How Important is International Trade for a Country Really? – A Value-Added Based Approach to Measure Economic Openness*

A study by Lars Wang**

Abstract

The importance of a country’s international trade is relevant for a multitude of questions in the economic research, since international dependences influence most economical variables of a country. Usually, the concept of openness degree of an economy is used to represent this international interlocking of trade, where previous studies applied mainly output-oriented operationalizations of the openness degree. But most of the designed economy openness indicators are not able to characterize the share of traded goods and services of the production in a sufficient way. Which is true especially for one of the most frequently applied economy openness indicators, being designed by exports in relation to gross domestic product. For example, when this measure exceeds 100 percent, then this implies a negative share of domestic non-traded goods and services.

Hence, the aim of this paper is to develop new input-oriented economy openness indicators and to compare them with a selection of established output-oriented measures for 53 countries. This is done by building a multiregional input-output model, offering the necessary instruments for both approaches to design economy openness indicators. Thus, alternative ways to indicate the importance of international trade for an economy are depicted. The results show that not merely different consequences of previous analyses are likely to be possible, but also potential deviations on their recommendations for the economic policy might occur.

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1. Introduction

Economies are integrated within the international division of labor at different levels. How should the level of importance of international trade for a country be specified to compare it with other economies? This is being done by operationalizing the term openness degree, showing the importance of a country’s international trade by economy openness indicators. Hence, a high openness degree of an economy represents a high level of participation within the international interlocking of trade. There are many ways to measure the importance of international trade. This is true, since the term openness degree incorporates several attributes, leading not only to different approaches to theoretically characterize the openness degree but also to diverse approaches to design economy openness indicators for empirical measurement. Thus, alternative operationalization approaches lead to different economy openness indicators, implying that the operationalization of the openness degree has an influence on results of analyses and hereby on their recommendations for the economic policy.

This paper introduces two new input-oriented economy openness indicators, where one focuses on the export side and the other one on the input side of a country’s international trade and compares them with their counterparts of established output-oriented measures. A simple example defends a new operationalization of the term openness degree, showing the necessity to shift from an output-orientated to an input-orientated representation of a country’s importance of international trade. Output-orientation means that an operationalization approach concentrates on international trade of goods and services. In contrast to this, an input-oriented approach focuses upon value added, being induced by this international interlocking of trade. The high importance of international trade with motor vehicles for Germany is indicated by a high degree of openness for this sector. Now, suppose an increased share of imported intermediate products for the automobiles’ production with an unchanged output of production, implying a reduction of necessary domestic production factors. Does not merely the importance of international trade with motor vehicles reduce for this economy, since less domestic production factors are used? Should not also an economy openness indicator reflect this change? Output-oriented approaches are not sufficiently capable to model such a change of production structures. This is true, since they do not explicitly take secondary inputs and primary inputs into account. Whereas, input-oriented approaches do so by concentrating on induced value added. Hence, an output-oriented measure indicates a higher level of importance of international interlocking of trade for an economy as an input-oriented economy openness indicator does.
Section 2 gives an overview of the current research, where measures of the economic openness were developed and applied, giving some background for the subsequent analysis. In section 3, the theoretical core to measure the openness degree of an economy is laid out. It presents a multiregional input-output model which helps to analyze the international interlocking of trade and thus offers instruments to develop established as well as new design approaches of economy openness indicators. Section 4 empirically analyzes several measures, which are calculated on the basis of the presented design approaches. It characterizes and compares input-oriented and corresponding output-oriented economy openness indicators to illustrate their differences on indicating the importance of trade for an economy. Section 5 concludes by summarizing the results and illustrates potential enhancements of the analysis.

2. Heterogeneous picture of the openness degree in current research

In the following, this section introduces the situation of the current research. It shows that the operationalization of the term openness degree leads to different characterization approaches of the openness degree. Whereby, they build the theoretical frameworks for alternative design approaches of economy openness indicators to empirically measure the importance of international trade for a country. Finally, this section depicts the relevance of the openness degree within the economic analysis.

2.1 Diverse characterizations of the openness degree

This subsection presents a selection of characterization approaches. They describe the term openness degree by their chosen attributes, where the most common approaches, interpreting the openness degree by international interlocking of trade, are briefly depicted. For completion of this overview, approaches, interpreting the openness degree by international trade policy, are referred to and the importance of international flows of capital for a country is mentioned as another meaning of openness degree.

McKinnon (1963), Tower and Willett (1970), Ishiyama (1975), and Rivera-Batiz and Rivera-Batiz (1985) characterize the openness degree as the ratio of international tradable goods to international non-tradable goods of a country. In comparison with that, Rivera-Batiz and Rivera-Batiz (1985) illustrate the openness degree by the degree of interlocking of trade of a country with all of its trading partners. In addition, Overturf (1994), Gros and Thygesen (1998), and De Grauwe (2000) characterize it by the degree of interlocking of trade of a coun-
try with its trading partners within an integration area. Grubel and Lloyd (1975) developed the degree of intra-industrial interlocking of trade of a country with its trading partners, which can be interpreted as a degree of openness for a specific category of products. Furthermore, Overturf (1994) introduced the degree of influence of tradable goods’ price change rate on domestic inflation rate. The approach of Cohen (1997) portrays the openness degree of an economy by the degree of substitution between domestic goods and foreign goods. Cohen (1997) enhances this approach by characterizing a broader openness degree when including an integration area. This openness degree is characterized by the degree of substitution between supply of goods from countries outside an integration area and supply of goods from member countries within this integration area. Finally, Knetter and Slaughter (2001) developed two characterization approaches, which also interpret the openness degree by international interlocking of trade. The first one illustrates the openness degree by the degree of international market thickness of a country. Contrary to this approach, the second one of Knetter and Slaughter (2001) characterizes the openness degree input-oriented by the degree of production fragmentation of an economy.

Hereby, these presented approaches characterize the openness degree by referring to the international exchange of goods and services. But the interpretation of the openness degree by international interlocking of trade enables additional characterization approaches. These indicate the international linkage of production, the international migration of labor, and the international interlocking of multinational companies (Revelas 1980, p. 98). Edwards (1998) delineates further operationalization approaches, interpreting the openness degree by international trade policy. In this case, a high openness degree signifies a small degree of interventions by trade policy. This implies a stronger participation of the economy within the international division of labor then it would be at a higher level of protection of international trade. Finally, a very different interpretation of the openness degree characterizes the importance of international flows of capital for a country, being done by international interlocking of capital and by control of international flows of capital respectively.

Already this incomplete overview shows the diversity of characterization approaches of the openness degree. The presented approaches, which interpret the international interlocking of trade, characterize the degree of openness output-oriented except one input-oriented approach from Knetter and Slaughter (2001).
2.2 Alternative ways to measure the openness degree

This subsection deals with the second part of the operationalization of the openness degree. It depicts a selection of design approaches of economy openness indicators, being based on the corresponding characterization approaches of the openness degree. These design approaches build the core for measures, indicating the importance of international trade for an economy.

One of the most frequently applied design approaches is the average export ratio of a country, showing the total exports in relation to gross domestic product (GDP) and gross national product (GNP) respectively. The average import ratio is also often applied for analyses (Rivera-Batiz and Rivera-Batiz 1985). This approach analogously indicates the importance of international trade by focusing on the import side. A combined design approach builds the framework for measuring the economy openness by the arithmetic mean value of total exports and total imports in relation to GDP. Two less widespread design approaches are the marginal export ratio as well as the marginal import ratio. De Grauwe (2000) and Gros and Thygesen (1998) applied the regional export ratio and the regional import ratio respectively as design approaches. The regional export ratio shows the exports of an integration area member to other member countries of this integration area as a share of GDP. Corresponding to this design approach, the regional import ratio indicates the importance of international interlocking of trade within an integration area for an economy by focusing on the import side.

Grubel and Lloyd (1975) developed an approach to measure the intra-industrial trade of an economy. Which can be interpreted as an operationalization approach of the term openness degree, since this approach also indicates the importance of international trade for a country by measures. This approach is applied to analyze the international interlocking of trade within a specific class of products then to evaluate the international trade of all product groups as in the approaches of the previous paragraph. Whereby, the difference of exports and imports of a specific product category is related to the sum of exports and imports of this product category.

Also Knetter and Slaughter (2001) developed design approaches, fitting to their corresponding characterization approaches to operationalize the term openness degree. The first one indicates the importance of international trade for an economy by the number of bilateral trade flows and thus it distinguishes from the previously presented value based approaches. Also, their second design approach changes the point of view. This concept shows the ratio of value added to gross output within industries. Hence, the operationalization of the openness degree of an economy is input-oriented, whereas the previous approaches focus on production output. Their way of integrating domestic production factors into the operationalization of the term
openness degree is new. But, the disadvantage of this design approach is that no direct comparison with established output-oriented economy openness indicators is possible and thereby additional implications cannot be derived from. This is true, since the design approach of Knetter and Slaughter (2001) uses the gross output to measure the importance of international trade for an economy. Thereby, in comparison to the output-oriented approaches they do not only view the GDP but also the economic integration within the sectors of an economy.

The presented design approaches of economy openness indicators give a diverse picture as in the subsection before, since they try to make the corresponding theoretical characterization approaches of the openness degree empirically measurable by economy openness indicators. Also here, Knetter and Slaughter (2001) introduced the only input-oriented approach.

2.3 Multitude applications of the openness degree

This subsection depicts applications of the openness degree and hence of different economy openness indicators, representing the importance of international trade for an economy as accurate as possible. After an example to illustrate the influence of international dependencies on the openness degree of an economy, its applications will be briefly overviewed.

International trade of an economy has an impact on almost all economic spheres of a country. E.g., when American people demand automobiles then they influence the production of cars in Germany in line with their preference for German motor vehicles. Whereby, the importance of international trade for an economy reflects the international dependencies, being represented by the openness degree of the country. As international trade of motor vehicles has a high importance for the German economy, American demand volatility has stronger impacts on German economic variables then for less influential industries.

Thus, the levels of many domestic real economic variables also depend on the openness degree. Beside the influence of the openness degree on the international transmission of business cycles, it also has an effect on the specialization of a country (Weinhold and Rauch 1999), leading to dynamic competition advantages (Buzaglo 1999). Furthermore, the economic openness correlates with the domestic employment (Blanchflower 2000, Panagariya 1999, Gonzaga 1996) and it influences the investments in a country (Razin et al. 2002, Baldwin and Seghezza 1996a). Also, the openness degree shows a relationship to the economic growth of a country (Andersson 2001, Baldwin 2000, Anoruo and Ahmad 1999, Edwards 1998, Baldwin and Seghezza 1996) and thus it influences innovations (Cameron 1998).
Beyond these relationships, the openness degree shows linkages to monetary variables of an economy. It correlates with the income and thereby the income distribution (Ekholm and Midelfart Knarvik 2001, Spilimbergo et al. 1999) as well as the per capita income (Ben-David and Kimhi 2000, Frankel and Romer 1996). Further, the economic openness shows a relationship to the price level of a country. And with that, it has an effect on the price relation between exports and imports (Bloch and Olive 2001), the menu costs (Dixon and Pompermaier 1999), and the inflation (Cavallari 2001, Bleaney 1999, Romer 1993). In addition, the openness degree has linkages to the domestic money stock. Consequently, it influences the monetary policy of the domestic central bank (Smets and Wouters 2002, Mussa et al. 2000, Karras 1999). Also, there is a relationship between the degree of openness and the currency of a country. It correlates with the choice of an exchange rate regime (Heller 1977), the establishment of a regionally delimited currency area (Tavlas 1993, Ishiyama 1975, McKinnon 1963), and the extent of volatility of exchange rates (Willett 2001, Hau 2002).

In addition to these links, there is a relationship between the openness degree and a country’s economical, political, and social development (Drabek and Laird 2001, Barrell et al. 2000, Pain 2000). Moreover the economic openness influences convergence and divergence of economic variables respectively between different countries in the lapse of time (Lutz 2001, Ben-David and Kimhi 2000, Slaughter 2001, Ben-David and Loewy 1998). Furthermore, the openness degree has an effect on the urban concentration within a country (Nitsch 2001), the government size (Alesina and Wacziarg 1998, Rodrik 1998), the development of financial markets (Svaleryd and Vlachos 2002) as well as the multilateral environmental cooperation of an economy (Neumayer 2002).

Already this brief systemization depicts that economy openness indicators are applied in many fields of economic research to link the international interlocking of trade for a country to domestic real and nominal variables with the concept of openness degree.

2.4 Established economy openness indicators lack of accuracy

Current studies developed a large number of approaches to operationalize the openness degree of an economy, since this term incorporates several dimensions. It also indicates the difficulty and complexity to derive economy openness indicators, representing the importance of international trade for an economy in an accurate way. Hence, different economy openness indicators exist, trying to represent the same openness degree of an economy as precise as possible. The importance of international trade for an economy has a high relevance for many questions
within the economic research, since international dependencies and interdependencies of trade are common in the most areas of an economy. This is also reflected by the multitude and variety of theoretical and empirical studies respectively, applying the concept of openness degree. The overview of the current research in this section revealed that although many design approaches of economy openness indicators got developed only a few of them got repeatedly applied for setting up the foundation of analyses. Since most of these approaches model the importance of international trade for an economy only from the output side of production, they might not produce sufficient measures of the economic openness. Hence, the following section will introduce new approaches, focusing on the input side of production and thus including the production structure into the measurement of the openness degree.

3. Value-added based theoretical foundation to measure the openness degree

This section presents the theoretical framework for measures, indicating the openness degree of an economy. After the presentation of a reason for shifting from an output-oriented operationalization approach towards an input-oriented concept, the section introduces a simple multiregional input-output model. This model builds the core for a further analysis in such a way that alternative design approaches of economy openness indicators choose the relevant instruments of the model to indicate the economic openness as accurate as possible. Beside the introduction of new value-added based design approaches this section also depicts established concepts to measure the openness degree for an empirical analysis in the subsequent section.

3.1 Motivation to change the perspective on the openness degree

This subsection depicts a reason for an additional way to measure the openness degree. First it presents an example, illustrating the motivation to move from an output-oriented operationalization of the openness degree towards an input-oriented approach. Then the perspective how such value-added based measures could be calculated is introduced.

The example for illustration takes up again the motor vehicle industry. As shown before the international trade with automobiles has a high importance for the German economy. Thereupon, an output-oriented economy openness indicator shows a high openness degree. But, does not the importance of international trade with motor vehicles for Germany changes, if the share of imported intermediate products increases for the same output of production and thus less domestic production factors are necessary? A reason for such a scenario might be the
expansion of international interlocking of production through the reduction of the production stages for cars at home. Output-oriented operationalization approaches of the term openness degree are not sufficiently able to model such a change of the production structure in the automobile sector. Consequently, their economy openness indicators show a too high importance of the country’s international trade. Therewith, primary inputs of exports come into the focus of the analysis. In what respect does the consideration of domestic production factors and imported intermediate products to manufacture the export products influence the assessment of the importance of international trade for an economy? The scope of this question can be expanded by applying it to import products, where exported intermediate products are processed in them.

Likewise the output-oriented operationalization approaches of the term openness degree in the previous section the new input-oriented concept leads to economy openness indicators, representing the importance of international trade. But, the theoretical reason for the empirical measures is linked closer. Established characterization approaches of the openness degree, which are of interest in the following analysis, are based on the interpretation of the openness degree by the degree of interlocking of trade of a country with all of its trading partners. This view shifts for the new approach towards an interpretation of the openness degree by the economic performance of the economic sectors of the producer country, being induced by the international interlocking of trade. Therefore, a high openness degree represents a high level of economic performance by the integration of the country into the international division of labor. The imported intermediate products for the production of export goods and services do not produce value added within the producer country. Hence, these imported intermediate products are separated in the new operationalization approach of the openness degree. Based on this interpretation of the importance of international trade the new characterization approach characterizes the openness degree by the degree of value added in the producer country, being induced by interlocking of trade of a country with all of its trading partners. This theoretical description of the economic openness leads to two new design approaches of economy openness indicators for an empirical measurement of the importance of international trade for an economy – one for the export side and the other one for the import side of a country. The first design approach is the average export induced domestic value-added ratio, showing the domestic value added in relation to GDP. This value added is induced by total exports. The second concept is the average import induced foreign value-added ratio. It shows the foreign value added in relation to GDP and this value added is induced by total imports.
Established concepts of openness degree do not sufficiently integrate the production structure of economies into their modeling and thus their measures may poorly indicate the importance of international trade for a country. This situation encouraged the development of a new value-added based approach to operationalize the term openness degree.

3.2 Modeling the linkages between input and output of production

This subsection introduces the first part of the multiregional input-output model, modeling the structure of production, consumption, and international trade of an economy and its trading partners. It presents some background for modeling these interconnections. Then it depicts the assumptions of this model and finally the subsection illustrates the sets of equations, describing these relationships.

The model shows the relations between the output of sectors and their input with a multiregional input-output table and an input-output analysis. Hence, the model includes not only an economy but also its trading partners and expands the view of Leontief (1936). The input-output table builds the framework to record national and international economic interrelations of these countries in the following way, where these relations are illustrated for an economy. They are analogously valid for its aggregated trading partners. First, the input-output table shows the output of economic sectors, which is the delivery of intermediate products to domestic sectors as well as to foreign sectors and the supply of goods and services to domestic and foreign final demand. On the other hand, economic sectors need input to produce their output. Thus, the input-output table presents these sectors’ obtainment of intermediate products from sectors at home and abroad. Beside these domestic and imported intermediate products sectors require also domestic production factors. Founded on this input-output table is the input-output analysis, which is subject of the subsequent subsection.

Several assumptions are made for modeling the described connections between the output and its input. It is supposed that every sector produces a homogeneous product by using a homogenous technology. Hence, the necessity to distinguish between products and economic sectors is omitted. Furthermore, a proportional relation between total production of a sector and its necessary intermediate products is assumed. Returns to scale are presumed as constant in the production and production coefficients are supposed to be independent from the factor input. An exogenously given final demand is assumed besides, being necessary for the determination of the economic sector’s total production. Finally, it is presupposed that a given production of a sector is only achievable by a combination of production factors. Thus, no possi-
bilities of factor substitution exist. As a result of that, an efficient input of factors is only achievable if all sectors produce the amount of intermediate products, which are required for the total production of the sector.

In the following, sets of equations describe the input-output table of the model. They include the regions \((k, l)\) home country \((1)\) and foreign country \((2)\), which show the sectors \((i, j)\) agriculture \((1)\), other primary production \((2)\), manufacturing \((3)\), and services \((4)\). These sectors use the factors \((g)\) unskilled labor \((1)\), skilled labor \((2)\), capital \((3)\), land \((4)\), and natural resources \((5)\). Finally, these economic sectors produce for the demand \((e)\) in the home country \((1)\) and in the foreign country \((2)\).

The illustration of the input-output table begins with the output of economic sectors, where the gross output of sector \(i\) of region \(k\) \((X_{ik})\) consists of the delivery of intermediate products to domestic sectors as well as the supply of goods and services to the domestic final demand

\[
X_{ik} = \sum_{j=1}^{4} X_{ijk} + \sum_{e=1}^{2} Y_{iekk}, \quad i = 1,2,3,4, \quad k = 1,2.
\]

\(X_{ijk}\) stands for the deliveries of intermediate products of sector \(i\) of region \(k\) to sector \(j\) of this region \(k\) and \(Y_{iekk}\) denotes the supplies of goods and services of sector \(i\) of region \(k\) to component \(e\) of final demand of the same region \(k\), including exports. In addition to that, the input of sectors follows. The gross output of sector \(j\) of region \(k\) \((X_{jk})\) contains deliveries of domestic intermediate products, imported intermediate products, and domestic production factors

\[
X_{jk} = \sum_{i=1}^{4} X_{ijlk} + \sum_{i=1}^{4} X_{ijlk} + \sum_{g=1}^{5} W_{gjk}, \quad j = 1,2,3,4, \quad k = 1,2, \quad l \notin k,
\]

where \(X_{ijlk}\) represents the deliveries of intermediate products of sector \(i\) of region \(l\) to sector \(j\) of region \(k\) and \(W_{gjk}\) denotes the production factor \(g\) of sector \(j\) of the same region \(k\). Thus, the gross output in (1) equals that in (2), since production output is of the same value as its input

\[
X_{ik} = X_{jk}, \quad i, j = 1,2,3,4, \quad k = 1,2.
\]

As a result of that, this relation leads to an additional presentation of the link between gross output and demand as given in (1), building the core for the subsequent input-output analysis. Thereupon, the direct production coefficient of region \(k\) \((a_{ijk})\) gets introduced as

\[
a_{ijk} = \frac{X_{ijk}}{X_{jk}}, \quad i, j = 1,2,3,4, \quad k = 1,2,
\]

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which shows the required intermediate products of sector i of region k for sector j of the same region k to produce one unit output of sector j of region k. Thus, (1) can be transformed into

\[ X_{ik} = \sum_{j=1}^{4} a_{ijk} X_{jk} + \sum_{e=1}^{2} Y_{iekk}, \quad i = 1,2,3,4, \quad k = 1,2. \]

The gross output of sector i of region k is determined by the domestic intermediate products of that sector i of region k and the domestic final demand of sector i of region k. Finally, the gross domestic product of region k \((Y_k)\) is of interest for the design approaches. It coincides with the primary inputs of region k and the domestic final demand of region k respectively

\[ Y_k = \sum_{i=1}^{4} \sum_{j=1}^{4} X_{ijk} + \sum_{g=1}^{5} \sum_{j=1}^{4} W_{gjk} = \sum_{i=1}^{4} \sum_{e=1}^{2} Y_{iekk}, \quad k = 1,2, \quad l \neq k. \]

The presented input-output table builds the framework to record the connections within an economy, within its aggregated trading partners, and between them. Consequently, it enables an analysis of the international interlocking of trade at a deeper level than output-oriented design approaches can do.

### 3.3 Instruments to evaluate the international interlocking of trade

This subsection presents the final part of the model, analyzing the relationships between output and input for an economy and its trading partners. After an overview of the input-output analysis it illustrates the sets of equations, describing the interconnections of interest.

The input-output analysis evaluates economic interdependencies, which the input-output table empirically records. This is carried out for an economy and is analogously valid for its aggregated trading partners. In the following, the input-output analysis derives the connection between the domestic final demand of products and the domestic production factors, which are required to produce the equivalent supply. As shown in the previous subsection, on the one hand the gross output consists of domestic intermediate products and domestic final demand and on the other hand it contains domestic intermediate products, imported intermediate products, and domestic production factors. Now, it is of interest how much gross output is necessary to supply the domestic final demand and then how much domestic production factors this gross output requires for its production, since these domestic production factors lead to the equivalent domestic value added. The value-added based design approaches in the subsequent subsection apply the instruments of this input-output analysis to link exports with their induced value added.
First, the gross output of the set of equations (5) is presented again in an alternative way. This begins with the introduction of the vector of gross output of region k ($x_k$)

$$x_k = (X_{1k}, X_{2k}, X_{3k}, X_{4k})^T, \quad k = 1, 2.$$

Then the vector of final demand of region k ($y_k$) gets defined

$$y_k = \left( \sum_{e=1}^{2} Y_{1ek}, \sum_{e=1}^{2} Y_{2ek}, \sum_{e=1}^{2} Y_{3ek}, \sum_{e=1}^{2} Y_{4ek} \right)^T, \quad k = 1, 2,$$

which is followed by the matrix of direct production coefficients of region k ($A_k$)

$$A_k = \begin{pmatrix} a_{11k} & a_{12k} & a_{13k} & a_{14k} \\ a_{21k} & a_{22k} & a_{23k} & a_{24k} \\ a_{31k} & a_{32k} & a_{33k} & a_{34k} \\ a_{41k} & a_{42k} & a_{43k} & a_{44k} \end{pmatrix}, \quad k = 1, 2.$$

Finally, the gross output of region k ($x_k$) in (5) can be rewritten

$$x_k = A_k x_k + y_k, \quad k = 1, 2.$$

This leads to the following question. How much gross output is required to supply the final demand? To solve this problem the identity matrix (B) gets introduced

$$B = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}, \quad b_n = \begin{cases} 1 \text{ for } r = s \\ 0 \text{ for } r \neq s, \end{cases}$$

which allows a transformation of (10) into

$$(B - A_k) x_k = y_k, \quad k = 1, 2.$$

Consequently, the answer of the question and thus the solution of the problem is

$$x_k = (B - A_k)^{-1} y_k, \quad k = 1, 2.$$

It is the first instrument of the input-output analysis, showing the necessary gross output of the economic sectors of region k for their deliveries of products to the final demand of region k. $(B - A_k)^{-1}$ is the Leontief inverse matrix of region k and its coefficients indicate the expenditure of sector i of region k for production of one unit final demand of sector j of region k.
The next question is how much production factors this gross output requires for its production. To answer this question the production factor coefficient of region \( k \) \((d_{gjk})\) gets introduced

\[
d_{gjk} = \frac{W_{gjk}}{X_{jk}}, \quad g = 1,2,\ldots,5, \quad j = 1,2,3,4, \quad k = 1,2,
\]

showing the necessary amount of production factor \( g \) for production of one unit output of sector \( j \) of region \( k \). Hence, the matrix of production factor coefficients of region \( k \) \((D_k)\) follows

\[
D_k = \begin{pmatrix}
    d_{11k} & d_{12k} & d_{13k} & d_{14k} \\
    d_{21k} & d_{22k} & d_{23k} & d_{24k} \\
    d_{31k} & d_{32k} & d_{33k} & d_{34k} \\
    d_{41k} & d_{42k} & d_{43k} & d_{44k} \\
    d_{51k} & d_{52k} & d_{53k} & d_{54k}
\end{pmatrix}, \quad k = 1,2,
\]

which leads to the vector of production factors of region \( k \) \((q_k)\)

\[
q_k = \begin{pmatrix}
    Q_{1k} \\
    Q_{2k} \\
    Q_{3k} \\
    Q_{4k} \\
    Q_{5k}
\end{pmatrix}^T, \quad q_k = D_k x_k, \quad k = 1,2.
\]

Thus, the final instrument of the input-output analysis shows the necessary production factors of region \( k \) to produce the gross output of region \( k \).

The presented input-output analysis offers instruments to evaluate the international interlocking of trade. Hence, it completes the model, which builds the theoretical foundation of the following design approaches.

### 3.4 Alternative approaches to calculate economy openness indicators

This subsection depicts different design approaches of economy openness indicators. First, it presents two established output-oriented approaches – one for the export side and the other one for the import side of a country – and then the subsection introduces the corresponding value-added based concepts to measure the openness degree.

The established design approaches of economy openness indicators are represented by the average export ratio of a country and the average import ratio, since both are most frequently applied in the economic research. Thus, the average export ratio (AER) shows the exports of the home country to the foreign country as share of the domestic GDP.
When focus is put on the import side of a country, then the average import ratio (AIR) shows the imports of the home country from the foreign country as share of the domestic GDP.

\[
\text{AIR} = \frac{\sum_{i=1}^{4} Y_{1i22}}{Y_1} \cdot 100,
\]

where imports of the home country correspond to exports of the foreign country. In both ways of measuring the economic openness each measure can exceed 100 percent.

In case of the value-added based design approaches, the average export induced domestic value-added ratio and the average import induced foreign value-added ratio get introduced. The average export induced domestic value-added ratio (AEDVAR) is applied to take the export side of a country into account and shows the domestic value added, being induced by exports from the home country to the foreign country, as share of the domestic GDP.

\[
\text{AEDVAR} = \frac{\sum_{g=1}^{5} Q_{g1}}{Y_1} \cdot 100.
\]

In comparison with that, the average import induced foreign value-added ratio (AIFVAR) shows the foreign value added, being induced by imports of the home country from the foreign country, as share of the domestic GDP.

\[
\text{AIFVAR} = \frac{\sum_{g=1}^{5} Q_{g2}}{Y_1} \cdot 100.
\]

Since the production of export products requires domestic production factors and imported intermediate products, the induced domestic value added together with the induced foreign value added correspond to the export value. Hence, the production structures within the economic sectors determine the distribution of the induced total value added. This implies that a value-added based measure is less than or equal to the corresponding output-oriented measure in line with this distribution. Thus, the difference between these two measures indicates the...
imported intermediate products, induced by exports, as share of the domestic GDP. The second implication is that the measure cannot exceed 100 percent. If all domestic production factors are used to produce export products and no imported intermediate products are necessary to produce them, then the value-added based economy openness indicator shows this maximum openness degree. The same relationships apply to import products in an equivalent way, being produced by the aggregated trading partners. At the import side of a country the measures can go over 100 percent, since imports include intermediate products for economic sectors as well as goods and services for final demand.

The presented design approaches for economy openness indicators build the framework to calculate measures, which indicate the importance of international trade for a country. Different to the output-oriented approaches the input-oriented concepts concentrate on the production structures of the economic sectors and thus these value-added based design approaches take the international distribution of trade induced value added into account. This section showed the theoretical core for economy openness indicators. First it introduced an input-output model, which offered instruments to analyze national and international interconnections. Then it presented design approaches, selecting the appropriate instruments to build measures. After the theoretical foundation of measuring the economic openness is given the following section presents an empirical analysis of economy openness indicators.

4. Empirical analysis of alternative measures of the openness degree

In the following, this section presents the empirical part of the analysis by investigating alternative economy openness indicators for 53 countries, which are calculated within the framework of the presented design approaches. It characterizes and compares these measures to illustrate their differences in indicating the importance of trade for an economy. This section gives a brief methodic background of the analysis and presents the analysis of the measures of economic openness together with an interpretation of the found results.

4.1 Univariate analysis and correlation analysis build methodic core

This subsection gives an overview of the empirical analysis process. It discusses the source of data for the analysis and refers to the data preparation. Then it describes the instruments to characterize and compare the measures of economic openness.
The GTAP Data Base Version 5 from the Center for Global Trade Analysis (2001) builds the source of the data basis for this analysis. It is described in Dimaranan and McDougall (2002). After a transformation of the GTAP 5 Data Base to fit the model of section 3 and the application of the design approaches of section 4 the economy openness indicators of interest where calculated. Table A1 shows these measures of economic openness for the export side as well as the import side of 53 countries. Beside the alternative economy openness indicators it also records their rank. The rank order begins for each design approach with one for the lowest level of openness degree of the measures and ends with the measure, indicating the most open economy. Additionally, table A1 includes imported intermediate products, being induced by exports, as share of GDP (AEFVAR) and also import induced exported intermediate products in relation to GDP (AIDVAR). Finally, this table shows the value-added based economy openness indicators as share of the corresponding output-oriented measures (AEDVAR as share of AER, AIFVAR as share of AIR).

The frequency distributions in figure A1 to figure A4 illustrate this sample of economy openness indicators, which is done by the normalized relative frequency for input-oriented measures and output-oriented indicators from the export side and import side of the analyzed countries. Since the histograms give a coarse impression of the alternative measures, the following subsection shows the analysis of the measures of economy openness of table A1 together with an interpretation of the results. The first part is a univariate analysis of the economy openness indicators, being calculated by the different design approaches. This includes the characterization and comparison of frequency distribution measures for central tendency, dispersion, and skewness. Finally, the second part includes the correlation analysis of the economy openness indicators, using the rank order to calculate correlation measures of output-oriented indicators and corresponding value-added based measures (Kendall and Dickinson Gibbons 1990).

4.2 Interpretation of the results

This subsection presents an empirical analysis of the economy openness indicators for the investigated countries. After a brief overview of these measures it shows the results and their interpretation of a univariate analysis and in the following of a correlation analysis.

Figure 1 and 2 depict in an alternative way to histograms the alternative economy openness indicators. They show value-added based indicators and corresponding output-oriented measures of economic openness by the rank order of the latter ones. Following, figure 1 presents the economy openness indicators of the export side of the countries in the sample.
It reflects the theoretically derived results that the value-added based measures of economic openness are less than or equal to their corresponding output-oriented economy openness indicators at the export side of a country and that they do not exceed 100 percent. Furthermore, figure 1 and figure A5, showing the regional distribution of the export induced value added, give the impression that the spread between these indicators increases with the rank number. Which means that the more export products the economic sectors of a country sell to their international trading partners the more intermediate products they buy abroad to produce these goods and services. Figure 2 shows measures of the import side for the same countries.

Also at the import side the value-added based measures of economic openness are less than or equal to their related output-oriented measures but they can go beyond 100 percent. In this
case figure 2 and figure A6 show nearly no spread between these measures. Thus, import products of a country contain only a small fraction of intermediate products, which the international trading partners bought from the domestic economic sectors. Figure A6 shows the regional distribution of the import induced value added.

In the following, the analysis of the frequency distribution of the economy openness indicators complements the previous overview. Table 1 shows a summary of the frequency distribution measures of the sample, being given in table A1.

Table 1: Characterization of economy openness indicators

<table>
<thead>
<tr>
<th>Economy openness indicator</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Median</th>
<th>Mean</th>
<th>Range</th>
<th>Standard deviation</th>
<th>Variation coefficient</th>
<th>Pearson skew</th>
<th>Bowley skew</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Export side</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>11.73</td>
<td>0.47</td>
<td>0.56</td>
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</tr>
<tr>
<td>AER</td>
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<td>167.44</td>
<td>27.59</td>
<td>35.70</td>
<td>159.87</td>
<td>26.42</td>
<td>0.74</td>
<td>0.92</td>
<td>0.47</td>
</tr>
<tr>
<td><strong>Import side</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIFVAR</td>
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<td>37.18</td>
<td>161.75</td>
<td>26.29</td>
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</tr>
<tr>
<td>AIR</td>
<td>9.87</td>
<td>172.45</td>
<td>28.36</td>
<td>37.34</td>
<td>162.59</td>
<td>26.40</td>
<td>0.71</td>
<td>1.02</td>
<td>0.46</td>
</tr>
</tbody>
</table>

Source: Center for Global Trade Analysis (2001) and own calculations.

At the export side of the analyzed economies the AEDVAR economy openness indicators have a lower minimum and maximum value as the AER indicators and this with a higher spread for the maximum as for the minimum. Hence, an economy which exports many goods and services to its international trading partners uses also many intermediate products from them to produce these exports, since the production structures of the economic sectors represent this economic openness. An example is the internationalization of production queues. The measures of central tendency (median and mean) show that AEDVAR economy openness indicators in comparison to AER measures indicate that economies have a lower openness degree and thus international trade is of less importance for them. This reflects the changed interpretation of importance of international trade from the value of internationally transported goods and offered services to their economic performance in the producer country. In addition to that, the measures of dispersion (range, standard deviation, and variation coefficient) show that AEDVAR economy openness indicators in comparison to AER measures indicate that economies have smaller differences in the openness degree and thus international trade has more similar importance for the countries. The measures of skewness (Pearson skew and Bowley skew) also show the impact of export induced imported intermediate products on the evaluation of the importance of international trade for the analyzed economies as shown.
before. At the import side of the countries the frequency distribution measures in table 1 reflect the small fraction of exported intermediate products, which are assembled in imports.

Finally, this subsection presents the correlation analysis of the economy openness indicators. Table 2 shows the rank order correlation measures \( \rho \) of Spearman and \( \tau \) of Kendall for the corresponding economy openness indicators at the export side and import side respectively.

<table>
<thead>
<tr>
<th>Economy openness indicators</th>
<th>Spearman ( \rho )</th>
<th>Kendall ( \tau )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Export side</td>
<td>0.98476</td>
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<tr>
<td>Import side</td>
<td>0.99968</td>
<td>0.99565</td>
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</table>

Source: Center for Global Trade Analysis (2001) and own calculations.

The correlation measures show for the export side of the analyzed economies a very high conformity in indicating the economic openness. Thus, the export induced imported intermediate products do little disturb the rank order between AEDVAR economy openness indicators and AER measures. Since the fractions of exported intermediate products, which are included in imports, are of very low magnitude the correlation measures for the import side show nearly their maximum.

This section showed that countries are less open and their openness degree are more similar when value-added based economy openness indicators instead of output-oriented measures of economic openness are applied to indicate the importance of trade for an economy. This result is at the export side of countries of high relevance and at the import side of very low significance. The different ways to measure the openness degree have low influence on the rank order of the countries. After the empirical analysis of the economy openness indicators is presented the following section concludes with implications for recommendations for the economic policy and illustrates potential enhancements of the analysis.

5. Summary and outlook

The overview of the relevance of the openness degree in the current research revealed that many ways exist to develop economy openness indicators. Most of them put the focus on the output of the production and do not include their input. Furthermore, many applications for measures of economic openness exist. The lack of including production structures to measure economic openness led to the introduction of two value-added based approaches to develop economy openness indicators – one for the export side and the other one for the import side of
a country. Thus, the idea of a regional distribution of trade induced value added builds the core of the interpretation of the importance of international trade for an economy. International trade is for a producer country important when trade induces a high level of value added in this country, which is indicated by a high openness degree. At the export side of a country the value-added based economy openness indicators are lower then their output-oriented counterparts and the maximum level is 100 percent of GDP and at the import side the alternative measures nearly equal each other. Consequently, a change in the operationalization of the term openness degree from an output-oriented to an input-oriented way leads to countries, which are less open then before and which show a more similar economic openness with other countries then before. These results occur when economic openness indicators of the export side are used. In case of the import side the countries’ openness stays similar then before. When the countries are put into a rank order by their openness degree they hardly change their position. The implication of these results is that a reassessment of previous analyses with value-added based measures of economic openness can lead to different consequences and thus their recommendations for the economic policy might be influenced.

The potential of the presented multiregional input-output model can be used for analyzing the structure of the economic openness. This could lead to value-added based design approaches of economy openness indicators, which show the different traded goods and services, their employment in the economic sectors or in the final demand, and the used production factors. A further step of enhancing the analysis is the modelling of integration areas, leading to value-added based measures of economic openness between member countries within an integration area and other trading partners. This might have a high impact for results of the theory of optimal currency areas.
## Appendix

### Table A1: Sample of input-oriented and output-oriented economy openness indicators

<table>
<thead>
<tr>
<th>Region</th>
<th>Country</th>
<th>1997 Exports</th>
<th>AEDVAR</th>
<th>AEFVAR</th>
<th>AER</th>
<th>Rank</th>
<th>% of AER</th>
<th>1997 Imports</th>
<th>AIDVAR</th>
<th>AIFVAR</th>
<th>AIR</th>
<th>Rank</th>
<th>% of AIR</th>
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<td>18.7</td>
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<td>99.9</td>
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<tr>
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</table>

Note: AEDVAR average export induced domestic value-added ratio
AEFVAR average export induced foreign value-added ratio (induced imported intermediate products)
AER average export ratio
AIFVAR average import induced foreign value-added ratio
AIDVAR average import induced domestic value-added ratio (induced exported intermediate products)
AIR average import ratio
GDP gross domestic product

(continued)
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<th>Country</th>
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<th>Imports</th>
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Source: Center for Global Trade Analysis (2001) and own calculations.

Note:  
AEDVAR  average export induced domestic value-added ratio  
AEFVAR  average export induced foreign value-added ratio (induced imported intermediate products)  
AER  average export ratio  
AIFVAR  average import induced foreign value-added ratio  
AIDVAR  average import induced domestic value-added ratio (induced exported intermediate products)  
AIR  average import ratio  
GDP  gross domestic product
Figure A1: Frequency distribution of the economy openness indicator AEDVAR

Source: Center for Global Trade Analysis (2001) and own calculations.

Figure A2: Frequency distribution of the economy openness indicator AER

Source: Center for Global Trade Analysis (2001) and own calculations.
Figure A3: Frequency distribution of the economy openness indicator AIFVAR

Source: Center for Global Trade Analysis (2001) and own calculations.

Figure A4: Frequency distribution of the economy openness indicator AIR

Source: Center for Global Trade Analysis (2001) and own calculations.
Figure A5: Composition of the economy openness indicator AER

Source: Center for Global Trade Analysis (2001) and own calculations.

Figure A6: Composition of the economy openness indicator AIR

Source: Center for Global Trade Analysis (2001) and own calculations.
References


Center for Global Trade Analysis (2001), GTAP Data Base Version 5, Purdue University, West Lafayette, IN.


Dimaranan, B.V./McDougall, R.A. (2002), Global Trade, Assistance, and Production: The GTAP 5 Data Base, West Lafayette, IN.


Lutz, M.G. (2001), Globalisation, Convergence and the Case for Openness in Developing Countries: What Do We Learn From Open Economy Growth Theory and Empirics?, CSGR Working Paper No. 72/01, Coventry.


Panagariya, A. (1999), Trade Openness: Consequences for the Elasticity of Demand for Labor and Wage Outcomes, University of Maryland Mimeo., College Park, MD.


