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# TOWARDS A NEW TAXONOMY OF MANUFACTURING COUNTRIES

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# TOWARDS A NEW TAXONOMY OF MANUFACTURING COUNTRIES

Livio Romano, Fabrizio Traù

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## Abstract

The scope of this paper is to propose a novel approach to the taxonomy of manufacturing development, aimed at accounting for the major global transformations that have occurred in the organisation of industrial activity in the last decades. It first addresses the way manufacturing development can be defined in order to provide a measure of the degree of industrialization of different countries, and then suggests a new taxonomy accordingly. Attention is paid to the fact that in the course of time countries can - and usually do - move from one group of manufacturers to another. Moreover, it is shown that cross-country differences in the degree of industrialisation are also mirrored by differences in their institutional features. Results offer some important lessons for industrial policy.

**JEL Classification:** F63, O14, O25

**Keywords:** Industrial Development, Taxonomy, Institutions.

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## 1 Introduction

This paper deals with the problems of measuring manufacturing development as well as with interpreting its actual meaning. Both issues have been heightened by the major changes that have affected the organisation of industrial activity all across the world in the years of globalisation, which have made obsolete the view according to which the world was sharply divided into two parts, largely unrelated to each other: on the one side, the 'North' of the world, basically coinciding with West Europe, North America and Japan; on the other, the 'South', including almost all other economies<sup>1</sup>.

Indeed, the last two decades have led to an unprecedented degree of productive interdependence at the country level, linking together economic systems originally characterised by strong differences in their degree of industrialisation and allowing the emergence of new manufacturing powerhouses. Not only has the bursting onto the economic scene of these players brought about the downsizing of manufacturing production within the 'North', but it has also been accompanied by the persistent stagnation of a conspicuous part of the economies of the 'South' of the world - determining in turn an increase in inequality within the whole group of laggards. This has led to an overall reshaping of the landscape of global manufacturing, implying a change in the relative distance among all the countries involved in manufacturing activity.

In the face of such deep transformations we still lack a metrics which is able to return a consistent picture of what global manufacturing has actually become. In fact, the standard way the degree of industrialisation of different countries is looked at is still largely rooted in the 'North-South' dichotomous way of thinking about development, and appears increasingly at odds with reality.

The contribution of this paper is to propose a novel approach to the categorization of countries, which rests on economic theory and empirical research to build a multi-dimensional metrics for measuring the degree of industrialisation of a given country. In particular, by applying cluster analysis to a set of complementary structural economic indicators it is possible to account for the increasing cross-country heterogeneity in the characterisation of a manufacturing base and to shed new light on the different directions undertaken in the last decades by manufacturing development worldwide.

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<sup>1</sup> This framework has set apart for many years, as a separate group, the ensemble of the East European countries, which were indeed characterised by a quite strong role of the industrial sector in the economy but were nevertheless classified outside the boundaries of the industrialised world.

The paper is organised as follows: section 2 provides an overview and an interpretive framework of the above-mentioned changes in world manufacturing, discussing the conditions for industrial development to happen and the reasons for heterogeneous paths to emerge. Section 3 addresses the way manufacturing development can be defined in order to provide a measure of the degree of industrialization of different countries. Section 4 first describes the methodology employed to define a new taxonomy of manufacturing countries, and then shows the results of its implementation, illustrating the specific features which characterise each of the resulting tiers (or groups) of manufacturers. Attention is paid in this connection to the fact that in the course of time countries can - and usually do - move from one tier of manufacturers to another. Section 5 focuses on the role played by institutional factors in explaining different degrees of development, revealing important differences across tiers of manufacturers. Section 6 discusses the policy implications and concludes.

## 2 Industrial development in the Globalisation Age

### 2.1 Organising production activity in the global world

The Globalisation Age has coincided with the expansion of manufacturing beyond the G7's borders and the emergence of new countries as manufacturers<sup>2</sup>. Indeed, the view according to which the world had to be intended in dichotomous terms as to industrialisation had long been challenged by the emergence of the four 'Asian tigers' since the 70s, that set something new somewhat in between the 'North' and the 'South'. Yet this did not translate into a rethinking of the idea according to which the world was to be divided into two blocs, until the emergence in the new century of *large* manufacturing countries such as China (and, to a lesser extent, the other BRICs) did actually alter the whole mechanism of industrial development at the global level.

This happened due to the very size of the new emerging countries (whose impact became suddenly visible), and the fact that their development hinged upon an increasing division of labour on a cross-country basis, creating a widespread flow of exchanges on productive grounds between the two sides of the world. Where did this come from, and how did it work?

A major event changing the basic conditions for industrial development in a global perspective has been the 'unfreezing' of large economic systems that still in the early 90s were sealed within a parallel world, outside of the area of market exchanges. Within an exceptionally narrow

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<sup>2</sup> For a wider treatment of the subject see Traù (2006).

period of time (the decade spanning from Deng's launch of the four modernisations in 1978 to the fall of the Berlin wall in 1989), new economic areas (and populations) *simultaneously* came to be part of the global world, sharply widening the boundaries of the world prone to market rules.

The outcome was a one-off event, unprecedented in industrial history, that almost suddenly opened up to the 'North' a new labour market characterised by an unlimited availability of labour at extremely low cost, linking together the most industrialised and the less industrialised economies in the world<sup>3</sup>. This new order, outlining a situation close - on a global scale - to that described in the Lewis-Kindleberger's model (Lewis, 1954), has set the premises for the launch in underdeveloped countries - *wherever some manufacturing know-how was already available* (infra) - of an industrialisation process, avoiding for a very long time any tension on output prices.

Yet industrial development did not happen anywhere: what is the mechanism whereby such a process did actually take place and why did it show different intensities in different areas? The basic point here is that as far as in laggard countries domestic demand was bounded to a minimum, the way out from underdevelopment had to come from external demand. In this connection the head start comes from what was called the second 'great unbundling', enabling the exploitation on a global scale of the so-called trade in tasks<sup>4</sup>. Put in a few words, the phenomenon has consisted in the transfer abroad of a part of domestic production of industrial countries. As far as it became possible to exploit huge cross-country cost differentials in underdeveloped countries, the conditions were created for a more or less extensive transfer of production stages - in general the more labour intensive ones - from the former to the latter.

Through this type of cross-country diffusion of production activities, supply chains became fragmented on a global scale<sup>5</sup>. On the whole the fragmentation of supply chains at the global level has determined an unprecedented demand shock. The breakdown of (some) complex industrial processes into separated production phases was the channel through which many economies had the possibility of being involved in the production of specific components<sup>6</sup>. This was the channel whereby emerging countries could gradually develop - starting by initially competing on prices - economies of specialisation that could lead in time to the unfolding of growing dynamic returns. Where did this happen, and where did it not?

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<sup>3</sup> The phenomenon, including India and other Asian underdeveloped economies, has been termed by Freeman (2007) as 'great doubling'.

<sup>4</sup> See, in particular, Baldwin (2006, 2012, 2014) on the former and UNIDO (2009), WTO and IDE-JETRO (2011) on the latter.

<sup>5</sup> The endless literature on Global Value Chains (GVCs) cannot be summarised here. Basic reference include, among others, Gereffi et al. (2005), Sturgeon (2008), Nolan and al. (2008), Cattaneo and al. (2010), Gereffi (2014).

<sup>6</sup> This was very much enhanced by the lifting of barriers to commercial integration following the new globalisation paradigm.

## 2.2 The economic conditions for emerging

Following Alice Amsden (2001), we can say that at the dawn of globalisation the laggards were already divided into two groups: on the one hand the 'Rest' (namely the group of countries oriented, to a greater or lesser extent and with differing degrees in the process implementation, towards an explicit industrialisation objective), and, on the other, the 'Remainder' (lacking manufacturing knowledge and adequate institutions)<sup>7</sup>. In Amsden's own words, "[c]ountries in 'the rest' that industrialised rapidly after World War II had accumulated manufacturing experience in the pre-war period. This differentiated them from countries in 'the remainder'". The point here is that "[p]ath dependence was such that no economy emerged from the blue as an industrial competitor" (2001:99).

As a result of the initial differences among the different areas of the developing world, then, industrialisation took place only in some developing countries and not in all of them. This set the very premises of what had to happen later, in the course of the Globalisation Age: for the emergence of new global manufacturers to unfold, the prior existence of an adequate endowment of manufacturing knowledge, as well as a peculiar institutional setting, was required.

Of course, the boundaries of the group of countries that in the following have been actually involved in an industrialisation process are somewhat larger than those strictly corresponding to the 'Rest'. This is due to the very logic of industrial development itself, which stems from a gradual strengthening of (cumulative) backward and forward linkages in the sense suggested by Hirschman (1958, 1981) - i.e. from the activation of an endogenous widening of the supply matrix following the expansion of demand. In this perspective the 'Rest' itself has played an active role in the development of neighbouring economies, adding in turn new external demand to that coming from the 'North' and allowing other laggards to enter new manufacturing activities. This has proved to be most evident in Eastern Asia, where a new integrated area has gradually emerged, including, other than Japan and the 'Rest' economies (China, Indonesia, South Korea, Malaysia, Taiwan and Thailand), laggards such as Philippines and Vietnam.

A further widening of the boundaries of emerging economies has been fed by the transition of former East European planned economies to the market. In this respect the previous existence of a widespread manufacturing knowledge in such countries has paved the way to the development and gradual thickening of market linkages between them and the countries belonging to

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<sup>7</sup> According to Amsden (2001), the 'Rest' includes China, India, Indonesia, Korea, Malaysia, Taiwan and Thailand in Asia; Argentina, Brazil, Chile and Mexico in Latin America, and Turkey in the Middle East. The development of these countries, that Amsden (see in particular chapters 4 and 5) illustrates through the review of a massive series of analyses relating to them individually, takes on a different profile depending on the way in which the economies lagging behind acquired manufacturing knowledge (and, in particular, depending on the presence or absence of a prior colonial experience).

the European Union (maxime Germany)<sup>8</sup>. With the notable exception of Russia, this has brought about a sudden passage of some of these countries - previously segregated elsewhere - into the international manufacturing system, making them an important component of the global value chains mechanism<sup>9</sup>.

In which terms, and to what extent, have such transformations changed the industrial world?

### 2.3 Heterogeneous paths

The emerging industrial world has widened. Yet, this has not been a linear process. On the one side, the whole range of South American economies has experienced in the years of globalisation just an opposite situation: once abandoned the deprecated import substitution industrial (ISI) policies, both the rhythm of manufacturing development and the widening of the supply matrix have dramatically fallen instead of rising, coinciding with a relative marginalisation of the industrial system in such countries notwithstanding the parallel fragmentation of value chains on a global scale<sup>10</sup>. The lack of competitive advantages, following the absence, in the ISI years, of a policy aimed at developing dynamic increasing returns, has pulled these countries away from taking advantage of the widening of demand at the international level brought about by market liberalisation in the face of globalisation, unlike it happened in many East Asian countries.

On the other side, entering industrialisation via trade in tasks does not automatically mean entering the road to self-sustaining (endogenous) industrial development. The point here is that the globalisation logic itself tends to hinder the spread of manufacturing to a large range of activities, insofar as it makes crucial the possession of static comparative advantages. It turns out that in a context of strong international competition laggard economies have found, with few exceptions, heavy difficulties in achieving a significant degree of expansion of their supply matrix and hence of their industrialisation rate, facing an early upper bound to manufacturing development (Romano and Traù, 2017).

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<sup>8</sup> As to Germany, this has been claimed to involve a strong change in the organisation of manufacturing activity even within the country itself, in terms of the emerging of what has been called the German 'Bazaar economy' (Sinn, 2006).

<sup>9</sup> Russia represents a spectacular example of the destructive consequences of an ideological application of the Washington Consensus rules, involving the simultaneous implementation of policies on price liberalization, accelerated privatization, tax provisions and commercial opening - without building up market institutions beforehand. The most evident counter-example is the maintaining of public property and control over domestic financial flows and capital movements in China, and in general the set of strategies pursued by the East-Asian economies (Lin2009).

<sup>10</sup> From this point of view a different way has been followed by Mexico, as far as it succeeded in becoming part of the North-American supply chain.

This framework is further complicated by the huge differences which characterise emerging countries as to their size. In general, whereas smaller economies necessarily need to base their development on specialisation (few industries that are competitive at the international level), larger ones can benefit from a domestic market that can activate supply also in non-competitive environments, therefore widening the absolute size of their manufacturing sector. This is what has allowed countries like Russia or Brazil to be considered as industrial countries, ranking within the world top fifteen manufacturing producers, even in the face of a quite low industrialisation rate (as against population).

This means that the very scale of emerging manufacturers has been crucial in determining the role they have been able to assume within the international industrial system (actually, this is why the growth of small East Asian NICs along the 70s did not substantially alter the way the spreading of industrial development across the world was perceived). In particular, an important consequence of such a feature is the displacement that the more competitive (and large) emerging economies could exercise upon other weaker (and small) emerging ones - other than upon the industrialised world, which is what has typically caught the attention of applied economists over the last twenty years<sup>11</sup>.

In this overall context it also happens that the very functioning of the GVCs mechanism has gradually changed, asking for increasingly evolved suppliers and a greater concentration in upstream markets. This sets the premises for demand from abroad to become more selective. Hence, it may happen that a divide between the emerging economies that succeed in keeping the pace and those that do not is going to take place, thwarting the possibility for some countries to maintain their connection to international value chains.

Looking forward, the combination of these elements suggests that a new cleavage, in addition to the one that emerged in the past between the 'Rest' and the 'Remainder', may be dawning *within* the emerging world: some economies may be subject to falling behind and losing ground, whereas others may have the possibility to come closer to already industrialised countries.

Yet, the Globalisation Age has brought about relevant changes also within the industrialised world. The pivot of these changes has been the abovementioned mechanism whereby the two sides of the world have become mutually interdependent, entering a common future through the setting up of systematic market relations. For unbundling to occur at the international level, industrial structure in the "North" was to be already fragmented along vertical lines. From this point of view, an important role was played by the fact that many Western industrial countries had

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<sup>11</sup> The displacement can take the form of competition in trade - both direct (export vs. import) and indirect (on third markets) - as well as that of a diversion of the FDI flows coming from the 'North' from weaker emerging areas to stronger ones.

already experienced a process of vertical dis-integration in the course of the last quarter of the XXth Century, led by the search for flexibility in the face of higher uncertainty and rising competition (Traù, 2003). Such a process started developing within national boundaries, in a few years largely trespassed them (Feenstra, 1998)<sup>12</sup>.

This mechanism has brought about a substantial cross-country reallocation of the supply potential. It is worth stressing that such a reallocation has to be intended in principle as a relative phenomenon, in the sense that, more than the result of a simple transfer from the industrialised countries to the emerging world, it is the outcome of different rates of growth in the different areas. In this sense, off-shoring has first to be viewed as the development abroad of new facilities and plants by multinational enterprises. Yet, in a great many cases the phenomenon has also involved a real cross-country transfer of productive activities (de-location). In such cases it has wrought a whittling down in the overall size of the manufacturing sector, as well as an uprise in import flows from emerging countries.

It follows that those countries that have been more active in off-shoring their activities have experienced both a reduction of the size of their manufacturing potential and a worsening of their trade (im)balances. The rising trade pressure from the emergent world upon industrial countries has to be viewed as the consequence of the production strategies of (some of their) firms. In the perspective suggested by Singh (1977, 1987), this may have also involved in these countries a reduction of efficiency of the manufacturing sector itself, as far as it has both raised their import requirements and lowered their export potential<sup>13</sup>.

In some economic systems such as the Southern European ones this effect has very much been exacerbated by the sheer consequences of the falling down of internal demand, owing to the heavy deflationary policies put in place in order to face sovereign debt crises. Given the general fall in global (international) demand involved by the crisis, this has turned out into a sharp output reduction - in absolute and relative terms - in these countries.

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<sup>12</sup> It is worth stressing that this sorts of vertical fragmentation relates to a different issue with respect to the horizontal fragmentation (sub specie of intra-trade) that had long characterised the trade relations among industrialised countries, mainly - albeit not exclusively - relating to final goods (Greenaway 1986).

<sup>13</sup> According to Singh "an efficient manufacturing sector in an open market context can be defined as one which (*currently as well as potentially*) *not only satisfies the demand of consumers at home, but is also able to sell enough of its products abroad to pay for the nation's input requirements*. This is, however, subject to the important restriction in that [...] [it] *must be able to achieve these objectives at socially acceptable levels of output, employment, and the exchange rate*" (1977:128, emphasis original).

### 3 Defining Industrial Development

The overall outcome of such changes has been a general blurring of the usual way of grouping countries according to their degree of development. Here the issue is twofold: on the one side, in spite of the still widespread habit of conceiving the world in dichotomous terms, the very emergence of "emerging" countries definitely sets something new between 'North' and 'South'<sup>14</sup>. On the other, the same sharp distinction between "industrial" and "emerging" countries seems in fact not to hold that much, in a context in which important differences seem to emerge *within* these same groups. Put in other words, new differences and similarities may lead to characterise the shape of the industrial world in more articulated way as compared to the past.

This is not simply a matter of classification of economic systems: this is first and foremost a conceptual issue, insofar as it has to do with the definition of what industrial development actually consists of. The point here is that the above-mentioned transformations have determined some changes in the relative distance among all the different countries belonging to the group of manufacturing producers. But how do we measure such distance, i.e. the degree of development of different countries?

In the same way as all international institutions typically refer to per capita GDP in order to measure overall economic development, when approaching the task to measure manufacturing development UNIDO refers to per capita manufacturing value added (see Upadhyaya, 2013)<sup>15</sup>.

Despite its straightforward interpretation, this indicator cannot suffice to the purpose of identifying different paths of industrialisation, because along the continuum of the distribution it is virtually impossible to identify the critical output thresholds according to which the whole population of countries should be divided into relatively homogeneous groups.

The solution proposed by UNIDO in this connection is to group countries according to a mix of alternative rules. These rules do alternatively pay attention to the level of manufacturing value added per capita, by using aprioristic information about the evolution of manufacturing share

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<sup>14</sup> "The literature is replete with competing terminologies; examples include poor/rich, backward/advanced, underdeveloped/developed, North/South, late comers/pioneers, Third World/First World, and developing/industrialized" (Nielsen 2011:99).

<sup>15</sup> The other economic institutions (IMF, World Bank, WTO and the like) that are in charge of ranking individual countries according to their level of development, for operational as well as analytical purposes, shape their definitions on the basis of the characteristics that matter for their specific institutional role (Nielsen, 2011). Hence, the IMF pays attention to the developing of financial markets, the United Nations Development Programme to the country's achievements in terms of longevity and education, and so on. For all institutions, anyway, the basic measure to refer to is generally per-capita income. Basically, this means that country grouping boils down to identifying the critical (absolute or relative) thresholds of per-capita income according to which the whole population of countries can be divided, taking into account in some ways also some other variables.

in GDP to define relevant thresholds, or to the level of GDP per capita or to the national share on world manufacturing value added, by using in both cases ad hoc rules of thumb to define relevant thresholds.

The overall result is the classification of countries into four groups (Industrialized economies, Emerging industrial economies, Other developing countries, Least developed countries)<sup>16</sup>. Yet by using very different criteria with reference to different countries, it turns out impossible to determine to what extent countries assigned to the same group are actually homogeneous in terms of their industrial development level.

The view set forth in this paper is that, in order to identify from the ground a taxonomy of manufacturing countries, the challenge is to build metrics which can capture the multidimensional, complex nature of the industrial development process. Such a process - other than the sheer expansion in the national manufacturing sector size - does involve important changes as to the relative manufacturing specialization of the entire economy, the range of manufacturing activities, their technological content (both in the sense of cross-sectoral shifts and of intra-sectoral upgrading processes), and their degree of international competitiveness. All such transformations are historically determined, knowledge-based and path-dependent, and can be viewed as an evolutionary process in the course of which a given country changes by moving (developing) through different states (phases of growth)<sup>17</sup>.

When aiming at classifying countries according to their degree of industrial development, the key issue then becomes to identify the variables which characterise such different states. In empirical terms, capturing these different dimensions is not straightforward, as far as information about some indicators of interest may not exist (maxime for non-OECD countries), or, even when available, it may happen that the way information is collected affects cross-country comparability due to methodological differences. Therefore the choice of the indicators that have to be taken

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<sup>16</sup> For instance, the group of 'Emerging industrial economies' is identified according to three alternative rules: a level of PPP-adjusted manufacturing value added per capita between 1,000 and 2,500 US\$; a level of PPP-adjusted GDP per capita greater than 10,000 US\$; a share in world manufacturing value added greater than 0.5%.

<sup>17</sup> It is important to stress that this has not to be intended as a mechanical sequence of stages, but simply as the logic to be followed by countries in the course of their development process. The literature on stages of growth has been developed with reference to both economic systems (as in Rostow (1960)'s analysis) and firms (mostly in management theory, see McMahon (1998) for all). The approach followed in this paper differs from such a way of interpreting the development process in that it challenges the idea of a unique pattern of development to be applied to all countries, in light of the thought of Gerschenkron (1962), Fuà (1978), Piore and Sabel (1984), Amsden (2001). It may be argued, for example, that laggards must come to terms with global markets that are already structured, and market shares that are already in the hands of incumbents, so that they have to rely upon different strategies with respect to first comers. Or that industrialisation may take place in quite different forms as to the organisation of production activity (hierarchies vs markets), and so on. Even more, as will be clear in the following, in this view countries can move along the development path (passing from one group to another) in both directions - i.e. no achievement can be taken for granted indefinitely.

into account needs to balance - in a way which is consistent with the final objective of identifying the most relevant phases of industrial development - the scope of information collected along the different dimensions of interest with the number of countries which can be actually compared.

To this end, the present analysis has been carried out by considering, in addition to the well-established manufacturing value added per capita, four other indicators (Tab. 1). Each of them is chosen on the basis of specific theoretical premises, and has to be intended as complementary to each other in characterising an industrial system.

**Table 1.** Variables used to build the taxonomy

<i>Variable</i>	<i>Mean</i>	<i>S.d.</i>	<i>Mean</i>	<i>S.d.</i>	<i>Source</i>
	<i>2015</i>		<i>2000</i>		
Manufacturing value added per capita (log, real \$)	7.81	1.03	7.51	1.20	UNIDO
Manufacturing value added on GDP (real \$)	0.16	0.06	0.15	0.05	UNIDO
Cmi index of intra-manufacturing value added (4 digit, real \$)	0.62	0.10	0.59	0.11	Oxford Economics
Share of M&High-tech manufacturing value added (real \$)	0.49	0.19	0.47	0.17	UNIDO
Manufacturing trade balance, normalized* (nominal \$)	-0.05	0.15	-0.04	0.18	ComTrade, OEC

\*: Normalization by sum of export and import

Two of the variables are commonly referred to in the literature on structural change: the well-known share of manufacturing value added in total value added - pioneered by Fisher (1939), Clark (1940), Fuchs (1968), and Kuznets (1973), and recalled in Kaldor (1966)'s analysis of increasing returns, hinging on Verdoorn (1949)'s approach - and the intra-manufacturing concentration of output - pioneered by Imbs and Wacziarg (2003) and recently also analysed by Romano and Traù (2017). The former is meant to capture the relative direct contribution of manufacturing to GDP, the latter to determine its absolute level of specialisation among the different sub-industries, that is the width of the national supply matrix.

The third variable is represented by the manufacturing trade balance normalized by the level of trade (exports plus imports), taken as a proxy for 'efficiency' of the manufacturing sector in the face of trade openness, in light of Singh's definition (see previous section). The fourth variable is the share of manufacturing valued added produced by medium and high-tech industries, identified according to OECD classification, that provides a measure (although imperfect) of relative intensity of the production technology generated within the domestic manufacturing sector<sup>18</sup>.

<sup>18</sup> Inter-alia, this indicator is referred to in order to measure the degree of attainment of one of the 17 sustainable development goals launched by the United Nations (UNCTAD, 2016).

Complete information on all these different features of a manufacturing system are retrieved for a sample of 50 countries, from all around the globe. The geographical distribution of the sample is largely rooted in the history of industrialisation - with Europe, North-America and Asia as main players, while Africa, Middle-East and Central Asia remaining largely excluded. It follows that despite being small in absolute terms - as compared to the full list of 144 countries covered by UNIDO statistics - the sample is highly representative of world manufacturing, accounting for around 94% of total value added (at current prices) and 95% of total exports in 2015<sup>19</sup>.

## 4 Identifying a New Taxonomy

### 4.1 Which tiers, and which countries do belong to them

The metrics according to which countries are classified is based upon the above-mentioned five variables, and employs them as ingredients of a clustering algorithm<sup>20</sup>. The variables have not been rescaled within a common range of values, as is often done before applying the clustering algorithm. This is due to the choice of not giving them the same explanatory power (the same weight) in the definition of groups. This way the (log) manufacturing value added per capita, which has a standard deviation eight times larger as compared to the average of the remaining four variables (see again Table 1), is given particular emphasis, and results as the most relevant factor to discriminate different degrees of industrialisation<sup>21</sup>. The number of groups is not defined *a priori*, but is chosen after having applied the Calinski and Harabasz (1974) optimization method to the results of a Ward's linkage cluster analysis.

As to 2015 (the latest available year), this statistical methodology leads to the identification of five different clusters. However, in order to get groups large enough to make robust statistical analysis, the fifth cluster, composed by only three countries, has been merged to the closer

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<sup>19</sup> See appendix A1 for details.

<sup>20</sup> Cluster analysis allows to assign each observation to a specific group on the basis on a multidimensional measure of similarity of their production systems. Two recent applications of cluster analysis to the study of economic development can be found in Zhang and Gao (2015) and Tezanos Vázquez and Sumner (2013). To the best of the knowledge of the authors of this paper, the cluster analysis presented in this work is the first attempt to apply it to the study of industrial development.

<sup>21</sup> This choice is consistent with the existing taxonomy proposed by UNIDO (Upadhyaya, 2013), while it is in contrast with the logic underlying the construction of the UNIDO Competitive Industrial Performance (CIP) index (see UNIDO, various years), which assigns to the manufacturing value added per capita the same weight as to other seven structural indicators.

one (i.e. the most similar in terms of manufacturing valued added per capita, so that the final number of clusters has been set to four<sup>22</sup>.

The cluster analysis draws a picture of the different profiles of manufacturing countries which confirms how blurred have become in the course of the Globalisation Age the boundaries between the 'North' and the 'South' of the world, at least when looking at industrial development (Tab. 2).

First of all, G-7 countries result to be splitted between the groups labeled as '1st tier manufacturers' and '2nd tier manufacturers', with Germany and Japan belonging to the former, while Canada, France, Italy, UK and USA belonging to the latter. The first group comprises also the Scandinavian block plus two Asian tigers, namely Singapore and South Korea (but not Taiwan, which has been included in the second group)<sup>23</sup>

**Table 2.** The new taxonomy of manufacturing countries

<b>1st tier manufacturers</b>	<b>2nd tier manufacturers</b>	<b>3rd tier manufacturers</b>	<b>4th tier manufacturers</b>
Austria	Australia	Argentina	Brazil
Denmark	Belgium	Chile	Bulgaria
Finland	Canada	China	Colombia
Germany	Czech Republic	Greece	Ecuador
Japan	France	Hungary	India
Norway	Israel	Malaysia	Indonesia
Singapore	Italy	Mexico	Iran
South Korea	Netherlands	Poland	Morocco
Sweden	New Zealand	Portugal	Pakistan
Switzerland	Slovak Republic	Romania	Philippines
	Spain	Russia	South Africa
	Taiwan	Thailand	Vietnam
	United Kingdom	Turkey	
	United States	Uruguay	
N: 10	N: 14	N: 14	N: 12

Note: Clusters defined according to k-means procedure, using the variables shown in Table 1.

Most of the remaining EU countries are classified as '2nd tier manufacturers', but not all of them: among Eastern European members, only Czechia and Slovakia are included, while Hungary, Poland and Romania are classified as '3rd tier manufacturers', and Bulgaria as one of the '4th tier manufacturers'. Noticeably enough, among Westerns European members Portugal and Greece

<sup>22</sup> In particular, Pakistan, India, and Vietnam, with the lowest levels of manufacturing valued added per capita, in the sample, have been identified by the clustering algorithm to form a separated group of manufacturers. The rationale for choosing the group in which to include these countries is provided in the next subsection.

<sup>23</sup> The fourth Asian Tiger, Hong Kong, has been excluded because its development represents a unique case, after China's annexation in 1997.

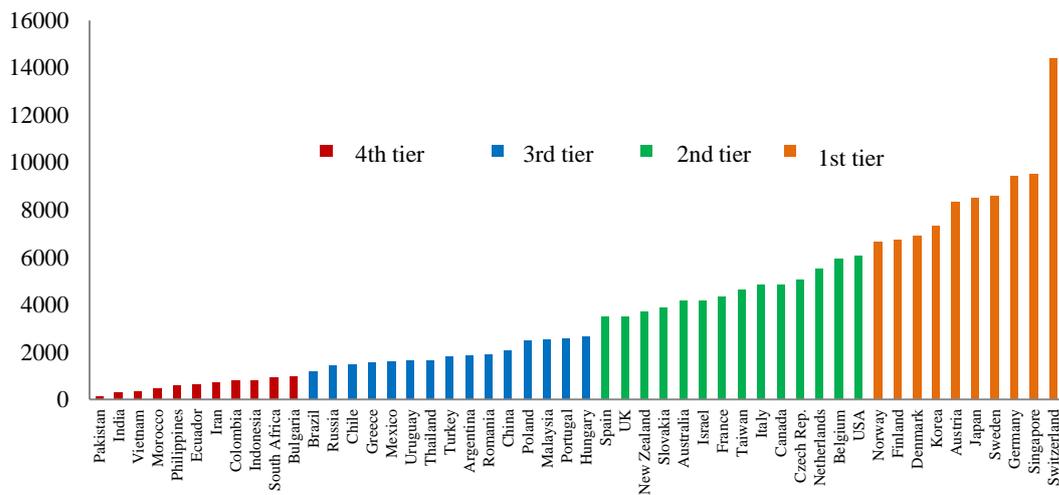
are classified as ‘3rd tier manufacturers’. Also BRICS are unevenly distributed among groups, with Brazil, China and Russia classified in the 3rd tier, while India and South Africa in the 4th one.

## 4.2 Characterisation of the different tiers

But what are the specific characteristics attached to the four groups of manufacturers that have been identified by the cluster analysis?

First of all, there is a clear and strong relation between the sequence of different tiers and the level of manufacturing value added per capita: the industrialisation rates within the 1st tier are always higher than those within the 2nd tier, which in turn are always higher than those within the 3rd tier, which in turn are always higher than those within the 4th tier (Fig. 1). This result suggests *prima facie* an interpretation of the different groups of manufacturers as a sequence of varying degrees of industrial development, from the lowest (corresponding to the 4th tier) to the highest (1st tier).

Fig. 1. Industrial development and manufacturing value added per capita (2005, real \$)



Yet, such an indicator does not allow on its own to identify which thresholds have to be chosen in order to assign each country to the different groups along the continuum of the distribution. For instance, the distance in the industrialisation rates existing between USA and Norway, showing respectively the highest value within 2nd tier and the lowest within 1st tier manufacturers,

is lower than that observed between South Korea and Austria or between Germany and Singapore, despite the fact that these four countries are classified as belonging to the same group.

On the other hand, the four groups also differ from each other in terms of the values assumed by the other four indicators included in the clustering algorithm. In particular, each indicator plays a role to discriminate between different pairs of groups, varying depending on the chosen comparison (Tab. 3)<sup>24</sup>.

First, as compared to 3rd tier ones, countries classified in the 4th tier show on average a significantly lower degree of diversification (higher Gini index) of manufacturing activities, and a worse positioning in international markets, as reflected by a five times larger trade deficit. No systematic differences emerge instead between the two groups in terms of the relative contribution of manufacturing to GDP and their technological intensity. In conceptual terms, this means that the widening of the supply matrix and the contemporary improvement of the trade balance are the two conditions that go along with the transition from a low to a medium-low degree of industrialisation rate.

**Table 3.** Characterisation of the different tiers of manufacturing countries (2015, mean values)

Variables used in the cluster analysis:	<i>4th tier</i>	<i>3rd tier</i>	<i>2nd tier</i>	<i>1st tier</i>
Manufacturing value added per capita (log)	6.29	7.52	8.41	9.04
Gini index of manufacturing VA	0.71	0.61	0.58	0.58
Share of Medium, High-Tech manufacturing VA	0.31	0.33	0.43	0.56
Manufacturing trade balance normalized	-0.22	-0.04	-0.05	0.06
Share of manufacturing VA on GDP	0.15	0.17	0.13	0.17
		<i>Difference</i>		
		<i>4th - 3rd tier</i>	<i>3rd - 2nd tier</i>	<i>2nd - 1st tier</i>
Manufacturing value added per capita (log)		<b>-1.23***</b>	<b>-0.89***</b>	<b>-0.62***</b>
Gini index of manufacturing VA		<b>0.10 **</b>	0.04	-0.01
Share of Medium, High-Tech manufacturing VA		-0.02	<b>-0.11**</b>	<b>-0.13 **</b>
Manufacturing trade balance normalized		<b>-0.18**</b>	0.01	<b>-0.11 **</b>
Share of manufacturing VA on GDP		-0.01	0.04	<b>-0.04 *</b>

Note: Manufacturer tiers defined according to Ward's linkage procedure. \* p < 0.10, \*\* p < 0.05, \*\*\* p < 0.01.

Second, 3rd tier countries are in turn significantly less specialized in medium and high-tech industries as compared to 2nd tier ones, while no systematic differences between the two groups emerge in terms of either sectoral concentration of manufacturing value added (both relative to GDP and within manufacturing) or trade balance. Put in other words, the foremost indicator

<sup>24</sup> The cross-cluster analysis that follows is not driven by the presence of outliers, as similar conclusions can be drawn by comparing median instead of the mean values for each variable in the different groups.

which characterizes the transition from a medium-low to a medium-high degree of industrialisation rate seems to be a higher capacity to generate production technology domestically.

Third, in comparison to 1st tier countries, 2nd tier ones show a systematically lower degree of specialization in medium and high-tech industries, a worse positioning in international markets (the 1st tier is the only cluster with a positive manufacturing trade balance on average), and also a lower share of GDP accounted for by domestic manufacturing. This means that the moving from a medium-high to a high degree of industrialisation rate results in a further increase of the capacity to generate production technology domestically, a significantly better trade balance, and an higher industrial specialization of the domestic economy.

### **4.3 New and Old Taxonomy in Comparison**

It is worthwhile to compare the results of the cluster analysis carried out on the basis of the above-mentioned indicators with those provided by the UNIDO classification of these same countries. Data reveal in this connection some important differences (Tab. 4).

According to the UNIDO classification the entire group of 1st tier and of 2nd tier, as well as a bunch of 3rd tier countries, namely Malaysia, Portugal and Russia, are assumed to belong to the same stage of development - and are coherently classified as 'Industrialized economies'. The rest of 3rd tier manufacturers and half of 4th ones are instead grouped together as 'Emerging industrial economies', while remaining '4th tier manufacturers' are classified as 'Other developing countries'.

On the whole, the UNIDO classification, with some important exceptions (mainly within the group of less industrialised economies), in contrast with the taxonomy proposed in this work, tends to replicate the well-established dichotomy between 'North' and 'South' of the world.

Moreover, the UNIDO classification draws a picture in which the majority of manufacturing countries (52% of the sample) is assumed to be at the latest stage of industrial development, while, according to the analysis carried out in this paper, the most advanced manufacturing power-houses represent only a minority (20%) of the sample.

**Table 4.** Comparing with UNIDO taxonomy of industrial development in 2015

<b>Industrialized economies</b>		<b>Emerging industrial economies</b>		<b>Other developing economies</b>	
1st tier	Austria	3rd tier	Argentina	4th tier	Iran
"	Denmark	"	Brazil	"	Morocco
"	Finland	"	Chile	"	Pakistan
"	Germany	"	China	"	Philippines
"	Japan	"	Colombia	"	Vietnam
"	Norway	"	Greece		
"	Singapore	"	Hungary		
"	South Korea	"	Mexico		
"	Sweden	"	Poland		
"	Switzerland	"	Romania		
2nd tier	Australia	"	Thailand		
"	Belgium	"	Turkey		
"	Canada	"	Uruguay		
"	Czech Republic	4th tier	Bulgaria		
"	France	"	Ecuador		
"	Israel	"	India		
"	Italy	"	Indonesia		
"	Netherlands	"	South Africa		
"	New Zealand				
"	Slovak Republic				
"	United Kingdom				
"	Spain				
"	Taiwan				
"	United States				
3rd tier	Malaysia				
"	Portugal				
"	Russia				
N: 27		N: 18		N: 5	

Note: UNIDO classification as from Upadhyaya (2013).

#### 4.4 Evolution of the taxonomy over time

One of the benefits of approaching the definition of a new taxonomy relying on observed data is that, by construction, the belonging of each country to a specific cluster as well as the number of clusters are not defined *a priori*, but can and do change in response to the different paths of industrial development observed over time.

In this respect, as explained in section 2, at the dawn of the new millennium major changes at the global level had already occurred, mostly due to the 'unfreezing' of large economic systems that still in early 90s were sealed within a parallel world, outside of the area of market exchanges.

Therefore, the cluster analysis should be able to reflect such a fragmentation of global manufacturing, before the overall reshaping brought about by the Globalisation Age.

Consistently with that, the analysis reveals that in 2001 five different groups of manufacturers could be detected, i.e. one more as compared to the present (Tab. 5). In particular, a mix of the least developed Western European economies (Greece and Portugal), of the most developed Eastern European ones (Czechia and Hungary), together with Malaysia and Mexico formed a relatively homogeneous group in the middle of the distribution of manufacturing value added per capita<sup>25</sup>.

**Table 5.** The taxonomy of manufacturing countries in 2001

1st tier	2nd tier	3rd tier	4th tier	5th tier
Austria	Australia	Czech Republic	Argentina	Bulgaria
Belgium	France	Greece	Brazil	China
Canada	Israel	Hungary	Chile	Colombia
Denmark	New Zealand	Malaysia	Poland	Ecuador
Finland	South Korea	Mexico	Romania	India
Germany	Spain	Portugal	Russia	Indonesia
Italy	Taiwan		South Africa	Iran
Japan	United Kingdom		Thailand	Morocco
Netherlands			Turkey	Pakistan
Norway			Slovak Republic	Philippines
Singapore			Uruguay	Vietnam
Sweden				
Switzerland				
United States				
N: 14	N: 8	N: 6	N: 11	N: 11

Note: Clusters defined according to Ward's linkage procedure, using the variables shown in Table 1. Colors are assigned to different tiers of manufacturers according to the 2015 taxonomy, as to Table 2.

All these countries, as already shown in Tab. 2, were then absorbed in the current group of 3rd tier manufactures, with the exception of Czechia that was able to join the 2nd tier. A significant reshuffling has also occurred within the group of most advanced manufacturing countries: Belgium, Canada, Italy, Netherlands and the United States have exited the group of 1st tier, joining the remaining old industrialised economies in the 2nd tier. South Korea, on the opposite, has become one of the leading manufacturing countries in the world, joining the 1st tier.

Within the groups of the least developed manufacturing countries, changes have characterised especially the relative position of BRICs: while Brazil and South Africa have moved towards

<sup>25</sup> As for the 2015 taxonomy, also in this case there is an unambiguous relation between the sequence of different tiers and the level of manufacturing value added per capita. Moreover, also in this case, a further (sixth) cluster including the three least developed manufacturing countries (Pakistan, India, and Vietnam) has been isolated by the hierarchical clustering algorithm. Just as for 2015, this group has then been merged with the adjacent one.

the bottom, joining the current group of 4th tier manufacturers, China, on the opposite, has been able to climb from the bottom, joining the current group of 3rd tiers.

Of course, there is also significant heterogeneity in the underlying dynamic performance of different countries, even for those that have experienced the same transition from one tier to another. For instance, the shift of Italy and Canada into the current 2nd tier is associated with a reduction in their manufacturing real value added per capita (-15.0% and -21.3% respectively along the 2001-2015 period), while the same movement of Belgium, Netherlands and the United States is associated with positive growth of the same indicator (4.1%, 4.4% and 10.8% respectively), although at a slower pace as compared to the remaining 1st tier manufacturers (16.7%). At the same time, although both China and Russia are currently classified in the same tier, their growth in the last fifteen years has been remarkably different: the former has more than doubled its industrialisation rate (+134.5%) while the latter has expanded at a speed (+36.1%) which has been below the average of remaining countries currently belonging to the 3rd tier (+41.6%). A negative record has instead characterised Greece and Portugal, the only two countries currently belonging to the 3rd tiers with negative manufacturing real value added growth between 2001 and 2015 (-38.7% and -8.9%, respectively).

Overall, by applying the same methodology described in the previous section to year 2001, it is possible to appreciate how the impressive acceleration of the globalisation process in the last fifteen years, as well as the tremendous and asymmetric effects of the Great Recession, have reshaped the geography of world manufacturing. We can expect new movements across tiers to occur also in the future and new groups to possibly emerge. The methodology proposed in this paper is flexible enough to (hopefully) being able to accommodate for such changes.

## 5 Institutional features

Institutions matter for development. They define the rules of the game according to which economic actors interact with each other and the scope and width of policy intervention in the economy (North, 1990; Acemoglu et al., 2008), influencing investment decisions, the accumulation of knowledge, and the whole organization of production. Indeed, as stressed, *inter alia*, by Amsden (2001), Acemoglu et al. (2001, 2002), Chang (2002, 2003), Cimoli et al. (2009), and Romano and Traù (2014), the different roles interpreted by public institutions in order to support industrial development in the course of the 20th century have been at the heart of the divergence in fortune observed among emerging economies. Significant institutional and policy heterogeneity also has

characterized the evolution of Western economies, despite the relatively higher degree of similarity (and harmonization) of their legal and regulatory frameworks<sup>26</sup>.

But institutions are not chosen once for all: they respond in the course of development to new societal and economic challenges which gradually do emerge, implying that also policies tend to (and should) be contingent on each phase of development (Hausmann et al., 2005). This is in line with Kim and Lee (2009), showing how different institutional arrangements and policies have mattered for economic growth in the last decades, but with varying intensity depending on the degree of development of countries.

Given this premise, one may ask whether - and to what extent - the different phases of industrialisation described in the previous section also mirror cross-country differences as to the institutional side. Cross-country analysis does not allow to make any causal inference about the relation between changes in the institutional setting and industrial development; nevertheless, it can be useful for the purpose of detecting which institutional features the different tiers of manufacturers are characterized by, so as to verify the existence of something like an 'institutional progression' (as suggested by Meisel and Ould Aoudia, 2008) when moving from one phase of development to the next.

To this end, the present analysis has been enriched by looking at the Institutional Profiles Database built jointly by the Agence Française de Développement (AFD), the French Direction Générale du Trésor (DG Trésor) and CEPII (2016)<sup>27</sup>. In particular, information about 46 institutional indicators for the 50 countries under consideration has been retrieved from the original database and compared across groups of manufacturers, to see which of them show systematic differences when moving from a tier to the next<sup>28</sup>. Such indicators, measured in ordinal (Likert) scale (from 0 to 4), are classified in the original dataset according to the following six functions: Functioning of public system, Free operation of markets, Security of transactions, Market regulations, Openness (to foreign exchanges) and Coordination of stakeholders, Strategic vision and innovation<sup>29</sup>.

The first five functions basically overlap the 'classical' good governance indicators used by the World Bank, which in turn reflect the old-fashioned idea behind the Washington Consensus of a desirable State intervention mainly (if not exclusively) limited to making domestic markets work better (Stiglitz, 1999). The sixth group, instead, echoes a novel approach to industrial policy, where the State is supposed to "perform a strategic and coordinating role in the productive sphere

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<sup>26</sup> See, for instance, Mazzucato (2011) with reference to public policies oriented towards technological innovation.

<sup>27</sup> To download the database and read related documentation: [www.cepii.fr/institutions/EN/ipd.asp](http://www.cepii.fr/institutions/EN/ipd.asp).

<sup>28</sup> See appendix A2 for the list of indicators.

<sup>29</sup> See Kaufmann et al. (2010) for details.

beyond simply ensuring property rights, contract enforcement, and macroeconomic stability" (Rodrik, 2004:3), affecting the sectoral composition of the economy and the transition towards new technological paradigms (Stiglitz, 2015).

The cross-tier comparison of the indicators appears informative in different respects (Tab. 6). It shows that important institutional differences do characterise each transition. This involves that challenges and priorities for industrial policy need to vary in intensity along the different phases of industrialisation. In particular, the most important discontinuity characterises the advancement from the 3rd to the 2nd tier of manufacturing countries. This is true considering both the number of indicators for which (statistically significant) differences have been detected and the range of institutional functions involved. Therefore, results are consistent with the view according to which the institutional progression across the different phases of industrialisation does not occur smoothly but requires at some point of industrial development - in particular when moving from a medium-low to a medium-high industrialisation rate - a radical change in the functioning of the public system, in the legal and regulatory framework surrounding market transactions, in the openness to international markets and in the degree of strategic collaboration and coordination with the private sector.

Moreover, the analysis shows that a significant portion of the institutional differences refer to the active role played by the State in curbing structural change through active support to technological innovation and coordination of public-private initiatives. This is true in all transitions, but it is particularly relevant within the group of the most advanced economies, where such institutional differences account for half of the total. In particular, 1st tier manufacturers are, on average, on a higher rank as compared to 2nd tier manufactures in terms of State long-term vision, public support for innovation and adaptation of training supply to business needs. Conversely, the large majority of standard market-friendly institutional arrangements, including those related to labour market rigidity or competition barriers, are systematically different only between 3rd and 2nd tier manufacturers.

## 6 Concluding remarks

The analysis proposed in this work has shown that industrial development is not only a matter of expanding the scale of manufacturing production. Changes in the degree of industrialisation go along with important differences in the manufacturing output share, in the sectoral composition of the production system, as well as in its external competitiveness.

Having identified different groups (tiers) of countries, corresponding to various degrees of industrial development, however, does not imply that countries are bound to follow, when developing, a mechanical path leading from one tier to another. Countries do not follow a pattern of development which is given once and for all, and the same characteristics that nowadays discriminate between different tiers of manufacturers could lose significance, change sign, or being replaced by new ones tomorrow, should changes in the prevailing technological and institutional paradigms occur, as happened in the past.

Does this imply that nothing can be said in order to inform policy-making on how to sustain industrial development? Giving precise policy prescriptions or recommendations goes well beyond the scope of this work, because this would require an in-depth analysis of the temporal evolution of both the institutional setting and the manufacturing system in each country. However, two general lessons for policy can be learned from the previous results.

First, the institutional progression that characterizes the actual transition from one tier of manufacturers to the next confirms the idea that enforcing the same development strategy in different phases of development is unlikely to prove effective in reaching the policy objective. In Hausman and co-authors' words, "[g]overnments face administrative and political limitations, and their policy-making capital is better deployed in alleviating binding constraints than in going after too many targets all at once. So growth strategies require a sense of priority" (Hausmann et al., 2005:2). In this respect, excessive emphasis on making institutions more market-oriented could be misleading for countries that are either very low or very high in terms of industrialisation, while it is appropriate for countries being in the middle range of industrialisation.

Second, results suggest that for a correct understanding of the policy challenges that go along with industrial development, a more comprehensive look at institutions, taking into account the role of the State in actively promoting and coordinating private investments, is necessary. However, the functions and scope of State involvement in the economy is not the same in all phases of development, but it should be fine-tuned to the actual needs of industry.

**Table 6.** Institutional differences across tiers of manufacturing countries (2015)

<i>Functioning of public system</i>	<i>Free operation of markets</i>	<i>Security of transactions</i>	<i>Market regulations</i>	<i>Openness</i>	<i>Coordination of stakeholders, strategic vision, innovation</i>
	<b>Moving from 4th to 3rd tier</b>				
+ capacity of sectoral reforms		- security of private contracts	+ importance of large-scale distribution		+ public support for innovation
- tax exemptions to economic sectors					
	<b>Moving from 3rd to 2nd tier</b>				
+ capacity of sectoral reforms	- share of state-owned companies	+ security of private contracts	- barriers to competition liberalisation	- obstacles to trade liberalisation	+ coordination in the public sphere
+ transparency	+ efficiency of state-owned companies	+ trade justice	+ competition regulation	- obstacles to capital liberalisation	+ priority to development and growth
+ efficiency of tax system and justice	- state-owned banks	+ insolvency law			+ long-term sectoral strategies
+ freedom to establish and operate organisations	+ mobility of workers	- termination of contracts by State			+ technological environment for firms
	+ ease of starting a business	+ in formation on firms			+ adaptation of training and schooling to business needs
	- pricing control	+ respect for intellectual property			
	<b>Moving from 2nd to 1st tier</b>				
+ efficiency of tax system		+ respect for intellectual property			+ state long-term vision
+ quality of the public policy making					+ public support for innovation
					+ adaptation of the training supply to business needs

Note: table reports only variables for which the difference between groups is statistically significant with a p-value < 0.05.

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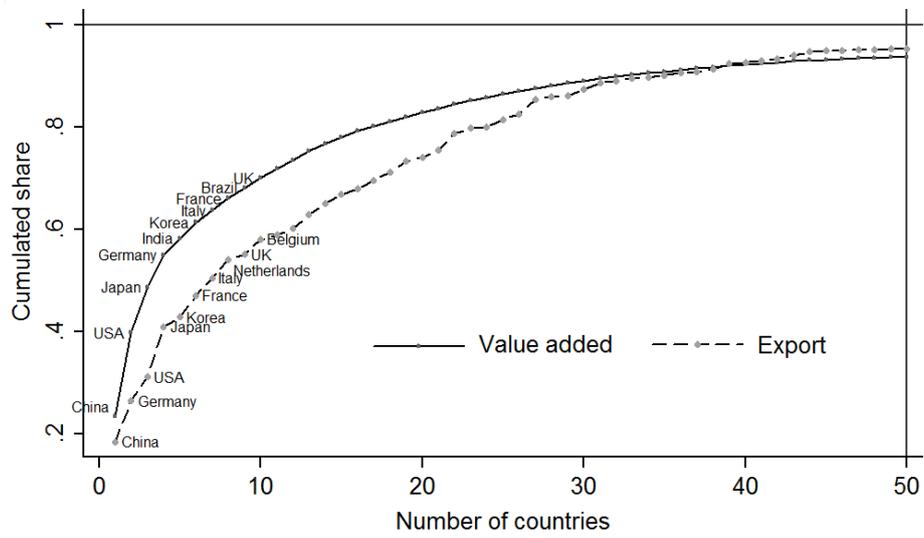
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Appendix A1: World shares of manufacturing countries in the sample (2005, nominal \$)



## Appendix A2: List of selected institutional indicators

Functioning of public administrations	Security of transactions and contracts
Transparency of economic policy	Security of private contracts
Efficiency of the tax administration	Trade justice
Transparency in public procurement	Insolvency law
Functioning of the justice system	Termination of contracts by the State
Influence of economic stakeholders	Respect for intellectual property
Freedom to establish organisations	Employment contract protection
Ease of starting a business	
Quality of the public policy making process	
Support for emerging dynamic sectors	
Consideration of the public interest in State-business relation	
Political authorities decision-making autonomy	
Quality of public services (provided by the public sector)	
Market regulations	Coordination of stakeholders, strategic vision, innovation
Competition: barriers to market entry	Capacity for State reform
Importance of large-scale distribution	Capacity for sectoral reform
Competition regulation	Tax exemptions
Scale of public ownership	Public-private cooperation
Information on the capital held by firms	Coordination in the public sphere
	Long-term vision
	Long-term sectoral strategies
	Spaces for reflection on the major national issues
	Priority of the elite in relation to development and growth
	Technological environment of firms
	Public support for innovation
	Venture capital
	Adaptation of the training supply to business needs
	Adaptation of the higher education system to business needs

Source of selected indicators: Institutional Profile Database.