Anticipating future growth potentials A policy-oriented consolidation of key methodologies May 2017

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1 Structural change as a driver of growth and innovation

The debate about the main determinants of growth, competitiveness and innovation has always been at the heart of development economics, and more specifically, the concept of structural change and diversification has played a central role. How the composition of economic sectors changes over time and what patterns of specialization emerge are crucial issues for productivity growth, technological upgrading and hence long-term economic dynamism. Structural change is uniquely considered *"as a central feature of the process of development and an essential element in accounting for the rate and pattern of growth. It can retard growth if its pace is too slow or its direction inefficient, but it can contribute to growth if it improves the allocation of resources"* (Syrquin 2007,4). Thus, structural change brings new economic players, technologies and products to the market and triggers innovation while accelerating the demise of non-competitive assets - a process ingeniously labeled as 'creative destruction' by Schumpeter (1942).

To date, there is a controversial debate on the validity of attempting to *predict* avenues of future structural change and, one step further, on appropriate policies to *steer* it into a certain direction. This is because, evidently, entrepreneurs are the main drivers of structural change. When investing financial, technological and managerial resources into new business ideas, they take risks, expand existing or create new demand, challenge incumbents and in the process change the structure of an economy. Policymakers can seek to align such market-induced structural change with broader societal objectives, such as those related to environmental sustainability. Often, this implies moving from short-term, commercially viable technology options favoured by markets to longer-term solutions that may be more expensive yet in line with anticipated future opportunities, as e.g. in the case of renewable energy sources. For such policies to succeed, evidence-based scenarios of future growth potentials can serve as a platform to bring the relevant stakeholders to the table, facilitate coordination and make the necessary pre-competitive investments. This leads us straight into the central issue addressed in this paper: *What are relevant theory-based predictors of future competitive advantages and how can they be effectively applied in guiding real world policy choices?*

In answering this question, our paper makes three essential contributions meant to advance the debate:

- We will assess the strengths and weaknesses of various contemporary methodologies and lay the foundation for a consolidated approach of identifying future competitive advantages.
- In doing so, we will factor in the growing role of disruptive structural change: If indeed we are faced today with radical structural change that arrives fast, impacts virtually all economic sectors across the board and disrupts the prevailing techno-economic trajectory (as seems to be the case with both decarbonization and digitalization), what then are the methodological implications for predicting future competitive advantages?
- We will highlight the necessity of embedding evidence-based approaches of measuring competitiveness and anticipating its future direction into a political economy framework that connects analytical tools to societal objectives (normative level) and to implementation capabilities (institutional level).

On a terminological note, throughout this paper both the terms 'comparative advantage' and 'competitive advantage' will be used. While this is unavoidable simply for practical reasons (as both terms feature in the various methodologies under consideration), our own preference is clearly in favour of the latter. In both the business development literature (Porter 1990) and the literature on global competition, trade and investment (Dunning 1992; Enright 1998), much emphasis is placed on policy-induced, 'man-made' competitive edges, on structural features of markets (entry and exit conditions), on patterns of demand and intra-industry trade, and generally on ways to combine market-based entrepreneurial search processes with pro-active policy support. Such a perspective seeks to integrate elements of a country's given resource endowment with elements rooted in capabilities created by history and policy, thus emphasizing the importance of context-specificity. This is clearly in line with the findings of evolutionary theory of economic change (Nelson/Winter 1982), specifically its emphasis on cumulative causation leading to self-reinforcing techno-institutional trajectories: Initial investments, which are often historically contingent, constitute sunk costs and create network effects and increasing returns, which favour path-dependent investments. Resulting patterns of specialization thus are not explicable on the basis of factor endowments alone. Likewise, the 'new trade theory' (Krugman 1980; Krugman 1991) essentially invokes economies of scale and network effects in explaining increasing intra-industry specialization among nations with similar factor endowments.

Against this backdrop, divergent productivity potentials between industries coupled with significant empirical evidence for technology spillovers make a strong argument for policies aimed at stimulating technological learning. Empirical evidence shows that creating competitive advantages is feasible: A proactively intervening industrial policy can, under the right circumstances and if judiciously applied, influence in which industries a country will develop strong growth potentials and future competitive edges (Rodrik 2007).

Yet, as emphasized above, even preceding the thorny issues of policy design and practice, the question emerges of exactly how promising economic sectors can be identified. This issue is at the heart of this paper. In recent years, several methodologies have been suggested which

exhibit complementary features and would seem to offer potential for consolidation. If this can be achieved, the analytical foundation for targeted industrial policies could be made both more evidence-based and more effective.

2 Key methodologies to identify competitive advantages

The following subsections present the rationale and theoretical underpinnings of five relevant methodologies to identify competitive economic sectors/industries for active policy promotion. The selection is based on three criteria. All five approaches

- emphasize specific determinants of competitive advantage
- provide practical methodologies and tools based on well established bodies of research, and
- have exerted significant impact on the policy discourse related to economic development.

As we will show, they are complementary in nature thus allowing a combination of tools in designing and implementing evidence-based industrial policy.[1] Section 2 is largely descriptive in nature and sets the stage for a comparative assessment of the relative strengths and weaknesses - and ultimately a consolidation - of these approaches, which will follow in section 3.

2.1 Growth identification and facilitation framework

We start our review with one of the most recent contributions, i.e. the growth identification and facilitation framework developed by Lin/Monga, which has rekindled the debate on suitable methodologies for pinpointing economic sectors/industries with promising development potential. The approach was developed in various publications, starting with initial thoughts in Lin/Chang (2009) which were subsequently formalized in Lin/Monga (2010) and Lin (2012, 2012a). We will draw on these sources as appropriate.[2]

Lin/Monga build essentially on Ricardo's concept of comparative advantage which they advance by introducing the notion of *latent* comparative advantages, proposing that governments should promote those industries in which a country is likely to develop a comparative advantage in the future, as suggested by the historical experience of successful similar countries. Lin/Monga argue strongly in favour of putting factor endowments at the center while also recognizing the need to sharpen and promote existing endowments with

[1] While being based on the above specific criteria, the ultimate selection of methodologies itself leaves room for debate and judgement. Additional methodologies have been proposed and could also be considered as done e.g. by Radosevic (2017, forthcoming) in the more specific context of assessing the European Union's 'smart specialization' concept.

[2] Lin/Chang (2009) was published in a debate format. When referring to this source, we will ensure attribution of individual views to each of the authors, respectively.

light-handed government interventions. On the one hand, they emphasize that profit maximizing firms will only then choose their industry and technology in accordance with comparative advantages, if the relative abundance of factors is reflected in their relative prices - hence an efficient market mechanism is critically important. On the other hand, firms assuming a pioneering role in a new industry of a developing country usually are quite far away from also being global pioneers, i.e. they cannot apply patents in order to gain a temporary monopoly position and retain parts of their rent. Lin/Monga thus argue that further incentive-creating government interventions can be justified. Specifically, these should be in the nature of lowering entrepreneurial search costs through the provision of risk-reducing information, the creation of hard and soft infrastructure in line with new capital and skill requirements, and direct support to risk-taking entrepreneurs rewarding their first-mover role (Lin/Monga 2010, 5-7).

Discussing historical experiences, Lin/Monga claim that overambitious goals were the key reason why governments in developing countries often failed when trying to proactively support desired industries: Too often, perceived 'winners' were picked despite the fact that they did not comply with a country's latent comparative advantage. Political aspirations to promote capital- or knowledge-intensive industries in poor countries were doomed to fail, because their required endowment with capital and skilled labour were "comparative-advantage-defying" (Lin, in: Lin/Chang 2009, 487).

Lin/Monga argue that developing countries were generally more successful when governments targeted mature industries in countries with similar endowment structures and only slightly higher levels of development. This comparative historical perspective helped governments to identify the *latent* comparative advantages that were *inherent* in their own industries (based on national factor endowment structures) so that little support by industrial policy was sufficient for these industries to quickly gain competitiveness. Future industrial potentials are seen as being "*endogenous* to the country's endowment structure" (Lin, in: Lin/Chang 2009, 485-486; emphasis in original), with the consequence that the role of government policy is confined to the provision of gradual upgrading support. Specifically, Lin/Monga suggest promoting industries, which have been proven drivers of growth in similarly endowed countries. To this end, they propose a number of concrete steps to be taken by policy-makers in developing countries (Lin 2012a).

2.2 Product space analysis

A different approach for identifying competitive advantages has been put forward by Hausmann/Hwan/Rodrik (2005), Hausmann/Klinger (2006) and Hidalgo et al. (2007). Building on evolutionary economic theory, they highlight how new technological capabilities gradually evolve based on spillovers from previously existing capabilities. A country's current export structure would thus reveal potential candidates for future competitive advantages that build on technologically related assets.

Hausmann/Klinger's (2006) model of the product space builds on the hypothesis that if a pair of products require similar infrastructure, technology, capital, institutions or skills, they are likely to be co-produced. Diversifying the industrial structure of a country is seen as easier, the more of the already existing specific assets and capabilities from 'nearby' products can be capitalized on, i.e. there is an explicit element of path dependency. Assuming that countries move through the product space by developing industries that can profit from technology spillovers, it is considered more difficult for poorer countries to diversify their exports and enhance their level of product sophistication than for countries already exporting a greater variety of products. Thus, poor economies risk getting locked into a 'lonely' part of the product space where the distance to new industries is large and further welfare-enhancing structural transformation becomes challenging.

Therefore, proximity and the structure of the product space matter. More specifically, a country's position within the product space is considered as having significant implications for its patterns and speed of structural transformation. The fact that the product space turns out to have a very densely connected core region and a periphery region with less connected products helps explain why some countries face barriers in upgrading their productive structure. It becomes important to balance proximity and upscaling potential of a product, and to steer the economy into denser parts of the product space.

Moreover, industrial policy measures aimed at promoting industries identified as being relatively easy to reach should acknowledge two types of externalities accompanying structural change (Hausmann/Klinger, 2006): First, new market entrants can profit from successful pioneer firms that have proven the economic viability and competitiveness of an activity and created dedicated capacities in terms of infrastructure, technology, knowledge, information etc. (*intra-industry spillover*). Second, as firms in other industries can learn from the experience gained in a certain sector and adopt, adjust and enhance technologies, every new industry 'shortens the distance' to other products, which may be produced in different industries (*inter-industry spillover*). Compensating pioneer firms that accept the challenge and 'try their luck' in a chosen sector for these externalities thus constitutes an important part of a successful intervention strategy.

2.3 Technological life-cycle approach

The concept of entrenched, historically shaped technological trajectories also informs the methodology developed by Keun Lee. Departing from the recognition that technologies have distinct life-cycles, i.e. go through phases of rise, maturity and decline, Lee (2013) presents a dynamic approach of identifying potential competitive advantages. Based on empirical evidence largely drawn from Asia, he suggests specializing on technologies that have short life-cycles – arguing that by strategically picking such technologies, exposure to competition from more advanced incumbents can be reduced.

His methodology is essentially targeting middle-income countries within a catch-up scenario. Specifically, it seeks to address the risk of countries entering a 'middle-income trap' in which previous growth spurts cannot be sustained. In such a scenario, middle-income countries are not yet capable of competing with more sophisticated producers in mature economies, while being no longer able to meet low-cost competition from poorer countries. The latter aspect is reinforced by the 'fallacy of composition' or 'adding up' syndrome *"that occurs when all developing countries flood the market with similar goods … thus reducing the relative price of these goods and making the sector less profitable"* (Lee 2013, 6). As a result, the 'low road' to competitiveness (competing on low-cost, low-skill manufacturing) is effectively being closed and the challenge is to gradually move into a pathway based on exploring new technological domains.

Lee's central argument evolves around the concept of technological life-cycles and posits that in times of paradigm shifts, in particular in short-cycle technologies, emerging economies are faced with a unique window of opportunity: *"Short-cycle technology-based sectors matter because these sectors are where new opportunities tend to emerge more frequently and are also where more profitable business is available with lower entry barriers"* (Lee 2013, 172). Also, there are less encounters with the technologies of advanced countries, fewer royalties to pay, and the possibility of first-mover advantages associated with product differentiation. Thus, gradually entering into sectors where technologies become obsolete more frequently leads to technological inter-sector diversification, increases leapfrogging possibilities, and promotes the localization of knowledge creation and diffusion. Due to the subsequent improvement of their technological capabilities, local firms can then upgrade and move towards technologies with longer cycles or greater originality, so that the investments into short-cycle technologies can be considered a strategic "detour" (Lee 2013, 22).

Furthermore, dominant incumbents frequently adopt conservative strategies of neglecting new technological threats and seeking to further exploit their existing innovation rents. The result is a 'competence-destroying discontinuity' that new entrants can turn into a competitive advantage.[3] Three possible catch-up avenues are being distinguished: path following (imitating technological leaders), path skipping (following technological leaders yet accelerating the process by skipping some of the stages taken by earlier leaders) and path creating (leapfrogging, i.e. exploring entirely new technological fields).

2.4 Value Chain Analysis

The approaches reviewed so far take different perspectives on how to identify future competitive advantages based on an economy's current capabilities. At the same time, they all share one implicit assumption: If a country has the right endowments, including technological

[3] Without developing an elaborate methodology, Ha-Joon Chang advocates a similar approach arguing that *"it is simply not possible for a backward economy to accumulate capabilities in new industries without defying comparative advantage and actually entering the industry before it has the ‚right' factor endowments"* (Chang, in: Lin/Chang 2009, 491).

and entrepreneurial capabilities, it can diversify into hitherto new products and start trading them. Value chain research casts doubts on this assumption. It shows that trade is increasingly organized by orders from of large international corporations that specify exactly what is to be produced how, when, and in which amount (Gereffi/ Korzeniewicz 1994). Whether firms (and countries) can embark on a new export activity and how easily they can accumulate new capabilities to move towards activities of higher returns and value added thus largely depends on their contracts with those corporations.

With the rising importance of economies of scale in production and decreasing transportation costs, global production processes are increasingly being sliced up into specialized stages of production, and investors seek locations to optimize the cost of production of each and every stage. The result is a functional and geographic unbundling of production (Baldwin 2012). More than half of today's trade in goods and close to three quarters of trade in services are accounted for by intermediate goods and components serving as inputs for further processing (Miroudot et al. 2009). The international corporations that dominate these production processes have been called 'lead firms'. Lead firms typically concentrate on a few core competencies which generate the highest value-added and, subsequently, rely on suppliers to take care of the non-core competencies. To guarantee that their suppliers produce according to the quality standards and consumer preferences prevailing in more sophisticated markets and ensure a friction-free flow of materals along the various stages of the value chain, the lead firms predefine many aspects of production including quantities, delivery times as well as technical, environmental or social product and process standards. Put differently, they "*set and/or enforce the parameters under which others in the chain operate"* (Humphrey/Schmitz, 2004, 96).

Such governance of value chains may happen in diverse ways and entail different benefits and risks for local producers (Gereffi/Luo 2014). There may be constellations where global contractors connect local firms to hitherto inaccessible international markets, make new technologies available and even actively support their suppliers in upgrading their capabilities and increasing their profits; but there may also be constellations in which local firms find themselves locked into low-revenue tasks, where lead firms systematically try to squeeze their margins and shift market risks onto their suppliers. Policymakers must therefore understand the respective market constellations as well as the strategic interests and actions of international lead firms.

Whether integration in global value chains becomes a driver of competitive specialization, technological learning and productive upgrading, and whether suppliers can capture a decent share of the overall rent, depends on a range of factors including the complementarity of lead firm vs. supplier assets; the complexity of transactions and codifiability of information; the capability of suppliers; the predictability of market trends; the relative importance of specific investments; and the quality of institutions in the host economy (for a detailed overview see Altenburg 2006). For example, the suppliers' bargaining power and upgrading opportunities increase when they possess scarce capabilities; when the number of local competitors is small; or when trust-based, long-term relationships are needed because parts of the contacts cannot

be codified in contracts. Conversely, their situation weakens when they are easily substitutable; when they need to make customer-specific investments that increase the cost of switching to other customers; or when output markets are subject to strong fluctuations and lead firms use subcontractors to pass on market risks. Moreover, suppliers may see their upgrading option restricted when lead firms prevent them from adopting higher-value functions that the latter regard as their own core competency (Schmitz/Knorringa, 1999).

2.5 Technology Foresight

The technology foresight approach takes an important additional step by adopting a principally open perspective on the whole menu of available technology choices. Essentially, it provides a set of tools *"for collectively exploring, anticipating and shaping the future"* (Cassingena Harper 2013, 6) within an overall scenario of high uncertainty and limited predictability of future economic and technological trends.

Indeed, identifying potential competitive advantages invariably involves a high degree of uncertainty, above all in an environment characterized by widespread policy interventions and by waves of disruptive change that tend to invalidate both historical patterns of development and trend extrapolations. Different foresight methodologies, instruments and implementation practices have been developed over time which all, though in various configurations, combine data analysis and expert knowledge. Considering the high degree of uncertainty that is inherent in the anticipation of emerging trends in technologies and markets, expert opinion plays a particularly important role in foresight exercises. Hence, we can generally observe a *"wide participation of a large number of stakeholders and experts, namely, the government, science, industry and civil society"* (UNIDO 2005, vi).

While not rigorously codified and more in the nature of a soft, qualitative approach, technology foresight has evolved over time and is often positioned today as integral element of an innovation system designed to respond to uncertainty. In this perspective, technology foresight can be considered as an instrument aimed at overcoming coordination deficits between fragmented actors: *"Foresight could be seen as reducing uncertainty by enabling creation and pooling of knowledge. Without an intervention firms might dissipate their technological efforts over too wide a range of activities and fail to achieve critical mass"* (Cassingena Harper 2013, 9). The two central contributions of foresight exercises to societal search processes thus lie in the systemic coordination of a multitude of actors and in the provision of a shared assessment and vision going forward, especially in times of disruptive change when linear extrapolations from the past provide little guidance – or put differently, in creating a 'national project' to direct structural change and transformation which can be regarded as a key element of an effective industrial policy (see also section 3.2 below).[4]

[4] More recently, specifically in dealing with global or regional climate change and energy scenarios. also 'backcasting' methodologies, i.e. exploring the technological implications and preconditions of meeting long-term targets are increasingly applied and translated into technology roadmaps (DDPP 2015; IEA 2014).

3 From methodologies to policies

In the preceding section, we have reviewed five different methodologies which have been developed to identify an economy's potential competitive advantages. To varying degrees, these methodologies are rooted in economic theory ranging from new structuralist to more evolutionary concepts, and from macro perspectives to technology and business orientations. All five approaches clearly seek policy relevance, i.e. beyond mere theorizing they aim at providing a practical apparatus meant to equip policy makers with effective tools for promoting structural change towards enhanced competitiveness.

In section 3, we will now take a step towards a possible consolidation of the approaches presented so far. We will argue that the various methodologies can be of a complementary nature and, by building on each other in an eclectic approach, there are significant synergies to be gained. Furthermore, we will emphasize that the various, essentially technocratic tools must be embedded in a policy implementation process that needs to meet a number of critical preconditions in order to be effective.

In this context and above all for the approach to be policy-relevant, it is essential to broaden the perspective beyond just targeting growth, productivity and competitiveness. Any meaningful methodology, i.e. any analytical tool that seeks relevance for real world policy choices, must be capable of responding to multiple societal goals encompassing e.g. also social inclusion and environmental sustainability. Industrial policy, like any other policy domain, is normative in nature and cannot afford to ignore the complexity of goal systems with both their synergies and trade-offs (Altenburg/Lütkenhorst 2015, 7ff.).

3.1 Consolidating various methodologies: A synthesis

Obviously, the sequence in which the various approaches were presented in section 2 was chosen deliberately. Combining conceptual novelty with a pragmatic implementation roadmap, the growth identification and facilitation approach has made a pivotal contribution to the debate on establishing and promoting future growth opportunities in developing country contexts. We will thus use it as our reference point for the consolidation sought in this section and build upon the foundation it has laid.

At its very core, the approach advocated by Lin/Monga suggests to pinpoint *latent* comparative advantages in industries that correspond both to a country's own endowment structure and, in a historical perspective, to upgrading potentials that have proven to be realistic in countries with higher levels of income per capita. During the ensuing debate, a number of problematic aspects have been raised which are briefly recapitulated below:

- At the empirical level, several authors have pointed to the strong evidence of sustained dynamic growth in countries (such as South Korea and China) that have aggressively promoted industrial sectors far removed from their existing or even latent comparative advantages (Chang, in: Lin/Chang 2009, 497; Rodrik 2011, 228). It is thus argued that the importance of new technological and policy capabilities and spillovers *originating from* a process of strategic, non-incremental risk-taking (Lim 2011, 303) is underestimated, i.e. that enhanced capabilities may well be created *as a result* of setting ambitious targets for economic diversification.
- The reference to slightly more advanced countries as comparators has been challenged, as their industrial structure and successfully growing sectors may themselves have been, at least to some extent, the result of policy distortions (Pack 2011, 298). Furthermore, the use of *per capita* income levels as yardstick has been questioned in view of its limited value as a predictor of available entrepreneurial and technical skills or the government's capability to create the institutional foundations for the necessary transformation.
- Venturing into new technologies poses difficult issues of absorption and adaptation, so that it cannot be assumed *"that technologies are equally accessible and can be efficiently operated by all producers"* (Amoako 2011, 296). This aspect implicitly points to the challenges of entering existing value chains in which power asymmetries between lead firms and new entrants may stifle opportunities to upgrade. When newly emerging market opportunities are seized by pioneer firms that are able to build first-mover advantages, entering the market at a later stage becomes increasingly difficult.
- At the most fundamental level, the Lin/Monga approach is considered as too static and incremental, thus limiting its responsiveness to entirely new framework conditions: *"What happens if the current circumstances have changed so fundamentally that a comparison with the past is less informative (for example, … new communications technology … new global rules and institutions, climate change)?"* (te Velde 2011, 260).

In what follows, we will review how the other approaches exposed in section 2 may be able to address some of the arguments raised above. In contrast to the growth identification and facilitation framework, the product space methodology developed by Hausmann/Hidalgo et al. does not suggest adapting success stories from other countries as much as searching for possibilities inherent in the domestic economy itself. Building on evolutionary economic theory, it highlights how new technological capabilities can be gradually derived as a result of spillovers from already existing ones. The approach starts from a stocktaking exercise during which countries first examine their current position in the product space and then identify specific opportunities of 'jumping' to 'proximate' goods. The emphasis is thus more on earlier skills and capability investments in related industries than on endowment-based factor cost constellations.

In terms of upgrading and diversification strategies, both Lin/Monga and Hausmann/Hidalgo advocate a gradual evolution rather than disruptive shifts in production patterns. However, the

latters' network analysis makes a distinction between more and less desirable product categories and suggests that developing countries at the periphery of the product space need to make rather large, challenging jumps in order to reach high-productivity products that may put them on a path towards income convergence with the richer economies at the core. To encourage the necessary entrepreneurial risk-taking associated with new activities, both approaches put equal stress on the importance of compensating pioneer firms.

While widely acknowledged as an innovative approach to determining competitive advantages, the product space methodology has been criticized on technical grounds specifically with regard to the availability and interpretation of trade data. It is pointed out that the reference to trade data as a proxy for a country's production structure may be tenuous, that trade classification systems often are not skill-specific, and that other important factors like trade policies and market size are insufficiently reflected (Radosevic 2017, forthcoming). Similarly, further context-dependent dimensions like e.g. geographic conditions, the quality of institutions or entrepreneurial capabilities are not adequately considered. Most importantly, *"the logic … is that only domestic factors are embodied in a country's export … Given the nature and scale of processing trade, this assumption does not hold necessarily true … in global supply chains"* (Fortunato/Razo/Vrolijk 2015, 13): Whether an exported computer incorporates the latest or an outdated technology, and whether it has been developed or just assembled in a country makes a big difference in terms of spillover potential. This is where the next two approaches come into the picture – implicitly in the case of the technology life-cycle approach and explicitly in the case of value chain analysis.

Lee's technology life-cycle approach, just like Hausmann's, is evolutionary in nature. However, the characteristics of products (and their underlying technologies) as a source of competitive advantage are specifically linked to dynamic life-cycle considerations. Based on the lead question of how catch-up processes can be sustained over time, Lee proposes *trade-based* specialization strategies for low-income countries as opposed to *technology-based* specialization strategies for middle-income countries, and suggests a growth trajectory that explores *"new opportunities in emerging technologies that rely less on existing technologies that are most likely already dominated by incumbent advanced countries"* (Lee 2013, 30), particularly as mature technologies may only offer low-wage niches with limited growth prospects. Based on this argument, Lee recommends for catch-up countries to specialize in shorter-cycle technologies which are characterized by a fast turnover, rely less on existing technologies and capabilities, and thus *"may lead to the faster localization of a knowledge-creation mechanism"* (Lee 2013, 19). However, this begs the question if a sequence of shorter-cycle technologies (as they are likely to be subject to frequent changes) will actually translate into a coherent and sustainable long-term development pathway.

Interestingly, Lee himself considers his approach to be directly complementary to that of Lin/Monga by adding short-cycle technology as a specific criterion for specialization. Similar to both Lin/Monga and Hausmann/Hidalgo, he also calls for targeted public support. Since entering into areas of emerging technologies is associated with risks, as e.g. the possible lack of an initial market for the new technologies, government assistance is suggested regarding

investment in R&D capabilities and encouragement of risk-taking. Lee concedes that a gradual and cautiously phased transition into new sectors should serve as a starting point before *"it becomes prudent to take the risk of leapfrogging … and thus reducing catch-up time"* (Lee 2013, 227). At the same time, there are also complementarities to certain elements of value chain analysis, such as the recognition that developing countries are forced to compete harder than advanced economies for a place in global value chains.

The three approaches compared so far share some common characteristics that point to limitations regarding their application in real world policy settings and to the risk of arriving at unrealistic conclusions:

- All three methodologies are 'mechanistic' in the sense that they advocate the reliance on formalized analytical tools (latent comparative advantage, product space, technological life cycles) regardless of the specific country context. Accordingly, they do not adequately capture institutional and policy capabilities as well as specificities like being land-locked or an island state.[5]
- More specifically, there is a general disregard of the important role being played by neighbouring countries. As underlined by Collier in the context of Africa, the development prospects of a land-locked country depend fundamentally on infrastructural transport investments undertaken by its coastal neighbor, which is why being *"landlocked with bad neighbors"* (Collier 2007, 53) is one of the greatest constraints to building up competitive industries.[6]
- In applying competitiveness analyses across countries mostly by looking at factor endowments, there is a danger of arriving at similar conclusions on the key sectors to be prioritized with the resultant risk of falling into the 'fallacy of composition' trap (Streeten 1982), i.e. recommending a sectoral strategy that may turn out to be self-defeating in terms of overly optimistic assumptions on global demand elasticities.

Against this backdrop, the value chain approach can deliver some of the required context-specificity. One of its key advantages is the emphasis on real world conditions for successful integration into global inter-firm transactions. Not being spatially blind, it can well capture factors related to geographical proximity. In addition, compared to the three approaches compared so far, value chain analysis explicitly addresses the challenge of exactly how to overcome power asymmetries in new technological and product spaces in which existing firms have already built up expertise, capabilities, market presence and supplier networks.

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[5] As explicitly stated by Hidalgo with reference to the product space approach, *"certain products, e.g. Rwandan prawns or Kenyan ivory, are listed as "export opportunities" … despite obvious geographical or political impediments to their production and export. The tables are meant to indicate relationships between capabilities, in order to be used as one tool among many in guiding production decisions"*(Hidalgo 2011, 20).

[6] As has recently been shown (Bahar/Hausmann/Hidalgo 2014), the chances of a product being successfully exported by a country rise dramatically (by 65 per cent) if it is already exported by one of its neighbors.

In terms of identifying upgrading potentials, value chain analysis calls for a more granular approach than looking at entire industries. The emphasis is placed on specific processing stages as well as business functions (such as R&D, design, assembly, packaging, marketing) within globally dispersed production systems. Trade flows are thus essentially broken down into a multitude of smaller 'tasks' that can be unbundled and linked to corresponding infrastructural and skill requirements (UNIDO 2009, 18-20).

However, also value chain analysis remains subject to an important 'single loop' caveat[7] insofar as it is essentially based on an analysis of prevailing constellations, thus limiting the relevance of its conclusions for future scenarios. This becomes particularly important when technological and/or institutional change is disruptive and fast.

This is where technology foresight enters the picture. In its various methodologies and tools, neither past experience, proximities or spillovers, nor issues of power and governance are placed at the center of attention. Within a dynamic, future-oriented perspective, technology foresight adopts a 'double loop' approach, i.e. is not confined to a given context, but can fundamentally question whether currently prevailing conditions will remain as they are. Foresight activities are used to passively predict, reactively manage and proactively create a still uncertain future with a focus on ways to steer development towards a desired direction. This future-oriented approach is able to identify drivers, anticipate what might happen under certain circumstances, and examine variations and interactions. It helps to predict and anticipate emerging opportunities and problems, and thus can identify priorities and design commensurate strategies.

In Table 1, we provide a comparative synopsis of the approaches discussed in this paper in which their defining features are recapitulated. Clearly, as argued above, they can be conceived as building upon each other, adding complementary layers of analysis and reflection and thus lending themselves to a *sequential application*. Starting with an identification of latent comparative advantages as assessed against the historical experience of comparator countries, and considering both the broader capabilities created so far and the potentials for technological spillovers, an initial list can be generated of industries providing seemingly reasonable candidates for upgrading. This can be considered as an evidence-based menu of options that needs to be narrowed down further by subjecting it to a 'reality check': Considering given power relations in global value chains, which of the industries stand a reasonable chance for insertion and upgrading? At the same time, only such industries deserve to be supported that exhibit a long-term potential for sustained growth. Drawing on tacit stakeholder knowledge with a view to anticipating future technological trends, a roadmap could be designed for a realistic development path.

[7] According to Argyris/Schön (1978), 'single loop' learning means that actions are adjusted when they do not lead to the desired result, whereas frame conditions are considered as given. In contrast, 'double loop' learning takes place in case adjusting actions is insufficient and frame conditions must be revised as well.

Table 1: Synoptic presentation of methodologies to identify competitive advantages

Highlighted determinants of diversification and upgrading	Growth identification & facilitation framework (Lin/Monga)	Product space analysis (Hausmann/Hidalgo et al.)	Technological life-cycle approach (Lee)	Value chain analysis (various authors)	Technology foresight (various authors)
Basic factor endowments and historical experiences of slightly more advanced countries	x				
Technological proximity to previously created (export) capabilities		x			
Length of technological life-cycles and intensity of competition with incumbents			x		
Power constellations within value chains affecting conditions for entry, upgrading and rent capture				x	
Data analysis, modeling and pooling of expert knowledge on 'likely futures'					x

Source: Authors

Overall, the merits of applying a particular approach depend essentially on the specificity of a given development context. In this context, two criteria deserve particular attention.

First and foremost, there are good reasons for linking different approaches to different levels of economic development. Arguably, at early stages of economic development when the relative weight of factor endowments is relatively high, trade-based specialization should be in the focus, whereas the risks taken in 'jumping ahead' are lower at later stages when significant technological, institutional and policy capabilities have already been acquired and mastered. This argument is acknowledged by both Lin/Monga and Lee.

Second, it would seem that methodologies placing less emphasis on technological continuity and past experience are a logical response to *disruptive structural change*. While key dynamics of competitive integration into world markets have remained largely unchanged, there are strong indications of more radical, path-disrupting changes going forward. In emerging scenarios of fast and radical transformation in framework conditions, a premium is placed on embracing the future and a penalty on sticking to the past. As Lee puts it when discussing 'competence-destroying discontinuity': *"The strategy of leapfrogging makes more sense during a paradigm shift when every country or firm finds itself faced with the challenge of dealing with a newly emerging techno-economic paradigm"* (Lee 2013, 18).

At present, arguably the most fundamental paradigm shift stems from *global climate change imperatives* and related international agreements that require all countries – albeit in varying degrees – to commit to decarbonization of their economies and future technology corridors

(DDPP 2015). The defining features of this transformation towards sustainable production and consumption patterns are the high uncertainty and long time horizons involved, as well as the need to create new and disrupt old pathways (Lütkenhorst et al. 2014). Such characteristics cannot be adequately captured by methodologies based on the historic development experience of comparator countries (Lin/Monga) or the infrastructure, technology, capital, institutions or skills created in existing sectors (Hausmann/Hidalgo). Any radical economic paradigm change, such as the shift from fossil to renewable sources of energy, is likely to turn previously valuable assets and capabilities from 'nearby' products into 'stranded assets' (Carbon Tracker Initiative 2013) that retard the necessary transition.

At the same time, there may be significant benefits to be reaped for developing countries positioning themselves strategically as early adopters of a low-carbon transformation (Porter/ van der Linde 1995; Ambec 2011). Such benefits include the early acquisition of the technological and managerial capabilities required for innovative low-carbon technologies, the generation of future export potentials in increasingly regulated markets (along the lines of measuring carbon footprints), and avoiding the risk of a 'carbon lock-in' (Unruh 2000) into technologies that are bound to decline and will possibly soon be subject to international *de jure* or *de facto* bans (Altenburg/Lütkenhorst 2015, 89).

In addition to climate change imperatives, there are likely to be fundamental implications arising from the *digital revolution* in its various manifestations. While the speed and magnitude of incipient changes are still subject to debate, it is beyond doubt that the patterns of international specialization are to some extent being redrawn: *"If you take most of the costs of labour out of the equation by installing robots and other types of automation, then the competitive advantage of low wages largely disappears"* (Brynjolfsson/McAfee 2014, 184). The result would be a growing trend towards 'reshoring' of previously outsourced labor-intensive manufacturing operations and thus significantly reduced scope for one of the most powerful avenues of creating competitive advantage for latecomer economies in recent decades.

If the current emphasis on disruptive structural change is justified – and there is indeed mounting evidence that we are faced with long-term fundamental transformation forces at work – then we will have to revisit how future competitive advantages are identified. This would essentially call for an integration of different strands of research (economic, technological, environmental) that to date are largely proceeding in parallel without much cross-fertilization. In combination with technology foresight tools, value chain analysis could provide an effective conduit for assessing the implications of disruptive change. Specifically, this applies to understanding the emerging trade implications of new carbon footprint compliance standards as well as to the digital technology-driven regionalization and shortening of previously global value chains.

3.2 Adopting a political economy perspective

As mentioned above, a crucial aspect in assessing the methodologies reviewed in this paper is related to their implementation under realistic policy conditions. Invariably, these are *normative* in nature and are fundamentally shaped by a multitude of broader societal goals that go beyond issues of competitiveness. They may reflect both additional economic objectives (e.g. related to employment, income and asset distribution, or the developmental impact of particular economic sectors[8]) and further non-economic objectives (e.g. related to social inclusion or environmental protection). Political boundaries thus stem from the fact that economic policy-making is inevitably guided by multiple societal goals and targets, which more often than not involve harsh trade-offs and are difficult to reconcile. This is easily overlooked when considering industrial policy just in the narrow economic space of productivity growth, competitiveness and patterns of specialization. Any specific industrial policy involves a delicate normative balancing act, which is further exacerbated in developing countries where the borderline between market and non-market governance structures is typically rather fuzzy (Cimoli et al. 2009, 21).

The methodologies themselves deliver a *technical basis* for analyzing current and prospective competitive advantages. While they do have some explanatory value, they provide only partial solutions and limited specificity when it comes to identifying commercially viable business opportunities and taking concrete investment decisions. What they help to establish are broad directions and 'corridors' for future competitive advantages that can guide entrepreneurial search. In this perspective, both profit-seeking business decisions and industrial policy decisions aimed at overcoming coordination failures are mutually connected in the same 'discovery process' (Rodrik 2007).

The actual application of the various analytical tools is embedded in complex political negotiation and decision-making processes that are shaped by vested and emerging interests, power asymmetries between different stakeholders, and often conflicting objectives. Moreover, societal values influence what kind of industries merit public support, e.g. in the case of risk-prone technologies or cultural industries. Hence, decisions about support-worthy industries are never purely technical or rational. Even well-intentioned, evidence-based policy making takes place within political boundaries that subject competitive search processes to the value judgements and self-interests of different actors: Rent seeking behaviour of enterprises is a reality as much as political capture which sometimes turns economically justified temporary subsidy schemes into long-lived bureaucratic monsters that counteract the intended purpose of incentives (Laffont/Tirole 1991). Rational and effective policy making towards identifying and promoting competitive advantages thus presupposes both the

[8] Indeed, when Rodrik diagnoses a 'premature deindustrialization' of many developing economies, this clearly carries the *normative notion* of a desirable sector-specific pathway, or in his own words: *"These developing countries are turning into service economies without having gone through a **proper** experience of industrialization"*(Rodrik 2015, 3; emphasis added). However, what exactly is considered 'proper' has remained subject to debate.

willingness and the capability of governments to act in support of the common good. Seen against the reality prevailing particularly in developing economies, both assumptions are often heroic (Chang 1996).

The methodologies discussed in this paper need to account for this reality and be responsive to a tangled web of interests, goals and actors – for which they seek to provide a strengthened evidence base. In reality, the creation of new competitive advantages originates from both antagonistic and cooperative relationships between governments, local and foreign firms, a variety of business and financial institutions, and civil society. This is the heart of the concept of embedded autonomy which portrays governments as having to walk a tightrope between independence and engagement: *"Embeddedness provides sources of intelligence and channels of implementation that enhance the competence of the state. Autonomy complements embeddedness, protecting the state from piecemeal capture"* (Evans 1995, 248).

We argue that this concept can serve as an overarching framework when it comes to applying the various methodologies presented in section 2 above. In this perspective, determining potential competitive advantages becomes less an abstract question of *selecting* a specific methodology than a challenge of *applying* complementary features of various approaches within a structured implementation process that reflects the shortcomings of real world politics.

Developmental states (which Evans juxtaposes with predator states) are characterized by the existence of a meritocratic bureaucracy and the presence of transformative alliances based on shared norms and trust between the public and private sectors. Where these basic preconditions are met, the identification of areas of competitive advantage and the design of conducive industrial policies can be interpreted as a joint endeavour *"designed to elicit information about objectives, distribute responsibilities for solutions, and evaluate outcomes as they appear"* (Rodrik 2007, 112).

What is needed is to put in place a *robust and structured process* of societal dialogue and stakeholder consultation in policy design, implementation and learning – a challenge that is as crucial as it is difficult to meet.[9] This paper is not the place to comprehensively address the broader issue of industrial policy making in developing countries. In a nutshell, they are faced with the formidable task of 'inventing' a competitive, inclusive and sustainable future under conditions of pervasive market failures and weak state capabilities. For this to succeed, numerous preconditions and good practice principles have been advanced. We will just highlight three main pillars:

Agreement on a national 'transformation project'

[9] Vidican (2013) provides a factually rich country study of what this entails in the specific case of the emerging solar energy industry in Morocco.

With a view to achieving unity of purpose and coherence of action, the various societal stakeholders need to agree on a long-term, broadly defined transformation project that establishes signposts for a desirable pathway towards future patterns of competitiveness and growth. This would establish a sense of directionality without stifling market-based decisions. Rather, private investors and their entrepreneurial search processes would benefit from well-defined development trajectories (sometimes also referred to as broad 'technology corridors'), within which competitive processes can and should unfold – and in which governments can be important facilitators of consensus-building among stakeholders and can enable distributed knowledge to feed into the chosen development path.[10]

This is turn calls not just for the identification of potentially competitive industries but also for designing a long-term 'policy path' that remains consistent over time. For instance, a government can create markets for green investments (as has been done in many countries through feed-in tariffs for renewable energy) which trigger technological learning effects, economies of scale and decreasing unit costs – and in turn increase the pressure on future governments to continue on the same path.[11] The various methodologies discussed in this paper can be instrumental in helping stakeholders make realistic and evidence-based choices.

Combining policy support with competitive elements

There is ample evidence of how effective industrial policy approaches can be designed by building upon competitive mechanisms. A few illustrative examples will suffice to make the point. In various countries, new product and process standards are derived from proposals and best practices coming from private industry; R&D subsidies are granted only after receiving and assessing competitive submissions from industrial clusters or, in some cases, entire regions; feed-in tariffs (i.e. prioritized and subsidized grid access for renewable energy sources) are applied on the basis of competitive bidding procedures; innovative technologies are piloted in cost-shared private-public collaboration schemes; and importantly, business development agencies provide their services within competitive approaches (e.g. with strict eligibility criteria for enterprises, compulsory co-financing or voucher schemes). This differs fundamentally from earlier rigid, top-down approaches imposed by government fiat.

Stimulating policy learning

There is a potential conflict between identifying future competitive advantages, designing a transformative 'national project' and 'locking in' a specific policy path (or 'corridor of options') on the one hand, and on the other hand being open to necessary policy adjustments

[10] Specifically with regard to the transition towards sustainability, Mazzucato argues that *"the history of technological change teaches us that choosing particular sectors in this process is absolutely critical … the green revolution will not take off until it is firmly picked and backed by the state"* (Mazzucato 2013, 27).

[11] In technical terms, this is referred to as enhancing the 'endogeneity' (Karp/Stevenson 2012) of future policies.

based on results derived from regular monitoring and evaluation. This makes openness to policy learning critically important and calls for the creation of strong and independent evaluation capacities, which are institutionally unbundled from policy implementation and regulatory functions. Enforcing continuous learning can help to move policy-making from a linear to an adaptive frame and eventually trigger a self-enforcing learning spiral. Again, this can be combined with various technical methodologies. At different points in a learning spiral, new competitive spaces, priority sectors and technological roadmaps are likely to emerge which need to be assessed and substantiated. At times, this may call for a look at factor endowments and latent comparative advantages; in other instances, the specific skills and capabilities needed for insertion into an existing value chain may need to be established; or, in contexts of high uncertainty, technology foresight exercises may be required to validate possible scenarios.

In conclusion, this paper argues that (a) a synthesis of the main stand-alone methodologies of anticipating future growth potentials is feasible and adds significant value and (b) there is a basic requirement of organizing a participatory policy process as a framework for effective implementation. Along the various steps of this process, decisions need to be made and risks taken which also implies that inevitably, failures will occur. The latter, however, can be minimized by insisting on cooperative approaches drawing on the manifold sources of distributed stakeholder knowledge and by designing robust policy learning mechanisms. This has the added advantage of keeping political capture in check. The various methodologies discussed in this paper offer considerable discretionary scope for interpretation and private agents will seek to influence policy decisions in their own favor. Allowing all stakeholders from industry, civil society, research and academia to take part in the process can contribute to confining and balancing the various vested interests. This assumes particular importance as transforming an economic structure inevitably has two dimensions: the creation of new competitive industries (where innovative investors lobby for access to incentives) and the flipside of phasing out uncompetitive industries and undesirable technologies (where incumbents lobby for compensation for their stranded assets).

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