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## **High Bandwidth Development Policy**

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### **Abstract**

Much of development policy has been based on the search for a short to do list that would get countries moving while growth theory has been based on the aggregate production function, where products disappear from the analysis. In this paper I depart from this framework and conceive of development as a process characterized by the co-evolution of capabilities and products that are dependent on a large set of rather specific public inputs. These capabilities are not just personal characteristics of individuals but are emergent social properties. This approach explains some of the patterns of the development process but requires a rather different understanding of what a development strategy would consist in. Instead of a short list of policy actions, the paper emphasizes the policy processes that lead to the determination of the large and evolving set of public inputs with which governments affect the productive potential of their countries.

Paper prepared for the Brookings Development Conference. May 29-30 2008. The ideas I present in this paper evolved gradually over the past few years. I am particularly indebted to Dani Rodrik and Chuck Sabel with whom I have been thinking about policy and to César Hidalgo and Bailey Klinger, with whom I have been studying the high dimensionality of the development process. The errors are mine.

Little else is requisite to carry a state to the highest degree of opulence from the lowest barbarism but peace, easy taxes, and a tolerable administration of justice: all the rest being brought about by the natural course of things.

Adam Smith, Lecture in 1755<sup>1</sup>

The uniform, constant and uninterrupted effort of every man to better his condition, the principle from which public and national, as well as private opulence is originally derived, is frequently powerful enough to maintain the natural progress of things toward improvement, in spite both of the extravagance of government, and of the greatest errors of administration. Like the unknown principle of animal life, it frequently restores health and vigour to the constitution, in spite, not only of the disease, but of the absurd prescriptions of the doctor.

The Wealth of Nations, Book II Chapter III

## 1. The progression towards higher dimensionality

Ever since Adam Smith, economists have been in search of a simple solution to the problem of the wealth of nations and the challenge of development, but the search has so far proved elusive. The idea that poor-country governments need to do little to catch up has been a constant refrain in policy circles<sup>2</sup>. For example, the Washington Consensus (Williamson, 1990) was based on 10 relatively straightforward policies that, if followed, promised economic success.

By contrast, most governments in the world have literally hundreds of thousands of pages of legislation managed by hundreds of public bureaucracies. Just the European common law – the *Acquis Communautaire* – has over fifty thousand pages of legislation. Table 1 shows the 35 chapters in which the Acquis was divided in its 6<sup>th</sup> enlargement. It is easy to see that the need for each chapter is quite compelling. But the accumulation of them all implies that it is hard to imagine how a minimal Smithian state could ever work in a modern society.

The search for a simple, low dimensional solution to the question of policy is highly influenced by the amazingly simple solution Adam Smith found to the problem of

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<sup>1</sup> Quoted by Dugald Stewart

<sup>2</sup> For example, as expressed by Roll and Tallbott (2001) “Once a developing country government establishes the rules to a fair game and ensures their enforcement, it would be well advised to stand back and enjoy the self-generating growth”. But as discussed in Hausmann, Pritchett and Rodrik (2006), most growth accelerations are not “self-generating” but peter out after 8 years leading to limited convergence of incomes.

planning the production and allocation of goods in a society and his explanation for the causes of the wealth of nations. A free market allows production to self-organize by linking many independent decision-makers – the producers of eggs, milk, cheese, butter, olives, olive oil, wheat, bread, coffee and sugar, salt, pepper and their inputs, (cows, poultry, tractors, seeds, animal feed, gasoline, credit, electricity, transportation, retailing, refrigeration, accounting, advertising, etc.) – so that we can decide to have a cheese omelet, toast and coffee for breakfast. Nobody has to plan these things centrally.

Table 1. Chapters of the Acquis Communautaire, 6<sup>th</sup> enlargement.

• Free movement of goods	• Statistics
• Freedom of movement for workers	• Social policy and employment
• Right of establishment and freedom to provide services	• Enterprise and industrial policy
• Free movement of capital	• Trans-European networks
• Public procurement	• Regional policy and coordination of structural instruments
• Company law	• Judiciary and fundamental rights
• Intellectual property law	• Justice, freedom and security
• Competition policy	• Science and research
• Financial services	• Education and culture
• Information society and media	• Environment
• Agriculture and rural development	• Consumer and health protection
• Food safety, veterinary and phytosanitary policy	• Customs union
• Fisheries	• External relations
• Transport policy	• Foreign, security and defence policy
• Energy	• Financial control
• Taxation	• Financial and budgetary provisions
• Economic and monetary policy	• Institutions
•	• Other issues

Economists since Adam Smith have been in awe of the miraculous capacity of the market to solve coordination problems that would be dauntingly complex if they were to be made

through the *purposeful* planning of any collection of agencies. Just consider the difficulties faced by aid agencies when trying to coordinate their efforts. Does the invisible hand imply the irrelevance of policy (“the absurd prescriptions of the doctor”), as the Smith quotes suggest? Can the system work with the provision of “peace, easy taxes and a tolerable administration of justice”? If so, why do we observe hundreds of thousands of pages of legislation and hundreds of government agencies? Why this complexity?

The typical economist’s answer is that government intervention is the consequence of rent-seeking. Regulations are created either by bureaucrats and politicians in order to extract rents or by incumbents so as to keep competitors out. The world would be better with a Smithian state. But it is easy to see that consumers need assurance that food, medicine, air travel, banks and work are safe so that they can confidently transact in markets. Just remember what happened to the meat market when a few animals came down with “mad cow” disease. But creating regulation that assures consumers in a world of rapidly changing products and technologies is a highly complex process.

Policy complexity may arise for quite constructive reasons. Take the simple case of the real estate market<sup>3</sup>. In this market, assets already exist. They just need to change hands. Buyers need to find out what properties are on sale and what their specific characteristics are. Sellers need to transmit that information to buyers. So a market of real estate brokers develops to achieve these goals. Now, not all the characteristics of a house or apartment are easily visible to a naked untrained eye. There may be hidden defects in the house that the owner knows about and has an interest in concealing from the buyer. This creates an asymmetric information problem that is addressed through a market for inspectors. These inspectors are licensed by some entity to assure their customers that they know what they are doing. They are hired by the buyer to report on the conditions of the property and its abidance by the building code. Then it is important to know whether the seller has full rights to the property and that there are no liens or other impediments on his right to sell. Otherwise a buyer may pay, only to find out that others also have a legal claim on the property. A system of property registries that can track financial and tax claims on individual properties is needed. But it may be inefficient for the buyer to bear the risk of any surprises or defects in the ownership rights, so a market for title insurance is helpful. Also, public authorities may have imposed some easements on that property to secure some public interest, or there may be municipal plans to change the conditions around the property that may significantly affect its value. In addition, the buyer needs finance to purchase the home, for which he needs a market for loans. To address willingness to pay and other incentive and information problems in this market it is convenient to be able to pledge the house as collateral to a lender with a set of rights in case the buyer does not abide by the mortgage contract. A legal system needs to define these rights and enforce them. The lender may also require insurance against fire, storms, etc, lest the collateral blow up in smoke. Hence, a home insurance market is needed. Furthermore, the sale takes time because after an initial agreement has been reached, the inspection needs to take place and the buyer needs to secure financing, title insurance and home insurance.

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<sup>3</sup> This example first appeared in Hausmann and Rodrik (2006).

Many unexpected events may happen during that process and it is important to clarify how to deal with them. It may be helpful to require a deposit, a down payment or establish an escrow account to deal with some of these contractual problems, for which a real estate lawyer is needed. The real estate lawyer in turn needs to be accredited (by some body) to carry these functions. If the property is an apartment in a condominium, it is important that the rights and obligations of the apartment owner vis-a-vis the rest of the condominium be clearly established and understood.

The previous paragraph shows how complex a simple transaction such as the sale of an existing property actually is and how it is related to a network of markets and institutional arrangements that must co-exist. We described not just a market for homes, but also a market for brokers, mortgage loans, inspections, title and home insurance and lawyers. It involves registries, municipal rules, accreditation of the different specialized agents, rules on creditor rights and condominiums, etc. And this is just part of what is required for trade in existing homes. Imagine now the added complexity involved in urban development and construction.

Note also that the role the public sector plays is deeply related to the specificity of the transaction costs involved in this activity. All the roles described here are legitimate and sector specific. They are not driven per se by rent seeking and cannot be solved through horizontal mechanisms that apply across all sectors. Interventions are sector-specific because the transaction costs they are designed to address are also specific. The government acts not because it is “picking winners”. It is simply providing the necessary complementary inputs to one of a myriad of activities in the economy.

This description of the interaction between markets and elements of policy suggest that they are high dimensional and deeply interacting. The way the market for insurance is organized affects the way the market for mortgages works, etc. This means that in general the way each of the hundreds of thousands of pages of legislation that an average country has is written can affect the impact of the other pages of legislation. These interactions make the system orders of magnitude more complex than just the length of the list. It includes that plus all the interaction terms. This inevitably makes interventions very context specific.

Recognition of the complexity of the requisite policy framework for a successful economy is slowly creeping into the profession, but it is doing so in a manner that tries to elude the complexity by hiding it. I will argue instead that the right policy approach is to embrace complexity and deal with it in the same way Smith dealt with the problem of the cheese omelet, toast and coffee referred above. Complexity in the policy space will require thinking of the policy process as something that looks more like the “invisible hand” rather than central planning. We will return to this point in the last section of this paper. In section 2 we will discuss the creeping entry of complexity into the economic analysis of countries. In section 3 we will then move to dealing with complexity in the analysis of production and structural transformation. We will then deal in section 4 with the policy implications of a complex world view.

## 2. Smith's policy simplicity: "We are not in Kansas any more"

If the world were low dimensional it could be benchmarked with few indicators. Take for example Larry Summers's (2003) often cited quote:

"I would suggest that the rate at which countries grow is substantially determined by three things: their ability to *integrate with the global economy* through trade and investment; their capacity to *maintain sustainable government finances and sound money*; and their ability to put in place an institutional environment in which *contracts can be enforced and property rights can be established*. I would challenge anyone to identify a country that has done all three of these things and has not grown at a substantial rate. And I would challenge anyone to identify a country that for any significant period has been held back either by excessive trade links with the global economy, overly sound public finances, or property rights and contracts that are excessively enforced."

According to this view, growth requires openness, sound money and property rights. A simple, low dimensional interpretation of this quote would argue that if this is the case, an index of the level of restrictions to trade and investment, the rate of inflation, the public debt ratio and an index of property right and contract enforcement should be enough to characterize what matters for the ability of countries to grow<sup>4</sup>. But as the Global Competitiveness Report 2007-2008 of the World Economic Forum (p.3) states: "Our experience in studying competitiveness has made it clear that the determinants of competitiveness are *many and complex*."

Consider now the Global Competitiveness Index produced by the World Economic Forum. It measures 12 areas or pillars that are seen as key for a country's competitiveness

Table 2. The 12 pillars of competitiveness  
Global Competitiveness Report 2007-2008

• institutions	• labor market efficiency
• infrastructure	• financial market sophistication
• macroeconomic stability	• technological readiness
• health and primary education	• market size
• higher education and training	• business sophistication
• goods market efficiency	• innovation

Moreover, each one of these areas is not just a single dimension but a composite of many others. For example, the institutions pillar is composed of the following 18 elements:

<sup>4</sup> A higher dimension interpretation of this quote would instead put the accent on the word "ability" or "capacity" which Summers uses three times: the ability to integrate with the global economy, the capacity to maintain sound money, the ability to put in place an institutional environment... These abilities may be very high dimensional and not be captured just by the level of tariffs or the inflation rate. They could be very complex and context specific.

Table 3. Components of the Institutions pillar of the Global Competitiveness Index

• intellectual property	• diversion of public funds
• protection of property rights	• strength of auditing and reporting standards
• transparency of government policymaking	• business costs of terrorism
• judicial independence	• efficacy of corporate boards
• efficiency of legal framework	• ethical behavior of firms
• favoritism in decisions of government officials	• business costs of crime and violence
• presence of organized crime	• wastefulness of government spending
• protection of minority shareholders' interests	• reliability of police services
• public trust of politicians	• burden of government regulation.

So the Global Competitiveness Report has over 100 indicators that underpin its 12 pillars. But many of these indicators are systemic properties, not fundamental areas of policy. Take for example public trust in politicians, transparency of government policymaking or wastefulness in government spending. These are outcomes of a system integrated by many agencies and rules and perceived by many constituencies. We do not really know what causes most of these outcomes and therefore we have very little idea of which actionable variables should be adjusted to improve performance in these areas. Most likely, the requisite policy actions constitute an even longer list.

A similar situation affects the attempt of the World Bank to measure the quality of the investment climate through its Doing Business Report. The index is composed of 10 different elements:

Table 4. The 10 Components of the World Bank's Doing Business Index

• starting a business	• protecting investors
• dealing with licenses	• paying taxes
• employing workers	• trading across borders
• registering property	• enforcing contracts
• getting credit	• closing a business

Each one of these components is characterized by many additional dimensions. For example, employing workers is in itself determined by 6 other indexes which measure the difficulty in hiring and in firing, rigidities in the work day and in employment, as well as non-wage and firing costs. Each one of these is in itself an aggregation of other sub-sub-indexes. In total, there are over 100 variables in this index. What to do with this high dimensional space?

## **Collapsing the high dimensional space**

So we have gone from the simple policy world that Adam Smith had envisioned to a Global Competitiveness Report or a Doing Business Report, where each has over 100 rather complex dimensions. In reality, the dimensionality of the problem is orders of magnitude larger, but this fact is suppressed by projecting the complexity into a lower dimensional space through a set of assumptions.

One mechanism to reduce dimensionality is to put many different real phenomena under the same label. The reduction thus obtained is more linguistic than practical. The concept “burden of regulation” in the Global Competitiveness Index is implicitly used to describe food safety standards, environmental controls, phytosanitary permits, capital adequacy requirements, zoning rules, etc. Property rights are given a single name but they include the right of a person to an apartment in a condominium, of a company to the mineral resources underground, of a bank to a loan and of a musician to a song. These rights are defined in different legal texts and enforced by different agencies. It is as if we would classify the men in the world into the categories of John, George, Joseph, Peter, Daniel, William, etc. But besides the name, the different individuals assigned to each group share few other things in common. As a consequence, when the issue becomes the improvement of performance in a certain area, dimensionality come back in full force as each individual in the group requires a different treatment.

A second strategy to reduce dimensionality is to suppress sector specificity. For example, the measure of dealing with licenses in the Doing Business Report is benchmarked by considering only the licenses required to set up a warehouse. The measure of enforcing contracts is benchmarked by considering only the problem of collecting a loan granted to a hotel. These are interesting examples to look at in order to compare countries along some common issue, but the problem of dealing with the licenses of a warehouse are very different from those dealing with registering a drug, getting a concession for a TV channel, obtaining rights over natural resources, or getting phytosanitary permits. The presumption is that if a country is bad at licensing a warehouse, it must be hopeless at dealing with any other of these more specific areas. But the real quality of the investment climate is affected by many sector-specific dimensions that are not fixed unless they are addressed at the right level of specificity.

Moreover, improving the licensing process is more than just cutting red tape. There are important trade-offs that licenses are trying to address, such as consumer safety, environmental protection, urban conditions, network effects, labor safety, intellectual property, etc. Each licensing process is distinct. It is often based on a different law and run by a different agency. Consider for example the many policy issues – e.g. environmental issues, right of way, network effects, urban spillovers, natural monopolies, tax issues, labor and consumer safety, standards – that arise in each of the following sectors: agriculture, power, telecoms, mining, ports or pharmaceutical sectors. The real problem for societies is how to organize the provision of an adequate investment climate in each of these areas and this is unfortunately a very high dimensional problem. Making

the licensing of a warehouse very expeditious will not solve any of this. Thus, the high dimensional nature of the problem does not disappear.

Another mechanism to reduce dimensionality is the assumption of linearity and separability<sup>5</sup> in the construction of indexes. Linearity makes all the dimensions of the index into substitutes. The number of licenses is averaged with the number of days it takes to get them and the formal fees that have to be paid. According to the index, if you under-perform on one, you can make it up by over-performing on the others. In real life, one license can stop all investments in a sector; it is not impacted by performance along other dimensions.

Separability means that the effect of improving things in one dimension is independent of the state of the other dimensions. The implicit assumption is that the mapping between each dimension and performance is monotonically increasing in all dimensions, all the time. This is highly unlikely to be the case. Second best interactions are bound to be very important. The benefit from having fewer licenses has to be traded off against the benefit of assuring consumers that products are safe and banks are sound. The benefit of having low license fees must be traded off against the cost of having licensing offices that are cash strapped because, in the absence of adequate fees, they depend on a weak central government budget. Low labor taxes in the US go with little public provision of health services leaving more of the burden of health insurance on corporate balance sheets while increasing the risk of labor mobility for workers.

If in real life things were linear and separable then we should observe that good countries choose good policies and bad countries choose lousier ones along the dimensions described by the index. However, the average cell in the correlation matrix of the Doing Business index is just 0.18 and this is in part because of correlations of more than 0.9 between some measures that are almost identical by construction such as export and import delays or the indirect cost of labor and labor taxes. The median coefficient in the correlation matrix is barely 0.16<sup>6</sup>. The best performers are clearly not going to a corner in each of the chosen dimensions. They are optimizing along some complicated internal solution and different countries find very different configurations.

I conclude from this analysis that the policy space has very high dimensionality. The recent attempts at capturing what matters highlight the role of an ever increasing number of dimensions which are deeply interacting, highly sector specific and look more like systemic properties rather than individual policy choices. The attempt to collapse all these dimensions into simple competitiveness or investment climate rankings does not achieve any practical simplification as each area can only be addressed at the right level of specificity. Moreover, the policy space is under constant revision and updating. It will be very hard for a central planner to keep all these considerations in mind when charting a course of action.

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<sup>5</sup> Rodriguez (2007) studies the validity of the assumption of linearity and separability in the context of Barro-style growth regressions and finds that the data rejects it.

<sup>6</sup> In order to take into account the fact that some correlations are expected to be positive and others negative, we take the absolute value of the estimated correlations to calculate these numbers.

### 3. High dimensionality in production: letting go of the aggregate production function

The aggregate production function looms large in the frameworks through which growth policies are thought. In this paradigm, output is determined by the factors of production that a country has and by the total factor productivity (TFP) with which it uses them. Factors of production are few – physical and human capital, mostly – and are measured by (their vintage-adjusted) investment levels and (quality-adjusted) years of schooling. Output growth is dependent on factor accumulation and TFP growth<sup>7</sup>. Much of the growth experience is not explained by factor accumulation but instead by TFP changes. There is a big debate as to whether growth is caused by institutions (e.g. rule of law, contract enforcement)<sup>8</sup>, geography (latitude, distance to the sea)<sup>9</sup> or (aggregate) policies (e.g. inflation, trade openness).

This is the natural way of organizing the debate if you start with the aggregate production function. And yet, there are many aspects of the world that are completely hidden from view if – to put it in Plato’s metaphor – these are the joints that are chosen to cut reality up. So, it is useful to point out what are the aspects of economic development that get obscured or hidden from view by the aggregate production function. As Robert Lucas put it: “I do not believe we can obtain a theory of economic miracles in a purely aggregative setup in which every country produces the same, single good (and a rich country is just one that produces more of it)”<sup>10</sup>.

The first thing that gets obscured is the product space<sup>11</sup>. Aggregate behavior is seen as independent of the concrete products a country makes. In other words, there is nothing inherent in the goods that may explain, for example, the rate of total factor productivity growth. Therefore, explanations of why some countries grow and others don’t does not have to take into account the composition of production as a potential explanation. These are just seen as epiphenomenal. It is just a mechanism through which the more

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<sup>7</sup> In a neo-classical growth model, accumulation may be partly explained by TFP growth itself, since the desired amount of capital is a function of TFP. The reverse however is not the case: TFP growth does not depend on capital accumulation.

<sup>8</sup> See for example, Hall and Jones (1999), Acemoglu, Johnson and Robinson (2001), Rodrik, Subramanian and Trebbi (2002).

<sup>9</sup> Gallup, Sachs and Melinger (1998).

<sup>10</sup> Robert Lucas, Making a Miracle, in Lectures on Economic Growth, pp. 73-74.

<sup>11</sup> Some of the issues that have traditionally been discussed in the literature regard the formal assumptions that are needed to make sense of the aggregate production function. For example, under what conditions adding up individual production functions lead to a sensible aggregate version. One important assumption in this regard is that all factors of production must be employed with the same marginal productivity. Banerjee and Duflo (2004) makes the point that this assumption is incompatible with the stylized facts of returns to capital in developing countries. I put less of an accent in this kind of failure to aggregate problem in my discussion. Jesus Felipe and Gerard Adams (2005) argue against the logic that sees the stability in labor shares as evidence of constant returns to scale in the production function and of competitive equilibria. They argue instead that these are the results of the accounting identities with which the data is constructed.

fundamental determinants of growth get expressed. They don't have an independent and policy-relevant story to tell. The Heckscher-Ohlin model also has this property.

Secondly, growth can be conceived of as if it was independent from structural transformation, i.e. from the process whereby countries change what they produce. And yet, to quote Lucas again: "A growth miracle sustained for a period of decades thus must involve the continual introduction of new goods, not merely continual learning on a fixed set of goods."<sup>12</sup> The problems or market failures that may arise in this process thus potentially constitute an important part of the growth process and of the policy environment that determines growth. But they remain hidden from view in the intuitions generated by the aggregate view of things.

Thirdly, in economics there is a very strong presupposition of the relationship between the "fundamental" elements of which reality is made and its aggregate properties. There are factors and then there is output. The intermediate levels add nothing to the explanation. It is as if physicists would postulate that aggregate matter is composed of protons, neutrons and electrons, but that the specific atoms, molecules, cells and organisms in which the fundamental particles get organized has nothing to do with the aggregate properties of the system. By contrast, physics was able to identify the atoms and the rules through which they combine decades before protons, neutrons and electrons were discovered<sup>13</sup>. Physics adopted an empirical strategy that lead to the accumulation of a corpus of evidence that inspired the development of theory. In economics, the demand for micro foundations has tended to force research into the narrow confines of the accepted underlying structure of the economic world: the representative agent, the canonical production functions (e.g. CES, Dixit-Stiglitz), the factors of production, etc. It is as if physics had started from the assumption that the world was composed of earth, water, air and fire and everything else was some combination of these elements. No wonder alchemists – of which Isaac Newton was one – thought it reasonable to assume that it should be possible to convert lead into gold. The rules limiting the ability of "fundamental particles" to combine would only be discovered centuries later when a more empirical approach towards the constituent elements of the world became central to the research program in physics. Lead atoms cannot be chemically made into gold even though both are just a combination of protons, neutrons and electrons. The reason is that the constraints that are relevant to this transformation are emergent properties that are not part of the more fundamental components themselves.

Similarly, there may be economic transformations that are impossible because the constraints that impede them are emergent properties that cannot be observed at the level

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<sup>12</sup> Idem pp. 86.

<sup>13</sup> For example, Mendeleev was able to posit in 1869 the periodic table showing how the chemical properties of atoms tended to recur periodically. He was even able to predict the existence of yet undiscovered atoms and their properties. This all happened at least some 60 years before quantum mechanics was able to account for this by understanding that chemical properties were regulated by the structure of the outermost electron orbits of the atom.

of the “fundamental” factors of production. This is often obscured by the way economics tries to relate the micro to the macro.

Consider Dani Rodrik’s characterization of the neoclassical methodological predisposition in the introduction to his book *One economics, many recipes* (p.3) where he character:

"social phenomena can best be understood by considering them to be an aggregation of purposeful behavior by individuals interacting with each other and acting under the constraints that their environment imposes."

To most economists this statement is unsurprising. It is a well understood part of our methodological approach. But consider the following: where did the constraints come from? How are they related to the way things are structured? Could it be that the “constraints” are themselves social phenomena that need explanation and that have dynamics beyond the ones suggested by the accounting identities that we often suppose underpin them?

Consider the following question about a particular country. Can you export a refrigerated container and obtain a phytosanitary permit before the produce rots? If so, then the export of Peruvian asparagus and artichoke becomes feasible. If not, tough luck. Can you use the postal system to deliver products or bills to your customers? If so, mail order commerce is a possibility.

Note that these are “constraints” producers will face when deciding what and how to produce. However, these constraints are neither a consequence of the endowments of individuals nor of the aggregate endowment of society. They relate to forms of social organization that may or may not come about. They cannot be overcome by any purposeful individual that accumulates more capital or skills. These constraints are social outcomes that exist at some intermediate level between individuals and aggregate behavior. Consider again the elements that the Global Competitiveness Report takes into account when thinking of institutions: public trust in politicians, favoritism, organized crime, etc. These are social outcomes that may be the “constraints” against which individuals optimize their purposeful behavior. These social capabilities are like the atoms or molecules through which the fundamental particles organize themselves and interact. But the story is in the determinants and evolution of those “constraints”. In this rendition, the individual coping strategies are epiphenomenal, it is emergent social capabilities where the story lies.

The point is that the puzzles of development may hide behind the formation of these intermediate social capabilities that may or may not be present in individual societies and may condition their possible evolution<sup>14</sup>. In principle, we do not know what the relevant social capabilities are and we cannot derive them from first principles. We face a problem similar to that faced by physicists when trying to determine what the constituent parts of nature were. It would have been hard to imagine that pure logic would have derived the

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<sup>14</sup> This view of development is closer to Hirschman (1958), where one new form of production triggers the appearance of others.

existence of 118 different atoms, some 17 fundamental particles (6 quarks, 6 leptons and 5 force carriers)<sup>15</sup>, 4 letters in the DNA code and about 220 distinct types of cells in the human body all produced from the instructions contained in a single genome composed of some 22,000 genes. It was not only important to show that in general the chemical properties of an atom can be worked out from the number of protons in its nucleus. It was still necessary to look at each individual atom and of its different forms of interaction with all other atoms. By the same token, it is not enough to know that “institutions” are key. It is important to know what these “institutions” actually are in practice, how they come about and how they interact and evolve.

### Letting the product space tell its story

So an alternative research strategy is to let the disaggregated data on production speak. This is complicated by several factors. First, there are no highly disaggregated large international datasets of production. However, there are very rich datasets on trade. This is not ideal but is not too bad. After all, countries tend to export the things they are best at so that the data on trade is revealing of the evolution of the countries’ comparative advantage<sup>16</sup>. A more important problem at this stage is that it is not obvious how to make the high dimensional character of this data speak in a way that is illuminating as opposed to showing just “one damn thing after another” to paraphrase Elbert Hubbard.

My first attempt at allowing the product space to enter the growth story was the paper “Economic Development as Self-Discovery” co-authored with Dani Rodrik, where we posited the idea that finding what to produce is a complex social process rife with information externalities and not just the simple consequence of a country’s factor endowments. We brought this idea to the growth story in our paper “What you export matters” co-authored with our student Jason Hwang. The title puts the emphasis on the fact that what is important is not just how much you export but also the characteristics of what you export. We developed one metric to describe the position of each country in the product space. We called it the level of sophistication of its exports or EXPY and it essentially reflects the level of income of a country’s competitors<sup>17</sup>. That paper has two main messages. First, rich (poor) countries tend to compete with other rich (poor) countries, i.e. EXPY and GDP per capita are positively related. This is unsurprising and is what would be expected from many theories<sup>18</sup>. However, this does highlight the fact

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<sup>15</sup> Potentially, if super-symmetric string theory turns out to be right, each particle would have a super-symmetric partner so the total number of fundamental particles would be 34.

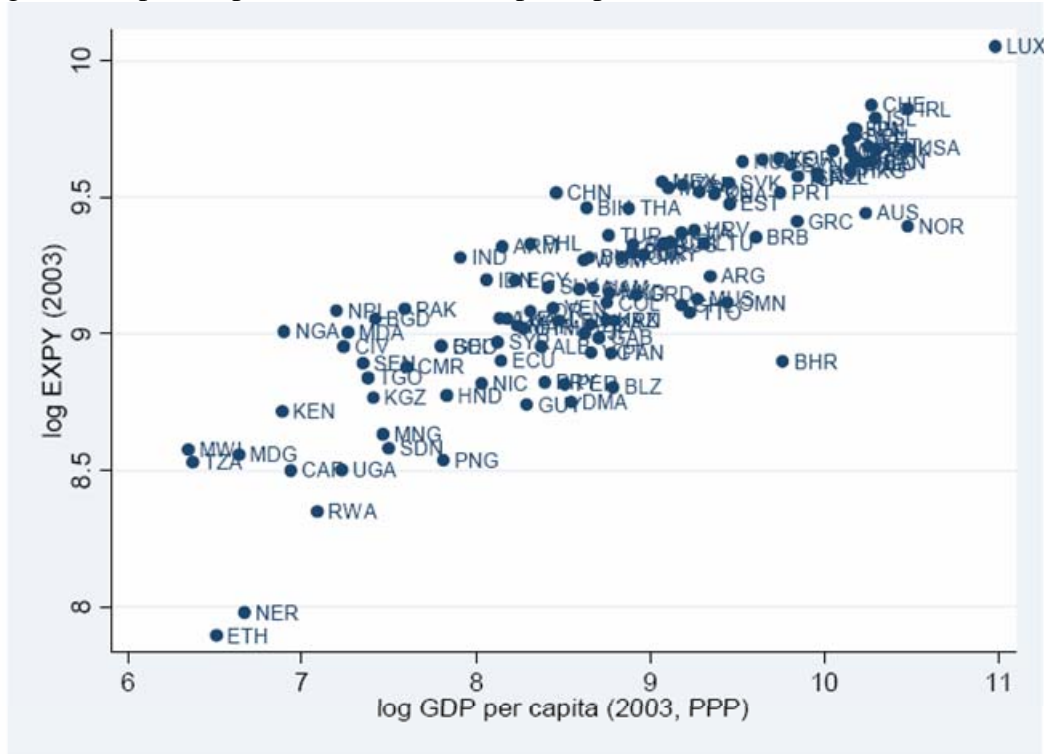
<sup>16</sup> Statistics on trade in services are very bad. Also a significant part of production is non-tradable and hence out of the trade statistics. Non-tradable capabilities and inputs are bound to be what pins down the geographic location of production.

<sup>17</sup> The calculation is a two step process. First, we developed a measure of a product’s sophistication based simply on the weighted average of the GDP per capita of the countries that export the good with the weights being the revealed comparative advantage of each country’s export of that good. We called this variable PRODY, or the product’s implicit income per capita. We then calculated the weighted average PRODY for the country, where the weights are the shares in exports.

<sup>18</sup> For example, in conventional trade theory *a la* Heckscher-Ohlin, countries export products that are more intensive in the factors of production that are relatively abundant at home. So, for example, rich countries tend to export the goods that are more intensive in physical, human or institutional capital.

that when countries grow, they don't just produce more of the same. They change what they produce and export, just as the above-mentioned Lucas quote had stated.

Figure 1. Export Sophistication and GDP per capita, 2003



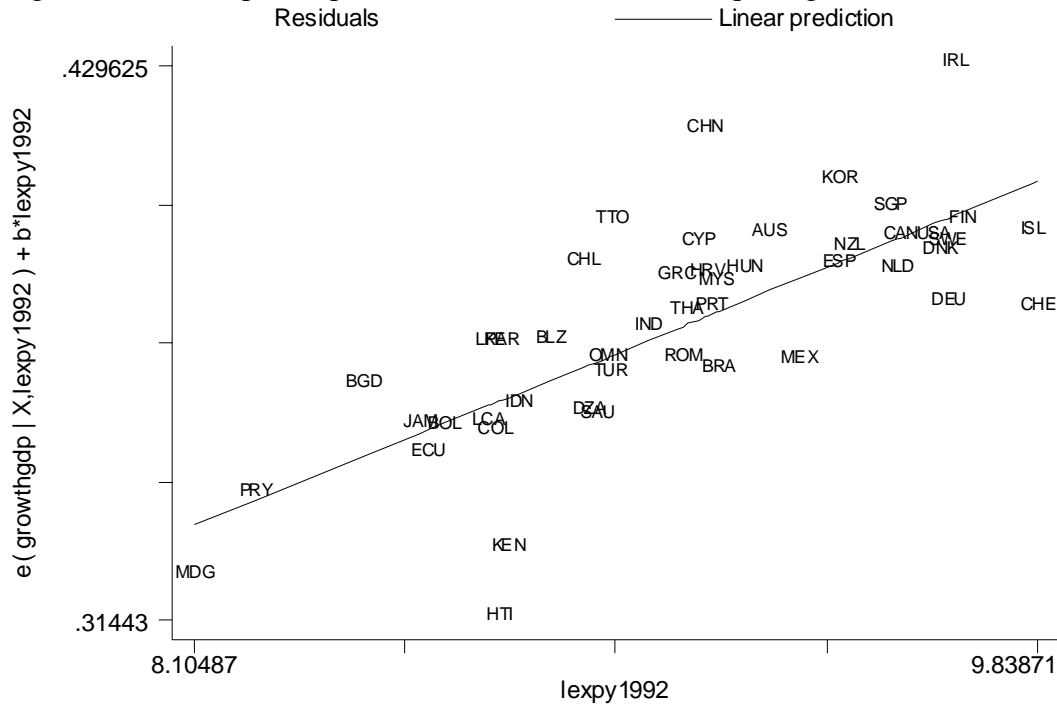
Source: Hausmann, Hwang and Rodrik (2006)

But the punch line of the paper is the fact that for a given level of initial income, the higher the level of initial sophistication of a country's exports the higher its future growth. In other words, countries converge to the level of income of their export competitors: they *become what they export*<sup>1920</sup>.

<sup>19</sup> To paraphrase Pindar, the pre-Socratic philosopher whose maxim was: "become what you are".

<sup>20</sup> Hausmann, Hwang and Rodrik (2006) we also perform 5-year and 10-year panel regressions using different estimation techniques and applying several robustness checks to confirm this result.

Figure 2. Initial export sophistication (EXPY) and subsequent growth



This is somewhat difficult to square with a strict interpretation in terms of conventional comparative advantage or Heckscher-Ohlin theory. Under received theory, a country with an export package that is significantly more sophisticated than that indicated by its current income level is one that has misallocated resources (by pushing them into areas where the country does not have a comparative advantage). Such a country should perform badly relative to countries whose export packages are more in line with current capabilities. That we observe the opposite suggests that the process of structural transformation is rife with market failures than is implied by standard trade theory.

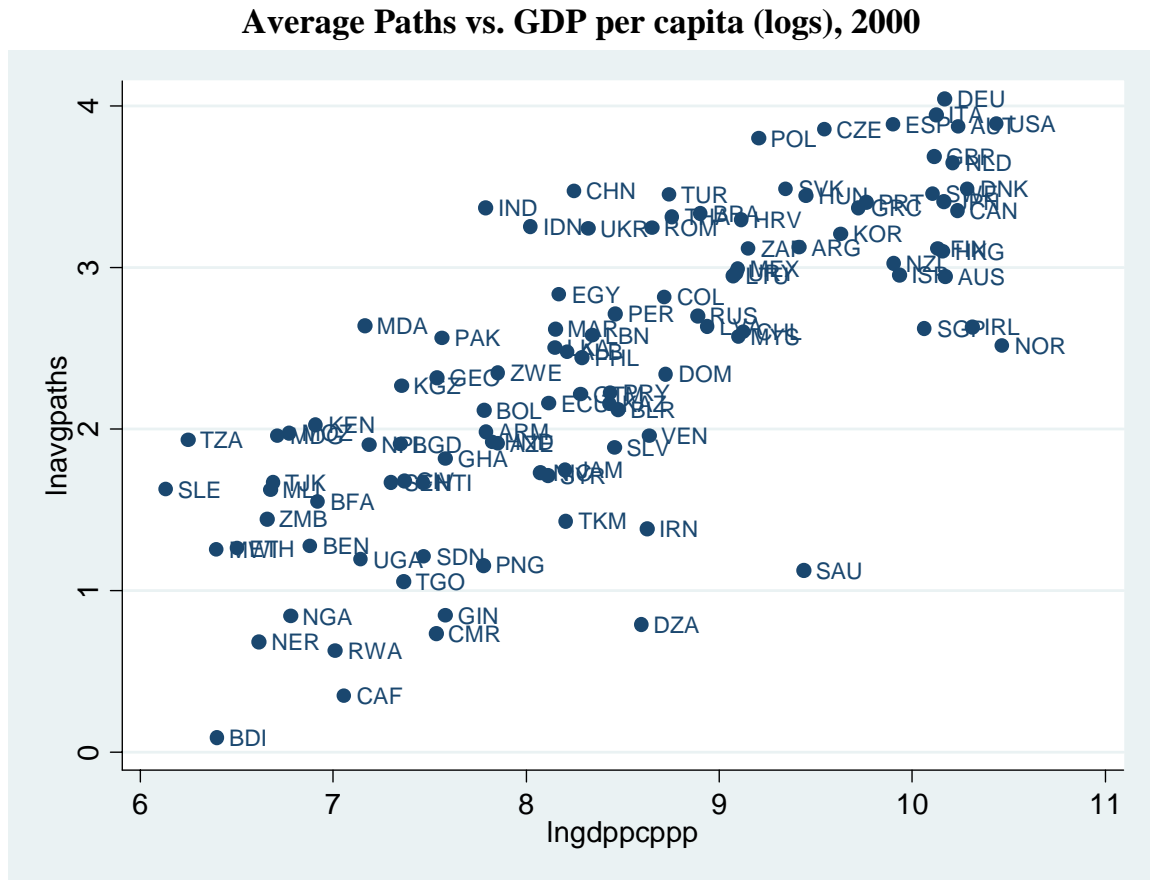
But why do we observe that some countries are able to upgrade their exports more rapidly than others? Could it be that the answer has something to do not only with the characteristics of the country per se, but of the characteristics of the products as well? For example, consider the fact that Korea exports microwave ovens and Chile exports farmed salmon. It is hard to know which product is technically more sophisticated. After all, having enough of a grip on the biology of the salmon to make it procreate in captivity is a major technological feat. But suppose the question is the following: what would happen if both the salmon and the microwave oven markets were to collapse? How would the two countries redeploy their capabilities? The intuition is that with the same factory and the same workers and engineers the Korean microwave oven plant would quickly find other products to manufacture. By contrast, much of the knowledge and physical assets employed in salmon farming would have little alternative use.

This is the underlying assumption behind a series of papers that look at other dimensions of the product space. With Bailey Klinger<sup>21</sup>, I developed the concept of “distance” between products. While we posited that underlying this notion of “distance” was the degree of similarity in the capabilities required by each product, we measured this distance simply as an outcome. We used the conditional probability that a country has revealed comparative advantage (RCA) in product  $j$ , given that it has RCA in product  $i$ . We showed that when countries change their areas of comparative advantage they do so predominantly towards “nearby” goods. Moreover, we developed a measure of the position of a country in the product space in terms of its proximity to other goods. We found that the product space is highly heterogeneous with dense parts and sparser parts. We found that developing countries tend to be in the sparser parts of the product space and this limits their capacity to move, while more developed countries are in denser parts of the space. However, controlling for the level of income and other country and product characteristics, countries in the denser parts of the product space upgrade their exports more quickly. Figure 3 shows a measure of how well connected are countries in the product space. Countries like Poland, the Czech Republic, China and India have many products in the vicinity of the current areas of comparative advantage while Saudi Arabia, Iran and Venezuela do not. Korea is better positioned than Chile. We find that this variable is highly predictive of the ability to upgrade a country’s exports.

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<sup>21</sup> Hausmann and Klinger (2006), Hausmann and Klinger (2007).

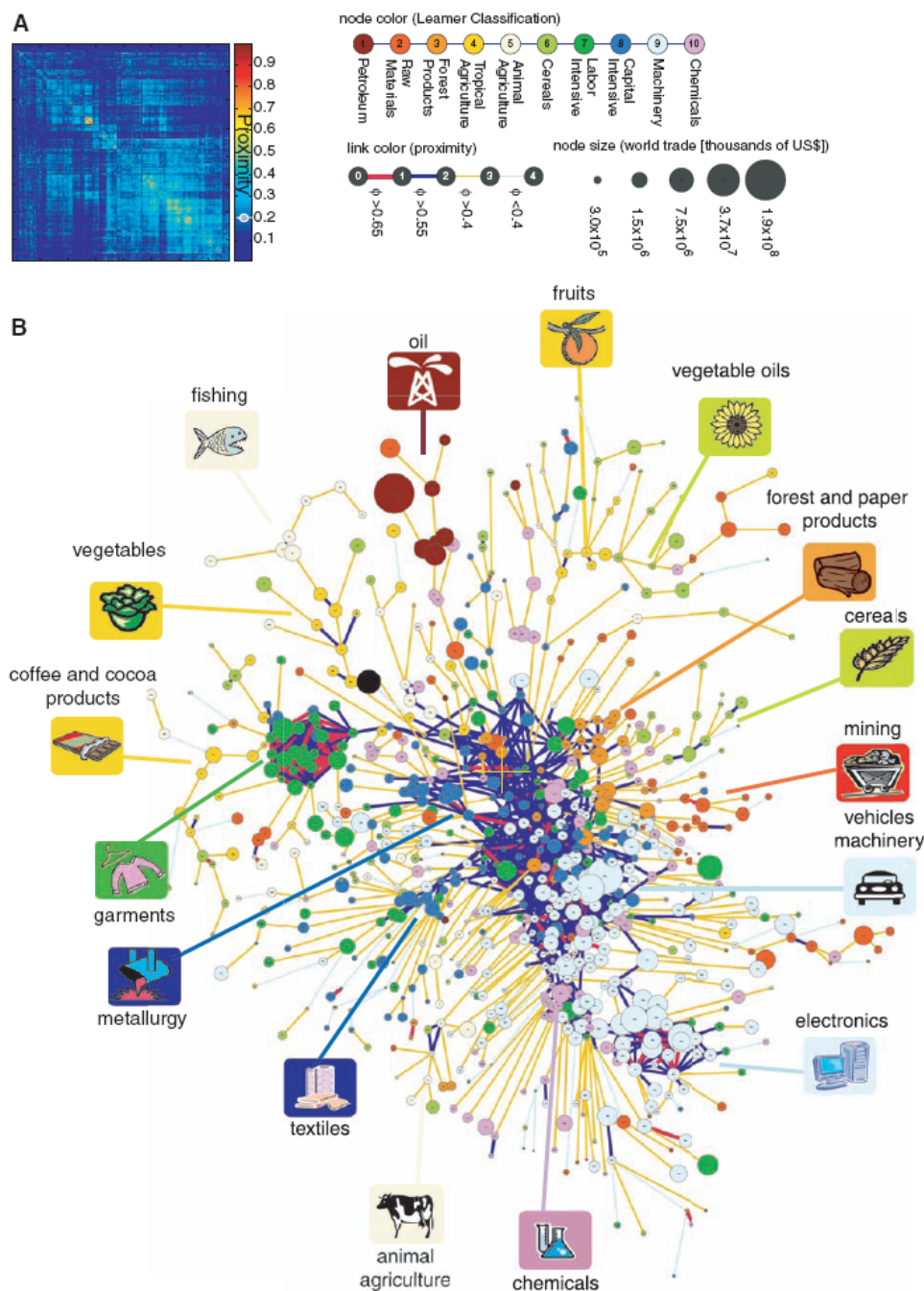
Figure 3. Average paths from the current areas of comparative advantage and GDP per capita



Source: Hausmann and Klinger (2007)

Working with Albert-Laszlo Barabasi and César Hidalgo we used network science to map the product space and analyze its properties. The title of the paper “The Product Space Conditions the Development of Nations” (2007) captures our findings. We showed a graphic representation of the product space, showed that countries move preferentially to nearby products and we simulated the diffusion of countries in this space. We found that if countries are allowed to move repeatedly to all nearby trees within a certain distance of their current position, they would only reach the better parts of the space if the jumps are of a size that we find to be infrequent. This is one explanation for the absence of income convergence across countries in the world: there are missing rungs in the stairway to heaven. There are transitions that involve too large a change in capabilities for countries to overcome.

Figure 4. Graphical Representation of the Product Space



**Fig. 1.** The product space. **(A)** Hierarchically clustered proximity ( $\phi$ ) matrix representing the 775 SITC-4 product classes exported in the 1998–2000 period. **(B)** Network representation of the product space. Links are color coded with their proximity value. The sizes of the nodes are proportional to world trade, and their colors are chosen according to the classification introduced by Leamer.

In general, there are two classes of problems that may be involved: coordination failures and information spillovers. Coordination failures occur when markets are incomplete so that the return to one investment depends on whether some other investment is also made: building a hotel near a beautiful beach may be profitable if somebody builds an airport. The opposite may also be the case. However, there may not be a way for the market to

coordinate both investments. A typical solution is for the government to provide a guarantee to both investors. If done well, this will be costless for the government ex post as the investments will be profitable when they both take place. If the guarantee is not credible, then the government can just build the airport and the hotels will follow

Another source of market failure is information spillovers. In Hausmann and Rodrik (2003) we stressed the spillovers in self-discovery, which we defined as the process of finding out the cost structure of an economy for the production of new goods.<sup>22</sup> The first mover will find out whether something is profitable or not; if it is, she will be copied by other entrants. But if she fails, she bears the whole loss. Because of this, the private returns from engaging in this type of innovation are lower than the social benefits, and the market incentives for self-discovery are inefficiently low. The typical policy implication is to provide a subsidy in order to bring the private returns in line with the social returns.

Labor training is another source of spillovers. A firm that trains its labor force provides a potential benefit to other firms that may poach its workers. This dampens the incentives to provide the optimal amount of training for fear of losing the investment. Clearly, labor mobility may not entail a social loss, as the worker can deploy his skills elsewhere, but the company cannot appropriate these benefits while incurring the training cost. The problem is inadequate investment in labor training; the solution is to subsidize training.

It is clear that coordination failures and spillovers are more acute for new activities than for already established ones. In the first place, coordination is impeded by the proverbial chicken and egg problem: new activities are hard to develop unless their suppliers are present, but why would the suppliers exist if they have nobody to sell to. Secondly, by definition, new activities must incur self-discovery costs. And finally, they cannot find workers with experience in the new activity, since the activity has not been in existence and hence has not been hiring and training workers for it.

So, how would structural change ever take place? One way forward is the development of new activities that can use the factors and capabilities that an economy has already developed for other purposes. We interpret this to be the cause of the path dependence we observe in the data.

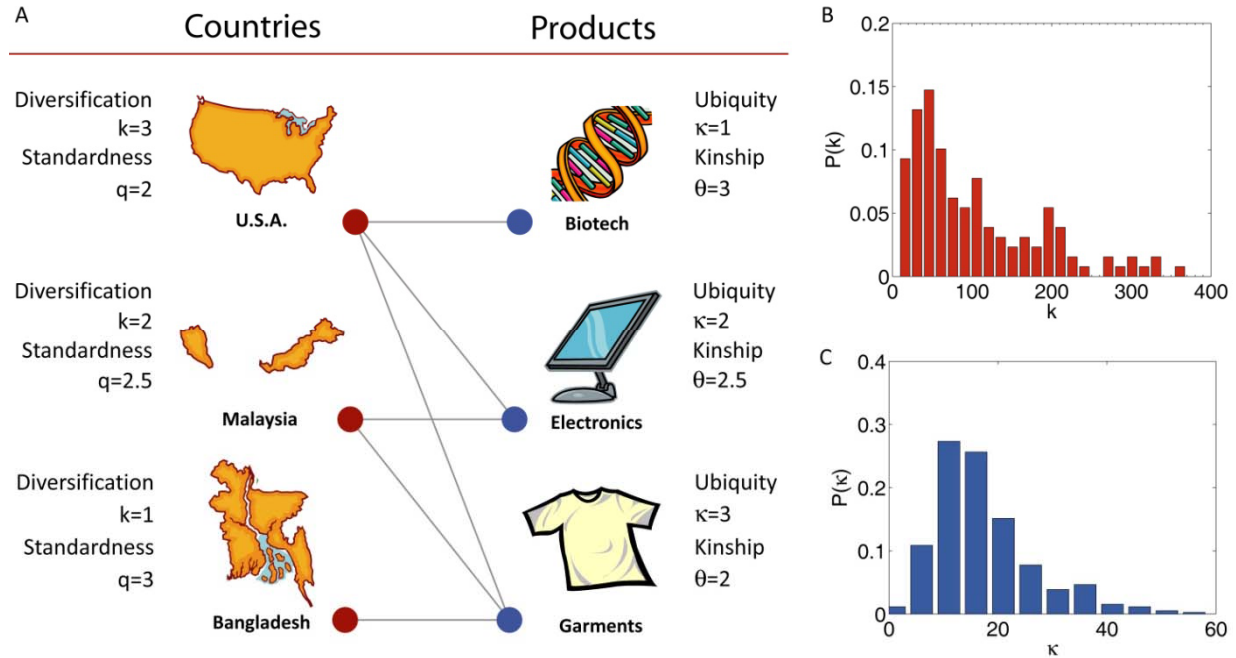
In this sense, a different way of describing the development process is as a co-evolution of products and capabilities. Products require capabilities but the accumulation of capabilities is something that is done in the expectation that someone will demand them. A country does not develop a cold-storage logistic system unless there is a market for it, but there will be no market unless products require it. Products move towards nearby goods because they share similar capabilities. Development is a sequence of stepping stones that justify the accumulation of an increasing number of ever more complex capabilities.

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<sup>22</sup> Structural transformation is not really about inventing new products. It is about identifying which of the products that exist in the world a particular country profitably produce. Hence, it is not a discovery of a product, but of a national capability: hence the term.

With César Hidalgo, we developed a way to analyze the relationship between products and countries as a bi-partite matrix. We develop four concepts, two for countries and two for products. For countries we calculate the average number of products they make which we call *diversification*. For products we calculate the number of countries that make them, which we call *ubiquity*. Then for countries, we calculate the average ubiquity of the products they make and we call it *standardness*. For products we calculate the average diversification of the countries that make those products, which we call *kinship*.

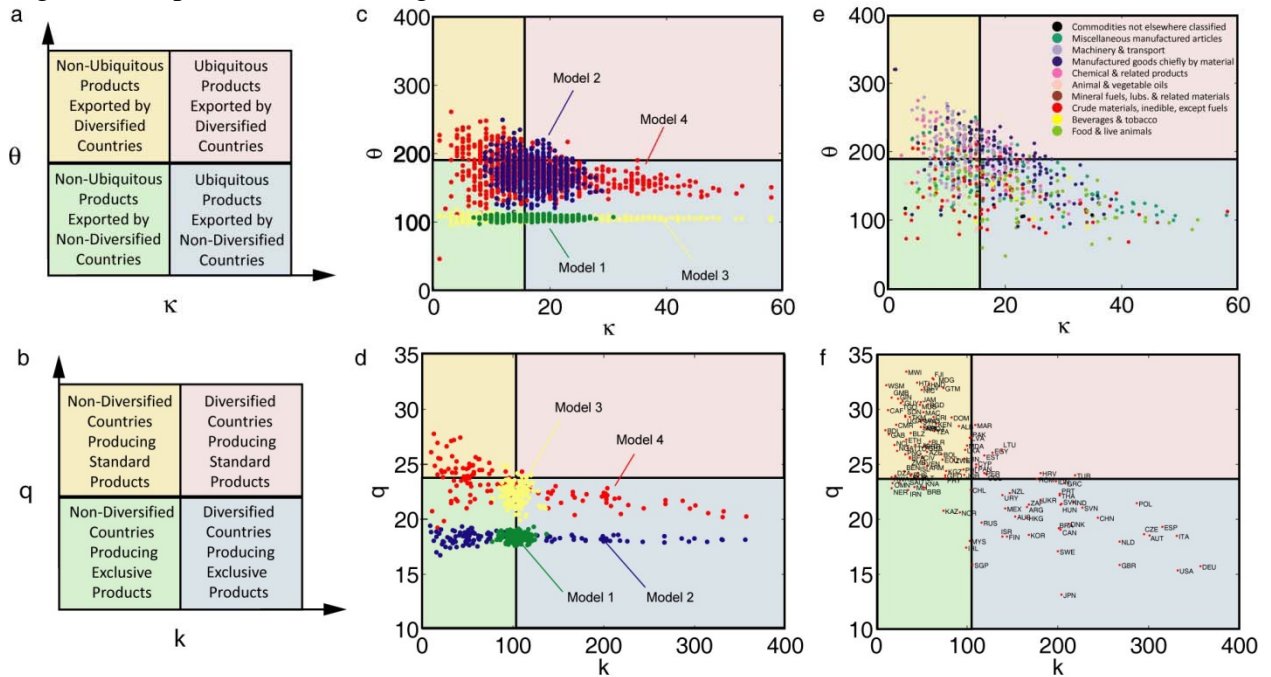
Figure 5. Analyzing the bi-partite matrix of countries and products



Imagine now that countries differ in the number and type of capabilities they have and that products differ in the number and kind of capabilities they require<sup>23</sup>. Countries that have many (few) capabilities are going to be able to make many (few) products, i.e. will have high (low) diversity. But they will be able to make products that few (many) other countries are able to make: meaning that these products should have low (high) standardness. Therefore, we should observe a negative relationship between diversification and standardness. By the same token, products that require many capabilities are going to be made only by the few countries that have many capabilities – hence will have low ubiquity – but those countries will be highly diversified, hence will have a high degree of kinship. Therefore we would expect to find a negative relationship between ubiquity and kinship. This is precisely what we find (Figure 6).

<sup>23</sup> A paper that looks implicitly at the product space in terms of levels of complexity is Michael Kremer's O-Ring model (1994). It describes a world in which products differ only in the number of steps they require, with the skill level being just the probability of performing the task successfully. This makes the product space 1 dimensional and the skill space also 1-dimensional.

Figure 6. Bi-partite network diagrams



Moreover, assume that a country now develops a new capability. This means that it will now be able to produce goods that require that capability plus all the other capabilities that the country previously had. If the country had few pre-existing capabilities, the new products will have high ubiquity (i.e. are products that many countries can make). Moreover, these products, by requiring few capabilities are bound to show high standardness. So the ubiquity and kinship of the products that a country is likely to discover is a function of the country's diversification and standardness. This is again what we find.

In ongoing research with César Hidalgo and Bailey Klinger we are applying this methodology to study the relationship between products and capabilities using the input-6-digit output matrix and the labor input coefficients of the US (which include 545 labor categories). Here we define capability as either a non-tradable input or a specific labor input. The idea is that tradable inputs can be imported and hence should not pin down where production takes place. However, non-tradable inputs and labor skills have to be available locally for production to take place. We analyze the product – capabilities matrix using a similar approach and derive a country – capability matrix assuming heroically that all countries use the US coefficients and using their actual export structure. We find that countries differ in the number of capabilities and in the average number of capabilities that their products require. We also find that the greater the number of capabilities a country has, the more complex the products it makes.

So the evidence is suggestive of the idea that products and capabilities co-evolve and that they underpin the patterns of structural transformation. But the analysis is not only important in establishing these general propositions. It allows us to know what products are near a country's current capabilities. Which of those products would be more strategic

in the sense that if the requisite capabilities were accumulated, more additional products would then be more easily developed? It allows us to characterize countries, products and capabilities in ways that may actually inform the policy process<sup>24</sup>.

With these concepts one can analyze a particular country in terms of the level of sophistication of its exports, its position in the product space, determine what yet-undeveloped goods lie in the vicinity of the current set of capabilities, how easy will it be for comparative advantage to evolve through movements towards those goods and think strategically in terms of the opportunity sets that would be opened if the country was able to move in a particular direction.

#### 4. High bandwidth development policymaking

We have argued in favor of a view of development as the co-evolution of products and capabilities. Capabilities exist not only at the individual level but include (mainly?) emergent social properties such as the ability to send a refrigerated container across borders or the capacity to accurately certify the safety of a drug in a reasonable time period. We say that products and capabilities co-evolve because products require capabilities and capabilities are accumulated because they are required in production.

Co-evolution implies that there is great potential for coordination failures, as it is hard to synchronize the development of a capability with the demand for it. Moreover, because capabilities are many and co-evolve locally, finding out how to do things in a given context involves a process that we have elsewhere called self-discovery (Hausmann and Rodrik, 2003)<sup>25</sup>. This process is potentially rife with information externalities.

If this is the paradigm, what is the role for policy? How should a government decide which of the hundreds of thousands of pages of legislation to revise or which of the hundreds of agencies to reform? How should it assess the impact of any reform in any area of legislation on the performance of other areas of activity and other second-best interactions? How should it balance the costs and benefits of different changes? How should it decide between the fight against foot and mouth disease, the building of new rural roads, the certification of dentists and of real estate brokers or the compliance with the prohibition against child labor and environmental degradation?

The policy space is truly very high dimensional. How can actual governments cope with such a high bandwidth of requisite information and decision-making needs? Stated this

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<sup>24</sup> Hausmann and Klinger (2006b) apply this kind of analysis to the case of South Africa.

<sup>25</sup> Acemoglu, Antras and Helpman (2005) have a model in which there are strong complementarities of inputs and limited contractability. Countries with better contractual environments avoid ex post renegotiations and are thus better able to solve the coordination problems and can thus produce goods that require more inputs. This would explain the division of labor across countries as a function of their contractual environment. It is an empirical question whether the requisite coordination of capabilities and products has been effectively addressed through legal enforcement of contracts or whether the world has relied on other forms of coordination.

way, this problem seems as hopeless as that of making an omelet with toast and coffee that we discussed in the introduction to this paper. The solution to the latter was Adam Smith's invisible hand. Central planning could not work. However, much of the thinking on policy, by disregarding the high dimensional nature of the problem, has tended to look for central planning solutions. Can we call Adam Smith to the rescue again?

The invisible hand works because information about social wants and possibilities is highly decentralized in society, so decisions have to be delegated to where the information exists: i.e. the suppliers and demanders of products and services. Similarly, the information about productive possibilities and obstacles is widely disseminated in society as is the capacity to see how one policy idea, often designed for one purpose, may have unintended consequences in other sectors. Therefore a more decentralized approach may actually work also for the provision of public policies.

However, the policy problem is different from the market problem because markets can use three elements that the policy process often lacks. First, *prices* give *information* about relative costs and willingness to pay. Second, *the profit motive* provides the *incentive* to respond to prices. Thirdly, the *capital market* assures the *resource mobilization* to areas that are expected to show good profit opportunities. The market is not expected to get everything right instantaneously and without waste. It is expected to figure things out over a reasonable period of time as imbalances show up and force agents to change their plans.

How could the policy process mimic a similar "invisible hand" approach to the problem? To see how this can be done we need a more detailed account of the interaction between policy and production. Production in a market economy requires many inputs that are provided by profit-motivated firms and individuals. If these inputs are tradable, they can be imported, so firms need not exist in the area. However, even here rules about trading across borders, requirements of product registration, copyrights, safety standards, logistics, other transaction costs, etc. come into consideration and these are provided by governments. Consider now inputs that are not tradable. This means that they must exist *in situ* if production is to take place. Here coordination failures and hold-up problems can make things much more complicated.

I find the stylized story of this process as modeled by Avner Greif particularly illuminating. Participants in the market see the possibilities and obstacles and try to cooperate to eliminate transaction costs through *private-order institutions* such as the Realtor's Association, the Financial Services Association or the Bar Association, to go back to our real estate example. They may come up with a negotiated agreement on how to regulate or norm certain activity. But the space of self-enforcing agreements is necessarily smaller than the space of agreements that may involve some *outside enforcement*. Sometimes, it is hard for private-order institutions to tax themselves to pay for club goods because of free rider problems. Other times, what they need involves other constituencies that are outside the group, as is the case with infrastructure or rules that affect their customers. This creates the need to involve the government, whose comparative advantage is precisely its ability to enforce norms through law and deal with

collective action problems. But the government may not be benevolent and may try to exploit its role for its own legitimate or illegitimate purposes. But governments are limited by what Greif calls coercion-constraining institutions, such as the election process or judiciary independence, that limit the capacity of the government to behave rapaciously. One implication is that the more trustworthy the government, the more the private sector will be willing to involve it in the institutionalization of the market processes. A more rapacious government will make the private sector less willing to involve it in any solutions to the problems it identifies and thus the institutional infrastructure fails to develop.

The rules, norms, infrastructure and other public actions that emerge from this process become inputs into the production process affecting the efficiency with which it operates or for some products it determines whether they are at all feasible. Let us call them *public inputs*. So, the production function involves not just private inputs that are provided by markets but also public inputs that come out of a different process. These public inputs are very high dimensional, as we have argued. However, these public inputs typically do not have a price so there is no decentralized system that delivers information about what is needed or profitable so it is very hard for governments to know what changes in norms or infrastructure would deliver the biggest bang. Moreover, even if the government had the information it would still face an incentive problem: the government is not supposed to be a profit-motivated entity, so it is not clear why it would react to price information. Finally, even if the government had the information and the incentive to provide a certain public input it is not clear how it could mobilize the resources since each public entity does not have ready access to the capital market.

However, somehow the world has been able to cope with this very high dimensional problem. How does it do it? Unfortunately, this is not a question that development economics has addressed in any significant way for a large sample of countries. We know a little of how things take place in the US, but it is likely to be a very unique case. Nevertheless, let us look into it.

As we know, there are 435 members of the House of Representatives and 100 senators. Contrary to the practice in many other countries, these elected officials are quite independent and frequently do not vote according to party lines. They can initiate legislation (something that is restricted to the Executive in many systems) and often can attach their names to pieces of legislation creating incentives for political entrepreneurship. In addition, as opposed to a parliamentary system, there is no guarantee that the Executive will have a majority in Congress so it becomes that much more important for the private sector to lobby Congress and not just the Executive.

According to the Center for Responsive Politics<sup>26</sup>, there are over 20,000 registered lobbyists that spent 2.8 billion dollars in 2007, double the amount spent in 1999<sup>27</sup>. What are these lobbyists about? The standard economist story is that they are about pure rent-

<sup>26</sup> See <http://www.opensecrets.org/lobby/index.php>

<sup>27</sup> Interestingly for our example above, the National Association of Realtors is the 11<sup>th</sup> largest spender in lobby activities. See also Grossman and Helpman (2001), especially Chapter 1.

seeking (Krueger, 1974). In our framework, lobbyists play a much more productive role. They provide information to their customers regarding the legislation that may benefit them and may want to promote and the legislative actions that they may find harmful and want to stop. They also influence the policymakers with information, analysis and campaign contributions.

For example, the stated mission of Good Government, a lobby group is:

To effectively impact the development of legislation and regulation important to the mortgage lending industry, working for laws that protect consumers and keep mortgage capital available to them on fair and affordable terms, in ways consistent with responsible corporate citizenship and Good Government<sup>28</sup>.

The group also has a description of what a good lobbyist does or should do which includes the following elements<sup>29</sup>:

- “Convinces politicians to vote on legislation by demonstrating that doing so is in the politicians' interest.
- Meets with legislators and provides information they would not otherwise have received.
- A good lobbyist educates legislators with support documentation (charts, graphs, polls, reports).
- Sits down with legislators and helps them draft legislation”

Note that there are many more lobbyists than legislators so that groups on opposite sides of an issue are normally present. This makes the system adversarial in nature, just as the judicial system. The idea is that by having each side put its best arguments on the table the system reveals much more information than would be the case if this was a process open only to experts that are informed by “best practices”.

So, in some sense, the US system has generated a social process whereby information is revealed and incentives are formed for policymakers to be responsive to that information. The decentralization of the legislative agenda and of committee work facilitates an open architecture approach to the process. There are many channels of communication between the private sector and government and there are many policy processes operating in parallel.

Clearly, this process must be far from optimal, in the sense of what could be achieved by an omniscient and benevolent social planner. For example, as argued by many economists, free-riding must be a factor that affects activities differentially. Concentrated interests or those where the capacity to cooperate is enhanced for other reasons are bound to be over-represented. In addition, in the US system, congressmen have to fund their

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<sup>28</sup> See <http://www.oomc.com/GoodGovt/index.shtml>

<sup>29</sup> See <http://www.oomc.com/GoodGovt/Civics/whatalobdoes.shtml>

own re-election every 2 years which makes their sensitivity to election finance very high. The tension between doing policies that are good for voters vs. policies that are good for contributors may not be well balanced. This may be balanced by the fact that willingness to pay may be a noisy signal of the value of a decision in terms of utility or of productivity-enhancement, not just rent-seeking.

Since economists have tended to describe the lobbying process as a pure rent-seeking game they have provided evidence of rents in support of this claim. Now, the fact that rents are present does not mean that this is what the process is about. Our alternative description of the process would emphasize the information and incentives constraints that lobbying is a response to. Given the different participation constraints that the different players face – especially free-riding on the part of the public – it makes sense for participants to expect some rents from the process. This does not mean that the process can be described as a pure rent-seeking game. People lobby to prohibit abortion and stem cell research, to curb the emission of greenhouse gasses, to create the legal infrastructure to sell music on the internet and protect copyrights, to curb acid rain, to save the whales, etc. Looking this as a simple rent-seeking game is like recounting Hamlet without the Prince.

The point is that we barely understand how the system that matches the demand for and the supply of public inputs actually works in the US, and we are even more ignorant of how it works in most developing countries. In some countries, parliaments play a small role in policymaking, essentially rubberstamping the initiatives of the Executive. Even when parliaments do play a role, decisions are often taken by political parties rather than individual members of parliament. The lobbying game must shift accordingly. In some countries the relationship between the political elite and the needs of the business sector is quite dysfunctional while in others there is a sense of shared interests. The nature of this game can be crucial in determining how economic failures of different types are addressed, how the provision of public inputs is improved and how animal spirits are affected when investors understand how the future provision of public inputs will be decided.

We have very little evidence of the potential importance of this channel in explaining growth, but there are some papers that are particularly suggestive. For example, Rodrik and Subramanian (2004) try to explain the growth acceleration in India by looking at a set of policy reforms and their dates. They find that growth accelerated about a decade before the major liberalizing reforms that are often considered to be the usual suspects, such as trade reform. They suggest that the cause of the growth acceleration was “an attitudinal shift by the government in the early 1980s” which turned in favor of the established business interests (as opposed to potential new entrants, say). This attitudinal shift was expressed in many small decisions but no major reforms. The established interests responded vigorously suggesting that they had been constrained by an inadequate provision of public inputs that could be improved with small changes. If the existing businesses can expect to get their issues resolved their animal spirits would respond quickly and productivity could rise very dramatically, as it did.

The alignment of incentives between investors and policymakers often take forms that are hard to present in polite society. Pritchett (2007) argues that what matters is not the policy actions that a government takes but the mapping between states of the world and the expected action. If the private sector can understand and trust the way future policy actions will be decided they will respond quickly in the present. For example, in Indonesia the government could be trusted to provide the right public inputs if the Suharto clan was adequately represented in the ownership structure of the firm but when Suharto's health started to fail and his sons got into a political quagmire the mechanism broke down and animal spirits flew out the window.

Another typical model of policy change involves the more or less secret negotiation of an IMF program or a World Bank policy loan. The elements of the policy matrix are derived by experts and are based on best practices. The priorities for reform come from the fashions of the day in the development community: trade liberalization, financial reform, privatization, etc. The solutions are seen as relatively obvious and derived from first principles and the policy problem is often defined as the lack of political will or reform appetite. Note how uninvolved the rest of society is in the way this process is conceptualized.

The debates on development policy have disregarded not just the process of policymaking but also the dimensions of the policy space. Part of this is done by giving pre-eminence to some dimensions in the growth process: education, low inflation, openness, etc. The goal is to be able to focus on the few issues that really matter. The idea is to set priorities in a more disciplined fashion, so as to adjust the demand of policy responses to the limited available supply.

But this need not be the way forward. The alternative approach is to increase the ability of the policy process to deal with more issues, i.e. to be able to operate at a higher bandwidth. This requires a multiplication of the channels through which policies are produced and the enrichment of the informational environment in which this process takes place.

A traditional way of conceiving the role of policy is based on Pigou. The idea is that market distortions create a wedge between private and public returns. So the role of policy is to create the Pigovian taxes or subsidies to bring these two returns into line. This approach may work for a very limited set of interventions, a good example being the cap and trade approach to environmental problems such as acid rain. However, in most public policy issues, what is required is the delivery by the public sector of a concrete action whether it be a specific regulation, infrastructure, etc., not a tax or a subsidy. The point is that compensating the private sector financially for the absence of a road or an appropriate solution to a transactions cost is inferior to solving the problem. But the set of interventions that achieve this is much larger, making the policy action space more high dimensional.

Another method that loses its appeal in a world of high dimensionality is the randomized trial approach. A typical program, whether a conditional cash transfer, a

micro-finance program or a health intervention can easily have 15 relevant dimensions. Assume that each dimension can only take 2 values. Then the possible combinations are  $2^{15}$  or 32,768 possible combinations. But randomized trials can only distinguish between a control group and 1 to 3 treatment groups. So, many of the design or contextual features are kept constant while just 1 or 3 are being varied. This means that the search over the design space is quite limited, while the external validity of these experiments is reduced by the fact that many of the design or contextual elements are bound to change from place to place. So, for the majority of the design elements, choices must be made in the absence of the support from randomized trials, which will necessarily play a secondary role in the actual practice of policymaking.

High dimensionality is more amenable to an evolutionary approach. Since the search space is so large, finding the optimum is just too difficult. So the point is to organize many searches and have a selection mechanism. In biology, the searches occur mostly at random, but if the selection mechanism is effective, the system will be constantly picking those variations that improve performance. Humans should be able to search more efficiently, but they still need an effective selection mechanism.

One approach that facilitates this process and is used effectively in the private sector is benchmarking, a practice that was started in the auto industry but has spread to many other areas. Units are given operational flexibility, but their performance is meticulously measured. The feedback loop created by repeated comparative measures is meant to facilitate the collective open-ended search for improvements. A repeated game of standardized tests and school autonomy is a rather different approach to experiments that try to find the impact of class size, teaching materials, de-worming or toilets on school performance. Some randomized trials might help, but the dimensions of school management is just too high dimensional for large randomized trial experiments to play a dominant function.

Increasing the bandwidth of the policymaking process requires a process to search the space of opportunities and obstacles. Here, as with the market vs. central planning, the problem is that information is highly dispersed in society so that information revelation becomes a central aspect of the policy process. In work with Dani Rodrik and Chuck Sabel<sup>30</sup> we proposed an open architecture approach to economic policymaking. The idea is to presume the government's need for information about the space of possibilities and obstacles and to create the mechanisms for the private sector to have incentives to provide the information and for the government to have the capacity and desire to respond effectively.

First, an *open architecture* approach gives the initiative for action to many *self-organizing bodies* in society. These bodies exist because they share interests in a set of public or club goods. By contrast, the attempt to have the government structure the conversation by parsing society into predetermined groups that must reach agreement will not necessarily reveal information about the missing public goods but instead will

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<sup>30</sup> Hausmann and Rodrik (2006) and Hausmann, Rodrik and Sabel (2007)

focus on whatever constitutes a common denominator, which often is a subsidy or a tax holiday rather than a more specific and productive intervention.

Secondly, if a public or club good is particularly productive the private sector should in principle be willing to *co-finance*. Therefore, willingness to co-pay may be a good screening device. Third, it is important that the relationship between the private and the public sector be seen as legitimate by the rest of society – and not a social program for the already rich. Therefore, principles of transparency must be present. Transparency will limit the type of requests that the private sector will be willing to make and will discipline the public response. Fourth, it is important that the government evaluate its actions on the grounds that they increase productivity, not just profitability. The latter can be achieved by transferring income from the rest of society (e.g. by buying inputs cheaper or selling output at a higher price), but unless there is an externality, this does not provide a rationale for action. By contrast, productivity increases the total amount of resources that a society can generate. Finally, it is important that solutions be designed with a universalist criteria not as an *ad hoc* remedy for a particular plaintiff. The idea is that the dialogue process should generate positive spillovers to other activities, not just the ones that ask for treatment.

Mechanisms of intervention should consider the fact that existing activities are likely to be over-represented relative to activities that could exist but do not because the right public inputs and other capabilities are not present. Thinking about mechanisms that can make more distant searches is important. In Hausmann, Rodrik and Sabel (2007) we argue that institutions such as development banks and industrial zones, can play a significant role in the search for these outer confines of the feasible product space and can facilitate the provision of the requisite public inputs.

To sum up, little is gained from disregarding the high dimensional nature of the development process and its requisite public inputs. Instead of focusing on a low number of potential silver bullets, development strategy should better focus on the mechanisms that allowed more decentralized parallel processing of the many issues that are involved in development. We should embrace complexity and deal with it rather than hide from it. This implies working not only at the level of the individual policy actions that may be required but also at the meta-level of the structures whereby problems are identified and addressed. This is what will ultimately allow societies to deal with the complexity they face.

Maybe Adam Smith could be reinterpreted a bit. As he said: “The uniform, constant and uninterrupted effort of every man to better his condition... is frequently powerful enough to maintain the natural progress of things toward improvement”. However, part of the effort to better his condition is exerted by man in the process of participating in the collective search for public policies that can seize opportunities and overcome obstacles. Letting that invisible hand operate to improve policies may be the appropriate way to deal with the high dimensionality of the real world.

## References

Acemoglu, Daron, Pol Antras and Elhanan Helpman (2005) "Contracts and the Division of Labor" MIT Department of Economics WP 05-14.

Banerjee, Abhijit and Esther Duflo (2004) "Growth Theory Through the Lens of Development Economics", MIT Economics Working Paper No. 05-01

Felipe, Jesus and Gerard Adams (2005) "A Theory of Production" The Estimation of the Cobb-Douglas Production Function: A Retrospective View", *Eastern Economic Journal*, Vol. 31, No.3, Summer 2005, pp. 427-443.

Hausmann, Ricardo and Bailey Klinger (2006) "Structural Transformation and the Patterns of Comparative Advantage in the Product Space", Center for International Development, WP No.128, August.

Hausmann, Ricardo and Bailey Klinger (2007) "The Product Space and the Evolution of Comparative Advantage", Center for International Development, WP No. 146, April.

Hausmann, Ricardo, Lant Pritchett and Dani Rodrik (2005) "Growth Accelerations", *Journal of Economic Growth*, 10, 303-329, 2005.

Hausmann, Ricardo and Dani Rodrik (2003) "Economic Development as Self-Discovery", *Journal of Development Economics*, Elsevier, vol. 72(2), pages 603-633, December.

Hausmann, Ricardo, Jason Hwang and Dani Rodrik (2007) *Journal of Economic Growth* 12.1 (March 2007): 1-25.

Hausmann, Ricardo and Dani Rodrik (2006) "Doomed to Choose: Industrial Policy as Predicament", mimeo Harvard University

Hausmann, Ricardo, Dani Rodrik and Charles Sable (2007) "Reconfiguring Industrial Policy: A Framework with an Application to South Africa, mimeo: Harvard University.

Hidalgo, César, Bailey Klinger, Albert-Laszlo Barabasi and Ricardo Hausmann (2007) "The Product Space Conditions the Development of Nations", *Science*, 317(5837): 482-487, 27 July 2007.

Hirschman, Albert (1958) *The Strategy of Economic Development*, New Haven, CT: Yale University Press.

Kremer, Michael (1993) "The O-Ring theory of economic development," *Quarterly Journal of Economics* 108 (1993):551-575.

Pritchett, Lant (2008) “Reform is like a box of chocolates: An Interpretive Essay on Understanding the Pleasant and Unpleasant Surprises of Policy Reform”, mimeo Harvard University

Rodrik, Dani (2007) *One Economics, Many Recipes*, Princeton University Press.

Rodrik, Dani and Arvind Subramanian (2004) “From “Hindu Growth” to Productivity Surge: The Mystery of the Indian Growth Transition”, IMF Working paper.

Rodriguez, Francisco (2007) “Cleaning up the kitchen sink: growth empirics when the world is not simple”, mimeo Wesleyan University, available at [http://frrodriguez.web.wesleyan.edu/docs/working\\_papers/cleaning\\_up\\_the\\_kitchen\\_sink.pdf](http://frrodriguez.web.wesleyan.edu/docs/working_papers/cleaning_up_the_kitchen_sink.pdf)

Williamson, John (1990) *Latin American Adjustment: How Much Has Happened?* , Washington DC: Institute for International Economics.