

Import intensities of final demand components and their implications for economic openness: The case of the Czech Republic

ZDENĚK PIKHART^{1*}  and ŠÁRKA PIKHARTOVÁ²

¹ Faculty of Finance and Accounting, University of Economics, W. Churchill Sq. 1938/4, 130 67 Prague 3, Czech Republic

² Faculty of Economics, University of Economics, Prague, Czech Republic

Received: July 9, 2020 • Revised manuscript received: December 6, 2021 • Accepted: January 23, 2022

© 2023 Akadémiai Kiadó, Budapest



ABSTRACT

The article deals with the estimation of import intensities of exports, final consumption expenditures and gross fixed capital formation. It uses the input-output methodology of computing direct and indirect imports to the final demand components, which compares with regression estimates. Unlike the widely used turnover approach, the results contribute fundamentally to knowledge about the genuine openness of the Czech economy with regard to how much value-added is exported. In 2015, the highest import intensity for exports amounting to 52%, closely followed by 49% for investments. Household consumption worked with 41% import intensity, while general government consumption expenditures showed the lowest import intensity of 16%. Based on our input-output findings, the true openness of the Czech economy can be revealed. While turnover of exports to GDP reached 80% in 2019, the value-added approach showed only a half, i.e., 40% value-added was exported. It implies a contra-intuitive conclusion that even in a relatively small and highly integrated country into the globalized economy, there is a 60% majority of the non-tradeable goods.

KEYWORDS

economic integration, import intensity, input-output analysis

JEL CLASSIFICATION INDICES

C67, F02, F15

* Corresponding author. E-mail: zdenek.pikhart@mfcz.cz

1. INTRODUCTION

Advanced economies have been deepening the international division of labour since World War II. Post-communist economies have been integrating into the globalized structures of the world economy since 1990s. The process of integration has been boosted by removing barriers to free trade and free movement of production factors. All post-communist countries have experienced a strong inflow of foreign capital, which has fundamentally encouraged economic activity and has accelerated the convergence process to the GDP per capita of the advanced economies. The case of the Czech Republic is no exception and the catching-up process has been further gathering pace after it joined the European Union in 2004.

The simplest way of how to capture the economic openness is the turnover approach – exports or imports share as a % of nominal GDP. The advantage of the turnover approach is its clarity and simplicity and, in this respect, it is a reasonable proxy variable of how to capture economic openness and its interlinkages in the global economy for various research purposes. But the main drawback of the turnover approach is its ambiguity in determining the real extent of the share of value-added, which is exported.

To reveal the real exported value-added, the import intensities of an aggregate demand must be found. This value-added approach is much more complex and gives all the information required, but since it is computed from input-output tables, it is available only on an annual basis with significant publication delays and the process of determining direct and indirect imports through the supply chain is not straightforward, and thus, requires a number of complicated matrix operations.

Let us illustrate the difference between turnover and value-added approach with an example of corner solutions. Assume two economies both with $GDP = 100$, absorption (consumption and investments) = 100, exports = 100 and imports = 100 (net exports = 0). The first economy has an import intensity of exports equal to 100%. It means that all exports come from abroad and are imported, thus 100% of value-added created within the first economy goes to domestic use and 0% of GDP is in fact exported. On the contrary, assume a 0% import intensity of exports in the second economy. So, all exports are created within the domestic economy. Thus 100% of the value-added goes to exports and all the amount of consumption and investments are imported. In other words, 0% of GDP is domestically used and 100% of the second economy goes to exports. But there is 100% ratio of exports to GDP in both cases. It is obvious, that the impact of foreign or domestic economic shocks, size of demand multipliers, vulnerability etc. would be completely different in these two extreme cases.

So, it is essential to know the import intensities across the GDP structure in order to conduct analyses and forecasts of economic activity. Based on the knowledge of import intensities of final demand components, the genuine share of tradeable and non-tradeable goods and services in the economy might be unveiled.

The research goal of this paper is to estimate the import intensities of exports and main domestic demand components in the case of the small and open Czech economy. The knowledge of import intensities thus provides an insight into true economic openness, leading to the knowledge of how much value-added is exported and how much is used domestically. The article applies input-output methodology of computing direct and indirect imports to the final demand components, which compares with regression estimates, but focuses exclusively on the Czech economy with higher details and longer time horizon than the current literature. The



paper presents long-term development and current values of import intensities of all final demand components, which are essential inputs for a wide range of macroeconomic analyses and forecasts including the derivation of the comparative price level.

2. LITERATURE REVIEW

Consensus of how to capture economic openness has not been reached so far which was pointed out, for instance by [Yanikkaya \(2003\)](#), [Busse – Koeniger \(2012\)](#) and [Huchet-Bourdon et al. \(2017\)](#). There are a few methodologically different approaches used in literature with specific pros and cons.

A more common and straightforward method used for capturing the economic openness work with a certain type of turnover approach. In order to avoid trade imbalances, [Squalli – Wilson \(2011\)](#) used the composite trade volume as a sum of exports and imports as a % of nominal GDP. [Alcala – Ciccone \(2004\)](#) applied the real trade share as a sum of exports and imports as a % of GDP in purchasing power parity. [Frankel \(2000\)](#) and [Li et al. \(2004\)](#) took foreign trade turnover divided by GDP and adjusted for the nation's share in the world production. [Tang \(2011\)](#) presented the trade volume as a share of a country's GDP factor, defined by a CES-function of its own GDP and the GDP of the rest of the world. [Dreher et al. \(2010\)](#) developed an indirect approach to measuring economic openness by creating a so-called globalization index composed of various weighted financial and real economic indicators.

The more sophisticated methods for quantifying economic openness indicate true exported value-added with respect to interlinkages of a global value chains. [Hummels et al. \(2001\)](#) analysed vertical trade structures, which are the consequences of international division of labour based on its specialisations. Vertical specializations share accounts for 25% of the world trade. Using panel regression models [Miroudot et al. \(2009\)](#) pointed out that trade in intermediates accounts for about 56% of world trade of goods and 70% of services. [Dedrick et al. \(2010\)](#) illustrated on micro data that less than 10% of the Chinese factory-gate price of the iPods are Chinese value-added, the rest of the components are imported from Japan, Korea and the US. [Koopman et al. \(2014\)](#) and [Los et al. \(2016\)](#) provided full methodological model of decomposition of domestic and foreign value-added within exports. They utilized data from international input-output tables based on the [Leontief model \(1936\)](#). [Francois et al. \(2014\)](#) developed the methodology of the World Bank and the OECD using similar input-output analysis for publishing exported value-added for many world economies, which focuses primarily on the supply side of an economy.

Using input-output tables, [Cappariello \(2012\)](#) captured the pattern of production fragmentation of Italian and German manufacturing industries through an increased imports of intermediate consumption in order to reduce costs. [Goldar \(2017\)](#) conducted input-output analyses to express import intensities of particular industries in India and other Asian economies with the similar results. [Auboin \(2018\)](#) examined the import intensities of aggregate demand of the world's main economies by international input-output methodology. The investment slump after 2008 undermined economic growth due to high import intensity. Regarding the post-communist economies, [Baer-Nawrocka – Mrówczyńska-Kamińska \(2019\)](#) estimated import intensity of agriculture industry between the European Union countries using the input-output models. Authors concluded that in the majority of the new Member States, the importance of non-agricultural inputs in the structure of total material flows in food production is gradually increasing, whereas



material flows within agriculture are decreasing. In the Czech Republic, changes in the structure of material flows to agriculture are accompanied by an increase in material intensity of agricultural production. In the conditions of the Czech economy Vltavská – Sixta (2017) use input-output analyses for quantifying regional interlinkages, but detailed estimates covering the import intensities of all main demand aggregates are lacking.

3. TRADEABLES AND NON-TRADEABLES

On the basis of Ricardo's classical trade theory (Ricardo, n.d.), a country will engage in international trade if it has a comparative advantage in the production of the goods. Heckscher et al. (1991) identified the sources of comparative advantages in relative endowment of production factors. Country with abundant supply of labour force (capital) will have comparative advantage in labour (capital) intensive industries. According to the New Trade Theory elaborated in Dixit – Stiglitz (1977) and Krugman (1980), the trade is beneficial even between similar countries producing similar product due to increasing returns to scale and preference for diversity in consumption. Potrafke (2015) analysed more than a hundred studies using globalization indexes with the conclusion that globalization has spurred economic growth, promoted gender equality and improved human rights.

The benefits of engaging in the international division of labour was also proved empirically. Busse – Koeniger (2012) and Gräbner et al. (2018) conducted a broad panel based empirical evidence of the benefits of trade integrations as a substantial factor of long-term economic growth both in developed and developing countries. The international division of factors of production is in line with the application of comparative advantages, which allows the deepening of the international division of labour force. Frankel – Romer (2000) estimated elasticity between the percentage point increase of the ratio of trade turnover to GDP and growth of income per person to 0.5. Felbermayr – Gröschl (2013) and Waugh – Ravikumar (2016) modified and extended panel models and confirmed the strong positive influence of trade openness on economic welfare.

In this paper, we estimated the true share of exported value-added in the Czech economy. Estimation of import elasticities of final demand has strong implications into derivation of a comparative price level (CPL) and an exchange rate deviation index (ERDI). The definition of purchasing power parity (PPP) is the ratio of domestic aggregate price level P_D and foreign aggregate price level P_F :

$$PPP = \frac{P_D}{P_F}$$

Then the comparative price level is the ratio of the PPP and a nominal exchange rate (ER):

$$CPL = \frac{\frac{P_D}{P_F}}{ER} = \frac{PPP}{ER}$$

If ER is weaker than PPP, then domestic economy has lower price level compared to foreign economy. If the ER is stronger than PPP, then domestic economy has higher relative price level. From relationship between PPP and ER, we can derive the exchange rate deviation index, which is a real exchange rate (RER) in absolute terms:



$$RER = ERDI = \frac{ER}{PPP} = \frac{1}{CPL} = \frac{1}{\frac{P_D}{P_F}} = ER \frac{P_F}{P_D}$$

In case of the Czech Republic, based on Eurostat (2020) the PPP of the euro area in 2019 was 17.9, thus the domestic price level was almost 18 times higher. The nominal exchange rate based on Czech National Bank (2020) was 25.7 CZK/EUR so the comparative price level reached 69.8%. The exchange rate deviation index or the real exchange rate is 1.43. The Czech currency is 43% weaker compared to the PPP, so there are cheaper goods and services in the Czech Republic in comparison with the euro area.

The development of the PPP in time can be expressed by growth of the implicit price GDP deflator (IPD):

$$PPP_{T+1}^D = PPP_T^D \frac{IPD_{T+1}^D}{IPD_{T+1}^F}$$

Then the comparative price level in next time period can be expressed by:

$$\begin{aligned} CPL_{T+1}^D &= CPL_T^D \Delta CPL_{T+1}^D = \frac{PPP_T^D \frac{IPD_{T+1}^D}{IPD_{T+1}^F}}{ER_{T+1}} = \\ &= \frac{PPP_T^D}{ER_T} \frac{\frac{IPD_{T+1}^D}{IPD_{T+1}^F}}{(1 + ER_{T+1})} = \frac{CPL_T^D}{(1 + ER_{T+1}) \frac{IPD_{T+1}^F}{IPD_{T+1}^D}} = \frac{CPL_T^D}{index\ RER_{T+1}} \end{aligned}$$

Based on the previous equation, the growth of the comparative price level in domestic economy can therefore proceed in three ways, in summary by appreciation of the real exchange rate (*index RER*):

- higher domestic inflation than foreign inflation;
- higher domestic deflation than foreign deflation;
- appreciation of nominal exchange rate.

The answer to question that how one country can have significantly different comparative price level gives the division of the goods and services into tradeables and non-tradeables. Tradeables are goods and services, which are traded internationally into globalized markets. A law of one price is applied. Cheaper tradeable good in one country motivates companies to buy it and sell it at higher price in another market for extra profit. But there are certain differences in prices across countries in short term due to different taxation, transportation costs, lags of supplies and incomplete information. But these deviations from parity in tradeables are offset upto substantial extent at aggregate level, so in the long term they are rather negligible and we can exclude them for the sake of simplicity.

The main difference in the comparative price level is due to non-tradeables, which are domestically produced and consumed goods and services. Typically, these are local services and perishable goods with prohibitively high costs of trading. For instance, it is not worth flying to the cheaper hairdresser, even if the price difference would be significant.



The subject of this article is to estimate import intensities of final demand, which leads to the demarcation of genuinely exported gross value-added and part of the value-added used domestically. From the next chapter, we already know that 40% of GDP is exported, which means at least the same share of non-tradeables within economy. This figure represents rather the lower bound, since more goods and services might be internationally traded, but they are not traded due to small price difference. The genuine tradeable sector includes primarily agriculture and industry with 32% share of the Czech gross value-added. The 40% share of tradeables estimated from input-output tables seems reasonable. We have to admit, that in line with the most studies, the majority of even small and open Czech economy is represented by non-tradeables.

As stated above, the differences in price levels among countries are caused by nontradeables. The theory that explains a deviation of prices of nontradeables among countries is called a Balassa-Samuelson effect.

If we have domestic price level of tradeables P_T^D and nontradeables P_N^D and foreign price level of tradeables P_T^F nontradeables P_N^F , then we have productivity in domestic tradeable Y_T^D and nontradeable Y_N^D sector and productivity in foreign tradeable Y_T^F and nontradeable Y_N^F sector. The Balassa-Samuelson effect could be described as follows:

$$\frac{P_N^D}{P_T^D} = \frac{\frac{Y_T^D}{Y_N^D}}{\frac{Y_T^F}{Y_N^F}} = \frac{Y_T^D}{Y_T^F} \frac{Y_N^F}{Y_N^D}$$

So, the relative prices of domestic nontradeables, and thus, the domestic aggregate comparative price level is higher if:

- higher is productivity of domestic tradeables compared to foreign tradeables;
- lower is productivity of domestic non-tradeables compared to foreign non-tradeables.

Balassa-Samuelson effect explains the impact on the comparative price level stemming from productivity increase in tradeables. The higher wages are compensated by productivity increase, so there are no price pressures on tradeables. But higher wages in tradeable sector attract employees from non-tradeable sectors, which are experiencing shortages of labour force resulting in wage growth. Since the wage growth is not offset by productivity increase unlike tradeable sector, it results in inflation of non-tradeable goods. This effect is called wage contagion.

Balassa-Samuelson effect explains relationship between GDP per capita in PPP and comparative price level. The consequence of the growth of productivity driven by tradeable sector, which is quite common (manufacturing industry, global competition etc.), is rise of the comparative price level. On the contrary, as we can envisaged from previous equation, when growth of GDP comes from non-tradeable sector (housing, healthcare, education, public administration etc.), a decline in comparative price level will occur.

By weighting the share of tradeable X and non-tradeable $(1 - X)$ sector on gross value-added in domestic economy and share of tradeable Y and non-tradeable $(1 - Y)$ sector in foreign economy, the domestic aggregate comparative price level can be calculated as:

$$CPL = \frac{XP_T^D + (1 - X)P_N^D}{YP_T^F + (1 - Y)P_N^F}$$

Let us apply given relations to the Czech economy. We assume domestic 53% relative productivity in domestic tradeable sector and 108% relative productivity in domestic non-tradeable



sector. It results in 48% price level in non-tradeable sector and 69% comparative price level of euro area:

$$\frac{P_N^D}{P_N^F} = \frac{Y_T^D}{Y_T^F} \frac{Y_N^F}{Y_N^D} = \frac{53}{100} \frac{100}{108} = 0.49$$

$$CPL = \frac{XP_T^D + (1 - X)P_N^D}{YP_T^F + (1 - Y)P_N^F} = \frac{(0.4 * 100) + (0.6 * 0.49 * 100)}{(0.4 * 100) + (0.6 * 100)} = \frac{69}{100} = 0.69$$

Using (input-output) I–O weights of tradeables and non-tradeables, the Czech GDP in PPP is 86% of euro area:

$$GDP_{PPP}^{CZ} = X * \frac{Y_T^D}{Y_T^F} + (1 - X) * \frac{Y_N^D}{Y_N^F} = (0.4 * 0.53) + (0.6 * 1.08) = 0.86$$

Czech macroeconomic data revealed relatively solid productivity in non-tradeables. If we assume the same relative productivity in non-tradeable sector and 50% share of tradeables and 50% of nontradeables, it implies the same relative economic and price level. The deviations from the unit relationship between real and nominal convergence result from non-balanced shares of tradeable and non-tradeable sectors and possible different relative productivities in non-tradeables.

Central banks can not affect long-term economic growth, and thus, it has no long-term impacts on the real exchange rate development. Also, the level and changes of comparative price levels are out of the role of the central bank. But monetary policy could choose besides the short-term deviations of interest rates and exchange rate from equilibrium if the comparative price level growth is driven by nominal exchange rate changes or inflation differential to foreign economy.

Assume the productivity growth in domestic tradeable sector. It will cause decline of aggregate price level with price level decline of tradeables outweighs price level increase in non-tradeables (Balassa-Samuelson effect), *ceteris paribus*. The general deflation occurs due to higher amount of goods on the same amount of money in circulation. Purchasing power parity in tradeables still holds due to exchange rate appreciation. These are non-tradeables, which stands behind growth of comparative price level. The only channel of real exchange rate appreciation is stronger nominal exchange rate.

Look at the second example of the productivity growth in domestic tradeable sector in same extent, but in fixation of nominal exchange rate. The pressures on decline of the price level of tradeables create inflow of money to the domestic economy. So the prices of nontradeables remain unchanged despite productivity increase. But higher money supply creates higher inflation of nontradeables. At the end of the day, the only channel of real exchange rate appreciation is higher price level of non-tradeables.

In both extreme examples – with no changes of money in circulation or full monetary accommodation of supply growth – the parity in tradeables was established and comparative price level increase was given by the growth of relative prices in non-tradeables.

Czech National Bank has a same inflation target as the European Central Bank. Inflation remained relatively low and stable and most of the nominal convergence of the Czech economy has been driven by the nominal exchange rate appreciation.



4. METHODS

The various possibilities of input-output analyses are explained in detail in Isard – Langford (1971) or Miller – Blair (2009). For the sake of estimating the import intensity of final demand, the symmetric I–O tables are particularly beneficial. These I–O tables can be derived from supply and use tables at current prices and also at the previous year's prices.

The supply and use tables do not contain information on the extent to which goods and services were produced domestically and which were imported. This information is necessary for analyses where the link between the supply and use of goods and services within the national economy is relevant. Information about import intensities within the economy is included in symmetric I–O tables, which is therefore a matter of our interest. The disadvantage of the symmetric I–O tables lies in the considerably delayed availability of 3 years. Unlike the classical production function, the I–O models are characterized by the Leontief production function which assumes the perfect complementarity of the factors of production.

The symmetric I–O tables are commonly distinguished between industry-industry and product-product tables. The industry-industry I–O table shows the sales of a particular industry to other industries and components of final demand such as final consumption, investment and exports, whereas the product-product I–O table shows the sales of a particular product for the production of other products and components of final demand.

Both types of symmetric I–O tables are published in 3 datasets which include:

- usage of domestic production;
- usage of imported production;
- usage of total production.

At first, there is a need of extracting information about indirect import intensities from data, which means finding import for the final demand through domestic producers within the supply chain. Assume categorization of economy into n industry, where x_i^{dom} represents production within the domestic economy from only domestically produced inputs of industry i , which is sold through the same and other industries z_{in}^{dom} (also known as intermediate sales) and for final demand f_i^{dom} :

$$x_i^{dom} = z_{i1}^{dom} + z_{in}^{dom} + \dots + z_{in}^{dom} + f_i^{dom} = \sum_{j=1}^n z_{ij}^{dom} + f_i^{dom}$$

We can express the equation for n industries, where each industry sells domestically produced goods and services to other industries including itself and final demand. There is 99 industries in the I–O tables. Final demand components are final expenditures of households and general government, gross fixed capital formation, changes of inventories and exports of goods and services.

$$\begin{bmatrix} x_1^{dom} \\ \vdots \\ x_n^{dom} \end{bmatrix} = \begin{bmatrix} z_{11}^{dom} & \dots & z_{1n}^{dom} \\ \vdots & \ddots & \vdots \\ z_{n1}^{dom} & \dots & z_{nn}^{dom} \end{bmatrix} + \begin{bmatrix} f_1^{dom} \\ \vdots \\ f_n^{dom} \end{bmatrix}$$

Similarly, x_i^{im} denotes imported production of the particular industry, which is sold through the same and other industries z_{in}^{im} and for final demand f_i^{im} :



$$x_i^{im} = z_{i1}^{im} + z_{in}^{im} + \dots + z_{in}^{im} + f_i^{im} = \sum_{j=1}^n z_{ij}^{im} + f_i^{im}$$

We can express that equation for n industries, where each industry sells foreign-produced goods and services to other industries including itself and final demand:

$$\begin{bmatrix} x_1^{im} \\ \vdots \\ x_n^{im} \end{bmatrix} = \begin{bmatrix} z_{11}^{im} & \dots & z_{1n}^{im} \\ \vdots & \ddots & \vdots \\ z_{n1}^{im} & \dots & z_{nn}^{im} \end{bmatrix} + \begin{bmatrix} f_1^{im} \\ \vdots \\ f_n^{im} \end{bmatrix}$$

Finally, x_i^{tot} denotes total production of the particular industry, which is sold through the same and other industries z_{in}^{tot} and for final demand f_i^{tot} :

$$x_i^{tot} = z_{i1}^{tot} + z_{in}^{tot} + \dots + z_{in}^{tot} + f_i^{tot} = \sum_{j=1}^n z_{ij}^{tot} + f_i^{tot}$$

In the following matrix, each industry sells goods and services whether imported or manufactured in the domestic economy to other industries including itself and final demand.

$$\begin{bmatrix} x_1^{tot} \\ \vdots \\ x_n^{tot} \end{bmatrix} = \begin{bmatrix} z_{11}^{tot} & \dots & z_{1n}^{tot} \\ \vdots & \ddots & \vdots \\ z_{n1}^{tot} & \dots & z_{nn}^{tot} \end{bmatrix} + \begin{bmatrix} f_1^{tot} \\ \vdots \\ f_n^{tot} \end{bmatrix}$$

These relationships can be utilized to create matrices of fixed technical coefficients A^{im} and A^{dom} presented in following matrices. A^{im} represents a share of imported intermediate sales of industry n to industry n in the total production (imported and domestically produced) of industry n :

$$A^{im} = \begin{bmatrix} \frac{z_{11}^{im}}{x_1^{tot}} & \dots & \frac{z_{1n}^{im}}{x_n^{tot}} \\ \vdots & \ddots & \vdots \\ \frac{z_{n1}^{im}}{x_1^{tot}} & \dots & \frac{z_{nn}^{im}}{x_n^{tot}} \end{bmatrix} = \begin{bmatrix} a_{11}^{im} & \dots & a_{1n}^{im} \\ \vdots & \ddots & \vdots \\ a_{n1}^{im} & \dots & a_{nn}^{im} \end{bmatrix}$$

Whereas A^{im} captures the share of domestically produced intermediate sales of industry n to industry n in the total production (imported and domestically produced) of industry n :

$$A^{dom} = \begin{bmatrix} \frac{z_{11}^{dom}}{x_1^{tot}} & \dots & \frac{z_{1n}^{dom}}{x_n^{tot}} \\ \vdots & \ddots & \vdots \\ \frac{z_{n1}^{dom}}{x_1^{tot}} & \dots & \frac{z_{nn}^{dom}}{x_n^{tot}} \end{bmatrix} = \begin{bmatrix} a_{11}^{dom} & \dots & a_{1n}^{dom} \\ \vdots & \ddots & \vdots \\ a_{n1}^{dom} & \dots & a_{nn}^{dom} \end{bmatrix}$$

I is an $n \times n$ identity matrix with 1 on the main diagonal and 0 elsewhere. Then A^{dom} is subtracted from I :



$$I = \begin{bmatrix} 1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & 1 \end{bmatrix} \text{ so then } (I - A^{\text{dom}}) = \begin{bmatrix} (1 - a_{11}^{\text{dom}}) & \cdots & -a_{1n}^{\text{dom}} \\ \vdots & \ddots & \vdots \\ -a_{n1}^{\text{dom}} & \cdots & (1 - a_{nn}^{\text{dom}}) \end{bmatrix}$$

From the relationship:

$$I = (I - A^{\text{dom}})(I - A^{\text{dom}})^{-1}$$

We get the Leontief inverse matrix L:

$$L = (I - A^{\text{dom}})^{-1}$$

Then the row matrix u is used with 1 to multiply matrix A^{im} . As a result uA^{im} captures the overall import intensity of the particular industry n as a sum of all imported intermediate sales on the total production of the industry:

$$u = [1 \quad \cdots \quad 1] \text{ so then } uA^{\text{im}} = [(a_{11}^{\text{im}} + \cdots + a_{n1}^{\text{im}}) \quad \cdots \quad (a_{1n}^{\text{im}} + \cdots + a_{nn}^{\text{im}})]$$

The Leontief inverse matrix L is then multiplied by the overall import intensities:

$$(uA^{\text{im}})(L) = (uA^{\text{im}})(I - A^{\text{dom}})^{-1} = [b_1 \quad \cdots \quad b_n]$$

The resulting matrix of technical coefficients $[b_1 \quad \cdots \quad b_n]$ is used in order to extract indirect imports IM_f^{INDIRECT} from domestically produced final demand components f_n^{dom} in monetary terms:

$$IM_f^{\text{INDIRECT}} = [(uA^{\text{im}})(L)] F^{\text{dom}} = [b_1 \quad \cdots \quad b_n] \begin{bmatrix} f_1^{\text{dom}} \\ \vdots \\ f_n^{\text{dom}} \end{bmatrix}$$

and in relative terms IMI_f^{INDIRECT} :

$$IMI_f^{\text{INDIRECT}} = \frac{IM_f^{\text{INDIRECT}}}{f^{\text{tot}}}$$

The direct imports to the final demand components f^{im} can be read directly from I-O tables and the direct import intensity IMI_f^{DIRECT} is composed in:

$$IMI_f^{\text{DIRECT}} = \frac{f^{\text{im}}}{f^{\text{tot}}}$$

The total import intensity of final demand components is thus calculated as a sum of direct and indirect ones:

$$IMI_f^{\text{TOTAL}} = IMI_f^{\text{INDIRECT}} + IMI_f^{\text{DIRECT}}$$



With the knowledge of the import intensity of final demand we might compute value-added, which is exported GDP^{ex} and value-added, which is used within domestic economy GDP^{dom} . With use of total import intensity of exports IMI_{ex}^{TOTAL} , the calculation is quite straightforward:

$$IM = IM^{ex} + IM^{dom}$$

$$IM^{ex} = EX * IMI_{ex}^{TOTAL}$$

$$IM^{dom} = IM - IM^{ex}$$

$$GDP^{ex} = \frac{EX - IM^{ex}}{GDP}$$

$$GDP^{dom} = \frac{(DOM.DEM. - IM^{dom})}{GDP}$$

Or alternatively with the same result:

$$GDP^{ex} = \frac{EX(1 - IMI_{ex}^{TOTAL})}{GDP}$$

$$GDP^{dom} = GDP - GDP^{ex}$$

Regression model estimates are presented for the sake of comparison with I–O import intensities calculations. We use the Czech final demand components as: final consumption expenditures of households, gross capital formation (better model results than using gross fixed capital formation), and exports and imports of goods and services. Final consumption expenditures of government institutions are not significant in our models, thus are not presented. It is not surprising since a substantial part of government consumption consists of imputed non-market value-added captured by compensations of government employees and amortization of capital. The real exchange rate gap has been incorporated as a factor affecting imports. It is the exchange rate of Czech koruna to euro currency deflated by GDP deflators and detrended by the Hodrick-Prescott filter with standard recommended lambda of 1,600 for quarterly data. The gap between actual real exchange rate values and its trend is used.

All national accounts data taken directly from the [Czech Statistical Office \(2020\)](#) are adjusted on a quarterly basis and seasonally. Nominal exchange rate values are taken from the [Czech National Bank \(2020\)](#). Time series are available from the 1st quarter of 1997 till the 3rd quarter of 2019 and are transformed to: difference over the preceding period and over the preceding year in nominal terms, and the quarterly and annual growth rate both in real and nominal terms.

Descriptive statistics are reported in [Table 1](#). It shows the mean value, standard deviation, Jarque-Bera test of normality of the distribution and augmented Dickey-Fuller unit root test. The series may be considered stationary, which is important information for further analysis.

5. RESULTS

The time series of import intensities of particular final demand components computed from the I–O tables divided into direct and indirect imports are presented first. Then the share of



Table 1. Descriptive statistics

Variable		Unit	Abbreviation	Sample	Mean	St. dev.	Jarque-Bera test	ADF
<i>Imports of goods and services</i>								
Difference over previous quarter	nominal	bil. CZK	qoq_dif_n_im	91	8.54	18.07	53.16***	−7.14***
Difference over same quarter of preceding year	nominal	bil. CZK	yoy_dif_n_im	91	34.53	43.93	7.78**	−4.59***
Quarterly growth	nominal	%	qoq_n_im	91	1.80	3.84	510.60***	−7.19***
Quarterly growth	real	%	qoq_r_im	91	1.78	3.28	375.35***	−8.26***
Annual growth	nominal	%	yoy_n_im	91	7.78	9.78	2.78	−4.22***
Annual growth	real	%	yoy_r_im	91	7.45	7.87	26.76***	−4.47***
<i>Exports of goods and services</i>								
Difference over previous quarter	nominal	bil. CZK	qoq_dif_n_ex	91	9.83	17.84	31.16***	−7.17***
Difference over same quarter of preceding year	nominal	bil. CZK	yoy_dif_n_ex	91	39.58	43.01	9.17**	−4.39***
Quarterly growth	nominal	%	qoq_n_ex	91	2.05	3.96	203.29***	−6.52***
Quarterly growth	real	%	qoq_r_ex	91	1.96	3.44	264.03***	−7.59***
Annual growth	nominal	%	yoy_n_ex	91	8.82	10.44	13.24***	−4.71***
Annual growth	real	%	yoy_r_ex	91	8.21	8.76	21.09***	−3.73***
<i>Final consumption expenditures of households</i>								
Difference over previous quarter	nominal	bil. CZK	qoq_dif_n_fce	91	4.82	3.49	0.04	−5.11***
Difference over same quarter of preceding year	nominal	bil. CZK	yoy_dif_n_fce	91	19.10	10.52	0.33	−2.81*
Quarterly growth	nominal	%	qoq_n_fce	91	1.17	0.84	0.11	−3.58***
Quarterly growth	real	%	qoq_r_fce	91	0.58	0.69	1.26	−7.24***
Annual growth	nominal	%	yoy_n_fce	91	4.87	2.76	1.73	−3.29**
Annual growth	real	%	yoy_r_fce	91	2.38	1.79	8.01**	−2.67*
<i>Gross capital formation</i>								
Difference over previous quarter	nominal	bil. CZK	qoq_dif_n_inv	91	2.23	10.29	0.75	−5.12***

(continued)



Table 1. Continued

Variable		Unit	Abbreviation	Sample	Mean	St. dev.	Jarque-Bera test	ADF
Difference over same quarter of preceding year	nominal	bil. CZK	yoy_dif_n_inv	91	8.73	22.54	9.71***	−5.13***
Quarterly growth	nominal	%	qoq_n_inv	91	0.97	3.93	1.19	−9.67***
Quarterly growth	real	%	qoq_r_inv	91	0.57	3.91	1.34	−9.27***
Annual growth	nominal	%	yoy_n_inv	91	3.95	8.66	1.49	−5.15***
Annual growth	real	%	yoy_r_inv	91	2.33	8.67	1.86	−5.54***
Real exchange rate gap	real	%	rer_gap	91	−0.21	3.08	28.49***	−5.35***

Source: Czech Statistical Office (2020), Czech National Bank (2020), own construction.

Notes: Jarque-Bera statistic is under the null of normal distribution. ADF is augmented Dickey-Fuller statistic under the null of unit root. *, **, *** denote rejection of the null at 10, 5 and 1% level of significance, respectively.

exported value-added is revealed, and finally, the import intensities are compared with different types of regression models.

The final consumption expenditures of households and non-profit institutions serving household (NPISH) import intensity (Figure 1, Table A1) had been gradually rising since 1990. This reached 40% in 2015 roughly equally divided into direct and indirect imports.

Final consumption expenditures of general government import intensity had remained relatively stable (Figure 2, Table A2), close to 16% with the dominance of indirect imports. As mentioned above, a major part of government consumption reflects the imputation of non-profit value-added, which had obviously zero import intensity. It seems that even a minor part of government purchases

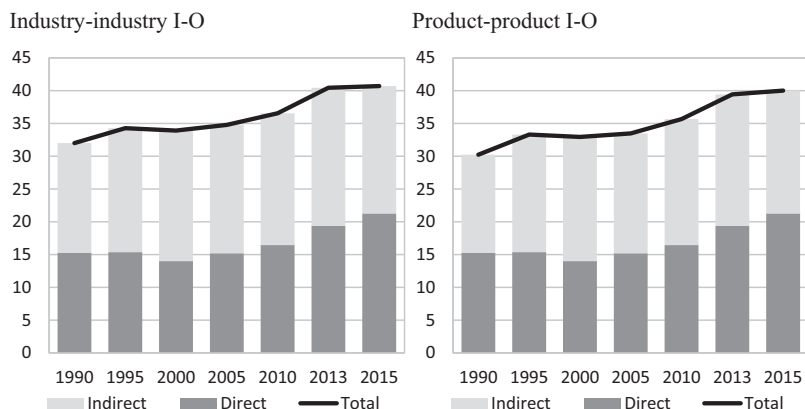


Fig. 1. Final consumption expenditures of households and NPISH import intensity (%)



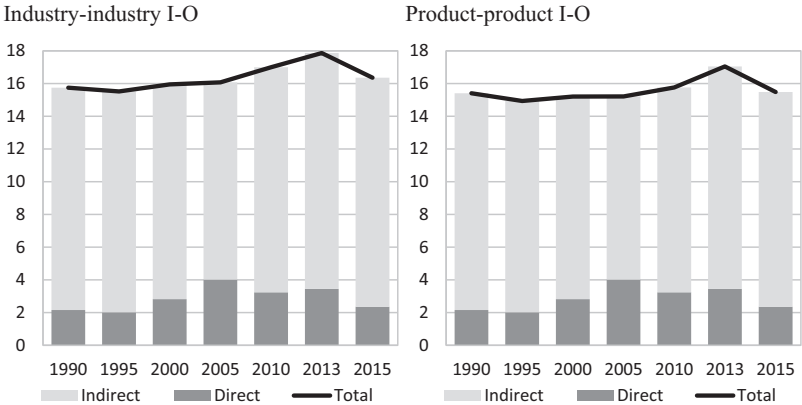


Fig. 2. Final consumption expenditures of general government import intensity (%)

of goods and services were not dependent on import much, and if so, then more indirectly through the imports of domestic producers. The I–O conclusions about low import intensity of government consumption have been confirmed by regression models, since they failed to capture any significance.

Gross fixed capital formation import intensity (Figure 3, Table A3) reached 49% in 2015 with an approximately 40% share of indirect and 60% of direct imports. The overall import intensity in 2015 is similar to its value in 2000, but noticeably higher compared to 37% in 1990. It can be assumed that government investment (mostly buildings and infrastructure) with only a fifth share of the whole aggregate are rather less import intensive than government consumption. Private investment activity with a high share of machinery and equipment has higher import intensity.

Exports of goods and services import intensity (Figure 4, Table A4) had been gathering pace till 2005. Since then, the import intensity had been increasing only slightly and reached 52% in

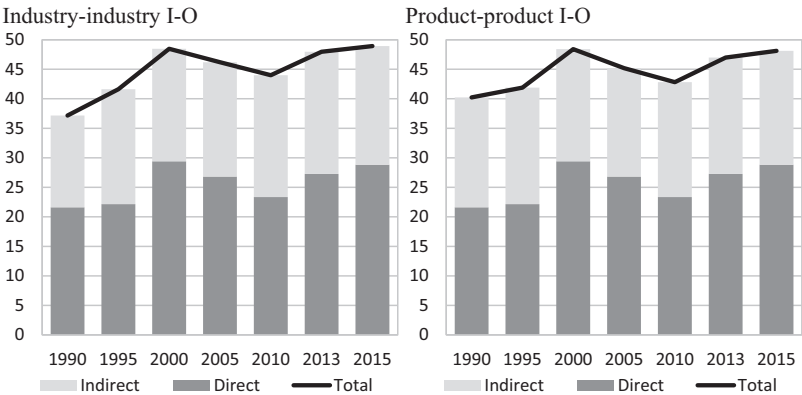


Fig. 3. Gross fixed capital formation import intensity (%)



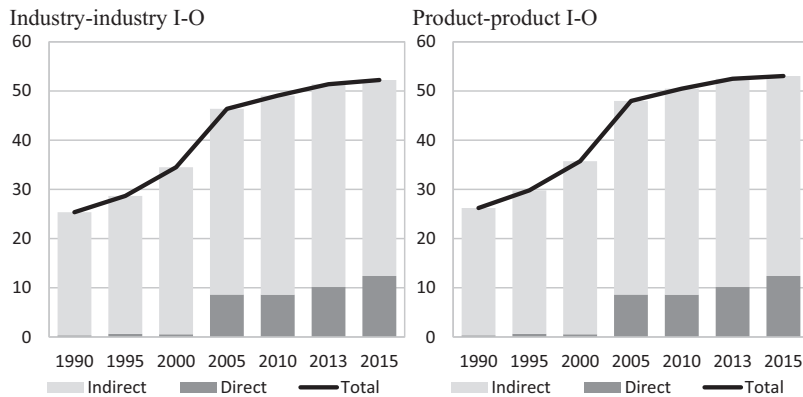


Fig. 4. Exports of goods and services import intensity (%)

2015. A predominant part of re-exported import goes indirectly in the form of intermediate consumption especially to the manufacturing industry.

The import intensity of final use (Figure 5, Table A5), which includes consumption, investment and exports, had been steadily and convincingly growing from 28% in 1990 to 45% in 2015.

Figure 6 (Table A6) presents two approaches of measurement of economic openness – turnover and value-added. Turnover of total exports of goods and services on GDP had been strongly rising and reached 80% in 2015, which points to a deeper involvement of labour and capital in the international division. Factors of production had become more specialized, and thus, the number of producers in global supply chains had been increased.

In contrast, the value-added approach using direct and concealed indirect import intensities from I–O datasets had recorded much more modest and a gradual share of exported value-added. While there was approximately a 30% share of exported value-added in 2000, it was slightly below 40% fifteen years later, which is half of the turnover approach. Even in the small

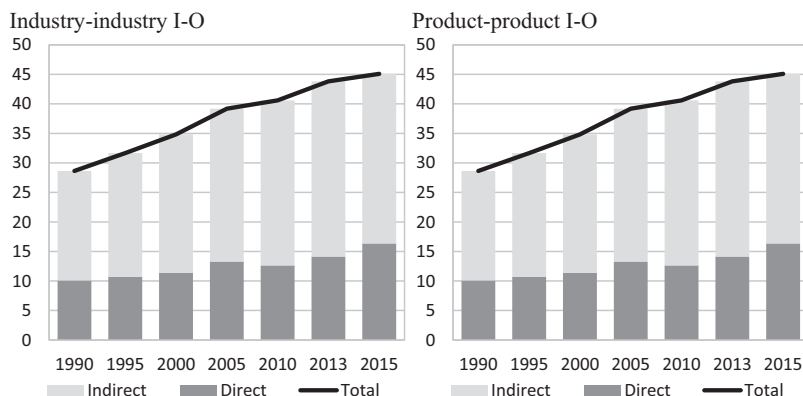


Fig. 5. Final use import intensity (%)



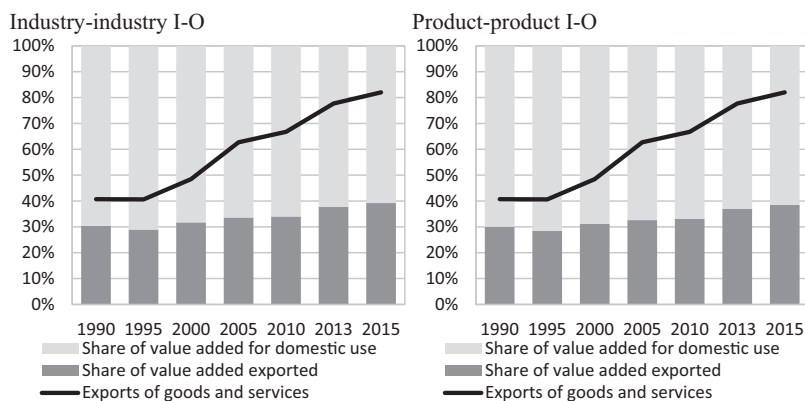


Fig. 6. Openness of economy (% of GDP)

and open economy of the Czech Republic, the majority of GDP has been produced for domestic demand within non-tradeable goods and services.

6. DISCUSSION

In this part we compare our estimates with other studies and results of the regression analysis. [Miroudot et al. \(2018\)](#) updated overall import intensity of total exports for the Czech Republic by using [Koopman et al. \(2014\)](#) and [Los et al. \(2016\)](#) input-output methodology on 2014 data with a result of 45.98%. It is approximately about 6 ppt lower value compared to our results presented in [Figure 4](#). The discrepancy might be given by using more up-to-date and revised data, since the national accounts input-output tables are subject of substantial revisions by the Czech Statistical Office. The comparison of import elasticities of main domestic demand aggregates is not possible due to unavailability in the literature.

This hypothesis is supported by latest [OECD \(2020\)](#) TiVA data according to which the foreign value-added share of gross exports in the case of the Czech Republic reached 39.3% in 2015. In [OECD \(2019\)](#) the foreign value-added content of gross exports captures the value of imported intermediate goods and services that are embodied in the domestic industry's exports. This result is thus almost identical to the indirect part of our import intensity of exports in [Figure 4](#), which represents 39.8% in 2015.

Further, we construct regression models with explained variable *imports* and explanatory variables *components of final demand*. It failed to capture the significance of final consumption expenditures of households and general government. The government consumption's low and uncertain import intensity is in line with the I-O data. But private consumption expenditures are close to 40% import intensity based on I-O data. So, it is surprising that the regression model on imports does not identify private consumption as the significant exogenous variable.

The relationship between imports and household consumption is somewhat ambiguous. [Table 2](#) with correlation coefficients suggests a lead of imports before consumption, which might be due to the fact that retail and wholesale producers keep their imported goods in a

Table 2. Cross correlations between imports and final consumption expenditures of households

t/variables	qoq_dif_n_im qoq_dif_n_fce (t)	yoy_dif_n_im yoy_dif_n_fce (t)	qoq_n_im qoq_n_fce (t)	qoq_r_im qoq_r_fce (t)	yoy_n_im yoy_n_fce (t)	yoy_r_im yoy_r_fce (t)
Paerson correlation coefficients						
t-5	−0.1154	−0.4022	−0.0622	0.1375	−0.2630	0.1242
t-4	−0.2614	−0.4147	−0.1947	0.1171	−0.2361	0.1831
t-3	−0.3249	−0.3573	−0.2650	0.0474	−0.1765	0.2077
t-2	−0.1300	−0.2132	−0.0236	0.0821	−0.0524	0.2157
t-1	0.0120	−0.0262	0.0811	0.0400	0.1010	0.2315
t	0.0776	0.1561	0.1100	0.0122	0.2351	0.2784
t+1	0.2446	0.3054	0.2875	0.2627	0.3245	0.3506
t+2	0.2346	0.3585	0.1856	0.2076	0.3379	0.3695
t+3	0.1138	0.3302	0.0736	0.0941	0.3059	0.3380
t+4	0.0983	0.2520	0.0761	0.0560	0.2519	0.2686
t+5	0.2053	0.1699	0.2437	0.1252	0.2025	0.1963
Spearman correlation coefficients						
t-5	−0.1077	−0.3380	−0.0641	0.2036	−0.2340	0.1505
t-4	−0.2546	−0.3501	−0.1969	0.1834	−0.2083	0.2099
t-3	−0.3176	−0.2920	−0.2675	0.1136	−0.1482	0.2348
t-2	−0.1232	−0.1479	−0.0256	0.1487	−0.0238	0.2421
t-1	0.0192	0.0387	0.0787	0.1067	0.1292	0.2584
t	0.0705	0.0914	0.1123	−0.0544	0.2069	0.2517
t+1	0.2377	0.2406	0.2899	0.1960	0.2964	0.3237
t+2	0.2278	0.2939	0.1882	0.1413	0.3100	0.3431
t+3	0.1066	0.2659	0.0757	0.0271	0.2776	0.3118
t+4	0.0911	0.1868	0.0779	−0.0109	0.2242	0.2413
t+5	0.1978	0.1058	0.2466	0.0579	0.1751	0.1703

Source: Own construction.

warehouse for 1 to 2 quarters before they sell them to the final consumer. It is likely the case of medium-term consumption and durables. For that reason, consumption cannot be used in the import models. The lagged change of household consumption expenditures in response to the change of imports is confirmed by most of the regression models presented in Table 3. Coefficients are relatively stable among models.



Table 3. Relationship between imports and final consumption expenditures of households

Model	1	2	3	4	5	6
Method	ARMA M-L	ARMA M-L	ARMA M-L	ARMA M-L	ARMA M-L	ARMA M-L
Endogenous/ exogenous	qoq_dif_n_fce	yoy_dif_n_fce	qoq_n_fce	qoq_r_fce	yoy_n_fce	yoy_r_fce
constant	4.569***	19.597***	1.072***	0.479***	5.223***	2.190***
	[0.664]	[4.576]	[0.132]	[0.100]	[1.341]	[0.642]
qoq_dif_n_im (-1)	0.028					
	[0.017]					
yoy_dif_n_im (-2)		0.029*				
		[0.014]				
qoq_n_im (-1)			0.046***			
			[0.022]			
qoq_r_im (-1)				0.047*		
				[0.025]		
yoy_n_im (-1)					0.050**	
					[0.024]	
yoy_r_im (-1)						0.035
						[0.024]
AR (1)	0.533***	0.881***	0.46***	0.251*	0.918***	0.814***
	[0.090]	[0.062]	[0.102]	[0.128]	[0.051]	[0.071]
MA (1)		0.440***			0.351***	0.205*
		[0.113]			[0.107]	[0.114]
Observations	90	89	90	90	90	90
Adj, R-squared	0.32	0.89	0.25	0.10	0.88	0.77
AIC	5.03	5.46	2.15	2.04	2.69	2.60
Durbin-Watson stat,	1.99	1.97	2.01	2.01	2.03	1.97
Theil	0.26	0.08	0.26	0.43	0.08	0.14
RMSE	2.86	3.48	0.66	0.64	0.85	0.83

Source: Own construction.

Notes: *, **, *** denote rejection of zero at 10, 5 and 1% level of significance, respectively. Values in brackets represent standard error of mean. OLS is ordinary least squares method. ARMA M-L is autoregressive moving average estimated by the maximum likelihood method. AIC stands for the Akaike information criterion. Theil is Thiel's inequality coefficient. RMSE is the Root mean square error.



Table 4. Import intensities by various models

Model	1	2	3	4	5	6
Method	OLS	ARMA M-L	OLS	ARMA M-L	ARMA M-L	ARMA M-L
Endogenous/exogenous	qoq_dif_n_im	yoy_dif_n_im	qoq_n_im	qoq_r_im	yoy_n_im	yoy_r_im
constant	−1.633***	−5.272**	−0.313*	−0.036	−0.790	0.207
	[0.572]	[2.088]	[0.179]	[0.100]	[0.896]	[0.536]
qoq_dif_n_ex	0.937***					
	[0.028]					
qoq_dif_n_inv	0.483***					
	[0.061]					
yoy_dif_n_ex		0.893***				
		[0.031]				
yoy_dif_n_inv		0.477***				
		[0.058]				
qoq_n_ex			0.922***			
			[0.043]			
qoq_n_inv			0.258***			
			[0.039]			
qoq_r_ex				0.846***		
				[0.018]		
qoq_r_inv				0.298***		
				[0.028]		
yoy_n_ex					0.846***	
					[0.027]	
yoy_n_inv					0.249***	
					[0.045]	
yoy_r_ex						0.788***
						[0.020]
yoy_r_inv						0.303***
						[0.028]
RER_GAP (-1)	0.706***		0.202***			
	[0.181]		[0.057]			

(continued)



Table 4. Continued

Model	1	2	3	4	5	6
Method	OLS	ARMA M-L	OLS	ARMA M-L	ARMA M-L	ARMA M-L
Endogenous/exogenous	qoq_dif_n_im	yoy_dif_n_im	qoq_n_im	qoq_r_im	yoy_n_im	yoy_r_im
RER_GAP (-2)				0.094***	0.300**	0.194**
				[0.032]	[0.114]	[0.082]
RER_GAP (-3)		1.217**				
		[0.391]				
AR (1)	-0.312***	0.528**		-0.190*	0.688***	0.607***
	[0.097]	[0.103]		[0.097]	[0.062]	[0.092]
Observations	90	88	90	89	89	89
Adj, <i>R</i> -squared	0.90	0.97	0.86	0.91	0.96	0.97
AIC	6.38	7.00	3.61	2.90	4.37	3.66
Durbin-Watson stat,	2.03	2.03	2.28	1.96	1.81	2.07
Theil	0.14	0.07	0.17	0.13	0.08	0.06
RMSE	5.50	7.50	1.41	0.96	2.01	1.42

Source: Own construction.

Notes: *, **, *** denote rejection of zero at 10%, 5% and 1% level of significance, respectively. Values in brackets represent standard error of mean. OLS is ordinary least squares method. ARMA M-L is autoregressive moving average estimated by the maximum likelihood method. AIC stands for the Akaike information criterion. Theil is Thiel's inequality coefficient. RMSE is the Root mean square error.

Table 4 shows different regression models estimated by ordinary least squares (OLS), or by the maximum likelihood in autoregressive-moving average models (ARMA M-L). Cointegration relationship has not been identified, thus all the data are transformed into stationary form by differencing. Models differ in various data transformation, see Table 1. All models identified exports and investment activity as strongly significant explanatory variables of imports.

Coefficients of exports are very close to each other across the models with an average value of 0.87, which means that 1 ppt increase of exports causes a 0.87 ppt hike of imports. The indicated import intensity that calculated from I–O tables lies substantially above and is much closer to the share of exports turnover to GDP. The difference between import intensity of exports based on the I–O tables and the regression estimates might be given by the fact, that regression results explain marginal import intensity of exports. These were particularly the products of manufacturing industry with higher share of imported components, while the I–O tables rather capture average state of the import intensities.

The range of gross capital formation coefficients is between 0.25 and 0.48 with an average value of 0.34. So, 1 ppt increase of investment activity is reflected in a 0.34 ppt growth of imports



on average. The upper estimates are very close to the I–O tables, which indicated a 48% import intensity of investments in 2015.

The real exchange rate deviation from its trend is an intuitive sign and ranges from 0.09 to 1.21, with an average value of 0.45. This means that 1 ppt positive real exchange gap (currency stronger than equilibrium) leads to an increase of imports of about 0.45 ppt, on average.

7. CONCLUSIONS

Knowledge of import intensities of exports, private and government consumption expenditures and investments might contribute to improve accuracy of macroeconomic analyses and forecasts. The first steps of how to deal with any foreign or domestic demand shock, lead to an estimation of import intensities regardless of the main model complexity. Even if analysts want to conduct an instant and approximate estimate of the impact for instance of the decline in German demand for the Czech automotive components on Czech GDP, they need to work with the assumption concerning the import intensity of the Czech exports in this case.

This paper dealt with the estimation of import intensities of main final demand components which are the final consumption expenditures of households and general government, gross fixed capital formation and exports of goods and services. The input-output methodology has been used for computing direct and indirect imports within the supply chain.

In 2015, the highest import intensity was found for exports amounting to 52%, closely followed by 49% for investments. Household consumption reported 41% import intensity and general government consumption expenditures showed the lowest import intensity of 16%.

Import intensities were compared with various regression estimates. All models identified exports and investment activity as strongly significant explanatory variables of imports. In accordance with input-output data, the import intensity of government consumption remained low and insignificant in the regression models. But surprisingly similar results unveiled households' consumption as their development was not able to explain the import variations. Correlations showed that private consumption was lagging behind imports which points to the interesting fact that retail and wholesale hold their imported stocks for 1–2 quarters before selling them.

Based on our input-output findings the genuine openness of the Czech economy has been revealed. While turnover of exports to GDP reached 80% in 2019, the value-added approach showed only a half, 40% value-added which was exported. It implies a contra-intuitive conclusion that even in a relatively small and highly integrated country into the globalized economy, there is a 60% majority of the non-tradeable sector. These results might help to provide an insight into the comparative price level which in the Czech case is below the relative economic level measured in purchasing power parity or could help to target anticyclical economic policies effectively, e.g., with regard to maximizing multiplier effect of fiscal or monetary stimulus.

ACKNOWLEDGEMENT

This research was supported by the Czech Science Foundation under Grant No. 18-12340S “Anti-cyclical policies and external equilibrium in a model of inflation targeting”.



REFERENCES

- Alcala, F. – Ciccone, A. (2004): Trade and Productivity. *Quarterly Journal of Economics*, 119(2): 613–646.
- Auboin, M. (2018): What is the Import Intensity of Global Aggregate Demand? *St. Petersburg University Journal of Economic Studies*, 34(1): 59–76.
- Baer-Nawrocka, A. – Mrówczyńska-Kamińska, A. (2019): Material and Import Intensity in the Agriculture of the European Union – Input-Output Analysis. *Problems of Agricultural Economics*, 358(1): 3–21.
- Busse, M. – Königer, J. (2012): Trade and Economic Growth: A Re-Examination of the Empirical Evidence. *SSRN Electronic Journal*, 23/2: 1–24.
- Cappariello, R. (2012): *Domestic Value-Added Content of Exports: A Cross-Country Comparison for the Major European Economies*. Paper Presented at the Final WIOD Conference: Causes and Consequences of Globalization.
- Czech National Bank (2020): ARAD – Time Series System. https://www.cnb.cz/docs/arady/html/Index_en.htm.
- Czech Statistical Office (2020): *Gross Domestic Product – Time Series*. https://www.Czso.Cz/Csu/Czso/Hdp_Ts.
- Dedrick, J. – Kraemer, K. L. – Linden, G. (2010): Who Profits from Innovation in Global Value Chains: A Study of the IPOD and Notebook Pcs. *Industrial and Corporate Change*, 19(1): 81–116.
- Dixit, A. K. – Stiglitz, J. E. (1977): Monopolistic Competition and Optimum Product Diversity. *The American Economic Review*, 67(3): 297–308.
- Dreher, A. – Gaston, N. – Martens, P. – Van Boxem, L. (2010): Measuring Globalization – Opening the Black Box. A Critical Analysis of Globalization Indices. *Journal of Globalization Studies*, 1(1): 166–185.
- Eurostat (2020): *Purchasing Power Parities*. Eurostat Database. <https://ec.europa.eu/eurostat/web/purchasing-power-parities/data/database>.
- Felbermayr, G. – Gröschl, J. (2013): Natural Disasters and the Effect of Trade on Income: A New Panel IV Approach. *European Economic Review*, 58(2): 18–30.
- Francois, J. – Manchin, M. – Tomberger, P. (2014): Explanatory Note: Export of Value-Added Database. *The World Bank*, 1–39.
- Frankel, J. – Romer, D. (2000): Does Trade Cause Growth? *American Economic Review*, 89(3): 379–399.
- Goldar, B. – Kusum, D. – Sengupta, S. – Chandra, P. (2017): *Domestic Value Addition and Foreign Content: An Analysis of India's Exports from 1995 to 2011*. ICRIER Working Paper, No. 332.
- Gräbner, C. – Heimberger, P. – Kapeller, J. – Springholz, F. (2018): *Measuring Economic Openness: A Review of Existing Measures and Empirical Practices*. ICAE Working Paper Series, No. 84.
- Heckscher, E. F. – Ohlin, B. – Flam, H. – Flanders, M. J. (1991): *Heckscher-Ohlin Trade Theory*. MIT Press, Cambridge, MA.
- Huchet-Bourdon, M. – Le Mouël, C. – Vijil, M. (2017): The Relationship between Trade Openness and Economic Growth: Some New Insights on the Openness Measurement Issue. *World Economy*, 41(1): 59–76.
- Hummels, D. – Ischii, J. – Key-Mu, Y. (2001): The Nature and Growth of Vertical Specialization in World Trade. *Journal of International Economics*, 54(1): 75–96.
- Isard, W. – Langford, T. (1971): *Regional Input-Output Study*. Cambridge: MIT Press.
- Koopman, R. – Zhi, W. – Shang-Jin, W. (2014): Tracing Value-Added and Double Counting in Gross Exports. *American Economic Review*, 104(2): 459–494.



- Krugman, P. (1980): Scale Economies, Product Differentiation, and the Pattern of Trade. *The American Economic Review*, 70(5): 950–959.
- Leontief, W. (1936): Quantitative Input and Output Relations in the Economic System of the United States. *The Review of Economic and Statistics*, 18: 105–125.
- Li, K. – Morck, R. – Yang, F. – Yeung, B. (2004): Firm-Specific Variation and Openness in Emerging Markets. *Review of Economics and Statistics*, 86(3): 658–669.
- Los, B. – Timmer, M. P. – Vries, G. (2016): Tracing Value-Added and Double Counting in Gross Exports: Comment. *American Economic Review*, 107(7): 1958–1966.
- Miller, R. E. – Blair, D. P. (2009): *Input-Output Analysis: Foundations and Extensions* (2nd ed.). New York, NY: Cambridge University Press.
- Miroudot, S. – Lanz, R. – Ragoussis, A. (2009): *Trade in Intermediate Goods and Services*. OECD Trade Policy Working Paper, No. 93.
- Miroudot, S. – Ming, Y. (2018): *A Simple and Accurate Method to Calculate Domestic and Foreign Value-Added in Gross Exports*. Munich Personal RePEc Archive, No. 89907.
- OECD (2019): *Guide to OECD's Trade in Value-Added (TiVA) Indicators*. Directorate for Science, Technology and Innovation.
- OECD (2020): *Trade in Value-Added – TiVA Database. Principal TiVA Indicators*. https://stats.oecd.org/Index.aspx?DataSetCode=TIVA_2018_C1.
- Potrafke, N. (2015): The Evidence on Globalisation. *The World Economy*, 38(3): 509–552.
- Ricardo, D. ([1817] 1951): On Foreign Trade. In: Sraffa, P. – Dobb, M. H. (eds): *The Works and Correspondence of David Ricardo*, Vol. 1. Cambridge, UK: Cambridge University Press.
- Squalli, J. – Wilson, K. (2011): A New Measure of Trade Openness. *The World Economy*, 34(10): 1745–1770.
- Tang, K. (2011): Correcting the Size Bias in Trade Openness and Globalization Measures. *Global Economy Journal*, 11(3): 1–24.
- Vltavska, K. – Sixta, J. (2017): Input-Output Tables for Regions of the Czech Republic. *Statistika: Statistics and Economy Journal*, 97(2): 4–14.
- Waugh, M. – Ravikumar, B. (2016): Measuring Openness to Trade. *Journal of Economic Dynamics and Control*, 72(6): 29–41.
- Yanikkaya, H. (2003): Trade Openness and Economic Growth: A Cross-Country Empirical Investigation. *Journal of Development Economics*, 72(1): 57–89.



Appendix

Table A1. Final consumption expenditures of households and NPISH import intensity (%)

	Industry-industry I–O table			Product-product I–O table		
	Direct import intensity	Indirect import intensity	Total import intensity	Direct import intensity	Indirect import intensity	Total import intensity
1990	15.28	16.72	32.01	15.28	14.95	30.23
1995	15.38	18.91	34.28	15.38	17.92	33.30
2000	14.00	19.92	33.92	14.00	18.95	32.95
2005	15.20	19.57	34.78	15.20	18.27	33.48
2010	16.45	20.10	36.55	16.45	19.22	35.66
2013	19.38	21.06	40.44	19.38	20.04	39.43
2015	21.27	19.44	40.71	21.27	18.73	40.01

Source: Own calculation.

Table A2. Final consumption expenditures of general government import intensity (%)

	Industry-industry I–O table			Product-product I–O table		
	Direct import intensity	Indirect import intensity	Total import intensity	Direct import intensity	Indirect import intensity	Total import intensity
1990	2.16	13.59	15.75	2.16	13.25	15.41
1995	2.02	13.50	15.52	2.02	12.92	14.93
2000	2.83	13.12	15.95	2.83	12.38	15.20
2005	4.02	12.05	16.07	4.02	11.19	15.21
2010	3.24	13.75	16.99	3.24	12.52	15.76
2013	3.45	14.42	17.87	3.45	13.60	17.04
2015	2.36	13.99	16.35	2.36	13.12	15.48

Source: Own calculation.



Table A3. Gross fixed capital formation import intensity (%)

	Industry-industry I-O table			Product-product I-O table		
	Direct import intensity	Indirect import intensity	Total import intensity	Direct import intensity	Indirect import intensity	Total import intensity
1990	21.62	15.54	37.16	21.62	18.61	40.23
1995	22.15	19.47	41.62	22.15	19.73	41.89
2000	29.40	19.06	48.46	29.40	18.99	48.39
2005	26.82	19.36	46.18	26.82	18.36	45.19
2010	23.35	20.63	43.98	23.35	19.47	42.82
2013	27.27	20.70	47.97	27.27	19.70	46.97
2015	28.84	20.10	48.93	28.84	19.28	48.11

Source: Own calculation.

Table A4. Exports of goods and services import intensity (%)

	Industry-industry I-O table			Product-product I-O table		
	Direct import intensity	Indirect import intensity	Total import intensity	Direct import intensity	Indirect import intensity	Total import intensity
1990	0.33	25.03	25.36	0.33	25.87	26.21
1995	0.64	28.03	28.68	0.64	29.16	29.80
2000	0.55	33.94	34.49	0.55	35.18	35.72
2005	8.63	37.75	46.38	8.63	39.35	47.98
2010	8.60	40.46	49.05	8.60	41.88	50.47
2013	10.16	41.21	51.37	10.16	42.31	52.47
2015	12.41	39.82	52.22	12.41	40.63	53.03

Source: Own calculation.



Table A5. Final use import intensity (%)

	Industry-industry I–O table			Product-product I–O table		
	Direct import intensity	Indirect import intensity	Total import intensity	Direct import intensity	Indirect import intensity	Total import intensity
1990	10.08	18.56	28.64	10.08	18.56	28.64
1995	10.72	20.96	31.68	10.72	20.96	31.68
2000	11.35	23.48	34.83	11.35	23.48	34.83
2005	13.29	25.90	39.19	13.29	25.90	39.19
2010	12.63	27.96	40.59	12.63	27.96	40.59
2013	14.14	29.68	43.82	14.14	29.68	43.82
2015	16.36	28.74	45.10	16.36	28.74	45.10

Source: Own calculation.

Table A6. Openness of economy (% of GDP)

	Industry-industry I–O table			Product-product I–O table		
	Share of value added exported	Share of value added for domestic use	Exports of goods and services	Share of value added exported	Share of value added for domestic use	Exports of goods and services
1990	30.38	69.62	40.70	30.04	69.96	40.70
1995	28.95	71.05	40.60	28.50	71.50	40.60
2000	31.74	68.26	48.44	31.14	68.86	48.44
2005	33.61	66.39	62.69	32.61	67.39	62.69
2010	34.01	65.99	66.76	33.07	66.93	66.76
2013	37.78	62.22	77.69	36.92	63.08	77.69
2015	39.19	60.81	82.02	38.52	61.48	82.02

Source: Own calculation.

