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The Complex Network of Public Policies. An Empirical Framework for Identifying their Relevance in Economic Development

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“The Complex Network of Public Policies. An Empirical Framework for Identifying their Relevance in Economic Development”

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Abstract

This paper presents an innovative methodology for discovering policies that are consistent with economic development. A ‘development footprint’ narrative is advanced to suggest that laggard countries can improve their good overall economic performance when tracking policy indicators of more advances but structurally similar economies. This narrative is converted in a workable policy guideline through the use of a complex network of public policies. The main results generated when the model is calibrated with a panel of countries in all income categories for the period 2006-2012 are as follows: (i) public policies are context dependent; (ii) there are different development modes that any country can undertake; (iii) policy interventions within each mode are part of a consistent package and, thus, they should not be implemented in isolation; (iv) bosting public governance indicators do not seem to be important for the poorest countries of income group 4, but this type of actions are very critical in upper-middle income countries of group 2.

I) Introduction.

The traditional view that there is a set of common factors that precludes the possibility of closing the income gap between developing and developed countries is somehow misleading. When analyzing the relative relevance of policies and institutions it is frequently assumed that their impact on countries' economic growth does not vary in terms of their current stage of development. However, there are many pieces of empirical evidence showing that similar policy interventions exhibit a large heterogeneity in countries' outcomes since they are implemented in a wide array of economic and governance structures. For example, Lee and Kim (2009) show that improving secondary education and political institutions is more effective in low and lower-middle income countries than in upper-middle and high income countries, while the latter get more benefit out of the establishment of policies that promote tertiary education and R&D.

For this reason, some development economists have, in recent year, advocated the design of policymaking through the identification of the country's binding constraints on growth [Rodrik, 2007 and Hausmann *et al* 2008]. The so-called method of 'growth diagnostics' is based on the idea that prices and shadow prices in specific factors, such as finance, education, infrastructure and governance institutions, reflect the scarcity of resources and, thus, they provide signals for identifying the key policy intervention that can ignite growth.[1] However, one of the shortcomings of this approach lies in the difficulty of determining a list of policy priorities even if an assessment can be produced for a large variety of factor prices. Therefore, an alternative method is needed to identify the relative relevance of the many factors that can exert an impact on the countries' economic performance, and how such impact varies depending on the countries' actual stage of development.

[1] This methodology starts from the conception that growth is always constrained by a lack of private investment and poor capital accumulation. In fact, the absence of growth can be explained by some other consideration (*e.g.*, a lack of an effective demand or a poor allocative efficiency). See Felipe and Usui (2008) for a discussion on the limitations of 'growth diagnostics'.

In this paper a data-driven framework for establishing development guidelines is elaborated based on the idea that societal outcomes (*e.g.*, growth, equity, resilience) come along with a large set of public policies with many interactions. Consequently, for selecting a particular combination of policies, which could be helpful for the performance of a country with specific 'initial conditions', it is convenient to build a complex network of public policies. In particular, the inclusion of a large number of factors, or development pillars, in such a network allows analyzing the relative relevance of different categories of policies and governance variables. The set of policy variables can be decomposed into macroeconomic management, health, education, physical infrastructure, research and development, among others. While the governance dimension can be divided into bureaucratic effectiveness, voice and accountability, rule of law, judiciary independence, among others.

In order to identify which policies might be suitable for a specific country, it is assumed that as countries evolve leave behind a 'development footprint' reflected in their set of policy indicators. That is, successful countries that crossed, in the past, certain threshold of income made use of particular types of public policies and, hence, this historical record can be employed as guidance for countries in a lower stage of development. Because policies and their corresponding historical record change deeply from one stage of development to the next, it seems rather inappropriate for poor countries to design policies that follow the recent record of distant advanced economies. Instead, this framework suggests replicating policies of similar countries that are just in the subsequent stage of development. A step-wise development process that relies on following successful countries' track is, indeed, observed in the real world when analyzing transformations in the economic structure of developing countries. The empirical literature shows that countries that cross a certain stage of development stop exporting labor intensive goods, such as garments and textiles, and start exporting high added-value goods, such as chemicals and high tech products. While the products that are left behind become the newly competitive industries of countries attempting to escalate in the development ladder.

Therefore, in the first step of the 'development footprint' framework a set of targeted countries has to be selected for specifying the values of the policy indicators to be replicated by the country under treatment. Besides of choosing targeted countries positioned in the next income category of the treated country, the set is reduced even more by taking into account only those countries whose economic structure is similar to the one observed in the treated country. Among economists, it is commonly accepted that for a country to be capable of replicating the performance of a more advance economy, it is necessary to look alike in terms of their comparative advantages. Then, in a second step, a complex network of public policies is used to simulate the impact that certain combinations of policy interventions have on the value of different policy indicators, with the aim that the treated country can move from its original policy indicators to those exhibited by the targeted countries.

The advantage of simulating the diffusion process of a policy through a network is to allow differentiating between exogenous public policies, or intervention policies, and the endogenous value of these policies described by the policy indicators. By looking only at the historical data, it is impossible to observe the size of a policy intervention since all policy indicators are composed by a mix of outcomes and the original policy efforts. However, in the network simulations the distinction is feasible because the model takes into consideration all the relevant interactions among the pillars of development, being either policy or governance variables. By means of a diffusion process, a specific policy intervention percolates into the system affecting other policy indicators, directly or through income, which later on produce a feedback with the indicator where the initial policy effort was set on.

Accordingly, in the simulation runs different sets of policy interventions are implemented with the objective to replicate actual policy indicators of the targeted countries. For this exercise to have empirical relevance and being able to condition public policies to the different stages of development, this procedure starts with the treated countries original indicators values, described in the data, and uses the actual topology of the network for countries in the same income group. Because there is an infinite set of policy combinations to be attempted, the framework uses a genetic algorithm (*GA*) where policy interventions are seen as 'chromosomes' that are selected through an evolutionary procedure that tends to perform rather well in non-linear optimization problems dealing with rugged objective functions. In this case, the function to be minimized is a mean square error defined with the difference between the simulated values of policy indicators and the corresponding values prevailing in targeted countries.

The rest of the paper has the following structure. Section two describes the 'development footprint' narrative as an extension of a traditional development theory on economic progress. Section three explains the advantages of using this framework as a policy guideline, instead of other commonly employed methods. Section four describes the variables and how the data is handled to calibrate the model. Section five presents the mathematical characterization of the diffusion process through the network by means of a system of coupled differential equations. Sections six explains how the package of policies are selected through an evolutionary algorithm. Section seven defines an index of similarity to determine when two countries look alike. Section eight explains the procedure to calibrate empirically the network of policy interactions. Section nine shows some simulation results and makes a comparative analysis of policy interventions depending on countries´ stage of development. Section ten shows some simulation results for Mexico and explains the nature of different development modes for the country. Finally the paper ends with the conclusions.[2]

II) From the 'flying geese' theory to the 'development footprint' narrative.

In the empirical literature of economic development, it is well documented that the dynamic of economic growth is closely related with a process of transformation in the productive structure, where latecomers undertake economic activities that previously prevailed in more advanced economies [*e.g.*, Chang, 2002]. With the exception of a tiny group of oil-exporting economies, countries that have developed in different periods follow a similar pattern of industrialization. That is, most currently developed countries moved from agriculture to industry and then to services, from the production of labor-intensive goods to capital intensive goods, and from low-tech industries to high-tech industries. By assembling a collection of study cases, early thinkers of comparative development, like List (1909), Gerschenkron (1962), Akamatsu (1962) and Kuznets (1966), made important contributions for the analysis of growth in terms of structural change, industrial upgrading and diversification. This contrasts with the neoclassical school, which emphasizes a view on growth based on aggregate capital accumulation and changes in total factor productivity through knowledge spillovers.

In particular, the Japanese economist Kaname Akamtsu elaborated the theory of the 'flying geese' to describe a development process of catching up observed in Asian countries during the 20th century. For this author, the Asian economies developed following an inverted-V pattern, like wild flying geese. Firstly, product development within a country moves sequentially from consumption, to

[2] Likewise, Appendix A presents additional tables with important simulation results, Appendix B presents a non-rigorous analysis that gives empirical support to the 'development footprint' narrative, and Appendix C presents a sensitivity analysis where network results are compared with those obtained with a much simpler method.

production and then to exports, so that the trends of these variables exhibit this shape when graphed through time. Secondly, this pattern is also observed in an inter-industry analysis where the country's economic structure changes from consumer to capital goods and from simple to sophisticated goods. Thirdly, in international comparisons, the 'flying geese' appears anew because of an upgrading process that takes place at different stages of development, where advanced economies move to more sophisticated industries while developing countries become competitive in those industries left behind.[3]

The 'flying geese' pattern seems to be a universal phenomenon for countries that have developed successfully since the industrial revolution: Britain in the 18th century, Germany, France, and the United States in the 19th century, the Scandinavian countries in the turn of the 20th century, Japan in the mid of the 20th century, and South Korea, Taiwan, Hong Kong, Singapore, Malaysia and other East Asian countries in the end of the 20th century. Then, in the first two decades of the 21st century, the structural transformation undertaken by China indicates the surge of a new economic leader [Lin, 2013]. According to Lin and Monga (2009), the catching up process in the development ladder was possible because these countries targeted mature industries in advanced countries with similar factor endowments and a relatively close per capita *GDP*.

For authors working along this line of reasoning, developing countries can benefit from their latecomer advantage when diversifying into industries inside the global technological frontier, as long as their industrialization process is consistent with their latent comparative advantage (*i.e.*, not fully

[3] For a recent reformulation of this theory see Ozawa (2011). This author shows a 'flying geese pattern' when analyzing labor-intensive *US* imports by country of origin. According to this data, Japan lost its prominence in the *US* market to the newly industrialized countries of Asia (*i.e.*, Hong Kong, South Korea, Taiwan and Singapore) in the early 70s of the last century. The exports of these economies rose until reaching a peak in the early 80s. A that point their drop in market share was slowly overtaken by *ASEAN*-4 countries (*i.e.*, Malaysia, Indonesia, Thailand and Philippines) and China. The latter fully dominated the *US* market at the end of the 90s.

exploited due to the existence of some market failure: information, coordination problems).[4] For instance, they start to be competitive in labor intensive industries once real wages become too high in countries just ahead of them in the development process, which themselves are enduring industrial upgrading according to the dynamic redefinition of their comparative advantage. This explains why Korea and Taiwan displaced Japan from its leadership in textiles and garments, while the latter was moving into high tech sectors such as electronics, transport and other capital-intensive goods. Then, when Korea and Taiwan upgraded to the electronic and automobile industries, Indonesia, Thailand and Vietnam entered forcefully into the textile and apparel industries.

The latent comparative advantage becomes real when a country undertakes important changes in their physical and institutional infrastructure. That is, when a collection of policies are implemented to deal with binding constraints and when the governance setting is modified to handle information and coordination failures. In other words, the 'flying geese' of industrial transformation becomes viable because countries moving up in the development ladder make changes in their infrastructure in line with targeted countries. As stated by Lin and Monga (2013, p 20, underlining is ours) "*Sustained economic growth is a process of constant industrial and technological upgrading <u>with parallel and consistent social and institutional changes</u>*". Therefore, policy and governance indicators can be seen as a collection of 'development footprints' that can guide countries in their attempt to move forward in their development. For a 'laggard goose' to become competitive in the former industries of similar but more advanced economies, it requires to apply policies that are aligned with the infrastructure of those countries.

[4] In this respect, Lin and Monga (2013) argue that the failure of industrial policies in most of the developing countries of the post II World War period was caused by their governments imposing overambitious development goals. That is, by the targeting of capital-intensive industries that were very detached from the countries' endowment structure. Very often these gigantic projects became 'white elephants' that drained public resources, created excessive distortions and hampered the prospects for growth. These failures are associated to the doctrine of the 'big push', pursued in communist-oriented countries, and to the structuralist view of 'import-substitution', commonly practiced in Latin American countries with a heavily protected private sector.

Recent empirical evidence shows that developing countries are competitive in international markets in specific communities of the product space despite their poor performance in several policy indicators [Castañeda and Chávez-Juárez, 2016], while advanced countries with high values in these indicators dominate in different communities of this network.[5] In particular, it is observed that the nature of the governance pillar exert an influence on how the countries' export profiles are positioned in the product space. Since successful countries develop by moving from the periphery, where low-value added products are located, to the core of the network, where high-value added and connected products are located, it can be argued that these countries have to implement policies that are consistent with this path of navigation. In other words, when the position of the country's export profile changes in the product space, it is likely that the country also modifies its physical and institutional infrastructure and, hence, in the process creates a 'development footprint'.

When implementing the network framework outlined in this paper for 'policy selection', it is also important to make sure that the income gap between the targeted country and the treated country is not too high, and that their export profiles (or economic structures) are in a relatively close proximity. These requirements help identify the policy package that is consistent with local conditions, making feasible the transformation of the treated country's productive structure. Thus, when designing a policy for a country like El Salvador it makes more sense to look at the recent historical record of Mexico rather than to Finland's policy indicators. The first two countries are in adjacent income groups and their economic structures are closer, according to the economic complexity ranking. However, countries that are very similar to the treated country, in term of policy indicators and income, are not very good candidates for being replicated. This is so because countries undertaking marginal changes in the policy and

[5] In a seminal work, Hidalgo, Hausmann and their colleagues (2007, 2009, 2013) study economic development through trade data and network theory. They build a product space where the export profiles (or productive structure) of any country can be positioned in a collection of products represented by nodes. This model predicts specific paths of structural transformation depending on initial conditions as the 'flying geese' theory suggests.

governance indicators will hardly experience any economic progress. Therefore, it is advisable to implement feasible strategies but different enough to the current ones to open up possibilities for growth.

The reader should be aware of an important caveat regarding the causality relationships in the 'development footprints narrative'. This framework only asserts that more advanced economies leave behind an historical record, without specifying if such footprints are a cause or an effect of their relative success. That is why the methodology proposed in this paper does not define the size of the policy interventions as the difference between the level of the policy indicators for the target country and the level of the actual indicators in the treated country. Instead of using this plain method of differences, a complex network of public policies is calibrated to estimate exogenous policy actions (or policy efforts) that, after a period of time and multiple channels of interrelationships, can replicate the endogenous policy indicators observed in more advanced economies.[6]

III) Motivations for using a network framework in the design of policy guidelines.

Despite of not being framed on a fully structured theoretical model, the complex network of public policies can be a very helpful tool to produce prospective analyses. Through the use of diffusion and GA procedures over a network, it is feasible to discover which type of policy interventions might change the development path of a particular country. In terms of the 'development footprint' narrative, this can be achieved when the set of policy indicators of the proper targeted country can be replicated. This methodology allows specifying historical records than can be followed by low income, lower-middle and upper-middle income countries, but not for high-income countries. The latter countries do not have

[6] Appendix C presents a comparison of results between the network model and the differences method. The conclusion here is that the two methodologies offer different rankings for the relevance of development pillars. Since the outcome of policy recommendations cannot be tested, it is argued that the network model is preferred because of its better empirical foundations in terms of initial conditions and the representation of interdependencies among policy indicators.

any historical paths to imitate and, thus, the model does not offer any insight with regard to the societal outcomes that can be obtained with a specific package of policies.

The network model is also capable of assessing the consequences of not undertaking enough efforts in a particular development pillar for a country in a specific stage of development. For instance, it is possible to infer if the current levels of the governance indicators are critical bottlenecks for a country that wants to replicate other socioeconomic variables and to move in the direction observed in more advanced economies. That is, for any country, it can be tested if high efforts of public governance are always required to make progress possible, irrespectively of the development mode that is followed. Likewise, the framework can also detect the need to make substantial improvements in governance indicators across all countries located in a specific stage of development.[7]

A key assumption behind the use of regression models and international benchmarks for advocating specific policy efforts is that public policies are substitutes; however, this assumption is usually not explicitly laid out when making recommendations. Under these perspectives, the negative impact created by a bad policy (*e.g.*, excessive fiscal imbalances) can be compensated up to certain extent with a policy action on some other dimension (*e.g.*, improving secondary education). Because of this, some economists and consulting firms tend to offer a misplaced advise for guiding policies on several issues (*e.g,*. competitiveness, social development) when utilizing comparisons of international aggregated indexes. At the subnational level it is also common to find regional development plans based on the ill-conceived idea that improvements in the citizens wellbeing will come along by reaching specific targets in a subset of policy indicators.   In contrast, when using the network framework, it is technically possible to test if a specific development pillar is operating as a binding constrain and, thus,

[7] For a comprehensive analysis of the relevance of public governance in development see Fukuyama (2014).

special efforts have to be made on the policies involved. In such a case, the substitutability assumed in regression and benchmark studies is empirically rejected.[8]

A more blunt critique for the use of regressions with aggregated variables for policy evaluation is presented in Rodrik (2012). This author argues that the standard growth regression, where indicators of policies are included as explanatory variables, does not say anything about the effectiveness of policies. Besides of the traditional econometric problems,[9] there is an important conceptual problem since policies are not random variables but are established by governments to obtain certain objectives. The endogeneity of policy is not only an econometric complication but also a severe drawback when the policy evaluation is the null hypothesis to be tested in the regression analysis.[10]

The Rodrik's critique is not applicable in this network framework since, in contrast to the regression analysis, it is not necessary to assume that policy indicators are exogenous. In the simulation process, policy interventions are defined by construction as exogenous variables, yet the final values of the corresponding policy indicators for a particular country are the result of the initial interventions and the simultaneous interactions among all policy variables and, hence such values reflect an endogenous outcome like in the real data. Furthermore, instead of attempting to measure the impact of an isolated

[8] The traditional regression analysis is not the proper tool to identify binding constraints for development even if the statistical significance of the variables is analyzed with different samples, where countries are assembled in income groups. Therefore, if R&D and tertiary education are significant for higher income countries but not for low income countries, this only means that these variables start to be relevant when crossing a development threshold. Accordingly, in the interpretation of the regression results, these variables become attractive substitutes of other policies and basic institutions, but this does not mean that R&D and tertiary are binding constraints for growth, as suggested in Lee and Kim (2009).

[9] The main concerns for this type of regression analyses are parameter heterogeneity, outliers, omitted variables, model uncertainty, measurement error and endogeneity. Some of them have been dealt relatively successfully in the modern econometric literature. For instance, with regard to parameter heterogeneity (Durlauf and Johnson, 1995), several techniques have been developed: quantile regression analysis (*e.g.,* Canarella y Pollard, 2004), varying coefficients (*e.g.,* Kourtellos, 2012), threshold methods (e.g., Minier, 2007). A common approach to handle heterogeneity is to split the sample into groups and run different regressions; however this can reduce the number of observations up to the point of creating sample size bias, especially if several groups are considered.

[10] When growth regressions are estimated with GMM-system the endogeneity is overcome in the econometric sense since the method deals with the problem of lack of orthogonality between the error term and the explanatory variables; however, the estimated coefficients for the policy indicators do not reflect effects of truly exogenous policies since the model does not take into account the rich interactions among explanatory variables.

policy established for unknown motives, the paper's methodology analyzes how well the economic indicators of a targeted country are replicated with the implementation of a complete package of policy efforts.

In brief, the complex network approach elaborated here provides an innovative alternative for designing policy guidelines and for solving important questions in the debate of policy *vs* institutions. This framework does not have to assume that policy indicators are exogenous nor that there is some sort of substitutability among them. Instead, the model takes into account the rich interactions among large sets of policy indicators by estimating a network topology which, in turn, allows detecting if specific policy or governance indicators are important bottlenecks for hampering economic performance. This diagnostic can be elaborated for a particular country or for a set of them when positioned in the same stage of development. Moreover, because this data-driven model considers many policy indicators simultaneously, it is possible to rank the relevance of the different development pillars for any country included in the three income groups analyzed here.

However, the reader should be aware, that the framework does not take into account political economy issues with respect to the implementation of policies. That is, the simulation runs can detect which are the proper policy interventions to replicate the historical record of countries that are a little higher in the development ladder, but remains silent on the possibilities that such actions can be set up under the current political scenario. Despite of the fact that the political economy is a relevant concern for a country to move away from a poverty trap, the feedback that comes from the model is also critical in discovering which policy settings are suitable for a country if the trap is to be unlocked. Moreover, this methodology is not capable of measuring which is the precise impact of a policy action on outcome indicators, such as *GDP* growth, nor to provide statistical inferences. It only offers an 'educated guideline' for identifying policy efforts that can reproduce the set of socioeconomic indicators exhibited by countries positioned in a higher stage of development. In this sense, the aspirations of the network model have a much narrower scope than those pretended by analysts and academicians when making policy evaluation through econometric models.

IV) Description of the data.

This section presents the data used for the construction of the complex network of public policies and the 'development footprints' of countries. Firstly, the different sources of the data are mentioned specifying the nature of the indicators available. Secondly, the actual policy indicators employed in this study are classified in 13 development pillars, and the methodology for handling these variables is also described. Finally, the countries considered in each income group are listed and some descriptive statistics and graphs are presented for the 80 policy indicators.

Data sources

The data required to implement the network framework stems from four data sources. The first three sources allow specifying the set of public policy indicators, while the last one is used to determine countries' comparative advantages. Although any public policy indicator is an endogenous variable that responds to the influence of several variables, those utilized here are narrowly defined so that they can be directly connected with government interventions associated to a very precise category of policies (*e.g.*, education, health, infrastructure). In contrast, an output indicator is a variable that measures a broad dimension of economic performance and whose value is determined by a large set of factors. In particular, the Gross Domestic Product per capita (*GDP pc*) is utilized here to classify countries in income groups so that they can be positioned in one of four stages of development. The three international databases used for measuring these two types of indicators are the following: the World

Economic Forum's Competitiveness Dataset, and the World Bank's World Development Indicators and Worldwide Governance Indicators.

(i) Global Competitiveness Report (*GCR*)

The World Economic Forum (*WEF*) publishes on an annual basis the Global Competitiveness Report, in which they estimate a measure of overall competitiveness. The computed index is based on a wide variety of indicators. In the report, these indicators are grouped into 12 pillars of different kind: health, education, market efficiency, business sophistication, to mention a few. In addition to the report, the *WEF* makes its data publicly available on the internet. In this study the indicators are taken from the Competitiveness Dataset 2006-2015, which covers 140 economies worldwide.

(ii) World Development Indicators (*WDI*)

The second most important source for the economic indicators considered here to operationalize the network framework is the World Bank's World Development Indicators database. A cross-country panel data set that includes development relevant indicators at the national level for the period from 1960 to today. However, for building the complex network it was required to match the other data sources and, thus, only the period from 2006 to 2012 was taken into account. While the database is provided by the World Bank, the data stem from various sources such as the International Monetary Fund, the United Nations and other international agencies.

(iii) Worldwide Governance Indicators (*WGI*)

The Worldwide Governance Indicators is the third international database used in this study. It collects indicators related to governance and groups them into 6 categories: Voice and Accountability, Political Stability and Absence of Violence, Government Effectiveness, Regulatory Quality, Rule of Law and

Control of Corruption. The data cover over 200 countries for the time between 1996 and 2014 and the database is jointly produced and distributed by the World Bank, the Natural Resource Governance Institute (*NRGI*) and the Brookings Institution.

(iv) *BACI* database

The *BACI* database from the *Centre d'Etudes Prospectives et d'Informations Internationales* (*CEPII*) classifies countries' exports through the harmonized system with 6 digits. The HS 92 version includes information for the years 1995-2013 in 221 countries.[11] This database is utilized in the analysis to reduce the set of targeted countries in terms of their similarity with the treated countries. With a similarity statistic is possible to measure how close the productive structures of pair of countries are. For that purpose, an export profile of each country is specified through coefficients of revealed comparative advantage. These are calculated for all its exporting industries, which in this case are classified with four digits of the Harmonized System code.

Classification of policy indicators and data handling

The first three aforementioned data sources are combined so that the variables in the working sample are classified into 13 categories of policy and governance indicators plus the outcome variables. The policy indicators selected here are strongly influenced by the categories, or development pillars, used in *WEF* (2014). However, for the purposes of this study some of the pillars have been redefined and adapted. Table 1 displays the pillars employed to classify the 80 policy indicators that correspond to the nodes in the public policies network:

[11] In turn *BACI* uses exports statistics from the United Nations' *COMTRADE* database. *BACI* is constructed with a method that reconciles the declarations of the exporter and the importer. Likewise, the harmonization procedure allows increasing the number of countries for which trade data is available.

Table 1
Definition of the pillars and data sources of the policy indicators and outcomes

Category	Number of indicators	Sources
1. Governance of firms	4	GCR
2. Infrastructure	8	GCR, WDI
3. Macroeconomic environment	5	GCR, WDI
4. Health	9	GCR, WDI
5. Education	3	GCR
6. Goods market efficiency	6	GCR
7. Labor market efficiency	5	GCR, WDI
8. Financial market development	5	GCR
9. Technological readiness	3	GCR
10. Business sophistication	9	GCR
11. R+D Innovation	7	GCR
12. Public Governance	9	GCR, WGI
13. Cost of doing business	7	GCR, WDI
Outcomes	2	WDI

With the aim of calibrating the network topology and describing the 'development footprint' of countries, it is important to process the raw data in order to make the different indicators comparable. The original variables have different scales and, hence, it is necessary to processes the data in a sequence of steps. In a first step, the variables are normalized to the interval between 0 and 1 using the following expression:

$$I_x^* = \frac{x - \min(x)}{\max(x) - \min(x)} \qquad \ldots(1)$$

where x refers to the raw data and the operators max() min() calculate the maximum and minimum values, respectively, of the original indicator for the entire sampling period. For some heavily skewed variables, essentially due to some outliers, the variable is rescaled further according to the following formulation:

$$I_x^{**} = \begin{cases} min\left(1, \frac{I_x^{*} - \min(I_x^{*})}{P96(I_x^{*}) - \min(I_x^{*})}\right) & if\ mean(I_x^{*}) < 0.2 \\ max\left(0, \frac{I_x^{*} - \mathrm{P04}(I_x^{*})}{max(I_x^{*}) - \mathrm{P04}(I_x^{*})}\right) & if\ mean(I_x^{*}) > 0.8 \\ I_x^{*} & otherwise \end{cases} \quad \text{….(2)}$$

where P04() and P96() refer to the fourth and the ninety-sixth percentile. Note that this additional normalization is only required in a few cases and allows fully exploiting the variance in these variables without relying too much on outliers.

Finally, a last normalization procedure is utilized to define all variables in a positive way. For instance, some indicators of *cost of doing business* are measured in terms of the number of days it generally takes to complete a formal procedure. Thus, smaller values refer to better outcomes in terms of cost of doing business. Therefore, the final indicator is defined as follows:

$$I_x = \begin{cases} I_x^{**} & if\ corr(GDPpc, I_x^{**}) > 0 \\ 1 - I_x^{**} & if\ corr(GDPpc, I_x^{**}) < 0 \end{cases} \quad \text{….(3)}$$

where some of the indicators are inverted to induce a positive correlation between the *GDP per capita* and each of the policy indicators. The motivation is simply that higher values in a policy indicator can be associated with better economic outcomes. Defining all indicators in a positive way also helps in making consistent interpretations in the simulation of the diffusion process, since an increase in the policy indicator is associated with improvements in the application of public policies.

Definition of income groups and descriptive statistics

In this subsection the reader can have a closer look at the data. The database built for the model assembles a sample of 88 countries. Table 2 displays the countries included in the study by income group as defined by the World Bank. The only countries removed from this working sample are those that do not provide enough information or have less than 1.2 million inhabitants in all the years of the sampling period. For each of the income groups (1, 2, 3 and 4) specific network topologies are constructed to identify one type of initial condition and, then, for comparison purposes an additional topology is calibrated with data including all groups. It is important to recall that for the selection of policies there is no need to build a network for group 1 since for these wealthy countries there is no historical record to follow.

Table 2
Overview of countries in the study by stage of development

Income group	Number group	Set of countries included
High income (32 countries)	1	Australia, Austria, Belgium, Canada, Chile, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Israel, Japan, Korea, Rep., Lithuania, Netherlands, Norway, Poland, Portugal, Russian Federation, Singapore, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States, Uruguay
Upper middle (23 countries)	2	Albania, Bosnia and Herzegovina, Brazil, Bulgaria, China, Colombia, Costa Rica, Dominican Republic, Ecuador, Hungary, Jordan, Macedonia FYR, Malaysia, Mauritius, Mexico, Namibia, Panama, Peru, Serbia, South Africa, Thailand, Tunisia, Turkey
Lower middle (21 countries)	3	Armenia, Cameroon, Egypt Arab Rep., El Salvador, Georgia, Guatemala, Honduras, India, Indonesia, Kyrgyz Republic, Lesotho, Morocco, Nicaragua, Pakistan, Paraguay, Philippines, Senegal, Sri Lanka, Ukraine, Vietnam, Zambia
Low income (12 countries)	4	Bangladesh, Benin, Burkina Faso, Burundi, Cambodia, Ethiopia, Kenya, Madagascar, Nepal, Tajikistan, Tanzania, Uganda

For the calibration of the weights in the network topology the entire time span covered in the sample (2006-2012) is used and, hence, the relatively few missing values of the original databases are substituted by the observed value in one of the contiguous years. Then, for establishing the 'development footprints' in the simulations of the diffusion process, a two-year period is used to deal with problems of missing values. That is, the period 2011/2012 either refers to the data in 2011 or in 2012 or the average of the two values in case both values are observed. The policy variables for this period are used either to indicate initial conditions of treated countries or the historical records of the targeted countries to be replicated. The period 2011/2012 is the last available with enough information to cover a large number of countries and indicators. The remaining years of the sample are not considered in the simulations since there are not enough yearly variations in the countries' policy indicators through the 7 year period of the sample.

Now, Tables 3.a, 3.b and 3.c present basic descriptive statistics for each of the policy and governance indicators, which are classified in their corresponding development pillar. The means and standard deviations (*SD*) presented here are calculated for the entire working sample, used in the network calibration, and for the 2011/2012 period, used in the simulation of the diffusion process. Additionally, these tables highlight if an additional normalization is employed for delivering the final indicator. The three dots in the *N2* column refer to the use of the fourth and the ninety-sixth percentiles to avoid too heavily skewed distributions, and the three dots in the 'Switch' column signal when the variable is inverted.

From these tables it is important to notice that 73 out of the 80 policy and governance indicators have a strikingly similar mean in the two periods analyzed. This facts indicates that, indeed, the within variation of the policy indicators is rather small along the sampling period. Being the only exceptions the following variables: Mobile cellular subscriptions, Redundancy costs (weeks of salary), Financing through local equity market, Ease of access to loans, Availability of latest technologies, Time required to register property (days) and Time required to start a business (days). This result indicates that in such a short span of time, countries are not able to achieve substantial changes in their historical record and, thus, it can be argued that the 'development footprint' of countries exhibits a strong inertia.[12]

[12] The same conclusion is reached if the means for periods 2006/2007 and 2011/2012 are compared.

Table 3.a
Descriptive statistics of public policy indicators

Pillars and indicators		N2	Switch	2006-2012 Mean	2006-2012 SD	2011/12 Mean	2011/12 SD
1. Governance of firms							
P01_1	Ethical behavior of firms			0.41	0.24	0.39	0.25
P01_2	Strength of auditing and reporting standards			0.56	0.21	0.55	0.19
P01_3	Efficacy of corporate boards			0.56	0.17	0.54	0.16
P01_4	Protection of minority shareholders' interests			0.48	0.21	0.44	0.19
2. Infrastructure							
P02_1	Quality of overall infrastructure			0.50	0.25	0.56	0.21
P02_2	Quality of roads			0.49	0.25	0.52	0.23
P02_4	Quality of port infrastructure			0.52	0.22	0.56	0.20
P02_5	Quality of air transport infrastructure			0.54	0.23	0.55	0.23
P02_6	Available airline seat km/(week*population), millions	•••		0.25	0.30	0.27	0.31
P02_7	Quality of electricity supply			0.61	0.27	0.62	0.27
P02_8	Mobile cellular subscriptions (per 100 people)			0.45	0.19	0.54	0.16
P02_9	Improved sanitation facilities, urban (% of urban population with access) <norm2			0.78	0.30	0.78	0.29
3. Macroeconomic environment							
P03_1	Inflation, annual % change		•••	0.68	0.10	0.70	0.07
P03_2	General government debt, % GDP	•••		0.45	0.24	0.46	0.24
P03_3	Foreign direct investment, net inflows (BoP, current US$)	•••		0.38	0.19	0.38	0.17
P03_4	Imports as a percentage of GDP	•••	•••	0.55	0.26	0.53	0.27
P03_5	Exports as a percentage of GDP	•••		0.43	0.25	0.43	0.26
4. Health							
P04_3	Tuberculosis cases/100,000 pop.	•••	•••	0.80	0.26	0.82	0.23
P04_6	Business impact of HIV/AIDS			0.67	0.21	0.68	0.20
P04_7	Infant mortality, deaths/1,000 live births		•••	0.80	0.23	0.83	0.20
P04_8	Adolescent fertility rate (births per 1,000 women ages 15-19)		•••	0.76	0.20	0.78	0.19
P04_9	Health expenditure, public (% of GDP)			0.38	0.24	0.40	0.25
P04_10	Immunization, DPT (% of children ages 12-23 months)	•••		0.75	0.27	0.76	0.27
P04_11	Life expectancy at birth, total (years)			0.72	0.21	0.74	0.20
P04_12	Survival to age 65, female (% of cohort)			0.79	0.20	0.81	0.18
P04_13	Survival to age 65, male (% of cohort)			0.72	0.21	0.74	0.20
5. Education							
P05_1	Quality of primary education			0.41	0.22	0.41	0.21
P05_2	Quality of math and science education			0.46	0.22	0.45	0.21
P05_3	Extent of staff training			0.54	0.20	0.54	0.17

Notes: Three dots in **N2** refer to the use of a second normalization to avoid too heavily skewed distributions. Three dots in **Switch** refer to the inversion of the variable (e.g. for time required to start a business (days) the value of 1 would be the shortest observed duration, not the longest).

Table 3.b
Descriptive statistics of public policy indicators (continuation)

Pillars and indicators				2006-2012		2011/12	
		N2	Switch	Mean	SD	Mean	SD
6. Goods market efficiency							
P06_1	Intensity of local competition			0.64	0.17	0.63	0.16
P06_2	Extent of market dominance			0.43	0.23	0.42	0.20
P06_3	Effectiveness of anti-monopoly policy			0.46	0.23	0.46	0.18
P06_5	Agricultural policy costs			0.44	0.18	0.44	0.18
P06_7	Degree of customer orientation			0.61	0.15	0.62	0.14
P06_8	Buyer sophistication			0.44	0.20	0.40	0.17
7. Labor market efficiency							
P07_1	Cooperation in labor-employer relations			0.47	0.19	0.44	0.19
P07_2	Redundancy costs, weeks of salary	•••	•••	0.63	0.29	0.73	0.19
P07_4	Pay and productivity			0.54	0.18	0.50	0.17
P07_5	Reliance on professional management			0.55	0.21	0.52	0.20
P07_8	Labor force participation rate for ages 15-24, total (%) (modeled ILO estimate)			0.49	0.22	0.47	0.22
8. Financial market development							
P08_3	Financing through local equity market			0.50	0.21	0.42	0.18
P08_4	Ease of access to loans			0.44	0.20	0.37	0.16
P08_5	Venture capital availability			0.37	0.19	0.31	0.16
P08_6	Soundness of banks			0.72	0.15	0.69	0.16
P08_7	Regulation of securities exchanges			0.55	0.20	0.52	0.19
9. Technological readiness							
P09_1	Availability of latest technologies			0.60	0.21	0.68	0.17
P09_2	Firm-level technology absorption			0.52	0.23	0.54	0.22
P09_3	FDI and technology transfer			0.53	0.17	0.49	0.17
10. Business sophistication							
P10_1	Local supplier quantity			0.52	0.18	0.52	0.15
P10_2	Local supplier quality			0.51	0.21	0.52	0.18
P10_3	State of cluster development			0.50	0.21	0.51	0.21
P10_4	Nature of competitive advantage			0.38	0.24	0.38	0.24
P10_5	Value chain breadth			0.45	0.21	0.44	0.19
P10_6	Control of international distribution			0.52	0.18	0.52	0.17
P10_7	Production process sophistication			0.48	0.22	0.49	0.22
P10_8	Extent of marketing			0.54	0.21	0.52	0.20
P10_9	Willingness to delegate authority			0.44	0.19	0.42	0.18

Notes: The three dots in **N2** refer to the second normalization to avoid too heavily skewed distributions. The three dots in **Switch** refer to the inversion of the variable

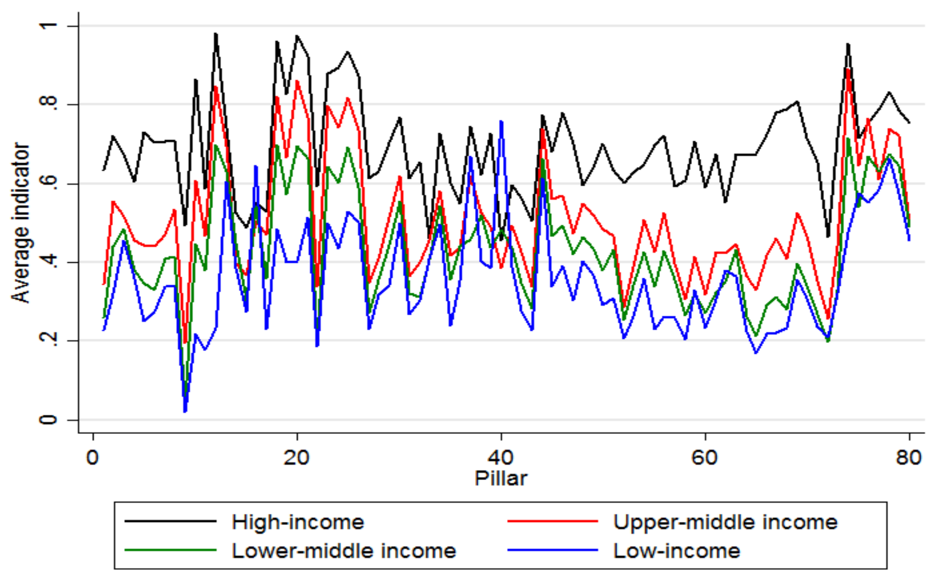
Table 3.c
Descriptive statistics of public policy (continuation)

Categories and variables		N2	Switch	2006-2012 Mean	2006-2012 SD	2011/12 Mean	2011/12 SD
11. R+D Innovation							
P11_1	Capacity for innovation			0.39	0.23	0.38	0.22
P11_2	Quality of scientific research institutions			0.49	0.24	0.47	0.24
P11_3	Company spending on R&D			0.39	0.23	0.39	0.21
P11_4	University-industry collaboration in R&D			0.48	0.23	0.52	0.21
P11_5	Government procurement of advanced technological products			0.45	0.18	0.43	0.17
P11_6	Availability of scientists and engineers			0.52	0.20	0.49	0.18
P11_7	Intellectual property protection			0.43	0.25	0.42	0.24
12. Public Governance							
P12_1	Control of Corruption: Estimate			0.41	0.26	0.40	0.26
P12_2	Government Effectiveness: Estimate			0.47	0.23	0.47	0.23
P12_3	Regulatory Quality: Estimate			0.51	0.26	0.51	0.25
P12_4	Rule of Law: Estimate			0.49	0.27	0.49	0.27
P12_5	Voice and Accountability: Estimate			0.58	0.24	0.58	0.24
P12_6	Property rights			0.51	0.24	0.47	0.23
P12_7	Diversion of public funds			0.43	0.25	0.40	0.25
P12_8	Public trust in politicians			0.31	0.22	0.32	0.20
P12_9	Judicial independence			0.50	0.25	0.49	0.25
13. Cost of doing business							
P13_1	Cost of business start-up procedures (% of GNI per capita)	•••	•••	0.82	0.24	0.85	0.20
P13_2	Time required to enforce a contract (days)		•••	0.64	0.21	0.64	0.21
P13_3	Time required to register property (days)	•••	•••	0.71	0.26	0.77	0.19
P13_4	Time required to start a business (days)	•••	•••	0.68	0.27	0.75	0.22
P13_5	Time to resolve insolvency (years)		•••	0.75	0.14	0.76	0.14
P13_6	Business costs of terrorism			0.71	0.18	0.72	0.17
P13_7	Business costs of crime and violence			0.58	0.22	0.59	0.21
Outcome variables							
Out_1	GDP per capita (constant 2005 US$)			0.18	0.24	0.19	0.24
Out_2	GDP per capita PPP USD			0.24	0.23	0.26	0.25

Notes: The three dots in **N2** refer to the second normalization to avoid too heavily skewed distributions. The three dots in **Switch** refer to the inversion of the variable.

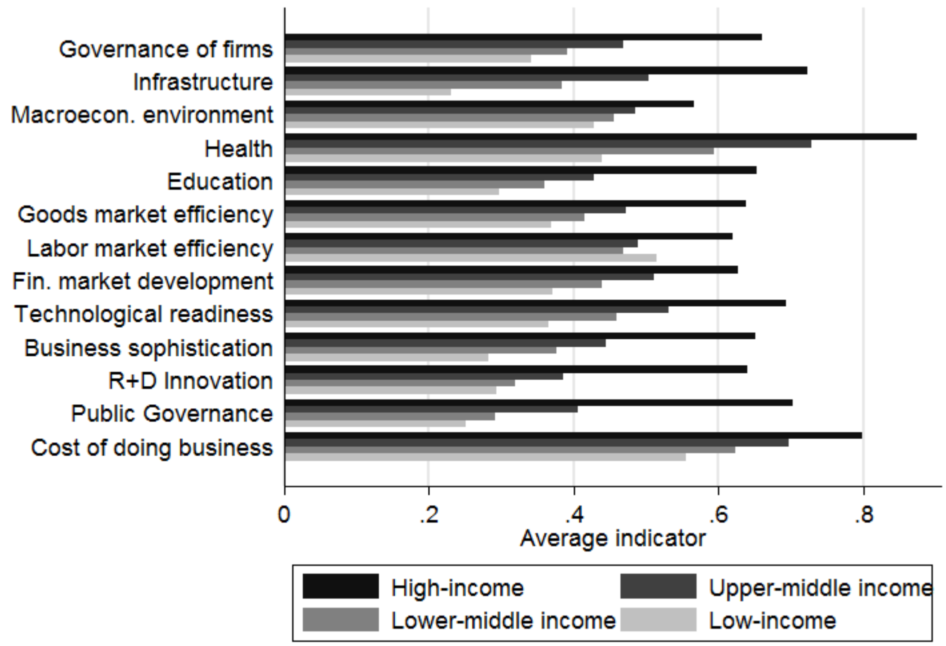
It is also interesting to look at the average levels that the policy indicators have for the countries in the four income groups in period 2011/2012. Figure 1 shows these levels for the 80 indicators, while in Figure 2 this is done averaging indicators of the 13 development pillars. In general, it is observed that the higher the income group, the higher are the levels of the indicators and pillars. There are few exceptions to this pattern, as can be seen in Figure 2 where the pillar 7 (labor market efficiency) is higher in the low-income group that in the following two stages of development. Notice also that the wider gaps in all pillars are between the high-income and upper-middle income groups, which indicate that escalating this echelon seems to be a rather difficult endeavor. Likewise, in this last echelon pillars 12 (public governance) and 11 (R&D innovation) present the largest gaps, although pillars 2 (infrastructure), 5 (education) and 10 (business sophistication) also exhibit important gaps.

Figure 1
Average levels for policy indicators in terms of income groups
(period 2011/2012)



Source: Own calculation with data from GCR, WDI, WGI

Figure 2
Average levels for development pillars in terms of income groups (period 2011/2012)



Source: Own calculation with data from GCR, WDI, WGI

Finally, it is important to analyze the correlations among the different development pillars, so that one can get a glimpse of their pattern of association for the entire sample of countries. Precisely, Table 4 displays the correlations for the period 2011/12 for all the pillars in terms of the average value of the policy indicators within each category. In general, relatively large positive correlations are observed; however, there are significant differences that make relevant the construction of a network topology. For instance, the following pair of pillars: 'Governance of firms' (1) and 'Public governance' (12), 'Good market efficiency' (6) and 'Business sophistication' (10), and 'Business sophistication' (10) and 'R&D Innovation' (11) have a correlation of 0.9 or above. While the following pillars: 'Health' (4) and 'Labor market efficiency' (7), 'Health' (4) and 'Financial market development' (8), and 'Financial market development' (8) and 'Cost of Doing Business' (13) have correlations below 0.4. Likewise, 'Health' (4) and 'Cost of Doing Business' (13) are poorly correlated with other categories since both pillars present four correlations below 0.5. Needless to say, these correlations only capture linear associations across categories and do not necessarily refer to causal relationships. Moreover, the analysis with the network model focus on the topology of interaction among all individual indicators rather than on category averages.

Table 4
Correlation coefficients between development pillars

	C01	C02	C03	C04	C05	C06	C07	C08	C09	C10	C11	C12	C13
C01	1.00												
C02	0.80	1.00											
C03	0.63	0.71	1.00										
C04	0.46	0.78	0.62	1.00									
C05	0.71	0.73	0.62	0.60	1.00								
C06	0.88	0.76	0.70	0.49	0.74	1.00							
C07	0.73	0.53	0.47	0.36	0.68	0.73	1.00						
C08	0.82	0.62	0.50	0.33	0.51	0.77	0.53	1.00					
C09	0.84	0.84	0.69	0.57	0.66	0.86	0.57	0.73	1.00				
C10	0.85	0.85	0.77	0.65	0.77	0.91	0.69	0.73	0.88	1.00			
C11	0.84	0.80	0.76	0.57	0.85	0.87	0.71	0.70	0.83	0.92	1.00		
C12	0.90	0.88	0.70	0.68	0.80	0.82	0.70	0.67	0.82	0.86	0.88	1.00	
C13	0.57	0.73	0.47	0.65	0.67	0.47	0.47	0.33	0.52	0.54	0.59	0.72	1.00

Notes: The labels in the first row and first column refer to the pillars presented in Table 1. The correlations are based on the average value of the policy indicators in each category.

V) The diffusion process over a weighted network of policy indicators.

A network with public policy nodes is built with a relatively large set of policy and governance indicators. A topology with non-directional weighted edges is estimated for each category of countries defined in terms of their income per capita, as indicated in the data section. Then, a diffusion procedure is implemented through a master equation whose structure is characterized by the topology of the network. Metaphorically, the policy efforts are interpreted as ‘drops of policy’, which slowly percolate through the network nodes and edges. Because these edges have weights there is a differenced filtering of policies along the network and, thus, particular patterns of ‘flooding’ start to emerge. This diffusion process continues for several tics (computer time) with the purpose of creating ‘instance of flooding’ for the set of policy indicators of the treated country, so that they resemble the real instances of targeted countries located in the subsequent stage of economic development.

The diffusion process begins with the original instance of policy indicators presented by the treated country in 2011-2012. As mentioned previously, these initial conditions describe the values of 80 policy and governance indicators, which are classified in 13 development pillars. The values of these indicators fluctuate in a range between zero and one since they have been previously normalized. These 'original instances of flooding' characterize the historical record for each of the countries in the sample according to its development attributes. Consequently, the model allows analyzing which type of policy package can change a treated country's original instance into those instances observed in targeted countries. This percolation takes place through a network topology calibrated with data coming from the income group of the treated country. It is important to remember that in the 'development footprint' framework the overall economic performance of countries is associated with a specific pattern of policies and governance

Methodology for calibrating the weight links

The edge weights are calculated using two approaches: a criterion of co-occurrence, used in Hidalgo *et al* (2007) for the case of export goods, and a scaled Pearson correlation used in Hausmann *et al* (2014). In the first approach, it is argued that two policies are proximate when both are relevant for a relatively large subset of countries. For calculating the relevance of a policy indicator, the framework uses a coefficient of revealed comparative relevance (*RCR*), described mathematically in expression (4), which measures how important a policy is within a country and with respect to other countries in the same income group.[13] It is important to recall that the indicators can be added up since they have been

[13] A low indicator value can attain the status of relevance when it is relatively high in comparison with the values of the remaining indicators in the same country, and when such indicator is low in most of the countries in the sample.

previously normalized; hence, when $RCR_{c,i} > 1$ it is concluded that policy i is relevant for the country c in relation to other countries in the same stage of development.

$$RCR_{c,i} = \frac{p(c,i)}{\sum_i p(c,i)} \Big/ \frac{\sum_c p(c,i)}{\sum_{c,i} p(c,i)} \qquad \ldots(4)$$

where $p(c, i) \in [0, 1]$ is the value of policy indicator i for country c, and the summation in the denominator runs for all countries that belong to a specific income group.

In the following step, an adjacent matrix is established with binary values depending if a particular policy indicator is relevant or not for a specific country. With this policy-country matrix, it is feasible to estimate the conditional probability that indicators i and j are jointly relevant for the sample of countries included in the income group $\varphi_{i,j} = min\ [P(i/j), P(j/i)]$. Consequently, $0 \leq \varphi_{i,j} \leq 1$ is the probability that policy indicators i and j co-occur in any country of the sample; that is, a high $\varphi_{i,j}$ means that when policy indicator i is relevant in a country within the income group, then policy indicator j is also relevant and *viceversa*. Thus, the higher the proximity weight the higher the probability that these two policies are strongly linked. The mathematical formulation for the calculation of these probabilities is stated in expression (5). Notice that the value of $\varphi_{i,j}$ does not depend on the type of conditionality and, thus, the network has undirected edges. In this respect the model does not attempt to specify an arrow of causality between policies in a dyadic relationship, but only a measurement of proximity that indicates whether or not the two policy indicators come along forcefully.

$$\varphi_{i,j} = \frac{\sum_c M_{c,i} M_{c,j}}{max(\sum_c M_{c,i}, \sum_c M_{c,j})} \qquad \ldots(5)$$

where $M_{c,i}$ is the adjacent matrix with binary cells indicating with one if the policy indicator i is relevant for country c (i.e., $RCR_{c,i} > 1$), the *max* operator is used to calculate the minimum probability.

The nature of the connection between policies is not explored in the model, only the strength of the edge is calibrated. This strength can be derived for different reasons: if the indicators are classified in the same development pillar (*e.g.*, infrastructure), political economy considerations that make possible the simultaneous change of both indicators, logistics of the bureaucracy that make their relevance in tandem possible or, perhaps, a mutual interdependency with the income level. Due to the lack of our knowledge with respect to the causal relationships among policies, a first approximation of the actual diffusion procedure is analyzed here with a much simpler characterization of these interdependencies. That is, an undirected grid is considered in the network model, where the weights of the links are calibrated using the strength of the dyadic relationship measured with a metric of proximity.

As suggested above, an alternative approach to measure proximity between policy indicators is to use a scaled Pearson correlation as shown in expression (6). The number one is added to avoid the possibility of using a negative estimate for the weights, and the number two is employed as a divisor to bind the proximity measure between zero and one. Notice that the correlation is also calculated for the coefficients of *RCR* of each pair of policy indicators. Therefore, a high positive Pearson correlations means that these two nodes are strongly connected and, thus, the associated policy indicators tend to be relevant in tandem for the countries included in the sample of a particular income group. In contrast, a high negative correlation specifies a low proximity and, hence, there cannot be a joint relevance of the indicators involved since they move in opposite directions. Despite that a plain correlation seems to be a coarser estimate of proximity, this statistic is more frequently used and hence at the end it is an empirical issue if they produce a similar topological calibration.

$$\varphi_{i,j} = {\left(1 + corr\{RCR_{c,i}, RCR_{c,j}\}\right)}\Big/{2} \qquad \text{…..(6)}$$

where the correlation statistic, *corr*, is calculated for all countries *c* included in an income group.

The master equation for the time evolution of policy indicators

In a hypothetical scenario where there is no policy intervention, the amount of 'water' that diffuses through the complex network never changes. Under these circumstances, a conservative diffusion process takes place since the level of 'flooding' can change in the individual policy indicators but not in the 'instance of flooding' in any particular moment of time. In mathematical terms the level of 'flooding' (or advances) for the *i-th* indicator is described by a time-dependent value $\rho_i(t)$. In physical terms, this value is a quantity that diffuses to neighboring node *j* through edge (*j*, *i*) with weight w_{ji},[14] and may also be interpreted as a density $\rho_i(t) = n_i(t)/n$ of random walkers in the network, where $n_i(t)$ = 0,….,n of walkers in *i* out of a total, constant number $n >> 0$. In other words, random walkers move from node *i* to *j* with probability proportional to ω_{ji}. This characterization attempts to emulate the macroscopic diffusion of the advances observed through time in the country's set of policy indicators. Following Simonsen *et al* (2004) and Simonsen (2008), the master equation that dictates the time evolution of a conservative system is given by the following equation:

$$\frac{d\rho_i}{dt} = \rho_i^{+}(t) - \rho_i^{-}(t) \qquad \text{…(7)}$$

where the change in walker density at node i during an infinitesimally small time interval *dt* is equal to the fraction $\rho_i^{+}(t)$ of walkers entering *i* in *dt*, minus the fraction $\rho_i^{-}(t)$ of walkers exiting *i* in *dt*.

However, for a realistic description of the world, it is necessary to relax the conservation condition and to allow for policy interventions that modify exogenously the advances in policy

[14] In an undirected network such as this $\omega_{ij} = \omega_{ji}$.

indicators. That is, $\rho(t) = \Sigma_i\ \rho_i(t)$ is not constant and the total fraction of random walkers in the network may grow or decrease from its initial value $\rho(0)$. Moreover, the condition $\rho_i(t)\ \varepsilon\ [0, 1]$ for all i,t is introduced in order to have bounded indicator values that correspond to the normalized values utilized in the database. Once $\rho(t)$ is allowed to vary between 0 and N, then, the dynamic of the system is transformed into a non-conservative diffusion process. A simple way to account for policy efforts is by removing or introducing a constant number $m_i = -n,\ldots..,n$ of random walkers to node i during the time interval dt, where the actions of removal or introduction correspond to the sign of m_i. These 'drops of policy' are defined as the policy intervention $p_i = m_i/n\ \varepsilon\ [-1, 1]$ for the i-th indicator; that is, as the constant rate at which the walkers leave or enter the node i beyond conservative diffusion.

Consequently, the master equation for the non-conservative diffusion is given by expression (8), where the last factor $f_i[\rho_i(t)]$ is established to avoid violating the condition $\rho_i(t)\ \varepsilon\ [0, 1]$, needed to compare our data, for certain values of p_i. Notice that, in this formulation, the i-th indicator advances when there is a positive policy effort and/or the incoming random walkers is larger than the outgoing random walkers in node i at time t. The introduction of this factor makes the system of equations non-linear and, thus, a candidate for it is the continuous logistic map $f_i[\rho_i(t)] = \rho_i(t)\ [1 - \rho_i(t)]$, which guarantees that the factor, and the instantaneous change of ρ_i, approaches zero as $\rho_i(t) \rightarrow 0, 1$.

$$\frac{d\rho_i}{dt} = [p_i + \rho_i^+(t) - \rho_i^-(t)]\big[f_i[\rho_i(t)]\big] \qquad \ldots(8)$$

The probability of a random walker taking the edge from i to j is measured by the ratio ω_{ji}/s_i^-, where $s_i^- = \Sigma_k\ \omega_{ki}$ is known as the outgoing strength of node i. Then, the fraction of walkers taking the edge from i to j in dt is $\rho_i(t)\omega_{ji}/s_i^-$ and, thus, the rate of outgoing walkers of node i is obtained by summing over all possible nodes j, as indicated below in expression (9a). A similar algebra is used to derive the mathematical formulation for the rate of incoming walkers of node i, whose final simplification is given in expression (9b).[15]

$$\rho_i^-(t) = \sum_j \frac{\omega_{ji}}{s_i^-} \rho_i(t) = \rho_i(t) \qquad \ldots(9a)$$

$$\rho_i^+(t) = \sum_j \frac{\omega_{ij}}{s_j^-} \rho_j(t) \qquad \ldots(9b)$$

Plugging (9a), (9b) and the logistic map into (8), one can obtain the final specification of the master equation for the diffusion process of policy indicators when the system is perturbed continuously with policy interventions. Notice that indicator *i* experiences some advances when there is a positive gap between the weighted sum of all indicators values and the value observed in indicator *i*. In other words, when the level of flooding in indicator *j* is greater than the one observed indicator *i* this creates a positive flow of 'water' from *j* to *i*.

$$\frac{d\rho_i}{dt} = [p_i + \rho_i^+(t) - \rho_i^-(t)]\rho_i(t)[1 - \rho_i(t)] \qquad \ldots(10)$$

According to this master equation, the increase of 'water' in a policy indicator ($d\rho_h$) is associated in part to the difference in the levels of 'flooding' in two connected nodes ($\rho_e - \rho_h$). In the problem at hand, this can be interpreted as saying that an increase in ρ_e (*e.g.*, secondary education) can promote an increase in ρ_h (*e.g.*, life expectancy) because better educated individuals take better care of themselves and this factor improves their life horizon. Another possibility is that they become more productive and, then, aggregate income increases and more resources are available for the government to improve medical care. Therefore, in both scenarios, this health indicator increases endogenously. However for the latter situation to happen the government has to implement some public policy to improve health

[15] It is easy to show analytically that, in the absence of public policy (*i.e.* in eq. (7)), the long term value of indicator *i* is proportional to its outgoing strength in the network, by a factor dependent on initial conditions $\rho(0)$ and the structure itself (s^-), that is, $\rho_i(\infty) = [\rho(o)/s^-]s_i^-$

facilities, yet this is not considered in the model as a policy intervention. For a policy effort to be classified as a policy intervention, it has to be defined as an explicit government strategy for inducing development, and not as a mere passive response to fulfill some need or requirement that appears endogenously in the economy.

VI) The process of policy identification through an evolutionary algorithm.

Next an evolutionary algorithm is implemented with the aim of identifying packages of policy values that are able to replicate the 'development footprint' of similar but more advanced economies. While the initial conditions of the treated country are set up as the starting point of the simulation, the algorithm finds the 'chromosome of policies' that best describe the 'instances of flooding' of one of the targeted countries among those that exhibit a relatively close productive structure and are positioned in the following stage of development. Each 'chromosome' depends on the particularities of a given country and, thus, it is related to initial conditions that have to do with (i) its own 'instance of flooding', (ii) its economic structure reflected in the export profile and (iii) the topology of the policy variables associated to its income group. In this sense, the model is very rich in the contextual detail of the location where policies are going to be implemented.

Consequently, in this epistemology, the diffusion-cum-evolutionary procedure identifies which policy efforts allow a treated country to mimic the policy indicators of targeted countries that are one step ahead, despite of the fact that the policy interactions might be different between income groups. This approach seems to be a reasonable approximation given our lack of understanding on the circumstances that make the topologies to vary between development stages. These discrepancies can be the result of a collection of different factors: geographical features, historical or cultural backgrounds, and structural issues related to the nature of the countries' economic activities and political decision-making.

A formal description of the evolutionary search of policy interventions

The master equations for the diffusion of policy and governance indicators described in (10, 9.a and 9.b) is a system of N coupled, non-linear ordinary differential equations, where the solutions $\rho(t) = [\rho_1(t)\ldots\rho_N(t)]^T$ is completely determined by the vector of public policies $p = [p_1\ldots..p_N]^T$ and the transfer matrix $\boldsymbol{T}$ with elements $T_{ij} = \omega_{ij}/s_j^-$, as well as the initial conditions $\rho(0)$. The network structure coded by $\boldsymbol{T}$ is constructed using the metrics of co-occurrence (5) or scaled correlation (6), with data for the public policy indicators in a particular income group; while $\rho(0)$ corresponds to the values for these indicators in the treated country in $t = 0$ –*i.e.*, period 2011/2012 in the data. The objective is, then, to find the values for the policy package p. Therefore, the value for the state variables $\rho(t)$ of a treated country at any intermediate time $t > 0$ is determined by the free parameter p, a point in the N-dimensional parameter space P.

Taking the available data into account for the calibration of the model, the process of finding a policy package whose indicators mimics closely a suitable 'development footprint' is as follows. A country with initial conditions $\rho(0)$ at an arbitrary $t = 0$ is treated with certain public policy package $p \in P$ which is implemented in each step of the diffusion process. Thus, under the effect of p and after a time $t > 0$ has elapsed, the treated country achieves a level of development characterized with the state vector $\rho(t)$ according to the dynamic of the N policy indicators described with the master equation. Moreover, the public policy p is implemented with the aim of reaching, after a period of time, a state as close as possible to the socioeconomic level ρ^* that a targeted country had at $t = 0$. Then, the (inverse) efficacy of p is defined as $E[\rho(t^*), \rho^*]$, an error metric that measures the minimum difference between $\rho(t)$ and

ρ^* achieved at time = t^*. Finally the selected public policy p^* is the one that minimizes the metric $E[\rho(t^*), \rho^*]$, in the allowed space P, and therefore brings the policy indicators of the treated country as close as possible to those observed in the more advanced targeted country.

Under this framework, finding a suitable public policy p^* is equivalent to an optimization problem in P, which for arbitrary $\rho(0)$, ρ^* and $\boldsymbol{T}$ may be infeasible to solve exactly, either analytically or numerically. An alternative approach is to use heuristics for parameter optimization via stochastic methods such as evolutionary algorithms (Sivanandam y Deepa 2008, Back *et al* 2000), where $E[\rho(t^*), \rho^*]$ takes the place of a fitness function that determines the quality of individuals p in an evolving population. Although evolutionary algorithms tend to perform well regardless of the shape of the fitness landscape, some problems (such as modularity maximization in empirical networks; see Good, de Montjoye & Clauset, 2010) may show extreme degeneracies that decrease the significance of the optimal solution found by them. In order to alleviate this potential issue and simplify the interpretation of the model results, the vector $p = [p_1 \ldots . p_N]^T$ of public policies for the whole set of indicators is substituted by a category vector $p_c = [\mu_1, \sigma_1 \ldots \mu_C, \sigma_C]^T$ which includes only a couple of public policy parameters per development pillar. Here, it is also assumed that, for all indicators $i_{c,j}$ in category c, their corresponding public policies are distributed randomly according to a Gaussian function with mean μ_C and standard deviation σ_C. In this way, it is possible to compute p from a given p_c, which allows solving the master equation with N indicators. Also P is substituted by the reduced space $P_C = [\mu_m, \mu_M] \times [\sigma_m, \sigma_M] \times \ldots \times [\mu_m, \mu_M] \times [\sigma_m, \sigma_M]$, where μ_m, σ_m, μ_M and σ_M are parameters determining the minimum and maximum allowed values for μ_C and σ_C. When using the data, this process reduces the space dimensionality of the optimization problem from $N = 80$ to $2C = 26$ and, hence, diminishes potential degeneracies for public policies inside each development pillar.

The pseudocode for the process of finding a suitable public policy is shown in the genetic algorithm (*GA*) described in Table 5. For a selected pair of treated and targeted countries, the values $\rho(0)$, ρ^* and $\boldsymbol{T}$ are calculated from the data. Then, for each realization r out of a total n_r, a *GA* is performed to obtain the optimal category vector p_c^*. The evolutionary algorithm consists of n_g generations labeled by g. For $g = 0$, the procedure starts with a population $P(g)$ of s_p individuals, where each individual is a category vector p_c chosen uniformly at random in P_c. Then, $P(g)$ is evaluated with the fitness function $E[\rho(t^*), \rho^*]$. The evaluation operator takes an individual p_c, computes p and $\rho(t)$ with Eq. (10), and finds the time $t^* \in [0, \Delta t, 2\Delta t \ldots t_M]$ that minimizes the error metric, giving $E[\rho(t^*), \rho^*]$ as the fitness of p_c. The parameters Δt and t_M define the precision with which to explore the solution of Eq. (10). In order to consider pillars of development equally regardless of their number of indicators, the fitness value is computed as the root-mean-square-error between indicators $\rho(t^*)$ and ρ^* in the same category, averaged over all categories.

At each generation g, $P(g)$ is entirely replaced by running s_p tournaments of s_t randomly-chosen individuals each, where the (possibly repeated) individuals with the best fitness are selected. Then, an offspring population $O(g)$ is generated by performing a variation over $P(g)$.The variation operator of the *GA* runs a random two-point crossover between consecutive individuals with probability π_c, as well as a Gaussian mutation (with mean μ_g and standard deviation σ_g) for each individual with probability π_i, where each attribute in the individual is mutated with probability π_a. Finally, individuals in $O(g)$ are evaluated to obtain their fitness, and $P(g)$ is substituted by $O(g)$. For each realization r, p_c^* is the individual with the best fitness in $P(g)\ \forall\ g$, and the procedure finishes by averaging p_c^* over all realizations to decrease fluctuations. Typical values for all parameters used in the simulations of the diffusion-cum-evolutionary procedure are shown in Table 6.

Table 5
Genetic Algorithm: finding a suitable public policy.

For a selected pair of treated and targeted countries, as well as a given network of policy and governance indicators, a simple genetic algorithm is used to find the optimal public policy that brings the treated country indicators closest to the ones observed in the targeted country. The GA uses operators of evaluation, selection, crossover and mutation to find the optimal solution relative to a fitness function.

```
get ρ(0), ρ* and T
r ← 0
for r < n_r, do
    g ← 0
    initialize P(g) randomly
    evaluate P(g) with E[ρ(t*), ρ*]
    for g < n_g do
        P(g) ← select P(g)
        O(g) ← crossover and mutate P(g)
        evaluate O(g) with E[ρ(t*), ρ*]
        P(g) ← O(g)
    end for
    p_c* ← best of P(g) ∀ g
end for
average p_c* over r
```

Table 6
Parameters used in the diffusion-cum-evolutionary procedure for finding suitable policies

List of parameters, and their typical values, employed in the simulations. Parameters are categorized according to their role in one of the two procedures: the diffusion dynamics and the evolutionary algorithm

	Parameters		**Assigned values**
General	ω_m	minimum weight	0.6
	n_r	number of realizations	10
Diffusion dynamics	t_M	maximum time	50
	Δt	time step	0.2
Population & individuals	μ_m , μ_M	min/max mean in category	-1, 5
	σ_m , σ_M	min/max standard deviation in category	0.001, 0.5
	s_p	population size	10
	n_g	number of generations	100
Genetic operators	π_c	probability of crossover	0.5
	π_i	probability of mutating individual	0.2
	μ_g	mean of Gaussian mutation	0
	σ_g	standard deviation of Gaussian mutation	2
	π_a	probability of mutating attribute	0.2
Selection	s_t	number of individuals in tournaments	3

VII) The productive similarity between countries.

Empirical evidence shows that the countries' export profile is associated with a particular physical and institutional infrastructure. Consequently, if the 'development footprint' of a particular targeted country is to be followed through policy interventions in the treated country, there should be certain consistency in the economic structures of both countries. This is the reason why the framework used here characterizes the initial conditions of the treated countries not only with the original 'instance of flooding' and the network topology by income group but also with its economic structure. In order to quantify this feasibility constrain, it is necessary to define an index of similarity that allows ranking targeted countries in terms of their closeness with a particular treated country. This is done with the coefficients of revealed comparative advantage (*RCA*) that are calculated for all the products in the countries' export profile. Therefore, the value of the index will be relative high, and the treated and targeted countries similar, if the correlation between their respective *RCA* coefficients crosses certain threshold.

The mathematical definition of this similarity index [Bahar *et al*, 2014], $S_{c,c'}$, is presented in expression (11). Notice that the statistic is an adjusted Pearson correlation where the *RCA* coefficients are measured in logarithms to avoid biases due to the presence of high observations. A value of ε = 0.1 is also added for dealing with *RCA* equal or close to zero, in the latter case the aim is to avoid that the similarity estimation is driven by products that countries export in reduced amounts. This index is calculated for pairs of countries and, thus, it is possible to establish a ranking of closeness between a treated country and all countries classified in the next income group. Therefore, those countries that are in the bottom positions of the ranking are discarded from the set of targeted countries given the fact that their economic structure is very different to the one observed in the treated country. This latter scenario makes very unlikely the possibility of implementing successfully policy efforts even if they were calculated by the method of complex replications.

$$S_{c,c'} = \frac{\sum_i (r_{c,i} - \bar{r}_c)(r_{c',i} - \bar{r}_{c'})}{\sqrt{\sum_i (r_{c,i} - \bar{r}_c)^2 \sum_i \left(r_{c',i} \bar{r}_{c'}\right)^2}} \qquad \ldots(11)$$

where $r_{c,i} = ln\,(RCA_{c,i} + \varepsilon)$ and $\bar{r}_c$ is the average $r_{c,i}$ over all indicators i for country c

VIII) The calibrated network topology

The calculations of link weights for the public policies network are made with two methods of calibration: co-occurrence and scaled Pearson correlation. In the 'development footprint' framework it is important to take into consideration countries' initial conditions. Thus, the empirical weights of five types of networks is analyzed, one for each income group and one for the entire sample. The first thing to notice in the results presented in Table 7 is that the two calibration procedures generate similar weights since the correlation of the two types of proximity values is above 80%, irrespectively if the network is defined for specific income groups or for the whole sample. The correlations of weights show that this resemblance is closer the higher is the average income of the countries included in the group, with a correlation of 89% for the network in income group 1 where the richest economies are classified. Accordingly, these empirical findings lead to the conclusion that any of these two methods can be used for the calibration of the network. Hence, the rest of the analysis presented in this paper is conducted with the method of the scaled Pearson correlation given its simplicity and widespread use.

Table 7
Correlations of the proximity metrics for the two calibration methods: co-occurance and scaled Pearson correlation, with yearly information in the period 2006-2012

Sample type:	Correlation between the two methods	Correlation between networks of different samples calibrated with the scaled Pearson method*	Correlation between networks of different samples calibrated with the co-occurrence method*
World	0.865810901		
Income group 1	0.892796091	0.753858026	0.73222374
Income group 2	0.821821517	0.791049583	0.731771667
Income group 3	0.822796714	0.7626871	0.634135274
Income group 4	0.804384015	0.597422174	0.497445151

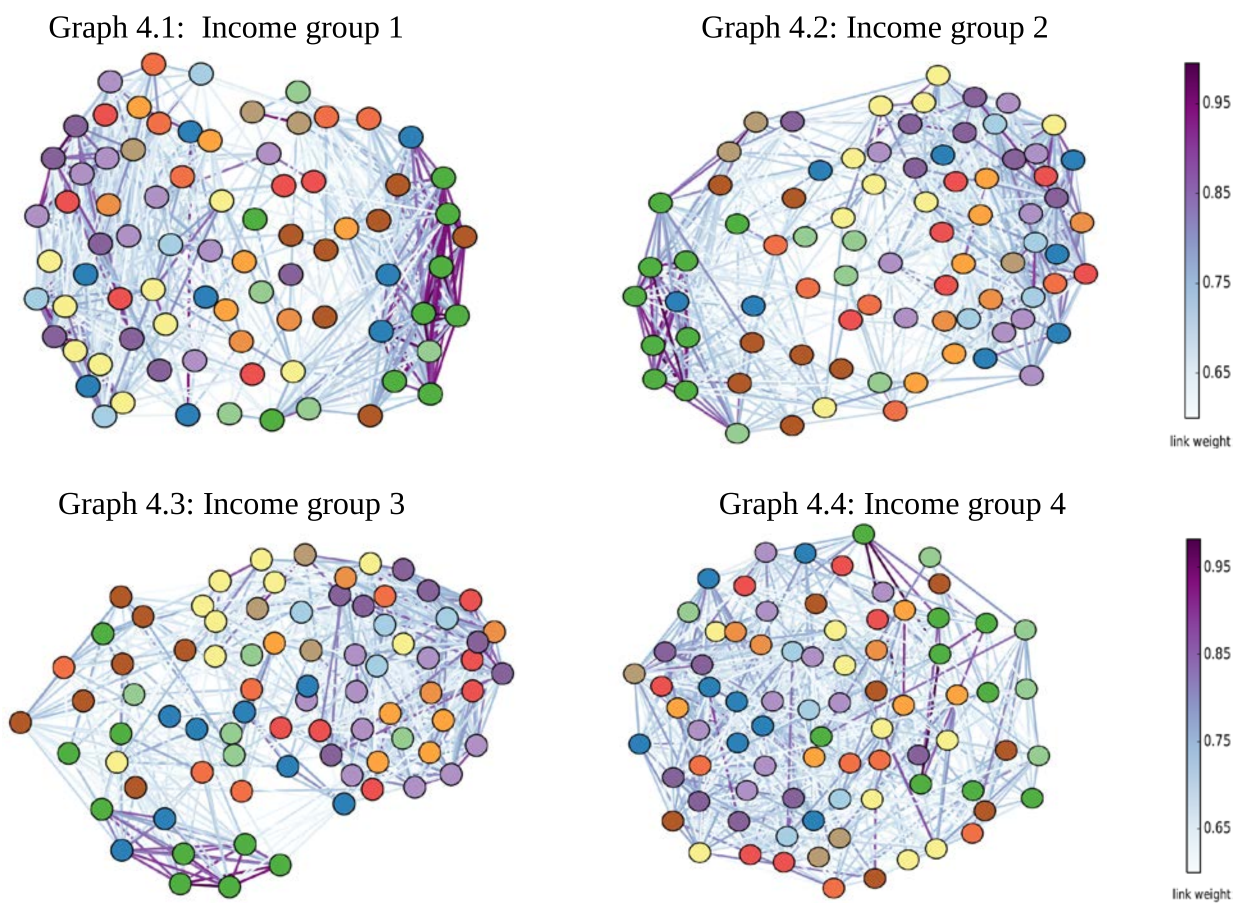
Note: annual proximity weights between nodes are calculated with information coming from the coefficients of revealed comparative advantage which, in turn, are estimated with the normalized values of policy indicators. Then, average proximity matrixes are defined with the arithmetic means of the annual weights. Finally, the Pearson correlations presented in the table are calculated for the cells of the average proximity matrixes under comparison. * These correlations are produced using as a benchmark the average proximity matrix for the world network.

The last two columns of Table 7 indicate that, independently of the calibration method, there are important differences in link weights depending on the income group. In particular, the correlations show that the weights of the world network is not always similar to the one observed in a specific income group. It seems that the networks including a sample of relatively poor countries (income groups 3 and 4) have different weights to the one observed in the world network. This result highlights the importance of considering specific network for each income group, so that the initial conditions for the treated countries in real life can have a better characterization in the model. In this case, with respect to the interactions among policy indicators that can prevail in a specific stage of development.

Once the values for the weight links are specified for each income group, it can be observed that there are different networks topologies. In Figure 3 these discrepancies are laid out by depicting graphically the network configuration for each of the four income groups. Because a fully connected network is not amicable for analyzing the topological structure of a complex system, these graphs show sparsely connected networks when links are kept only if their weights are relatively strong (*i.e.*, with a cut-off of 0.6).[16] The intensity of the colored link is related to the strength of the link, being the intense purple link an indication of a high proximity between the two policy indicators. The color of the node describes the development pillar where the corresponding policy indicator is classified. In general, it is observed that policies within the same pillar have strong links, although, there are cases where nodes classified in different pillars are also relatively proximate. Likewise, these configurations show that nodes of the same color are usually assembled in specific communities of the networks. In other words, not only policy indicators within a pillar tend to have pairwise proximity but also exhibit a large set of interdependencies, which in this graphical representation means that the nodes within a pillar tend to be attracted.

[16] The supplementary material present these network graphs for a 0.4 cut-off.

Figure 3
Networks of public policies by stages of development
(Weighted links calibrated for the period 2006-2012 with a cut-off of 0.6)



Source: own calculation with normalized policy indicators obtained from *GCR*, *WDI* and *WGI*
Note: the color of the nodes describes the different development pillars: governance of firms (light blue), infrastructure (blue), macroeconomic environment (light green), health (green), education (light brown), goods market efficiency (red), labor market efficiency (orange), financial market development (light orange), technological readiness (yellow ochre), business sophistication (violet), R&D innovation (purple), public governance (yellow) and cost of doing business (dark brown)

When the four topologies are compared, there are clear differences between the networks for the richer economies (income groups 1 and 2) and the networks for the poorer economies (income groups 3 and 4), especially for the latter. While the pattern observed in the networks of richer economies describes nodes split into two groups and delineated clusters around specific development pillars, the pattern for the poorest economies describes a network structure with more homogeneously connected nodes. Perhaps, this change in patterns reflects that in the initial stage of development most policy indicators are uniformly related and, thus, all sorts of policies have to be implemented to have a working economy. While the relevance of the policy indicators becomes more unequal and their interdependency narrows to specific pillars, as the development process climbs more echelons.

In order to have a more precise description of the topologies of each network, Table 8 presents the value of the metrics for some of the average properties of their nodes when a 0.6 cut-off is considered. Although the values for the average properties among networks defined in terms of income groups are somehow similar, there are some important discrepancies that are highlighted with the numbers shown in the table.[17] First of all, there is not a clear trend in any of these properties when moving in the development ladder; however when comparing the networks of income group 2 and 4, it becomes evident that their policy indicators have quite different interrelationships. The upper-middle income countries have more strong links, these links are in average stronger, their triadic relationships are more evident, pairs of nodes are slightly farther away in average, their average centrality is larger, and their assortative mixing is less pronounced.

Table 8
Properties of the network topologies by income group
(with a 0.6 cut-off for weight links)

Network type	N. of edges	Avg. strength	Avg, clustering	Avg. shortest path length	Avg. betweenness centrality	Assortative coefficient
Income group 1	826	14.6189735906	0.444843437058	2.89908788004	0.0130842259007	0.19663096522
Income group 2	948	16.5251538623	0.445639872389	2.75224711908	0.01179406037	0.291869178508
Income group 3	832	14.3385213731	0.404025434316	2.80647284553	0.0119806880883	0.433976889407
Income group 4	863	14.7777663264	0.360763288897	2.65837237581	0.0108893216488	0.359652494074
World	747	12.7795619474	0.442582231477	3.2403699259	0.0153967867575	0.451677647356

Notes: average node strength = sum of edge weights for a node, averaged over all nodes; average clustering = number of closed triplets (or 3 x triangles) over the total number of triplets (both open and closed), averaged over all nodes; average shortest path length = minimum distance (i.e. sum of inverse weights) between pairs of nodes, averaged over all nodes; average betweeness centrality = number of shortest paths from all vertices to all others that pass through that node, averaged over all nodes; assortative coefficient = Pearson correlation coefficient of degree between all pairs of linked nodes

[17] These differences are made more apparent when a 0.6 cut-off is used instead of a 0.4 cut-off, as indicated in the supplementary material.

These characteristics point out that the policy indicators of upper-middle income countries have more interdependencies than in the network of poor countries and these are stronger; moreover, the higher presence of interdependencies creates more triangular relationships but does not help to reduce the distance between any two indicators selected at random in the network; these added interrelationships do not preclude the existence of fewer hub since the network seems to be more hierarchical; finally, highly connected policy indicators for the upper-middle income countries are less likely to be linked than in the network of poor countries and similarly for barely connected nodes. The latter result means that in the group-4 network feedbacks between two policy indicators are more uniform because both sides of the dyadic relationship tend to have the same degree.

All these properties are consistent with the graphical visualizations presented in Graph 4.2 and Graph 4.4. In the former case the nodes are split in three communities, the extreme ones are highly clustered while the central one plays a connecting role. In contrast, in the latter case, the nodes tend to be more uniformly distributed with a lower tendency to show clusters and central nodes. In other words, the diffusion of the policy actions tend to be concentrated in a much narrow set of indicators in the network for income group 2 which, as stated above, allows governments to be more focused when implementing policies.

IX) The selection of policy packages through simulation in a complex network.

Once the topology of the network has been calibrated for each income group and a proper pair of countries is selected, it is possible to run simulations for different policy packages in an attempt to replicate the ‘instance of flooding’ of the targeted country. According to the ‘development footprint’ narrative, with context-specific physical and institutional infrastructure it is possible to induce a transformation in the country's productive structure. Next, simulations outcomes are produced for 53 countries that are classified in the three lower income group categories. The network model allows generating simulation results for all pairs of treated and targeted countries and, thus, it is feasible to establish several development paths for each treated country. In other words, there is not a specific mode of development that a country should follow; nonetheless, due to space limitations, only one development path is analyzed here for the 53 countries, and this is done by replicating the footprints of a 'representative targeted country'.

In order to characterize the representative target of a particular country, the set of countries in the following stage of development is reduced to include only those whose ranking of similarity with respect to the treated country is in the top 30%. The idea here is to consider a feasibility criterion in the selection of a development path because laggard countries are not capable of following countries which are very far apart in terms of their productive structures. Therefore, for the creation of a representative 'instance of flooding' for any treated country, the values of all policy indicators for the countries included in this limited set are averaged.

The simulation starts with the original instance of policy indicators for the treated country, in period 2011/2012, (see Figure 4 for the Mexican case) and a 'chromosome' of policy interventions. The latter is established at random within the parameter bounds established in the *GA* procedure section. The values of the selected 'chromosome', that minimizes the fitness function, are interpreted as the policy interventions that can replicate the policy indicators observed in a previously defined representative target (see Figure 5). This educated guideline can help policymakers in defining the relative relevance that each development pillars has if the treated country (*e.g*. Mexico) wants to follow the representative target's 'development footprints'.

Figure 4
Initial instance of flooding for Mexico
(Normalized values of policy indicators arranged by development pillars, 2011/2012)

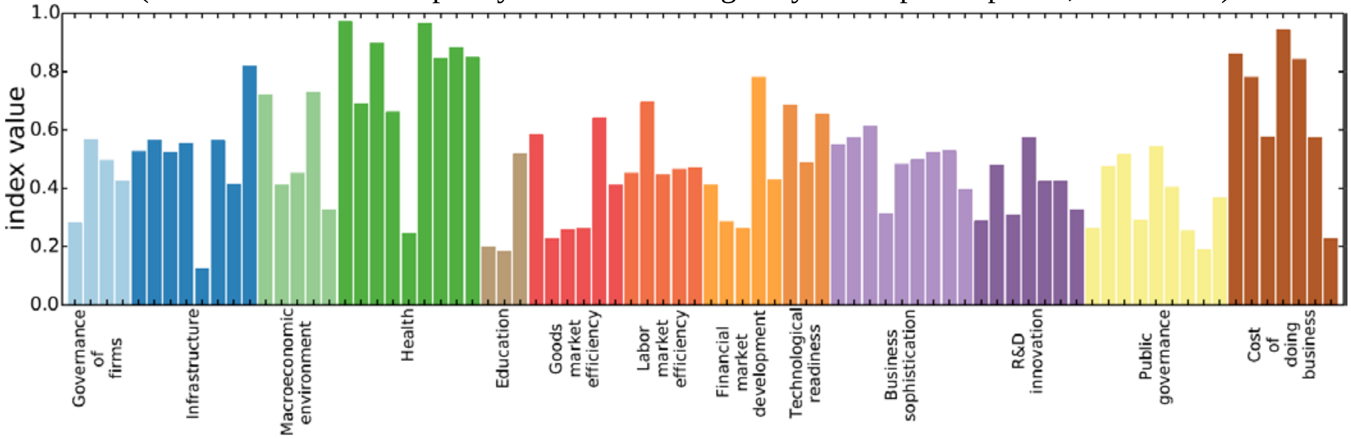
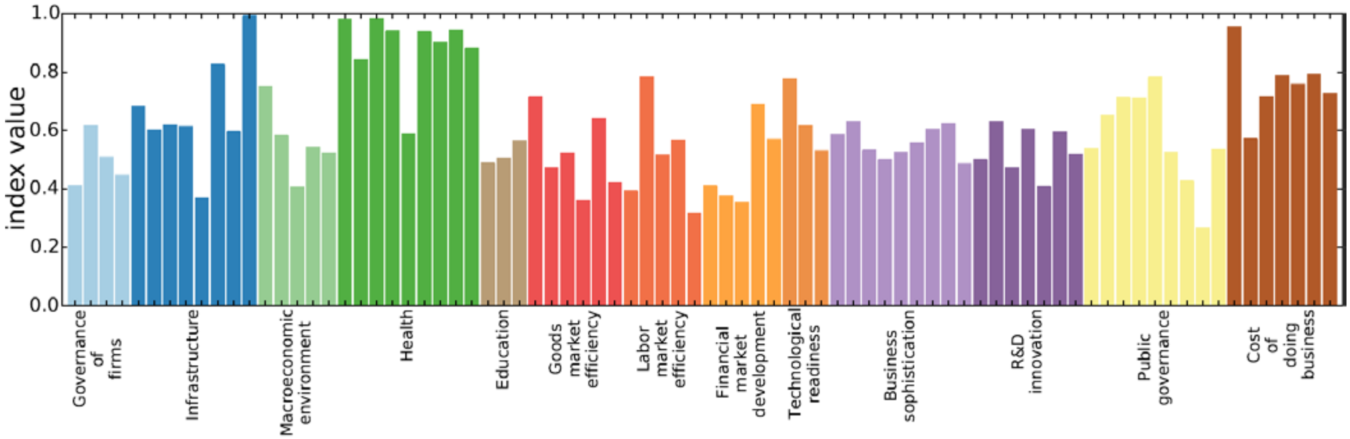


Figure 5
Representative instance of flooding for Mexico to follow
(Average values of normalized policy indicators for similar but more advanced countries, 2011/2012)



For each treated country, there is a selected policy package and a value for its goodness of fit (*i.e.*, an optimal *Mean Square Error*). Here optimality is defined only in terms of the best possible replication of policy indicators in the representative target; it does not necessarily mean that the suggested policy actions are conducive to the best economic performance. Table 9 presents the optimal value of the fitness function (column 4) for the *GA* applied to each of the 12 treated countries positioned in income group 4. Notice also that the *MSE* obtained when comparing the simulated instance and the actual instance of the targeted country (column 4) is lower than the *MSE* calculated by comparing the original instance of the treated country with the actual instance of the targeted country (column 3). The simulated outcomes indicate that the quality of the fitness is good enough in all but two cases, which means that the model is capable of generating policy packages that produce policy indicators that are closer to the targeted countries in comparison with the actual gap.[18] The Appendix A of this paper presents similar Tables for income groups 3 and 2, where it can be seen that 18 out of the 20 countries in income group 3 have a good enough fit (the exceptions are India and Sri Lanka), and the same happens for 20 out of 21 countries in income group 2 (the exception is Malaysia).

Table 9
Results of the genetic algorithm for countries in income group 4
(Using the average values of the indicators of similar countries as a representative target)

Num.	Treated country	*MSE* with the treated and targeted country instances (actual gap)	Optimal *MSE* (simulated gap)	Similar countries used to define the representative target.**
1	Bangladesh	0.147312730253	0.121681043585	LKA MAR NIC PAK SLV VNM
2	Benin	0.131087424645	0.121799002226	CMR GTM NIC PRY SEN ZMB
3	Burkina Faso	0.15057426895	0.123337682706	CMR EGY GTM PAK SEN ZMB
4	Burundi	0.218478849225	0.132276526869	CMR GTM KGZ NIC SEN ZMB
5	Cambodia	0.136351071476	0.127817008178	HND LKA NIC PAK SLV VNM
6	Ethiopia	0.190011653766	0.164509213536	GTM KGZ LKA MAR NIC PAK
7	Kenya	0.125510943386	0.113660200186	GTM HND LKA NIC SEN SLV
8	Madagascar	0.209896689296	0.154877513311	IND LKA MAR NIC PAK VNM
9	Nepal	0.177609383205	0.127368280111	GTM IND LKA PAK SLV VNM
10	Tajikistan*	0.109892778882	0.10242797415	EGY HND KGZ MAR PAK SEN
11	Tanzania	0.101744136143	0.0922184356412	CMR EGY NIC PAK SEN ZMB
12	Uganda*	0.099144024357	0.0911253605529	CMR GTM NIC PAK SEN ZMB

Note: * for these countries the *MSE* of the actual and simulated gaps are similar; ** countries included are specified in terms of their International Standards Organization (ISO) 3-digit alphabetic code.

Now, Table 10 exhibits the average policy ratios for the countries of income group 4 and the number of countries where each development pillar appears in the top four of the estimated policy efforts. Because the simulations have different goodness of fit and the overall policy effort for reaching the representative target varies from one country to another, policy ratios are used here to simplify the interpretation of the results. For example, for the Asian countries in group 4 the 'Governance of the

[18] For Tajikistan and Uganda the simulations are not capable of generating good enough fits since the optimal *MSE* for these targeted countries are just slightly lower than the *MSE* of the actual gaps. In other words, the *GA* does not identify policy packages that can make these countries closer to their corresponding representative target in terms of policy indicators.

firms' pillar requires 12.8% of the overall policy effort to reach their representative target positioned in the following development stage; while for the African countries 14% of such effort should be allocated to the improvement of the 'Health' pillar.

Table 10
Policy ratios for countries in income group 4 by region
(Averages across countries in the same region)

Development pillar	G.4.Asia	Top-4	G.4.Africa	Top-4
Governance of firms	0.128 T	3	0.072	2
Infrastructure	0.101	2	0.115 T	3
Macroeconomic envir.	0.106 T	1	0.060 B	1
Health	0.124 T	1	0.140 T	5
Education	-0.004 B	0	0.002 B	0
Goods market efficiency	0.026 B	1	0.083	3
Labor market efficiency	0.014 B	0	0.068	0
Financial market devel.	0.096	1	0.086	5
Technological readiness	0.055 B	1	0.094 T	4
Business sophistication	0.130 T	4	0.115 T	4
R&D innovation	0.063	2	0.043 B	1
Public governance	0.089	0	0.037 B	1
Cost of doing business	0.073	0	0.084	3
No. countries included		4		8

Notes: policy ratio = estimated policy effort for the pillar / sum of all policy efforts across pillars.
A negative policy ratio indicates that the corresponding country has some slack in the pillar's indicators with respect to the requirements needed to reach the representative target.
Top-4 = number of countries where pillar appears in the top four policy efforts
T = pillar in the top four of average policy ratios
B = pillar in the bottom four of average policy ratios

The first thing to notice is that the relative relevance of the development pillar varies between geographical regions. This can be seen more clearly by looking at the top four average policy ratios, which for the Asian countries included in this category are as follows: 'Business sophistication', 'Governance of firms', 'Health' and 'Macroeconomic environment'; while for the African countries the top four are in the following order: 'Health', 'Infrastructure', 'Business sophistication' and 'Technological readiness'. Notice also, from this table and those of the remaining income groups,[19] that the highest average policy ratios tend to coincide with the largest number of times that such pillars are in

[19] These tables are exhibited in the Appendix A.

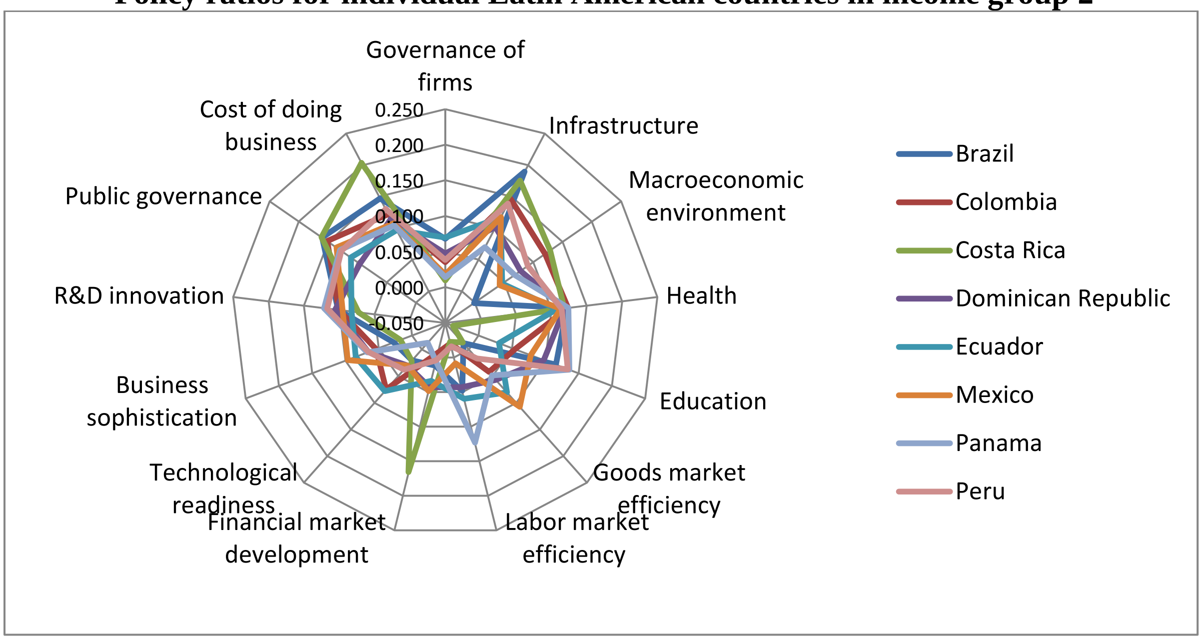
the top four policy efforts, although there are some exceptions; for instance, ‘Financial market development’ is a top-4 for five African countries despite of the fact that such pillar does not present a very high average policy ratio.

Not only there is an important variety in the policy ratios among regions of the same income category, but there are also variations in such ratios within a region controlling for income group. The supplementary material of this paper presents the calculated policy efforts and ratios for all the 53 countries analyzed here, which belong to every income category and different geographical region. As an illustration of this type of disparities, Figures 6 and 7 show spider graphs for the policy ratios of Latin American and East European countries that are classified in income group 2. As can be seen in Figure 6, most Latin American countries have a striking similarity in terms of the relative relevance of policy ratios. In particular the top four pillars for the region as a whole ‘Public Governance’, Infrastructure’, ‘Cost of doing business’ and ‘Health’ have large spikes in most of these countries; in fact these pillars appear in the top-4 for 7, 7, 7 and 6 times out of 8 countries, respectively.

In contrast, Figure 7 shows that there are wider disparities in the policy ratios of the East European countries of income group 2; in particular, Turkey follows a pattern that is clearly distinctive. For this region the highest priorities are given to the following pillars: ‘Infrastructure’ (4 appearances in the top-4), ‘Public Governance’ (5), ‘Business sophistication’ (3) and ‘Research & development’ (3); consequently, the lower number of times that a pillar appears in the top-4 indicates that there is less uniformity in the selected policy package within this region. Moreover, the comparison of these two spider graphs highlights that there are disparities among regions within the same income group. Although, two pillars are very important for both regions, ‘Infrastructure’ and ‘Public Governance’, the other two relevant pillars differ.

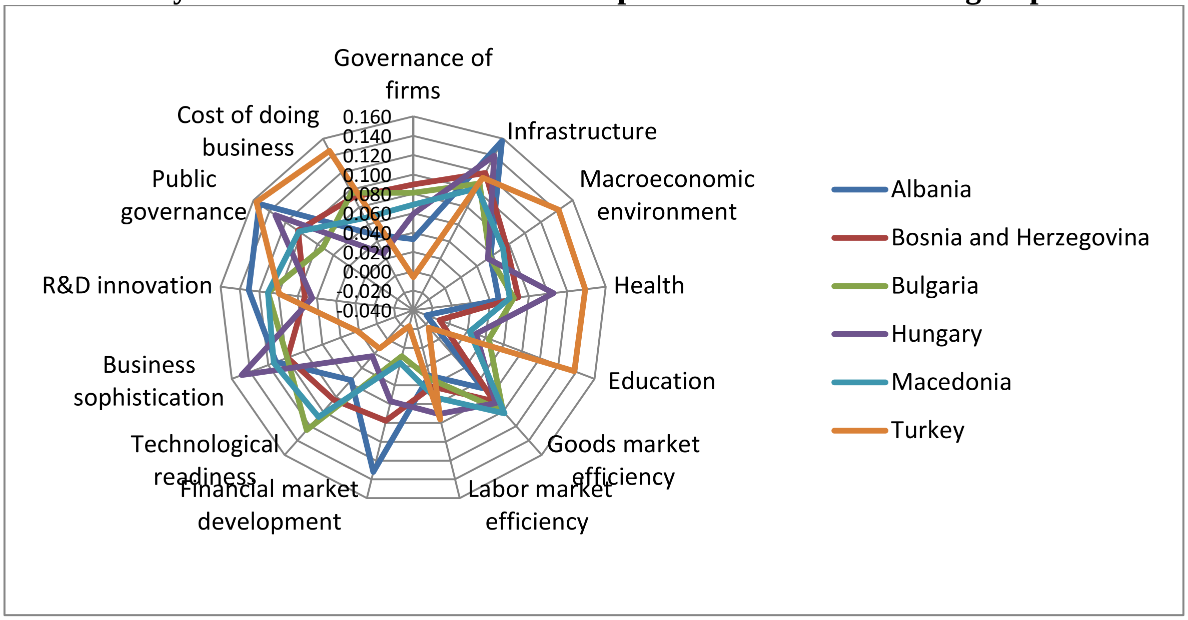
Instead of describing the particular policy efforts that each country needs to implement for being capable of following the development path of its representative target,[20] a better picture of the nature of the required policy efforts can be obtained by analyzing box-and-whisker plots for the development pillars of the countries included in each of the three income categories. When comparing these diagrams, it is easy to appreciate whether or not the priorities of policies change as countries move along the development ladder. Likewise, it can be stated which shape this change of priorities takes: ascending/descending, concave/convex, stagnant/moving, top-priority/bottom-priority, as it will be explained below.

Figure 6
Policy ratios for individual Latin American countries in income group 2



[20] The spider graphs for all regions and income groups are also presented in the supplementary material.

Figure 7
Policy ratios for individual East European countries of income group 2



Figures 8-10 show the box-and-whisker plots for the 13 pillars of the countries included in income categories 4, 3 and 2, respectively.[21] The order of the plots for the pillars within each category is arranged in terms of their means of policy ratios calculated across countries; thus, the box of the most important pillar is specified in the top of the graph, while the box of the least important pillar is set in the bottom of the graph. For instance, for income group 4 the largest policy efforts should be allocated in the following order: 'Health', 'Business sophistication', 'Infrastructure' and ''Governance of firms'; while for income group 2 the order of priorities should be allocated as follows: ''Public governance', 'Infrastructure', 'Health' and 'Cost of doing business'.

[21] In these box-and-whiskers plots the dark line in the box describes the median, the filled-in boxes denotes the interquartile range (i.e., between the lower and the upper quartile) and the whiskers extend to cover most of the data. Data points outside the whiskers are considered outliers.

Figure 8
Order of priorities for policy efforts in income group 4

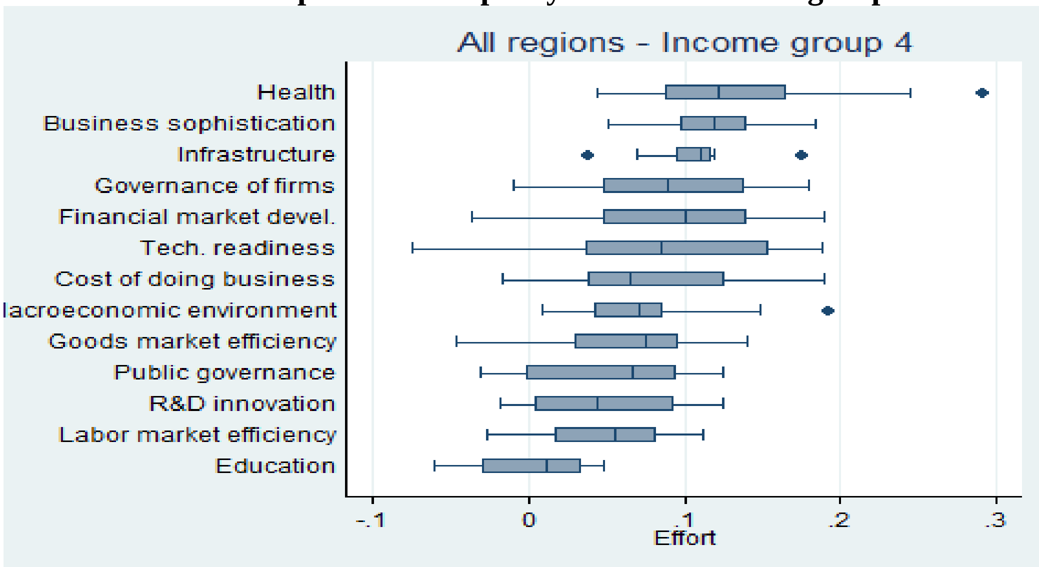
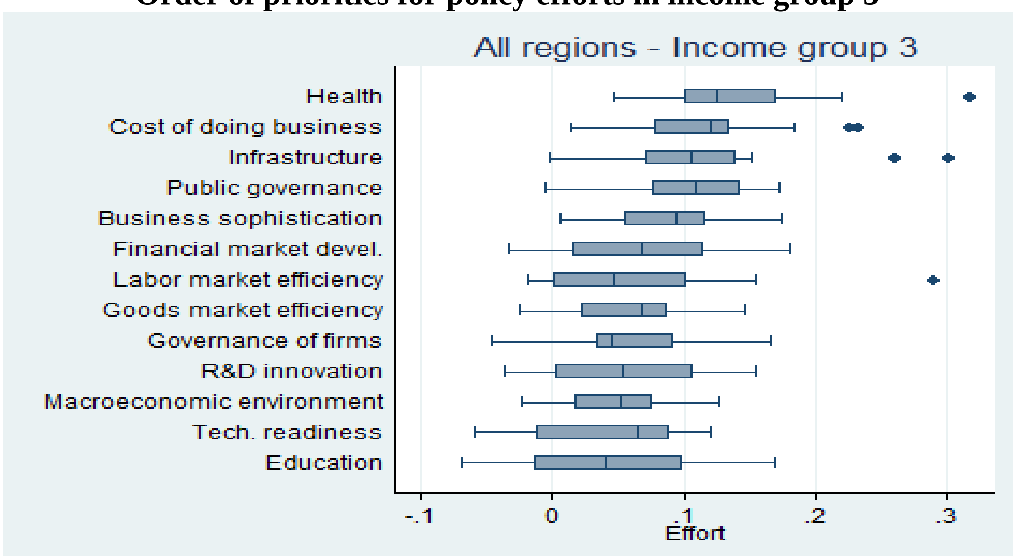
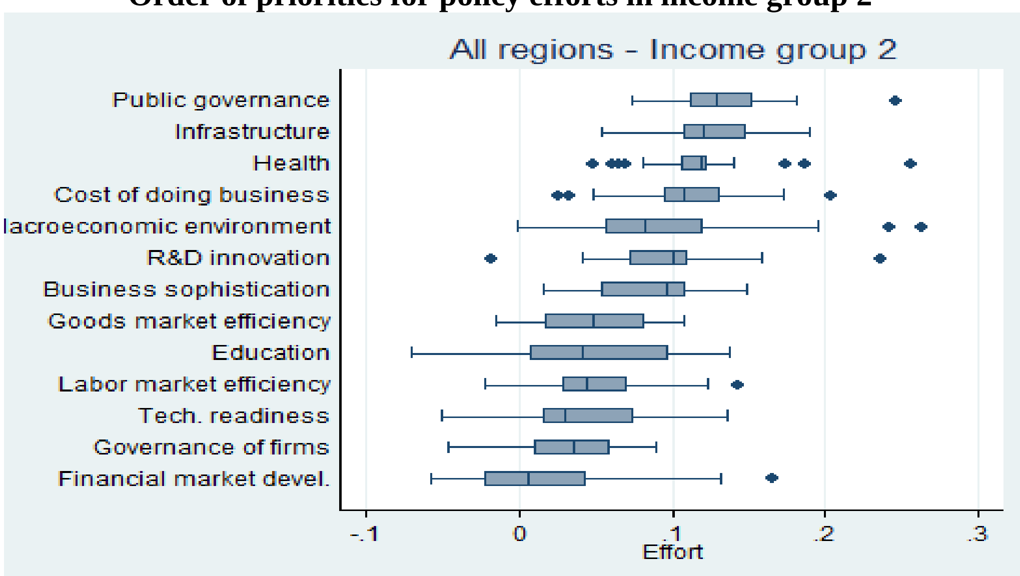


Figure 9
Order of priorities for policy efforts in income group 3



A synthesis in the information contained in these three graphs of boxes is presented in Table 11, where the dynamics of the policy priorities are specified when countries move along the development ladder. The most important outcome of this table has to do with the empirical backing of an important feature of the "development footprint" narrative, which indicates that policy packages are strongly context dependent. In other words, policy efforts change widely depending on the stage of development where a country is positioned. Furthermore, the dynamic of the change of priorities does not follow the same pattern for all development pillars, since seven of them exhibit a trend while other three show a non-linear pattern; this is the case for 'Cost of doing business', 'Labor flexibility' and 'Macroeconomic environment'. Finally, for only three development pillars there are relatively small or no changes in the priority rank of the three income categories ('Health', 'Infrastructure' and 'Goods market efficiency').

Figure 10
Order of priorities for policy efforts in income group 2



With regard to some particularities of Table 11, it is important to highlight that policy efforts in 'Public Governance' are not always important. They are ranked in the 10th place in income group 4 but move rapidly to the 4th position in group 3 and then to the 1st position in income group 2. This means that badly working institutions of public governance do not always constrain the development process. This seems to be the case for very poor countries attempting to reach the economic performance of countries in income group 3. However, this constrain becomes truly binding for upper-middle income countries that attempt to escalate in the development ladder and reach the performance of countries in income group 1. In contrast, 'Health' and 'Infrastructure' are always very relevant, irrespectively of the category where the country is positioned; although there are some slight changes in their relative priority, these two pillars always remain in the top levels of the ranking.

Table 11
Nature of changes in policy efforts along the development ladder

	Moves across the spectrum of priorities	Remains in top priorities	Remains in bottom priorities
Ascending trend	Public governance Research & development	…	Education
Descending trend	Governance of firms Financial development Technological readiness	Business sophistication	….
Shifts along a concave curve	Labor flexibility	Cost of doing business	…
Shifts along a convex curve	Macroeconomic environment	…	…
Relatively fixed	…	Health Infrastructure	Goods market efficiency

Notes: across the spectrum means that the pillar's priority moves from top to bottom positions (or the other way around) in the ranking of policy ratios; a pillar is defined as a top priority if it is positioned in the 7^{th} place or above; a pillar is defined as a bottom priority if it is positioned in the 8^{th} place or below.

Another interesting case is the pillar of 'Education' that exhibits an ascending trend, although in the bottom part of the priorities. The type of standardized and basic knowledge that two of the three the corresponding indicators measure are far from relevant in terms of escalating the development ladder for countries located in income groups 4 and 3; however, for upper-middle income countries this pillar moves up to the 9^{th} place in the policy ranking. It is important to clarify that the previous analysis is made for the average country within each category and, thus, for specific policy guidelines it is necessary to look at the individual country simulation. For instance, policy efforts in 'Education' are prime for Latin American countries in income group 3 attempting to achieve the economic performance of their representative targets.

Notice also that 'Governance of firms', 'Financial market development' and 'Technological readiness' have the opposite pattern to the one found for 'Public Governance', since the former three exhibit a descending trend. The 'Governance of the firms' pillar moves from a relatively high position (4^{th}) in income group 4 to the 9^{th} place in income group 3, and then to the 12^{th} position in income group 2.; that is why in Table 11 it is stated that this pillar moves along the spectrum of priorities. Similarly, 'Financial market development' decrease in priority from the 5^{th} place in income group 4 to 6^{th} and then to 13^{th} in income groups 3 and 2, respectively. Likewise, 'Macroeconomic environment' moves in a convex shape across the spectrum of priorities since it, first, goes down from the 8^{th} to the 11^{th} place and, then goes up to reach the 5^{th} place in the ranking for countries in income group 2. All in all this table, and the simulation results, assert that the dynamics of each development pillar is quite different and that only two of them keep a relatively low priority for all income groups in average ('Education' and 'Goods market efficiency').

Two final comments are critical to have a better grasp of the results obtained with this type of simulations. Firstly, it is important to point out that besides the disparities found in the estimated policy ratios across countries, there are also important variations with respect to the size of the overall policy efforts among countries. This latter result was expected since the *MSE* of the actual gaps between the treated country and the representative target varies widely according to the data in Table 9 for income group 4 and the corresponding tables in the Appendix A for the other categories. That is, for some countries to reach the performance of its representative target can be a very ambitious endeavor, while for others is not necessarily the case. As a consistency result of this idea, the correlation between the estimated policy efforts by country and the actual *MSE* is positive and relatively high ($\rho = 0.551$).[22] Moreover, the optimal 'computer time', for the *GA* to reach the selected policy package, exhibits also a

[22] The actual *MSE*, optimal sampled *MSE*, optimal averaged *MSE* and averaged optimal time for all countries' simulations are presented in the supplementary material.

positive relationship with the overall policy effort and a high correlation coefficient ($\rho = 0.531$). In other words, the largest is the policy effort the more time is required to replicate the target's instances of policy indicators. In a similar vein, the larger the actual *MSE* (i.e. the more ambitious are the target's indicators) the larger is the 'computer time' needed for optimal replication ($\rho = 0.851$).

Secondly, it is also important to have in mind that the simulated policy efforts should not be seen as a set of conditions for a treated country to escalate the development ladder, despite of the fact that such policy interventions are, by construction, exogenously determined in the model. This is so, because a fraction of these policy efforts could have been implemented once the targeted country was performing as a more advanced economy. Consequently, the network model is in fact capturing the relative relevance of development pillars for countries that are already members of a specific income group (3, 2 and 1). In other words, the simulated policy efforts should not be interpreted as causal features for boosting economic performance (*e.g.*, growth acceleration) but as a combination of exogenous interventions implemented for changing income group and for acting as a member of the more advanced group. This result *per se* is a good step for improving our comprehension of the development process because, on the one hand, it distinguishes between policy indicators and policy efforts and, on the other hand, it discovers priorities for policy interventions in the historical record of economies with different stages of development.[23] These records could include, for example, the 'footprints' of policies that were implemented, initially, by a country in income group 4 to start growth and, later on, to sustain growth under its new status as a member of income group 3.

[23] Obviously, it would be much better to have a procedure capable of disentangling policy efforts that move a country in the development latter, from policy interventions that these countries implement when being more developed. However, these results are not produced in the network model.

X) The selection of policy packages for alternative development modes: The Mexican case.

In this section the case of Mexico is used to exemplify how to identify different development modes that are suitable for a country according to its current conditions. With this framework it is possible to analyze 32 different simulations since México is classified in income group 2 and, thus, it can tentatively attempt to replicate countries classified in income group 1. For each of these targeted countries, there is a selected package and a value for its goodness of fit. Therefore, the targeted country that can be replicated with the best fit (*i.e.*, the lowest *MSE* ratio) is considered the 'global optimal target'. However, this 'global optimal target' it is not necessarily the best alternative to imitate for Mexico, because according to the narrative of the framework, targeted countries present different degrees of similarity with Mexico in terms of their productive structure. Thus, both criteria replicability and similarity have to be taken into consideration when selecting a suitable development path.

Table 12 presents the optimal ratio of the fitness function (column 5) for the *GA* procedure applied to each of the Mexico's targeted countries. According to these results, Sweden is the potential target with the best replication of policy indicators (*MSE* ratio= 0.277). [24] Although, there is a set of 17 countries whose 'development footprint' can also be replicated with a *MSE* ratio lower than 0.6. These countries are as follows: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Israel, Japan, Netherlands, Norway, Singapore, Sweden, Switzerland, United Kingdom and United

[24] The correlation between the actual gaps and the optimal *MSE* is -0.079, which means that the two absolute gaps are not linearly related; however, the correlation between the actual gap and the MSE ratio is very large (-0.915), which means that that the higher the actual gap the lower the relative optimal gap. In other words, the *GA* procedure has a tendency to produce less quality fittings for countries whose policy indicators are closer to the target's.

States. Notice also that that the quality of the fitness is good enough in all but two cases (actual *MSE* > simulated *MSE*).[25]

Table 12
Results of the Genetic Algorithm for Mexico as a treated country
(With the network topology of income group 2 using a 0.6 cut-off for weight links)

	Targeted countries in income group 1	*MSE* with the treated and targeted country instances (actual gap)	Optimal *MSE* (simulated gap)	MSE Ratio (optimal/actual)	Similarity coefficient between the treated and targeted country	Similarity ranking
1	Australia	0.291083440512	0.165089076623	0.567°	0.0474858	20
2	Austria	0.293520134981	0.159952734634	0.545°	0.1048428	25
3	Belgium#	0.319744601374	0.155636159196	0.487°	0.1515615	15*
4	Canada#	0.304107941651	0.129624785103	0.426°	0.1610288	14*
5	Chile	0.171636787787	0.135591441362	0.790	0.0194384	30
6	Croatia	0.159604983416	0.137973802333	0.864	0.1758184	10*
7	Czech Republic	0.179552713914	0.142160815686	0.792	0.2225033	4*
8	Denmark#	0.321578875356	0.137513701959	0.428°	0.1674209	11*
9	Estonia	0.227827164376	0.151822781746	0.666	0.1140865	22
10	Finland	0.3664013072	0.120103611768	0.328°	0.1086822	24
11	France	0.260289248533	0.13106052843	0.504°	0.1098369	23
12	Germany	0.300943211916	0.149539828752	0.497°	0.1409194	18
13	Greece	0.186261249385	0.166138906784	0.892	0.1762993	9*
14	Ireland	0.303594496958	0.208120703307	0.686	0.1352003	19
15	Israel#	0.242569611423	0.137974750819	0.569°	0.1798308	8*
16	Japan	0.316886682654	0.153812411155	0.485°	0.0768531	27
17	Korea, Rep.	0.220125227555	0.137127809986	0.623	0.162015	13*
18	Lithuania	0.176943891884	0.154565443504	0.874	0.1653133	12*
19	Netherlands	0.363968608228	0.137419499643	0.378°	0.1445617	17
20	Norway	0.305524711066	0.119443004037	0.391°	0.0342374	23
21	Poland	0.155921805158	0.123341205451	0.791	0.3072434	1*
22	Portugal	0.177215738968	0.121990164172	0.688	0.1506843	16
23	Russian Federat.	0.197407997535	0.175312399802	0.888	-0.0039178	32
24	Singapore	0.398660905783	0.160984974373	0.404°	0.0699602	28
25	Slovak Republic	0.16992026519	0.160758649002	0.946	0.2234783	2*
26	Slovenia	0.209354439666	0.160711017764	0.768	0.2227698	3*
27	Spain	0.163696247812	0.124681970072	0.762	0.2027396	5*
28	Sweden#	0.350366386221	0.096971032294	0.277°	0.1908177	6*
29	Switzerland	0.370630257628	0.135539075861	0.366°	0.0194384	30
30	United Kingdom	0.303229833204	0.123929212356	0.409°	0.1185177	21
31	United States#	0.286090592761	0.138654676165	0.485°	0.1852385	7*
32	Uruguay	0.157400344944	0.151034355693	0.960	0.0134663	31

Notes: ° countries with a MSE ratio < 0.6; * countries in the first 15 places of the similarity ranking with Mexico; # countries meeting both criteria (replicability and similarity are met).

[25] For the Slovak Republic and Uruguay the simulations are not capable of generating good enough fits since the optimal *MSE* for these targeted countries are just slightly lower than the *MSE* of the actual gaps. In other words, the *GA* does not identify policy packages that can make Mexico closer to these two countries in terms of policy indicators.

For combining the similarity and replicability criteria in the selection of potential development modes, the steps used to reach the definite set of targeted countries are as follows: (i) for achieving replicability, select those countries whose *MSE* ratio is lower than certain threshold (*e.g.,* 0.6); (iii) for achieving economic similarity (as a criteria of feasibility), select those countries whose productive structure is relatively close to the one observed in the treated countries (*i.e.,* whose ranking of similarity is in the top 15; see column 7); (iii) pick the countries that lie in intersection of the previous two requirements.

Once these steps are applied, the selected countries for Mexico are the following: Canada, Belgium, Denmark, Israel, Sweden, and United States. That is, not only the simulated policy packages produce a relatively small optimal *MSE* ratio, but also these country have an export profile that is not too distant from Mexico and, thus, they can be considered feasible targets. Among these countries, Israel, Sweden and United States have a closer similarity with Mexico in terms of their economic structures. In this set, there are four European countries –two of them Nordic- and Mexico's two partners in *NAFTA*. The next step is to compare the policy interventions estimated with the *GA* procedure for this narrower set of targeted countries.

The policy interventions estimated for the selected countries show that there are different development modes that Mexico can follow to climb one echelon in the development ladder and, presumably, to start performing in terms of its wealthier status. According to Table 13 and the spider graph of Figure 11, some of the policy packages put a special emphasis on the governance pillars, others in improving human capital, others more in R&D and business sophistication, and son and so forth. This multiplicity of paths does not mean that anything goes since the suggested policy packages have internal coherency and, thus, policy efforts should be implemented with specific degrees of intensity.

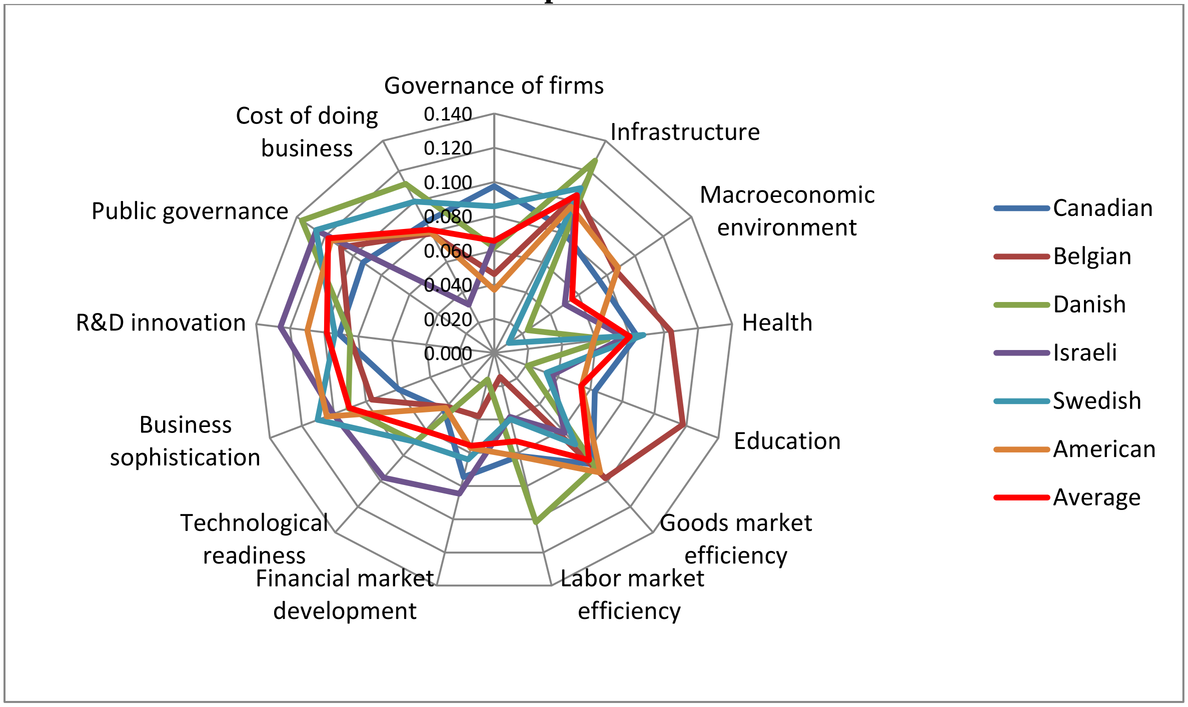
Table 13
Policy ratios for six development modes for Mexico

Development pillar	Belgium	Canadian	Danish	Israeli	Swedish	American	Average
Governance of firms	0.046 (10)B	0.098 (1)T	0.062 (10)B	0.066 (8)	0.086 (7)	0.037 (13)B	0.066 (8)
Infrastructure	0.105 (3)T	0.084 (7)	0.127 (2)T	0.105 (3)T	0.109 (3)T	0.096 (4)T	0.104 (2)T
Macroeconomic envir.	0.086 (6)	0.075 (9)	0.024 (11)B	0.050 (10)B	0.010 (13)B	0.088 (6)	0.055 (11)B
Health	0.104 (4)T	0.084 (6)	0.067 (9)	0.077 (7)	0.088 (6)	0.059 (9)	0.080 (7)
Education	0.118 (1)T	0.063 (10)B	0.021 (12)B	0.036 (12)B	0.033 (12)B	0.055 (11)B	0.054 (12)B
Goods market efficiency	0.098 (5)	0.087 (4)T	0.089 (6)	0.062 (9)	0.071 (8)	0.093 (5)	0.083 (5)
Labor market efficiency	0.014 (13)B	0.062 (11)B	0.102 (4)T	0.038 (11)B	0.040 (11)B	0.062 (8)	0.053 (13)B
Financial market devel.	0.038 (12)B	0.075 (8)	0.016 (13)B	0.085 (6)	0.064 (10)B	0.057 (10)B	0.056 (10)B
Technological readiness	0.042 (11)B	0.044 (13)B	0.069 (8)	0.097 (5)	0.069 (9)	0.043 (12)B	0.061 (9)
Business sophistication	0.077 (9)	0.060 (12)B	0.091 (5)	0.101 (4)T	0.110 (2)T	0.105 (3)T	0.090 (4)T
R&D innovation	0.085 (7)	0.091 (3)T	0.085 (7)	0.126 (2)T	0.094 (5)	0.110 (2)T	0.098 (3)T
Public governance	0.109 (2)T	0.093 (2)T	0.137 (1)T	0.126 (1)T	0.126 (1)T	0.116 (1)T	0.118 (1)T
Cost of doing business	0.079 (8)	0.086 (5)	0.111 (3)T	0.032 (13)B	0.100 (4)T	0.080 (7)	0.081 (6)

Notes: number in the ranking for the policy ratios in parenthesis, T = pillar in the top four of policy ratios, B = pillar in the bottom four of policy ratios

Likewise, 'Public governance' and 'Infrastructure' are two pillars that need to be strongly boosted in most of the development paths, these types of policies are ranked top-4 in 6 and 5 out of 6 cases, respectively. On the contrary, 'Financial market development' and 'Technological readiness' do not seem critical for replicating the policy package observed in most of the targeted countries for Mexico. This result comes from the fact that these pillars are ranked bottom-4 in 4 and 3 out of 6 cases, respectively. Other policy interventions exhibit drastic shifts from one development path to another; for instance, 'Education' is positioned 1 time in the top-4 but also 5 times in the bottom-4.

Figure 11
Alternative development modes for Mexico



When analyzing the policy ratios for the 6 targeted countries, it is possible to characterize specific development paths. According to the top-4 policies, one can distinguish the following broad modes of development:[26] institutions and business practices & technology (*i.e.* Canada), infrastructure, human capital and institutions (*i.e.*, Belgium), and infrastructure, institutions and business practices & technology (*i.e.*, Denmark, Israel, Sweden and United States). Notice that the spikes in the spider graph make evident that the relevance of human capital is a very distinctive feature of the Belgian mode of development.

Although, the data shows that all these alternative modes of development are associated with higher standards of living than those experienced by Mexicans, these paths if implemented can exhibit different degrees of difficulty. This is so because the actual gap between the instance of Mexico and the

[26] The groupings are made with the following taxonomy: (i) institutions –public governance, goods market efficiency, labor market flexibility, financial market development-, (ii) human capital –health, education-, (iii) business practices & technology –governance of firms, business sophistication, cost of doing business, technological readiness, R& D innovation-.

instance of each of the targeted country varies considerably.[27] Therefore, with the actual $MSE_{i,}$ as a rough criterion of difficulty, it is possible to identify the development mode with the less cumbersome type of policy intervention (see Table 12 column 3): Israeli and American; while the required effort is the heaviest for the Swedish, Danish, Canadian and Belgian modes.

XI) Conclusions.

Some of the tools traditionally used to evaluate and design public policies for economic development, such as regression analyses and benchmarking, do not have a solid foundation despite of the fact that they are commonly used by policymakers, consultants and multilateral organizations. In particular, they assume that policies have certain degree of substitutability and exogeneity, as well as an independency with respect to initial conditions; these assumptions clearly differ with the empirical evidence and, hence, there is a need of an alternative approach. This paper attempts, precisely, to build a new methodology based upon a different framework of thinking. Taking as a point of departure the 'flying geese' theory of economic development, where laggard countries fill economic niches left behind by more successful countries, a 'development footprint' narrative is elaborated by exploring that idea that there is also a tracking of physical and institutional infrastructure.

In order to make this narrative a workable methodology for designing policy packages, a complex network of public policies is defined and calibrated with international data. In this network policy and governance indicators are seen as nodes and, thus, policy interventions are interpreted as exogenous policy efforts that percolate through the grid. The end result of considering all possible

[27] A similar measurement of difficulty can be obtained with the summation of policy efforts for each country since the larger the actual gap with respect to the status observed in Mexico the larger the overall policy effort. Obviously, these approaches are far from ideal since the efforts for implementing each policy are very different in terms of budgetary resources, coordination requirements and political economy considerations, among others.

interrelationships among policy indicators is a simulated set (or instance) of endogenous policy indicators that resemble those observed in more advanced economies. The sophisticated topology of these networks illustrates the fact that policies are, in general, interrelated and that assuming substitutability is too far-fetched. Additionally, the particular topologies observed in networks calibrated for countries in different income categories, indicate that initial condition matter. Furthermore, other elements of a context dependent analysis in the methodology are included by considering original instance of policy indicators for treated countries, and targeted countries selected in terms of an index of similarity with respect to the treated country.

Then, the methodology is capable of designing profiles of policies by means of a set of coupled differential equations, which simulate the diffusion process through the network, and an evolutionary algorithm that can replicate the instance of policy indicators of a targeted country. Although the soundness of the policy recommendations cannot be validated statistically due to the lack of a long panel of data, the Appendix B presents an empirical tests that shows that, as suggested by the 'development footprint' narrative, countries that change policy indicators in the direction of structurally similar but more advanced economies exhibit more economic growth.

Besides of introducing an innovative methodology for designing broad economic development policies, the first main result of this paper is that policy interventions are context dependent, and that suggested policies vary significantly when moving in the development ladder. For instance, policies dealing with public governance do not seem to be all that relevant for poor countries included in income group 4 but they are critical for the upper-middle income countries of group 2. The second main result is that there are many development modes that a country, like Mexico, can follow. Some of these policies can be highly relevant in all or most of these modes, but the latter are also characterized by particular types of policies. The suggested policies in each mode come in consistent packages and, thus, they cannot be easily substituted; in other words, the degrees of freedom for policymakers have more to do with the selection of a particular development mode than with changing an isolated policy.

Appendix A

Some additional results when the simulations use a representative target

Table 1.A
Results of the genetic algorithm for countries in income group 3
(Using mean values of similar countries as a representative target)

No.	Treated country	*MSE* with the treated and targeted country instances (actual gap)	Optimal *MSE*	Similar countries used to define the representative target**
1	Armenia	0.108173141365	0.0818904766734	BGR CRI DOM JOR MKD MUS
2	Cameroon	0.146365800059	0.121541050996	BIH COL CRI DOM ECU PER
3	Egypt, Arab Rep	0.140499969574	0.0855986551287	COL DOM JOR MKD TUN TUR
4	El Salvador	0.131059710075	0.0942358950396	COL CRI DOM JOR MUS TUR
5	Georgia	0.119043089517	0.087191586703	ALB BGR BIH JOR MKD ZAF
6	Guatemala	0.132611565781	0.115913812529	COL CRI DOM ECU JOR MUS
7	Honduras	0.109282000656	0.0950205559843	COL CRI DOM MKD MUS PER
8	India*	0.13947141111	0.134716650096	CHN COL MUS THA TUN TUR
9	Indonesia	0.113081367771	0.102470042458	COL DOM ECU MYS THA TUN
10	Kyrgyz Republic	0.197714294411	0.125848984082	ALB BIH DOM JOR MKD TUR
11	Morocco	0.0916157366472	0.0855241052682	ALB DOM MKD PER TUN TUR
12	Nicaragua	0.170382637797	0.105016093084	ALB CRI DOM ECU JOR MUS
13	Pakistan	0.161610396394	0.135115381293	ALB DOM MKD MUS TUN TUR
14	Paraguay	0.145374627403	0.0949668838213	ALB BIH BRA CRI DOM ECU
15	Philippines	0.13509395428	0.0918029638063	CRI DOM MYS PAN THA TUN
16	Senegal	0.136896897334	0.121406140053	CRI DOM ECU JOR PER ZAF
17	Sri Lanka*	0.143966657839	0.140349805023	ALB DOM MUS THA TUN TUR
18	Ukraine	0.155209431577	0.112309724865	BGR BIH HUN MKD TUR ZAF
19	Vietnam	0.152818756596	0.111756061483	BIH CHN DOM MUS THA TUN
20	Zambia	0.135418126338	0.125677822991	BGR COL CRI DOM PER ZAF

Note: * for these countries the *MSE* of the actual and simulated gaps are similar; ** countries included are specified in terms of their International Standards Organization (ISO) 3-digit alphabetic code.

Table 2.A
Policy ratios for countries in income group 3 by region
(Averages across countries)

Development pillar	G.3.ExC	Top-4	G.3.Asia	Top-4	G.3.Latin	Top-4	G.3Africa	Top-4
Governance of firms	0.109 T	2	0.060	1	0.045 B	0	0.020 B	0
Infrastructure	0.068 B	1	0.191 T	5	0.058	0	0.129 T	3
Macroeconomic envir.	0.046 B	0	0.053	0	0.066	1	0.043	0
Health	0.105 T	3	0.163 T	5	0.108 T	2	0.182 T	4
Education	0.034 B	0	0.016 B	0	0.124 T	4	0.000 B	1
Goods market efficiency	0.083	1	0.028	0	0.063	2	0.061	1
Labor market efficiency	-0.010 B	0	0.079	1	0.049 B	0	0.116 T	3
Financial market devel.	0.139 T	5	0.019 B	0	0.034 B	0	0.073	1
Technological readiness	0.084	1	0.023 B	0	0.044 B	0	0.038 B	0
Business sophistication	0.107 T	3	0.050	0	0.076	2	0.126 T	3
R&D innovation	0.078	1	0.027 B	1	0.103	2	0.010 B	0
Public governance	0.085	2	0.127 T	3	0.117 T	4	0.088	2
Cost of doing business	0.071	1	0.163 T	4	0.113 T	3	0.113	2
No. of countries included		5		5		5		5

Notes: policy ratio = estimated policy effort for the pillar / sum of all policy efforts across pillars.
A negative policy ratio indicates that the corresponding country has some slack in the pillar's indicators with respect to the requirements needed to reach the representative target. Top-4 = number of countries where pillar appears in the top four policy efforts. T = pillar in the top four of average policy ratios. B = pillar in the bottom four of average policy ratios

Table 3.A
Results of the genetic algorithm for countries in income group 2
(Using mean values of similar countries as a representative target)

No.	Treated country	*MSE* with the treated and targeted country instances (actual gap)	Optimal *MSE*	Similar countries used to define the representative target**
1	Albania	0.164500266158	0.113059224857	CHL DNK ESP EST GRC HRV LTU POL PRT SVK
2	Bosnia & Herze.	0.183851406749	0.124637091386	AUT CZE EST GRC HRV LTU POL PRT SVK SVN
3	Brazil	0.199764391802	0.14739405619	AUS AUT CAN CHL ESP FIN RUS SVN URY USA
4	Bulgaria	0.152107246399	0.0878860043895	CHL CZE EST GRC HRV LTU POL PRT SVK SVN
5	China	0.184788156548	0.148510778685	AUT CHE CZE EST ISR JPN KOR PRT SVK SVN
6	Colombia	0.174211335391	0.122948639686	BEL ESP GRC HRV ISR LTU POL PRT SVK SVN
7	Costa Rica	0.136749422012	0.10147973822	CHL DNK GRC HRV ISR LTU NLD POL PRT SVN
8	Dominican Repu.	0.241158265814	0.152735450835	DNK ESP EST GRC HRV ISR LTU NLD PRT SVK
9	Ecuador	0.236223054879	0.126565558519	CHL DNK ESP EST GRC HRV LTU NLD PRT URY
10	Hungary	0.140972438568	0.0915048632346	AUT CZE DEU DNK FRA HRV LTU POL SVK SVN
11	Jordan	0.116471445487	0.0928849324182	BEL DNK ESP GRC HRV ISR LTU NLD POL PRT
12	Macedonia FYR	0.158392142588	0.0791493004412	CHL DNK ESP EST GRC HRV LTU POL PRT SVK
13	Malaysia*	0.138068083715	0.132199927813	CZE DEU EST JPN KOR NLD POL SGP SVK SVN
14	Mauritius	0.121756033797	0.107085819321	DNK EST FRA GRC HRV LTU POL PRT SVN URY
15	Mexico	0.151815052635	0.104414259849	CZE ESP GRC HRV ISR POL SVK SVN SWE USA
16	Panama	0.202078296033	0.121148628226	CHE DNK EST GBR HRV IRL LTU PRT SGP SVN
17	Peru	0.185981683235	0.112811509533	AUS BEL CAN CHL ESP GRC LTU PRT RUS URY
18	South Africa	0.237765954415	0.18334347351	AUS BEL CAN CHL ESP FIN GRC NOR RUS USA
19	Thailand	0.14574032715	0.0974149400068	CZE DNK GRC JPN KOR POL PRT SGP SVK SVN
20	Tunisia	0.105871981307	0.0935227653824	DNK ESP EST GRC HRV LTU POL PRT SVK SVN
21	Turkey	0.132599579396	0.113802508967	CZE ESP EST GRC HRV LTU POL PRT SVK SVN

Note: * for these countries the *MSE* of the actual and simulated gaps are similar; ** countries included are specified in terms of their International Standards Organization (ISO) 3-digit alphabetic code.

Table 4.A
Policy ratios for countries in income group 2 by region
(Averages across countries)

Development pillar	G.2Latin	Top-4	G.2.Euro.	Top-4	G.2.Asia	Top-4	G.2.Africa	Top-4
Governance of firms	0.037^{B}	0	0.054^{B}	0	0.025^{B}	0	-0.032^{B}	0
Infrastructure	0.132^{T}	7	0.124^{T}	4	0.108	2	0.149^{T}	2
Macroeconomic envir.	0.072	0	0.076	1	0.144^{T}	2	0.179^{T}	2
Health	0.118^{T}	6	0.081	2	0.132^{T}	3	0.185^{T}	2
Education	0.076	2	0.033^{B}	0	0.026^{B}	0	0.025^{B}	1
Goods market efficiency	0.041	0	0.071	1	0.035^{B}	0	0.040	0
Labor market efficiency	0.028^{B}	1	0.051^{B}	0	0.065	0	0.062	1
Financial market devel.	0.038^{B}	1	0.045^{B}	1	-0.028^{B}	0	-0.035^{B}	0
Technological readiness	0.035^{B}	0	0.068	2	0.042	1	0.000^{B}	0
Business sophistication	0.060	0	0.099^{T}	3	0.107	1	0.063	0
R&D innovation	0.100	1	0.098^{T}	3	0.073	1	0.118	1
Public governance	0.134^{T}	7	0.121^{T}	5	0.146^{T}	3	0.143^{T}	1
Cost of doing business	0.128^{T}	7	0.079	2	0.125^{T}	3	0.106	2
No. of countries included		8		6		4		3

Notes: policy ratio = estimated policy effort for the pillar / sum of all policy efforts across pillars.
A negative policy ratio indicates that the corresponding country has some slack in the pillar's indicators with respect to the requirements needed to reach the representative target. Top-4 = number of countries where pillar appears in the top four policy efforts. T = pillar in the top four of average policy ratios. B = pillar in the bottom four of average policy ratios

Appendix B

A non-rigorous empirical backing of the model

The methodology for policy selection outlined in this paper is not supported with a comprehensive set of statistical tests and hence this prospective analysis can only be seen as an 'educated framework'. The limited information available precludes the possibility of applying a full-fledged statistical analysis of the causal relationship between suggested policies and countries' overall economic performance. A much longer panel of policy indicators is required to check, firstly, if the policy advice inferred with the model is relatively close to observed policies and, secondly, if these are relatively successful. That is, an estimation period is needed to come up with the suggested policy package and, then, another long period is required for evaluation purposes.

An estimation period of, say, 5 to 10 years would be necessary just to calibrate the topology of the network at *t*, and to figure out different package of policies that could be implemented to follow the 'development footprints' of specific countries. Likewise, an evaluation period of one or two decades would be needed for countries having enough time to modify their policies radically with respect to their initial conditions at *t*. Therefore, the model will be considered helpful for selecting policies, in a statistical sense, when there are enough cases of catching up countries with a historical record at $t+n$ which resembles the experience of one of the targeted countries at *t*. However, if the data shows that most countries implemented policy efforts that led to policy indicators very different to those reproduced when designing policies with the model, then, the benefits of the recommended policies cannot be tested. Nevertheless, this latter scenario would reject the hypothesis that developing countries tend to follow other economies' 'development footprints'.

Although the soundness of the recommendations produced with the complex network of public policies cannot be tested with the current data, at least, it is possible to check statistically if the tracking the recent historical record of more advanced countries coincides with a in improvement in the well-being of the treated country. A methodology for backing empirically the 'development footprint' narrative is based on the idea that countries which improve their policy indicators are more likely to exhibit a larger *GDP* per capita growth, especially if the policy changes are produced in the direction of a similar targeted country. It is important to keep in mind that this is not a causality test and, hence, it is not possible to know whether increased growth helps treated countries to mimic the indicators of targeted countries, or the other way around. Nevertheless, for testing the positive relationship between tracking indicators and overall economic performance, it is necessary to elaborate a metric for the tracking of policy indicators in similar but more advanced economies.

A simple statistical procedure for supporting the 'development footprint' narrative

First of all, it is convenient to know whether or not countries made substantial efforts to change their policy indicators. A prerequisite for developing countries to alter their development path is doing something different. Therefore, the 'instances of flooding' in the period 2012/2011 for each of the treated countries in income groups 2, 3 and 4 are compared with the corresponding instance for the same country in the period 2007/2006. With this information, the closeness of policy indicators across time for a particular treated country is calculated with the Euclidean distance:[28]

$$D_M = \|M_{t+n} - M_t\| = \left(\sum_j^N [m_{j,t+n} - m_{j,t}]^2\right)^{1/2} \qquad \text{....(1.B)}$$

where D_M is an indicator of policy action during the sampling period for a treated or mimicking country; $t + n$ = 2012/2011 and t = 2007/2006, $m_{j,t}$ is the j-th policy indicator for period t; hence, the larger the distance D_M the larger are the policy changes and, presumably, the larger are the achieved improvements.

Secondly, for analyzing if policy changes were made in the direction of the 'development footprint' narrative, a similar metric is calculated for the mimicking country in income group g in period 2012/2011and a set of targeted countries in income group g - 1 in period 2007/2006, with the added restriction that mimicking and copied countries have to be very similar in terms of their productive structure. The value of their similarity is measured using formula (11) in the main text, so that only 30% of the countries with the highest ranking are considered as feasible candidates to imitate. With this Euclidean distance, it is possible to estimate if policy efforts implemented in the treated country between t and $t + n$ tracked policy indicators of the targeted country attained at t.

[28] Although the Euclidean metric measures only distance and, thus, it does not check directly for improvements in the level of policy indicators. By looking at the empirical time series, it can be argued that a larger distance is associated with improvements in most of these indicators.

$$D_1 = \|M_{t+n} - T_t\| = \left(\sum_j^N [m_{j,t+n} - \tau_{j,t}]^2\right)^{1/2} \qquad \text{….(2.B)}$$

where D_1 is an indicator of absolute tracking (or resemblance) during the sampling period between a mimicking country (M) at $t + n$ and a targeted similar country (T) at t, $m_{j,t+n}$ is the *j-th* policy indicator for the mimicking country at $t+n$, $\tau_{j,t}$ is the *j-th* policy indicator for the targeted country at t; this distance is calculated for all targeted/similar countries and, hence, a small D_1 means that such a country is closely mimicked by the treated country.

In order to estimate how good is the tracking of indicators for a particular country with respect to the set of possible targeted countries, it is necessary to obtain a ratio of Euclidean distances that measures the relative convergence of the policy indicators. The denominator in this ratio describes the metric calculated in the previous step for the targeted country that exhibits the minimum distance, and the numerator presents a similar metric for the same country but with the distance observed at t. Thus, a high ratio (R) can be interpreted as a treated country converging relatively fast during this period in a suitable direction.

$$R = \frac{D_2}{D_1} \quad where \quad D_2 = \|M_t - T_t^*\| = \left(\sum_j^N [m_{j,t} - \tau_{j,t}^*]^2\right)^{1/2} \qquad \text{….(3.B)}$$

where T^* = *argmin* (D_1) over the set T –*i.e.*, a targeted country which is followed more closely according to the previous step-; notice that this distance is measured with indicators for both types of countries at the initial period t.

Finally, an adjusted metric for the tracking of policy indicators is built in formulation (4.B), where the metric describing absolute policy improvements (1.B) is interacted with the ratio (3.B) that measures if the policy changes moved along the proper direction. This combined metric produces an indicator that measures how active is a treated country in implementing policies during the sampling period and whether such policies track closely a specific ‘development footprint’. Therefore, for not rejecting the underlying narrative of this framework, it is necessary to observe a positive and significant correlation between the indicator of tracking (*IT*) and *GDP* per capita growth during the sampling period.

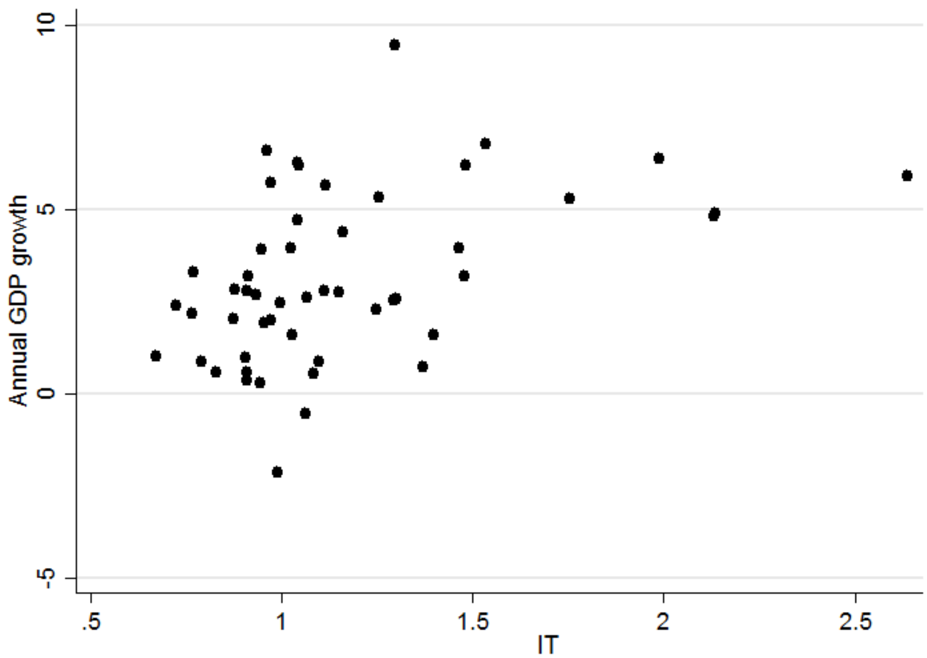
$$IT = D_M \cdot \frac{D_2}{D1} = \|M_{t+n} - M_t\| \cdot \frac{\|M_t - T_t^*\|}{\|M_{t+n} - T_t^*\|} \qquad \text{....(4.B)}$$

Because one cannot observe in reality the policy efforts implemented for a large set of dimensions, it is impossible to test whether policies of countries in a higher development echelon are closely replicated. Nonetheless, policy indicators are strongly influenced by policies and, thus, analyzing the resemblance in these indicators between treated and targeted countries is a reasonable alternative. Therefore, when this convergence is achieved through time it can be argued that policies were modified to provide an infrastructure that could boost overall socioeconomic performance in the treated country. Accordingly, with this indicator of the countries’ capability of tracking ‘development footprints’ it is possible to test if more successful countries in policy-making (*i.e.*, attempting to match policy indicators of similar but more advanced economies) exhibit higher growth.

Empirical results

The ‘development footprint’ hypothesis is not rejected by the pattern shown in the scattered diagram of Figure 1.B, where the *GDP* per-capita growth, in the vertical axis, is graphed against the indicator of tracking policies (*IT*), in the horizontal axis. This diagram plots 51 countries included in the original database that belong to incomes groups 2, 3 and 4. That is, advanced economies of the income group 1 are not analyzed since they do not have a reference country to mimic. The cases of Burundi and Ethiopia are excluded since they have a substantial growth rate during the period and, hence, are considered outliers; while the cases of Serbia, Lesotho and Namibia where also discarded since data for characterizing their productive structure is not available. Independently, of the countries' stage of development, it is clear from this figure that there is a positive and significant correlation between these two variables.

Figure 1.B
The tracking of policy indicators and overall economic performance



Source: own elaboration, GDP is measured in per-capita terms and constant 2005 US$, while the growth rate was annualized for the five two-year moving averages between 2006/2007 and 2011/2012.

According with the results presented in Table 1.B the correlation between growth and the indicator of tracking for all 51 countries in the sample is 0.456 with a P-value of 0.00076 and, thus, the null hypothesis of zero correlation is statistically rejected. In this table the sample is also split into the four income groups, although the first income groups is only used for estimating the correlation between growth and the *DM* indicator, that is the metric that measures how large are the policy changes without making reference to the direction of those changes. Notice, in the second column, that for income groups 2, 3 and 4, the more active are the countries in policy-making during the period 2006/07 – 2011/12 the higher is the observed annualized rate of growth for the same period. Consequently, despite of the fact that the data comes only for a relatively short period of time, there seems to be some empirical evidence suggesting that these policy changes are related to economic performance. Likewise, the negative correlation observed for countries classified in income group 1 indicates that policy changes in these countries is, presumably, not addressing growth concerns as seems to be the case for developing countries.

Table 1.B
Correlation coefficients between policy activity and growth by income group

Income group	Correlation (*DM* vs *GDP*)	Correlation (*IT* vs *GDP*)
1	-0.28567	
2	0.224569	0.405354
3	0.437992	0.546655
4	0.227405	0.413832
2, 3, 4 (p-value)	0.300715 (0.02714)	0.456413 (0.000762)

Source: own elaboration, GDP is measured in per capita terms

Then, column three of the table shows the correlation coefficient between the annualized growth rate and the indicator of tracking policies. As can be seen, in the three incomes groups where this calculation makes sense for analyzing the 'development footprint' narrative, the correlation is positive and significative (*i.e.*, always higher than 0.40). In all these cases the correlation is higher than the one observed in column two and, consequently, it can be argued that not only policy changes are important for performance but the direction of those changes is also relevant. For the 51 countries of the sample such correlation increased from 0.3007 to 0.4564 when the calculation of policy changes interacted with the ratio of convergence. Because there is not enough data for each income group, only the p-values for the correlation statistics with the 51 countries are included in the last row.

Finally, another empirical backing of the 'development footprint' narrative is presented in Table 2.B with the estimations of growth regressions with *OLS*. In these regressions the annualized rate of

GDP growth is run against the indicator of tracking policies. A simple regression is estimated in the second column, while the third and four columns correspond to models of multiple regression where *IT* is controlled with one or two variables measured in 2006/07. That is, with *GDP* per capita and a policy indicator used commonly in this type of growth regressions such as government effectiveness. Given the limited number of observations, the regression analysis is very rudimentary and does not attempt to take care of endogeneity concerns. Nonetheless, it strengthens the view that there is a positive connection between countries' economic performance and their capability to make changes in their policy indicators in a suitable direction.

Table 2.B
Regressions results for cross-section models of growth

Independent variables:	Model (1)	Model (2)	Model (3)
IT , for 2006/07 -2011/12	2.667 (0.743)**	2.369 (0.743)**	2.521 (0.736)**
GDP per capita (constant US$), for 2006/07		-15.375 (8.361)	-27.504 (10.990)*
Government Effectiveness, for 2006/07			5.208 (3.136)
Constant	0.041 (0.910)	0.934 (1.013)	-0.532 (1.330)
R^2	0.21	0.26	0.30
Number of observations	51	51	51

Notes: standard deviations in parenthesis: * $p<0.05$; ** $p<0.01$. Control variables are normalized as indicated in the data section.

Appendix C

A sensitivity analysis: comparing results from the network model and the differences method

The network model of public policies helps design policy guidelines that are in line with the 'development footprint' narrative. This quantitative methodology is somehow complicated because, among other things, requires the calibration of a network and the use of a master equation and a *GA* procedure. Nonetheless, the method offers an innovative alternative to other frameworks, such as regression analysis and international benchmarking, with the additional advantage of taking into account the multiple interactions among all policy indicators. In this section, the aim is to test whether the inclusion of such interactions in a computational model and the use of a sophisticated simulation procedure is a worthwhile task. This would not be the case if the method provided estimations of policy packages that were similar to the calculations obtained with a much simpler approach.

A rough methodology to create policy values for each indicator is to define the size of the policy intervention, or policy effort, as the plain difference between the current values of the indicator for the targeted and treated countries. Obviously, this simpler approach neither considers interactions of any sort nor the fact that policy indicators are endogenous variables, in contrast with the policy interventions that a well-grounded policy design requires. In case the two approaches generated the same results, it would mean that the theoretically underpinnings of the network model were fragile. In such a case, it can be stated that the distinction between policy indicators and policy interventions is inadequate and that the complex network, as suggested here, does not help get a better picture of reality. In contrast, if the results of both frameworks do not match it would imply that the network model provided additional information that cannot be obtained through the method of differences. In so far as the network model is not formally validated, it is not possible to asses statistically which approach is better; however, under these circumstances, the complex network method would be the preferred option because its theoretical support is more consistent with different features of reality.

Firstly, the policy ranking is calculated for the 13 development pillars by means of the method of differences. Then, this alternative ranking is compared with the ranking of the complex network model. The marks in Table 1.C signal if the positions in both rankings coincide for the corresponding pillar (√), or if there is a discrepancy between them of two or more positions (X). As can be seen from the Table, which analyzes the 6 development modes for the Mexican case, the rankings generated with the two methods are far from identical. There are at least four rough discrepancies for the selected countries and never more than three coincidences.

Table 1.C
Comparison of the difference and network rankings
(discrepancies: X vs coincidences: √)

Development pillars	BEL	CAN	DNK	ISR	SWE	USA
Governance of firms	X	…	X	…	X	X
Infrastructure	X	…	…	X	X	√
Macroeconomic environment	X	X	…	…	√	X
Health	X	X	…	X	X	X
Education	√	X	X	X	X	X
Goods market efficiency	…	√	…	…	X	√
Labor market efficiency	…	X	…	√	…	…
Financial market development	…	…	…	X	X	√
Technological readiness	…	X	…	…	√	…
Business sophistication	X	…	X	…	X	X
R&D innovation	X	X	…	…	…	…
Public governance	√	…	√	…	√	…
Cost of doing business	√	X	X	√	X	X
Discrepancies/coincidences	6/3	7/1	4/1	4/1	8/3	6/3

Note: X indicates a discrepancy of two or more positions; √ indicates a coincidence;
… indicates that there is a discrepancy but this is not rough (i.e. only one position)

The average number of rough discrepancies for the development modes is 5.3 out of the 13 pillars, although it is true that in some cases the positions coincide. The number of discrepancies in a particular mode can be as large as 8 (Swedish), and the ratio of discrepancies to coincidences can be as large as 7/1 (Canadian). Inclusively, in certain development modes the shift in position for some policies is considerably large (*e.g.*, from 10 to 4 in ‘Health’ for the Belgian mode, from 2 to 10 in ‘Education’ for the Canadian, from 2 to 12 in ‘Education’ for the Danish, from 8 to 3 in ‘Infrastructure’ for the Swedish, from 3 to 11 in ‘Education’ for the US-American). Furthermore, in none of the targeted countries the same group of policies is identified in the top-4 positions for both rankings.[29] Therefore, one can conclude that the methodology elaborated in this paper offers different policy recommendations with the benefit of being anchored on a better foundation.

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[29] When the difference method is applied to a broader set of countries, it can be observed that it tends to produce fewer discrepancies with respect to the network model when the targeted countries are closer to Mexico (*i.e.*, lower actual *MSE*). In other words, when targeted and treated countries are not too close, the networks model is capable of refining the relative relevance of policy efforts and, in the process, improving the quality of the fit.

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