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Peru in the global economy: Recent trends and potential diversification strategies

Application of the DIVE tool to support export diversification policies in developing countries

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Table of contents

List of abbreviations

EU	European Union
EXPY	Country sophistication or complexity
HS	Harmonized System
OECD	Organisation for Economic Co-operation and Development
OS	Option Set
PRODUCE	Ministerio de la Producción
PRODY	Product sophistication or complexity
PS	Product Space
RCA	Revealed Comparative Advantage
SITC	Standard International Trade Classification
UNIDO	United Nations Industrial Development Organization
VEED	Valor Estratégico Esperado y Descontado

List of tables

List of figures

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Foreword

Gerd Müller
Director General of UNIDO

Promoting sustainable industrialization (SDG 9) means promoting a virtuous circle of continuous growth, harnessing economies of scale, driving technological innovation and creating backward and forward linkages to other sectors of the economy. Closely connected to sustainable industrialization, SDG 8 stresses the importance of economic diversification based on technological upgrading to boost productivity. Diversification is an integral part of the industrialization process. It lets countries expand their range of goods produced and to add value to their current export basket. This is particularly relevant for developing countries, which often heavily rely on a small number of basic agricultural commodities, energy sources or unprocessed minerals, while only producing a limited variety of manufactured goods.

Through its research and policy advisory services, UNIDO assists Member State governments not only in identifying and setting targets, but also in facilitating the achievement of those objectives. The Global Policy Facility, an innovative funding mechanism, gives UNIDO more flexibility to respond to Member States' request for support. UNIDO leveraged this technical cooperation mechanism to assist the Government of Peru in consolidating the country's diversification policy.

The analytical tool DIVE (Diversifying Industries and Value Chains for Exports) is one of UNIDO's innovative research services. It was developed in collaboration with prestigious academic institutions to enable policymakers to make informed decisions on industrial diversification policies. The successful collaboration between UNIDO and the Government of Peru in applying the DIVE tool through the Global Policy Facility is an impressive example of innovative partnership generating concrete and actionable evidence for informed decision-making.

In this era of multiple crises and the urgent need to accelerate progress towards the achievement of Agenda 2030, policymakers need robust, rigorous, yet user-friendly information for effective decision-making. In line with the spirit of our motto *Progress by innovation*, I reaffirm UNIDO's commitment to our strategic partnership with the Government of Peru and other countries in the Latin America and Caribbean region. We will continue expanding our support for their industrialization agendas, offering practical solutions that drive sustainable development and create a prosperous future for all.

Ana María Choquehuanca de Villanueva
Peruvian Minister of Production

Historically, micro-, small and medium-sized enterprises (MSMEs) have played a fundamental role in Peru's inclusive economic development. Today, these firms represent 99.4 per cent of the country's business sector, contribute 21 per cent to gross domestic product (GDP) and employ over 60 per cent of the economically active population. These factors make MSMEs the most effective vehicle for increasing growth and reducing poverty, thereby assigning them a special economic and social role in driving Peru's development.

Over the years, I have recognized the importance of formulating clear and viable policies based on adequate and reliable evidence as a determining factor for their effective implementation. Therefore, within my role to serve my country, I have been promoting the management, analysis, and facilitation of evidence for decision-making in alignment with promoting MSME development.

The study we have prepared jointly with the United Nations Industrial Development Organization (UNIDO) provides insights on potential targets for Peru's economic diversification policies based on viability criteria, and highlights opportunities for productive development. These insights will undoubtedly facilitate a better understanding of the underlying reasons why our export basket has evolved towards a higher level of complexity over the last 24 years. The pursuit of enhanced quality and innovation standards has enabled greater participation in global value chains. However, plenty of work still lies ahead, considering that large enterprises currently provide the highest contribution to GDP, a scenario resulting from the extensive productivity gaps between the sizes of Peru's enterprises.

The Ministry of Production has invested substantial efforts to generate evidence within the industrial sector in close collaboration with UNIDO through the Programme for Country Partnership for Peru (PCP Peru). This specialized analysis, conducted within the context of PCP Peru, will undoubtedly significantly enhance our understanding of the national and regional productive potential of our country. The findings of this analysis will contribute to the formulation of improved policies for productive development, with a central focus on the well-being of citizens and the promotion and sustainability of companies in Peru.

Each of the conclusions presented in this document is of particular relevance given the current circumstances. They suggest an approach aimed at eliminating bottlenecks and boosting the productivity of enterprises, especially MSMEs. I am convinced that the findings uncovered by this study will allow the public sector, the private sector, and academia to make more focused and effective decisions.

I am honoured to reaffirm our commitment, as the Government of Peru, to continue to tirelessly provide our timely support to the sustainable development of our country. I firmly believe that we can build a more just and equitable country and increase opportunities through public services tailored to meet the excellence expected by our citizens.

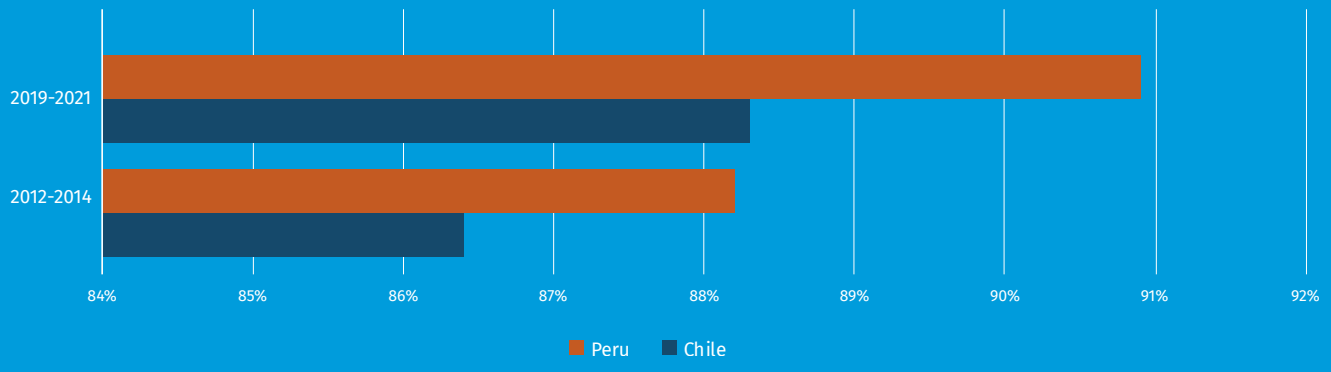
Executive summary

Diversification policy and structural change

Structural transformation is a key driver of sustained economic growth. The transformation of economic systems is a dynamic process during which new and more sophisticated products are added to the country's export basket. This transformative process does not evolve 'naturally' but is the result of a progressive acquisition of a larger and more refined set of production capacities. Market forces play an important role, with private economic agents reacting to price stimuli and to opportunities, consequently engaging in behaviours that drive productive transformation (e.g. investments, specialized training, cost-discovery activities). Yet widespread market failures—such as those prevalent in developing countries—often lock in countries' current specializations and prevent structural change. Active public policies, such as diversification, industrial and innovation policies, could play a crucial role in promoting productive and sustainable diversification.

When we look at countries that have had a successful productive transformation, we find that they did not follow a single one-lane road but pursued different paths towards structural transformation. Many countries adopted a sector-neutral approach—often labelled horizontal policies—which generally aims to facilitate the emergence of new productive capabilities (e.g. human capital or entrepreneurial talent) or to reduce/remove bottlenecks that are common to many economic sectors (e.g. trade barriers and costs, red tape, access to credit). By contrast, vertical policies, i.e. selective interventions that promote specific products or sectors, have been 'taboo' due to the innate difficulties and risks faced by governments that target the 'right' sectors and design and implement the 'right' policies. The stories of successful productive transformations around the globe suggest that the taboo of adopting vertical or selective policies is not completely unjustified (Inter-American Development Bank, 2014). Horizontal policies are crucial for creating the socio-economic fabric that weaves diversification, but might not suffice on their own to promote diversification. Even the case of Chile—often considered a champion of positive integration in the global economy—is indicative of the limits of an almost exclusive reliance on sector-neutral horizontal policies. Chile's economy has deindustrialized in recent decades and the country's export sector, which was the engine of Chile's growth for many

Figure 1 | Commodity exports as share of all allocated product exports



Source: UNCTAD. *State of Commodity Dependence 2023*.

years, has failed to significantly diversify (Bril-Mascarenhas and Madariaga, 2019).[1]

Diversification is particularly important for countries such as Peru which are highly specialized in a few products, mostly in the primary sector (Figure 1).

Well-designed vertical policies based on an explicit assessment of risks[2], as well as on the potential benefits of targeting, could be fundamental in promoting structural transformation through diversification of the production base. The implementation of Peru's National Productive Diversification Plan (Ministerio de la Producción, 2014) builds on these considerations, in particular with the action line aimed at facilitating "the emergence of new engines of the Peruvian economy. It means providing public goods that foster the emergence of new industries and correcting market and State failures which deters their growth".

The need to define priorities and UNIDO's tool DIVE (Diversifying Industries and Value Chains for Exports)

Recent contributions highlight the definition of priorities in industrial policy as an important tool for promoting sustainable economic diversification (Inter-American Development Bank, 2014; Alvarez and Huamaní, 2017). Such tools can help the Government of Peru select potential targets for vertical as well as for horizontal diversification and industrial policies.

We apply UNIDO's DIVE methodology to arrive at findings to inform Peru's policy strategies:

1. by assessing the current level of diversification of Peru's economy with the specific aim of analysing its level of complexity and vulnerability;
2. by studying the characteristics of recent changes in the composition of Peru's production basket. This allows us to assess the ability of Peru's economy to diversify away from its initial specialization relative to other countries with a similar level of development;
3. by identifying sets of products/sectors that represent both desirable and feasible targets for diversification policy. The DIVE tool identifies so-called 'short jumps'—or products that are not yet being exported with a strong specialization but that require productive capabilities that are likely already available in the Peruvian economy—as well as 'long jumps' – or products that represent novel areas for structural transformation. The DIVE tool considers the degree to which a country's diversification strategy is feasible for this latter set of products, which generally represents a more interesting pathway towards structural change (Hidalgo et al., 2007).

The process of prioritization as a first step in the formulation of diversification policies is gaining momentum across developing and emerging economies. Recent analyses have been carried out in Peru and other Latin American countries

[1] Bril-Mascarenhas and Madariaga (2019) report that "*while in 1983, 65 per cent of Chilean exports were minerals, that proportion remained close to or above 60 per cent throughout the 2000s and 2010s; the share of raw mineral exports grew steadily vis-à-vis processed ones, especially in the 2000s and 2010s. Unprocessed commodities more broadly rose from about 25 per cent of the export basket in 1983 to roughly 40 per cent in the 2000s and 2010s*". The reconstruction of the political and institutional process around industrial policy in Chile, according to Bril-Mascarenhas and Madariaga (2019), suggests that selective policies such as the well-known case of the rise of the salmon industry—which the Fundación Chile played a crucial role in—are the exception rather than the rule. The only significant vertical approach to industrial policies was the identification of a potential cluster promoted by the Consejo Nacional de la Innovación para la Competitividad (CNIC).

[2] The adoption of selective industrial policies is clearly associated with risks, particularly in countries with weak institutions. Prioritization tools based on sound methodologies can help limit some of the risks (for instance, pressure by lobbies and excessive discretion in targeting), but the quality of institutions is essential. Government interventions reduce some risks of failure that private actors might face in developing a new industry/sector, but do not reduce all risks of failure. On the other hand, State involvement might also generate new risks such as market distortions, policy capture and corruption. For a comprehensive discussion of the risks of selective policies, see the report of the Inter-American Development Bank (2014).

(see Alvarez and Huamaní, 2017 and Inter-American Development Bank, 2014 for references on the experience of Chile, Colombia and Mexico).[3] The DIVE tool adopts the innovative methodology recently developed by UNIDO based on Coniglio et al. (2021) to better assess the feasibility of specialization in a given product/sector. Contrary to most recent approaches—which a priori define 'unrelated diversification'[4] as being unfeasible, hence discourage any ambitious diversification and industrial policies that target 'long jumps'—the DIVE approach suggests that countries could potentially succeed in targeting some unrelated products (namely those for which the set of ex ante productive capabilities matters less) and, in fact, these new specializations might be desirable for broadening the set of Peru's capabilities and for boosting both the country's economic performance and structural change of its economy (see Box 2 for the main differences between the DIVE tool's approach and those adopting the standard approach developed by Hidalgo et al. (2007) and Hidalgo and Hausmann (2009), which the Peruvian Plan Nacional de Diversificación Productiva, among others, is rooted in). Long jumps might in fact be instrumental for defying a country's static comparative advantage to upgrade its industry and promote society's long-term well-being.

In addition, the DIVE tool provides a set of product-level characteristics for each of the potential target products/sectors (listed in Chapter 4 of the report) which might inform the desirability of Peru to explore these paths of diversification (complexity, feasibility advantage vis-à-vis competitors, recent trends in global demand, number of countries with a specialization in the product, Peru's export potential measured as a weighted import penetration index, etc.).

A snapshot of the main findings and results

- Peru's export basket—identified as the set of products with a revealed comparative advantage (RCA) higher than unity for at least two years out of a total of three years—consists of 153 products in the Harmonized System 4-digit nomenclature. The country's export basket is characterized by a low level of product sophistication—the index captures how advanced or complex Peru's production is, proxying the level of productivity associated with the country's bundle of products—equal to USD 9,706 in the period 2017–2019. This figure is well below both the world average (USD 15,064) and the average of upper middle-income countries (USD 14,177).
- The overall level of country vulnerability to competition from other countries is high. Peru's current export specialization ranks among the 30 per cent most vulnerable countries (73rd percentile of world distribution). The set of products Peru specializes in consists of goods with a relatively ubiquitous specialization, and which recorded a high number of new entries over the period 1995–2019, with a relatively low entry barrier as measured by the high degree of path departure.
- During the period 1995–2019, Peru's economy specialized in 52 new products (presented in Table 2), a figure that is slightly below the mean of the 32 countries that belong to the same income group as Peru. These new entries in the country's export basket accounted for approximately USD 4.7 billion, i.e. 8.3 per cent of total exports in the last year considered.
- Peru's export basket has evolved towards a higher level of complexity. The level of product sophistication of the majority of new entries is greater than Peru's current export basket (EXPY in 2019 was equal to USD 9,706); the av-

[3] Chapter 4 compares the DIVE approach and the prioritization exercise carried out by the PRODUCE team of the Peruvian government, which follows the methodology developed by Alvarez and Huamani, (2017).

[4] Unrelated diversification is generally referred to as the targeting of products/sectors in which a country currently does not have a latent comparative advantage, i.e. a product that is 'distant' from the current set of available production capabilities. We explain this and other key concepts in detail in Chapter 2 and in Appendix B.

erage gain in complexity was equal to USD 3,682.

- Peru entered specializations alongside a significantly higher number of competing countries.
- The development of the country's export basket indicates a relatively high capacity of Peru's economy to jump far across the Product Space (PS). The average relatedness of new entries with the country's initial export specialization was lower than that of the global economy and of other upper middle-income countries.
- In terms of structural dynamism—a composite index of a country's ability to diversify away from its initial comparative advantage—Peru fares well compared to other countries at a similar level of development with an index of 0.664, placing the country in the 87th percentile of the distribution.
- High regional disparities are evident in all above dimensions, with dynamic coastal areas in Peru, in particular Lima, and a less diversified and more structurally vulnerable interior.
- In applying the DIVE tool, four sets of potential targets for diversification policies are selected based on feasibility and desirability criteria. A set of useful indicators is reported for each of these products to better assess their potential and strategic value and to derive information on regions with a potential advantage in developing specializations in the given products. More precisely, the different sets of target sectors are categorized as follows (see Chapter 4 for further details):
  - *Short jumps with a high path dependence and many competitors*. These products belong to Peru's potential diversification space and have a high degree of path dependence, i.e. products for which an economy's initial capabilities matter for the acquisition of a new specialization, and which are characterized by a high degree of proximity (or relatedness) with the country's current export basket. In other words, these are targets with the highest level of feasibility for Peru's economy (i.e. lower risks related to missing productive capabilities). In addition, we employ two criteria that enhance the targets' strategic value: i) a positive relatedness gain (or advantage), namely a condition that ensures that the product is more closely related to Peru's export basket than to that of other countries with a similar level of development (upper middle-income countries); ii) a large number of countries that already have a specialization in the given product (a proxy for a relatively low entry barrier for Peru).
  - *Short jumps with a high path dependence and few competitors*. These are products with the same features as those described above but have only a limited number of competitors or countries with a comparative advantage in the product. A low number of competitors means a potentially high desirability due to lower competition. It also means that entry barriers might be relatively high (lower feasibility).
  - *Long jumps with a high path dependence, low relatedness and relatedness advantage*. These are products in Peru's potential diversification space that have a high degree of path dependence, i.e. products for which the economy's initial capabilities matter substantially for the acquisition of a comparative advantage in those products, and which are characterized by a low degree of relatedness with the country's export basket. In other words, these products are relatively far from Peru's current export basket and the feasibility of acquiring a specialization is hence relatively low. These targets—when we consider Peru's current specialization basket—are more ambitious. With the aim of diversifying away from the current comparative advantage, these products are particularly interesting but are typically excluded from the standard policy approach (for example, the PS approach). Although these targets are more ambitious, we include products in this set for which Peru's economy still has some strategic advantage compared to other upper middle-income countries.

We use the existence of a positive relatedness gain as an additional criterion, which suggests that Peru is more closely related to these products than other countries at a similar level of development.

- *Long jumps with low path dependence, high frequency of new entries and few competitors*. These products are potential diversification targets for Peru and have a low degree of path dependence as well as a high observed frequency of entry in the global economy. The combination of these two features suggests that the low initial relatedness with Peru's current export basket is not a constraint for the development of a specialization in the product. In fact, we observe that many countries—even those with an unrelated initial specialization—have succeeded in acquiring a comparative advantage in the product. Moreover, these products might be of particular interest as a policy target, provided that they possess other characteristics (e.g. complexity, positive spillovers, strategic sectors), thus making them desirable for Peru.

- A comparison between the prioritization determined using the DIVE and the PRODUCE methodologies (Alvarez and Houmaní, 2017) reveals an overlap of 21 products. These common targets are likely to have highly interesting feasibility and desirability features.
- The prioritization exercise, as highlighted by the Inter-American Development Bank (2014), is a useful first layer of analysis that provides guidance on the trade-off between feasibility and desirability of alternative targets or reinforces/confutes the targets identified by PRODUCE using alternative methodologies. A second layer of analysis after potential opportunities for diversification have been identified should focus on the precise identification of market failures and bottlenecks, and calls on policymakers to analyse the specific markets/sectors together with relevant private sector actors.

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Introduction

The Peruvian economy in the global production space. Current trends in export specialization and potential targets for diversification policies

Economic diversification is a key goal in developing countries' policy agendas in the light of challenges as well as opportunities related to their participation in the global economy. Diversification is not only crucial for reducing the degree of vulnerability to internal and external shocks, but also for promoting structural change and consequently, higher levels of productivity and societal well-being. By adding new products to a country's export basket, a wider and more differentiated set of productive capabilities can be re-combined to develop additional new or better products, thus contributing to the country's improved long-term economic performance. The manufacturing sector plays a decisive role in shaping the economic development of low- and lower middle-income countries as confirmed by Sustainable Development Goal 9 (SDG 9) "Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation". In the Lima Declaration, industrialization is identified as the driver of development by increasing productivity, creating jobs and generating income, indirectly contributing to poverty eradication and addressing other development goals.

Peru, like most developing economies, is specialized in a limited bundle of products, mainly in the agricultural or extractive sectors. Such products are produced and exported by many other competing countries (ubiquitous products). The Government of Peru launched the National Plan for Production Diversification (PNDP)[5], led by the Ministry of Production (PRODUCE), to promote the diversification of the country's production structure. A prominent role has been given to the goal of facilitating the emergence of new engines of growth in the Peruvian economy in line with the Hausmann and Rodrik (2003) framework for economic diversification.

Along these same lines, UNIDO recognizes that the promotion of production of a highly diversified set of products—mainly high value-added products that are often present in the export bundle of a relatively more developed country—is important. Economic diversification is an opportunity for commodity rich countries, such as Peru, which have registered growing financial surpluses as a result of the 2002 commodity price boom. Additional resources from the extractive sector can generate the potential to support an investment programme in industrial diversification, not necessarily at the expense of the resource sector (as prices are likely to remain robust for some years to come) but as complementary to it (UNIDO, 2012).

Using the DIVE tool, this report aims to support the design of diversification policies by providing a comprehensive assessment of Peru's current position and of recent dynamics in the global production space (PS) as well as useful information to identify potential targets for these policies.

The road to diversification: An application of UNIDO's DIVE tool to Peru

While there is strong consensus on the need to promote diversification, there is little agreement on how to design and implement diversification and industrial strategies. The first fundamental step of a successful policy is an analysis of the current productive landscape, in particular the features of the existing export and production basket and its recent trends.

The key question we aim to answer is which direction diversification should follow and specifically, whether it is desirable to exclusively diversify in new products that rely on the set of capabilities that have already been developed

[5] The details on the PNDP are available at https://www.mesadeconcertacion.org.pe/sites/default/files/archivos/2015/documentos/11/mp_plan_nacional_de_diversificacion_productiva_2014.pdf

and that are linked to available endowments (related products) or, on the contrary, whether it is feasible to develop new specializations in products that have a limited degree of similarity with the country's existing production structure (unrelated products). In fact, whether to aim at 'short jumps' by targeting specialization in related products, or at 'long jumps' by promoting the development of a comparative advantage in unrelated and more 'distant' products, is a crucial element of policy design, which has often been addressed but with little empirical guidance and rigour.

The DIVE approach is based on a comprehensive analysis of the degree to which potential new specializations, i.e. all products that are not part of a country's existing export or specialization basket, could realistically be developed in the near future, even in countries that currently do not seem to possess the required set of productive capabilities (as proxied by the current existence of related products in the export basket that use similar capabilities). We define products as 'path-dependent' when—based on an analysis of world trade data of the last 25 years—the development of a new specialization in that product is only likely to occur if the country is already specialized in related products that 'share' similar production capabilities. The main implication from a policy perspective when products are highly path-dependent is that it is unlikely that diversification policy will be successful, unless the country already has a specialization in related products. In other words, what a country currently produces and exports has an influence on target products that are path-dependent and on defining feasible paths for future diversification. On the other hand, a large number of potential products can be 'path-departing' or 'path-defying' as specialization in those products has only occurred in countries with an initially unrelated export basket. Contrary to most recent approaches which a priori define 'unrelated diversification' as unfeasible—hence discouraging ambitious policies targeting 'long jumps'—the DIVE approach suggests that countries could succeed in targeting unrelated products that are path-departing and that in fact, these new specializations might actually be desirable to broaden the country's set of capabilities and to boost economic performance.

The application of the DIVE tool to Peru seeks to answer the following questions:

1. How diversified is Peru's economy? How vulnerable is its current specialization to external competition?
2. What are the main features of diversification, i.e. the addition of new entries in Peru's economy over the last 25 years? Has Peru been able to diversify away from its initial comparative advantage?
3. Given the current structure of Peru's export basket, what are feasible and at the same time desirable paths for future diversification?

Structure of the report

This report is structured as follows. Chapter 1 introduces the key elements of the analysis for using the DIVE tool. The main concepts, new metrics and methodologies are presented in an intuitive and accessible way. The methodological details are available in the Appendix. The main features of Peru's export basket, such as its degree of diversification/concentration, sophistication and structural vulnerability, are analysed in Chapter 2. Chapter 3 presents an analysis of products that have been added to Peru's export basket since 1995. This allows for an assessment of Peru's ability to diversify its economy towards goods that are relatively unrelated compared to the economy's initial comparative advantage, i.e. of Peru's structural dynamism. Chapter 4 focuses on potential targets for future diversification policies identified using the DIVE tool and categorized into four different groups based on a set of identification criteria. Chapter 5 concludes with some final remarks. The report also includes several boxes with product-level information that can be derived from the DIVE tool.

Box 1 | Progress in productive or industrial development in Peru

Low productivity is often the unintended result of a host of market and government failures that distort incentives to innovate, thwart the expansion of efficient firms, and promote the survival and growth of inefficient ones (Banco Interamericano de Desarrollo, 2010). Such state and market failures are more acute in low-income economies—including Latin America—and are one of the key explanations for the relatively low levels of productivity

The Ministry of Production (hereinafter PRODUCE) has been committed to policies aimed at increasing productivity and promoting productive diversification for nearly 10 years. In 2014, the "National Plan for Productive Diversification was approved" through Supreme Decree No. 004-2014-PRODUCE. Under the framework, temporary public-private working groups were created with the objective of identifying and removing bottlenecks that affect productivity in different sectors or very specific productive factors called Mesas Ejecutivas (PRODUCE, 2016), which in Latin America are considered one of the few productive development tools that are particularly suitable for solving coordination problems (Ghezzi, 2019).

All these efforts reinforced the strategies and actions required for boosting productivity, especially with reference to highly fragmented markets or industries. To hone the efforts, especially those aimed at improving the industrial sector's productivity and competitiveness, PRODUCE, together with various public and private stakeholders, took the lead in developing the first National Industrial Development Policy[6] (hereinafter PNDI), with the vision that Peru's manufacturing industry will be more competitive and have greater added value by 2030, achieving a share of between14 per cent (expected scenario) and 16 per cent (best case scenario) of national GDP.

The PNDI addresses structural gaps within the industrial sector, a sector which over the last five years has, on average, accounted for 12.5 per cent of the national GDP, 8.8 per cent of national employment, and 15.8 per cent of total taxes collected.[7] The industrial sector has witnessed a significant decline in productivity over the last decade. In 2017, an average Peruvian worker in the industrial sector generated USD 26.100[8], half of what an equivalent worker in Chile generated. This value has been decreasing, as the industrial sector's labour productivity in Peru fell by 7.4 per cent between 2015 and 2017, from USD 28.200 to USD 26.100.[9] Likewise, productivity varies widely depending on company size; in 2019, micro-enterprises achieved only 5.5 per cent of the productivity of large companies.[10] Likewise, Peru's industry exports low value-added goods, with 90 per cent of the country's exports falling into the category of primary manufacturing and only around 10 per cent into the medium- and high-technology goods category.[11]

Internationally, countries such as Colombia, Mexico and Chile, have promoted national competitiveness and productivity policies; in fact, there is growing global consensus on the need to promote this type of initiative. On the other hand, the challenges and opportunities of a modern industrial policy in the post-pandemic context mark a trend towards industrial development characterized by digitization, technology and industrial resilience, as well as the neces-

[6] PRODUCE approved in November 2022, through Supreme Decree. N° 016-2022-PRODUCE, the National Industrial Development Policy.

[7] Calculation made by PRODUCE – Policy Directorate, considering statistical information obtained from BCRP, INEI and SUNAT. Real GDP at millions of Soles of the year 2007.

[8] In PPP (US$ international prices).

[9] Calculation made by the Policy Department of PRODUCE, based on statistical information from the Central Bank of Chile and the Central Bank of Peru.

[10] Calculation made by PRODUCE – OGEIEE – Office of Economical\ Studies, based on the Encuesta Nacional de Empresas (INEI, 2019).

[11] Calculation made by the Policy Department of PRODUCE, based on CEPAL (2020). SIGCI – Sistema Gráfico de Comercio Internacional.

sary pursuit of greener industries. In the context of climate change, experts recommend developing eco-friendly infrastructure; sustainable buildings; invest in education, training and natural capital; big data analytics, cloud computing and 3D printing, which are all included in the PNDI.

Accordingly, the PNDI includes the following four priority objectives (PO):

1. PO 01: Increase the productivity of manufacturing sector companies by 35.2 per cent compared to the base year (2019);
2. PO 02: Increase the complexity of manufactured products in manufacturing sector companies, with the goal of achieving a share of 15.9 per cent of medium- and high-technology products in manufacturing exports by 2030 compared to 10.3 per cent in the base year (2019);
3. PO 03: Increase the share of adequate industrial productive infrastructure and specialized services for manufacturing companies; and
4. PO 04: Improve the quality of the institutional and regulatory environment for the development of manufacturing activities; which will be implemented through services aimed at meeting the needs of its target population, for which national compliance standards have been established.

PRODUCE has taken the necessary actions at the strategic level to properly implement the PNDI. For example, PNDI activities are being incorporated into the sector's strategic planning instruments. It is expected that PRODUCE's Multiannual Sectoral Strategic Plan (PESEM) will be approved by December, and which will incorporate the PNDI.

Furthermore, sectoral strategic agendas for the development of sustainable medium- and high-technology industries such as electromobility are being devised. At the governance level, a sectoral working group has been set up to coordinate the gradual provision of PNDI services by favouring prioritized companies, with the aim of ensuring specific and measurable results.

On the other hand, at the regional level, opportunities for dynamic public-private interaction have been created in three of the country's regions based on the model of the Mesas Ejecutivas created under the framework of the PNDP, in which under the leadership of the regional government and the active participation of companies, "working agendas for industrial productive development" have been developed. It is expected that the productive agendas of seven regions with industry presence will be approved through regional ordinances this year.

The aforementioned productive agendas will include the prioritization of strategic sectors at the national level. A gap analysis and an analysis of the root causes will be carried out, a proposal and prioritization of actions to boost them will be prepared. There is growing international recognition of the importance of specific vertical interventions to address bottlenecks (Agosin et al., 2014). UNCTAD (2018) asserts that there is increasing agreement that structural transformation does not occur on its own, but requires proactive policies that facilitate a transition to new sectors and activities with both higher productivity and added value, and to simultaneously promote inclusive and sustainable development.

Although there are multiple needs at the national level, it is expected that through vertical interventions that meet the needs and specificities at the regional level, the prioritized strategic sectors will have access to the necessary capacities, that is, the necessary assets and skills, to be successfully produced in relation to other countries ("revealed comparative advantage"), generating more employment and income.

In short, the business sector and the State have committed to working together to achieve a more competitive Peruvian industry, with greater added value and which generates better development opportunities for families in Peru in an inclusive and sustainable manner.

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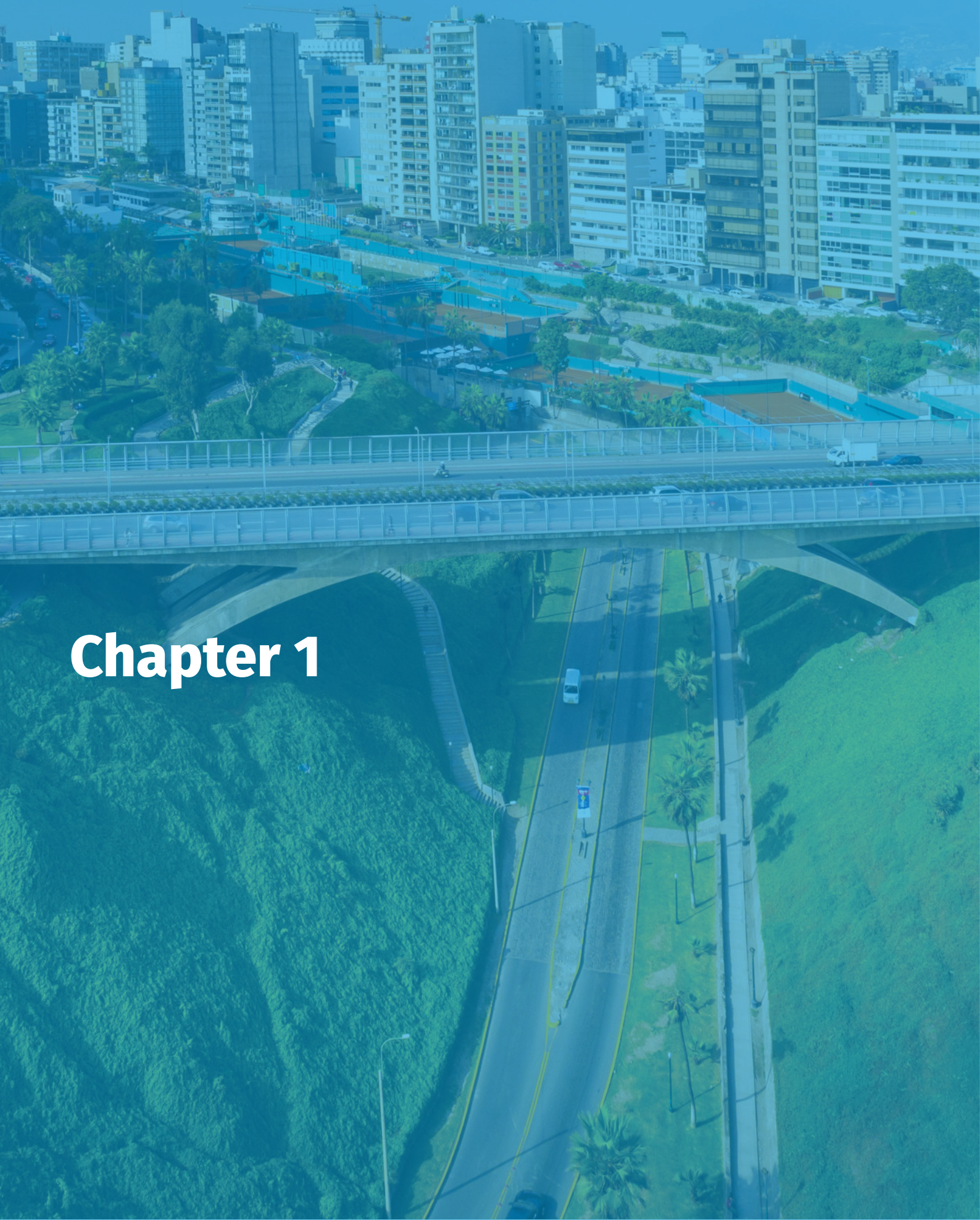


Chapter 1

Informing diversification policies: UNIDO's DIVE tool

The primary aim of UNIDO's DIVE tool, which is briefly described in this chapter[12], is to provide strategic direction to the design of industrial and export diversification policies.

Using novel insights on the development of productive specializations in the global economy from the last three decades, the country-level analysis presented in the following chapters was developed based on three logical steps:

Step 1. Analysis of the country's current specialization and its structural vulnerability

The first component of the DIVE tool provides information on the country's current export basket, i.e. the products in which a country has a revealed comparative advantage (RCA) (or specialization). The analysis of 'where we are' is fundamental for assessing 'where can we possibly go' in relation to a country's diversification strategies. One of the key concepts developed by the DIVE tool is 'vulnerability'. Peru's current export basket is assessed using a product-level index of vulnerability which measures how 'easy' it is for other countries to develop a specialization in the products Peru's economy has a current comparative advantage in. The index of vulnerability is built using data on the product-level degree of path dependence[13] and the frequency of new export specializations in the product in the world economy[14] over the last 25 years.

By weighing the significance of each specialization in Peru's export basket, we can determine country-level structural vulnerability, which provides a synthetic assessment of how contestable Peru's current position in global trade is. The answer is straightforward: the more specialized a country is in products with a low entry barrier, the more vulnerable the country's export basket is to international competition. This information provides useful guidance for policymakers and a rationale for diversification policies.

Step 2. New entries in the export basket: How dynamic has the Peruvian economy been?

In this second step of the analysis, we use the DIVE tool to assess Peru's diversification performance by focusing on 'new entries' in the export basket over the last 25 years. New entries are defined as non-temporary export surges or new specializations in products that were not exported with an RCA in the five preceding years.[15] We provide both quantitative (type, number and size of new exports) and qualitative data of Peru's new entries (degree of path dependence, vulnerability, level of sophistication of new exports).

Another important dimension analysed in this second step is the ability of the Peruvian economy to diversify its export basket towards products that were unrelated with its initial (static) comparative advantage. This information is captured by the index of structural dynamism, a country-level measure of countries' ability to perform 'long jumps' over the potential PS. Recent evidence confirms that a country's ability to diversify away from its current comparative advantage is associated with better growth performance (Coniglio et al., 2021; see Box 2).

[12] The methodological details are available in UNIDO (2022) and Coniglio et al. (2021).

[13] See Appendix A and B for a detailed definition of path dependence.

[14] The frequency of a new entry is a measure of the number of countries that acquire a sudden and economically significant export specialization in a given product. We use the Harmonized System (HS) Rev 2, 4-digit level of disaggregation, which includes 1,241 products.

[15] We define new entries as products in which a country develops a new, non-temporary and quantitatively significant specialization. We use the standard concept of RCA à la Balassa and define a new entry as a product with an RCA>1 and which had an RCA below the threshold of 0.5 in the preceding 5 years. See UNIDO 2022 for methodological details.

Step 3. Directions for future diversification

The goal of the third step is to highlight Peru's diversification options which simultaneously consider the degree of capability similarity with its current economic structure; the potential dynamics of the new specialization; the extent to which the development of a product is constrained by the set of capabilities already available; the relative advantage compared to other countries at the same stage of development, and the product-level degree of vulnerability (i.e. the extent to which a new specialization is contestable, once developed). The DIVE tool identifies alternative targets with heterogeneous degrees of desirability and feasibility among short jumps (products that require capabilities likely already available in Peru) and long jumps (products unrelated with the country's current export structure and that therefore require capabilities not yet available in the country). The selection criteria can be used in a flexible way in line with the country's specific strategies.

Compared to alternative approaches (for instance those inspired by the Product Space (PS) approach), the analysis based on the DIVE tool adds a new dimension to diversification strategies. Contrary to most of the recent approaches, which a priori define 'unrelated diversification' as unfeasible, hence discouraging ambitious policies that target 'long jumps', our approach suggests that countries could succeed in targeting unrelated products with a low index of path dependence. These new specializations might in fact be desirable for broadening the set of capabilities of Peru's economy and for boosting its economic performance and promoting structural change (see Box 2). Long jumps might be instrumental to defying a country's static comparative advantage, in upgrading its industry and promoting long-term societal well-being.

In the following sections of this chapter, we elaborate on the three steps briefly described above and present the metrics and indices used to analyse the current development of specialization of Peru's economy and the methodological details for identifying potential targets for future diversification strategies.

Box 2 | A critical review of the Product Space approach: long jumps are not rare events!

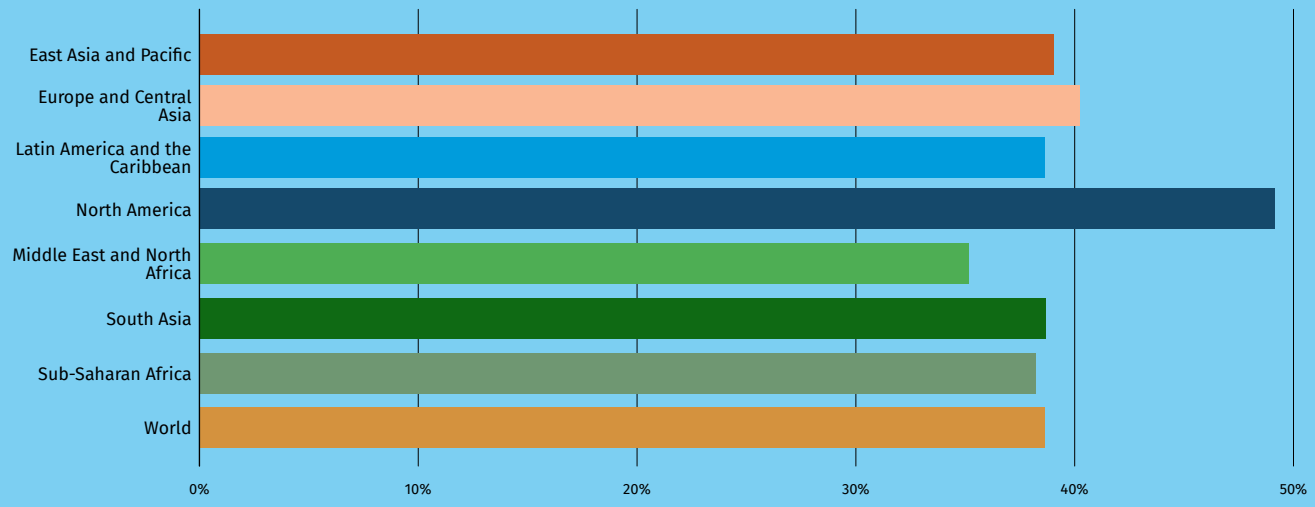
Several studies adopted the Product Space (PS) approach to investigate whether new entries are more closely connected with the economy's pre-existing structure; whether a nexus exists between path dependence and economic performance, and which sectors to focus on to outperform in the medium- to long run. In a recent article published in the Journal of International Economics, Coniglio et al. (2021) test the validity of the framework at the global level for the period 1995–2015. Their study generally confirms the hypothesis of path dependence, but also finds that a non-negligible number of new specializations developed in the world economy were unrelated to pre-existing export baskets. The share of new products in a country's export basket that defy its initial comparative advantage is at least 39 per cent of the country's total exports. The figure below presents the share of path-defying new entries by geographical region.

Although this finding generally supports the capability approaches which assert that countries that diversify by building on their existing capabilities, the flip side of the coin is that unrelated diversification is far from being an unlikely event. The share of long jumps is higher for relatively more developed economies because they are less constrained by their initial export baskets by virtue of their broader sets of capabilities, skills and know-how, which all favour path-defying diversification. Notable examples have been widely discussed by policymakers and their

advisers and include the case of the aeronautical industry in Brazil and the high-tech and capital-intensive industries in the Republic of Korea.

The work of Coniglio et al. (2021) also suggests that countries that can diversify their economies towards unrelated products achieve better economic performance. A high degree of path dependence, on the other hand, is associated with lower growth rates. This relationship is particularly marked in low-income countries. The conclusion is that sticking to 'short jumps'—as advocated by the analysis inspired by the PS approach—may not only overlook the fact that 'long jumps' are frequent occurrences in developing economies as well (in other words, long jumps are feasible diversification targets), but might also contribute to a decline in economic performance.

Share of path-defying new entries between 1995 and 2015



Note: The chart refers to the share of "long jumps" new entries in total new entries.
Source: Elaborated from Coniglio et al. (2021), by using the World Bank geographical classification.

Reference: Coniglio, N. D., Vurchio, D., Cantore, N. and Clara, M. (2021), On the evolution of comparative advantage: Path-dependent versus path-defying changes, *Journal of International Economics*, Volume 133.

1.1 Analysis of current specialization (export basket) and its structural vulnerability

As is the case in most of the literature on export specialization, we rely on export data to identify the economic structure of countries that participate in trade. To define the set of products that make up Peru's export basket, we use the BACI trade database (CEPII) at the HS 4-digit disaggregation to identify which products are exported with an RCA larger than unity.[16]

Since trade data are characterized by a non-negligible degree of volatility, we only include products that are permanently exported with an RCA larger than unity. More precisely, we include products in the Peruvian export basket if specialization was maintained for at least two out of three years following the product's initial entry. Using export data from 1995 to 2019, we obtain the set of products Peru is specialized in and explore its dynamics for the period 1995–2017.[17]

The analysis of Peru's export basket covers several dimensions. First, we assess the degree of diversification by considering the number of products and the export basket's concentration; the latter is measured using the Herfindahl-Hirschman Index and is compared with that of other countries, particularly those with a similar level of development (the World Bank classifies Peru as an upper middle-income country). The second dimension analysed by the DIVE tool is the export basket's overall complexity measured by EXPY, a weighted average of the country's gross domestic product (GDP) per capita associated with the products the country is specialized in (see Hausmann et al., 2007; details are reported in the Appendix).

Third, we compute an index of structural vulnerability[18] for the products Peru is specialized in and aggregate the corresponding values to obtain a country-level measure of structural vulnerability. The resulting measure is compared with the global average and with a benchmark (the average value for other upper middle-income countries).

To understand to what extent specialization in a product is associated with a high degree of vulnerability due to potential new competitors—and consequently, to understand the degree of a country's vulnerability—we combine three different elements:

1. The *frequency of a new entry*[19] measures how often countries acquire a comparative advantage in the product. The DIVE tool considers the relative distribution of the frequency of new entries for each product in the HS 4-digit trade classification (No. 1241) and normalizes this measure in the interval [0,1]. We can thereby measure the degree of contestability of a product specialization;
2. The *degree of product-level path departure of new entries* (the opposite of path dependence) is a proxy for the importance of previously acquired production capabilities to develop comparative advantage. The degree of path departure with values in the [0,1] interval, where values close to 1 indicate that new entries for a given product have largely occurred in countries with unrelated products in their pre-existing export baskets.
3. The *number of countries with a comparative advantage in the product* (a measure of ubiquity of specialization in the product). A sub-index with values normalized in the interval [0,1] is computed by considering the relative position of each product in the overall distribution based on the 1,241 products in the HS 4-digit

[16] For details, see Appendix A.

[17] The time interval ends in 2017 as data for the period 2017–2019 are needed to classify stable export specializations.

[18] Methodological details on how the three dimensions are accounted for are provided in Appendix A.

[19] The frequency of new entries is computed by identifying them in the global economy during the period 2000–2019 (see Section 2.1) and aggregating them at the product level. Each product in the HS 4-digit classification enters countries' export baskets 8.8 times on average during the period considered (standard deviation 5.5). We find that no countries developed a new comparative advantage for 58 products during the period considered. By contrast, the maximum number of new entries was 32 for *HS4 7801 Lead refined unwrought*.

classification. This information highlights a different but complementary dimension of a product specialization's degree of competition.

The emergence of a new trade specialization depends on two elements: i) geographical diffusion of the capabilities necessary to produce the product (ubiquity/scarcity); and ii) 'ease' of obtaining or generating the required capabilities to produce it. Some products are more likely to enter countries' export baskets either because the required production capabilities are 'ubiquitous' (i.e. available in most countries in the world) and/or because the production of these goods is not severely constrained by currently existing capabilities. On the other hand, some products are produced using 'rare' production capabilities or may be constrained by the requirement of a highly specific ecosystem of capabilities. The index of structural vulnerability reveals the ease with which a specific specialization can be entered into, i.e. the entry barriers associated with a given specialization. For instance, the frequency of new trade specializations delivers valuable information, which is of relevance for policymakers, as products in which many countries develop a comparative advantage are likely to have a low 'entry' threshold in terms of the required productive capabilities – in particular when combined with a high index of path departure. On the other hand, 'rare' specializations—especially when combined with a low index of path departure—are difficult targets of diversification policies, as the required set of production capabilities is also rare and not easily reproducible.

We define and measure country-level structural vulnerability by relating the product-level indexes of vulnerability as described above to a country's current export basket, weighted by the products' relative importance (i.e. the share of product *i* in the total trade of country *k*). A high level of structural vulnerability suggests that a country is largely specialized in highly vulnerable products, that is, products that are likely easily contestable by competitors. A low level of structural vulnerability, on the other hand, suggests that a country is specialized in products that rarely enter countries' export baskets, and when this does occur, the high level of relatedness plays a fundamental role in limiting the number of countries with a latent comparative advantage in these products. Among developed countries, Japan, Ireland, the Republic of Korea and Singapore show particularly low levels of structural vulnerability. This is also true for countries such as China, Malaysia, the Philippines and Madagascar. Not surprisingly, countries that rely heavily on a few commodity exports, such as Algeria, Nigeria, Qatar and Venezuela, have a high index of structural vulnerability.

1.2 New entries in the export basket: Measuring the ability of countries to 'jump' over the production space

The second component of the DIVE tool identifies and analyses the new specializations in Peru's economy over the last 25 years. The starting point is the identification of 'new entries' in the country's export basket. To this end, we employ a series of criteria to avoid labelling sporadic and irrelevant episodes of export booms as new entries (both in absolute and relative terms). New specializations are considered products for which: i) the average export value increased in absolute terms; ii) the Balassa index of specialization (RCA) is consistently above unity; and iii) the country had a relatively low degree of specialization in the product before its entry in the export basket (low RCA).[20]

Several product-level features of new entries are analysed. More precisely, the DIVE tool determines the level of sophistication or complexity (proxied by the PRODY index); recent dynamics in terms of growth in global demand for the respective product; the number of countries specialized in its export as well as the number of new entries of the product during the period analysed. One of the DIVE tool's fundamental contribution is the possibility to determine whether the new specializations that entered Peru's export basket were related or unrelated to the country's pre-existing comparative advantage in the preceding five years, that is, the specialization's relatedness. We compute the relatedness between a new entry (and all potential new entries, i.e. products in the option set (OS)) and the country's pre-existing export basket.[21] [22]

As mentioned above, by looking at the full set of new entries in the global economy, we are able to define a novel metric labelled product-level index of path dependence (or, its opposite, product-level index of path departure) for each product that belongs to the HS 4-digit trade classification (a total of 1,241 products), which provides information on the degree to which the products, when entering the export basket, were related (or unrelated in the case of path departure) to the set of products the country was already specialized in. This information is crucial from a policy perspective, as strong path dependence implies that it is unlikely that the country can develop a new specialization in that product, unless it is already specialized in related products; in other words, what a country produces today has a strong influence in terms of feasibility of developing a new specialization. On the other hand, if a product is characterized by low path dependence (or high path departure), the current set of capabilities—as expressed by the current export basket—does not significantly influence the development of a specialization in that product.

We measure product-level path dependence (or departure) in a highly intuitive way. Suppose a certain product, say *Electrical boards (HS 8537)*, enters the export basket of countries in the global economy a given number of times over the last two decades, how do we determine whether these entries are path-dependent or not? We compute the actual proximities between *Electrical boards (HS 8537)* and the export baskets of those countries where this product became a new specialization, and compare the resulting average proximities with a counterfactual one, which represents the proximities we would have if these countries

[20] See Appendix A for additional details on the identification of new entries in the export basket.

[21] We define relatedness as the maximum value taken from all possible pairwise proximities between the new entry (or the product in the OS) and products included in the country's export basket.

[22] We follow Hidalgo et al. (2007) and measure relatedness as the minimum of the pairwise conditional probability of being in an export basket at the same time. We compute year-specific networks of relatedness, i.e. a non-static PS, which considers the dynamics in the degree of similarity between products' capabilities. For robustness of the analysis, Coniglio et al. (2021) employ alternative measures of relatedness – for instance, average proximity between a new entry and all products in the export basket. Their analysis shows that the results are qualitatively similar. The use of the maximum level of proximity is preferred as being more consistent with the theoretical notion of 'shared productive capabilities' between products.

had developed a specialization in randomly drawn products from their option sets. This strategy allows us to assess each of the 1,241 products traded in the world (HS 4-digit classification); by looking at real data, we find that their entry in export baskets is more or less related to the pre-existing export basket as compared to a counterfactual[23], which includes all products that might in principle enter the set of specializations.

Has Peru diversified close or far from its initial comparative advantage? In other words, has the Peruvian economy made short or long jumps across the potential space for production diversification? The answer to this question is important as countries that can diversify towards unrelated products show greater structural dynamism and, in turn, a higher growth potential. The DIVE tool includes a measure of the degree to which countries diversify away from their initial export basket, the country index of path departure. This index is built as a weighted average of the product-level indexes of path departure as described above. A high level of path departure suggests that a country's new entries have largely been registered in unrelated products, that is, long jumps over the PS have taken place. Peru's index is compared with that of other countries that belong to the same income group.

The analysis also includes a country index of structural dynamism which examines the following two elements: i) how many new products have been added to the country's export basket; and ii) the extent to which these new entries diverge from the country's path. The country index of path departure is computed as a weighted average of the products' degree of path departure (using the percentile method) while the number of new entries in the economy's export basket is normalized by ranking all countries' frequencies of such entries. Additional methodological details are provided in Appendix A.

[23] According to the choice of the counterfactual relatedness, we develop three different measures of product path dependence (or path departure). Details are reported in Appendix A).

1.3 Identifying country-specific opportunities for future diversification of the Peruvian economy

The ultimate goal of diversification policies is to broaden a country's PS, i.e. to increase the number of products a country is specialized in. On average, countries around the world are specialized in 129 products across a total of 1,241 products contained in the HS4 trade classification: in other words, the potential diversification set is equivalent, on average, to 90 per cent of the products traded in the world economy. Some countries have a highly diversified economy (e.g. China, Italy, Germany and Spain) while others' export baskets are highly concentrated in a few products (e.g. Angola, Chad and Equatorial Guinea), but the choice set of target products for all countries is relatively wide. Which products should policymakers consider as targets of their policies? The answer to this question depends on the policymaker's specific goals as well as on the feasibility of alternative strategies. The traditional approach developed by Hidalgo et al. (2007) suggests that countries should prioritize 'related' products, i.e. should focus on 'short distance jumps' over the PS, as these represent feasible and realistic diversification opportunities. The UNIDO DIVE tool approach, on the other hand, suggests that this strategy is not necessarily the most desirable one from a growth perspective (see Box 2). In fact, 'relatedness' only matters for those products that have a high index of path dependence for which the initial set of capabilities is fundamental for acquiring a comparative advantage. Initial relatedness does not matter or matters less for a relatively large set of products. The capabilities required for developing a comparative advantage in these products are likely to be ubiquitous and relatively 'easy' to be generated or acquired in countries that do not initially possess them.

Bearing the above considerations in mind, this report identifies four sets of country-specific opportunities for diversifying Peru's economy:

- *Short jumps with a high path dependence and many competitors*. These products belong to Peru's potential diversification space (also labelled 'option set') with a high degree of path dependence, i.e. for which initial capabilities do matter, and which are characterized by a high degree of relatedness with the country's export basket. We employ two additional criteria: i) a positive relatedness gain (or advantage), i.e. a condition that ensures that Peru's economy is more closely related to the product compared to other countries at a similar level of development (upper middle-income countries); and ii) a large number of countries that already have a specialization in the product (above the median).
- *Short jumps with a high path dependence and few competitors*. These are products with the same features as those described above but that have a limited number of competitors, or countries with a comparative advantage in the product.
- *Long jumps with a high path dependence, low relatedness and relatedness advantage*. These are products in Peru's potential diversification space with a high degree of path dependence, i.e. for which initial capabilities matter for the acquisition of a new specialization, which are characterized by a low degree of relatedness with the country's export basket. In other words, these products are far from Peru's current export basket. With the aim of diversifying away from the current comparative advantage, these products are particularly interesting (but are typically excluded from the PS's standard policy approach), albeit being more ambitious targets. We employ the existence of a positive relatedness gain, which suggests that Peru is more closely related to the product compared to other countries at a similar level of development.
- *Long jumps with a low path dependence, high frequency of new entries and few competitors*. These products are potential diversification targets for Peru with a low degree of path depen-

dence as well as a high observed frequency of entry in the global economy. The combination of these two features suggests that the low initial relatedness with the current Peruvian export basket is not a constraint for the development of a specialization in the given product. In fact, we observe that many countries—even those with an unrelated initial specialization—have succeeded in acquiring a comparative advantage in the product. Such products might be of high interest as a policy target, provided that they possess other characteristics (e.g. complexity, positive spillovers, strategic sectors) which make them desirable for Peru.

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Chapter 2

The current specialization of Peru's economy: Main features

Peru's export basket—identified as the set of products that have had an RCA higher than unity for at least two years out of a total of three years—consists of 153 products in the Harmonized System 4-digit nomenclature. It is characterized by a low level of product sophistication—the index that captures how advanced or complex production is, proxying the level of productivity associated with the bundle of products—equal to USD 9,706 in the period 2017–2019. This value is well below both the world average (USD 15,064) and the average of upper middle-income countries (USD 14,177).

The low level of sophistication of Peru's export basket is attributable to the presence of mineral, agriculture and stone products that represent 43.41 per cent, 22.88 per cent and 15.57 per cent of Peruvian exports, respectively. Metal and textile products represent a smaller share of exports (7.44 per cent and 2.03 per cent, respectively). One positive aspect of Peru's exports is the share of domestic content in gross exports: in 2018, domestically generated value-added accounted for 86.57 per cent of Peru's gross trade, suggesting that exports represent a channel through which to promote the country's development.[24] In this regard, tradeable goods sectors with the highest share of domestic value added are mining support service activities and agriculture, hunting and forestry at 97.21 per cent and 96.09 per cent, respectively. "Computer, electronics and optical equipment", "Electrical equipment" and "Coke and refined petroleum products" have a lower relative importance in domestic value added, with a domestic content of 53.92 per cent, 57.96 per cent and 57.96 per cent, respectively. Such products are more visible in global value chains.

By looking at both product-level vulnerability and the products' weight in Peru's export basket, we can compute the overall level of country vulnerability to competition. Peru is among the 30 per cent most vulnerable countries (73rd percentile of the distribution) with a vulnerability of 0.715, while the world average is equal to 0.646. This is attributable to the fact that the set of products Peru is specialized in is composed of goods with a relatively ubiquitous specialization, which recorded a high number of new entries between 1995 and 2019 with a relatively high degree of path departure.

Although the Peruvian export basket is mostly composed of products in the primary sector, the concentration of its exports is less pronounced than in countries at a similar level of development. We adopt a measure of concentration of exports—the Herfindahl–Hirschman index (HHI), which captures the inverse of export diversification—which is 0.099, a value double that of the world average (0.199) and well below the average for countries in Peru's World Bank income group (0.210). Peru's natural resources are distributed unevenly across regions and ecological areas (Pacific Ocean, arid coast, Andes and Amazonia). Orihuela and Echenique (2019) define Peru as a "diversified resource-based economy", since mining exports play an important role, but "their collective historical significance varies" contrary to Chile's (or other countries) characterized by mono-commodity dependence.[25]

Table 1 presents details for the top 10 products in Peru's export basket, ranked by export value in 2019. The country's export basket is strongly influenced by the presence of natural resources that shape the country's international specialization. Half of the products reported in Table 1 are mineral products, with *HS 2603 Copper ore* representing the main export with a value above USD 12 billion corresponding to more than 26 per cent of

[24] Using data from the OECD's TiVA database and applying the decomposition by Koopman. Wei and Wang (2014), we performed the Stata command developed by Belotti, Borin and Mancini (2021) which allows disentangling the composition of gross trade.

[25] In Chile, copper played a dominant role in the mid-19th century, followed by nitrates in the 1870s to 1920s; after this period, copper once again became the main export commodity. From a geographical perspective, the Chilean resource-based economy shows a higher concentration, as it is largely located in the northern regions.

the total value of exports. The comparative advantage—measured by the Balassa index—of Peru's copper ore production is extremely high, with a specialization index of around 84. The second most representative product in the country's export basket is *HS 7108 Gold*, with a total export value equal to USD 6.8 billion, representing 14.45 per cent of total exports. The index of specialization of gold is around 8. All remaining products had export shares lower than 5 per cent in 2019. The first eight products reported in Table 1 have a level of vulnerability higher than the world average (0.646), primarily because several other countries have a comparative advantage in these products. Gold, for instance, was in the export basket of 63 countries in the period 2017–2019, indicating a discrete level of ubiquity and thus, competition for international markets. Moreover, in the case of such products, the relatively high number of countries that acquired a comparative advantage during the period 1995–2019 is another element of vulnerability: such information provides a measure of how contestable the product's market is to newcomers. With regard to the vulnerability of Peru's set of specializations, Table 1 provides further information on the percentage of path-dependent new entries, i.e. how often the product represents an export diversification related to the set of pre-existing capabilities. For instance, the tenth product in the table, "Other fresh fruit", is only present in countries endowed with related capabilities. On the other hand, when looking at the products that represent Peru's main export specializations, we denote the presence of relatively low shares of path dependence: this feature is typical of products in the primary sector and extractive industries for which the set of capabilities is often confined to geological or climatic conditions. In 44 per cent of cases in which a country developed a new specialization in the product "copper ore" in the period 1995–2019, this occurred in an unrelated way; in other words, the country developing the new product was not specialized in similar products. The share of path-dependent new entries is even lower in the case of *Refined copper and copper alloys (HS 7403)* with a share of 43 per cent; such products only recorded 7 new entries worldwide during the period 1995–2019, with only one of these new entries registered in countries in the same income group as Peru.

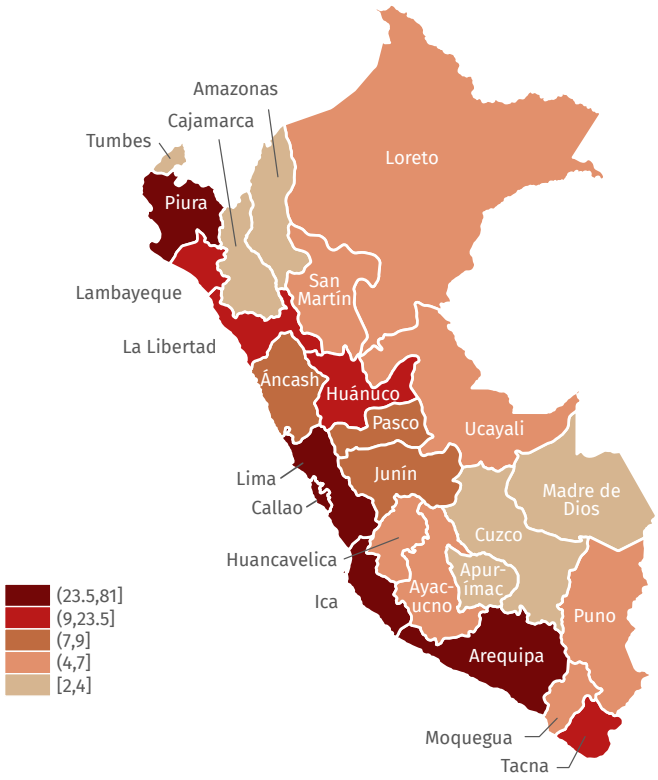
Table 1 | Top 10 products in Peru's export basket (ranked by value of export in 2019)

HS code	HS description	Product sector	Exports in 2019 (billion USD)	Comparative advantage (Balassa)	Product sophistication (2017–2019; USD)	Countries specialized in production (2017–19)	Countries in the same income group specialized in production (2017–19)	Frequency of entry (1995–2019)	Frequency of entry in countries in the same income group (1995–2019)	% of path-dependent new entries	Index of vulnerability
2603	Copper ore	Minerals	12.18	79	6,698	26	9	18	8	56	0.732
7108	Gold	Stone	6.76	8	7,324	63	14	28	9	61	0.836
2710	Petroleum oils, refined	Minerals	2.21	1	17,009	57	15	16	4	69	0.831
2608	Zinc ore	Minerals	1.65	57	4,931	31	10	8	2	75	0.645
7403	Refined copper and copper alloys	Metals	1.62	10	5,484	27	7	7	1	43	0.655
2301	Flours of fish, for animal feed	Agriculture	1.54	86	12,881	45	13	11	4	73	0.771
804	Avocados, pineapples, mangos, etc.	Agriculture	1.09	28	6,432	59	22	9	3	89	0.736
2607	Lead ore	Minerals	1.01	65	4,759	30	11	7	1	71	0.602
2601	Iron ores and concentrates	Minerals	0.98	3	15,189	18	6	10	4	40	0.627
810	Other fresh fruit	Agriculture	0.92	20	12,239	42	13	12	3	100	0.755
	Average (1241 products in HS 4-digit classification)				***37,057***	***17***	***-***	***4***	***1***	***75***	***0.381***

While most of the products in Peru's export basket are characterized by a low level of sophistication, those specializations that lead to more productive/complex productions are an exception. Among these, *Petroleum oils, refined (HS 2710)* is worth mentioning, representing slightly less than 5 per cent of Peruvian exports with a level of sophistication of USD 17,009. Nevertheless, such specialization does not seem to be very robust since the Balassa index is slightly higher than 1. Other sophisticated and upgraded products reported in Table 1 are *Iron ores and concentrates (HS 2610)*, with an index equal to USD 15,189 and *Other fresh fruit (HS 0810)*, with a level of sophistication of USD 12,239.

We shift the focus to the regional dimension and find that the geographical distribution of Peru's export specializations is noteworthy. Figure 2 presents how many of the 153 products that make up the country's export basket each Peruvian region has an export share in that is higher than the country average, a measure of the geography of the specialization of Peru's sectors.

Figure 2 | Geographical distribution of Peru's export specializations (% of share of products belonging to the country's export basket)



Most of Peru's product specializations are concentrated in the coastal regions, with the capital region Lima registering the highest number of export specializations, namely 81 out of a total of 153. This implies that the region of Lima is better endowed in terms of capabilities that reflect Peru's participation in global markets. Other regions Peru's export specializations are concentrated in are Callao (40 specializations out of a total of 153), Piura (27), Ica and Arequipa (24) and Tacna (23). On the other hand, regions such as Apurimac and Cusco report a location quotient above unity for only two of Peru's export specializations, namely *Copper ore (HS 2603)* for both regions, *Worked cereal grains (HS 1104)* for Cusco and *Molybdenum ore (HS 2613)* for Apurimac. The leading source regions for the main product in Peru's export basket, "Copper ore", are Cusco and Apurimac, with a location quotient equal to 3.37 and 3.63, respectively. Other source regions for "Copper ore" are Junin, Ancash and Arequipa, with Lima—Peru's most diversified region—playing a marginal role in the export of this particular product. The dimensions of specialization and diversification of Peru's second most important export, *Gold (HS 7108)*, differ considerably. The main exporting regions are Puno (location quotient of 6.35), Ayacucho (5.81), Madre de Dios (4.68), Cajamarca (3.93), La Libertad (2.72) and Huancavelica (2.47), that is, in the ranking of the most diversified regions reported in Figure 2, they are far from the top of the distribution.

Figure 3 illustrates the vulnerability of Peruvian regions' export baskets. By considering the weighted average of the degree of vulnerability of products in the country's export basket, we are able to rank the regions that are more and less vulnerable to foreign competition. Tumbes and Amazona, with export baskets that are strongly specialized in non-dynamic products (products that rarely enter countries' export baskets) in agriculture and fishery sectors (in particular, "Crustaceans" and "Coffee"), are not vulnerable to international competition and have a relatively low level of vulnerability (lower than 0.6). Regions such as San Martin, Moquegua, Ucayali and Tacna also have a modest level of vulnerability. The most vulnerable regions are those with a strong

concentration of exports in globally ubiquitous products. Vulnerability in Peru's regions is driven by the strong dependence on gold exports (product vulnerability index: 0.836). Between 2017 and 2019, Puno (0.832) and Ayacucho (0.82) were the most vulnerable regions because of their high export shares in gold, equal to 97.6 per cent and 89.2 per cent, respectively. Other regions with a high dependence on gold exports are La Libertad, Cajamarca and Huancavelica, with export shares equal to 41.8 per cent, 60.4 per cent and 38. per cent, respectively.

Figura 3 | Vulnerability of regional export baskets between 2017 and 2019

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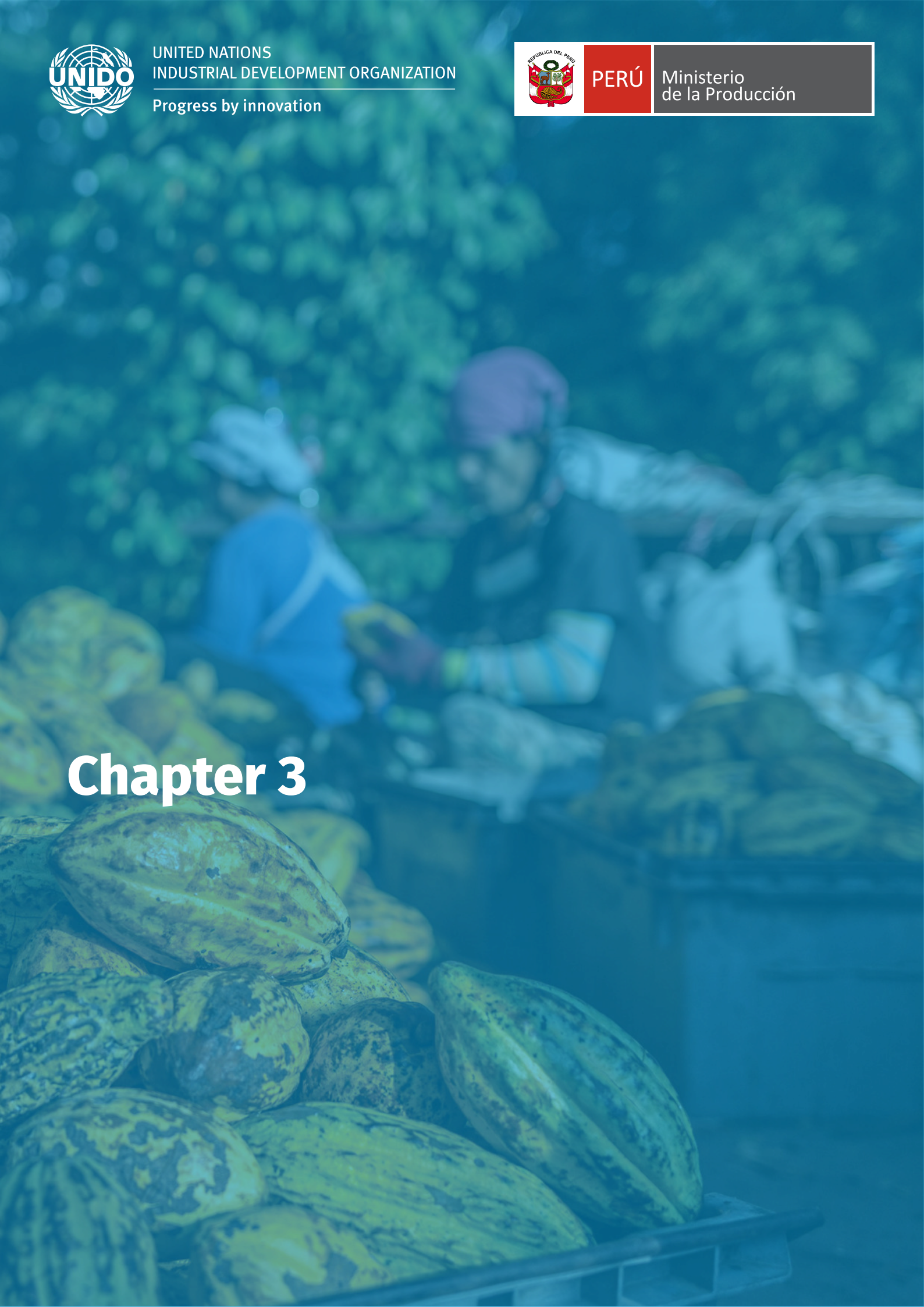


Chapter 3

Recent trends in the Peruvian export basket

The Peruvian economy acquired specializations in 52 new products from 1995–2019 (listed in Table 2). These new entries in the export basket accounted for approximately USD 4.7 billion, i.e. 8.3 per cent of total exports in the last year considered. On average, 3.5 new export specializations were developed each year; a number that is slightly below the mean of the 32 countries that belong to the upper middle-income group (a range between 8.7 new entries per year for Romania and 0.4 for Algeria).

Half of the new entries (26) were registered in the agricultural sector, followed by the chemical sector (9), minerals (5), stones and textile (4 each). There were fewer new specializations in the metals and machinery sectors, with 3 and 1 new additions to the export basket, respectively. The majority of new entries have a level of product sophistication that is greater than Peru's current export basket (EXPY in 2019 was equal to USD 9,706); the average gain in complexity was equal to USD 3,682. This suggests that Peru's export basket evolved towards a higher level of complexity. What was of particular importance in this respect were the new entries in the chemical sector (such as *HS 3502 Albumin* or *HS 3920 Other plates of plastics, noncellular and not reinforced*) or the only one in machinery (*HS 8430 Other moving, excavating or boring machinery*). A few new entries in the agricultural sector requiring a relative more complex set of productive capabilities are associated with a high complexity gain (for example, *HS 402 Milk, concentrated* and *HS 601 Flower bulbs)*.

A total of 34.8 countries of which 9 are at the same level of development as Peru specialized in the products that entered Peru's export basket; this figure was higher than the average for all new entries in the global economy (28) as well as compared with the average of other upper middle-income countries (28.2). In other words, Peru entered in specializations with a significantly higher number of competing countries.

The last three columns report the relatedness of each new entry in Peru's export basket with respect to its initial basket and two measures of product path dependence. The average relatedness of new entries is lower compared to the global economy and to other upper middle-income countries; this is an indication of a relatively better capacity of Peru's economy to jump far over the PS.

Table 2 | Peru's new entries in the export basket in the period 1995–2019

Year*	HS code	HS description	Product sector	Product sophistication (2017–2019; USD)	Growth in global trade (%, 2017–19)	Countries specialized in production (2017–19)	Countries in the same income group specialized in production (2017–19)	Prod. relatedness	Product path dependence (1)	Product path dependence (2)
2000	3923	Packing lids	Chemicals	16,787	8	61	18	0.442	0.155	81
2000	4803	Tissue	Agriculture	12,394	10.2	32	8	0.535	0.398	98
2000	6802	Worked building stone	Stone	5,859	-7.3	32	12	0.363	-0.051	39
2000	6910	Ceramic sinks, washbasins, and similar sanitary fixtures	Stone	12,396	40.5	24	10	0.495	0.293	95
2001	407	Eggs, in shell	Agriculture	14,020	1	43	15	0.501	0.307	95
2001	604	Other parts of plants	Agriculture	14,458	6.6	33	8	0.336	-0.123	26
2001	4105	Tanned sheepskins	Agriculture	3,326	-12.7	41	10	0.364	-0.05	38

2001	4409	Wood shaped along its edges	Agriculture	13,386	0.2	42	9	0.755	0.972	100
2002	402	Milk, concentrated	Agriculture	28,075	8.4	34	6	0.384	-0.015	47
2002	803	Bananas and plantains	Agriculture	7,196	4.5	37	14	0.301	-0.228	12
2002	805	Citrus fruit	Agriculture	9,696	0.1	31	6	0.375	-0.038	42
2002	1106	Flour of dried legumes	Agriculture	6,198	7.3	45	11	0.408	0.045	60
2002	1905	Bakery products	Agriculture	16,580	10.4	63	17	0.461	0.181	84
2002	4820	Notebooks	Agriculture	10,658	6.7	43	12	0.441	0.131	77
2003	1104	Worked cereal grains	Agriculture	9,982	13.8	41	9	0.389	-0.006	51
2003	2207	Ethyl alcohol > 80%	Agriculture	9,962	7	35	10	0.417	0.063	64
2003	2904	Sulfonated, nitrated derivatives of hydrocarbons	Chemicals	21,599	73.8	12	1	0.429	0.096	70
2003	5101	Wool	Textiles	14,854	-18.6	18	6	0.455	0.16	81
2003	6305	Bags for packing goods	Textiles	3,797	2	46	12	0.572	0.459	98
2003	7409	Copper plates, sheets and strip > 0.15 mm	Metals	18,546	-7.2	15	4	0.41	0.047	61
2004	3915	Plastic waste	Chemicals	15,857	-36.3	69	20	0.325	-0.165	23
2005	7401	Copper mattes	Metals	15,027	21.6	22	8	0.367	-0.048	42
2007	1517	Margarine	Agriculture	15,393	-5.3	35	7	0.432	0.126	72
2007	3920	Other plates of plastics, noncellular and not reinforced	Chemicals	22,261	3.7	39	9	0.506	0.319	92
2007	4012	Used pneumatic tires of rubber	Chemicals	9,048	-0.8	27	5	0.383	-0.002	51
2007	4818	Toilet paper	Agriculture	14,455	5.4	43	11	0.521	0.359	94
2008	1801	Cocoa beans	Agriculture	2,683	0.2	36	9	0.373	-0.039	44
2008	6002	Other knitted fabrics	Textiles	12,783	4.5	20	3	0.412	0.06	61
2009	2508	Clays	Minerals	10,412	0.6	27	6	0.442	0.149	76
2010	2009	Fruit juices	Agriculture	10,079	-6	59	17	0.476	0.257	87
2010	2510	Natural calcium phosphates	Minerals	6,684	0.9	18	5	0.226	-0.403	4
2010	2711	Petroleum gases	Minerals	21,461	8.4	38	11	0.272	-0.281	11
2010	2829	Sodium chlorate	Chemicals	21,833	-11.5	12	2	0.339	-0.104	34
2010	2906	Cyclic alcohols	Chemicals	21,807	18.7	13	2	0.271	-0.284	11
2011	4413	Densified wood	Agriculture	10,080	6.4	29	6	0.531	0.405	94
2011	5505	Waste of man-made fibres	Textiles	15,285	-7.5	36	9	0.461	0.219	83
2011	6811	Asbestos-cement or cellulose fibre-cement	Stone	12,135	4.6	23	6	0.447	0.184	80
2011	7010	Glass containers for conveyance	Stone	14,044	11.4	47	12	0.437	0.157	77
2011	7804	Lead foil <2mm	Metals	10,247	-16.4	19	3	0.311	-0.178	23
2012	1515	Other vegetable fats and oils	Agriculture	7,683	-3.9	46	11	0.428	0.117	71
2012	3103	Phosphatic fertilizers	Chemicals	8,569	9.3	20	8	0.308	-0.194	20
2012	4805	Other uncoated paper and paperboard	Agriculture	22,609	3	26	7	0.383	0.002	53
2013	205	Horse meat	Agriculture	9,493	2.8	23	8	0.371	-0.027	47
2013	810	Other fresh fruit	Agriculture	12,239	15.2	42	13	0.5	0.311	90
2013	1207	Other oil seeds	Agriculture	1,424	28.5	59	6	0.469	0.23	85
2013	3502	Albumins	Chemicals	34,068	5.9	17	0	0.36	-0.057	42
2014	601	Flower bulbs	Agriculture	24,599	0.5	11	2	0.304	-0.212	18
2014	1516	Vegetable fats, hydrogenated	Agriculture	8,098	-9.3	38	9	0.451	0.168	76
2014	1701	Sugarcane & sucrose	Agriculture	5,901	-33.2	54	20	0.408	0.058	62
2014	2523	Cements	Minerals	9,269	7.6	71	21	0.413	0.071	63
2014	2620	Slag, ash and residues containing metals	Minerals	18,283	39.3	40	9	0.387	0.002	52
2014	8430	Other moving, excavating or boring machinery	Machinery	22,552	9.7	22	6	0.274	-0.289	11

(1) corresponds to the difference between product relatedness and the average relatedness of the option set, divided by the latter; (2) corresponds to the average percentile position of a product's relatedness with respect to the option set relatedness distribution.
**The year reported is the one in the middle of the evaluation time interval.*

This better ability to defy the initial comparative advantage is confirmed when we look at the index of path departure (Table 3), which shows values that are significantly above the world average and above the average index of similar countries. For instance, the share of path-defying new entries in Peru was 35.5 per cent compared with 28.7 per cent in other upper middle-income countries. A high level of path departure suggests that a country's new entries occurred largely in unrelated products, i.e. long jumps over the PS.

Table 3 | Degree of path-defying diversification (index of path departure, 1995–2019)

	Degree of path departure (deviance from threshold)	Share of path-defying new entries	Degree of path departure (percentile method)
Peru	-0.081	0.355	40.052
Percentile position	75.96	72.12	75.96
Upper middle-income countries	-0.213	0.287	33.287
World average	-0.203	0.283	33.384

The analysis also includes a country index of structural dynamism which examines the following two elements: i) how many new products were added to the country's export basket; ii) the extent to which such new entries diverged from the path. The country index of path departure is computed as the weighted average of the products' degree of path departure (using the percentile method) while the number of new entries in the export basket of an economy is normalized by ranking all countries' frequencies. Peru fares well compared to other countries, with an index of 0.664 which places it in the 87th percentile of the distribution.

Table 4 | Country-level index of structural dynamism (1995–2019)

Peru	0.664	Percentile position:	87.02
Upper middle-income countries	0.473		
World average	0.446		

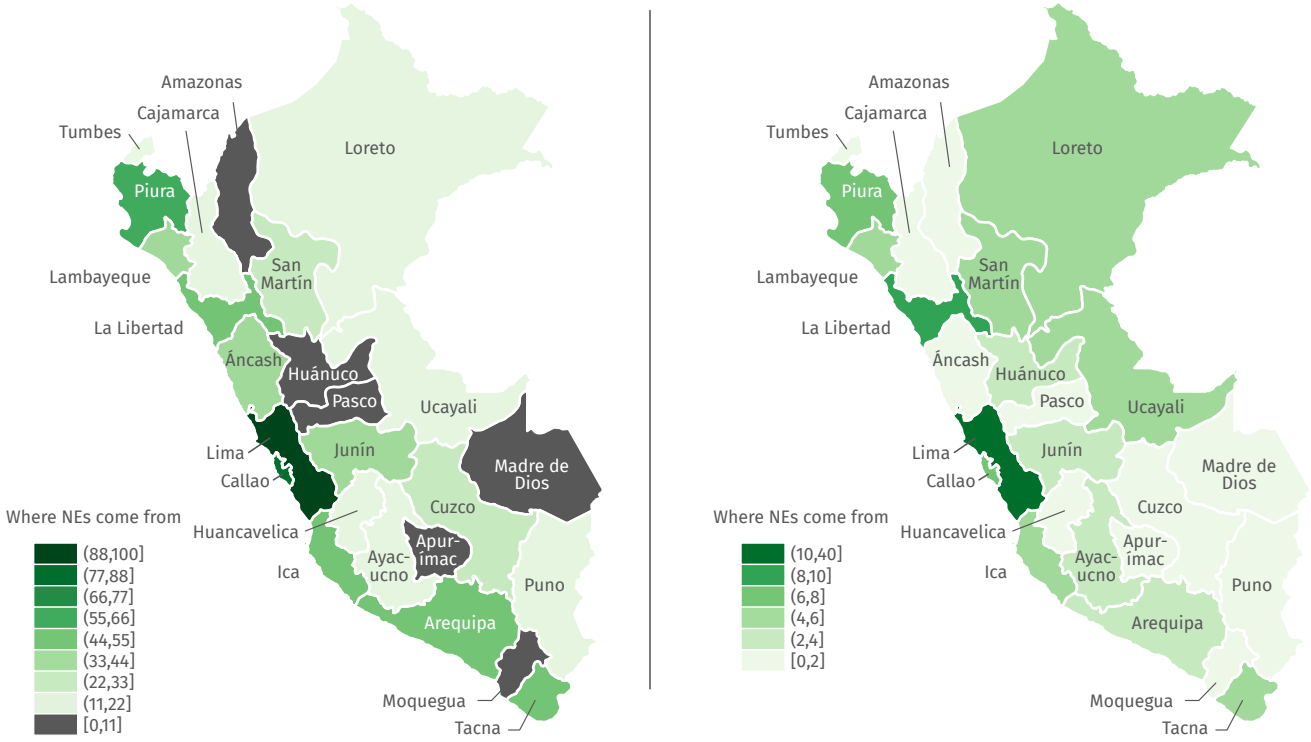
Although the bulk of Peru's export basket is highly concentrated in relatively unsophisticated goods produced by many competing countries, the analysis of recent trends of its export basket suggests a high and promising degree of structural dynamism with a specialization in unrelated products with a significant gain in complexity.

By shifting the focus on the regional dimension, we can identify from which Peruvian regions the new entries are currently exported. Figure 4 presents two panels. Panel a) shows the average percentile of regions in the distribution of new entries' export values.[26] High values indicate that a region has a high export value for most products among Peru's new entries. With an average ranking of 97.4, Lima is among the top exporters of each product in the list of new entries. The second region is Callao, with an average percentile position of 86.5. This is due also to the fact that these two regions have non-zero export flows for all 52 new entries. Other regions, where the new entries were present in the period 2017–2019, were other coastal regions such as Piura (55.9), Tacna (52.8), La Libertad (52.6) and Arequipa (52.0). On the

[26] We rank regions' export values for each product among those labelled as new entries in the period 1995–2019. If a region is the main exporter of a product, its export value will be highest and thus its ranking position will be 100. By contrast, regions that have no exports of any product are ranked close to zero.

other hand, regions hardly involved in the dynamism of Peru's export basket include Amazonas and Moquegua, for which the average percentile in the distribution of export values was 1.7 and 3.6, respectively. Panel b) provides information on the extent to which Peru's regions have a location quotient of exports higher than unity. High values indicate that a region often has 'new products' export shares that are higher than the average. The Lima region is the main 'engine' of export dynamism, with a location quotient higher than unity for 40 out of 52 new entries. All other regions have values lower than 10. Although the coastal regions also outperform the interior regions, for example La Libertad (9), Piura (8) and Callao (7), interior regions such as San Martin (6), Loreto (5) and Ucayali (5) show a concentration of exports of new entries that is higher than the median. None of the new entries' capabilities are concentrated in the Ancash, Apurimac, Moquegua and Cajamarca regions.

Figura 4 | Regional distribution of exports of new entries (average 2017–2019)



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Chapter 4

Potential diversification strategies

The process of diversification is not automatic and does not occur in a vacuum. Policies, both horizontal and vertical, are crucial for removing the multiple market failures and bottlenecks that prevent private economic agents from engaging in cost-discovery activities that lead to the development of new and better products. As argued above, industry-neutral horizontal policies are important for expanding the pool of productive capabilities, but the 'history of industrial success' suggests that this does not suffice. Well-drafted vertical policies might be fundamental for promoting structural transformation via the diversification of the production base. These policies require an ex ante process of defining priorities based on an explicit and rigorous assessment of risks—in particular, those related to the effective feasibility of a specific path of diversification—as well as potential benefits or strategic value. Prioritization also lies at the core of the implementation of the National Productive Diversification Plan (Ministerio de la Producción, 2014), in particular with the action line aimed at "Facilitating the emergence of new engines of the Peruvian economy".

As described above, the DIVE tool adopts an innovative methodology that was recently developed by Coniglio et al. (2021) to better assess the feasibility of specialization in a product/sector. Contrary to most recent approaches which a priori define 'unrelated diversification' as unfeasible, hence discouraging ambitious diversification and industrial policies targeting 'long jumps', the DIVE approach suggests that countries might succeed in targeting some unrelated products (namely those for which the set of ex ante productive capabilities matters less) and, in fact, these new specializations might be desirable for broadening the set of capabilities and for boosting the performance and structural change of Peru's economy.

We report on four sets of potential targets for diversification policies selected from Peru's OS based on the application of the DIVE tool (see Chapter 2). We also compare these products with those prioritized by the PRODUCE methodology described in Alvarez and Huamaní (2017), which are based on a different measure of feasibility as in Hidalgo et al. (2007). The potential targets are grouped into four tables and reported below. To better qualify the desirability of the different diversification options, in addition to the name of the products and the HS code, we report the following information that could be useful for policymakers:

- *Complexity gain*, measured as the difference between the sophistication of the product reported in each row of the table and the average sophistication of Peru's export basket (USD 9,706 in 2019). A positive figure implies that a specialization in the product would lead to an increase in the country's average level of sophistication/complexity.
- *Export growth 2017–19*[27] represents the growth rate of world exports in the specific product over the last three years. This figure reflects how dynamic international trade in the product has been in recent years.
- *Number of countries specialized in the product*, a measure of the number of countries with an RCA in the product in the last year for which data are available (2019).
- *Number of countries that belong to the benchmark group (low middle-income countries, LMI) specialized in the product.*
- *Relatedness*. The degree of relatedness between the potential new entry and the country's export basket. A high degree of relatedness suggests that the set of capabilities required to produce the potential diversification option might already be available in the country.
- *Relatedness advantage*. Measures Peru's proximity advantage to the potential product compared to countries in the same income group (upper middle-income countries). This coun-

[27] Note that although 2020 data are available, given the COVID-19-induced shocks on international trade, we use previous data that more reliably reflect the structure of the global economy and the pattern of comparative advantages.

try advantage is particularly important for products with a high level of path dependence.

- *Number of countries that developed a new specialization in the product during the period analysed* (2000–2019). This value reflects countries' general ability to acquire a comparative advantage in the product and is likely to be strongly related with the extent of entry barriers/difficulty of acquiring the required production capabilities.
- *Index of structural vulnerability (min 0/max 1).* This novel index measures how 'easy' it is for countries—for Peru and for potential competitors—to develop a specialization in the product. The index combines information on the degree of path dependence as well as the frequency of new entries and countries with a comparative advantage in the global economy (see Chapter 2).
- *Import penetration index*. The index measures the intensity of potential demand of the product among Peruvian exports. The import penetration index is computed in two steps. First, an RCA Balassa index is applied to imports to compute a weighted average of countries' tendency to import the given product. In a second step, to measure potential demand for Peruvian exports, the product-by-country import indexes are weighted by adopting importing countries' GDP over a distance from Peru as the weight. The higher the import penetration index, the higher the propensity of countries that are geographically close to Peru to import the product. In other words, this is a measure of Peru's market potential in the HS 4-digit product.
- *Import penetration index* (countries with a trade agreement with Peru). This product-specific index is computed like the previous one, the only difference being that the countries included in the computation of the weighted average are those that have at least a preferential agreement with Peru. The rationale is to define a sub-set of potential export markets for which barriers to trade have already been substantially reduced.

The first set of products prioritized using the DIVE tool (Table 5) are products that belong to Peru's potential diversification space and combine two fundamental features: i) a high degree of path dependence, i.e. products for which initial capabilities matter and which constrain diversification efforts; and ii) a high degree of relatedness with Peru's export basket. We also employ two additional selection criteria with the aim of identifying those targets for which Peru has a feasibility advantage: i) a positive relatedness gain (or advantage), i.e. a condition that ensures that Peru is more closely related to the product compared to other countries at a similar level of development (upper middle-income countries); and ii) a large number of countries that already have a specialization in the product (above the median), i.e. a product-level feature that suggests that entry barriers might not be preventive.

Strategic value can be assessed based on several product-level features reported in Table 5. For instance, the complexity gain is high for HS *8418 Refrigerators, freezers* (USD 11,608) (also described in Box 3), and represents an interesting trade potential for Peru (import penetration index equal to 1.172, and slightly higher when considering the market potential towards countries Peru has an existing trade agreement with). This product is also interesting in terms of the potential linkages it might generate for agricultural products, where lack of efficient 'cold chain' logistics is often an important bottleneck in developing and peripheral regions. The complexity gain is also high for *HS 5401 Synthetic sowing thread*, for which the export potential is lower and the number of countries that developed a specialization over the last 20 years is relatively high (11 new countries); or for *HS 7217 Wire of iron or non-alloy steel*, which shows a high relatedness and a relatively low number of countries with an RCA index above 1. Peru is the second most important exporter of the latter product in Latin America after Brazil, although with a modest gross export value (less than USD 8 million) and a relative specialization in the region of Callao (see Figure 5 below).

Table 5 | Short jumps with a high path dependence and many competitors (ranked by the relative relatedness advantage of other upper middle-income countries)

HS code	HS description	Product sector	Complexity gain (USD)	Growth in global trade (%, 2017–19)	Countries specialized in production (2017–19)	Countries in the same income group specialized in production (2017–19)	Prod. relatedness	Relat. advantage	Number of new entries (1995–2019)	Imp. penetr. index world	Imp penetr. index TA
6103	Men's suits, knit	Textiles	-4393	7.3	46	11	0.872	0.37	3	1.097	1.086
6205	Men's shirts	Textiles	-3120	-1.9	51	14	0.784	0.292	4	1.234	1.301
6204	Women's suits and pants	Textiles	-1991	7.8	48	12	0.792	0.266	6	1.047	1.075
6206	Women's shirts	Textiles	-2099	-6	41	10	0.729	0.242	6	1.062	1.125
6203	Men's suits and pants	Textiles	-4429	2.3	55	14	0.745	0.235	3	1.06	1.1
6211	Activewear	Textiles	-2293	12.6	48	12	0.729	0.23	5	1.155	1.197
6107	Men's undergarments, knit	Textiles	-184	4.3	42	12	0.681	0.207	10	1.202	1.257
6101	Men's overcoats, knit	Textiles	-3985	10	38	9	0.659	0.183	3	1.225	1.313
302	Fish, excluding fillets	Agriculture	5305	6	59	16	0.576	0.173	9	0.96	1.017
6207	Men's undergarments	Textiles	-4736	-3.2	39	12	0.614	0.167	1	1.151	1.165
7217	Wire of iron or nonalloy steel	Metals	7996	7	32	11	0.563	0.157	5	0.912	0.871
6208	Women's undergarments	Textiles	-3675	0.1	34	8	0.614	0.157	7	1.097	1.095
8418	Refrigerators, freezers	Machinery	11608	6.3	28	9	0.607	0.156	4	1.172	1.175
6209	Babies' garments	Textiles	-4607	-8.6	39	7	0.617	0.151	2	1.065	1.073
4408	Sheets for veneering for plywood	Agriculture	-1243	8.8	40	6	0.595	0.144	7	0.84	0.825
6210	Garments made of textile felts and nonwoven fabric	Textiles	1182	9.1	31	6	0.545	0.143	7	1.068	1.121
5401	Synthetic sowing thread	Textiles	9500	-1.9	26	8	0.5	0.142	11	0.771	0.627
4203	Leather apparel	Agriculture	4713	1.1	35	8	0.553	0.133	6	1.026	1.079
6310	Used or new rags textile scraps	Textiles	-1779	-18.9	46	10	0.532	0.13	7	0.964	0.818
5601	Wadding of textile materials	Textiles	4469	4.8	30	7	0.533	0.129	10	0.838	0.754

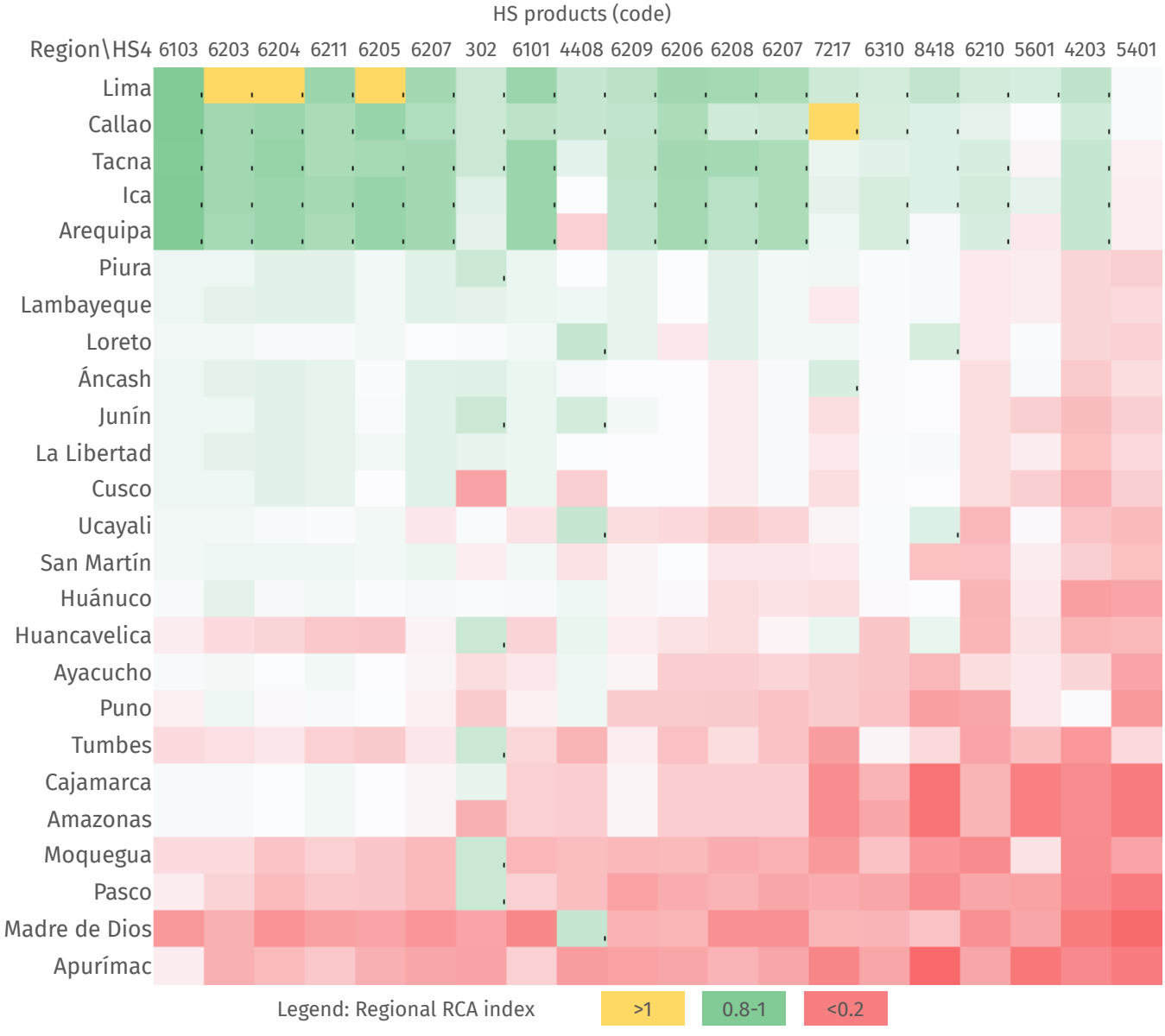
The target products in Table 5 for which Peru has the highest relatedness advantage vis-à-vis other similar countries are concentrated in the textile industry and generally show a negative complexity advantage, although some of these witnessed a relatively dynamic growth in global demand. These targets generally represent low hanging fruits for diversification policies, in particular those at the top of Table 5, which have a higher level of relatedness (as well as a relatedness advantage) with Peru's current export basket. These products often represent a natural addition or upgrade of existing value chains for the textile or agricultural and fisheries sectors. This is the case, for instance, of *HS 302 Fish, excluding fillets* (with an approximate global demand of USD 20 billion in 2020), a product related to the export basket of several coastal regions that are highly specialized in fisheries (mostly exporting fish flour for animal feed).

Figure 5 reports the 'regional advantages' of all targets identified in Table 5, measured as the current RCA indexes. The 'heatmap' presented below provides information on those regions where some export activities are already taking place but are not yet in the specialization basket (in green); in some cases, selected regions already show an RCA index above 1 (in yellow).

These figures report products in columns based on a decreasing level of presence across Peruvian regions (i.e. from left to right, we report products with a decreasing presence in terms of RCA values in the 25 geographical regions reported in the individual rows).

Diversification strategies might also take the pool of capabilities already present in a region into account, which also have a direct or indirect territorial policy component.

Figure 5 | Regional comparative advantages in target products reported in Table 5 (Short jumps with high path dependence and many competitors)

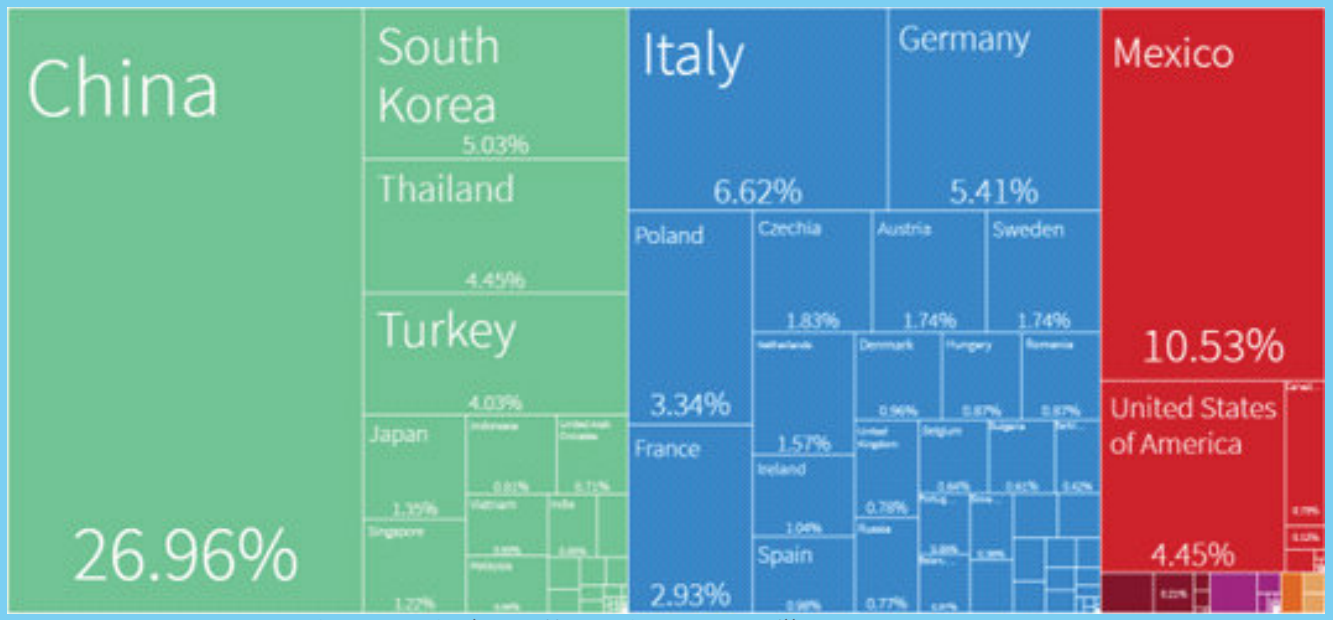


Box 3 | Product-level analysis: *Refrigerators, freezers (HS 8418)*

Industrialization processes have often followed common specialization trajectories. Specialization in durable goods, such as televisions, washing machines, refrigerators, cars and computers, is often emblematic of economies in an advanced stage of industrialization. Using the tools developed in this manual, we analyse the production of *Refrigerators, freezers (HS 8418)*.

Although considered a product with mature technology, the global value of exports of this product category is relatively high (2.6 per cent of global exports with a total value of USD 46 billion in 2020) with a fairly positive pre-COVID dynamic (+6.29 per cent between 2017 and 2019). As for other equipment, regulatory changes, international quality standards and demand for more efficient and environmentally friendly products have spurred a new wave of innovation and the development of more sophisticated products.

Exporters of *Refrigerators, freezers (HS 8418)* in 2020 (% of total exports; USD 46 billion)



Source: The Atlas of Economic Complexity (https://atlas.cid.harvar.edu/))

Global exports (USD billions, current)

2017	2018	2019	Growth rate last 3 years (%)
44.23	47.05	47.01	6.29
Top 10 exporters by value: China, Mexico, Italy, the United States, Germany, Rep. of Korea, Thailand, Türkiye, France, Poland.			
Top 10 exporters by export share: Türkiye, Mexico, Serbia, Thailand, Bulgaria, Romania, Italy, Belarus, Poland, Lebanon.			

Countries specialized in the production of *Refrigerators, freezers (HS 8418)* range from old and new industrial powerhouses. The top 10 exporters include developed OECD countries such as Germany, Italy, the Unites States, the Republic of Korea as well as emerging industrial economies such as China, Mexico, Thailand and Türkiye.

In the global economy, 28 countries had a specialization in this product in 2017 of which 16 were high-income countries (57 per cent of the total) and 9 were upper- and lower middle-income countries (32 per cent). In fact, the product's level of sophistication is relatively high (PRODY equal to USD 21,300 compared to an average of USD 18,800).

Product sophistication

	Refrigerators, freezers (HS 8418)	Machinery (174 products)	All products (1,241 products)
PRODY (USD; average value 2017–2019)	21,313.46	24,474.17	18,787.82

Source: Authors' elaboration based on UNCOMTRADE data

The relative importance of the product countries' export baskets is particularly high for emerging countries that are geographically close to main consumption markets (Türkiye and other Eastern European countries such as Serbia, Bulgaria, Poland and Romania for Europe; Mexico for the United States; Thailand for Asian markets). Proximity suggests the importance of good market access as well as the availability of industrial capabilities in engineering, a specialization in the production of this good.

Number of countries with a specializtaion in the production of *Refrigerators, freezers (HS 8418)* in 2017-2019 by income level

	All countries	High-income	Upper middle-income	Lower middle-income	Low-income	Other
Refrigerators, freezers (HS 8418)	28	16	9	2	0	1
Machinery (174 products)	16.59	10.74	3.28	1.43	0.38	0.76
All products (1,241 products)	22.5	10.74	5.17	4.24	1.43	0.88

Source: Authors' elaboration based on UNCOMTRADE data

Only four countries acquired a new specialization in refrigerators during the period 1995–2019 (Bosnia-Herzegovina, Bulgaria, Sri Lanka and Syria). Not only the frequency of new entries—a measure of ease in acquiring a comparative advantage in a product—is relatively low (also compared to other products in the broader category of 'machinery'), but our analysis suggests that all these new entries were characterized by a high degree of path dependence. In other words, only countries that already had a specialization in highly related products were able to develop a specialization in *Refrigerators, freezers (HS 8418)*.

Number of new entries in the export basket of *Refrigerators, freezers (HS 8418)* between 1995 and 2019 by income level

	All countries	High-income	Upper middle-income	Lower middle-income	Low-income	Other
Refrigerators, freezers (HS 8418)	4	0	2	2	0	0
Machinery (736 new entries)	4.24	20.5	1.21	0.67	0.21	0.1
All products (6,975 new entries)	5.64	2.2	1.52	1.4	0.4	0.12

Source: Authors' elaboration based on UNCOMTRADE data

The product-level index of path dependence is 0.324, a value that is substantially higher than other products in the same macro category (the average value for all new entries in the world economy is 0.110, while it is 0.086 for all new entries in the machinery sector). All other metrics of path dependence confirm the importance of the set of initial capabilities for the production of this product.

Path dependence: alternative metrics

	Refrigerators, freezers (HS 8418)	Machinery (736 new entries)	All products (6,975 new entries)
Path dependence (1)	0.342	0.086	0.11
Share of path-dependent new entries	100	67.1	65.4
Average percentile: proximity between new entries and export basket (2)	91.2	61.7	61.3
Average relatedness of new entry	0.511	0.417	0.428

(1) Average distance of the product's relatedness from the mean value of countries' option sets. Higher values imply a higher degree of path dependence (see methodological section and UNIDO, 2023).
(2) Higher values imply a higher degree of proximity or relatedness between new entries and the country's pre-existing export basket (see methodological section and UNIDO, 2023).

Source: Authors' elaboration based on UNCOMTRADE data

Our analysis allows us to also identify countries that currently have an export basket related to the product, but which do not yet have a trade specialization in it. These countries (listed below) have the potential of acquiring a specialization in 'Refrigerators, freezers' (HS 8418) in the future. It is interesting to note that some of these countries, such as Viet Nam and Malaysia, but also Brazil and Tunisia, have features that resemble those of countries that have recently developed a specialization in the product: growing industrial capabilities and geographical proximity to main export markets (European Union (EU), the United States and Japan).

Countries with a highly related export basket in 2019 not specialized in the production of refrigerators, freezers (*)

Brazil; Dominica; India; Malaysia; Namibia; Peru; Republic of Moldova; Tunisia; Ukraine; Viet Nam.

(*) Countries - excluding high-income ones not specialized in refrigerators, freezers and with a high level of relatedness

Although each export surge episode has different drivers, policymakers can draw useful information and lessons from a more in-depth analysis of the factors underlying new entries. As reported below, four countries developed a stable and quantitatively meaningful comparative advantage in the production of Refrigerators, freezers in the period analysed (1995–2019), Bulgaria (from 2001), Syria (from 2004 until the outbreak of the conflict), Sri Lanka (from 2009) and Bosnia-Herzegovina (from 2001, although for a limited trade volume).

The local production of refrigerators has a long tradition in Bulgaria (for instance, a local company, MRAZ S.A., has over 40 years of experience in the field of refrigeration), but foreign investors—building on local capabilities—further strengthened its industrial capacity. In 1999, the Liebherr Group (a German multinational) set up a large production plant in the city of Radinovo, Liebherr-Hausgeräte Marica EOOD.

In Sri Lanka, foreign investors were key in the development of this product specialization. A subsidiary of the U.S.-based Singer Corporation, Regnis Lanka, was established in the country in 1988 to start production of refrigerators and washing machines. The development of these products was rooted in other core products of the company such as sewing machines.

In Syria, the expansion of the sector was the result of activities of domestic firms such as L.I.D.A. (founded in 1991) and the Joud Group (a family group with industrial operations in several related industries). In this case, technological partnerships with foreign firms were crucial in the sector's development.

In Table 6, we report 'short jumps' towards highly related products that have similar features as the previous set of target products, except for a limited number of competitors or for countries that have a comparative advantage in the product. These different selection criteria imply, on the one hand, that these targets' strategic value might be higher, but on the other hand, it implies that feasibility might be lower as the limited number of countries with a specialization could indicate a higher entry barrier or market failures to develop such specializations.

The following list contains products with a significantly higher complexity gain as well as a more differentiated pool of macro-sectors compared to the previous set. Evidence of the trade-off between desirability and feasibility is also provided in Figure 6, which reports current regional specializations, indicating that Peruvian regions have a less pronounced presence of these industries in their current export pools. The relative advantage of Peru compared to other countries at a similar level of development is particularly high for *HS 5111 Woven fabrics of carded wool*, which also has a complexity gain of USD 28,212. Only two countries observed an export surge of this product in the global economy between 1995 and 2019, namely Spain (around 2004) and Mongolia (in 2013), the latter with modest export values. *HS 5801 Woven pile fabrics* has a lower complexity gain but a more dynamic growth in global demand – close to USD 1.8 billion in 2020, and a higher market potential for Peru. The product with the highest complexity gains among this set also belongs to the broader category of textiles, *HS 5902 Tire cord fabric*, with a gain of USD 45,561 and a global market of approximately USD 2 billion in 2020. The presence of this product in Peruvian regions is almost non-existent, with the highest RCA indexes in the Ucayali and Ica regions. Latin America is a net importer of this product, with modest exports only from Colombia. The import penetration index shows a beneficial market potential for Peru.

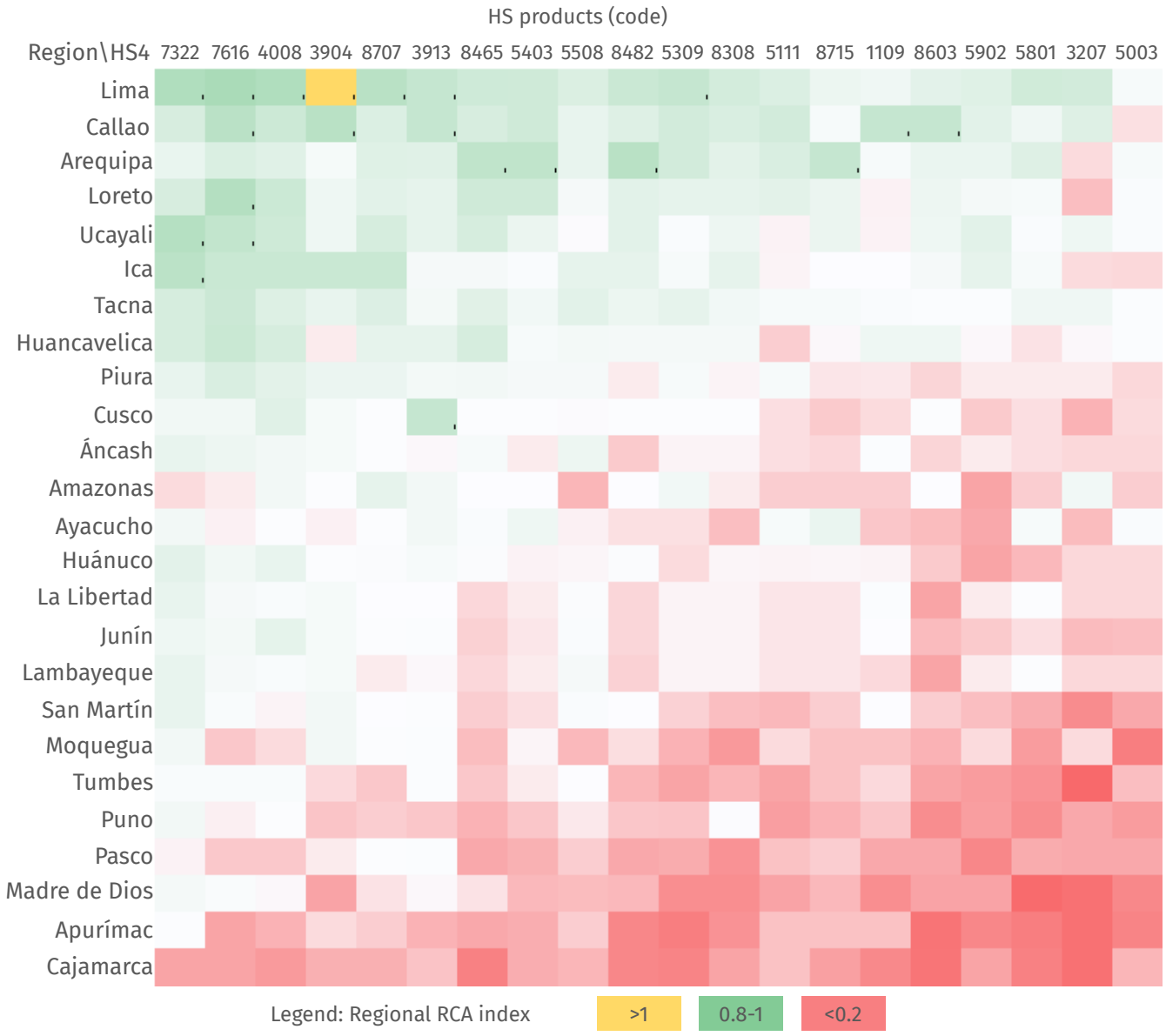
We report additional details on *HS 8465 Machine tools for working wood* in Box 4. This product combines very high strategic value measured by its complexity gain as well as its market poten-

tial and might represent an interesting addition to Peru's export basket in terms of expertise and capabilities. Product *HS 3904 Polymers of vinyl chloride*, for which an embryonic comparative advantage is evident in the Lima region, is also worth mentioning. Similar considerations apply to *HS 4008 Vulcanized rubber plates*, where some non-trivial levels of exports were observed in the capital region, or *HS 3913 Naturals polymers* with some export capacity in the Lima, Callao and Cusco regions. These products in the chemical industry also have high degrees of market potential.

Table 6 | Short jumps with a high path dependence and few competitors (ranked by relative relatedness advantage in relation to other upper middle-income countries)

HS code	HS description	Product sector	Complexity gain (USD)	Growth in global trade (%, 2017–19)	Countries specialized in production (2017–19)	Countries in the same income group specialized in production (2017–19)	Prod. relatedness	Relat. advantage	Number of new entries (1995–2019)	Imp. penetr. index world	Imp. penetr. index TA
5111	Woven fabrics of carded wool	Textiles	28212	-2.3	15	3	0.6	0.27	2	0.649	0.586
5801	Woven pile fabrics	Textiles	10875	15.2	13	3	0.533	0.194	4	0.847	0.768
8308	Clasps, buckles etc. of metal	Metals	13006	13.7	19	4	0.55	0.177	4	0.72	0.673
8715	Baby carriages	Vehicles	13549	-3.7	13	4	0.5	0.173	1	1.109	1.121
8482	Ball or roller bearings	Machinery	11537	1.6	15	5	0.563	0.169	3	0.986	1.009
4008	Vulcanized rubber plates	Chemicals	20158	3.3	22	3	0.609	0.163	4	0.878	0.892
3904	Polymers of vinyl chloride	Chemicals	11502	-3.8	21	4	0.565	0.162	6	0.959	0.881
1109	Wheat gluten	Agriculture	18507	-2.3	12	0	0.5	0.158	4	1.291	1.393
5403	Artificial filament yarn	Textiles	12987	-7.1	17	3	0.529	0.157	3	0.691	0.592
5309	Woven fabrics of flax	Textiles	18452	40.4	15	4	0.533	0.157	4	0.766	0.742
8603	Self-propelled railway coaches	Vehicles	18273	-0.6	10	1	0.5	0.152	6	0.806	0.687
3913	Natural polymers	Chemicals	18209	16.8	22	3	0.5	0.149	1	1.151	1.189
5508	Synthetic staple fibres sewing thread	Textiles	348	4.6	23	6	0.467	0.148	8	0.808	0.608
7322	Radiators for central heating of iron or steel	Metals	10266	6.2	22	6	0.609	0.147	8	1.035	1.068
8465	Machine tools for working wood	Machinery	28364	10.1	16	4	0.529	0.143	4	1.073	1.086
8707	Vehicle Bodies	Vehicles	18689	5.7	18	4	0.565	0.138	7	0.887	0.778
3207	Prepared pigments	Chemicals	12239	-2	10	2	0.438	0.127	0	0.846	0.777
5902	Tire cord fabric	Textiles	45561	1.4	13	5	0.467	0.126	4	1.055	1.009
7616	Other articles of aluminium	Metals	12397	6.8	24	7	0.6	0.124	4	0.915	0.948
5003	Silk waste	Textiles	-5709	17.3	12	2	0.4	0.124	1	0.837	0.781

Figure 6 | Regional comparative advantage in target products reported in Table 6 (Short jumps with high path dependence and few competitors)

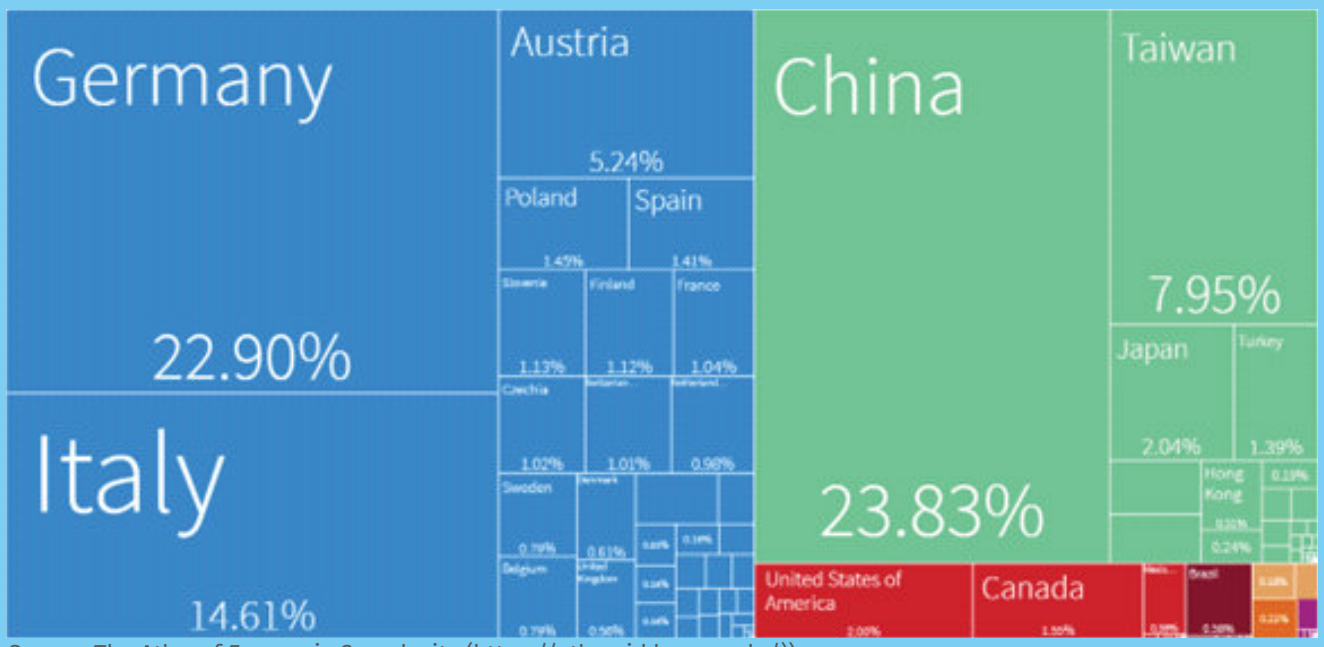


Box 4 | Product-level analysis: *Machine tools for working wood (HS 8465)*

The global market for *Machine tools for working wood (HS 8465)* had a value of USD 7.7 billion in 2022, with a growth in the last three years of +10.1 per cent. Latin American countries accounted for a relatively small fraction of imports (USD 203 million) and even lower exports (USD 46.9 million). The low participation in one of the key inputs in the woodworking value chain is relatively strong evidence of the low capital and technology intensity that characterizes Peru's wood-related products, from forestry to furniture. The current status represents both a challenge and an opportunity for Peru due to the industry's likely growing importance.

Compared to the average product in Peru's export basket, *Machine tools for working wood (HS 8465)* is more sophisticated with a potential complexity gain of USD 28,364. In fact, countries specialized in the production of HS 8465 are mostly developed countries such as Germany (22.9 per cent of the global market), Italy (14.6 per cent), Austria (5.2 per cent) as well as emerging industrial economies such as China (23.8 per cent) and the Republic of China (Taiwan) (approx. 8 per cent).

Exporters of *Machine tools for working wood (HS 8465)* in 2020 (% of total export; USD 7.74 billion)



Source: The Atlas of Economic Complexity (https://atlas.cid.harvar.edu/))

Global export (USD billions, current)

2017	2018	2019	Growth rate last 3 years (%)
7.8	8.6	8.6	10.13

Top 10 exporters by value: China, Germany, Italy, Austria, the United States, Canada, Japan, Poland, Finland, Spain.

Top 10 exporters by export share: San Marino, Austria, Italy, Slovenia, Finland, Estonia, Djibouti, Germany, Wallis and Futuna Islands, Saint Maarten.

In the global economy, 16 countries had a specialization in this product in 2017, of which 12 were high-income countries (75 per cent of the total) and 4 were upper- and lower middle-income countries (25 per cent). The product's level of sophistication is high (PRODY equal to USD 28,400 compared to an average of USD 18,800).

Product sophistication

	Machine tools for working wood (HS 8465)	Machinery (174 products)	All products (1,241 products)
PRODY (USD; average value 2017-2019)	28,364	24,474	18,787

Source: Authors' elaboration based on UNCOMTRADE data

In 1995, China only had a share of 1 per cent of the global market with an overall trade of approximately USD 4.3 billion. The rise of China was accompanied by a decline in the shares of two leading producers, Italy (the largest exporter in 1995 accounting for 26.6 per cent of the global market) and Japan (with a market share of 9.8 per cent in 1995, dropping to only 2 per cent 25 years later). Delocalization and the process of regional economic integration played an important role in the emergence of new players. For instance, Poland and Türkiye did not export these products in 1995 and are now among the top exporters with a market share of 1.45 per cent and 1.4 per cent, respectively.

Number of countries with a specialization in the production of *Machine tools for working wood (HS 8465)* in 2017–2019 by income level

	All countries	High-income	Upper middle-income	Lower middle-income	Low-income	Other
Machine tools for working wood (HS 8465)	16	12	4	0	0	0
Machinery (174 products)	16.59	10.74	3.28	1.43	0.38	0.76
All products (1,241 products)	22.5	10.74	5.17	4.24	1.43	0.88

Source: Authors' elaboration based on UNCOMTRADE data

Only four countries acquired a new specialization in the product during the period 1995–2019 (Bosnia-Herzegovina in 2003, Belarus in 2000, Cyprus in 2008 and Türkiye in 2006). The frequency of new entries—a measure of ease in acquiring a comparative advantage in a product—is low in absolute terms and compared to other products in the broader category of 'machinery'. All new entries featured a high degree of path dependence, as the four countries mentioned above had related products in their export baskets.

Number of new entries in the export basket of *Machine tools for working wood (HS 8465)* between 1995 and 2019 by income level

	All countries	High-income	Upper middle-income	Lower middle-income	Low-income	Other
Machine tools for working wood (HS 8465)	4	1	3	0	0	0
Machinery (736 new entries)	4.24	20.5	1.21	0.67	0.21	0.1
All products (6,975 new entries)	5.64	2.2	1.52	1.4	0.4	0.12

Source: Authors' elaboration based on UNCOMTRADE data

The product-level index of path dependence is 0.169, a value that is two times higher than other products in the same macro category (the average value for all new entries in the world economy is 0.110 while it is 0.086 for all new entries in the machinery sector). All other metrics of path dependence confirm the importance of the set of initial capabilities to produce this product.

Path dependence: Alternative metrics

	Machine tools for working wood (HS 8465)	Machinery (736 new entries)	All products (6975 new entries)
Path dependence (1)	*0.169*	*0.086*	*0.11*
Share of path-dependent new entries	100	67.1	65.4
Average percentile: proximity between new entries and export basket (2)	76.2	61.7	61.3
Average relatedness as new entry	0.468	0.417	0.428

(1) Average distance of product's relatedness from the mean value of countries' option sets. Higher values imply a higher degree of path dependence (see methodological section and UNIDO, 2023).
(2) Higher values imply a higher degree of proximity or relatedness between new entries and the pre-existing export basket (see methodological section and UNIDO, 2023).

Source: Authors' elaboration based on UNCOMTRADE data

Given Peru's high level of relatedness, the country together with nine other countries listed below has the potential of acquiring a specialization in *Machine tools for working woods (HS 8465)* in the future. These are mostly countries that are in the same income group as Peru; the majority have already developed significant industrial capabilities and have considerable presence in downstream markets as well, such as furniture and other wood products.

Countries with a highly related export basket in 2019 not specialized in the production of machine tools for working woods (*)

Grenada; India; Indonesia; Mauritius; Mexico; Peru; Romania; Syria; Thailand; Tunisia.

(*) Countries—excluding high-income ones—not specialized in 'Machine tools for working woods' and with a high level of relatedness

Türkiye's export surge for this product provides interesting lessons for other countries. According to the OECD, a few years after concluding the Europe-Turkey Custom Union in 1995, the Turkish machinery sector initiated a process of harmonization with EU legislation and machinery directives. The "CE" marking became mandatory for machinery products within the European Economic Area, which Türkiye is a member of. This process of integration was a fundamental element for the enhanced competitiveness of Türkiye's machinery industry (OECD, 2016). Interestingly, Türkiye's machinery industry is dominated by small enterprises, as demand for differentiated and customized products prevents a substantial exploitation of economies of scale. Less than 1 per cent of firms in this industry have over 250 employees and in 2014, only four mechanical companies were in the top 500 firms by size. Less than ¼ of the biggest machinery enterprises were owned by foreign investors, suggesting a non-crucial role of foreign capital. The industry is concentrated in the main urban areas, suggesting a need for a relatively large set of capabilities and infrastructure. Urban locations also have an advantage in terms of facilitation of (private and public) research and development (R&D) activities and expenditures, which are substantial in this industry. Türkiye's Ministry of Science, Industry and Technology has played an active role in this regard.

Source: OECD (2016), *Strengthening the Spatial Dimension in the Sector Strategies of Turkey*, OECD: Paris, France. Published in September 2016.

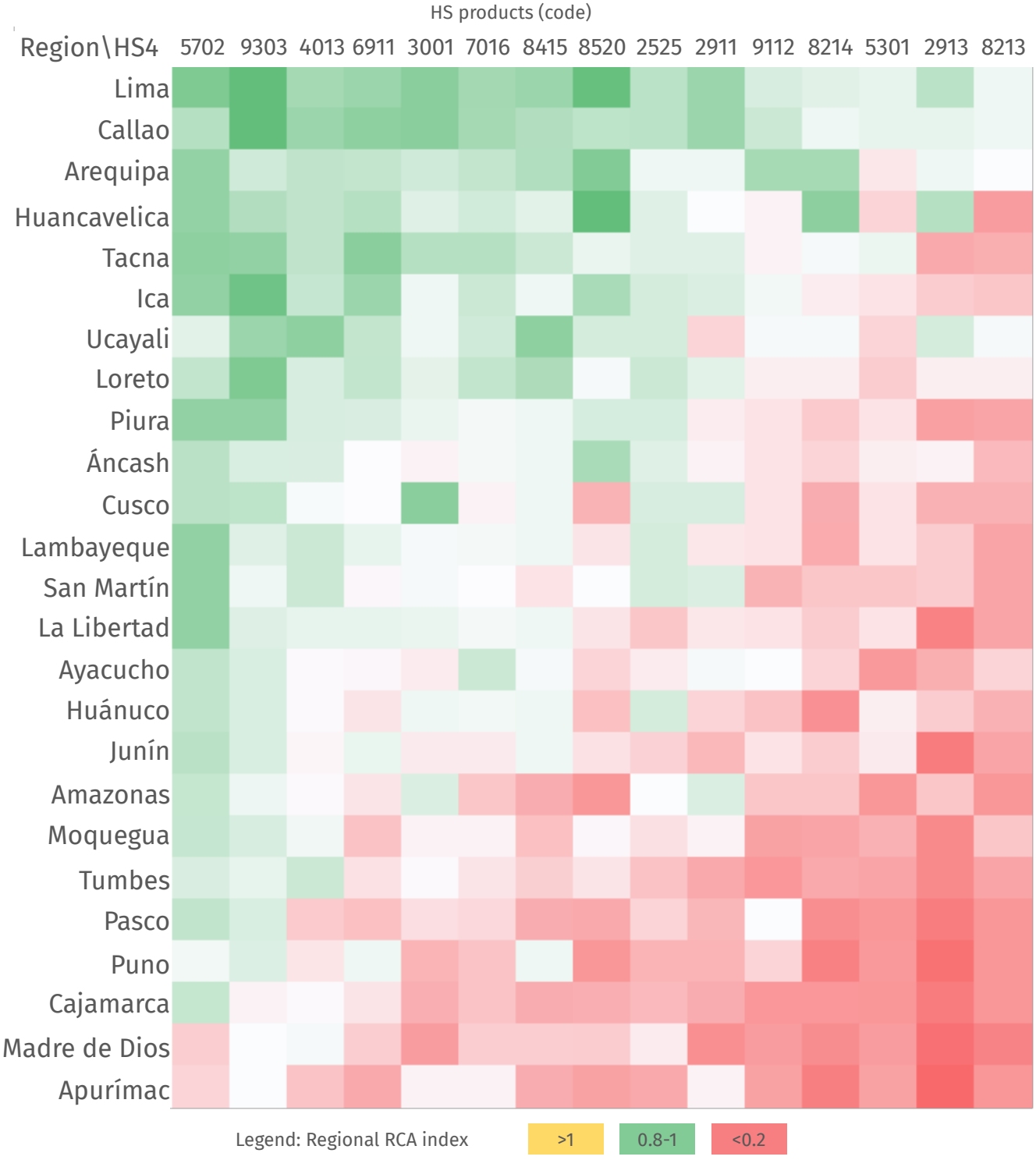
In Table 7, we shift the analysis to target products that are currently far away from Peru's current export basket (unrelated products, thus labelled as 'long jumps') that have a high degree of path dependence. These products require capabilities that are currently not fully available in the Peruvian economy while the lack of such capabilities has proven to be an important entry barrier. These targets are hence more ambitious in terms of feasibility, but with the aim of diversifying away from the current comparative advantage, these products could be highly interesting. It is important to note that this table includes products Peru has a strategic advantage in, i.e. a relatedness advantage compared to other countries at a similar level of development (that is, Peru is more closely related to these products).

Table 7 | Long jumps with a high path dependence, low relatedness and relatedness advantage (ranked by the relative relatedness advantage with respect to other upper middle-income countries)

HS code	HS description	Product sector	Complexity gain (USD)	Growth in global trade (%, 2017–19)	Countries specialized in production (2017–19)	Countries in the same income group specialized in production (2017–19)	Prod. relatedness	Relat. advantage	Number of new entries (1995–2019)	Index of vulnerability	Imp. penetr. index world	Imp. penetr. index TA
2525	Mica	Minerals	-5445	-7.3	14	3	0.375	0.085	2	0.204	1.002	1.053
8520	Magnetic tape recorders	Electronics	13195	7.9	13	4	0.375	0.065	4	0.258	1.153	1.218
5301	Flax, raw or processed	Textiles	10240	63.7	7	2	0.273	0.065	1	0.295	0.743	0.747
8213	Scissors	Metals	4402	5.3	6	3	0.273	0.064	1	0.28	1.152	1.144
9112	Clock cases	Machinery	10156	9.9	10	4	0.313	0.062	2	0.188	0.659	0.56
3001	Heparin for therapeutic use	Chemicals	23943	22.9	12	2	0.364	0.059	3	0.241	0.937	0.993
4013	Rubber inner tubes	Chemicals	2955	-4.5	15	2	0.375	0.056	4	0.297	1.266	1.127
2913	Derivatives of aldehydes	Chemicals	7786	25.9	5	2	0.278	0.056	1	0.121	0.806	0.633
8214	Other cutlery	Metals	2468	-1.7	9	3	0.313	0.05	1	0.073	1.144	1.111
9303	Other firearms	Machinery	1368	17.1	21	3	0.381	0.047	2	0.382	1.271	1.263
8415	Air conditioners	Machinery	9710	11.8	17	5	0.333	0.047	2	0.24	1.155	1.133
2911	Acetals and hemiacetals	Chemicals	20647	0.5	9	2	0.333	0.047	4	0.261	1.146	1.178
6911	Porcelain or China household articles	Stone	11024	8.5	19	6	0.368	0.046	1	0.324	0.831	0.708
5702	Woven carpets and rugs	Textiles	-609	1.3	21	5	0.381	0.045	6	0.472	1.19	1.134
7016	Glass paving blocks or other moulded products	Stone	154	-7.3	13	6	0.316	0.045	2	0.244	1.353	1.334

Within this group of products, the DIVE tool identifies products with a heterogeneous level of complexity, for instance *HS 3001 Heparin for therapeutic use* at nearly USD 24,000 to negative complexity gains of *HS 2525 Mica* and *HS 5702 Woven carpets and rugs*. The latter might still have some desirable features related to export potential or a relatively higher product relatedness with Peru's current export basket. This attractiveness might also be related to a more widespread feasibility from a geographical perspective; in this respect, *HS 5702 Woven carpets and rugs* is already being exported—albeit not with an RCA greater than 1—from nearly all regions of Peru (see Figure 7).

Figure 7 | Regional comparative advantage in target products reported in Table 7 (Long jumps with high path dependence, low relatedness and relatedness advantage)



Finally, Table 8 presents target products for which a distance from the current export basket is less relevant. These are products that are potential diversification targets for Peru with a low degree of path dependence as well as a high observed frequency of entry in the global economy. The combination of these two features suggests that the low initial relatedness with Peru's current export basket is unlikely to represent a constraint for the development of a specialization in the product. In fact, looking at the trend of comparative advantage in the last 25 years, we find that

Table 8 | Long jumps with a low path dependence, high frequency of new entries and few competitors (ranked by complexity gain)

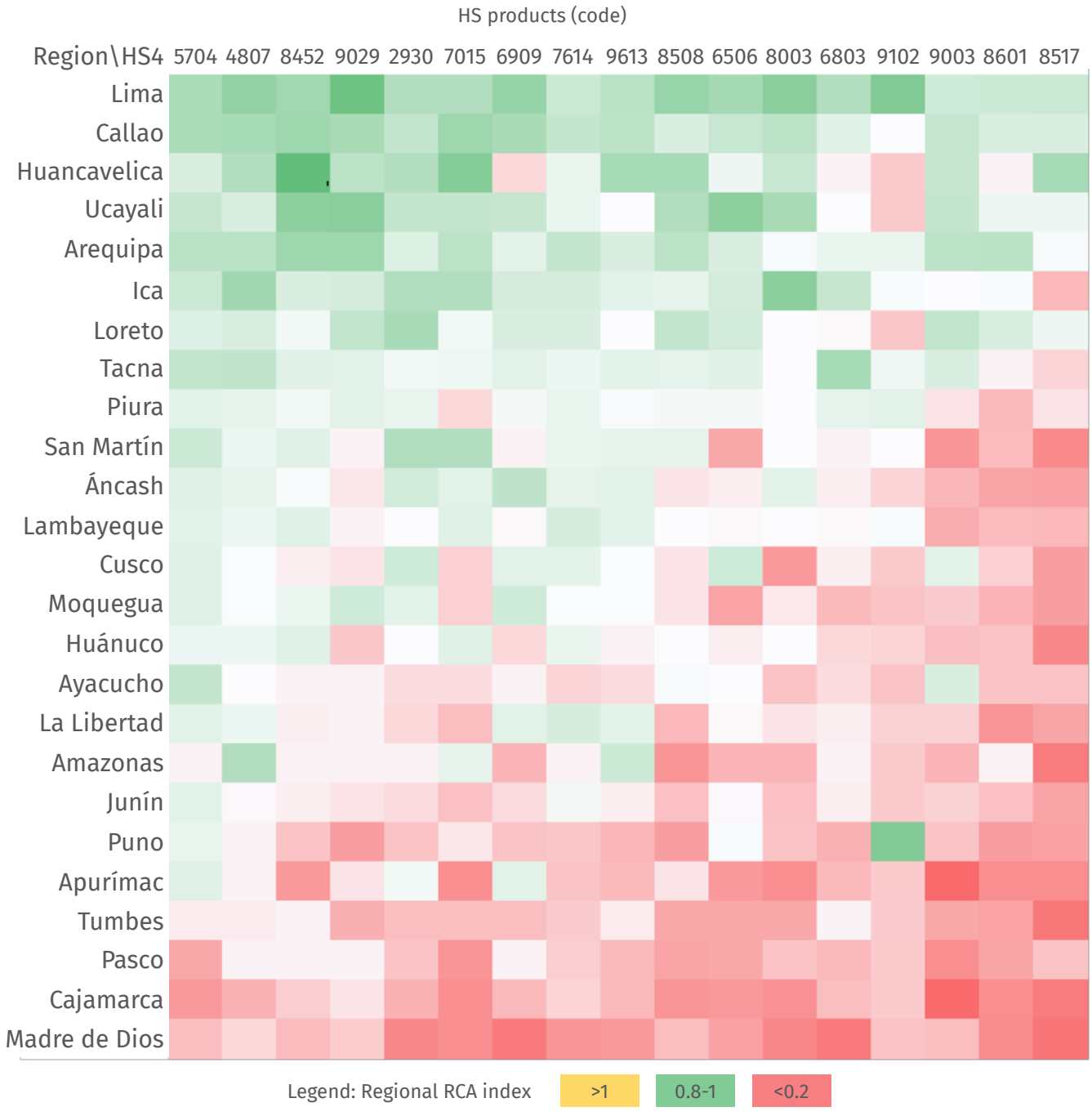
HS code	HS description	Product sector	Complexity gain (USD)	Growth in global trade (%, 2017–19)	Countries specialized in production (2017–19)	Countries in the same income group specialized in production (2017–19)	Prod. Relatedness	Relat. advantage	Number of new entries (1995–2019)	Index of vulnerability	Imp. penetr. index world	Imp. penetr. index TA
9102	Watches	Machinery	29190	1.2	17	6	0.368	0.115	9	0.581	0.786	0.792
7015	Clock or watch glasses and similar glasses	Stone	20359	-15.4	13	7	0.375	0.075	5	0.345	0.649	0.582
8508	Vacuum cleaners	Electronics	19836	9.9	12	4	0.333	0.031	6	0.44	1.235	1.296
8601	Electric trains	Vehicles	18588	25	9	3	0.316	0.053	7	0.443	0.481	0.376
2930	Organosulfur compounds	Chemicals	18335	-0.5	15	3	0.375	0.039	5	0.367	1.374	1.395
4807	Uncoated composite paper	Agriculture	18180	-2	14	4	0.357	0.044	6	0.485	0.884	0.902
9003	Frames for spectacles, goggles	Machinery	16677	4.1	15	4	0.316	0.007	5	0.407	1.077	1.148
6909	Ceramic wares for technical ware	Stone	15236	12.2	12	4	0.353	0.043	7	0.531	0.918	0.933
8517	Telephones	Electronics	12862	-12.5	11	4	0.25	0.01	11	0.559	0.972	0.956
6803	Worked slate	Stone	12789	0.1	11	3	0.333	0.072	5	0.569	0.975	1.038
8003	Tin bars and wire	Metals	12451	3.1	11	3	0		10	0.548	0.669	0.687
9029	Meters	Machinery	11179	6.1	16	3	0.375	0.042	7	0.476	1.169	1.25
9613	Cigarette lighters	Machinery	9582	-1	13	5	0.313	0.017	7	0.495	1.079	1.061
6506	Other headgear	Textiles	9517	13.9	17	3	0.316	0.027	5	0.455	1.106	1.148
8452	Sewing machines	Machinery	9329	-1.2	15	5	0.375	0.031	7	0.496	0.892	0.811
7614	Aluminium wire, not insulated	Metals	8267	12.6	17	7	0.321	0.063	7	0.468	1.192	1.037
5704	Carpets of felt	Textiles	7364	-12.4	17	3	0.368	0.065	7	0.606	0.824	0.842

many countries—even those with an unrelated initial specialization—have managed to acquire a comparative advantage in the product. These products might be of high interest as a policy target, provided that they possess other characteristics (e.g. complexity, positive spillovers, strategic sectors), which make them desirable for Peru. The products in Table 8 are ranked by their complexity gain. Interestingly, this set shows high values in terms of the import penetration index (a high market potential for Peruvian firms) in comparison with the previous one. In this respect, *HS 2930 Organosulfur compound (chemicals)*, *HS 8508 Vacuum cleaners (electronics)*, *HS 9029 Meters*

(machinery), *HS 7614 Aluminium wires (metals)* show high values for market potential in countries to which Peru has preferential market access. The number of new entries in the period 1995–2019 is suggestive of the fact that these target products are not a priori out of reach of diversification policies.

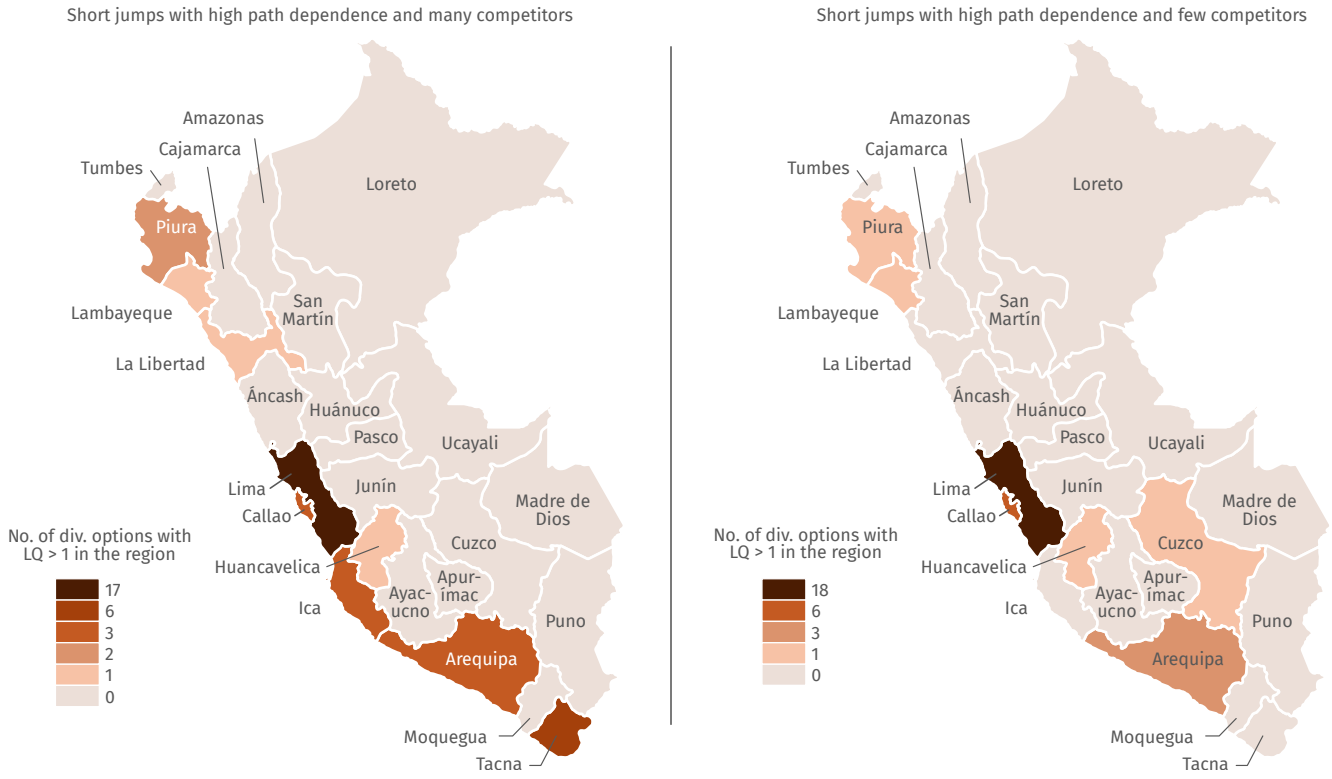
Table 8 reports *HS 8601 Electric trains*—a 'new' product when we look at the regional dimension reported in Figure 8—which presents a high complexity gain and a relatively low number of specialized countries and new entries in the global economy. The opposite is true for HS 5704 Carpets of felt, a less ambitious target in terms of strategic value, where local production capabilities are present and geographically widespread.

Figure 8 | Regional comparative advantage in target products reported in Table 8
(Long jumps with a low path dependence, high frequency of new entries and few competitors)



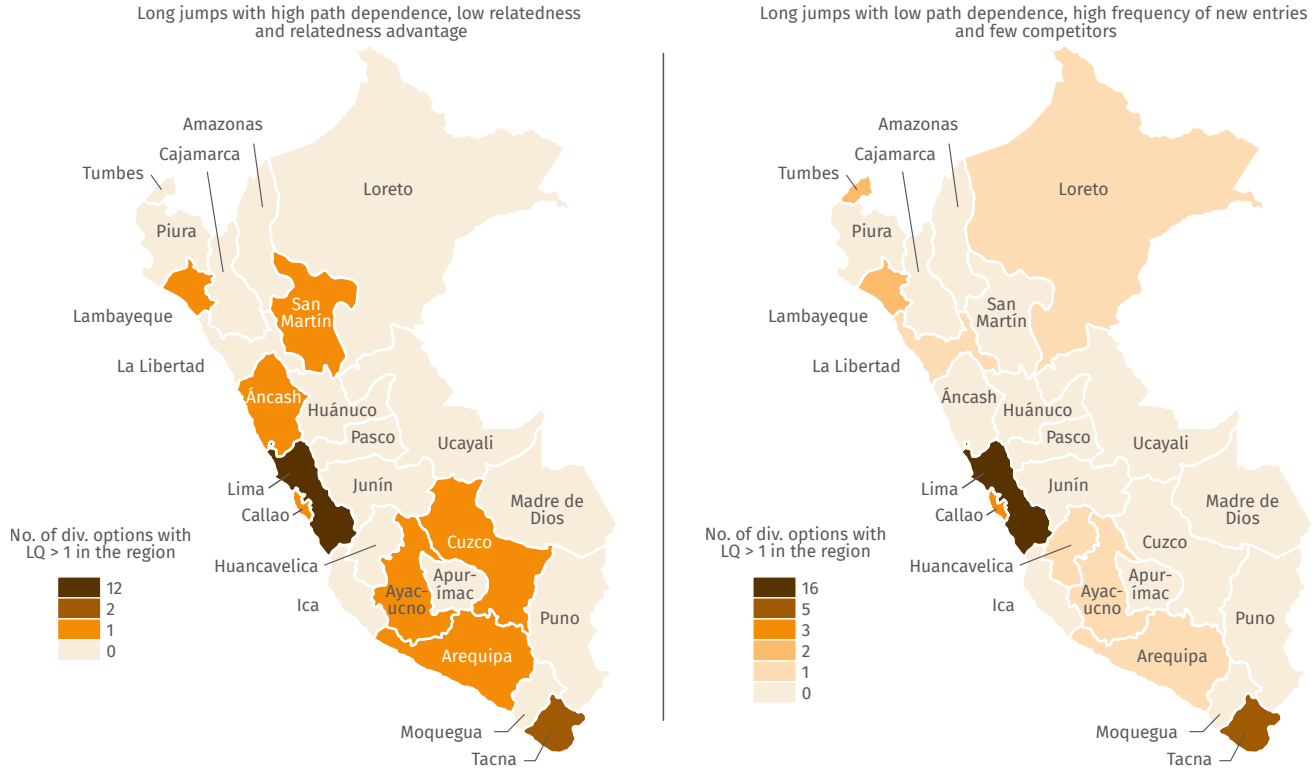
Moving the focus of the analysis to the regional dimension, we provide some information on where the producers of the identified options are located. This helps us understand whether some initial capabilities are present when analysing exports at a territorial disaggregated level.

Figure 9 | Regional distribution of current exports of products in diversification strategies (average 2017–2019). Short jumps



For each Peruvian region, Figure 9 presents the number of products in the diversification OS of short jumps that have a location quotient above unity. This captures regions with product export shares that are higher than the Peruvian average. Lima is the region with the strongest presence of exports of products reported in Tables 5 and 6 (17 and 18 products, respectively). Panel a) shows that 6 out of 20 products among the short jumps with a high path dependence and many competitors are located in the Tacna region while the regions of Arequipa, Callao and Ica have an export share that is higher than the Peruvian average for only three products. Piura, La Libertad, Lambayeque and Huancavelica are already exporting a significant value of trade for at least one of the proposed products. Among these products, those produced and exported in different regions are *Refrigerators, freezers (HS 8418)* in Callao, Ica, Lima and Piura; *Fish, excluding fillets (HS 0302)* in Callao, Ica and Piura; *Leather apparel (HS 4203)* in Arequipa, La Libertad and Lima; *Synthetic sowing thread (HS 5401)* in Lambayeque, Lima and Tacna; and *Activewear (HS 6211)* in Arequipa, Lima and Tacna. Panel b) presents more concentrated values: apart from Lima (18 products), other regions with above average export shares include Callao (6), Arequipa (3), Huancavelica (1), Lambayeque (1), Cusco (1) and Piura (1). Focusing on products, we highlight the presence of three products in at least three different regions. These are *Woven fabrics of carded wool (HS 5111)* in Arequipa, Huancavelica and Lima, *Ball or roller bearings (HS 8482)* in Arequipa, Callao and Lima. *Silk waste (HS 5003)* was not exported by any Peruvian region in the 2017–2019 period.

Figure 10 | Regional distribution of current exports of products in diversification strategies (average 2017–2019). Long jumps



For each Peruvian region, Figure 10 presents the number of products in the diversification OS of long jumps that have a location quotient above unity. Lima is the region with the strongest presence of exports of products reported in Tables 7 and 8 (12 and 16 products, respectively). Panel a) presents relatively concentrated values: regions have above average export shares for only few products and, in most cases, for only one. Tacna has a slight relative advantage in the production of two products (*HS 8214 Other cutlery* and *HS 9112 Clock cases*), while Ancash, Arequipa, Ayacucho, Callao, Cusco, Lambayeque and San Martin only have a relative advantage for one product. The most ubiquitous products are *Woven carpets and rugs (HS 5702)* and *Glass paving blocks or other moulded products (HS 7016)* with a location quotient higher than unity in three regions. Panel b) shows that five of the long jumps with a high path dependence, low relatedness and a relatedness advantage are located in the Tacna region while Callao has an export share higher than the Peruvian average for three products (*HS 2930 Organo-sulfur compounds*, *HS 8517 Telephones* and *HS 9029 Meters*). Arequipa, Lambayeque and Tumbes already export two long jump diversification options. Among these products, those produced and exported from different regions are *Other headgear (HS 6506)* in Arequipa, Ayacucho, La Libertad, Lima and Tacna; *Aluminium wire, not insulated (HS 7614)* in Lambayeque, Lima and Tacna; *Sewing machines (HS 8452)* in Lambayeque, Lima and Tumbes; *Telephones (HS 8517)* in Callao, Huancavelica and Lima; and *Meters (HS 9029)* in Callao, Lima and Loreto.

In the last step of our analysis, we compare the priorities/targets identified by the DIVE methodology with those recently defined by the PRODUCE methodology described in Alvarez and Huamaní (2017). In their study, the authors propose a prioritization strategy that combines—like in Hausmann et al. (2014a, 2014b)—feasibility and desirability, but for the measurement of the latter, they explicitly account for additional relevant policy variables such as impatience (measured with an inter-temporal discount parameter) and risk aversion. For products in Peru's potential diversification space, the authors computed the 'Valor Estratégico Esperado y Descontado' (VEED), which provides an assessment of the strategic potential

of target products considering the balancing of discounted expected gains and risks. Although this approach has the merit of adding two relevant criteria for prioritization which have been disregarded by other studies, we believe that the selection is characterized by the same limitations highlighted in Chapter 2, namely that there is an a priori assumption that 'distance' (the key measure of feasibility of a diversification strategy) is always relevant, i.e. that distance from the initial export basket matters for all products. Our selection of target products corrects for this methodological limitation by considering a product-specific measure of feasibility based on observed path dependence rather than on an assumed one.

The comparison between the two prioritization strategies is highly relevant insofar as it provides additional robustness, considering that products identified as potential targets by both methodologies are likely to present attractive features in terms of a feasibility/desirability (or strategic value) mix. Table 9 reports the products identified by PRODUCE, which are also included in the selection presented above. The DIVE prioritization analysis contains 21 of the 87 products listed in the PRODUCE analysis performed using Alvarez and Huamaní's methodology (2017).[28] These overlapping products belong to both the 'short' and 'long' jumps category over the Peruvian diversification space. Among the short jumps, i.e. products that are closer to Peru's current specialization basket and which the country possesses a relatedness advantage in relative to competing economies, Table 9 incudes one product in the textile industry, *HS 5601 Wadding of textile materials*, two products in the machinery industry *HS8418 Refrigerators, freezers* and *HS 8465 Machine tools for working wood* (see Boxes 2 and 3), and three in the chemical industry, *HS 3207 Prepared pigments*, *HS 3913 Natural polymers* and *HS 4008 Vulcanized rubber plates*. The list of commonly identified long jumps is more comprehensive, from pharma products (*HS 3001 therapeutic heparin*) to different types of machinery and meters.

These are products for which a more in-depth analysis of bottlenecks and market failures preventing diversification might be especially valuable.

[28] Note that the match between HS and SICT classification is an imperfect exercise as there is no perfect overlap of products in these two classifications.

Table 9 | Comparing UNIDO's DIVE with PRODUCE's targets

Short jumps with a high path dependence and many competitors			
DIVE methodology		**PRODUCE methodology**	
HS 4 Description	**HS 4 code**	**SICT 4 code**	**SICT 4 Description**
Wadding of textile materials	5601	6577	Textiles Tejidos para Maquinarias y plantas industriales
Refrigerators, freezers	8418	7414	Equipo de refrigeración varios

Short jumps with a high path dependence and few competitors			
DIVE methodology		**PRODUCE methodology**	
HS 4 Description	**HS 4 code**	**SICT 4 code**	**SICT 4 Description**
Prepared pigments	3207	5335	Esmaltes
Natural polymers	3913	5852	Plásticos artificiales diversos
Vulcanized rubber plates	4008	6210	Materiales de cauchos
Machine tools for working wood	8465	7442	Maquinaria de elevación y carga

Long jumps with a high path dependence, low relatedness and relatedness advantage			
DIVE methodology		**PRODUCE methodology**	
HS 4 Description	**HS 4 code**	**SICT 4 code**	**SICT 4 Description**
Heparin for therapeutic use	3001	5417	Medicamentos
//	3001	5989	Productos químicos *
Glass paving blocks or other moulded products	7016	6649	Vidrio diverso
Magnetic tape recorders	8520	8812	Cámaras y equipos de cine

Long jumps with a low path dependence, high frequency of new entries and few competitors			
DIVE methodology		**PRODUCE methodology**	
HS 4 Description	**HS 4 code**	**SICT 4 code**	**SICT 4 Description**
Uncoated composite paper	4807	6428	Cajas de papel, impresiones varias, manufacturas diversas de papel
//	4807	6418	Papel recubierto
//	4807	6424	Papel cortado a medida
Clock or watch glasses and similar glasses	7015	6649	Vidrio diverso
Vacuum cleaners	8508	6973	Estufas domésticas no eléctricas
//	8508	8749	Piezas de instrumentos de medición *
Telephones	8517	7247	Maquinaria para textil varios
//	8517	7267	Máquinas de impresión diversas
//	8517	7648	Equipos de telecomunicaciones varios *
Meters	9029	8732	Dispositivos de conteo no electrónico
//	9029	8749	Piezas de instrumentos de medición

(*) Partial match between the Harmonized Systemt (HS) and the SICT classifications.

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Chapter 5

Peru in the global economy: Recent trends and potential diversification strategies

The design of diversification and industrial and innovation policies is a complex task that relies on a comprehensive set of methods and information. The aim of applying the DIVE tool to Peru is to highlight information that could support the process of prioritization of target products/sectors in diversification policy. The tool provides a first-level diagnosis of the trends of Peru's export basket, highlighting notable features such as its structural vulnerability, i.e. the potential of other countries to specialize in products that belong to Peru's current export basket, and to analyse the ability of Peru and its individual regions to jump over the PS in the direction of unrelated products. The latter is an interesting proxy of the ability of the Peruvian economy to acquire or recombine production capabilities, a key ingredient of structural change. In fact, although Peru scores significantly worse in terms of diversification than other countries at a similar level of development, the concentration of its export basket in a few—often low complexity—products, the analysis of recent new entries provides a positive assessment of the country's ability to defy its static comparative advantage. The regional analysis reveals a highly heterogeneous degree of diversification and dynamism, which policymakers should take into account.

Our analysis provides an assessment of the 'direction' Peru's diversification strategies could take in the future. The list of potential products that might represent new sectors/areas of diversification should be considered a first step in the design of policies. To this end, the DIVE tool provides useful information and new metrics for analysing specific 'target' products. Additional information at the product level is reported in Boxes 2-3, a starting point for a useful and highly recommended second layer of assessment of potential targets with the aim of a more in-depth analysis of specific value chains and the identification of key production nodes, where rents are concentrated and for which a diversification strategy for Peru is feasible. This second layer of analysis—once potential opportunities for diversification have been identified—should focus on obtaining an informed picture of industry dynamics (e.g. evolving technologies, potential demand, key industrial and institutional players) as well as the precise identification of market failures and bottlenecks that prevent the development of target sectors. Targets have a strategic value that is related to the actual and/or potential linkages with domestic firms. The analysis should also highlight those sectors connected by backward and forward linkages that are already competitive or might become competitive in the near future with adequate policy stimuli (Farooki and Kaplinsky, 2014).

The analyses of specific markets/sectors should be aimed at understanding which actions/incentives might correct prevailing market failures or which specific public good is required. This analysis cannot be conducted by governments without the involvement of relevant actors from the private sector and without a rigorous assessment of the technical, organizational and political capacity to implement policy actions.

References

1. Agosín, M., Larraín, C., and N. Grau (2009). *Industrial policy in Chile* (Working Paper No. 294). Santiago de Chile: Departamento de Economía Universidad de Chile.
2. Agosin, M. R., Urzúa, S., Wagner, R., Trejos, A., De Olloqui, F., Pietrobelli, C., ... & Panizza, U. (2014). *¿Cómo repensar el desarrollo productivo?: políticas e instituciones sólidas para la transformación económica*. Inter-American Development Bank
3. Álvarez Lourdes and Edson Huamaní (2017). *Identificación de Nuevos Motores para la Diversificación Productiva de Perú*. Manuscrito no publicado.
4. Arellano-Yanguas, J. (2019). Extractive industries and regional development: lessons from Peru on the limitations of revenue devolution to producing regions. *Reg. Fed. Stud*. 29 (2), 249–273.
5. Banco Interamericano de Desarrollo (2010). *La era de la productividad: cómo transformar las economías desde sus cimientos*. Washington, D.C.: BID.
6. Bril-Mascarenhas T. and A. Madariaga (2019). Business power and the minimal State: the defeat of Industrial Policy in Chile. *The Journal of Development Studies*, Vol. 55(6): 1047-1066.
7. Chang, H. and Lebdioui, A. (2020). From fiscal stabilization to economic diversification: a developmental approach to managing resource revenues (Documento de trabajo No 2020/108). WIDER Documento de trabajo. 10.35188/UNU-WIDER/2020/865-8.
8. Coniglio, N.D., Vurchio, D., Cantore, N. and Clara, M. (2021). On the evolution of comparative advantage: Path-dependent versus path-defying changes. *Journal of International Economics*, Volume 133.
9. Farooki Masuma and Raphael Kaplinsky (2014). Promoting diversification in resource-rich economies. *Mineral Economics*, Vol. 27:103–113.
10. Ghezzi, P. (2019). *Mesas ejecutivas en Perú. Una tecnología para el desarrollo productivo. Documento para discusión N° IDB-DP-711.*
11. Hausmann R. Hwang, J. and Rodrik, D. (2007). What you export matters. *Journal of Economic Growth*, vol. 12(1), pages 1-25, Marzo.
12. Hausmann R. and Hidalgo, C. (2011). The network structure of economic output. *Journal of economic growth*, vol. 16(4), Diciembre.
13. Hausmann, R., Hidalgo, C. A., Bustos, S., Coscia, M., Simoes, A., & Yıldırım, M. A. (2014a). The atlas of economic complexity: Mapping paths to prosperity. MIT Press.
14. Hausmann, R., Cunningham, B., Matovu, J., Osire R., & Wyet. K. (2014b). How should Uganda grow? Center for International Development at Harvard University, CID Working
15. Hausmann R., and D. Rodrik. (2003). Economic Development as Self-discovery. *Journal of Development Economics*, vol. 72:603–633.
16. Hidalgo C. and Hausmann R. (2009). The Building Blocks of Economic Complexity. *Documentos 0909.3890, arXiv.org*
17. Hidalgo, C., Klinger, B., Barabasi, A. and Hausmann, R. (2007). The Product Space Conditions the Development of Nations. *Science Magazine 317(5837): 482-487.*
18. Inter-American Development Bank / Banco Interamericano de Desarrollo (2014). *¿Cómo repensar el desarrollo productivo? Políticas e instituciones para la transformación económica*. Crespi, G., Fernández-Arias E. and E. Stein (Eds).
19. Inter-American Development Bank. (2014). Rethinking productive development: Sound policies and institutions for economic transformation. New York, NY: Palgrave Macmillan.
20. OECD/WTO (2019). Aid for Trade at a Glance 2019: Economic Diversification and Empowerment. OECD Publishing, Paris, https://doi.org/10.1787/18ea27d8-en.

21. Orihuela, José Carlos and Victor Gamarra Echenique (2019). Volatile and spatially varied: The geographically differentiated economic outcomes of resource-based development in Peru, 2001–2015. *The Extractive Industries and Society*, vol. 6, pp. 1143-1155.
22. PRODUCE – Ministerio de la Producción (2016). Mesas Ejecutivas: Nuevas Herramientas para la Diversificación Productiva en el Perú. Lima: PRODUCE.
23. United Nations Conference on Tariffs and Trade - UNCTAD (2018). Informe sobre las inversiones en el mundo: La inversión y las nuevas políticas industriales.
24. UNIDO (2012). Promoting industrial diversification in resource intensive economies—the experiences of Sub-Saharan Africa and Central Asia Regions, http://www.unido.org/fileadmin/user_media/Publications/Research_and_statistics/Branch_publications/Research_and_Policy/Files/Reports/Other_Reports/Promoting%20Industrial%20Diversification%20Report.pdf
25. UNIDO (2016). UNIDO Industrial Development Report, "The role of technology and innovation in inclusive and sustainable industrial development", Vienna. https://www.unido.org/resources-publications-flagship-publications-industrial-development-report-series/industrial-development-report-2016
26. UNIDO (2023). DIVE tool manual. Diversifying Industries and Value-Chains for Exports. https://www.unido.org/sites/default/files/files/2023-06/DIVE_Tool_Manual.pdf.

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Appendices

Appendix A: Methodological details

a. Identification of export baskets

Using trade data HS 4-digit Rev. 1992, we adopt the Balassa index of revealed comparative advantage to quantify the degree of export specialization for each product *i*, each country *k* and each year *t*. The index of export specialization is computed as follows:

$$RCA_{ikt} = \frac{\frac{x_{ikt}}{\sum_i x_{ikt}}}{\frac{\sum_k x_{ikt}}{\sum_i \sum_k x_{ikt}}}$$

Where x_{ikt} is the export value of product *i* in country *k* at time *t*. The Balassa index is computed for all years for which data are available. A product is only included in a country's export basket if its RCA was above unity for at least two years in the interval $[t,t+2]$.

b. Computation of relatedness between products

Following Hidalgo et al. (2007), we compute the network of relatedness as the minimum of the pairwise conditional probability of being co-exported with an RCA above unity over a three-year period $[t,t+2]$. The relatedness between product *i* and product *j* at time *t* is thus computed as follows:

$$\varphi_{ijt} = min\{P(EB_{it}/EB_{jt}, P(EB_{jt}/EB_{it})\}$$

where EB_{it} denotes the presence of product *i* in the export basket at time *t*. The degree of similarity in the capability required to produce different goods changes over time, and thus for computing distances in terms of relatedness, we adopt year-specific networks.

c. New export specializations

A product is a new export specialization at time *t* if:

1. it is exported with an RCA higher than unity at time *t*;
2. it has been exported with an RCA lower than 0.5 for at least two in the previous 5 years;
3. it has never been exported with an RCA higher than unity in the previous 5 years;
4. alternatively,
    1. it has been exported with an RCA higher than unity for at least 2 years in the following 5 years and has been exported with an RCA lower than 0.5 for no more than once in the following 5 years;
    2. it has been exported with an RCA higher than unity in the following 3 years;
5. the average export value in the following 5 years is higher than the average export values in the previous 5 years;
6. the export value at time *t* is higher than USD 1 million.

d. The option set (OS)

To be included in a country's OS and in line with ex-ante criteria for the identification of new entries, a product is part of the diversification (or option) set if it:

1. is exported with an RCA lower than unity at time *t*;
2. is exported with an RCA lower than 0.5 for at least two years in the previous 5 years;
3. is never exported with an RCA higher than unity in the previous 5 years.

We retrieved information of countries' option sets for the period 2000–2019.

e. Distance between new entries/products in the OS and pre-existing export basket

The degree of relatedness between products outside the export basket and those already being exported with an RCA is given by the degree of proximity between such new entries/products in the OS and the closest products among those in the export basket.

$$dist_{i,EB_{kt}} = max\{\varphi_{ij}\} \; with \; j \in EB_{kt}$$

where product i is the new entry (or alternatively, the product in the diversification set) and EB_{kt} is the country's export basket at time t. In our approach, we focus on this definition, avoiding measures of average distance from the overall export basket, e.g. network density metrics. A measure of network density is reliable in a context of an ex-ante forecast of potential new entries and, as reported in many works that adopted the PS framework, is correlated with the probability of entering a country's export basket. Our analysis relies on the distance of actual new entries and potential ones to export baskets, and we virtually attach the new entries that are close to the most related product. Averaging over the entire set of proximities would underestimate the degree of relatedness of products with high similarities in terms of local capabilities with only a few existing specializations.

To compute the relatedness of new export specializations and products in the diversification space at time t, we adopt relatedness matrices referred to as time $t - 5$ so that the proximity is computed a priori, thus avoiding endogeneity.

f. Product index of path departure

To detect the extent to which a product usually follows 'the path', we have developed three alternative metrics that capture distinct aspects of diversification. The three metrics focus on the country-product dimension to capture the country-specific heterogeneity of product path dependence and subsequently, aggregate the information on path departure at the product level.

The first step is to identify the average proximity of the products in the OS for each country and each initial year. This represents the threshold for distinguishing between path-dependent and path-defying new entries.

- Relative distance from threshold: the first metrics compute the extent to which a single new entry defies the path and is given by the ratio between the difference in relatedness between the threshold and the new entry and the threshold value, as follows:

$$ipd_{ikt} = \frac{\mu_{kt} - dist_{i,EB_{kt}}}{\mu_{kt}}$$

where μ_{kt} is the country-time-specific threshold and $dist_{i,EB_{kt}}$ is the distance between new entry i and the pre-existing export basket of country k at time t - 5. The index has a positive value when the new entry has a lower proximity to the export basket than the OS, on average. The metrics obtained thereby are subsequently aggregated at the product level for the entire period of analysis, as follows:

$$IPD_i = \frac{\sum_t \sum_k ipd_{ikt}}{|NE_i|}$$

where $|NE_i|$ is the number of total new entries of product i in the period considered.

- Share of path-defying new entries: by adopting the threshold value introduced above, we assign a dichotomic value to each new entry: if the relatedness is higher than the average proximity of the OS, it represents a path-dependent new entry; by contrast, if the relatedness of the new entry is lower than the average proximity of the OS, it is labelled as a path-defying new entry.

$$d\_ipd_{ikt} = \begin{cases} 1 \; if \; \mu_{kt} > dist_{i,EB_{kt}} \\ 0 \; otherwise \end{cases}$$

The product-level metrics, similarly to the previous one, is computed as follows:

$$d\_IPD_i = \frac{\sum_t \sum_k d\_ipd_{ikt}}{|NE_i|}$$

- The third metrics take the entire distribution of the OS's relatedness distribution into consideration. Each new entry's inverse measure of distance from the export basket ($dist_{i,EB_{kt}}$) is associated with a percentile in the distribution of the OS ranging from 0 to 100. Higher values denote path-dependent new entries, thus we transform this value into a measure of path departure as follows:

$$percentile_{ikt} = 1 - rank_{OS,ikt}/100$$

The path departure product-country-time-specific metrics are subsequently transformed into a product-specific measure of path departure as follows:

$$av\_perc\_dep_{it} = \frac{\sum_t \sum_k percentile_{ikt}}{|NE_i|}$$

g. Product and country index of vulnerability

As reported in the main text, a vulnerable product is one with a high level of path departure (low path dependence suggests that the set of available local capabilities is not difficult to acquire), high ubiquity (due to the fact that capabilities are present in several countries, so international competition is high), and high frequency of entry (high level of contestability in the middle-long run).

All three dimensions are computed using an index with values ranging from 0 to 1. For frequency and ubiquity, the product value is obtained as the relative position (percentile) of its frequency/ubiquity with respect to other products' frequency/ubiquity. A value of 1 is assigned to products that entered export baskets the most. A value of 0.5 is assigned to products in the middle of the distribution. The value of the degree of product-level path defiance is computed by:

1. comparing new entry relatedness with the pre-existing export basket with the OS's relatedness distribution and obtaining a value for each new entry in each country;
2. averaging the product-country relative position in the OS distribution across countries. Products with a value of 1 have the lowest level of relatedness of all products in the OS.

The three dimensions are joint in a unique index computed as follows:

$$IPV_i = \frac{\sqrt{freq_i^2 + pathdepa_i^2 + ubiq_i^2}}{\sqrt{3}}$$

where the index of product vulnerability of product *i* is equal to the square root of the sum of the square of the three components divided by the square root of 3 (the denominator serves to obtain an index ranging in the [0,1] interval). Assuming the product index of frequency, the product index of path departure and the product index of ubiquity as three dimensions represented as a 3x1 vector, the numerator corresponds to its norm.

Moving to the country dimension, we can easily compute the index of structural vulnerability for the export basket. This is obtained as the weighted average of the indices of product vulnerability, where the weights are given by the export shares of product *i* of country *k*.

$$ISV_k = \sum_i sh_{ik} IPV_i$$

h. Country index of path departure

All product indices of path departure presented have been used to obtain a metric that is valid for the entire set of products exported by each country. Similarly to the measure adopted, with ipd_i denoting the product index of path departure, the country measure is obtained as follows:

$$IPD_k = \sum_i sh_{ik} ipd_i$$

where IPD_k indicates, alternatively, the country's relative distance from path dependence, the share of path-dependent new entries or the average percentile position of the country's export basket.

i. Country index of structural dynamism

By considering one measure that has already been introduced, i.e. the country index of path departure (as measured by the percentile method) and the number of new entries of each country in the period analysed, we obtain a country index of structural dynamism (*ISD_k*), which gives a measure of how dynamic an economy's export basket is over a given period (in our case, 1995–2019).

We have already introduced the country index of path departure. The number of a country's new entries is normalized in the interval [0.1] by assigning a value to each country that corresponds to its relative position in the distribution of countries' new entries number. In other words, the country with the highest number of new entries over the period analysed, i.e. the country that witnessed the biggest changes in its set of specializations, has a value equal to 1. If a country has no entries, it has a value very close to 0.

Similarly to the country index of structural vulnerability, we have added the two dimensions as follows:

$$ISD_i = \frac{\sqrt{NE\_rank_i^2 + pathdepa_i^2}}{\sqrt{2}}$$

where NE_rank_i is the relative position of country i in the distribution of world economies according to the number of new entries in the period 1995–2019. The denominator serves as a correction to obtain an index bounded in the interval [0,1].

Appendix B: Definitions and key concepts

Revealed Comparative Advantage (RCA) is an index that can be used to compute the relative advantage—or disadvantage—of an economy in producing a certain product or class of products using international trade data. In its best-known formulation, the Balassa index of RCA of an economy *c* in the production of a good *c* is given by the ratio between the relative value of good *i* exports over country *c* total exports (country export share of product *i*) and the relative value of good *i* exports over global total exports (world export share of product *i*). Values lower than 1 reflect a country's disadvantage in the production of a product while values higher than unity reflect a country's relative advantage in the production of a product. Its success is due to its ability to proxy the underlying structure of an economy since it allows identification of which (set of) class of products an economy is specialized in, or 'the export basket' (the bundle of products exported with an RCA higher than 1).

Path dependence/path defiance. A path-dependent new entry occurs when a newly introduced specialization is related to the existing export basket. By contrast, with path departure (or path defiance), we indicate the case in which a new economic specialization is characterized by the presence of production capabilities non-strictly related to those already developed in a country.

Export basket: the set of products[29] countries have a specialization in. The export basket is identified measuring RCAs. In this study, using export data[30], we analyse how export baskets change over time or in other words, we identify 'new entries' in the export basket in recent decades for all countries in the world. One of the core novelties of the DIVE tool is the assessment of the degree of "path dependence" of these new product specializations.

The Product Space (PS). The PS is a network representation of all goods traded in the world in which every good is linked to others according to its "relatedness". Hidalgo et al. initially presented the PS in a seminal contribution published in 2007, entitled "The Product Space Conditions the Development of Nations". The authors highlight the role of path dependence in the process of a country's specialization over time. As economies' export mix changes, there is a strong tendency to move towards related goods rather than to goods that are less related.

Relatedness. The theoretical concept of relatedness refers to the degree to which the set of production capabilities required for specialization in the production of two products (say product A and product B) overlap. The empirical measure of relatedness is the (minimum of) pairwise probability that products A and B are co-exported with a revealed comparative advantage higher than 1 (RCA>1). See Hidalgo et al. (2007) and Appendix A for details on how relatedness is computed.

Relatedness advantage. We define this measure as the difference between the relatedness of product i to the export country of the country under analysis (in our case Peru) and its relatedness with other countries at a similar level of development. A higher advantage signals that the country is in a better position to diversify towards the product compared to potential competitors; this concept is relevant for products characterized by a high level of path dependence (low level of path defiance).

Product sophistication or complexity (PRODY). Products are complex or sophisticated when they require a complex set of productive capabilities that are generally abundant and available in high productivity economic contexts (for instance those that characterize rich and developed economies). In this report, we measure product

[29] We identify products according to the Harmonized System (HS) nomenclature, Rev. 1992.

[30] We adopt the BACI dataset provided by CEPII.

complexity by employing the PRODY index developed by Hausmann et al. (2007).

Sophistication or complexity gain. We report a measure of the gain in complexity associated with a new entry (actual or potential), which is given by the difference between the product's PRODY and the country's EXPY. The higher the gain, the higher the potential of a product to increase a country's level of production complexity.

Country sophistication or complexity (EXPY). Using the values of the PRODY of products belonging to countries' export baskets, we measure the aggregated level of complexity or sophistication. Empirical results show that the measures of complexity are positively correlated with level of income, and that deviations from this relationship are predictive of future growth.

Diversification space or option set. The diversification space, alternatively referred to as option set (OS), is the country-time-specific bundle of products representing potential specializations that have not yet been developed. For each country and for each year of analysis, the OS represents the bundle of potential new entries.

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