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The Role of Comparative Advantage, Endowments, and Technology in Structural Transformation

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19.1 Introduction

One of the most dramatic structural changes affecting developed economies has been the sharp decline of employment in the primary sector, both in agriculture and in the extraction of commodities. In 1840, about two-thirds of US workers worked in the primary sector; at the turn of the new millennium, this share had fallen to just 2.4 per cent (Jones 2016). Still, the common wisdom is that natural resource endowments and the comparative advantages in trade stemming from them can represent an essential ingredient of prosperity and development. In such a perspective, no further discussion is warranted: trade benefits all participants, and comparative advantages shape international specialization patterns giving rise to efficient outcomes. Unfortunately, all that glitters is not gold.

Back in 1613, Antonio Serra investigated and discussed why the Republic of Venice was much richer than the Kingdom of Naples, despite having no comparable natural resources (Serra 1613; Reinert 1999). When Serra was writing, Venice was probably one of the richest places in the world, with a florid industrial production specialized in high-value-added manufacture (e.g. glass) exported on foreign markets; Naples, on the contrary, was a rather backward country in spite of the fertile lands and abundance of raw materials. Although with rudimentary instruments and a mercantilistic approach, Serra found the answer in the very difference between primary and industrial activities: while the latter enjoy what we would now call *increasing returns*, the former do not allow similar long-term wealth generation and eventually suffer decreasing returns to scale (Reinert 1996; see also Chapter 3 by Porcile in this volume).

In this chapter, we look to answer the very same question as Antonio Serra in light of the waves of trade liberalization and globalization since the 1980s. We shall argue that endowment-based comparative advantages turn out to be misleading as drivers of economic development. This is true historically and we argue that it continues to be so in the era of globalization. In Section 19.2 we offer an outline of how alternative theories of trade make opposite predictions on the role played by comparative advantages on structural change. Section 19.3 presents a stylized technology gap model that illustrates the main mechanisms and that will guide our review of the empirical evidence. Next, in Section 19.4 we present the findings of empirical studies on structural change, looking both at the historical evidence and at the recent wave of globalization. Section 19.5 concludes and discusses the implication for policymaking.

Giovanni Dosi and Matteo Tranchero, *The Role of Comparative Advantage, Endowments, and Technology in Structural Transformation* In: *New Perspectives on Structural Change: Causes and Consequences of Structural Change in the Global Economy*. Edited by: Neil Foster-McGregor, Ludovico Alcorta, Adam Szirmai, and Bart Verspagen, Oxford University Press (2021). © Oxford University Press.
DOI: 10.1093/oso/9780198850113.003.0019

19.2 International Trade, Comparative Advantages, and Structural Transformation

19.2.1 Natural Resources in Economic and Trade Theories

The traditional theory of trade has its intellectual roots in the seminal work of Ricardo (1817) and later Heckscher (1919) and Ohlin (1933), and includes contributions that fall under the umbrellas of 'new trade theory' (Krugman 1979) and 'new new trade theory' (Melitz & Trefler 2012). Broadly speaking, this family of trade theories identifies the main determinant of trade flows in the *law of comparative advantage*, first identified by Ricardo with a famous numerical example of two countries (England and Portugal) and two goods (cloth and wine), both produced by a certain fixed amount of the same factor of production (labour). The standard theory goes as follows: given the neoclassical assumptions on technology, demand, perfect competition, and market clearing, each country will do better when it specializes in the production of different goods and it engages in international exchanges; remarkably, Ricardo proved that under those assumptions this is true even when one country has an absolute advantage in the production of every good (Gandolfo 2013).

In the original contribution of Ricardo (1817), intercountry technological differences as reflected in labour productivity differentials were the source of comparative advantage. However, economic analyses usually rely on generalizations and refinements of the Heckscher-Ohlin model. This type of model underlies a *factor proportions theory of comparative advantages* (Flam & Flanders 1991) according to which international specialization stems from different endowment structures; said otherwise, natural resource endowments such as oilfields or fertile soils ultimately determine the patterns of trade.[1] Recent contributions have relaxed some hypotheses or changed the source of comparative advantage,[2] but overall the reliance on comparative advantages is still the cornerstone of neoclassical trade theory.

Despite their analytic elegance, trade theories inspired by Ricardo tend to share two main conceptual limitations when applied to structural change in developing countries. First, they neglect the dynamics of trade-induced structural specialization and, second, they espouse a rather Panglossian optimism in the optimality of the trade equilibrium, mainly stemming

[1] Notably, this class of theories does not provide an ad hoc treatment of cheap labour endowments. If anything, an abundance of an unskilled workforce is treated precisely as any other possible commodity endowment, leading to the analogue prescription of specializing in labour-intensive low-technology manufacturing activities (see, for instance, Lin 2011). And even if the workforce is intrinsically able to learn new skills through learning by doing, this fact per se is not enough to automatically climb the development ladder. As an example, consider the Mexican maquila-type assembly lines producing for the US market, that in the absence of suitable policies, have not been able to bring countrywide technological upgrading (Cimoli & Katz 2003).

[2] Starting in the 1970s, new trade theory introduced economies of scale to relax standard assumptions on the production function (Krugman 1987). This class of models places the microfoundations of intra-industry trade in the strategic behaviours of firms operating in conditions of monopolistic competition due to the assumptions of 'love of variety' and product differentiation (Krugman 1980; Grossman & Helpman 1989). New trade theory posits that comparative advantages stemming from economies of scale and the market structure, more than natural resource endowments, give rise to international trade. More recently, general equilibrium theories of trade have been expanded in two directions. On the one hand, new new trade theory has dropped the assumption of the representative firm: in these models, firms differ in their productivity levels and only the most productive ones engage in international trade (Melitz 2003; Bernard et al. 2007). On the other hand, 'neo-Ricardians' revamped the study of comparative advantages in the spirit of Ricardo by means of structural general equilibrium models (Eaton & Kortum 2002, 2012). These models adopt a probabilistic representation of technologies as random draws from extreme value or Poisson distributions in order to keep the model tractable and reflect the empirical evidence; however, this modelling choice prevents the exploration of the origins and evolution of inter-country technology gaps.

from the hypothesis of full utilization of resources (Samuelson 2004).[3] Take for instance the case of natural resource endowments. The historical record consistently shows a widespread underperformance of economic growth in resource-rich economies (Auty 1983; van der Ploeg 2011; Venables 2016). It is a striking fact that many of the poorest countries in the world are also the richest in oil or other natural resources, even after controlling for many potential alternative explanations (Sachs & Warner 2001). This finding, which is not only inconsistent with conventional trade theories but also seems to go against what common sense would suggest,[4] was dubbed the 'natural resource curse' in a classic book by Auty (1983). In Table 19.1 we provide a selected list of the most important mechanisms that have been proposed to explain the empirical findings.

Among the plausible mechanisms, two are particularly tied to the issues of structural change and trade. Back in the 1980s, some economists studied the peculiar case of the Netherlands after the discovery of the Groningen gas field (Corden & Neary 1982; Corden 1984). Due to the discovery, two phenomena were observed. On the one hand, wealth due to the increase in exports changed the international balance of payments and induced an appreciation of the local currency, making exports less competitive and having a strong negative effect on domestic manufacturing producers. On the other hand, the booming commodity sector required labour, raising wages and drawing workers away from tradable industries. Note however that, given the generally low labour-intensity of modern extraction activities, the latter 'direct deindustrialization' mechanism is of smaller magnitude when compared with the 'indirect deindustrialization' mechanisms operating via international trade (Corden 1984). Consequently, the increase of extractive activities crowded out production of tradable goods, a phenomenon eloquently named 'Dutch disease' since then (Torvik 2009; van der Ploeg 2011). A further problem is the dynamic growth loss resulting from a contraction of the manufacturing sector. Many studies document how the manufacturing sector constitutes the engine of growth due to externalities, learning by doing, and innovativeness (Dosi 1988; Szirmai 2012; Pisano & Shih 2012; Stiglitz & Greenwald 2014). For these reasons, the reduction of manufacturing activities will harm growth even in the years following the initial structural adjustment induced by trade, as can be seen in the models of Matsuyama (1992) and Sachs & Warner (1995).

In summary, a story based only on the optimality of comparative advantages as drivers of development is unable to deal with both the historical record and the persisting international differences in income levels. Contrary to what conventional wisdom takes for granted, large resource endowments often end up being a comparative disadvantage in practice.

19.2.2 Beyond Comparative Advantages: Competitiveness and International Trade

An established tradition in economic research holds that technological change, despite having some informational features, is by and large an evolutionary process that advances along paradigms and trajectories (Dosi 1982; Dosi & Nelson 2010; Martinelli 2012). Unlike

[3] However, the recent empirical contributions on the impact of trade on local labour markets (e.g. Autor et al. 2013; Pierce & Schott 2016) are leading to much less optimistic assessments (Autor et al. 2016).

[4] The first to suggest that countries can profit from their endowments was Adam Smith (1776) with his 'vent for surplus' theory: poor countries can export under-used natural resources which are highly valued abroad, thus generating economic rents. However, economic research has shown that other more subtle mechanisms are at play when dealing with exports of natural resources.

Table 19.1. List of the main causal mechanisms explaining the 'natural resource curse'

Mechanism	Description
Prebisch-Singer hypothesis	Manufactured goods have a greater income elasticity of demand than primary products: as incomes rise, demand for manufactured goods increases more rapidly than demand for primary products. In addition, primary products have a low-price elasticity of demand, so a decline in their prices tends to reduce revenue rather than increase it (leading to a secular reduction of the terms of trade for primary exporting countries)
Dutch disease	The extra wealth generated by the sale of natural resources induces an appreciation of the real exchange rate and an ensuing contraction of investments in the traded sector, which loses international competitiveness
Loss in learning by doing	The traded sector is the engine of growth and benefits most from learning by doing and other positive externalities, while the commodity export sectors do not entail learning given their few 'forward and backward linkages' with the rest of the economy
Damages to institutional quality	Political economy problems: rents induce more inequality and undermine democratic institutions. Entrepreneurial spirits are stifled because badly defined property rights, imperfect markets, and poorly functioning legal systems provide ideal opportunities for rent-seeking behaviours
Corruption	Resource dependence elicits corruption and rent seeking via protection, exclusive licenses to exploit and export resources by the political elite, oligarchs, and their cronies to capture wealth and political power
Macroeconomic instability and volatility of commodity prices	Boom–bust cycles induced by volatile commodity prices lead to balance-of-payment crises and macroeconomic instability. When commodity prices are high, resource-rich countries use them as collateral for debt, but when prices fall, they find themselves in a debt-overhang situation
Conflicts over resources control	Higher resource income makes warfare more attractive as there is more to fight over and many groups try to seize the rents generated by extractive activities
Government mismanagement	Natural resource wealth may encourage countries to engage in 'excessive' borrowing, reduction of productive and infrastructural investments because the resources bonanza induces a false sense of economic security, and lead to the postponement of economic reforms
'Political' Dutch disease	Rent seeking from political elites: resource abundance generates the consolidation of elites' allocative power (distributive influence)

Sources: Auty (1983), van der Ploeg (2011), and Venables (2016).

sheer information, knowledge is usually organization- and people-embodied, consisting of tacit elements that make it spatially clustered and persistent (Bell & Pavitt 1993). Given the complexity and cumulativeness of technology (Pavitt 1987), learning and capability-building processes become of the utmost importance. A first consequence of a theory of production based on such premises is the relevance of what can be labelled *dominant* (Dosi et al. 1990) or *general purpose* technologies (Bresnahan & Trajtenberg 1995). The patterns of absolute advantage in these dominant technologies often take the form of core inventions with the potential to shape productive efficiency in a wide set of sectors due to technological interdependencies, hierarchical links between technologies and learning externalities. More interesting for our analysis, general purpose technologies are double-edged swords that act both as enablers for new innovation and as constraints for those countries not mastering them. In other words, a country displaying a large gap in these core technologies will probably be severely impaired in its ability to profit from international trade independently of the pattern of comparative advantage, up to the point that it might not take part in international trade at all (Cimoli et al. 2009a).

Given the many sectoral peculiarities of technology (Pavitt 1984; Malerba 2002),[5] one can specify sectoral trade performance as follows (Dosi et al. 1990):

$$X_{ij} = f(T_{ij}, C_{ij}, O_{ij}) \tag{1}$$

where X_{ij} is a measure of performance in country i in sector j relative to its trading partners. For instance, X_{ij} can be taken to represent the market share of exports in a certain sector, and as such it is an indicator of how *internationally competitive* the country is in that sector. Following Dosi et al. (1990), we model competitiveness as a function of technological levels, T_{ij}, variable (mainly labour) costs, C_{ij}, and the sectoral forms of industrial organization, O_{ij}. The latter variable takes into account the organizational specificities of each national industry and its path-dependent accumulation of organizational capabilities (Dosi et al. 2001). Equation (1) makes clear that short-run variations in cost prices (such as currency devaluations or contraction of labour costs) can improve trade performance, but that these gains will prove ephemeral if they are not accompanied by technological upgrading, especially for technological and skill-intensive sectors.[6] Somewhat dramatizing, we argue that in the majority of industrial sectors (especially high-wage innovative ones, such as aerospace) there is no way to challenge the industrial leaders (e.g. Airbus and Boeing) by means of cheap-labour only. Rather, the pattern of absolute advantage in the technological base will be the key determinant of international trade, as has been confirmed by a large body of empirical literature at the country (e.g. Fagerberg 1988) and sector level (e.g. Laursen & Meliciani 2002), which has only recently been complemented by firm-level analyses (Dosi et al. 2015).[7]

The discussion above also helps to clarify what we mean by the word *competitiveness*. A term first introduced and elaborated by scholars affiliated with the Berkeley Roundtable on the International Economy (BRIE), its most standard definition is the following:[8]

[5] While it is certainly true that each industrial sector shows specific traits, this approximation is not meant to neglect the considerable heterogeneity within sectors (Srholec & Verspagen 2012) which can be very persistent over time (Coad 2019).

[6] This is also implied by the so-called Kaldor paradox, namely the fact that export market shares and relative unit costs/prices tend to move together over the long term for a number of countries (Fagerberg 1996). The solution to this seemingly paradox has to be found in technological upgrading raising both productivity and quality (Fagerberg 1988), which allows higher wages to be paid. This is a crucial hint that specialization patterns are fundamental determinants of the wealth of nations, given that some sectors and activities entail larger learning and innovation opportunities, in turn assuring higher wages and welfare (Cimoli et al. 2009a).

[7] For a systematic and updated review of empirical studies, see Section 3 in Dosi et al. (2015).

[8] The notion of competitiveness remains a controversial one, and it historically spurred heated controversies (see the exchange in *Foreign Affairs* between Krugman (1994) and Cohen (1994)). While neoclassical economists see it as 'a poetic way of saying productivity' (Krugman 1994), one can identify two main interpretations of the concept (Mulatu 2016). The 'quasi-competitiveness school' acknowledges that trade is tied to growth and in the absence of interventions it can have negative welfare consequences. However, this approach is mainly about benchmarking national economic performance relative to the other trading partners (Fagerberg 1996; Godin 2004). Rather, Dosi et al. (1990), Reinert (1995), and the BRIE group (Tyson 1993; Cohen 1994) espouse a more

> [competitiveness is] our ability to produce goods and services that meet the test of international markets while our citizens enjoy a standard of living that is both rising and sustainable. (Tyson 1993, p. 1)

Thus, competitiveness is mostly about engaging in 'high-value' economic activities which can generate national prosperity (Mulatu 2016). The concept encompasses the familiar notion of productivity but goes beyond it in recognizing that achieving efficiency per se is not a sufficient condition of prosperity (Reinert 1995, 2007; Cimoli et al. 2009a). Despite being extremely efficient and productive in the sector of their comparative advantages, many countries remain poor because they specialize in products which do not provide competitiveness in the 'income-raising meaning of the word' (Reinert 1995). In a sense, competitiveness is an 'absolute' concept, because it is independent of intranational comparison of activities where a country is relatively better or worse, but rather compares one country with the rest of the world based on sectoral absolute advantages (Dosi et al. 1990).

Note that a Ricardian analysis based on comparative advantage can be derived from the framework presented above by taking ratios of the absolute sectoral competitiveness levels. The relationship between wage rates (in international currency) and average technological levels of each country determines the borderline between sectors of comparative advantage and those of comparative disadvantage (Dosi et al. 1990). In practice, comparative advantages are only an ex post computation stemming from ratios of absolute productivity levels, and many recent empirical applications do indeed recover measures of comparative advantages in this way (e.g. Hanson et al. 2015). Let us define a synthetic measure of competitiveness at the country level:

$$X_i = F(T_i, C_i, O_i) \tag{2}$$

where the variables without the sector suffix are weighted sectoral averages for each country. Then, *revealed comparative advantage* as first defined by Balassa (1965)[9] will be the ratio of two absolute measures of competitiveness:

$$RCA_{ij} = \frac{X_{ij}}{X_i} = \frac{f(T_{ij}, C_{ij}, O_{ij})}{F(T_i, C_i, O_i)} \tag{3}$$

with RCA_{ij} being the index of revealed comparative advantage of country i in sector j, and the X s are the already mentioned measure of absolute advantages, for instance international market shares. Under the assumption of competitive conditions, the variable O would become irrelevant, and likewise T would lose importance if international technological convergence were to be achieved. As shown by Dosi et al. (1990), under these two

compelling definition taking into account that different economic activities entail varying levels of innovation and learning opportunities, which in turn translate into the well-being of citizens (low unemployment, high wages, and so on). Similar views are presented in Porter (1990), who adopts a perspective closer to business economic insights (see also Delgado et al. (2012) for more recent refinements).

9 Since Balassa's contribution, many refinements of his index have been proposed (e.g. Eaton & Kortum 2002). Still, the rather a-theoretical RCA index is very robust and remains a good approximation of the data (French 2017). Dosi et al. (1990) refer to the RCA as 'revealed relative allocations' stemming from intra-country differences in inter-sectoral technological levels.

conditions the determination of comparative advantage and of sectoral competitiveness become the same thing.[10]

But what if these two conditions are not met? Then, the technological structure does not allow all relevant information about absolute levels to be summarized by comparing ratios. As a consequence, an analysis based only on comparative advantages can be highly misleading (MacDonald & Markusen 1985), because countries with similar relative productivity can be very different in absolute technological levels.[11] In turn, absolute technological levels (and not comparative ones) are a fundamental driver of trade performance and, ultimately, welfare. For instance, technological capabilities constrain what a country can produce efficiently, with ensuing consequences for its participation in world trade. To clarify the point, Cimoli et al. (2009a) describe the thought experiment of opening trade between a 'Stone Age economy' and an ICT-based one. As Ricardo would argue, the country coming from the Stone Age should be more likely to export 'stone-intensive' products for which it has a comparative advantage (and vice versa for the ICT-based economy with, say, computers). However, if the more advanced ICT economy ends up producing almost anything worth trading or for which there is international demand, then the Stone Age economy could end up not taking part in international trade, irrespective of the stone- or ICT-intensities of its products. What matters might ultimately be absolute levels of technological capabilities and how they interact with world demand for products, as we shall discuss in what follows.

19.2.3 The Effects of Trade upon the Process of Development

In the foregoing, we distinguished two research traditions in international trade following Dosi et al. (1990). On the one hand, conventional theories of trade locate the source of trade in differing resource endowments and rely on comparative advantage as the key determinant of trade flows. On the other hand, a second 'heretic' line of thinking focuses its analysis on absolute technological advantages due to the accumulation of technological capabilities. In this perspective, comparative advantages are only the ex post outcome of technological learning processes and public policies are of the utmost importance for the acquisition of absolute technological advantages and competences (Dosi et al. 1990; Bell & Pavitt 1993; Cimoli et al. 2009a; Mulatu 2016; Juhász 2018).

The two schools of thought also differ in their normative predictions about the dynamics of trade-induced structural change. Mainstream trade theories generally hold that free trade benefits every country taking part in it, even those showing an absolute disadvantage in every sector. In general equilibrium models specialization according to comparative advantages is usually shown to provide the best strategy for structural transformation, since it

[10] More in detail, the RCA index is usually defined equal to the proportion of the country's exports that are of the class under consideration divided by the proportion of world exports that are of that class. Consider now a measure of competitiveness at sectoral (e.g. absolute market shares of a country in a certain sector) and country level (e.g. absolute market share in world trade, as a weighted average of sectoral competitiveness levels). Neglecting the role played by dominant technologies and organizational capabilities, then the ratio between these measures of absolute advantage reduces to a calculation similar to the RCA index.

[11] To state this with a vivid example of MacDonald & Markusen (1985, p. 278): 'It is not persuasive that the employee with the highest comparative advantage in management should become president. Indeed, it is plausible that the presidency assignment will have something to do with absolute advantage; alternatively, a person with poor management skills will not be chosen even if he is relatively worse at every other task in the firm.'

leads to a globally optimal utilization of resources. The fundamental premise underlying this set of propositions is what we can call a *Ricardian adjustment mechanism* (Dosi et al. 1990). To put it bluntly, Ricardian adjustments are 'stationary' adjustment processes (i.e. holding technology constant) based on the behavioural tendency at the microeconomic level towards minimum-cost/maximum-profit activities. The standard assumption in these models is that adjustment processes do not affect the rate of utilization of the stock of inputs themselves, so that trade affects the inter-sectoral allocation of inputs quantities and prices only. Even under this heroic assumption, conforming to comparative advantage induces at best a once-and-for-all increase in the short-term efficiency of the international location of productive activities.

Suppose now that, due to a successful innovation, any one country *i* improves its productivity in sector *j*, i.e. it increases its absolute advantage in only that sector. Clearly, an increase in productivity (and hence profitability) of that sector would spur the comparative advantage mechanism of adjustment and change the inter-sectoral allocation of resources, thus leading to structural change in the direction indicated by comparative advantages. However, increased technological capabilities in a certain sector vis-à-vis foreign competitors will also lead to an increase in world market shares of country *i* in that sector (Dosi et al. 1990). This competitiveness-related mechanism of adjustment entails macroeconomic dimensions, such as changes in the absolute amount of employed resources, the rate of growth, and wage rates. Higher export market shares will lead to higher levels of economic activity, with the gains from increased competitiveness distributed between higher growth and higher wages. If higher world market shares in sector *j* for country *i* were matched with unchanged world market shares in all other sectors, then it can be concluded that a gain in competitiveness will unambiguously be a Pareto improvement. More likely, the increase in wages will slightly harm competitiveness in other sectors, but still without eroding all the other gains of the innovative process (Dosi et al. 1990).

Given the link between trade and macroeconomic activity levels, when evaluating trade-induced structural change we can introduce two other efficiency criteria besides sheer Ricardian static efficiency. *Keynesian efficiency* relates to the property by which open economies pull each other's demand via imports, while at the same time constraining each other's growth possibilities via the need to balance the foreign accounts (Cimoli 1988; Dosi et al. 1990). Indeed, international trade flows entail an often-neglected macroeconomic dimension insofar as producing goods with high foreign demand stimulates domestic economic activity. Instead, *Schumpeterian efficiency* is a 'dynamic' concept that pertains technological change and the specialization in sectors that create more technological externalities, have higher technological opportunities, and exhibit higher rates of innovation. Technical change is of paramount importance in shaping the inner dynamism of the international system by expanding the possibilities of growth and possibly redistributing them between countries. Schumpeterian adjustments are thus fundamental, and specialization in the most innovative sectors dominates the short-term gains induced by Ricardian comparative advantages.[12] To make a similar point, Reinert proposes two extreme types of economic activities, Schumpeterian and Malthusian activities. While the

[12] Analogue conclusions and policy suggestions are derived with a formal apparatus by the new trade theory, by simply allowing for some form of increasing returns and imperfect competition. Even without adopting an evolutionary view on technology, the sheer presence of dynamic scale economies in the form of learning by doing are sufficient to justify policy interventions to alter the given pattern of comparative advantages (Krugman 1987).

former activities are distinguished by continual innovations and dynamic increasing returns that lead to increasing wages and prosperity, the latter keep low wage levels because of the absence of technological learning. Needless to say, Schumpeterian activities are more common in manufacturing, whereas the other category is found typically in agriculture and commodity production (Reinert 2007; Hausmann et al. 2007). Resource-based economic activities also suffer from a drawback relative to other industrial activities, namely *diminishing returns* (Reinert 1996). Output increases in resource-based activities will eventually lead to a point after which the crucial resource is no longer available, or it is left only in lower quality (extractive activities provide a straightforward example of such a situation). This is what Reinert (1996) dubbed the 'double trap of resource-based nations': the resource-based nation is locked into an economic activity which yields less and less as its specialization according to its comparative advantage deepens.

To summarize, (technological) *absolute advantages* can be said to dominate over comparative advantages as determinants of trade flows: absolute advantages account for most of the composition of trade flows by country and by commodity and explain the evolution of such trade flows over time. In general, the most advanced countries will show a higher participation in world trade in their sectors of comparative disadvantage than will any backward country show in its sector of comparative advantage, due to the absolute macroeconomic dimension that competitiveness entails (Dosi et al. 1990). However important, the efficacy of Ricardian adjustment mechanisms is constrained by absolute levels of competitiveness and the ensuing world market shares. Only in a world tending to technological convergence, will intra-country mechanisms of specialization related to comparative advantages be the fundamental factor in explaining patterns of trade-induced structural change. The opposite will apply to a world where technological asymmetries are increasing (or at least not reducing): sectoral technological absolute advantages between countries become the major determinant of international market shares (Dosi et al. 1990). This situation justifies the need for undertaking structural transformation against comparative advantages in order to specialize in activities characterized by increasing returns, learning, and positive externalities (Krugman 1987; Reinert 2007; Chang 2002; Cimoli et al. 2009a; Stiglitz & Greenwald 2014; Juhász 2018).

19.3 Why Competitiveness Matters: Insights from a Stylized Technology Gap Model

We have so far outlined the main tenets of a theory of absolute technological advantages, discussing how it differs from trade theories based on endowment-based comparative advantages. In order to explore the consequences of trade on structural change, we will now rely on the Dosi-Pavitt-Soete (DPS) model (Dosi et al. 1990) which we will present in a simplified version. The model will also be useful later, when we discuss the consequences of the liberalist turn of the 1980s and of current globalization patterns.

Let us start by assuming the existence of two kinds of commodities. The first group is constituted by *Ricardian commodities*, i.e. commodities that are traded only on the grounds of the cost of production. The second group are the *innovative commodities*, whose production requires the possession of adequate technological capabilities. We next assume that the only production input for both groups of products is labour. For the sake of simplicity, we will further postulate the existence of only two countries, *A* and *B*, with the former being the only one initially capable of producing and exporting innovative commodities.[13] Their labour input coefficients for the production of Ricardian commodities will be $a_1, a_2, \ldots, a_n$ and $a_1^*, a_2^*, \ldots, a_n^*$ for country A and B, respectively. If these coefficients are ranked according to the diminishing comparative advantage of country A, we will have:

$$\frac{a_1^*}{a_1} > \ldots > \frac{a_i^*}{a_i} \geq 1 > \ldots > \frac{a_n^*}{a_n} \tag{4}$$

where, for instance, country A has the largest comparative advantage on the first few Ricardian commodities, a situation that reverses after commodity i. Calling z the generic Ricardian commodity, for each z we can define the following function $A(\cdot) : [0,1] \mapsto \mathbb{R}_+$:

$$A(z) = \frac{a^*(z)}{a(z)} \text{ with } A'(z) < 0 \tag{5}$$

International specialization for each commodity in A or B will depend on the relative unit labour cost, in turn depending on the labour input coefficients and the wage rates w and w^*:

$$a(z) \cdot w \gtrless a^*(z) \cdot w^* \text{ i.e. } \omega \gtrless A(z), \text{with } \omega = \frac{w}{w^*} \tag{6}$$

Figure 19.1 summarizes the model thus far. At the generic wage ratio ω, country A specializes in the set of commodities from r_0 to z_0, where $z_0 = A^{-1}(\omega)$ is the borderline commodity separating the group of products for which A has a comparative advantage. The graph also shows the effects of an increase in productivity in A (for instance as a consequence of process innovation) that moves the R_0 line to R_1, thus allowing for a wider

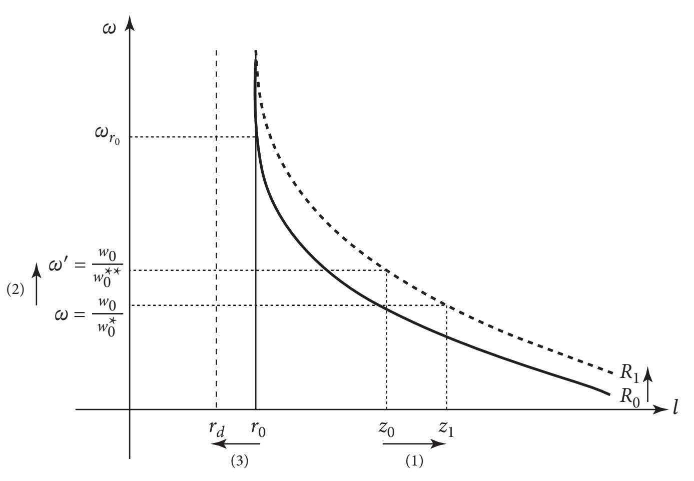

Figure 19.1. International specialization with a continuum of innovative and Ricardian commodities
Source: Authors' elaboration.

[13] The two countries correspond to what could be labelled North and South in the terminology introduced by Ronald Findlay (e.g. Cimoli 1988).

specialization (arrow 1 in Figure 19.1) for a given wage ratio ω_0, or a higher wage ratio for a given specialization (arrow 2).

However, this applies only for Ricardian commodities: the set of innovative commodities (from the origin to r_0) will be produced and traded only by the technological leader, which we assumed to be country *A*. Therefore, an increase in domestic wage relative to the partner country will reduce the set of commodities which the country can competitively produce but does not affect the international distribution of technological capabilities (and hence the production of innovative goods). Rather, country *B* should put in place industrial and trade policies capable of reducing its technological gap, that is shifting r_0 as shown by the arrow labelled (3). The graph and the model also highlight the limits to the Ricardian adjustment processes for developing countries, that is structural change in the pattern of production based on comparative advantage. This is given by r_0, that is the borderline commodity between innovative and Ricardian products: any increase in the wage ratio ω above ω_{r0} (due for example by a decrease in *B*'s wages) will have no effect on specialization, but it only worsens the terms of trade for *B*.

This sketch of the DPS model highlights the possibility of unintended consequences of trade liberalization, that is what can be dubbed 'imported deindustrialization' (Reinert 2007; Rodrik 2016): a sudden opening of trade between nations with asymmetrical technological levels will likely harm the most advanced and knowledge-intensive industry of the more backward country. Reinert (2007) argues that the ensuing 'primitivization' of the national production system will ultimately reduce welfare as it will eliminate the production of innovative goods in developing countries (resulting in r_0 shifting to the right in Figure 19.1). Therefore, premature liberalization can have negative consequences protracted over time. Given the presence of localized increasing returns and learning, greater integration might lead to phenomena of increasing differentiation with self-reinforcements and lock-in of particular production activities and specialization patterns (Dosi et al. 1990; Cimoli et al. 2009a). The strand of research that better acknowledges this point is probably Latin American structuralism (see Chapter 3 by Porcile in this volume), which explicitly deals with the centre–periphery dynamics that emerge between unequal trading partners (as shown in the North–South model developed by Cimoli 1988).

To map these processes of production and specialization to income and employment, we follow Dosi et al. (1990) and assume that national incomes of *A* and *B* will be given respectively by:

$$Y = wN \text{ and } Y^* = w^* N^* \tag{7}$$

where w , w^*, and N , N^* are wages and employment levels in country *A* and *B* respectively. This is a reasonable approximation given our assumption of labour as the only input. Note that employment levels *N* are not necessarily equal to the whole labour force *L*, that is $N \leq L$ and $N^* \leq L^*$. Finally, in our simplified model with only two countries, it must be that each economy satisfies the trade-balance constraint. The GDP of each country will be given by the sum of internal demand and exports (i.e. external demand), which in turn represents the other country's imports.[14]

[14] More formally, we have that the income of country *B* multiplied by its import propensity must equal that of country *A* times the latter's import propensity. If we specify import propensity as a function $\varphi(\cdot)$ of the commodity *z* in question and of both national and international wage rates (the first affecting consumption and the latter imports' costs, see Dosi et al.1990), we can write: $\frac{Y}{Y^*} = \frac{\phi^*(z,\omega)}{\phi(z,\omega)}$ (8).

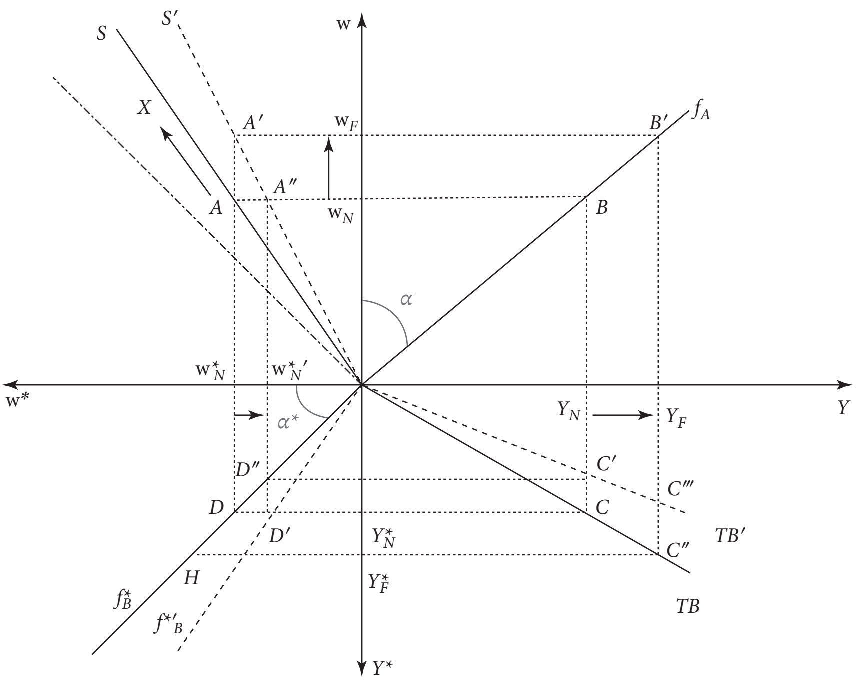

Figure 19.2. An illustration of the relationship between specialization, trade, and levels of macroeconomic activity
Source: Authors' elaboration.

Figure 19.2 illustrates the whole picture constituted by the system of equations 6, 7, and 8 in the footnote. The line *S* in the top-left quadrant is the locus of the ratios between wages in *A* and *B* that guarantee a certain specialization, as represented by commodity z_0 in Figure 19.1. Each pattern of international specialization corresponds to a line *TB*, representing the locus of equilibrium points for the trade balance between the two countries. In the simplest case of $Y = wN$, the angle α is a measure of employment in country *A*, with the same applying for a^* and country *B*. The situation represented shows country *A* having an absolute advantage in productivity over its trading partner, thus the line *S* lies above the dash-dotted 45-degree line.

Let us start from an initial situation corresponding to the points *ABCD* on the thick lines *S*, f_A, *TB*, and f_B^*, respectively. Country *A* has higher technological capabilities and this allows higher absolute productivity and higher wages. Still, neither country is at full employment levels: for instance, given the current international specialization, country *B* would reach full employment at point *H*, which is however incompatible with the current trade balance *TB* and prevailing wages. Nevertheless, the situation represented here is efficient in static allocative terms, because it satisfies by construction the Ricardian criterion of efficiency discussed in Figure 19.1. Another point worth noting is the dominance of absolute technological levels in the determination of income. *Ceteris paribus*, an increase in absolute productivities shifting point *A* to point *X* would leave both countries better off, irrespective of comparative advantages. This mirrors the point of MacDonald & Markusen (1985) that relative measures can obscure the importance of absolute levels, often more relevant in economic terms.

Suppose now that the line S rotates to S' because there is a change in the international wage ratio, $\omega = \frac{w}{w^*}$. This could happen because country B reduces its wages from w_N^* to $w_N^{*'}$, so that point A moves to A'' if wages (and hence income) in the technological leader A do not change. The new situation could turn out to be favourable to the developing country B because point D moved to D' on the line $f_B^{*'}$, corresponding to a higher employment level. But what if the reduction of wages changed the comparative advantage of B, thus leading it to specialize in commodities that a lower share of consumers in country A is willing to buy? In this case, a reduction in imports from A shifts the trade balance constraint to TB', completely offsetting the employment gains resulting from the wage cut ($f_B^{*'}$ rotates back to f_B^* and D goes to D''). Country B is now poorer because its Ricardian adjustment process led to the 'wrong' kind of specialization. Similarly, an increase in the technological gap could move point A to A'. If TB and hence the import propensity of A remain unchanged, then country B would experience an increase in income and employment (because C moves to C'' and requires f_B^* to rotate to the right). This apparently paradoxical result is due to the increase of GDP and consumption in the richest country A, which could translate in higher imports from country B. But again, if technological advance makes country A capable of efficiently producing almost all worth trading, then TB would rotate upward to TB'. This once again emphasizes the relevance of Keynesian efficiency relative to microeconomic criteria of efficiency in the spirit of Ricardo.

Specialization patterns thus bear important implications for international competitiveness: engaging in high-value sectors (usually the high-technology ones) characterized by a high income elasticity of demand and high learning opportunities will likely result in higher wages and wealth for the entire country (Cimoli et al. 2009a). This remark, which may at a first glance appear a platitude, for a long time has been a controversial view in the economic debate. Indeed, a strict application of neoclassical trade theory would imply the infamous proposition attributed to Michael Boskin, who allegedly claimed that 'it does not make any difference whether a country makes potato chips or computer chips!' (Thurow 1994). In this perspective, specialization according to comparative advantage would always be the best path to prosperity, whatever the outcome of the specialization process. Ricardian trade theories are rather agnostic on the quality of goods traded, implicitly assuming that trade is good for everyone no matter the kind of goods effectively traded (Kemp & van Long 1984). Both common sense and economic research show that this is not the case (Reinert 2007; Hausmann et al. 2007), and specialization patterns are highly predictive of economic performances (Tacchella et al. 2012).[15]

However, comparative advantages might not induce a country to specialize in those sectors: if left to themselves, countries endowed with natural resources will likely end up exporting primary goods. Take for instance the labour productivity level reported in Table 19.2, adapted from McMillan & Rodrik (2011). Inter-sectoral productivity levels tend to be much wider in developing countries, with the staggering example of Nigeria making the point. If anything, this should spur Ricardian processes of resources reallocation towards more efficient and remunerative sectors, in turn providing growth-enhancing structural change. However, the issue here is the *nature* of sectors where developing countries often show high productivity, namely commodities production. The problem for countries with large endowments in natural products is that primary sectors operate at relatively high productivity levels, but they generate very low employment (McMillan &

[15] See Chapter 10 by Freire in this volume for a review of the product-space literature that makes a similar point.

Table 19.2. Productivity of labour for selected countries and sectors in 2005

	Labour productivity	Sector with the highest labour productivity		Sector with the lowest labour productivity	
	Economy-wide	**Sector**	**Productivity**	**Sector**	**Productivity**
United States	70,235	public utilities	391,875	construction	39,081
France	56,563	public utilities	190,785	personal and public services	37,148
Argentina	30,340	mining	239,645	finance, business services	18,290
Nigeria	4,926	mining	866,646	personal and public services	264

Note: Figures are in 2000 PPP$.
Source: McMillan & Rodrik (2011).

Rodrik 2011). Inter-sectoral comparative advantages are thus misleading drivers of development, and the positive impact of structural change is found to be larger for countries that manage to reallocate a large share of employment to manufacturing activities (McMillan et al. 2014). To paraphrase Amsden (1989), countries rich in natural endowments should 'get Ricardo wrong' and use industrial and trade policies to alter the given pattern of comparative advantages.

In conclusion, the key point for policymakers is that sheer acceptance of comparative advantages might not be sufficient to achieve satisfactory competitiveness levels. Not every type of economic activity is bound to generate the same levels of learning and accumulation of technological capabilities. Different commodities and sectors are likely to be associated with different levels of opportunities for innovation and different income elasticities of demand (Dosi et al. 1990). The presence of increasing returns and learning effects might even lock in the economy to an inferior technology (David 1985; Dosi et al. 1994). It is thus easy to imagine situations where Ricardian efficiency in static terms could conflict with the achievement of the maximum rate of innovative dynamism, namely Schumpeterian efficiency. Similarly, countries might 'efficiently' specialize in the production of commodities that a small or decreasing number of world consumers wants to buy, with the ensuing negative long-term effects in terms of Keynesian efficiency (Dosi et al. 1990).[16]

19.4 Structural Change According to Comparative Advantage: A Discussion of the Empirical Evidence

19.4.1 Many Exceptions or a Different Rule? The Historical Evidence

Since the late 1950s, the economics profession has been investigating the issues of growth and structural transformation intensively (for a review of the other early contributions see Chenery 1960; Kuznets 1966; Syrquin 1988). In his Nobel Prize lecture, Kuznets (1973)

[16] This is precisely what Engel's law would predict for the primary sector: as per capita incomes rise, the share of agricultural expenditures in total expenditures declines due to low income elasticity (Szirmai & Verspagen 2015).

highlighted what he saw as constituting the main characteristics of modern economic growth. Indeed, the third of these 'Kuznets facts' is the high structural transformation rate of the economy: Kuznets was referring to the progressive shift away from the industries relying on natural resource endowments (agriculture, mining, commodities) towards manufacturing and services (Herrendorf et al. 2014). Roughly speaking, one could claim that successful development entails a systematic effort to build a national production capacity (Cimoli & Dosi 1995), a process that does not need any particular kind of starting endowments to be successful.

A comprehensive historical account of structural change and industrialization is provided by Ha-Joon Chang (2002). The most telling cases of successful latecomers' industrialization are probably the United States and Germany. Indeed, it was the first Secretary of the US Treasury, Alexander Hamilton, who systematically set out the infant industry argument in 1791. In a nutshell, Hamilton argued that foreign competition would have prevented domestic industries from becoming internationally competitive, unless the state had intervened to compensate initial losses or to enforce import duties (Hamilton 1791). American industries ended up being literally the most protected in the world until after WWII (Chang 2002), which goes a long way in explaining the US pattern of structural change. Furthermore, the role of the Federal government in industrial development has been substantial even in the post-war era, thanks to the large amount of defence-related procurement and mission-oriented research (Mazzucato 2015; Mowery 2012).[17] Similarly, in List (1841) we find a very lucid discussion of the shortcomings of simply adhering to comparative advantages: in his view, the true objective of developed countries trying to impose free trade over Europe was simply 'kicking away the ladder' that they themselves had climbed (Chang 2002). The German experience also points to the importance of ad hoc institutional innovations which facilitated catching up and were the basis for the successive forging ahead with respect to Britain. Of importance was the introduction of the Humboldtian model of higher education to form the human capital that proved essential for the diffusion of in-house industrial R&D departments (Dosi et al. 1994). Another pillar of German industrialization was the emulation of imported British machine tools (often thanks to British craftsmen attracted to Prussia, see Freeman 1995). More recently, Japan (Freeman 1987) and the Asian Tigers (Nelson & Pack 1999) were able to reap the benefits from fast-growing technological markets, unlike Latin American economies. At the root of the Japanese success was the explicit decision by Japanese political authorities to neglect the path of 'natural' development implied by comparative advantages (Freeman 2004). In just a few years, Japan ceased being an importer of foreign technology and developed important indigenous innovation capabilities, even surpassing the United States in terms of R&D efforts. The secret of its success was building up of one of the most successful innovation systems (the one that inspired the concept, see Freeman 1987), where the long-term planning of the MITI fostered learning and spurred innovation in the export-led industrial complexes.

[17] The United States also benefited from abundant natural resources, but their role in explaining the American long-standing success is controversial. Wright (1997) and David & Wright (1997) suggest that the contribution to growth of the fixed set of natural endowments was actually the outcome of technological learning coupled with institutional arrangements that encouraged both public and private search efforts. However, other historical accounts even question the basic tenet that natural resource endowments fostered US industrialization. Allen (2014) argues that abundant natural resources eventually retarded the industrialization of the United States given that the large volume of exports of primary products was inflationary and produced a Dutch disease situation.

The classic works mentioned above are detailed case studies of single countries and their historical experience. More recently, research leveraging natural quasi-experiments and new estimation techniques has allowed the precise causal identification of the effects of sectoral trade and industrial policies. For instance, China's 11th five-year plan (2006–2010) promoted shipbuilding as a strategic industry for defence-related purposes. Kalouptsidi (2017) finds that the reduction in production costs associated with the policy explains the massive Chinese gains of global market shares in ships: in the absence of the targeted subsidies, China's production would be cut to less than half. Lane (2017) studies the Heavy Chemical and Industry (HCI) policy that the Republic of Korea enacted in 1973 as a response to the US troop withdrawal. Again, targeted industries were chosen for their military importance, and the comparison with otherwise similar industries shows that the policy promoted rapid development that lasted long after the measures were removed. Interestingly enough, downstream sectors also benefitted from the lower prices induced by the policy, an instance of the policy-induced industrial externalities that Hirschman (1958) labelled 'forward linkages'. The HCI entailed both industrial subsidies and targeted trade protection; nonetheless, it must be noted that in certain situations sheer trade protection can be sufficient to change the patterns of trade and to allow industrialization. Juhász (2018) documents that the temporary protection from British imports caused by the Napoleonic Blockade was fundamental in the accumulation of technological capabilities in nineteenth-century France. The mechanized cotton-spinning industry rapidly developed in French departments that received more sheltering, in plain accord with the predictions of the infant industry argument. Hanlon (2019) complements this evidence by looking at production input advantages, instead of output market protection. Using data from last century's metal shipbuilding, he shows that even a temporary cost advantage can become the source of long-lasting competitive advantage due to dynamic localized learning effects and learning by doing.

Some general patterns can be distilled from these historical cases. First, all countries that successfully industrialized appear to have been guided by the principle of emulation of the countries at the technological frontier (Reinert 2007). Countries that have got rich have usually disregarded their endowment structures, rather preferring to 'get the prices wrong' and guide their structural transformation towards high-value-added sectors (Amsden 1989). Secondly, as the Japanese and German experiences highlight, successful development can rarely be achieved without introducing the necessary social technologies and institutional changes tailored to the specific needs of the country (Abramovitz 1986; Dosi et al. 1994; Nelson & Sampat 2001).

As a final point, virtually every now developed country actively used industrial and trade policies to protect and promote its industrial sector (Chang 2002; Reinert 1999; Cimoli et al. 2009a), sometimes even inadvertently (Juhász 2018). Each country had to develop its own substitutive factors according to its idiosyncratic necessities and the then prevailing techno-economic paradigm (Gerschenkron 1962; Dosi et al. 1994; Reinert 1999; Freeman & Louçã 2001). Often, the state had to do more than simply push entrepreneurs into certain strategic sectors, sometimes even ending up acting as 'entrepreneur of last resort' (Reinert 1999; Baldwin & Krugman 1988; Head 1994).[18]

[18] These considerations notwithstanding, one must bear in mind also the many instances where industrial policies failed in achieving their aims (Harrison & Rodríguez-Clare 2010). The interested reader is referred to the discussion in Cimoli et al. (2009a) on the practical challenges in designing industrial policies consistent with the internal power balances and institutional setting of each country.

19.4.2 Comparative Advantages after Globalization

Starting from the early 1980s, a set of policies emerged that formed a rather invariant recipe for development. These policies, known under the heading of 'Washington Consensus', rested on three main tenets: a market economy, openness to the world, and macroeconomic discipline (Rodrik 2006; Serra & Stiglitz 2008). The Consensus entailed a development strategy markedly different from the set of policies followed by development states during the previous decades (and centuries). In practical terms, it translated into deep fiscal adjustment and a dramatic reduction for the role of the state in the economy. The Consensus also spurred a widespread liberalization of international trade and a generalized reduction of tariffs. The new trade landscape, crystallized by the creation of the World Trade Organization (WTO) in 1995, entailed very low tariffs on industrial products, with very narrow tariff dispersion both across countries and across products (Akyz 2009). Furthermore, the policy space of single countries has been substantially reduced, depriving them of most industrial and trade policy tools (see Chapter 27 by Felipe in this volume).

The DPS model (Dosi et al. 1990) presented in Section 19.3 can help shed light on the consequences of globalization on the dynamics of structural change induced by trade. To begin with, we already mentioned the 'Vanek-Reinert effect' (Reinert 2007) or 'imported deindustrialization' (Rodrik 2016). Technological gaps strongly condition the dynamics of trade, and Ricardian adjustment processes tend to go against the accumulation of technological skills over time, thus leading to a polarization of manufacturing in few countries. Premature liberalization can also have negative consequences that are protracted over time. Given the presence of localized increasing returns and learning, greater integration may lead to phenomena of self-reinforcing lock-in in production activities which are not efficient in Schumpeterian and Keynesian terms (Dosi et al. 1990; Cimoli et al. 2009a). Finally, the curtailing of policy space might have increased the relative importance of natural resource endowments and curbed the virtuous structural transformation into industrial economies of less-developed countries (LDCs) (McMillan & Rodrik 2011). In other words, comparative advantages could now be exerting a more dominant role on structural change because of unbridled globalization. McMillan and Rodrik have investigated the role of natural resources in structural change in a series of studies (McMillan & Rodrik 2011; McMillan et al. 2014; Diao et al. 2017). Their basic finding confirms our expectations: when globalization is not moderated by policies to guide structural transformation, countries specialize according to comparative advantages. Still, this specialization faces physiological limits due to the very low employment that the primary sector can generate, despite operating at relatively high productivity levels.

Consistent with the historical evidence summarized above, Figure 19.3 using data from Feenstra et al. (2005) and the BACI dataset documents a secular decline in the share of primary commodities in world trade. Besides structural change and the growth of trade in manufacturing, one explanation for this decline is the declining real price of commodities. During the twentieth century, world demand for commodities has been growing, while their price in real terms has been declining (Figure 19.4; see the discussion in Jones 2016). Indeed, the low demand and supply elasticities of commodities make fluctuations in their prices quite large (Fally & Sayre 2018). These big and often cumulative fluctuations are usually much larger than price changes in manufactured goods (Jacks et al. 2011). For many developing countries primary products account for most of their exports (Fally & Sayre 2018), so that the consequences of this volatility can be very large and partially account for the slow growth of resource-dependent countries (James 2015).

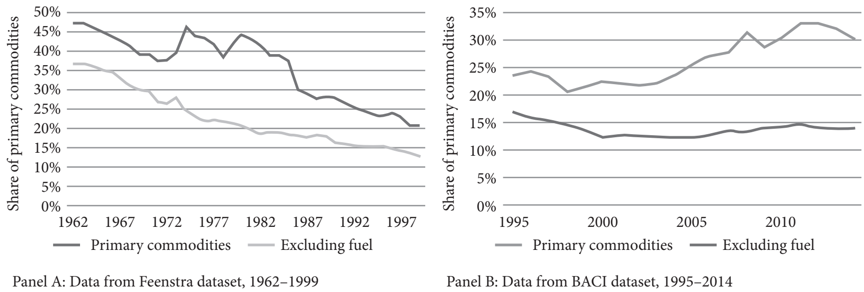

Figure 19.3. Evolution of the share (in value) of primary commodities in world trade
Note: Panel A: Data from Feenstra dataset, 1962–1999. Panel B: Data from BACI dataset, 1995–2014.
Source: Feenstra et al. (2005) and BACI dataset.

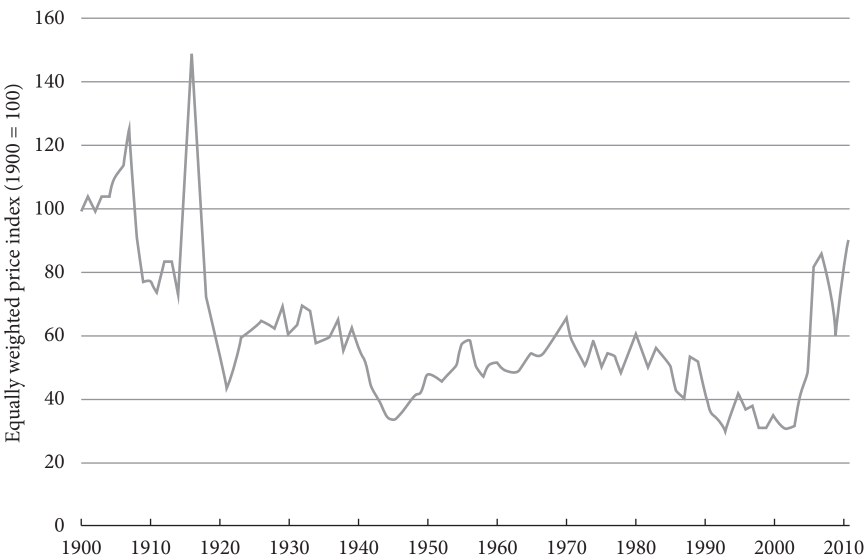

Figure 19.4. The real price of metal commodities (aluminium, copper, lead, silver, tin, and zinc)
Source: Based on data from Pfaffenzeller et al. (2007).

However, what Figure 19.3 also shows is a pick-up of trade in commodities starting from around the year 2000, as well as a large increase in their real price (Jones 2016). Part of the explanation is to be found in the rapid growth of China and India, which entailed a large increase in the demand for commodities over this period. Be that as it may, this phenomenon had two effects on developing countries: while initially stimulating growth, they also led to an increasing reliance on exports of natural resources, thus reinforcing structural change along the lines of comparative advantage.

Suggestive descriptive evidence is provided in Figure 19.5, which summarizes the growth of export production during the last decade broken down by sector. While developed countries mostly exported services and manufacturing goods, Latin America, the Middle East and North Africa (MENA), and sub-Saharan Africa (SSA) witnessed increases of exports largely concentrated in natural commodities (amounting to 30 per cent, 42 per

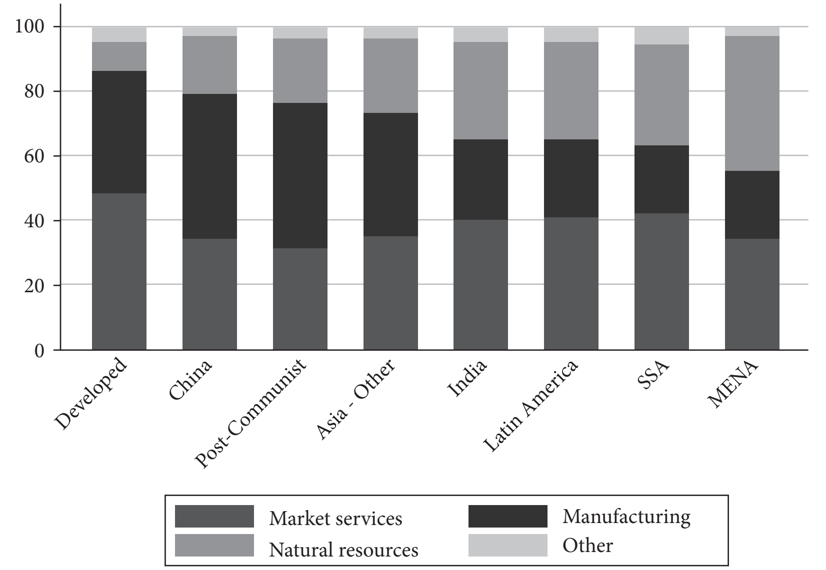

Figure 19.5. Growth of production for foreign markets broken down by sector and country group, 2001–2011

Note: SSA = sub-Saharan Africa; MENA = Middle-East and North Africa.
Source: Based on data from Verspagen & Kaltenberg (2015).

cent, and 31 per cent respectively, see Verspagen & Kaltenberg 2015). As predicted by the DPS model, this situation has the double effect of encouraging specialization in commodities through Ricardian adjustments while impeding the formation of an industrial sector capable of absorbing a larger fraction of the workforce. The empirical evidence by Coniglio et al. (2018) confirms how large natural resource endowments make it more difficult to diversify away from the current comparative advantage. For every dollar of resource exports it is estimated that 74 cents of non-resource exports are displaced (Harding & Venables 2016).

Several scholars have also provided new evidence on the rather old hypothesis of manufacturing as the 'engine of growth' (Szirmai 2012; Szirmai & Verspagen 2015; Haraguchi et al. 2017). Rodrik (2012) shows that the manufacturing sector exhibits unconditional convergence in labour productivity: the poorer a country is, the faster the productivity in its manufacturing sector will increase towards the technological frontier. Relative to other sectors, manufacturing has a higher potential for technological progress without being dependent on other country-specific conditions (Haraguchi et al. 2017) and it has traditionally absorbed significant quantities of unskilled labour, unlike mining activities (Rodrik 2016). Linkages between natural resource production and other sectors have historically been weaker than between manufacturing and the rest of the economy (Greenwald & Stiglitz 2013), helping to explain the persistent large gap between the state of technology in the natural resource sector (mainly mining) and other sectors documented in Table 19.2.

Throughout this period, a number of developed countries have remained technological leaders (Castaldi et al. 2009; Castellacci 2008), with very few new entries in this 'technology club' due to the absence of proper policies (Castellacci & Archibugi 2008). Note that similar conclusions are reached using the notions of 'complexity' and 'product space' to guide empirical analyses (see Chapter 10 by Freire in this volume). First introduced by Hidalgo & Hausmann (2009), complexity rests on the idea of using the range of exported goods to proxy the technological and productive capabilities of a country. The concept has been refined by Tacchella et al. (2012) and Tacchella et al. (2013), who developed a complexity-weighted diversification index that they called *Fitness*. In practice, they consider that developed countries export most products, thus making the main information on products' complexity determined by the worst of its producers. For instance, a product that is produced by some scarcely competitive countries will have a low complexity, while the opposite will be true for products that only few developed countries produce. Therefore, a reasonable measure of country fitness or competitiveness (what we labelled X_i in Equation (2)) will be given by the sum of all the products of the export basket weighted by their complexity.[19] The notion of fitness is thus well in tune with how we defined competitiveness, and its microfoundations are akin to our 'qualities of specialization': that is, the type and properties of exported products combine to determine income and growth rates, as shown by many empirical papers (Hausmann et al. 2007; Hidalgo & Hausmann 2009; Tacchella et al. 2012). This literature also confirms the contention of Dosi et al. (1990) that absolute advantages determined by technological capabilities are the fundamental determinant of countries' participation in international trade. Advanced countries are also found to export products for which they do not possess a comparative advantage, contrary to what Ricardo would have predicted. If anything, comparative advantage theory is found to be working only in developing countries, whose export basket is limited to a handful of products. This asymmetry shows the relevance of diversification (Hidalgo & Hausmann 2009) and its advantage over Ricardian specialization (Tacchella et al. 2013); however, diversification is a luxury only available for countries that possess the necessary productive capabilities (Bahar & Santos 2018).

19.4.3 Is This Time Different? What China Can Teach Latin America

Despite this dismal overview, some exceptions to the common pattern exist. Globalization did not harm the East Asia Tigers, which kept growing and industrializing at a satisfactory pace. This is partly explained by their overall defiance of the Washington Consensus prescriptions that led them to retain a wide range of heterodox policies (Cimoli et al. 2009a). These examples show the importance of staging and gradual opening to international trade according to the specific needs of each economy.

On average, countries that managed to keep in place their trade and industrial policies achieved a successful development performance, China being the obvious example. Indeed, the last three decades have seen an impressive growth of the Chinese economy (Yao 2014). China undertook a deep and fast structural transformation, from a traditional and mostly rural economy to an economy driven by industrial activities. It is fair to say that China has been able to enormously profit from globalization, and it is now its fiercer advocate (*New York Times* 2017; Lund & Tyson 2018).

The causes of this success are manifold. *In primis*, China has adopted a gradualist approach of economic reform and market opening (Yu et al. 2015). Chinese firms entered global markets only after several decades of protection and capabilities accumulation,

[19] In recent papers, both Hidalgo (Albeaik et al. 2017) and Hausmann (Brummitt et al. 2018) have proposed new versions of their original complexity index. Still, their new work adds very little to the Fitness Index, and it seems a simple rediscovery of the work by Tacchella et al. (2012) and Tacchella et al. (2013) (see Pietronero et al. 2017 for a discussion).

avoiding the negative Reinert-Vanek effect of sudden international competition. Reforms had a ‘dualistic nature’, where a separate export-promoting regime was created alongside the existing regime of import-substitution (Harrison 2014). Secondly, China has been using a whole range of industrial policies and direct state interventions to govern its industrialization (see Dahlman 2009 for a thorough analysis). Those have entailed controls on FDI, the establishment of special export-processing zones amidst diffused protectionism, local content requirements, the establishment of heavily subsidized state-owned enterprises and massive investments in education and training. With reference to trade policy, tariffs have been generally high and consistently biased towards export-oriented sectors (Harrison 2014). Furthermore, China has institutionalized the policy of emulation of foreign technologies by means of a deliberately lax IPRs regime (Reinert 2009; Dahlman 2009). Recent microeconometric evidence confirms this view, locating the roots of Chinese manufacturing catching-up into ‘creative restructuring’ and accumulation of absorptive capabilities by domestic firms, rather than sheer ‘creative destruction’ fostered by globalized markets (Yu et al. 2015; Dosi et al. 2017). Chinese enterprises were thus able to move beyond labour cost advantages and gradually improve their international competitiveness through a mix of technology imports and increasing endogenous learning.

The Chinese example offers an interesting model for economies not yet industrialized, especially when compared with the opposite trajectory of Latin America.[20] Castaldi et al. (2009) discuss the Latin America performance after the liberal reforms of the 1980s and show how almost the whole region ended up caught in a ‘low growth trap’. Indeed, after the sudden opening of their economies, many Latin American countries saw an increase of the income elasticity of the demand for imports, which was not matched by an equal increase of exporting activities (Cimoli et al. 2009b). Cimoli & Correa (2005) show how Latin American economies have changed their specialization according to their factor endowments, namely cheap labour and natural resources. Over time, Latin America witnessed an increasing specialization in low-technology products and the emergence of a dualistic economy where only a few firms were able to compete internationally (Cimoli & Katz 2003; Cimoli & Correa 2005). Table 19.3 provides evidence for some major countries in

Table 19.3. Exports of primary products as a share of total exports for the main Latin American economies

	1975	1980	1985	1990	1995	2000	2005	2010	2017
Argentina	75.6	76.9	78.6	70.9	66.1	67.5	69.2	66.8	71.2
Brazil	74.7	62.8	56.3	48.1	46.5	41.6	47.0	63.4	62.4
Chile	90.0	90.9	93.1	88.7	86.5	83.8	84.9	87.4	85.9
Colombia	79.1	80.4	83.1	74.9	65.2	67.5	64.2	76.1	–
Mexico	68.9	88.1	72.9	56.5	22.3	16.5	22.9	24.0	17.9
Peru	97.1	83.2	88.0	81.6	85.2	77.6	82.6	86.3	88.6
Uruguay	70.0	62.1	65.0	61.2	61.2	58.1	68.1	74.0	79.8

Source: ECLAC-CEPALSTAT Database.

[20] At the same time, the very emergence of China as a major industrial player has profoundly changed the patterns of opportunities and constraints facing other economies (Kaplinsky & Morris 2008). As an example, Coxhead (2007) argues that China’s growth and globalization are likely to cause South East Asian countries to experience negative terms-of-trade shocks for labour-intensive manufactures, and positive shocks for primary products. Similar negative impacts on developed economies are increasingly documented within a growing strand of empirical research (Autor et al. 2013; Pierce & Schott 2016).

Latin America showing their persistent reliance on the export of commodities. The impressive difference with the growth of China can be explained by the absence of careful industrial and trade policies that actively fostered the accumulation of technological capabilities in spite of comparative advantage (Lectard & Rougier 2018).

19.5 Conclusions and Implications for Policy

In this chapter we have analysed the role played by endowment-based comparative advantages in structural change. We began explaining what we meant by competitiveness, and its double meaning in terms of wealth creation and international trade performance. In turn, we highlighted how the latter feeds back into national income: exports and market shares influence macroeconomic levels of activity, employment, and wages. In this perspective, technological absolute advantages are the main determinant of trade performance and predict countries' participation in international trade. Comparative advantages are only an ex post synthetic measure of absolute productivity levels, and they might end up obscuring some economic dimensions of the phenomenon. The Dosi-Pavitt-Soete technology gap model (Dosi et al. 1990) allowed us to investigate adjustment mechanisms that go beyond sheer Ricardian efficiency. A key determinant of country wealth is constituted by the kind of goods and sectors on which the country specializes, which we characterized in terms of Keynesian and Schumpeterian efficiency.

Without appropriate policy interventions, countries tend to specialize according to their comparative advantages. Intra-country intersectoral differences in productivity and profitability trigger Ricardian adjustment processes that are comparative advantage conforming. This is what happened during the last three decades of globalization: international demand for primary commodities has pushed resource-rich countries towards increasing specialization in their comparative advantages, as shown by the increasing weight of commodities in the production for foreign markets. On the technological front, innovative capabilities remain highly concentrated in the leading 'technology club', with LDCs still lagging. A notable exception is constituted by the rapid industrialization of China, but whose performance can be traced back to the implementation of a set of policies that stand in blatant contrast with the tenets of the Washington Consensus. Instead of simply conforming to the comparative advantage stemming from their given endowments, developing countries should put in place a wide array of trade and industrial policies that would foster the accumulation of technological capabilities. As the historical record shows, 'getting Ricardo wrong' has been the single most important step towards industrialization and development.

Simply correcting market failures while gradually upgrading the export structure in accordance to the given comparative advantage, as advocated by the 'new structuralist approach' of Lin (2011), will hardly be sufficient. Lin's argument rests on the assumption that export diversification and sophistication result from capital accumulation, which upgrades the factor endowment structure and over time shifts comparative advantage towards goods and industries that allow higher welfare. But as we have shown, the fallacies of this story reside in the characteristics of Ricardian adjustment processes, which by no means 'naturally' lead to development. Quite the contrary: specialization in natural resources is historically associated with poverty and underdevelopment, and rarely followed by the needed growth-enhancing structural change. Many elements of comparative advantage are endogenous to policy choices (Stiglitz 2011), so that attempts to escape poverty by openly defying comparative advantage should not be a taboo. Indeed, the results of Lectard & Rougier (2018) indicate that large benefits for the whole economy can be achieved by putting the transformation of the productive structure ahead of factor accumulation. Rather, the challenge should be avoiding that the targeted sectors become enclaves that do not deliver technological spillovers to the rest of the economy (Cimoli & Katz 2003).

Today's developing nations lack the support of intellectuals like Hamilton or List: the consensus in the economic profession is still mostly in favour of deeper trade and financial integration at the international level (even though few would still defend the shock therapies of the original Washington Consensus) and very few voices are advocating changes that would leave LDCs the policy space to industrialize. We deem it difficult to reach a new consensus and set of policies for economic development without at the same time breaching the orthodoxy of the economic theory on trade, similarly to what Hamilton originally did in justifying the infant industry argument. The picture is complicated by the tendency of the new winners of globalization to join forces with developed countries in defending the merits of free trade (*New York Times* 2017), despite their development being based on the blatant neglect of those same principles (Chang 2002). On the technological side, the rapid pace at which manufacturing is merging with digital technologies (e.g. Lasi et al. 2014) is likely to prove a further obstacle to industrialization for countries not possessing the necessary capabilities in ITC (Lund & Tyson 2018).[21] Policymakers in poor countries should employ all the policy space left by multilateral trade agreements to protect their strategic industries and nurture specialization in dynamic sectors. Nevertheless, the existing regime might still end up being too tight, and in this case partial and ad hoc renegotiations might be necessary (Cimoli et al. 2009a). Without even greater government involvement in designing the necessary catch-up policies we are unlikely to see many success stories soon.

Quite surprisingly, the most recent critiques to the multilateral trade system are coming from the world technological leader, the United States (*The Washington Post* 2018). Solid empirical research has documented the adverse labour consequences of Chinese competition (Autor et al. 2013; Pierce & Schott 2016), a finding that helps explain the recent comeback of protectionist policies in advanced economies. In particular, the Trump Administration had started imposing tariffs on imports (especially from China) with the stated aim of reducing the US trade deficit. The recent protectionist surge in the United States mostly targeted 'old' industries, such as steel and aluminium (*New York Times* 2018). These are hardly the industries from which the next technological paradigm is going to arise, and the potential of technological learning from them is much reduced for the United States. Considering our preceding discussion, we contend that the set of industrial and trade policies that we have been advocating should clearly be tailored to the level of development of each country. While for Latin America achieving structural transformation and building a strong manufacturing base might be a priority, the strategic needs of advanced countries like the United States are bound to be different. Overall, it seems that recent protectionism has been targeted at labour-intensive declining industries, with the aim of protecting jobs. This is consistent with the so-called 'Australian case for protection' (Samuelson 1981), a policy usually very costly but that at times can have positive

[21] The more innovative end of the economy in recent years has been the development of so-called digital platforms (from Uber to Amazon and its Chinese counterpart, Alibaba). Many platforms by their very nature prove to be winner-take-all markets, in which only a handful of companies survive and are able to monopolize the global marketplace (Kenney & Zysman 2016). Entering those markets is proving difficult even for many advanced economies, and thus will pose a serious challenge for LDCs constrained in their policy space (Lund & Tyson 2018).

welfare effects in imperfectly competitive sectors (Harrison 1994). It might well be too soon to evaluate its overall welfare effects on the United States; however, we do think that the right set of policies for the technological leader should be focused on pushing ahead the *endless frontier* by means of innovation subsidies (Akcigit et al. 2018) and mission-oriented programmes (Mazzucato 2015; Mowery 2012), rather than pouring resources into sunset industries. Also, the stickiness and the tacitness of much advanced technologies makes technology transfer and international emulation second-order concerns as long as the United States keeps investing to retain technological leadership, making a 'techno-mercantilist' approach unwarranted. We suggest that officials in the Trump Administration would have found it highly beneficial to read again the work done at the Berkeley Roundtable on the International Economy in the 1980s, when the same issues were discussed with reference to Japan (Zysman & Cohen 1982).

To conclude, the research on development and structural change has not yet reached a definitive set of practical policies for escaping the resource curse and the lock-in into comparative advantages. In this chapter, however, we have provided a theoretical framework capable of answering the long-standing question posed by Stiglitz (2011): is there any a priori reason why Switzerland should have a long-run comparative advantage in watches? Similarly, the evidence discussed suggests the continuing importance of the puzzles of Antonio Serra on the wealth of Venice vis-à-vis the poverty of Naples: indeed, it is technological learning and not endowments that will lead underdeveloped countries to become tomorrow's Venice.

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