a different
<i>k</i> > 0	(Schumpeterian effect): the higher k is, the lower the	impact on labor productivity. In sectors
	Southern relative productivity for a given <i>G</i> (across-	with high "technological opportunity"
	the-board effect on productivity of the North-South	this impact is higher.
	gap).	1 0
b > 0	<i>Effect of the knowledge-intensity of the good on relative</i>	This is a good-specific effect that
	<i>productivity</i> . The higher the technological intensity of	depends on the technological requisites
	the good, the lower the comparative advantage of the	of production.
	South. This implies that the South-North relative	
	productivity is lower in high tech goods than in the	
	production of standardized, low-technology goods	
h > 0	Keynesian effect: the income elasticity ratio (elasticity	The parameter value depends on
	of exports / elasticity of imports) varies as a result of	patterns of international demand that
	changes in the pattern of specialization. This effect	cannot be changed by domestic
	links the pattern of specialization to the dynamics of	policies
	effective demand.	
$\Theta \ge 0$	Exchange rate effect. Autonomous increase or	This parameter shifts as a response to
	decrease in the relative wage due to changes in the	variations in capital inflows, terms of
	nominal exchange rate (<i>e</i>)	trade and the rate of devaluation /
		revaluation of the domestic currency,
		as defined by the exchange rate policy

Table 1. Parameters: what they mean and what factors affect them

The three isoclines, $\dot{G} = \hat{N} = \dot{W} = 0$ are respectively:

$$\begin{split} \tilde{G} &= \frac{u}{v} - \frac{gh}{v}N \qquad \text{with} \quad \frac{d\tilde{G}}{dN}\Big|_{G} < 0 \quad \text{and} \quad \frac{d\tilde{G}}{dW}\Big|_{G} = 0 \\ \tilde{N} &= \frac{1}{b}(\alpha - kG - W) \qquad \text{with} \quad \frac{d\tilde{N}}{dG}\Big|_{N} < 0 \quad \text{and} \quad \frac{d\tilde{N}}{dW}\Big|_{N} < 0 \end{split}$$
(L11)
$$\\ \tilde{W} &= \frac{\Theta - \omega k\Omega G + \omega \Sigma N}{(\omega b\phi + \xi)} \qquad \text{with} \quad \frac{d\tilde{W}}{dN}\Big|_{W} \leqslant 0 \quad \text{and} \quad \frac{d\tilde{W}}{dG}\Big|_{W} \leqslant 0 \end{split}$$

The equilibrium values (*G**, *N** and *W**) can be computed by solving the system (L11). In matrix notation, $\dot{X} = [A] dX$ is the expansion around the first Taylor's approximation of equilibrium:

$$\begin{bmatrix} \dot{G} \\ \dot{N} \\ \dot{W} \end{bmatrix} = \begin{bmatrix} -v & -gh & 0 \\ -\phi k & -\phi b & -\phi \\ -\omega k\Omega & \omega \Sigma & -(\omega b\phi + \xi) \end{bmatrix} \begin{bmatrix} dG \\ dN \\ dw \end{bmatrix}$$
(L12)

The Routh-Hurwitz stability condition for a 3x3 system like (L12) states that the system is asymptotically and globally stable if the characteristic roots (eigenvalues) of A-D=0 are negative, real and distinct. If some eigenvalue is complex, the real part must be negative. The characteristic polynomial $\alpha_0\lambda^3 + \alpha_1\lambda^2 + \alpha_2\lambda + \alpha_3$ for equation (L12) is the following:

$$\lambda^{3} + [(1+\omega)b\phi + \xi]\lambda^{2} + \begin{bmatrix} \omega b\phi v \\ \omega h\phi \\ b\phi v - (1+\omega)ghk\phi \\ b\phi \xi \\ v\xi \end{bmatrix} \lambda + \begin{bmatrix} b\phi v\xi & -2bghk\omega\phi^{2} \\ \omega h\phi v - ghk\phi\xi^{2} \end{bmatrix}$$
(L13)

The Routh-Hurwtiz conditions state that $\alpha_0, \alpha_1, \alpha_2, \alpha_3 > 0$ and $\alpha_1\alpha_2 > \alpha_0\alpha_3$ are required for stability. The first two coefficient of the polynomial, α_0, α_1 , are unequivocally positive; the signs of α_2 and α_3 , on the other hand, are ambiguous. It is more likely to have positive coefficients when *k* (Schumpeterian effect), *h* (Keynesian effect) and *g* (Kaldorian effect) are low, since they appear in the negative terms of α_2 and α_3 . These are "destabilizing" parameters because they reflect the intensity of the cumulative processes of innovation, competitiveness, economic growth and learning by doing.

It is more difficult to establish whether the condition $\alpha_1 \alpha_2 > \alpha_0 \alpha_3$ is satisfied. Nevertheless, some assumptions help illustrate the forces leading to stability or instability. Assume, for instance, that the Kaldor effect is nil (g = 0)— in other words, there is no feed-back from growth to learning.

In this case all the negative terms of the coefficients of the characteristic equation disappear. Normalize $\phi = 1$ and the characteristic equation becomes:

$$\lambda^{3} + [(1+\omega)b + \xi]\lambda^{2} + \begin{bmatrix} \omega bv \\ \omega h \\ bv \\ b\xi \\ v\xi \end{bmatrix} \lambda + v(b\xi + \omega h)$$
(L14)

Now all coefficients are unambiguously positive. The stability condition $\alpha_1\alpha_2 > \alpha_0\alpha_3$ boils down to the following inequality: $[(1 + \omega)b + \xi](\omega bv + \omega h + bv + b\xi + v\xi) - v(b\xi + \omega h) > 0$. How does the stability condition is affected by changes in key parameters? The partial derivative of the stability condition with respect to *b* is unambiguously positive. The derivative with respect to *b* and ω is positive except for values extremely high of *h* and low of *b*. Intuitively, this can be read as follows: if Kaldor-Verdoorn is weak, growth and diversification in the South leads to just marginal gains in productivity; at the same time, the increasing technological complexity of the production of new goods (*b*) prevents the process of diversification from advancing further. The effect of a low *h* and a low *k* is the same as that of a low *g*. Looking at the stability problem from the standpoint of the North, it can be observed that if *h*, *k* and *g* are low, and technological spillovers are high (*v*), an initial technological advantage will fail to trigger the cumulative process of growth, learning and innovation that would leave the South behind, especially if wages in the North (South) are rising (falling) fast (ω).

The scenario in which the system is unstable is not less interesting than the stability scenario from a development point of view. If the strengthening of the NSI in the developing economy produces a high v and a high g (i.e. if all the learning parameters are high), and this prompts rapid diversification in the South (high h), increasing returns will allow the South to close the technology gap through time. In other words, a Hirschmanian view of development (based on disequilibria) as a result of a policy that boosts learning is not inconsistent with the dynamics suggested in the model. The creation of disequilibria stemming from learning is a path to development.

2.5 Policy shocks and comparative dynamics

The model allows for discussing the effects of different types of policies that change the parameters of the system. Two types of policies will be considered in this section. The first type is an ITP aimed at encouraging structural change and strengthening the NSI, which raises the parameters v and g, and reduces u (see table 1). They include investments in training, subsidies to R&D in general (performed by private and/or public institutions), agreements to transfer technology, financial and technological support to adapt and improve foreign technology, starts-up and the development of new sectors. The outcomes are a fall in the technology gap and an increase in the sophistication of the production structure, which prompt a rise in the relative wage. The second type of policies is

directed at the labor market and the exchange rate. They are aimed at reducing costs through a lower relative wage or through the depreciation of the domestic currency. While ITP reduces unitary costs by increasing labor productivity, the labor market and exchange rate policies do so by reducing the relative wage. These policies comprise incentives to internal (rural to urban) and international migration, which raises ξ and increases the supply of labor; less protection to workers and unions, which reduces ω and hence the response of wages to a rise in labor demand; and a policy of accelerated devaluations that heightens *e* and therefore increases the wages in the North in units of the Southern currency (changes in Θ).

Assume that the government adopts a new ITP that fosters the absorptive capabilities of the economy as represented by the parameter v, which increases 20 % (from v = 0.5 to v = 0.6)—for instance, subsidies to R&D cooperation between universities and firms. For a given technology gap, the economy now invests more to identify, adapt and use foreign technology. Formally, in terms of the isoclines \tilde{G} , \tilde{N} and \tilde{W} in (L.11), a higher v reduces the intercept of \tilde{G} and its slope with respect to N; and raises the slope of \tilde{N} with respect to G (note that v appears only in the negative term ($-\omega kv$) in the numerator of the locus $\dot{W} = 0$). The isocline \tilde{N} is not affected.

The changes described above set in motion a process in which *N*, *W* and π co-evolve. The initial positions of the three state variables are represented in Figure 3a by a circle (top set of panels). This initial position corresponds to the equilibrium values of *G*, *N* and π before the change in policy. Figure 3b (center set of panels) represents the path followed by the variables *after* the adoption of a stronger ITP drive. In this example, the parameters were chosen to produce a stable equilibrium. The co-movement of the variables from the initial equilibrium (marked by the circle) to the new equilibrium (after the increase in absorptive capacity) is represented by the black curve. To help visualize the dynamics, the three panels are drawn in the same scale and each panel hides the evolution of one of the variables while displaying the co-movement of the other two. In the three panels of Figure 3b the "old" and "new" equilibrium points occupy exactly the same place within the cube. The adoption of a policy that enhances the ability of the South to absorb foreign technology therefore produces a new equilibrium which features a lower technology gap, higher diversification (as the increase in labor productivity reduces unitary costs in the South) and higher relative wage¹⁰.

A similar point is valid for the North. If it adopts an ITP which fosters learning, while the South does not react promptly, the technology gap will increase and the South will lag behind. (Indeed, as discussed later, this is precisely what happened to Argentina and Brazil – abandonment of ITP while the rest of the world kept the effort at innovation, which made the Latin America countries lag behind.)

More generally, what is going on is a (Schumpeterian) technological race and competition. The evolution of the gap, competitiveness and growth depends on the relative velocity of innovation

¹⁰ In the numerical example, the equilibrium point changed from coordinates (G = 1.6, N = 0.3, W = 0.4) to (G = 1.2, N = 0.6, W = 0.5). Note that more diversification also leads to a higher rate of growth with external equilibrium. The new rates of growth are not shown in separate graphs due to lack of space.

in the North and diffusion of technology to the South. Even if the two countries do have an active ITP, the one which accumulates and uses knowledge more efficiently will have an advantage (the "Red Queen Effect": a country must run if it wants to remain in the same place).





A second policy shock whose dynamics be described by the model affects the labor market. Assume now that the government adopts a policy that fosters immigration, which increases ξ by 14%. Graph 1c (bottom set of panels) depicts the trajectory of the variables after the adoption of the new policy. The effect is a fall in the relative wage, which at the same time reduces costs and favours diversification. As a result, the technology gap falls due to increasing returns to learning. The economy thus succeeds in changing its pattern of specialization and reducing the technology gap, but this happens at the cost of a lower relative wage in the South. The increase in *N* and the fall in *G* in the new equilibrium tend to be higher when the fall in costs is due to an acceleration of technical change than when it comes from a fall in the relative wages.

In sum, different combinations of parameter values allow for representing different growth scenarios and policies. The next section illustrates this dynamics with an historical example that focuses on the ITP of three countries, Argentina, Brazil and Korea. As mentioned, there has been a long discussion of the role that these policies played in the Korean convergence and the Latin American divergence. In addition, the literature has also pointed out that the real exchange rate has tended to appreciate in Latin America as a result of financial liberalization and (recently) the bonanza in commodity prices (see below). The model presented in this section allows us to frame this discussion in a formal model that stresses the interactions between productivity, technology and dynamic comparative advantages.

3 Policy and growth trajectories: applying the model to understand divergence

3.1 The proxies

As mentioned, the literature points out ITP as a crucial driver of convergence and structural change in several Asian economies. Inversely, its institutional and political weaknesses help to

explain the Latin American failure. This can be illustrated through the cases of Argentina and Brazil in Latin America, and South Korea in Asia.

To begin with, it is necessary to choose proxies for G (technology gap), N (the knowledgeintensity of the production structure) and W (relative wage). Relative labor productivity between a catching-up country and the country on the technological frontier (usually, the USA) has been used as a proxy for the technology gap G since the pioneer work of Fagerberg (1988). This proxy is also consistent with the idea that the technology gap and relative productivity move hand in hand, as suggested in the model. In this paper we will keep this convention.

As a indicator of the technological intensity of production *N* it will be used the Engineering Index (EI), defined as the ratio between the relative share of the engineering industries in total manufacturing value added¹¹ in a certain country, and this share in a country on the technological frontier (the USA; see graph 4). The interpretation of the EI is straightforward: a EI_{*i*} = 0.5 means that the share of the engineering industries in total manufacturing value added in country *i* is half of this share in the USA. An increase in EI indicates progressive structural change ($\dot{N} > 0$), a move towards a pattern of specialization which is more technology-intensive. The period of analysis is limited by the availability of data to compute the EI index, which is between 1970 and 2008.

Finally, it is not possible to have comparable long run data for the relative wage, but this can be approached by the real exchange rate (q) estimated through the Balassa correction for GDP per capita (Rodrik, 2008). Recall that in the model prices are set based on the mark up rule and similar mark-up factors are assumed. This implies $(P_R e / P_S) = (W_R e \pi_S / W_S \pi_R) = q$. The real exchange rate will vary with changes in productivity and changes in the relative wage; both forces are captured in the estimation of q corrected by the GDP per capita. Countries with a strong ITP that sustains learning are expected to show a fall in q through time, while *ceteris paribus* laggard countries should experience a rise in q.

3.2 Continuity and discontinuity in ITP: Argentina, Brazil and Korea

The continuity of ITP in Korea as compared to its abandonment in Argentina and Brazil is behind the diverging growth patterns observed in Asia and Latin America. From an empirical point of view, it is important to clearly establish the moment in which these Latin American countries gave up ITP. This discontinuity occurred in the mid-seventies in Argentina and in practice in the early eighties in Brazil, although formally Brazil abandoned its industrialization policy in the 1990s (more details below). Such discontinuity produced a kind of natural experiment (albeit imperfect), in which there was a bifurcation in the paths followed by labor productivity, specialization and growth after the change in policy. In terms of the model of the previous section, this represents a change in the parameter *v*, the country's absorptive capacity.

¹¹ Engineering Industries comprise in the Standard International Trade Classification (SITC): Fabricated metal products, except machinery and equipment; Machinery and equipment; Transport equipment.

In Argentina, the watershed was the military coup of March 1976. Until this moment, the country had followed a pattern of industrialization based on import-substitution (with high tariff and non-tariff protection of the manufacturing sector) and, gradually, on export promotion. After the 1976 coup, trade and financial liberalization advanced hand in hand and at a very rapid pace. The industrial policy was then seen as a heavy burden inherited from the "Peronist" administrations of the 1940s and 1950s, which distorted the price system and should be eliminated through liberalization and deregulation (Schvarzer, 1983; Katz and Kosacoff, 1988). The index of pro-market reforms suggested by Morley et al (1999)¹² increased in Argentina from 0.41 in 1976 (when the reforms started) to 0.61 in 1986 and to 0.81 in 1990 (see figure 4).

Trade liberalization and the liberalization of the capital account took place in a context of high liquidity in the international financial markets. A high domestic interest rate combined with a system of pre-announced devaluations (la *tablita*) attracted capital inflows and appreciated the Argentina currency (Frenkel and Rapetti, 2011). While such a policy was efficient to curb inflation, the appreciation of the real exchange rate in Argentina led to cumulative deficits in current account (in the model this effect amounts to an increase in the parameter Θ). The debt contracted at a low interest rate in the international markets in the 1970s became an insurmountable burden on growth when the interest rate escalated between 1979 and 1983 (after the nomination of Paul Volcker as chairman of the Federal Reserve in July 1979). This eventually led to the 1982 external debt crisis—following the Mexican default of the external debt—and the contraction of investment and GDP.

The chronology of reforms in Latin America suggested by Morley et al (1999) also shows that Brazil was a late comer in trade and financial liberalization (see figure 4). Brazil's ITP in the 1970s moved in the opposite direction of that in Argentina. Brazil launched its Second National Plan of Development (II PND) in 1974, which represented the country's last major effort at developing indigenous capital goods and intermediate goods industries (Castro, 1989; Baer, 2008, chapter 5). With this objective it deployed a vast array of policies in favor of the industrial sector (protectionist barriers, subsidies, credit facilities) that boosted industrial growth between 1974 and 1979. Quantitative restrictions were widespread. Brazil thus remained a country relatively closed to international trade throughout the 1970s and 1980s; the process of trade liberalization would only begin in the early 1990s.

¹² The index of reform is the simple average of six sub indexes that capture the levels of government intervention in the economy, including levels of import protection and the degree in which the government interfered in the allocation of credit.

Figure 4. Index of Liberalization Reforms, Argentina and Brazil, 1970-1995



Source: Morley et al (1989).

However, ITP ceased to be operative since 1980. To move forward its program of heavy industrialization, Brazil increased exponentially its external debt—taking advantage of the low international interest rates of the second half of the seventies. In a similar way to what happened in Argentina, the debt became explosive after 1979. The solvency of the private sector and private investment collapsed, which prompted the public sector to absorb the debt (Cardoso and Fishlow, 1989). As a result, in the 1980s Brazil neither had the fiscal space nor the room for maneuver necessary to continue its support to import substitution and export diversification¹³. Such a support ended in the 1980s, although only in the 1990s would Brazil formally dismantle its ITP¹⁴.

Both Argentina and Brazil embraced a strong pro-market stance at the beginning of the 1990s. This was the era of the "Washington Consensus", in which most governments in Latin America sought to minimize government intervention in the economy. Until the early 2000s, prevailed in Latin America the idea that the "best industrial policy is none at all". ¹⁵ By the end of the nineties, however, it was visible a fatigue of the "neoliberal reforms". Industrial policy entered again in the policy agenda in Argentina and Brazil. The attempts to reconstruct its institutions were mostly unsuccessful in the 2000s¹⁶. The commodity boom allowed Argentina and Brazil to expand their fiscal space after 2004, but this opportunity was not seized to advance ITP. From one hand, the improvement in the country's fiscal position was used mainly to respond to social demands that had been kept repressed for a long time (ECLAC, 2012). On the other hand, the rise in the price of the main commodities exported by South American countries further appreciated their currencies and

¹³ Cf. Aldrighi and Colistete (2013).

¹⁴ This break with the industrial policy of the past was marked, but less sharp than in Argentina (Katz, 1996 and 1997; Katz and Stumpo, 2001). Brazil kept some instruments to promote industry in place—notably the National Bank of Development (BNDES), which provided financing to selected sectors and firms.

 ¹⁵ For a discussion of how governments manage the problems of rent-seeking in industrial policy see Khan (2000).
 ¹⁶ Cf. Nasssif et al (2012, 2013).

strengthened specialization in natural resources—a new shock in Θ ; see Bresser-Pereira (2008); Ocampo et al (2009); McMillan and Rodrik (2011); Stumpo and Rivas (2013), Nasssif et al (2012, 2013). The collapse of ITP in the 1990s in Latin America was therefore not reversed in the 2000s.

In Korea, ITP did not suffer the sharp discontinuity that halted industrialization in Latin America. On the contrary, its focus on targeting increasingly more sophisticated industries through time was the hallmark of the Korean development process in the post-war period¹⁷. Successive 5-year plans transformed the industrial basis from consumer goods to heavy industries and, since the nineties, towards electronics, ITC, optics and aerospace. In all the industrialization stages the government played a key role in coordinating investments and redefining incentives to make viable structural change (Rodrik, 1994). In the 2000s the quest for new engines of growth emphasized "green industries", high-tech convergence and high value-added services¹⁸.

In parallel to structural change, there was a rise in R&D expenditure, first led by the public sector and subsequently, in the 2000s, with a larger role for the private sector (whose share in total R&D increased from 30 % in the late 1970s to 75 % in 2011; see Koo, 2013). The liberalization of imports was gradual, which allowed Korea to attain a level of import liberalization similar to that of the OECD countries in the 1990s (Koh, 2010, p. 740). Korea combined in different degrees import substitution and export promotion throughout its development process after World War II, but emphasized export promotion since the early 1960s. The system of multiple exchange rates was replaced by a single fluctuating exchange rate, which remained high and fairly stable thereafter (which avoided a fall in θ ; see Yoon and Kim, 1995). This combination of pro-competitiveness macroeconomic policy and ITP sustained the diversification of exports (the "acid test" of learning) and allowed Korea to redefine its comparative advantages.

3.3 Co-evolution of the technology gap and structural change: 1970-2008

Figure 5 shows the co-evolution of relative South-North productivity (the inverse of the technology gap, 1/G) and structural change (*N*) between 1970 and 2008 in Korea, Argentina and Brazil between 1970 and 2008. In terms of the model presented above, the trajectory of Korea illustrates the process by which ITP constantly moved forward the equilibrium values of the state variables, namely relative productivity and the technological intensity of production. Relative productivity (respecting the US) increased steadily as the production structure diversified towards new, more sophisticated industries. In parallel, the real exchange rate fell.

In Brazil, both variables moved upwards until the 1980s (see figure 5). Indeed, Brazil and Korea followed almost parallel paths in this period. Both countries adopted similar policies to boost industrialization, which explains this similarity - even though Brazil was less efficient than Korea in

¹⁷ See for instance Amsden (1989), Kim (1997, 2011), and Lee (2013).

¹⁸ As observed by Koo (2013): "In particular, next-generation growth engine industries received policy attention in 2003 with the development of high technologies, that is, the so-called 6T: information, bio-, nano-, space, environment, and cultural technologies".

fostering international competitiveness. Their paths, however, began to diverge in the 1980s. There was a drastic reversal of the positive trend in Brazil when the external debt severely hit public and private investment, and public support to industrialization collapsed. A new negative policy shock occurred in the 1990s - unilateral trade liberalization - that consolidated the slow-growth, low-learning trap that has been hampering the Brazilian economy since the 1980s.

In the case of Argentina, the policy shock came earlier (as discussed in the previous section), as can be seen in the fall of the engineering index since the mid-seventies, and regressive structural change continued in the 1990s (see figure 5). Both countries were unable to rebuild in the 2000a the capabilities they had lost after the policy shocks of the seventies and nineties.



Figure 5. Co-evolution of the technology gap and the technological intensity of production

Source: ECLAC Padiwin; INDSTAT4 2013, UNIDO; Laborstat, ILO; CEPALSTAT

The evolution of the real exchange rate reflects the combined effects of the rise in productivity and of changes in international financial liquidity and the terms of trade (see figure 6). Looking at the behavior of the real exchange rate in parallel with the current account allows for identifying distinct sources of appreciation:

- a) Financial liberalization in the 1990s and the positive terms of trade shock of the commodity boom after 2004 in Argentina and Brazil led to a significant appreciation of the real exchange rate;
- b) Appreciation was always related to a deficit in current account in Argentina and Brazil, except for the period of the commodity boom in Latin America;
- c) The real exchange rate in Korea fell *pari passu* with the improvement in the current account balance. This trend expresses the long trend rise in productivity and non-price competitiveness in this country.



Source: Authors' calculation based on Penn World Tables and World Bank. As in Rodrik (2008), an undervaluation index was constructed using the Balassa correction.

Thus, appreciation in the real exchange rate seems to be the consequence of structural change and productivity growth in Korea (changes in v and g), while in the case of Argentina and Brazil is by large a response to changes the nominal exchange rate and the terms of trade (changes in Θ). When appreciation comes from the two latter sources, it implies a loss of competitiveness and a deficit in current account that makes appreciation unsustainable. The more erratic behavior of the RER in Argentina and Brazil reveals that appreciation did not come from a sustained process of growth in relative productivity.

Figure 7. GDP Growth Trend: Argentina, Brazil and Korea, 1070-2015



Source: Elaborated based on World Bank National Accounts data, <u>http://data.worldbank.org/indicator/NY</u>. The growth trend is estimated through the Hodrick-Prescott filter, lambda = 100.

Figure 7 confirms the remarkable asymmetry in the performance of Korea as compared to the two Latin American countries. Not only growth was higher; it was also more stable, which is consistent with the "stop-and-go" pattern of growth experienced by economies that are recurrently subject to external crisis and the BOP constraint.

4 Concluding remarks

Technology gap models of trade and growth provide useful insights on the forces of convergence and divergence in a world of open economies in which Schumpeterian competition prevails. This paper presented a model whose structure is relatively simple and yet capable of reproducing different scenarios following a (positive or negative) policy shock. These shocks change the structural parameters that define the rate of learning, diversification, exchange rate policies and the response of the labor market to a rise in labor demand. The usefulness of the model was illustrated by applying it to discuss the role of ITP in divergence (Argentina and Brazil) and convergence (Korea). Argentina kept until the mid-seventies and Brazil until the early eighties an ITP that encouraged the diversification of production and exports. Such policies were discontinued thereafter, and these countries lost significant tracts of their productive and technological capabilities. This was not the case in Korea, where ITP were upgraded though time to respond to new technological challenges, from low-technology industries at the beginning to capital goods and engineering industries, and more recently to ICT and advanced services. The impacts of these policies can be qualitatively reproduced by the dynamic system set forth in the model.

The list of themes and problems left outside the model is long. In particular, the rich micromacro interactions that arise from combining Schumpeterian competition with Keynesian demandled growth are not addressed (as in Ciarli et al, 2010 and Dosi et al, 2015). On the other hand, the crucial role of technological asymmetries and the institutions for learning is stressed in the model. While the 'new institutionalist' approach to economic growth usually sees the role of institutions as either generating or correcting distortions that hinder convergence, the technology gap model takes divergence as a point of departure. Heterogeneity in capabilities and institutions provides the (historically rooted) initial conditions. The role of the policy-maker is not to build institutions that resembles to the closest possibly extent the ideal Walrasian setting, but to strengthen the National System of Innovation and halt endogenous divergence in a Schumpeterian world of increasing returns and technological asymmetries.

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