

Review and assessment of import diversification methods and measures in the primary economic sector

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Abstract

The diversification of import plays a very important role in the current world full of risks and political perturbations. Covid-19 lockdowns and Russian - Ukrainian war cause disruptions in supply chains. Therefore, import diversification is very important for ensuring the country's supply security. There are many measures and tools developed for assessing economic diversification, including import diversification though the majority of studies are addressing export diversification and analyzing the importance of economic diversification for economic growth and macro-economic stability in the primary sector. However, risks of supply disruptions, especially in the current globalized world, can cause many problems for specific industries, regions and countries. There is a literature gap on the analysis of import diversification methods and measures in terms of their suitability for economic analysis and decision-making in all economic sectors, including mining. The paper aims to overcome this gap by analyzing import diversification measures based on a systematic literature review and assessing them according to the main criteria of suitability for economic analysis and decision-making: simplicity, data availability, comparability and transparency. The ranking of import diversification methods and measures was provided based on conducted analysis and assessment.

Keywords

Economic diversification; import diversification; measures; multi-criteria assessment.



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Introduction

There is agreement among scholars that trade openness and export and import diversification both positively impact economic growth. The understanding of linkages between economic development and trade diversification from the export and import angles is necessary. Therefore, the recent empirical works were dedicated to the association between trade diversification or concentration and economic progress in all the economic sectors, including mining (Imbs and Wacziarg, 2003; Cadot et al., 2011, 2013; Hesse, 2006; Fajgelbaum et al., 2011). The scholars (Girma et al., 2004; Helpman et al., 2008; Mejia, 2011; Laderman, Maloney, 2012; Hallak, Sivadasan, 2013; Parteka, Tamberini, 2013) paying the main attention to the analysis of the linkage between economic progress and export diversification, and import diversification was not widely addressed in scientific literature though the current global risks linked to covid-19 and Russian-Ukrainian war showed the importance of import diversification due to interruptions in global supply chain. Import diversification allows for increasing resilience of local industries relying on imports of intermediate goods (Jaimovich, 2012; Mityakov et al., 2013). Scholars (Krugman, 2009; Grossman and Helpman, 1991; Imbs and Wacziarg, 2003; Agosin et al., 2012) in their studies showed that import diversification provides extra benefits from trade for local producers and customers as well. For example, scholars showed that importing more varieties positively impacts productivity growth. Several studies (Halpern et al., 2015; Kasahara and Rodrigue, 2008; Goldberg et al., 2009, 2010) carried out on the micro level proved that firms' productivity increases with the growth of various inputs.

Amiti and Konings (2007) analyzed the most common measures of trade liberalization and import diversification and applied them to Indonesia in order to reduce various evaluation errors and measurement bias. Colantone and Crino (2014) analyzed the import diversification of various inputs and demonstrated that economic policies implemented in developing countries to promote trade diversification are not appropriate for less developed economies. According to an older study by Wall (1968), it is necessary to ensure the foreign exchange inflow growth in order to finance imports and as less developed countries usually pursue the growth of non-productive imports, in the end, the import growth in these countries does not have a positive impact on economic growth. Panchamukhi (1969) analyzed the significance of import structure and proved that country productivity of production efficiency is contrariwise linked to the content of import. The study by Panchamukhi (1969) showed that an increase in import content has an impact on a decrease in efficiency. However, there are possibilities that some sectors dependent on imports might positively affect economic growth. Another more recent study by Acemoglu and Yared (2010) proved that states undergoing faster militarization than the neighbouring countries have experienced lower growth in imports and exports over recent years.

Nevertheless, it is necessary to stress that the scientific debate was mainly focused on export diversification without putting importance on import diversification though it is clear that for the security of supply, import diversification plays a crucial role, taking into account recent breaks in supply chains due to Russian-Ukrainian war, the sanction imposed on various countries and experience of world COVID-19 pandemics and its consequences. However, several studies recently put more emphasis on imports following the New Growth Theory, and the role of import diversification has been studied in recent years based on firm's level data though the importance of increase of country import diversification is also obvious. For this type of study, import diversification/concentration measures play a crucial role.

This study aims to analyze import diversification measures and assess their diversification based on several important criteria for economic analysis and decision-making: simplicity, data availability, comparability and transparency. The study is built on a comprehensive systematic literature review on trade and economic diversification measures putting the main emphasis on import diversification, including empirical studies using these measures to assess various implications of trade diversification like economic growth, macroeconomic stability, various risks associated with supply disruptions and dependency on a single supplier in the primary economic sector.

Data and methods

A systematic literature review was applied in this study. The analysis of import diversification measurements was performed based on an appraisal of scientific papers referred to in the Web of Science, Scopus and Google Scholar databases. The review was executed for the period 1990 – 2022. The following keywords were used for searching studies: "economic diversification measures", "trade diversification frameworks", "trade diversification measures", and "import concentration measures". In total, more than 70 relevant sources, including theoretical and empirical studies dealing with economic diversification frameworks and guidelines and valuations of economic diversification, were found. Then, all studies were assessed based on import diversification measures provided. The incorporation of the studies based on this issue led to the next phase of our study. In the next stage seeking to define which economic diversification indicators are applied and are the best for measuring import diversification, the following important questions were developed for preparing a systematic literature review:

- Which main economic diversification indicators are found in literature, and how can they be grouped?

- What are the theoretical assumptions for developing these indicators?
- Which economic diversification measures are most appropriate for import diversification assessment?

In the subsequent stage of the systematic literature review, the abstracts of studies selected during the initial search on databases were analyzed, and after the primary review and content analysis, studies that were not related to the aim of our research were excluded. To find as many import diversification measures as possible, a snowballing technique was also used.

Based on a systematic literature review, measures of import diversification were analyzed and grouped based on theoretical background. The import diversification measures were assessed based on the main criteria of indicators assessment: Simplicity; Data availability; Comparability and Transparency (UNFCCC, 2016). These criteria are important for indicators and measures to provide important and well-presented information for policy analysis and decision-making.

The Simplicity; Data availability; Comparability and Transparency of import diversification measures are assessed on a five-point scale :

- 5 indicates a superior quality of import diversification measure based on simplicity; data availability and comparability and transparency criteria;
- 4 indicates a very good quality of import diversification measure based on simplicity; data availability and comparability and transparency criteria;
- 3 indicates a moderate quality of import diversification measure based on simplicity; data availability and comparability and transparency criteria;
- 2 indicates a low quality of import diversification measure based on simplicity; data availability and comparability and transparency criteria;
- 1 indicates an extremely low quality of import diversification measure based on simplicity; data availability and comparability and transparency criteria.

The import diversification measures were further ranked based on cumulative scores according to each criteria.

Literature review on import diversification and its measures

Scholars usually agree that economic diversification, including import and export diversification, has a positive impact on economic development and competitiveness, and economic policies try to find the best strategies to ensure economic diversification for countries and firms (Bernard et al., 2003; 2007; Klinger, Lederman, 2004; 2006; Bas, Strauss-Kahn, 2010; Ardelean, Lugovskyy, 2010; Bista, 2019; Firtescu et al., 2020; Istudor et al., 2020). Scholars were performing various empirical studies to reveal the performance of economic diversification policies on trade diversification. The various empirical techniques were applied to assess trade diversification to build an understanding of various determinants of trade diversification/concentration and their impacts. Several studies analyzed import diversification, like the study by Jaimovich (2012), and found that import diversification can be related to the income per capita of importing countries. Therefore, higher import diversification provides for higher income per capita (Khandelwal, 2010; Mohler and Seitz, 2012). Other studies presented evidence that high import diversity has a positive impact on the productivity of firms. For example, based on Hungarian panel data for firms, it was revealed that the growth of imports provides for significant growth in the productivity of Hungarian firms (Halpern et al., 2015). Kasahara and Rodrigue (2008) also analyzed the impact of imports on the productivity of firms and found a direct positive relationship. Colantone and Crino (2014) applied panel data from European countries and found that new import lines encourage the production of new domestic products and also provide an opportunity for countries to get an advantage from diverse sets of intermediate goods. Feng et al. (2012) analyzed the linkages between intermediate goods imports and export by Chinese manufacturing firms and revealed that the increase in the variety of intermediate goods has a positive effect on their export expansion in terms of value and scope. Another study by Le Bris et al. (2013) revealed the linkages between intermediate goods imports and the intensive and extensive import margins (number of imported products and number of import markets). Bas and Strauss-Kahn (2014) used panel data from French firms and showed how the growth of the import of varieties of goods increases the diversity of exported goods.

It is necessary to stress that the association between export diversification and economic development has been extensively examined. However, there is an obvious literature gap on import diversification's impact on economic growth at the macro level. Therefore, there are no clear linkages between import diversification and the economic development of countries addressed in scientific studies. Most studies addressed the role of the import of intermediate goods and its impact on the growth of export at the firm level in all the economic sectors, including mining.

In the case of foreign trade's effect on economic progress, the most important is the high diversity of goods and high heterogeneity of companies. Studies analyzing the connections between international trade and economic growth advocate the possible advantages resulting from the diversification of imports, which are mainly connected

to national supply and demand. It is obvious that international increases customers' welfare on the demand side as consumers have a broader choice of goods at lower prices (Hallak, 2006; Hummels, Klenow, 2005; Jaimovich, Merella, 2012). Therefore, due to import diversification, the consumers would gain from trade because of a wide diversity of choices. The study (Broada, Weinstein, 2006) conducted in the US showed a significant increase in customer welfare due to the import of new varieties. The diversification of various production inputs on the supply side shows such benefits as productivity growth and economic succession (Romer, 1990; Rivera-Batiz, Romer, 1991; Grossman and Helpman, 1991).

A wider variety of imports might positively affect the supply side through the three possible channels. Several models were developed, providing that imports enhance productivity through their associations with competitiveness (Grossman, Helpman, 1991; Jetter, Ramirez Hassan, 2015). Models showed that due to competition, firms aim to innovate and improve their performance by implementing reorganization and eliminating causes of inefficiency. Melitz (2003) and Bernard et al. (2003) constructed the models of heterogeneous firms and showed how import competition provides for a firm's productivity increase. The second channel is linked to the approach to striving for better inputs from imports. The studies showed that the growth of imports provides firms with better access to cheaper and locally unattainable inputs (Grossman, Helpman, 1991; Rivera-Batiz, Romer, 1991; Romer, 1990). Due to the growth of imports, firms increase their productivity and decrease costs. The third channel on the supply side is linked to the transfer of technologies. According to the findings of several studies, imports provide important access to new technologies represented in imported inputs (Grossman, Helpman, 1991, Kugler, Verhoogen, 2012; Todaro, Smith, 2006). Scholars Imbs and Wacziarg (2003) in their study showed that economic diversification does not increase monotonically with income. Passing a specific level of income (9000 USD PPP/person), there is a trend to reconcentrate economic activity's structure, represented by value-added, employment and trade flows.

There is no agreed definition of import diversification nor well-established metrics to evaluate import diversification. There are diversification indexes developed for world countries provided by international organizations such as World Bank, IMF, and UNCTAD (UNFCCC, 2016). Various empirical studies on applying various trade diversification and concentration measures ranging from simple indicators to multifaceted econometric techniques like Input-Output matrix or GEM. There is no understanding among scholars yet which measure of trade diversification/concentration is the best, though it is evident that the empirical findings of these studies are linked to the measures and approaches applied.

The assessing of import diversification at the national level provides many benefits for decision-makers in shaping international trade policies targeting the increase of import diversification as it allows for monitoring the effects of implemented response measures.

The main concentration/diversification indexes created for analysis of trade openness are based on quantitative assessment indicators which are mainly coming from the income-distribution literature linked to concentration measurements. All concentration or diversification indices are developed to evaluate inequality between import shares; in the end, they can be calculated at any desired level of aggregation. It is necessary to stress that the finer the disaggregation, the more advanced the measure of import diversification.

The most often used diversification/concentration measures in scientific studies and international organizations reports are Herfindahl-Hirschman, entropy indexes by Shanon, Theil, etc., Gini index, Hachman index, and portfolio variance indexes. There are attempts to apply their modifications. The most frequently used concentration indices to measure import diversification or concentration are Herfindahl, Gini and Theil indexes (Klinger and Lederman, 2004, 2006; Cadot et al., 2011, 2013; Laderman et al., 2015, 2021; Lederman, Maloney, 2012).

In general, the indices used to measure trade diversification, including import diversification, can be classified in the following way: indexes which evaluate the absolute specialization of the country (Herfindahl-Hirschmann index, Gini index, ogive index, or their modifications etc.); and indexes which evaluate the structure of import based on a reference group of industries or countries (for instance, Theil index, relative Gini index, inequality in productive sectors). Indices used to evaluate absolute specialization might provide an assessment of a given country's specialization level. For example, France focuses on textiles production, Sweden and Finland on wood industries and pulp and paper production etc.

All measures of import diversification can be classified based on the theoretical background being applied to measure concentration/diversification. In general, all import diversification measures analyzed below can be applied to measure economic diversification in general. But, of course, they can be successfully applied for the assessment of import and export diversification levels.

The industrial organization theory provides that the overall organization of a country's industrial sector is contingent on the country's economic diversification level. The absolute specialization indices are applied within the framework of this theory. A larger number of sectors in a country or more import lines show lower market concentration providing for the higher diversification of the economy and import as well. More diversified sectors and import lines provide better competitiveness (Cadot et al., 2013). The main empirical measures implied by industrial organization theory are the following: the Herfindahl-Hirschmann index, the Ogive index, the Shannon

and Theil entropy indexes and their modifications, the Gini index, etc.) which quantify the absolute concentration or specialization.

Herfindahl-Hirschmann index (HHI) is most widely used to quantify market or economic concentration, as well of export and import concentration (Acar, Sankaran, 1999; Agosin et al., 2012, Cadot et al., 2013; Albassam, 2015; Albassam, 2015). HHI is a simple and easy calculable index applied to measure absolute specialization. HHI quantifies the extent to which a particular economy or import is dominated by a few sectors or import lines. It is calculated by applying the following formula:

$$HHI = \sum_{i=1}^N S_i^2 \tag{1}$$

where S_i is the share of imports by sector i in the total imports; n is the number of sectors. The value of the *HHI* index is in the range of 0 to 1. A country having a perfectly diversified import has an *HHI* index close to 0. A higher *HHI* index shows a higher concentration of imports. The share of each industry is squared (S^2), providing more weight to bigger firms. By using *HHI* to assess import diversity, it can be split into several *HHI* (intersectoral or inter-industry) (Acar and Sankaran, 1999).

Therefore, HHI for a specific country and year is calculated by applying the following equation:

$$HHI = \frac{\sum_{k=1}^n n(S_k^2) - 1/n}{1 - 1/n} \tag{2}$$

Where $S_k = xk / \sum_{k=1}^n x_k$ - is the share of import line k (with the amount imported x_k) in total imports, and n is the number of import lines.

The ogive index of economic diversity can also be used as an absolute measure of economic diversification, including import diversification in line with industrial organization theory (Palan, 2010; UNFCCC, 2016). This index assesses the distribution of economic activity, including export and import among sectors in the selected country and is calculated by the following formula:

$$ogive\ index = \sum_{i=1}^N \frac{(S_i - 1/N)^2}{1/N} \tag{3}$$

where N is the number of sectors in the selected country and S_i is the sectoral share of import for the i -th sector. An even distribution of imports among sectors characterizes higher import diversity. N is the number of sectors. The equal distribution of imports suggests that S_i is equal to $1/N$. This is the ideal share for each sector's imports, and the ogive index is equal to zero showing the perfect diversity of imports. The Ogive index can be treated as a linear transformation of the *HHI* index (Palan, 2010).

The Shannon entropy index (SEI) allows for the comparison of the distribution of imports or other economic activities among industries in a selected country with an equi- proportional distribution (UNFCCC, 2016). The SEI is evaluated as the negative sum of import shares multiplied by the natural logarithm of import shares of every single industry in the following way:

$$SEI = \sum_{i=1}^N S_i \ln \left(\frac{1}{S_i} \right) = - \sum_{i=1}^N S_i \ln (S_i) \tag{4}$$

where N is the number of sectors in the country, S_i is the share of import in the i -th sector and $\ln(.)$ is the natural logarithm. Assuming that equally distributed import is treated as higher diversity, the higher value of the entropy index shows higher relative diversification and the lower values of SEI imply higher relative specialization. Therefore, then import is applied to measure the diversity of economic activity. The equivalent distribution of imports among all sectors will produce a higher SEI value. The minimum value of SEI is equal to zero in the case that import is concentrated in one sector. As SEI applies a logarithmic for the assessment of import diversification, in this case, the relative weights of large imports have lower values compared to HHI and the Ogive index. Therefore countries having large sizes of specific imports will be assessed as more specialized by HHI and the ogive index than by applying SEI (Palan, 2010). SEI calculation can also be problematic if industries with an import share equal to zero are included in the sample.

Theil's entropy index is calculated in the following way (Cadot et al., 2013):

$$T = \frac{1}{n} \sum_{k=1}^n \frac{x_k}{\mu} \ln \frac{x_k}{\mu} \text{ where } \mu = \frac{\sum_{k=1}^n x_k}{n} \tag{5}$$

Where n – the number of exports or import lines (for example, 5016 line of the HS5 nomenclature or the total number of trade partners); x_k - the amount of exported or imported of k -export/import line.

Theil's index can be evaluated for a group of individual import lines and also allows decomposition into within groups and between groups of constituents.

The Gini index is another measure of import diversification introduced based on the theory of industrial organization. It is more time-consuming to calculate, and this index fails to meet other important criteria for the best measures or indices of diversification, such as data availability, comparability and transparency (Palan, 2010). For the Gini index, several likewise definitions have been proposed.

The Gini coefficient is defined by the following formula (Cadot et al., 2013):

$$G = 1 - \frac{\sum_{k=1}^n (X_k - X_{k-1})}{n} \tag{6}$$

where n -the number of export/import lines, x_k - is the amount exported of import/export line k .

Typically, imports or exports are dominated by several main lines, even in the case of developed industrial countries. Consequently, Gini index is close to 1 and does not fluctuate greatly.

Based on the study by Cadot et al. (2013), distinguishing the different margins of trade diversification allows us to understand better the import diversification phenomenon and to measure its extent. The intensive import margins capture the changes in import diversification between a set of commodities that are regularly traded during the established period. The extensive import margin reveals the impact of newly imported or disappearing commodities on the diversification of imports (Santos et al., 2014). Providing which margin is the more influential driver of import diversification is important for developing trade policies and measures (Mohler, 2014). The aim of entering into new commodities or new trade markets- at the extensive import margin and raising import volumes at the intensive import margin requires completely different policies and measures. Overall, diversification at the extensive margin shows the increasing quantity of active import lines expressed by commodity, destination or both of them. The decomposition of Theil's index might be used for the assessment of intensive and extensive margins.

Therefore, import concentration quantified at the intensive margin shows unequal distribution among the portions of active import lines. Contrariwise, diversification at the intensive margin during $t_0 - t_1$ period shows the merging of import shares amongst goods being imported at t_0 . Concentration at the extensive margin is a more difficult conception. For example, the country can extend its imports by adding one (HS 5810 or another good HS 8408) to its import. Both goods have different economic significance, though both are based on active import lines and would be treated in the same way. As this is an important problem for the assessment of import diversification, Hummels and Klenow (2005) in their study introduced a different delineation of the intensive and extensive margins by trying to integrate this important information in the evaluation of import diversification.

Suppose that X_k^i - the value of the country i import of the good k ; X_k^W -the value of the world's exports of good k . Suppose that G_1^i is the set of country i active export lines. The intensive margin, in this case for country i , will be evaluated in the following way:

$$IM^i = \frac{\sum_{k \in G_1^i} X_k^i}{\sum_{k \in G_1^i} X_k^W} \tag{10}$$

The extensive margin of country i is expressed in the following way:

$$EM^i = \frac{\sum_{k \in G_1^i} X_k^W}{\sum_{k=1}^m X_k^W} \tag{11}$$

The extensive margin explains how much the commodities that the i -th country imports amount to international trade. Multiplying these margins provides information on the country's portion in world trade. Consequently, the country having a high intensive margin and a minor extensive margin holds a big share of comparatively unimportant world markets.

There are other definitions of the extensive and intensive margins developed by Brenton and Newfarmer (2007) on the basis of bilateral trade flows. The index of diversification introduced by Brenton and Newfarmer quantifies the number of destination markets/ imports enclosed fully or partly by the country. The index does not take into account the values of trade flows.

Consider that G_1^i is the set of country i active import lines or the group of commodities imported to the country i from any destination; G_1^{ij} - the group of commodities imported by i country from destination country j ; M_1^j - the group of commodities exported by the destination country j to any region. On the basis of these all groups, the following binary variables are set:

$$g_k^{ij} = \begin{cases} 1, & \text{if } k \in G_1^{ij} \\ 0, & \text{otherwise} \end{cases} \tag{12}$$

$$m_k^j = \begin{cases} 1, & \text{if } k \in M_1^j \\ 0, & \text{otherwise} \end{cases}$$

Therefore, the Brenton and Newfarmer index of country i is calculated in the following way:

$$IEMP_i = \frac{\sum_{k \in G_1^i} g_k^{ij}}{\sum_{k \in G_1^i} m_k^j} \quad (13)$$

Where the numerator is the number of goods that country i exports to country j ; the denominator is the number of goods that country j imports from somewhere, and this is country i exports to somewhere. Therefore, the index provides the aggregation of actual and potential bilateral trade flows country i supplies and country j demands), and the portion indicates how many of those potential trade flows actually happen.

Other measures of import/export diversification are calculated as an untraditional margin of import expansion. Besedes and Pmsa (2006), in their study, developed a diversification index analyzing the endurance of bilateral trade flows. The index takes into account the length of time during which bilateral imports/exports of a specific product are taking place without disruption. This is a good indication that shows how imports/exports vary, providing a margin for trade policy development.

Though the majority of studies on trade diversification put emphasis on the contemporaneous import/export basket of the country, Laderman et al. (2021) developed a new measure of latent import/export diversification. It aims to assess a country's capability to enter into export or import lines for which the country had earlier involvement in imports or exports. As already analyzed, measures of import diversification like HHI and other indexes of diversification or intensive and extensive margins usually are based cross-sectional import/export basket of the country. Nevertheless, a complete understanding of the capabilities of countries to enter into import/export lines is very important for considering the ability of the country to transfer resources among different sectors and goods.

The latent diversification is calculated by applying the following formula:

$$N_{(c,T)}^L = |\cup_{t=t_0}^T \{X^{(c,t)}\}| \quad (14)$$

where $X^{(c,t)}$ - the set of products which were imported into country c in year t ; t_0 - the initial year of the study period; T - the final year of the study period, $|\cdot|$ - the operator used for quantifying the set cardinality.

Therefore, two constituents of latent import lines are important for the analysis of linkages among the import diversification proxy and the established conceptual ideal of latent diversification. The first component includes already open but not necessarily active import lines. The second constituent includes not open import lines in period t , which can be released in period $t+1$. This latter component can't be evaluated ex-ante, and there are difficulties in applying it as a proxy of latent diversification. The first component is also difficult to quantify precisely, mainly due to the finite time dimension and the fact that there are also outdated import lines. Consequently, the latent import diversification is based on the hypothesis that, in the case of serious external shocks, a country can shift resources to import these goods. Additionally, it is necessary to stress that countries are able to diversify their imports/export in terms of quality of goods.

The export base theory considers that the economic development of countries is determined by export and import growth. This concept was introduced by Frank Hachman (1994). Frank Hachman developed an index to measure how closely the distribution of economic activities in the region corresponds to the country as a whole. The index fluctuates in the range from 0 to 1. The value 1 for the Hachman index shows that the region has the same economic activity structure or import structure as the country. In the case of the Hachman index value of zero, the region has a completely different import structure compared to the country.

The Hachman index is calculated in the following way:

$$\text{Hachman index} = \frac{1}{\sum_{i=1}^N [S_i^{\text{region}} / S_i^{\text{country}}] \times S_i^{\text{state}}} = \frac{1}{\sum_{i=1}^N [LQ \times S_i^{\text{state}}]} \quad (15)$$

where S_i^{region} - the share of import in the i -th industry of the region, S_i^{country} - the share of import in the i -th industry of the country; N - the number of industries available; LQ - the location quotient of the country in the consequent industry.

Location theory analyzes the spatial distribution of economic activity, including import. The theory considers that production costs are lower in industrial regions, and this provides the main reasons for the specialization and

competitive advantage of selected regions (UNFCCC, 2016). The location quotient (LQ) is the ratio which measures the concentration of specific economic activity, like import in a region, compared with the import concentration of all countries. Consequently, the LQ ratio allows us to compare a specific region with a larger reference region based on the concentration of specific economic activity (Hidalgo et al., 2007; Baldwin and Harrigan, 2011). Let's consider that X is the size of some import in a region and Y is the total size of the import in the same region, then the ratio: X/Y is the 'concentration' of specific imports in a certain region. It is possible to apply the LQ ratio for the country to determine its sectors' trade activities. The sectors having higher than 1 location quotient are considered export sectors as their main outputs are exported. The sectors with a lower than 1 location quotient are treated as indigenous sectors assuming that their outputs will be consumed within the country.

The regional business cycle theory considers that economic uncertainty is linked to export or import demand. Regional business cycle theory quantifies economic instability based on the difference between stable and unstable sectors in the country or region. Based on this concept, a region's share of stable or unstable sectors is applied for economic diversity measurements. The region's economy is assumed stable if its sectoral structure of economic activities, including imports, is similar to the country's structure of economic activity.

The **National average index (NAI)** introduced by regional business cycle theory (UNFCCC, 2016) is calculated in the following way:

$$NAI = \sum_{i=1}^N \frac{(S_i^{Region} - S_i^{Country})^2}{S_i^{Country}} \tag{16}$$

where S_i^{Region} – the share of import of i -th sector in the region; $S_i^{Country}$ - the average portion of import in the i -th sector of the country; N – the number of sectors in the economy. If the region's share of import in a specific sector is approaching the country's share of import in all sectors, the NAI is becoming close to 0. If the share of import of a specific sector of a region diverges from the country's portion of import of all sectors, the NAI becomes larger. Therefore, the NAI is a relative measure of import diversification as it quantifies the size of inequality between a country's and a region's import distribution.

A portfolio theory was developed to assess the diversification of financial assets and later extended and widely applied for trade diversification analysis (Nowrouzi et al., 2019; Canela et al., 2020; Bolino and Galkin, 2021). The main concept of portfolio theory can be applied to the analysis of other economic activities diversification as well as import/export diversification. Based on portfolio theory, if every sector is associated with specific investments in a selected region, the package of sectors can be characterized as a portfolio of investments in a certain region. The aim of economic diversification is to minimize the instability of total investment returns to the region by distributing limited resources of the selected region for all sectors comprising a portfolio of investments.

A region's portfolio variance, showing regional instability, is assessed in the following way:

$$\delta_p^2 = \sum_{i=1}^N S_i^2 \delta_i^2(x_i) + \sum_{i=1}^N \sum_{j=1, j \neq i} S_i S_j \delta_{ij}(x_i x_j) \tag{17}$$

where S_i and S_j are import share of the i -th and j -th sectors, respectively; δ_{ij} - the variance of imports in the i -th and j -th sectors. The instability of the region is evaluated as the weighted sum of the variances of the sector's import share fluctuations and covariances or intersectoral import share variations. Therefore, regional stability depends on individual sector fluctuations and on the correlation of fluctuations between sectors. The lower variance of the portfolio shows the higher diversification of imports.

Economic development theory considers that economic diversification depends upon instantaneous modifications in manufacture, import/export and consumption. Based on this theory, economic diversification is accelerated by the unbalanced growth of various economic sectors. For the evaluation of growth and its impacts on various sectors, information about various sectors and their interlinkages is necessary. According to the economic development theory concept, the diversification of economic activities, including import, can be assessed in terms of variations in an input-output (I-O) matrix or built on interlinkages between various sectors presented in a detailed way by the I-O matrix.

Siegel et al. (1994; 1995) created an integrating framework for the analysis of import/export diversification by integrating into the I-O matrix the most important elements of portfolio theory. The integrated I-O model is a comprehensive framework for modelling and forecasting countries' or regions' economic structure based on the relationship between production, consumption and import/export. The region or country's economic performance is evaluated based on its economic structure. The integrated I-O model allows evaluation of the impact of different diversification strategies on economic growth and economic structure changes. The model also allows us to assess the effect caused by changes in I-O connections in the I-O matrix. It is possible to model the impact of import substitution strategy on production, consumption and trade by applying the integrated I-O framework. These various impacts can be addressed on various levels, like the whole economy or particular sectors. The model provides very detailed information on import diversification and its drivers and is a very useful tool for ranking

different trade policies based on their effects on economic growth and stability and assessing the economic growth and stability trade-offs. Therefore, this is the most advanced and powerful measure of import diversification however requires large quantities of data and huge time resources for calculations and interpretation of results.

Discussion of results

Empirical studies dealing with international trade apply various import/export concentration/diversification measures and various sets of statistical tools, covering simple absolute or absolute indicators and also very complex econometric techniques like General Equilibrium Models. There is no agreement among scholars yet on which concentration/diversification index is best for shaping trade policies. However, it is obvious that the results of empirical studies depend greatly on the statistical technique or diversification measure used in the study.

The main approach of quantifying diversification is based on quantification of concentration as a larger number of sectors in a country's economy means less market concentration, which also provides for a higher diversification level (UNFCCC, 2016). As trade is one of the main economic activities, the same approach for quantifying import/export diversification is being applied. The main approach to measuring the diversification of imports is to quantify the share of sectors in imports (import concentration) and a country's dependence on the import of specific goods. The measures of import diversification of a country allow one to understand the situation and define policies and measures to tackle problems linked to import dependency on a single supplier (Feng et al., 2012). This is very important for ensuring the security of supply as the import diversification in terms of countries and goods allows countries to reduce dependency on imports from the only supplier. Therefore, various concentration/diversification measures were developed to address this problem; however, taking into account current problems of broking supply chains due to lockdowns during covid-19 pandemic and due to the Russian-Ukrainian war, the importance of import diversification is significantly increased, and it is important to systematize and assess the main strengths and weaknesses of these measures.

The main indices for measuring import diversification can be organized into two main sets. The first set of measures is created to quantify the absolute specialization/concentration level of the country. This group includes the well-known Herfindahl-Hirschmann index, Gini index; entropy index; ogive index, etc. The measure of absolute specialization specifies the country's specialization level, like a small number of industries exhibiting high shares of imports. For example, Germany specializes in imports of energy carriers, and Northern countries in the import of agriculture and food products. The second set of import diversification/concentration measures aims to assess the import structure of the country from a reference group of industries (relative Gini index or Theil index).

The various measures of import diversification analyzed are systematized based on theoretical concepts in Table 1.

Table 1. Measures of import diversification

Measure of diversification	Theoretical background	Explanation of Values
Herfindahl-Hirschmann Index (HHI)	The theory of industrial organization considers that the industrial organization of a country decides the diversification level of the economy. The higher diversification level of economic activities is being treated as the main driver of competitiveness of countries.	The lower the value, the higher is level of import diversification.
Ogive index		The lower the value, the higher is level of import diversification.
Shannon entropy Index		The lower the value, the higher is level of import diversification.
Theil entropy index		The lower the value, the higher is level of import diversification.
The Gini coefficient		The lower the value, the higher is level of import diversification.
Intensive and extensive import margins		The higher the value of intensive or extensive import margins, the more diversified the import is.
Brenton and Newfarmer's index (IEMP)		The higher the value of the index, the more diversified the import is.
Latent import margins		The higher the value of the index, the more diversified the import is.

Hachman index	Export base theory simulates that economic growth is driven by export demand.	The value of one means that the region has exactly the same import structure as the nation, and zero means that the region has a completely different import structure. The higher the value of the index, the more stable the economy; a sector with a high value is an export sector.
National average index	Regional business cycle theory considers that economic instability is caused by export demand, and instability is assessed by the difference between stable and unstable sectors. To test this association, a region's share of stable or unstable sectors is used to measure economic diversification.	As the region's share of import of specific sectors approaches the country's share for all sectors, the index approaches zero.
Portfolio variance	Portfolio theory developed for the financial sector was applied to measure import diversification based on import portfolio instead of investment portfolio variance assessment.	The lower the portfolio variance, the higher the diversification level of imports.
Input-Output matrix	The theory of economic development believes that economic diversification is driven by simultaneous changes in patterns of production, consumption, and trade. Assessing the impact on growth and instability requires knowledge about sectors and cross-sectoral linkages. Economic diversification can be measured in terms of changes in the input-output (I-O) matrix or based on the cross-sectoral linkages identified in the I-O matrix.	Diversification is advanced by the unbalanced growth of specific sectors, particularly by the quicker advance of sectors having high-income elasticity of demand.
Integrated input-output model	An Integrated I-O model, incorporating elements of portfolio theory, was developed for the analysis of economic diversification. This model allows us to follow the growth and stability effects of different diversification strategies involving changes in the level and mix of final external inputs.	Defines the impacts of different diversification strategies on growth and stability by tracking variations in input-output relationships of the I-O matrix.

Sources: own study

In Table 2, various measures of import diversification are ranked based on several criteria: Simplicity; Data availability; Comparability and Transparency. These criteria are important for indicators and measures to provide important and well-presented information for policy analysis and decision-making. Simplicity shows the ease of calculations. Data availability provides the availability of data for assessing import diversification. Comparability criteria show how the import diversification measure can be applied for country or temporal comparison. The transparency criteria show how the import diversification measure can capture all import diversification issues

based on a set of rules that define the main preferable characteristics that the measure of diversification/concentration should have:

- The possibility of concentration curve ranking: if the concentration curve of country i is plotted over the concentration curve of country j , country i has more concentrated imports/exports compared to country j ;
- Import transfer rule: the concentration measure should change if the country starts importing products that previously had minor shares of the market;
- Import of new products rule: if a country starts importing a new product and this new commodity share in imports is below the average size of existing commodities portions, the level of concentration is supposed to diminish, considering that the relevant shares of existing commodity groups continue to be stable.

Table 2. Ranking of import diversification measures based on Simplicity; Data availability; Comparability and Transparency criteria

The measure of import diversification	Scores for ranking criteria				Total score	Ranking
	Simplicity	Data availability	Comparability	Transparency		
Herfindahl-Hirschmann Index (HHI)	5	5	5	3	18	1
Ogive index	5	4	4	3	16	3
Shannon entropy Index	4	4	4	4	16	3
Theil entropy index	4	4	5	4	17	2
The Gini coefficient	2	2	3	2	9	7
Intensive and extensive import margins	3	3	3	3	12	6
IEMP	3	3	3	3	12	6
Latent diversification margins	3	3	3	4	13	5
Hachman index	2	2	2	3	9	7
National average index	2	2	2	3	9	7
Portfolio variance	3	3	2	4	12	6
Input-Output matrix	2	3	4	5	14	4
Input-output model: a unified framework	1	3	4	5	13	5

Sources: own study

As one can notice from the information provided by Table 2, the highest-ranked measures of import diversification are Herfindahl-Hirschmann Index (HHI), Theil entropy index and Ogive index as well as Shannon entropy Index, followed by the Input-Output matrix and Latent import margins. The lowest-ranked import diversification measures are the Gini index, Hachman index and National average index.

Due to the fact that usually in developed industrialized countries, imports or exports are dominated by a few main lines, the Gini index is close to 1 and does not fluctuate greatly. Theil and Herfindahl indices are more transparent in providing information on import diversification.

Absolute and relative measures of import diversification can be applied depending on the purpose of the study. The absolute measures have several advantages in comparison with relative measures due to the fact they also evaluate imports from new commodities, and based on absolute measures, it is possible to assess better diversification levels and compare two countries having identical import diversification ratios but different shares of these commodities in import (Acar, Sankaran, 1999). The intensive and extensive import margin indicators of diversification emphasize the country's contemporaneous import/export basket (Goldberg, Campa, 2010). There are extensive and intensive margins based on the bilateral trade flows. The latent diversification margins addressed the ability of the country to enter its former import/exports lines in case of various international shocks; however, it is difficult to calculate it precisely due to the finite time dimension and other methodological hurdles (Amurgo-Pachego, Pierola, 2008).

The portfolio variance is an excellent measure of import diversification in explaining regional economic instability paralleled with other methods to measure import diversification like the ogive index, entropy indexes and NAI (Wundt, 1992; Acar, Sankaran, 1999) as it provides much information on import diversification.

However, this measure does not use for the analysis of linkages between diversity and instability as it does not quantify diversity independent of instability (Sherwood-Call, 1990).

Therefore, HHI is the simplest and most affordable measure of import diversification due to its simplicity and availability of data. With regards to suitability for comparison among countries and time, the HHI, Ogive index, Shannon entropy Index, and Theil entropy indices can be successful due to the use of homogeneous export data collected by UNCTAD. Also, it is necessary to stress that the import diversification index is also calculated and published by the World Bank, UNCTAD and IMF for major world countries. However, the transparency of HHI is limited as the same HHI values can be obtained for different commodity groups having different shares in imports (Hummels, Klenow, 2005).

An input-output model is the most comprehensive import diversification measure. However, it requires a lot of expertise and time to apply (Canelas et al., 2020; Nowrouzi et al., 2019).

Whereas ranking of import diversification measures against the main rules for measuring concentration, according to Palan (2010), HHI met all requirements, and the Theil entropy index can be treated as the second-best index in addressing all requirements for concentration measurements. Also, decision-makers are able to choose between aggregate and discrete measures of concentration/diversification based on the targeted policy analysis. The discrete measures have some weaknesses as they do not take into account the relative size variations in product groups, and it could equally assess import diversification of the country which imports one commodity and a country importing several commodity groups having the same shares etc. Therefore, it is recommended to assess import diversification based on aggregate rather than discrete or semi-discrete measures, as summary measures allow a clearer view of a country's import diversification changes over the time period.

Conclusions

The country's economy is vulnerable to various external shocks linked to the disruption of supply chains due to various political perturbations etc. if the country is dependent upon the import of a narrow range of commodities from fewer countries.

Trade and especially import and all economy diversification is the main policy to mitigate risks and to build the resilience of the country's economy to the various adverse external impacts caused by major world crises. However, economic and import/export diversification is a challenging task.

State policies to promote import diversification are necessary, ranging from soft and hard industrial etc. policies. A rigorous process of measuring, monitoring, and analyzing import/export and economic concentration is necessary for planning and implementing policies targeting import diversification. Policies have to be developed by taking into account the national circumstances, the geographical and political situation and available resources, etc.

The literature review undertaken has revealed various findings and understandings with regard to trade diversification, including import diversification and their measures in all the economic sectors, including mining.

Empirical studies dealing with international trade apply various specialization and concentration measures based on a wide variety of statistical tools, including not complicated descriptive indexes and multifaceted econometric methods. So, there is no agreement among scholars on which measure is the best for policy analysis and decision-making, though the findings of empirical studies are related to the statistical techniques and measures applied.

For shaping trade policies, countries need to have a full picture of import/export concentration. For this reason, various measures of import/export concentration/diversification can be applied depending on the purpose of analysis, data availability and available resources. The simplest way of import diversification measurement is quantifying the share of specific sectors in imports or the assessment of import concentration showing a country's dependence on the import of specific commodities from certain countries. For this purpose, concentration indices are widely applied. There are absolute and relative indices for measuring import diversification. The absolute measures of diversification have more advantages in comparison with relative indexes as they allow to have a more comprehensive view of import concentration as they allow to compare two countries in terms of import diversification having identical import diversification ratios but different shares of specific commodities in import.

Analytical tools focusing on specific industries, like the I-O model, were discovered to be more valuable for planning economic diversification in the primary economic sector, not except mining. Combining IO with other methods like LQ, extensive and intensive export margins, and latent import and export diversification is useful for the identification of clusters. Applying an integrated I-O model based on detailed industry-level data makes it possible to categorize emerging or growing industries and develop appropriate policies to support their growth. Also, to increase import diversification, countries need to systematically analyze extensive and intensive margins, as import diversification is determined more by the extensive margin and export growth is determined more by the intensive margin.

Assessment of analyzed import diversification measures based on 4 important criteria: Simplicity; Data availability; Comparability, and Transparency revealed that the best important diversification measures are:

Herfindahl-Hirschmann Index (HHI), Theil entropy index and Ogive index as well as the Shannon entropy Index followed by Input-Output matrix and Latent import margins. The lowest-ranked import diversification measures are the Hachman index and the National average index. The portfolio variance is the best tool for quantifying economic diversity in terms of regional economic instability than other measures of diversity (for instance, the ogive index, entropy index and NAI).

The study has limitations as it analyses and assesses import diversification measures based on a scientific literature review without empirical application of analyzed import diversification measures. Future research is necessary for developing a case study on the empirical application of discussed import diversification measures to update the ranking provided by a systematic literature review.

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