Structural Interdependence Among Peruvian Departments

Wallace Patrick Santos de Farias Souza – UFPB – USP
Pós-doutorando em Economia – FEA-USP – NEREUS
Doutor em Economia Aplicada – UFRGS
Professor do Departamento de Economia - UFPB

Fernando Salgueiro Perobelli – UFJF
Doutor em Economia, Professor Titular do Departamento de Economia da Universidade Federal de Juiz de Fora (UFJF), Brasil.

Eduardo Amaral Haddad – USP
Doutor em Economia, Professor Titular da Faculdade de Economia, Administração, Contabilidade e Atuária da Universidade de São Paulo (FEA-USP), Brasil.

Regional interdependence can be measured by different approachs. In this paper we will implement a sistemic analysis using the idea of intersectoral linkages to address this issue. More specifically we will implement a hypothetical extraction approach. In order to build a regional hierarchy in terms of interdependence we will extract each of the 26 regions one at a time. We depart from an inter-regional input-output matrix calibrated for 2022 with 12 productive activities and 26 regions. Both the sectorial and spatial disaggregation will enable to contribute to a better understanding of the regional issues in Peru. Peru presents a high degree of regional heterogeneity both in terms of sectorial production and income distribution. Among the historical causes of regional disparities, criteria related to resource distribution, geographical factors, and climate change have contributed to the unequal development across the country. The territorial division into three major regions (coast, mountain, and jungle) since the colonial period has resulted in unequal opportunities for development, with extractive activities impacting growth in an inequitable manner. These disparities ultimately create gaps in human capital accumulation between regions, establishing an intergenerational cycle of poverty and inequality.

Keywords: hypothetical extraction; inequality; growth; Peru

JEL Classification: R15; O54; R11; O18

ÁREA 3: Localização e concentração das atividades econômicas

1. Introduction

Different indicators can be used to measure regional interdependence. This article focuses on intermediate consumption using interregional input-output matrix data for Peru for the year 2022, in order to analyze sectoral interdependence among the country's 26 departments. Analyzing the structure and regional interdependence is important for understanding development disparities, identifying spatial connections, and informing better regional policy design. The article follows the framework applied by Perobelli and Hewings (2023), who revisited the analysis of interdependence among Colombian departments, yielding relevant findings on that country's regional development dynamics.

Economic development is intrinsically linked to the generation of inequalities, as regions exhibit different capacities and potential to foster real income growth. However, this relationship tends to be more pronounced in the early stages of development, reaching a peak and subsequently declining as the process advances to more mature stages — as proposed by the well-known "inverted-U" hypothesis of the Kuznets curve (1955).

An analysis of Peru's departments reveals considerable heterogeneity in terms of population, per capita income, and main economic activities. Additionally, the country is geographically divided into three distinct regions: the coastal region to the west, the high-altitude Andean region in the center, and the Amazon region to the east. More specifically, Peru is composed of 26 departments (regions), which represent the highest-level administrative units. Each department is subdivided into several provinces, and each province can contain multiple districts. This article focuses on analyzing regional interdependence at the departmental level, examining the impact of the hypothetical extraction of each of the 26 regions on per capita income, one at a time.

Regional data indicate a strong concentration of income, population, and economic activity in the coastal departments and areas near the capital. The five wealthiest departments account for just over 60% of national GDP, with the Metropolitan Region of Lima alone representing approximately 30% of this total. Lima is also the most populous department and the one with the highest level of commercial integration in the country. Among the main economic activities on the coast are manufacturing, commerce, and services in the capital; agro-exports in the departments of Piura, Lambayeque, and Ica; metal mining in Moquegua and Arequipa; and the fishing industry in Piura, Ancash, and Arequipa. These activities are predominantly concentrated in the coastal departments, the region with the highest population density and income level in Peru.

The Andean region of Peru, in turn, presents a productive structure primarily characterized by mining, agriculture, and livestock activities. Departments such as Cajamarca, Apurímac, Pasco, and Cusco rely heavily on the extraction of metallic minerals, especially copper, gold, and silver, as a significant part of their regional economies. In contrast, agricultural and livestock activities dominate in departments like Huancavelica and Ayacucho, with a focus on crops such as potatoes and corn. Other notable activities include commerce, public services, and construction, which have been expanding in urban areas, particularly in mid-sized cities and regional capitals. Finally, in the Amazon region—comprising Loreto, Ucayali, San Martín, and Madre de Dios—vegetal extraction, logging, and the cultivation of tropical products such as cocoa, coffee, and palm oil are prevalent, especially in the departments of San Martín and Ucayali. Additionally, hydrocarbon extraction in Loreto and Ucayali stands out as a central activity, reflecting a less diversified productive structure with limited integration into the broader national economy.

The interrelationship among Peru's different regions reveals a concentrated economic structure, in which the flows of goods and services are primarily directed toward the Metropolitan Region of Lima. The coastal region concentrates industrial, logistical, and commercial sectors that coordinate production from the rest of the country, serving as the main hub for demand and redistribution. Although the Andean departments play an important role in supplying mineral resources and agricultural products, their economic linkages are predominantly oriented toward coastal urban centers. In contrast, the Amazon region shows lower integration into interregional value chains, with limited flows focused mainly on primary sectors. This configuration reflects asymmetric and heterogeneous patterns of integration, in which the dynamism of peripheral areas depends largely on demand generated in the more developed coastal regions.

These regional disparities have been the subject of extensive study in the literature, particularly with a focus on analyzing the potential for convergence among Peru's regions. Studies such as Del Pozo and Espinoza (2011); Delgado and del Pozo Segura (2011); and Delgado and Rodríguez (2015), for instance, aim to test whether there is convergence across Peruvian regions and to estimate the rate of such convergence. Taking spatial aspects into account, Palomino and Rodríguez (2019) estimate convergence using spatial panel data models that control for spatial heterogeneity and spatial interdependence. Their findings identify four convergence clusters: one with high productivity and dynamism, another with moderate productivity along the coastal region,

a third with negative productivity in the Amazon region, and a fourth in the Andean region characterized by economic stagnation.

Regional disparities may not disappear as a result of market forces alone. This article aims to analyze the magnitude of these disparities by examining geographic conditions, agglomeration effects, and gaps in key economic indicators. As such, the results may be instrumental in shaping long-term government policies focused on stagnant and impoverished regions. For a country historically marked by unequal development opportunities since colonization—and strongly influenced by geographic factors across distinct regions—robust and current evidence on regional development dynamics becomes especially relevant.

Beyond the introduction, the remainder of the article is divided into four sections. Section 2 presents descriptive statistics on income, population, and the structure of Colombia's regional and international trade. Section 3 describes the dataset and the hypothetical extraction strategy employed. Section 4 presents and discusses the main results, while Section 5 concludes the article with final remarks.

2. The Structure of Peruvian Regional and International Trade

This section will analyze some structural components of the Peruvian economy, focusing on aspects of regional and international trade across its departments. We use data from the 2022 interregional input-output matrix and present statistics such as the degree of openness, the coverage ratio, and the share of intraregional trade, aiming to understand the performance of intraregional, interregional, and international trade for each Peruvian department. We then focus on capturing the interdependence among regions by simulating the impact on GDP caused by a disruption in trade from the demand side.

Figure 1 shows the spatial distribution of GDP per capita across Peruvian departments, given the strong correlation with trade. It is evident that departments located near Lima and/or along the coast exhibit the highest per capita GDP, reinforcing the high degree of spatial concentration. The five departments with the highest per capita GDP (Metropolitan Lima, Callao, Arequipa, Ica, and La Libertad) account for 60.2% of Peru's GDP, with Metropolitan Lima alone concentrating approximately 30%. Additionally, these departments concentrate 41% of employment and 48% of the population. However, the department with the second-largest population and number of employed persons is

Piura, with 6.29% and 6.75% of the total, respectively, despite not being among the top in income. These statistics reveal a concentration of income, population, and employment in the coastal departments, particularly in the Lima region. The distribution of the employed population is shown in Figure 2.

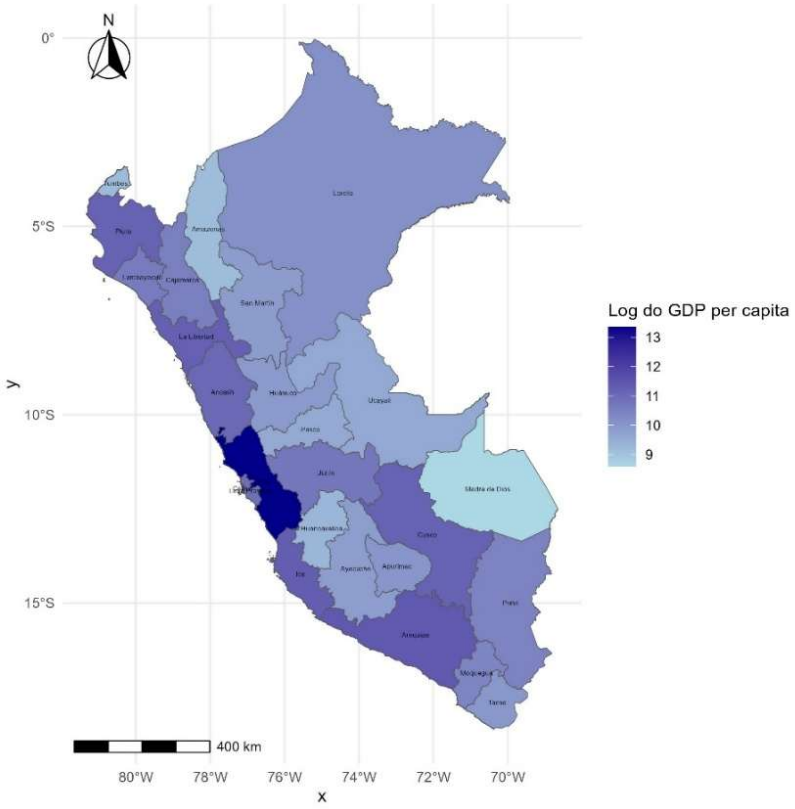

Fig. 1 – Spatial distribution of GDP (in current prices). *Source:* Elaborated by the authors based on the interregional input–output table for Peru, 2022

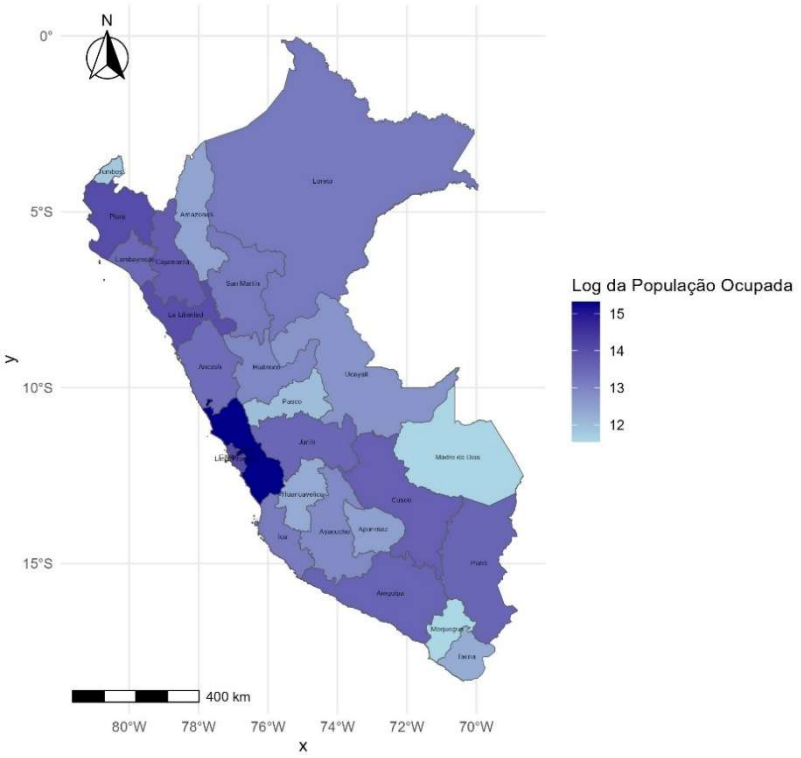

Fig. 2 – Spatial Distribution of Employment. *Source:* Elaborated by the authors based on the interregional input–output table for Peru, 2022

Next, Figure 3 presents intraregional trade among Peru's departments, based on the 2022 interregional input-output matrix. Once again, there is a clear concentration of trade flows in the Metropolitan Region of Lima and in other coastal departments, some of which are located near the capital. The Metropolitan Region of Lima accounts for 51.4% of intraregional trade, followed by the departments of Piura (5.09%), Arequipa (4.93%), Callao (4.84%), and La Libertad (4.64%). These departments also rank among those with the highest GDP per capita, total population, and employed population (as shown previously), reinforcing the pattern of spatial concentration and inequality in the distribution of economic activity across the country. Other coastal departments, such as Áncash and Ica, also show significant levels of intraregional trade, partly due to their proximity to Lima. A noteworthy exception is the department of Cusco, which, despite not being located on the coast or bordering Lima, exhibits a relatively high volume of intraregional trade.

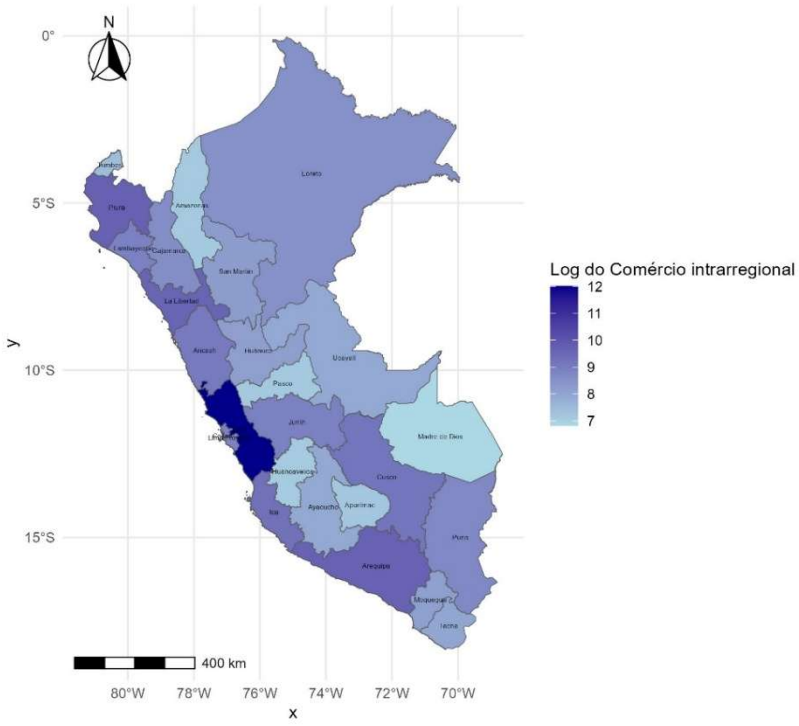

Fig. 3 Intra-regional trade share. *Source:* Elaborated by the authors based on the interregional input–output table for Peru, 2022

Figure 4 shows the interregional trade openness index, calculated as the sum of imports and exports of each department divided by its gross domestic product. Internal imports are defined as the total demand of each department for goods and services from all other departments, excluding its own internal demand. Similarly, internal exports are measured by the total use of a department's intermediate inputs by all other departments, excluding its own use. Unlike the previous figures, the spatial distribution of interregional trade openness is more dispersed across the territory, although the departments of Callao, Huancavelica, and Pasco stand out. Since the index measures trade as a proportion of GDP, it tends to be higher in regions with lower production and/or smaller populations, where trade intensity is relatively more significant. Additionally, trade openness tends to be higher in departments that are commodity exporters and/or dependent on other regions, compared to larger regions that are relatively more self-sufficient. To complement the analysis, Figure 5 presents the same indicators for international trade. A similarly dispersed spatial pattern is observed, with notable values in the departments of Moquegua, Apurímac, and Áncash.

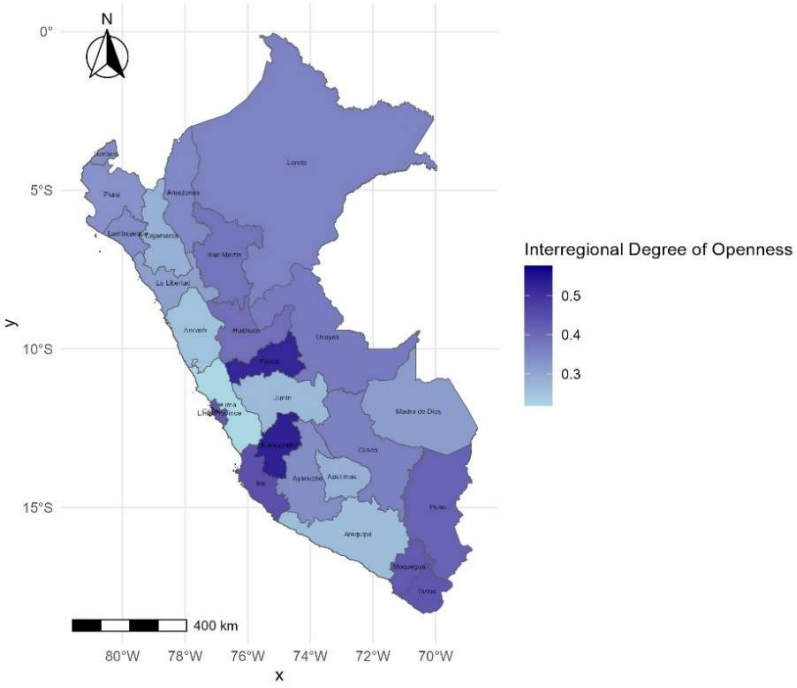

Fig. 4 Interregional openness to trade. *Source* Elaborated by the authors based on the interregional input–output table for Peru, 2022

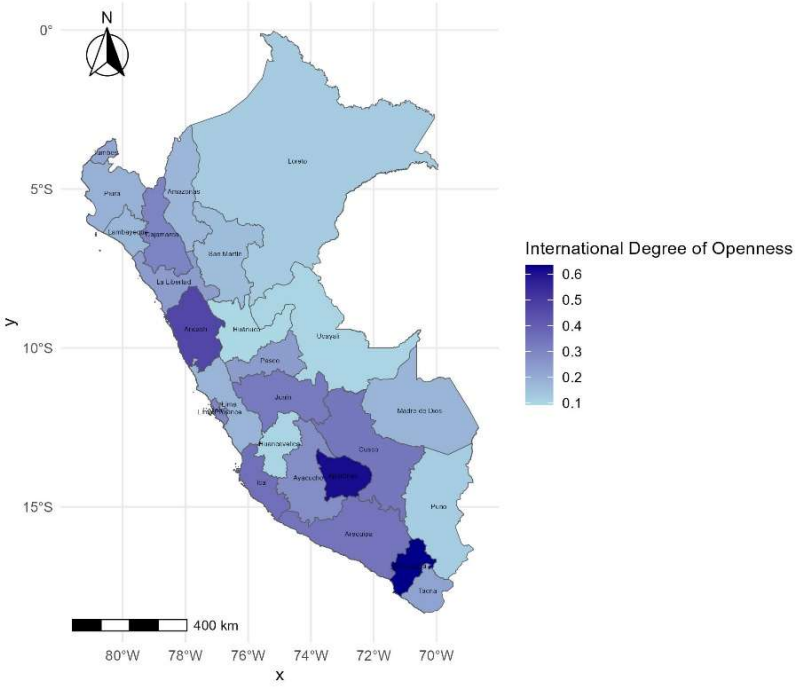

Fig. 5 International openness to trade. *Source* Elaborated by the authors based on the interregional input–output table for Peru, 2022

Finally, Figure 6 presents the interregional and international coverage ratios, which indicate the ratio between exports and imports. This index reflects how much of a department's imports are covered by its exports. A coverage ratio greater than 1 suggests a more developed trade structure, whereas a ratio below 1 indicates greater trade dependency. For the interregional coverage ratio (left panel), there is considerable variation across departments, highlighting the importance of trade with other regions. Most departments with a coverage ratio above 1 are not among those with the highest income or population levels, indicating that trade has greater relative importance in smaller or less developed regions. On the other hand, the international coverage ratio (right panel) shows a more spatially concentrated pattern, with particularly high values in the departments of Moquegua, Apurímac, and Áncash, underscoring the significance of trade in these areas. This can be explained by their specialization in export-oriented activities and lower external dependency. In all three departments, the main export activity is the extraction of metallic minerals — with the exception of Moquegua, where the manufacture of precious and non-ferrous metals ranks first, followed by metallic mineral extraction.

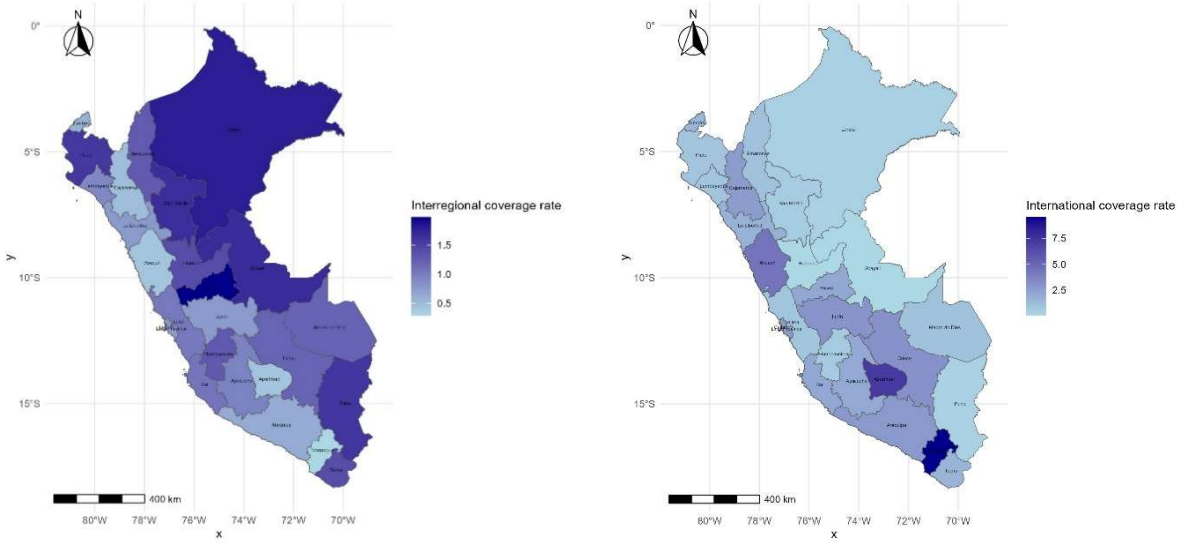

Fig. 6 Interregional e International coverage rate. Source: Elaborated by the authors based on the interregional input–output table for Peru, 2022

In summary, we observe a strong spatial interdependence among departments located near Lima and its metropolitan region, which concentrate a significant share of Peru's GDP, population, and employment. On the other hand, international trade is more

dispersed and concentrated in departments that rely on commodity exports, particularly metallic minerals. Therefore, understanding the degree of structural interdependence among Peruvian departments through a systemic analysis is crucial to shedding light on the intensity of regional integration.

3. Data e Methodology

3.1 Data

The data used to analyze the internal interdependence structure among Peruvian departments are based on Haddad & Araújo (2024). The construction of the tables follows a standardized conceptual framework, grounded in officially published input-output matrices, complemented by regional accounts from the National Institute of Statistics and Informatics (INEI) of Peru. Table 1 summarizes the main characteristics of the database used in our analysis.

Table 1: Interregional input–output database

Region (R)	26
Industry (N)	12
Dimension (NR x NR)	312 × 312
Year	2022
Currency	COP billion

Source: Elaborated by the authors based on the interregional input–output table for Peru, 2022

Peru is composed of 26 departments, which represent the country's main political-administrative divisions. The inter-regional input-output matrix (IIO) used in this study is disaggregated into 12 economic activities, allowing for a sectoral analysis of the productive structure and trade interrelations across departments. This sectoral breakdown enables a more precise understanding of regional specialization patterns and interdependence. Table 2 provides a breakdown of the 12 economic activities that structure the sectoral dimension of the IIO matrix and Table 3 lists the 26 departments included in the analysis.

Table 2: List of Activities

Code	Description
S01	Agriculture, Livestock, Hunting and Forestry
S02	Fishing and Aquaculture
S03	Oil, Gas and Mineral Extraction
S04	Manufacturing
S05	Electricity, Gas and Water
S06	Construction
S07	Trade
S08	Transport, Storage, Mail and Courier Services
S09	Accommodation and Restaurants
S10	Telecom and Other Information Services
S11	Public Administration and Defense
S12	Other Services

Source: Elaborated by the authors based on the interregional input–output table for Peru, 2022

Table 3: Lists the 26 Departments

Code	Region	Department
R01	R01: AM	Amazonas
R02	R02: AN	Áncash
R03	R03: AP	Apurímac
R04	R04: AR	Arequipa
R05	R05: AY	Ayacucho
R06	R06: CJ	Cajamarca
R07	R07: CL	Callao
R08	R08: CS	Cusco
R09	R09: HV	Huancavelica
R10	R10: HC	Huánuco
R11	R11: IC	Ica
R12	R12: JU	Junín
R13	R13: LL	La Libertad
R14	R14: LB	Lambayeque
R15	R15: LP	Lima Provincias
R16	R16: LM	Lima Metropolitana
R17	R17: LO	Loreto

Code	Region	Department
R18	R18: MD	Madre de Dios
R19	R19: MQ	Moquegua
R20	R20: PA	Pasco
R21	R21: PI	Piura
R22	R22: PU	Puno
R23	R23: SM	San Martín
R24	R24: TA	Tacna
R25	R25: TU	Tumbes
R26	R26: UC	Ucayali

Source: Elaborated by the authors based on the interregional input–output table for Peru, 2022

3.2 Methodology

The traditional input–output model is defined by

$$x = Ax + f \qquad (1)$$

e

$$x = (I - A)^{-1} f = Bf \qquad (2)$$

where x and f are the vectors of gross output and final demand, respectively, A is the matrix with technological coefficients, $[a_{ij}]$, defined as the quantity of product i required per unit of output j (in monetary terms) $-i, j = 1, \ldots, n$ –i, j = 1, …, n, and B is the Leontief inverse matrix.

Modifying Eq. (1) and Eq. (2) to an interregional context, with r different regions, generates:

$$x = \begin{bmatrix} x^1 \\ \vdots \\ x^R \end{bmatrix}; A = \begin{bmatrix} A^{11} & \cdots & A^{1R} \\ \vdots & \ddots & \vdots \\ A^{R1} & \ldots & A^{RR} \end{bmatrix}; f = \begin{bmatrix} f^1 \\ \vdots \\ f^R \end{bmatrix}; B = \begin{bmatrix} B^{11} & \cdots & B^{1R} \\ \vdots & \ddots & \vdots \\ B^{R1} & \ldots & B^{RR} \end{bmatrix} \qquad (3)$$

and

$$x^1 = B^{11} f^1 + \cdots + B^{1R} f^R$$
$$\vdots$$
$$x^R = B^{R1} f^1 + \cdots + B^{RR} f^R$$

We use Eq. (3) to implement the hypothetical regional extraction to better understand and analyze the interdependence from the intermediate inputs side.

The extraction method, described in Dietzenbacher et al. (1993), consists of the hypothetical extraction of a sector in the input–output matrix. The purpose is to determine

how much the total output of an economy with n sectors could change if a particular sector was removed from the economy. This technique identifies the importance of a sector in an economic structure, given the extraction and the consequent reduction in the level of economic activity, the greater the degree of interdependence of a sector with the others, the bigger the impact. We can apply the same rationale to the extraction of all sectors in a region.

Using Eq. (2) to represent the general model with all regions, the reduced model or the model with the hypothetical regional extraction can be represented by:

$$\bar{x} = (I - \bar{A})^{-1}\bar{f} \qquad (4)$$

where $\bar{A}$ is the technical coefficient matrix after the extraction of a specific region, $\bar{f}$ is the final demand vector after the extraction of a specific region, and $\bar{x}$ is the final output vector after the extraction of a specific region.

Comparing the two models, Eq. (2) and Eq. (4), we obtain:

$$T = i'x - i'\bar{x} \qquad (5)$$

where T is the aggregate measure of the annual loss in the economy (reduction in total output without production associated with a specific region); thus, Eq. (5) presents a measure of the relative importance of the activities carried out by a specific region or the total linkages to which such a region is associated.

The indicators above show the global impact and total interdependence, but the methodology is flexible and can separate the backward and forward effects of a hypothetical extraction. Thus, to represent the hypothetical backward regional extraction, we assume that all sectors j located in the region r buy no intermediate inputs from any production sector, which means that all sector $j's$ backward linkages are removed in region r. This exercise is done for all regions, one at a time. This is done by replacing all columns j in A of region r with zeros. Denote this new matrix $A_{(cj)}$. The earlier representation of $\bar{\bar{A}}$ denotes a structure in which row and column j of a region r were deleted. To represent the backward impact, we put a "c" to indicate that it is all column j at region r that was extracted. Then, the reduced model to represent the hypothetical extraction of all buying sector j located at the region r is represented by:

$$x_{(cj)} = (I - A_{(cj)})^{-1}f \qquad (6)$$

and the aggregated measure of backward linkage for all sector j located at region r is as follows:

$$T_j = i'x - i'x_{(cj)} \qquad (7)$$

4. Results

This section presents the main results derived from the hypothetical extraction by department in Peru, based on data from the 2022 input-output matrix. Figure 7 shows the five departments with the largest and smallest impacts resulting from the extraction of each department, considering the backward, forward, and total effects. Among those with the highest impacts, the Lima Metropolitan Region stands out, with a total effect exceeding 50% of GDP per capita. This result is consistent with the descriptive statistics previously presented, which highlighted this department as having a high concentration of income, population, and employment. The region accounts for a significant share of the wealth generated in Peru, followed by Callao and Ica - regions adjacent to Lima. These findings reinforce the country's dependence on Lima and its neighboring regions, confirming the spatial interconnectedness of departments near the capital. Completing the top five highest impacts are Arequipa and Cusco, two departments located to the south and relatively close to Lima.

On the other hand, the departments with the lowest results across all three indicators are geographically remote, located in the Amazon region, and characterized by low population density and lower levels of economic activity. An exception is the department of Huancavelica, which is situated in the central region, adjacent to the Lima Metropolitan Area. Although not part of the Amazon, it is a mountainous and cold region with a low population density.

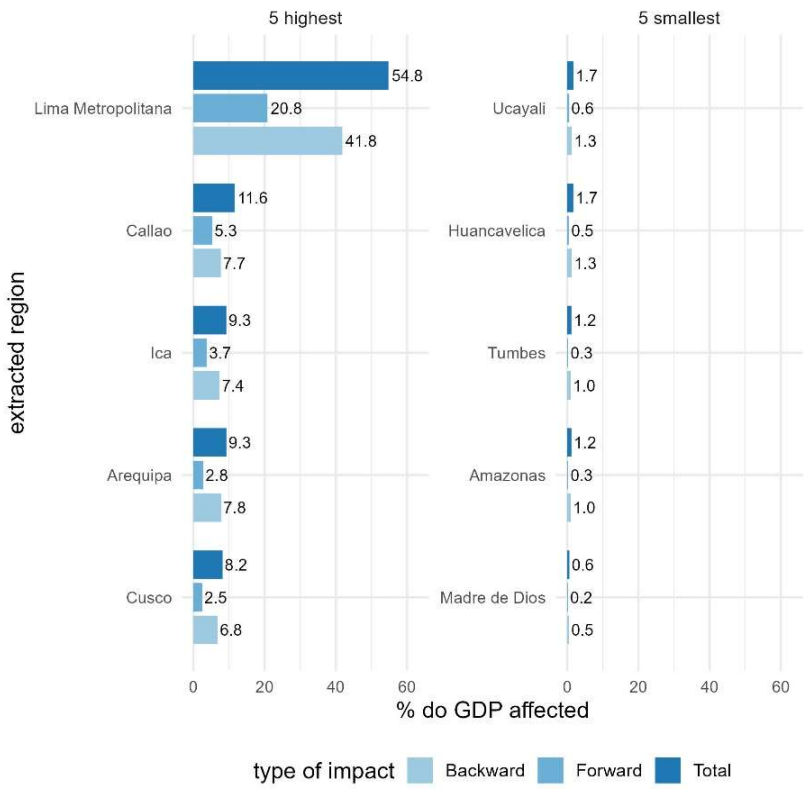

Fig. 7 Interdependence indicators. five major and minor effects from hypothetical extraction. *Source* Elaborated by the authors based on the hypothetical extraction, Peru 2022.

Figure 8 presents two heat maps highlighting the five departments with the highest backward and forward effects, expressed as a proportion of GDP per capita, resulting from the hypothetical extraction. As expected, the most significant impact occurs within the extracted department itself, followed by relevant effects in neighboring regions, reflecting the spatial interdependence of the Peruvian economy. In the case of the Lima Metropolitan, darker shades appear on both the left (backward) and right (forward) maps, underscoring the department's central role in connecting national production chains and its function as a driver of economic activity in other regions.

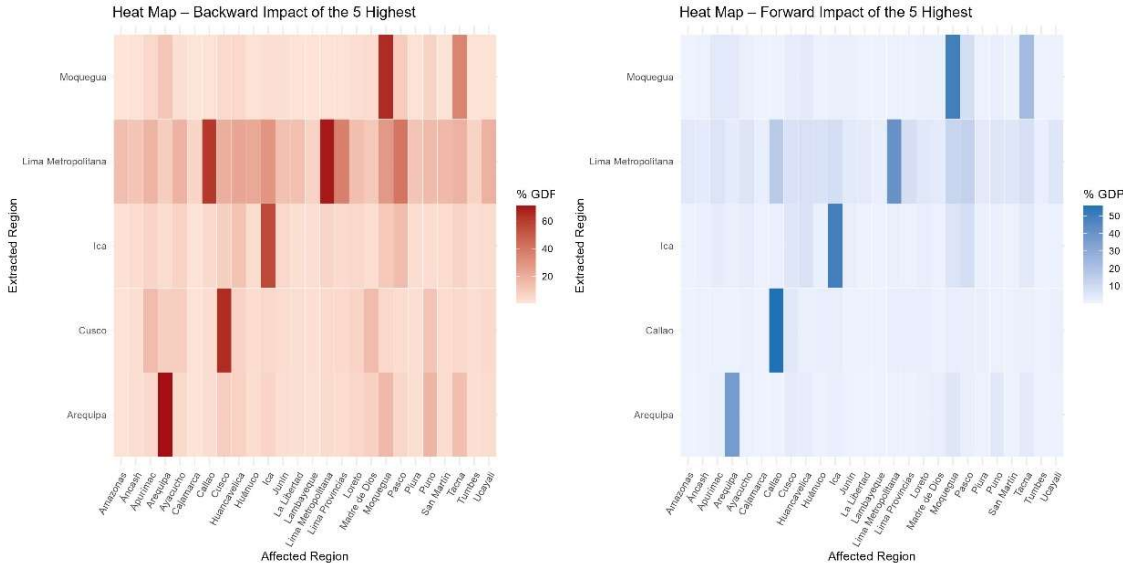

Fig. 8 Forward and backward effects of the hypothetical extraction of the five largest departments.
Source: Elaborated by the authors based on the hypothetical extraction, Peru 2022.

Given the relevance of the Lima Metropolitan Region in the effects on GDP per capita, Figure 9 displays the map resulting from the hypothetical extraction of this department, illustrating the spatial distribution of impacts generated by the removal of Lima's purchasing sector on the other departments of the Peruvian economy. Light blue shades indicate lower impacts, while darker tones reflect more intense effects.

As previously mentioned, the impacts are not limited to the extracted department but extend across multiple regions, with greater intensity in areas that are either geographically closer or economically more relevant. These departments rely on Lima as a key market for their products, revealing the strong productive and commercial interdependence among the country's most dynamic regions. The results further reinforce the high degree of integration between the Lima Metropolitan Region and its neighboring departments, driven not only by geographic proximity but also by the economic centrality that the capital's metropolitan area holds within the national territory.

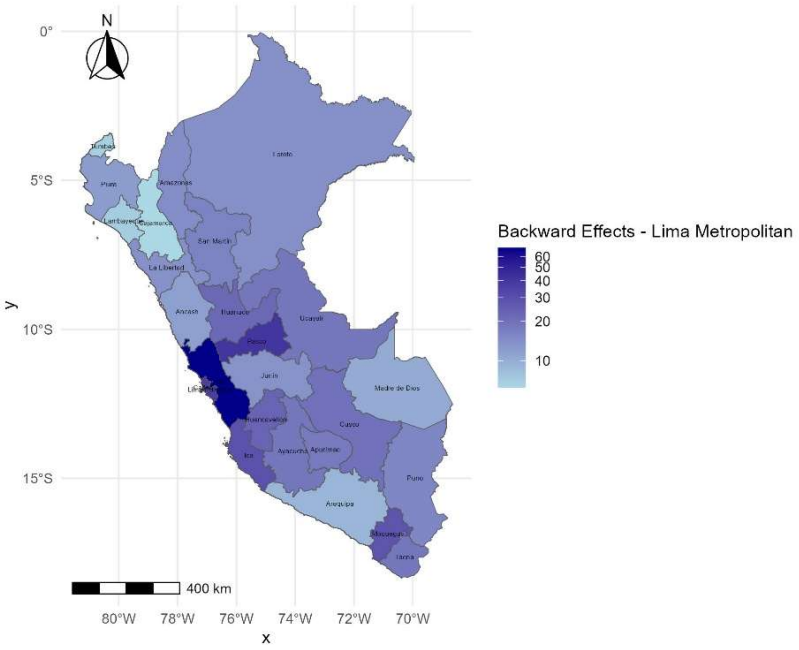

Fig. 9 Backward effects: percentile map (Lima Metropolitan). *Source* Elaborated by the authors based on the hypothetical extraction, Peru 2022.

Based on these results, it is possible to state that the departments with the highest internal impacts exhibit strong interdependence, particularly with other departments located along the coastal and/or highland regions. The main effects are concentrated along the economic corridor formed by Lima Metropolitana, Arequipa, and La Libertad, highlighting the strong productive integration among these key hubs. In this context, the Lima Metropolitan Region plays a central role, acting as the main consumer market and a key link in the articulation of national production chains. In contrast, there is lower integration between departments in the Amazon region and the rest of the country, reflecting weaker economic ties with the extracted departments. These findings reveal the concentrated structure of the Peruvian economy and the central role of Lima in the country's interregional economic dynamics.

In summary, the results indicate that all departments exhibit a net dependence on Lima, with a spatial concentration of the hypothetical extraction effects—stemming from the removal of purchases in any territory—centered around the Lima Metropolitan Region. This pattern reflects a classic center-periphery structure.

5. Final Considerations

This chapter analyzed the regional interdependence among Peruvian departments from a systemic perspective, using hypothetical extraction for each department based on an interregional input-output matrix calibrated for 2022, with 12 productive sectors and 26 regions. Both sectoral and spatial disaggregation contributed to a better understanding of regional issues in Peru. This approach made it possible to assess the spatial dispersion of the results and the integration of Peru's regions based on the main ones in terms of their share of total GDP, employment, and population.

The results of the hypothetical extraction analysis reveal asymmetries in interregional economic dependence in Peru. The Lima Metropolitan Region stands out as the main productive center, concentrating a substantial share of economic activity and exerting influence over both neighboring departments and more distant regions. Its removal generates the strongest backward and forward effects, highlighting its role as a major purchaser and a key link in national production chains.

The departments with the greatest internal impacts tend to show strong integration with Lima and other economically dynamic regions, such as Arequipa and La Libertad, forming a central economic corridor along the coast and the highlands. This pattern reinforces a core-periphery dynamic, in which a few central departments act as hubs of economic activity, while others — especially those located in the Amazon region — maintain weaker economic ties and show lower sensitivity to interregional shocks. Among other factors, the topographic division contributes to this heterogeneity, as highland and Amazonian regions face greater access challenges and geographic isolation, which increases transportation costs and limits their productive integration.

In sum, most departments exhibit some degree of dependence on Lima, reflecting the high level of spatial concentration of the Peruvian economy. The results underscore Lima’s importance not only as the political and demographic center, but also as the country’s main economic hub. These findings have important implications for regional development policies, highlighting the need for strategies that promote greater territorial balance and reduce excessive dependence on a single metropolitan area. To achieve this, policies must adequately reflect the endogenous characteristics of each region, focusing on local potential and fostering local economic dynamics.

References

Del Pozo, J. M., & Espinoza, L. M. (2011). Un análisis exploratorio de convergencia en el PIB per cápita entre departamentos en el Perú, 1979-2008. In J. Iguiñiz & J. León (Eds.), *Desigualdad distributiva en el Perú: Dimensiones* (Capítulo 4). Lima: Pontificia Universidad Católica del Perú.

Delgado, A., & Del Pozo Segura, J. M. (2011). *Convergencia y ciclos económicos departamentales en el Perú: 1979-2008*. Lima: Consorcio de Investigación Económica y Social (CIES).

Delgado, A., & Rodríguez, G. (2015). Structural breaks and convergence in the regions of Peru: 1970–2010. *Review of Development Economics, 19*(2), 346–357.

Gabriel Rodríguez & Palomino, J. (2019). *Peru's regional growth and convergence in 1979–2017: An empirical spatial panel data analysis* (Documentos de Trabajo No. 2019-478). Departamento de Economía – Pontificia Universidad Católica del Perú.

Haddad, E. A., & Araújo, I. F. (2024). *Matriz interregional de insumo-produto para el Perú, 2022*. São Paulo: Fundação Instituto de Pesquisas Econômicas (FIPE).

Kuznets, S. (1955). Economic growth and income inequality. *American Economic Review, 45*(1), 1–28.

Perobelli, F. S., Haddad, E. A., Bonet, J., & Hewings, G. J. D. (2010). Structural interdependence among Colombian departments. *Economic Systems Research, 33*(3), 279–300.

Perobelli, F. S., & Hewings, G. J. D. (2023). Revisiting the structural interdependence among Colombian departments. In E. A. Haddad, J. Bonet & G. J. D. Hewings (Eds.), *The Colombian economy and its regional structural challenges* (pp. 121–146). Cham: Springer. https://doi.org/10.1007/978-3-031-22653-3_7