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Applying import-adjusted demand methodology to trade analysis during the COVID-19 crisis: What do we learn?

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World Trade Organization

Economic Research and Statistics Division

**APPLYING IMPORT-ADJUSTED DEMAND METHODOLOGY TO TRADE ANALYSIS DURING THE
COVID-19 CRISIS: WHAT DO WE LEARN?**

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APPLYING IMPORT-ADJUSTED DEMAND METHODOLOGY TO TRADE ANALYSIS DURING THE COVID-19 CRISIS: WHAT DO WE LEARN?

Marc Auboin^a, Floriana Borino^b

Abstract

In this paper, we estimated the standard (macro-economic) import equation over the period 1995-2021Q2, using an import intensity-adjusted measure of aggregate demand (IAD) calculated from input-output tables at country level, and compared the results with regressions using GDP. Initially introduced by Bussière (2013), this "synthetic" concept of IAD was perfected, *inter alia*, by the IMF (2016) and by us (2017), with a view to explaining the "missing" trade flows unpredicted by GDP-based import models during the trade collapse of 2009 and subsequent recovery from it. At the time, it appeared that the integration of IAD helped predict over three-quarters of the changes in global imports, a better performance than if using GDP (two-thirds) or any other measure of aggregate demand. We had found much value to this method, as a complement to existing analytical tools, enabling to measure the relative importance of each component of demand in the variations of country/global imports, over entire economy cycles (a phase of trade expansion, a sudden collapse and a recovery). Moreover, by weighting each aggregate demand component by its direct and indirect traded inputs, import-adjusted integrated a supply-side dimension to such macro-economic modelling.

By extending our estimates to cover global trade during the (on-going) Covid-19 pandemic (1995-2021 Q2), we found the IAD-based model to continue performing well, predicting 79% of changes in global imports during the period 1995-2021Q2 (10 percentage points more than when using GDP). We also found that, on average, 97% of the difference in global import growth between the pre-pandemic (2012-2019) and the pandemic period (2020), was attributable to IAD. Most of the variations in imports can be explained by changes in the growth of investment and exports, the two-most trade-intensive elements of demand, by 29% and 45%. The variations of consumption also accounted for a significant share of global import variations during this period (25%).

Keywords: Investment; global outlook, trade policy; trade forecasting; business cycles

JEL classifications: E22, F01, F13, F17, F44

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I. INTRODUCTION

The outbreak of the Covid-19 pandemic affected the world economy through a combination of supply and demand shocks, affecting all parameters of the economy – output, investment, consumption and trade. While in the first part of 2020 strict lockdowns led to factory closures and major disruptions in supply chains worldwide, consumption and investment patterns have also been affected by the early epidemic waves through 2020 and 2021. The trade impact of the recession – very strong in the first half of 2020, has been much discussed, in particular from the point of view of the relative incidence of supply and demand effects. Comparisons with the global financial crisis were also made, an observation being that, despite the accumulation of obstacles to trade (export restrictions, disruptions of supply routes and documentation), trade flows in 2020 fell less relative to global economic activity than at the peak of the global financial crisis. According to current statistics, the fall of trade in goods and services has been very large in absolute terms (-8.9% in 2020 for trade in goods and services, against -10.4% in 2009), but less relative to GDP (-3.3% for global real GDP in 2020, against -0.6% in 2009). Reflecting the strong impact of lockdowns and other health-related restrictions, trade in goods has been less affected than trade in services.

As early as the second half of 2020, trade in goods experienced a strong rebound, in connection with catch-up demand, the drawdown of accumulated savings, the effect of income support policies in the developed economies, and a reorientation of consumption towards manufactured goods (away from unavailable services). The rebound of global merchandise trade continued at a fast pace in the first half of 2021 – although unevenly across regions, reflecting differences in vaccination roll-out and fiscal policy support (IMF, 2021).

In 2017, we had worked at improving the predictive value of traditional import-based macro-economic models using GDP or unweighted aggregate demand as a dependent variable, which had performed moderately well during the great trade collapse and subsequent mild recovery of trade. Along with other authors (for example the IMF, 2016), we perfected a "hybrid" form of analysis initially introduced by Bussière (2013), using an import intensity-adjusted measure of aggregate demand (IAD), calculated from input-output tables at country level, to analyse the variations of aggregate demand by its component (investment, consumption, net government expenditures, and exports), through a trade lens. We had found that the use of import-adjusted demand not only helped better predict imports – leaving limited clue behind the global trade collapse and "missing trade" predicted by GDP-based import models, but it also enabled to measure the relative importance of each component of demand in the variations of country/global imports, through an entire cycle (a trade collapse and a recovery). Moreover, import-adjusted demand calculated on the basis of input-output tables provided a supply-side dimension to such macro-economic modelling.

While there might be less "clue" in the fall and subsequent recovery in global trade during the pandemic than there had been during the global financial crisis, we thought that applying this "hybrid" approach combining a supply-side dimension (direct and indirect import content in aggregate expenditure components) into a demand-based approach could yield interesting results and further validate this form of analysis.

We therefore covered the period of 1995 to 2021, second quarter (Q2). We find that, through the overall estimation period, the model performs well. The model using IAD country-by-country predicts on average 79% of the changes in import of goods and services during the

period 1995Q1-2021Q2, compared to 69% explained by the model using GDP. The superiority of IAD against GDP in tracking real import growth through the entire estimation is relatively clear from figure 4 and figure 6; backward projections for real import growth based on the IAD measure are generally closer to actual values than projections based on GDP.

We also found that, on average, 97% of the difference in global import growth between the pre-pandemic (2012-2019, a period of moderate real trade growth) and the height of the pandemic (2020, a fall in trade in real terms), was attributable to IAD. Most of the variations in imports can be explained by changes in the growth of investment and exports, the two-most trade-intensive elements of demand, by 29% and 45%. The variations of consumption also accounted for a significant share of global import variations during this period (25%). However, the difference between the two projections narrows down as one "approaches" the start of the COVID-19 pandemic period, and becomes almost nul during the pandemic. In itself, such relative "improvement" of the estimative performance of GDP based models does not invalidate the "quality" of the IAD concept and its usefulness as a complementary tool for analysis. As described in the paper, IAD-based analysis provides less volatile trade to demand/income elasticities, while GDP-based regressions show systematically lower R-squared values.

II. LITERATURE

Research on the trade effects of the Covid-19 pandemic has been abundant (Liu and al., 2021), and in part linked to the broader discussion regarding the relative importance of the supply and demand shocks to economic activity, a debate of importance for designing appropriate policy responses.³ A large number of authors agreed that the 2020 global recession involved both a demand and a supply shock (Del Rio-Chanona et al. (2020), Brinca et al. (2020), Gopinath (2020(a), Baldwin (2020)), one point of discussion being the timing of these relative effects, and their respective impacts on real GDP at the height of the recession.

For example, Beckeart et al. (2020) attributed two-thirds of the US GDP decline in the first quarter of 2020 to the negative shock to aggregate demand, the remaining third being explained by supply-side effects. By contrast, they estimated that two-thirds of the even larger decline in US GDP in the second quarter of 2020 was due to the reduction in aggregate supply, the remaining third being attributed to demand effects. The authors noted that the demand shock in that second quarter, the period during which lockdowns were implemented, had been met by the accompanying increase in unemployment benefits which, at least for certain categories of households, had helped support aggregate demand. At the same time, they observed that supply chains in several industries had been affected not only internationally but also domestically, resulting in domestic price increases for many goods and services. Benguria and Taylor (2020) suggested that demand-driven crises were more likely to have strong effects on imports of final goods, in particular of durables, and to a lesser extent on imports of intermediate goods, when crises are associated with household deleveraging shocks. Imports

³ Blanchard and Quah (1989) defined demand shocks as shocks in which real interest rates and GDP moved in the same direction, while supply shocks drove them in opposite directions. A shock resulting in large demand shortfalls may lead macroeconomists to recommend monetary and fiscal stimulus, while supply-shocks could be addressed by structural reforms (supply-side shocks may include productivity changes which may have longer run effects on output) and tax reductions, for example. Some of the recent literature has been addressing the role of trade, notably of supply-chain trade, in the context of the analysis of the supply/demand shock discussion.

of intermediate inputs were found to be impacted by supply-side shocks, although this was less the case for final goods imports.

Liu and al. (2021) observed that since both demand and supply shocks yielded negative effects on activity, the resulting impact on a country's import demand – defined as the difference between domestic demand and supply, was a priori unknown. And so were the spill-overs from this combination of domestic supply and demand effects on trading partners' own import demand. Based on such broad observation, they looked at China's imports. They found that, on the one hand, lockdowns and health-related effects of the pandemic in anyone country had reduced imports from China in that country, suggesting that negative (domestic) demand effects prevailed over negative (domestic) supply effects of the pandemic. On the other hand, lockdowns and health effects in the trading partners of that country induced more imports from China than pre-pandemic, partly offsetting the initial country's own effects. The net impact of the own country's effect and spill-over effects on the trading partners was an overall reduction in imports from China (-10%).

Other authors focused on supply-side effects, such Bonadio, Huo, Levchenko, and Pandalai-Nayar (2020). They calculated that about one quarter of the total size of the GDP shock during the height of the pandemic was due to the transmission through global supply chains. Bellora, Bois and Jean (2020) found that EU trade in sectors most dependent on global value chains (i.e. sectors relying on foreign inputs or foreign demand for domestic inputs) had not been particularly vulnerable during the pandemic. These sectors have actually been more resilient than others, in contrast to what happened during the GFC. Conversely, sectors least dependent on global value chains experienced a sharper drop in their trade flows. Another study using a dataset comprising 4,433 enterprises across 133 countries shows that firms engaged in international trade have taken more resilient actions during the COVID-19 crisis than firms that only operate domestically (Borino et al., 2021). These results underscore the importance of global interconnectedness and international trade for promoting resilience to economic shocks.

The role of demand, supply and that of the composition of trade, had been examined during the global financial crisis (GFC). Eaton et al. (2016) had calculated that two thirds of the drop in trade during the GFC, relative to GDP, could be attributed to the shift in spending away from manufactures, particularly from durables. Baldwin (2009) also highlighted the convergence of views on the central role of real final demand (Bems, Johnson and Yi, 2013), amplified by the existence of highly integrated and synchronized production networks (Yi, 2009), which eventually contributed to spread the effects of stumbling trade-intensive durable goods.

In the line of thoughts developed by Eaton et al. (2016), Bussière et al. (2013) adopted an original approach incorporating the changing patterns of trade into the analysis of demand. Rather than using a standard import demand model, which prediction value declined during and after the global trade collapse, they constructed an import-intensity adjusted measure of aggregate demand. This measure weights each component of aggregate expenditure (consumption, government expenditure, fixed capital investment, exports) by their import intensity, computed from OECD input-output tables. Looking at data from 18 OECD countries in the period 1985-2011, their model, incorporating the import-intensity measure, explained 80% of the average fall in imports of the G7 countries' imports during the great trade collapse. They concluded that "trade fell mostly because demand crashed globally and did so particularly

in its most import-intensive component". Bussière (et al.) methodology was used in other contributions on the decline in trade income elasticities. IMF (2016) used the import-intensity measure of demand as part of its import demand models, explaining three-quarters of the global goods' import growth decline in the period 2012-15, relative to the period 2003-2007 by a slowdown in aggregate demand.

Haugh et al. (2016) and ECB (2016) showed relatively similar findings but in different proportions. Haugh et al. (2016) suggested that weak demand, on the one hand, as captured by output gaps and investment growth, and the slowdown in global value chains expansion, on the other, accounted for roughly equal proportions to the global trade slowdown after the global financial crisis. The ECB (2016) emphasized the shift of growth in trade and economic activity towards economies with lower trade intensity (i.e., developing and emerging economies), and changes in the composition of aggregate demand towards less trade intensive-components.

In Auboin and Borino (2017), we supported the findings by Bussière and al., as well as that of the IMF (2016) and ECB (2016). We estimated the standard import equation for 38 advanced and developing countries over the period 1995-2015, using an import intensity-adjusted measure of aggregate demand (IAD), calculated from input-output tables at country level, and we compared results with the regressions using GDP. The integration of IAD allowed to predict 76% to 86% of the changes in global imports (76% when using panel regression, 86% for country-regressions), a better performance than if using GDP (63% and 80% respectively)). The use of IAD enabled to measure the relative importance of each component of demand, according to their trade intensity. The model accounted for over 90% of the recent trade collapse and subsequent slow recovery (from 2012 to 2015), with IAD alone explaining 80% of it. The slowdown in global value chains explained more than half of the remaining share (20%) of the global trade slowdown, not explained by demand factors. Our measure of protectionism did not come up in the simulations as statistically significant.

III. USING THE IAD METHODOLOGY TO PREDICT TRADE DURING THE COVID PANDEMIC

III.1 Applying the IAD methodology to look at recent trade developments

We thought of re-applying the IAD methodology to the Covid-crisis. In itself, the methodology might not contribute to disentangling supply and demand shocks and their respective trade effects. Actually, the methodology does somewhat the opposite, as it actually incorporates a supply-side dimension into a demand-base model – the trade-weighted shares of aggregate expenditure – with a view to improving its predictive value. We had also found in our 2017 paper that IAD provided more stability to the import demand equation. Using GDP or any other measure of demand tended to over-estimate the income elasticity of trade (1.3 if using IAD against 2 for GDP). Hence when using this model in 2016, we not only predicted a higher share of the changes in trade during the trade collapse, but also in the subsequent trade slowdown (2012-2015). Of particular interest was the fact that calculations established that the composition of demand had been the main explanation of that slowdown, because the most trade-intensive components, such as investment, had been the ones slowing down the most.

We thought that extending the database by several years to cover the period of the Covid-19 could yield interesting results, from the point of view of understanding the dynamics of

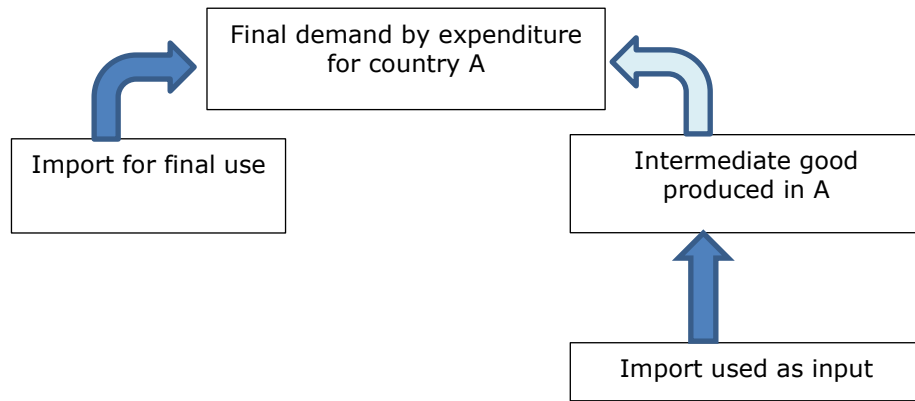
demand components and its impact on trade during this period. The methodology's details are described below, to be followed by the simulation results.

III.2 Methodology and data

Methodology

We continued to follow the methodology initially developed by Busssière (2013), refined in our paper of 2017. In a first step, we computed the total import content of final demand expenditure (private consumption, gross fixed capital formation, government consumption and exports) using Input-Output tables, explained in detail in Box 1.⁴ In a second step, by weighting each component of expenditure in each economy with its import content, we calculated the import-intensity adjusted demand (IAD) in the way that is explained below. In the next section, we used the import-intensity adjusted demand in the import demand function in lieu of GDP and other usual determinants.

Figure 1: Import content of an expenditure component for country A



As shown in figure 1, the total value of imports for each expenditure component is given by the sum of imports of final goods and services for final use/demand, i.e. direct imports, and imports of inputs required by domestic industries to produce an output which will either be absorbed domestically or exported (indirect import). The distinction between direct and indirect imports is allowed by the use of national Input-Output (I-O) tables in a way described by the matrices simplified in Box 1.

For each expenditure component k , national Input-Output tables are used to calculate the value of direct imports (M_k^{dir}) and the value of indirect imports (M_k^{indir}). The total value of imports of each expenditure component (M_k) is then given by:

$$(1) \quad \mathbf{M}_k = \mathbf{M}_k^{dir} + \mathbf{M}_k^{indir}$$

With k = Private consumption, Government consumption, Investment, Exports

⁴ Although we are aware that investment does not coincide with Gross Fixed Capital Formation (GFCF), the fact that changes in inventories are highly volatile prevented us from the construction of the import contents of changes in inventories. Therefore, we will use the term investment instead of GFCF in the rest of the paper.

The total import content of each expenditure component k (ω_k) is then calculated by dividing the total value of imports of each expenditure component k (M_k) by the total final demand for domestic output (value added) plus imports, for the respective expenditure component (F_k):

$$(2) \quad \omega_k = \frac{M_k}{F_k}$$

Equivalently, combining equations (1) and (2), we obtain:

$$(3) \quad \omega_k = \frac{M_k^{dir} + M_k^{indir}}{F_k} = \frac{M_k^{dir}}{F_k} + \frac{M_k^{indir}}{F_k} = \omega_k^{dir} + \omega_k^{ind}$$

Where, the total import content of each expenditure component (ω_k) is the sum of the direct (ω_k^{dir}) and indirect (ω_k^{ind}) import contents. The indirect import content of each aggregate expenditure component represents the share of intermediate imported inputs per unit of final demand, while the direct import content represents the share of imported final goods and services per unit of final demand.⁵ In section IV, we will use this decomposition to distinguish the contribution of direct and indirect import demand in the recent trade slowdown.

The import-intensity-adjusted demand (IAD) was thus constructed country-by-country as a weighted average of traditional aggregate demand components:

$$(4) \quad \ln IAD_t = \omega_{C,t} * \ln C_t + \omega_{G,t} * \ln G_t + \omega_{I,t} * \ln I_t + \omega_{X,t} * \ln X_t$$

Where, C stands for private consumption, G for government consumption, I for investment and X for exports. The weights ($\omega_{k,t}$, with $k = C, G, I, X$) are the total import content of each of the four final demand expenditure components (C, G, I or X) and they are constructed as explained above. Weights are time varying and normalised in each year so that they sum up to 1.

As indicated in IMF (2016), "this approach explicitly account for differences in the import content of the aggregate demand components and captures the effects of changes in the overall strength of economic activities and across its drivers". While Bussière et al. (2013) made such calculation for 18 OECD countries, we have extended it to a set of 38 countries, accounting for more than three quarters of global trade. Such calculations incorporated in particular developing countries that are not members of the OECD, such as the "BRICs" (Brazil, Russian Federation, India and China) and other emerging market economies in Asia and Latin America.

Data

Bussière et al. (2013) calculations of import content of final demand expenditures were based on OECD input-output (I-O) data, which, at the time, were available only for three

⁵ Note that the direct import content of exports is zero as we excluded re-exports of goods and services from our analysis. We are aware that for some countries, such as China and other emerging economies, this assumption might be a bit problematic due to the high amount of processing trade; therefore in these countries we are likely to bias downward the total import content of exports.

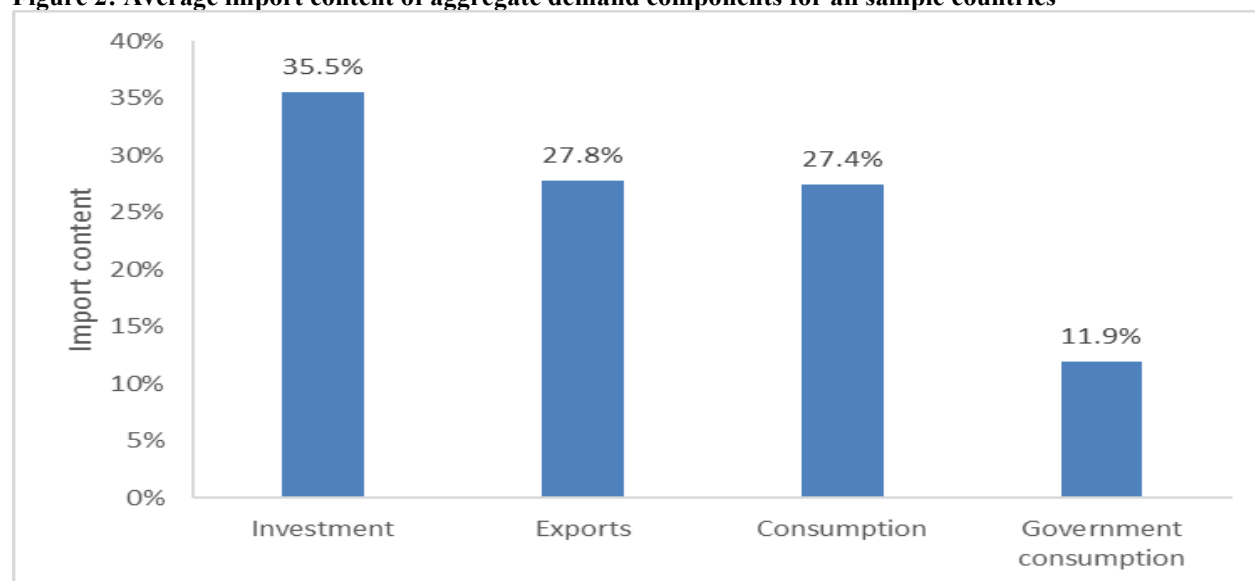
benchmark years, 1995, 2000 and 2005. Progress in constructing global input-output data bases helped us extend Bussière’s work, in terms of geographical coverage and available years. We used the World Input-Output Database (WIOD), an EU-funded project. The WIOD covers 43 countries, including all 27 EU countries, the United Kingdom, United States of America, Japan, Canada, and the main emerging market economies (including the BRICs). The WIOD database provides a model for the rest-of-the-world.⁶ We calculated the annual import content of the four components of aggregate demand for 38 countries from 1995 to 2014 (2014 being the last benchmark year in the WIOD database) and froze the trade weights for the years 2015-2021 at their 2014 levels. The 38 countries for which we calculated the annual import content of the four components of aggregate demand account for some 84% of world GDP and 75% of world exports.⁷ The results of our calculations are presented in Figure 2 and 3 below.

III.3 Results

III.3.1 Import weights and content

Figure 2 shows the average total import content of the four GDP expenditure components (private consumption, government expenditure, gross fixed capital formation and exports) in the 38 countries analysed, over the analysed period. The most pro-cyclical components of aggregate demand, i.e. investment, exports and private consumption, are also found to be most import intensive; net government expenditures are less so.

Figure 2: Average import content of aggregate demand components for all sample countries



Source: WIOD Input-Output tables and authors' calculations, 1995-2014.

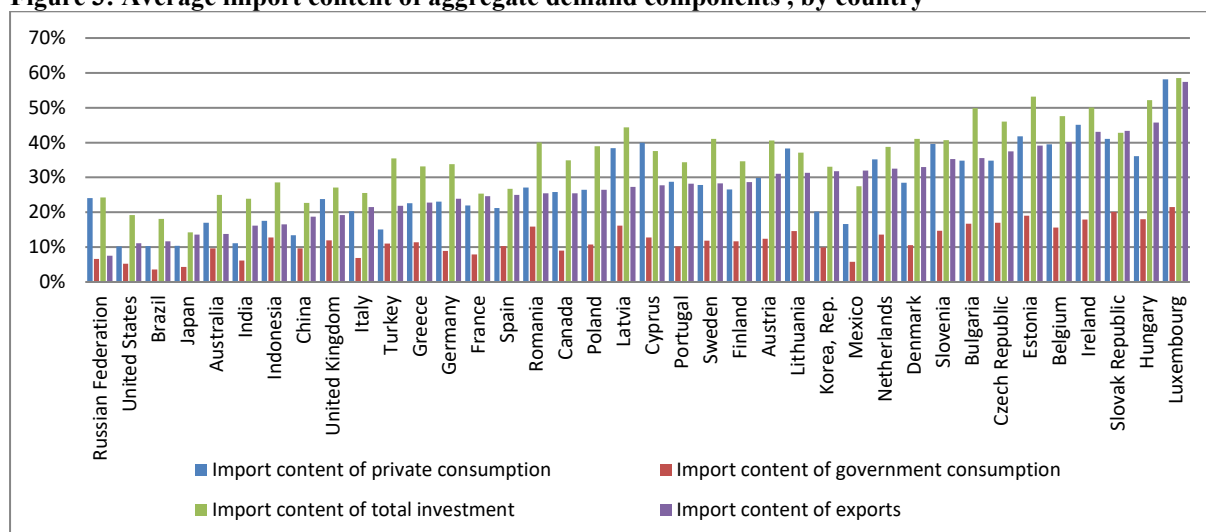
⁶ In addition, the WIOD has been constructed in a clear conceptual framework on the basis of officially published input-output tables in conjunction with national accounts and international trade statistics and therefore, it ensures a high level of data quality, partially at the expense of coverage in term of the number of countries covered. The industry classification of the WIOD 2016 release is based on the ISIC Rev. 4 system and it covers 56 sectors, including agriculture, mining, construction, utilities, manufacturing industries, and services industries.

⁷ Data for 2020. The 38 countries included in our analysis are: 25 European countries (Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxemburg, Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden) and 13 other major countries (Australia; Brazil; Canada; China; India; Indonesia; Japan; Korea, Republic of; Mexico; Russian Federation; Turkey; United Kingdom; and the United States of America).

Investment is the most import-intensive component of domestic demand, with an average import content (for all 38 countries) of 35.5%, although the overall import content of exports and of private consumption have been the two components of demand growing the fastest over the sample period.

The general increase in the import content of aggregate demand reflects the growing openness of our economies, falling trade costs, and international production fragmentation. There was a drop in import-intensity during the global financial crisis of 2008-2009, followed by a very slow recovery afterwards. Since then, investment has continued to be the most import-intensive component of GDP; the import intensity of exports and private consumption slightly increased in recent years.

Figure 3: Average import content of aggregate demand components , by country



Source: WIOD Input-Output tables and authors' calculations, 1995-2014.

Figure 3 shows that the import content of aggregate demand components varies across countries. For smaller, outward-oriented economies, the import content of exports is particularly high (Belgium, Luxembourg). It is lower for countries with substantial exports in natural resources since these activities require fewer intermediate goods in the production process. Relative to other advanced economies, the United States and Japan display lower import intensities, reflecting the large pool of domestic intermediate suppliers. However, in Japan, the import content of all aggregate demand components has been rising significantly over the past two decades. The import content of investment and private consumption, in particular, increased fourfold between 1995 and 2014.

In China the import intensity of GDP components has followed a different pattern. Import-contents peaked in mid-2000s and have followed a downward trend since then. This declining trend in the import content reflects the rebalancing of China's economic growth towards the domestic consumption of non-tradables, mostly services (rent, business and private services). On the production side, this rebalancing has coincided with the rapid expansion of the services sectors, which is less import and investment intensive, relative to manufacturing.

IV. EMPIRICAL STRATEGY

The construction of import-intensity adjusted demand indicators aims at better understanding the drivers of trade growth, in particular in break-out periods, and to look at the role of such changes in the composition of import-weighted aggregate expenditure to explain variations in global trade. The substitution of IAD into standard macro-economic import model provided, as explained below, for an improved quantitative and qualitative information.

In sub-section IV.1, we estimated the standard import equation over the period 1995Q1-2021Q2, using IAD as the measure of aggregate demand and compared the results with regressions using GDP. As shown by Figure 4 and 6, the introduction of IAD improves the performance of the equation over the entire estimation period. The panel based-model using IAD predicts on average 68% of the changes in import of goods and services during the period 1995Q1-2021Q2, while the country-by-country regressions of the same model predicts 79% of the changes. Models using GDP explained a lower percentage of the changes over the whole period, 55% and 69% of the changes in real imports respectively, although during Covid, GDP-based models performed well, almost as well as IAD-based models. Elasticities of import to demand are less volatile when using IAD compared to GDP. In Section IV.2, we have looked at the role of IAD in explaining trade shocks, notably during the global financial crisis, and the Covid-19 pandemic periods.

IV.1 The main model

We have regressed the year-on-year growth rate of real import of goods and services for each of the 38 countries ($\Delta \ln M_{c,t}$) on their year-on-year growth rate of import-intensity adjusted demand ($\Delta \ln IAD_{c,t}$) and changes in their real effective exchange rate ($\Delta \ln REER_{c,t}$), as a proxy for relative price and competitiveness changes.⁸ We added country dummies (γ_c), in panel regressions, to account for countries heterogeneity. Lags of the dependent and explanatory variables' growth rates are also included in the model to allow for richer dynamics.

We used both panel and country-by-country regressions. The former calculates one aggregate income and price elasticity for imports of all 38 countries, whereas country-by-country regressions calculate elasticities for each country present in the regression (the results presented in Table 3 are simple averages of such elasticities for the countries concerned).⁹ Since all variables are expressed in logs, coefficients may be interpreted as elasticities.

The periodicity for all these variables is quarterly, and regressions have been run over the period 1995Q1-2021Q2. Regarding the construction of IAD for each country, since the IO tables allow us to compute the import weights only every year, we assumed the import weights did not change in the four quarters that compose each of the years. In addition, since the latest available year for WIOD is 2014, we assumed the import weights from 2015 onwards are the same as the import weights in 2014. The components of aggregate demand (private and government consumption, gross fixed capital formation and exports of goods and services), all in volume, are pulled from quarterly national accounts from the OECD. The real effective

⁸ We carried out a set of unit root tests (Augmented Dickey-Fuller test or Phillips-Perron test) for all the variables involved in the regression. Overall, results confirm that our time series appear non-stationary in level and stationary in first difference. Therefore, we used all variables in first difference in equation (5). As we used the growth rates for all the variables in our regressions, co-integration did not turn to be a major issue.

⁹ In country-by-country regressions, we have used the Newey-West (1987) estimator to correct for heteroskedasticity and autocorrelation.

exchange rates (CPI-based) used as an indicator of competitiveness/relative prices changes are obtained from the Bruegel's Institute database.

The main specification tested, both for panel and country-by-country regressions, is as follows:

$$(5) \quad \Delta \ln M_{c,t} = \beta_{IAD} \Delta \ln IAD_{c,t} + \beta_{REER} \Delta \ln REER_{c,t} + \beta_{IAD,l} \Delta \ln IAD_{c,t-1} + \beta_{REER,l} \Delta \ln REER_{c,t-1} + \beta_M \Delta \ln M_{c,t-1} + \gamma_c + \varepsilon_{c,t}$$

Where: $\Delta \ln M_{c,t}$ is the year-on-year growth rate of real imports of goods and services for 38 major trading nations, $\Delta \ln IAD_{c,t}$ is the year-on-year growth rate of import-intensity adjusted demand for these countries, $\Delta \ln REER_{c,t}$ is the changes in their Real Effective Exchange Rate (as a proxy for relative price and competitiveness changes), $\varepsilon_{c,t}$ is the error term.

Panel analysis

Panel regressions estimated the average import-elasticity of IAD to be about 1.4 over the period 1995-2021, against around 1.8 using real GDP (Table 1).

The real effective exchange rate (REER) is positively correlated with real imports, suggesting that when the REER increases, that is the exchange rate of the country under study appreciates, imports are cheaper and increase in real terms. When it depreciates, imports decrease. In Table 1, time t REER is not statistically significant, but lagged REER is, which is consistent with the literature (exchange rates changes tend to affect trade demand over time). The panel regression using IAD performs better compared to GDP in term of goodness of fit, with R-squared being higher by around 0.2.

Table 1: Panel regression's estimation results

| VARIABLES | (1) IAD lags | (2) GDP lags |
|----------------------------|------------------------|-----------------------|
| IAD | 1.370*** (0.0631) | |
| REER | 0.0903 (0.124) | 0.107 (0.149) |
| Real import growth(lagged) | -0.246*** (0.0263) | -0.238*** (0.0408) |
| IAD (lagged) | 0.250*** (0.0578) | |
| REER (lagged) | 0.0797*** (0.0292) | 0.140** (0.0541) |
| GDP | | 1.833*** (0.0983) |
| GDP (lagged) | | 0.362** (0.164) |
| Constant | 0.00684** (0.00280) | 0.00349 (0.00330) |

| | | |
|---------------------|-------|-------|
| Observations | 3,715 | 3,715 |
| R-squared | 0.704 | 0.495 |
| Number of countries | 38 | 38 |

Note: The table shows estimates of panel regressions from equation 5, performed on the full set of 38 countries between 1995Q1 and 2021Q2. To save space we did not report the point estimates of the lagged value of the dependent variable and Import Demand. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

For each country-year, we obtained the real import growth predicted by our model, by applying the estimated coefficients of equation (5) to the actual data. The predicted real import growth for each country-year was given by the following condition:

$$(6) \quad \Delta \ln \widehat{M}_{c,t} = \widehat{\beta}_{IAD} * \Delta \ln IAD_{c,t} + \widehat{\beta}_{REER} * \Delta \ln REER_{c,t} + \widehat{\beta}_{IAD,l} * \Delta \ln IAD_{c,t-1} + \widehat{\beta}_{REER,l} * \Delta \ln REER_{c,t-1} + \widehat{\beta}_M * \Delta \ln M_{c,t-1}$$

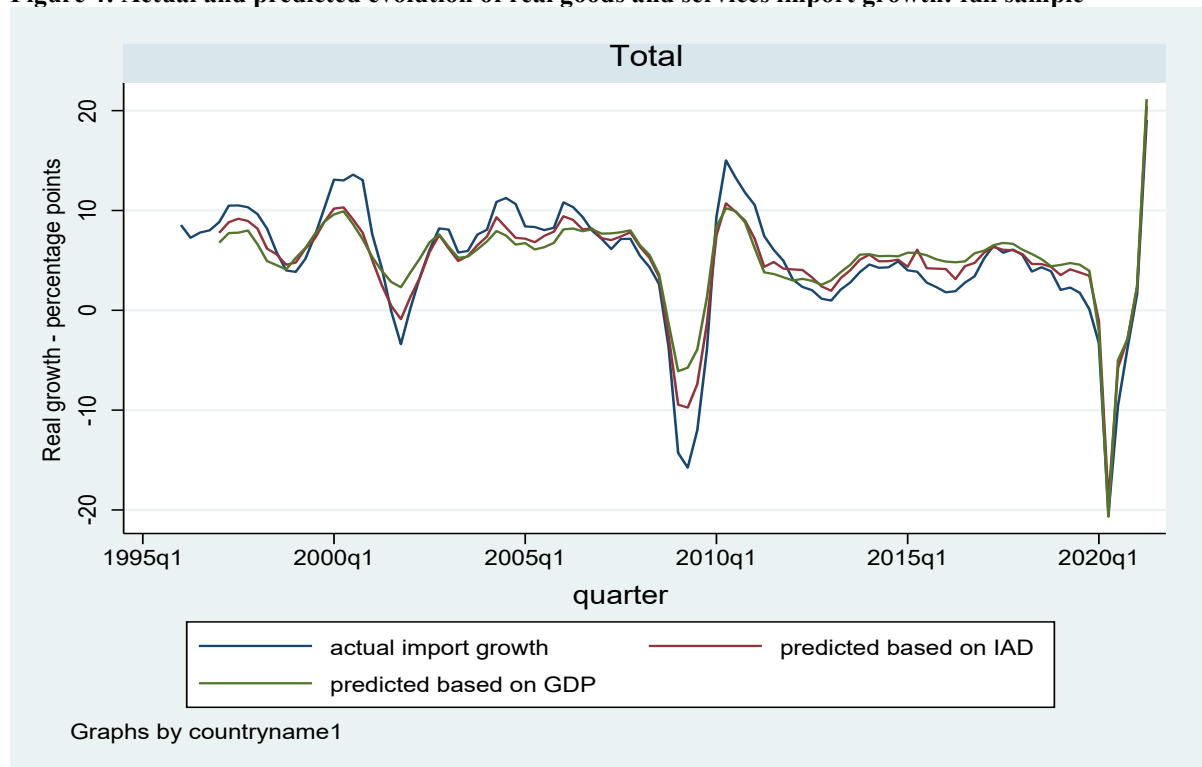
where $\widehat{\beta}_{IAD}$, $\widehat{\beta}_{REER}$, $\widehat{\beta}_{IAD,l}$, $\widehat{\beta}_{REER,l}$, $\widehat{\beta}_M$ are the estimates of coefficients in equation (5).

The average actual and predicted real import growth was then calculated as the weighted average of country-specific real import growth rates, where nominal import shares between 2005 and 2014 were used as weights.

Figure 4 presents the actual average real import growth in the 38 countries analysed together with the predicted average real import growth, using either GDP or IAD as proxy for demand. The empirical model tracks real import growth quite closely.

Over the entire sample period 1995Q1-2021Q2, the panel based-model using IAD predicts on average 68% of the changes in import of goods and services during the period, compared to 55% explained by the model using GDP.

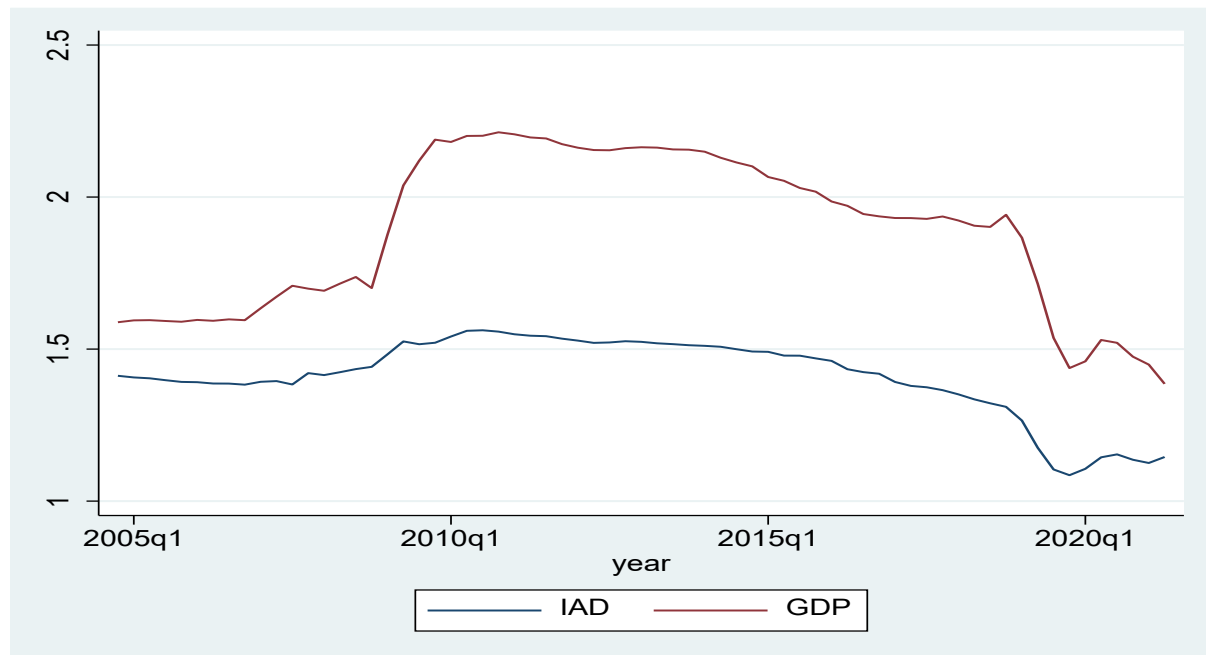
Figure 4: Actual and predicted evolution of real goods and services import growth: full sample



Note: the blue line shows the weighted average of country-specific actual real import growth. The green line shows the weighted average of country-specific fitted value based on panel regression, using GDP as a measure of demand. The red line shows the weighted average of country-specific fitted value based on panel regression, using IAD as the measure of demand.

We also re-estimated regressions of the form of equation (5) with 10 years rolling windows in order to explore the presence of structural break in demand elasticities. The figure below shows the evolution of panel import elasticities to IAD and GDP over the period 2005:Q1 to 2021:Q2. The empirical model using IAD as proxy of demand yields estimated elasticities of imports to demand that are significantly less volatile compared to the one using GDP (Figure 5). This suggests that using GDP as a demand measure in trade equation may indicate structural breaks in the estimated elasticity, even when this is not the case when using IAD.

Figure 5: Evolution of import demand elasticities over time



Note: The figure shows the evolution of the contemporaneous coefficient of the two demand measures, GDP and IAD, using panel regression from equation (5), with 10 years rolling windows. Dates in the x-axis correspond to the final quarter of each of the 10 years rolling windows.

As shown in Table 2, advanced economies have on average slightly lower elasticities than emerging and emerging and developing ones (1.31 versus 1.49 using IAD).¹⁰

Table 2: Panel regression's estimation results, by development status

| VARIABLES | Emerging & developing economies | | Advanced economies | |
|----------------------------|---------------------------------|-----------------------|------------------------|------------------------|
| | IAD | GDP | IAD | GDP |
| Import Demand | 1.489*** (0.116) | 1.922*** (0.221) | 1.306*** (0.0717) | 1.787*** (0.1000) |
| REER | 0.0953 (0.187) | 0.152 (0.220) | 0.0645 (0.0823) | 0.0376 (0.0904) |
| Real import growth(lagged) | -0.268*** (0.0304) | -0.260*** (0.0409) | -0.213*** (0.0297) | -0.226*** (0.0740) |
| Import Demand (lagged) | 0.351*** (0.0750) | 0.642** (0.219) | 0.163** (0.0597) | 0.216 (0.218) |
| REER (lagged) | 0.0963** (0.0389) | 0.203*** (0.0402) | 0.00428 (0.0404) | -0.0100 (0.0519) |
| Constant | -0.00853 (0.00903) | -0.0163 (0.00950) | 0.0124*** (0.00200) | 0.0106*** (0.00239) |
| Observations | 1,069 | 1,069 | 2,646 | 2,646 |
| R-squared | 0.639 | 0.464 | 0.770 | 0.544 |
| Number of countries | 11 | 11 | 27 | 27 |

¹⁰ Developing and emerging economies as well as advanced economies are defined based on the IMF's World Economic Outlook classification. Our sample covers 27 advanced economies (Australia; Austria; Belgium; Canada; Cyprus; Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Ireland; Italy; Japan; Korea, Republic of; Latvia; Lithuania; Luxemburg; Netherlands; Portugal; Slovak Republic; Slovenia; Spain; Sweden; United Kingdom; and the United States of America) and 11 emerging and developing economies (Brazil, Bulgaria, China, Hungary, India, Indonesia, Mexico, Poland, Romania, Russian Federation, Turkey).

Note: The table shows estimates of panel regressions from equation 5, performed on the full set of advanced or emerging & developing economies between 1995Q1 and 2021Q2. To save space we did not report the point estimates of the lagged value of the dependent variable and Import Demand. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Country-by-country analysis

There is some heterogeneity across countries, as could be expected. Therefore, we estimated the model separately for each of the 38 countries (country-by-country regressions). Table 3 shows relatively similar results as Table 2 in terms of average elasticities (around 1.5 for IAD and 1.9 for GDP).

However, country-by-country regression allows for a better differentiation between categories of countries, showing greater dispersion and volatility in the import elasticities of demand. The REER is not always positive and statistically significant, depending on countries (the negative value here is an average of the country-by-country coefficients).

Table 3: Country-by-country regression's estimation results

| | GDP | | | IAD | | |
|---------------|-------|--------------|--------------|-------|--------------|--------------|
| | mean | 1st quartile | 3rd quartile | mean | 1st quartile | 3rd quartile |
| Import demand | 1.91 | 1.69 | 2.13 | 1.46 | 1.31 | 1.64 |
| REER | -0.04 | -0.35 | 0.30 | -0.06 | -0.26 | 0.16 |
| REER(lag) | -0.05 | -0.16 | 0.16 | -0.05 | -0.14 | 0.07 |
| constant | 0.00 | -0.01 | 0.02 | 0.01 | 0.00 | 0.02 |
| R squared | 0.69 | 0.58 | 0.82 | 0.82 | 0.77 | 0.89 |

Note: The table reports (simple) averages as well as interquartile ranges of import demand elasticities calculated for each country separately. The analysis uses quarterly data from 1995Q1 to 2021Q2. Import Demand variable is statistically significant at 1% in each country, while the other explanatory variables are statistically significant only in some countries.

Figure 6 shows the weighted average of predicted import growth coming from country-by-country regressions. The results are very similar those displayed in Figure 4. The shortfall in real import growth relative to the predicted value, from 2012 onwards, is even smaller. The model using IAD country-by-country predicts on average 79% of the changes in import of goods and services during the period 1995Q1-2021Q2, compared to 69% explained by the model using GDP.

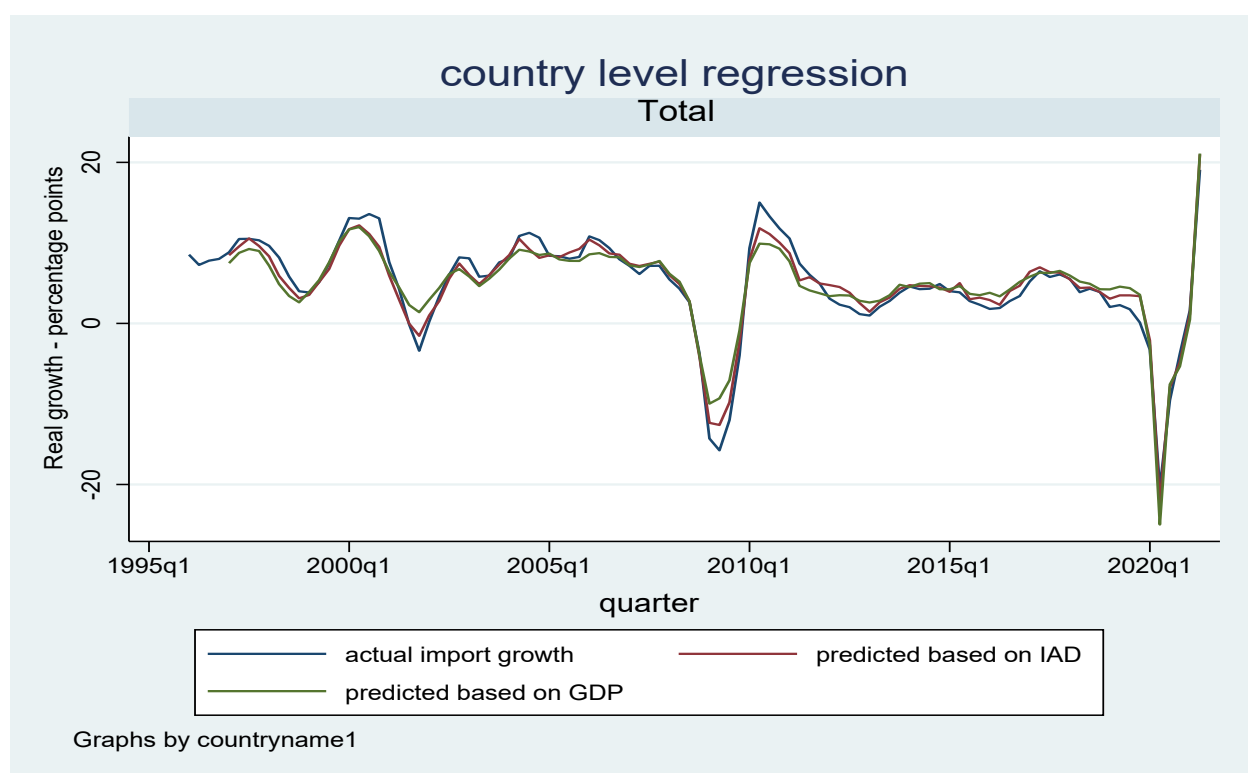
The superiority of IAD against GDP in tracking real import growth through the entire estimation is relatively clear from figure 4 and figure 6; backward projections for real import growth based on the IAD measure are generally close to actual values than projections based on GDP.

However, the difference between the two projections narrows down as one "approaches" the start of the COVID-19 pandemic period, and becomes almost nul during the pandemic, in 2020-2021 (until Q2). In itself, such relative "improvement" of the estimative performance of GDP based models does not invalidate the "quality" of the IAD concept and its usefulness as a complementary tool for analysis. As described earlier, IAD-based analysis provides less volatile trade to demand/income elasticities, while GDP-based regressions show systematically lower R-squared values, suggesting lower explanatory power. At the same time, improved

forecasting performance during Covid is puzzling and could offer an interesting avenue for further research.

There are several possible explanations for improved relative performance of GDP-based equations, one of which could be in the relative role of goods and services in both GDP and trade during the pandemic, when compared to the global financial crisis. The argument would be that IAD-based models are particularly helpful in explaining changes in trade-to-income elasticities because it captures changes in the most trade intensive elements of demand (investment and exports) which are particularly intensive in manufacturing inputs. When both services' GDP and trade are relatively more affected by a shock, GDP-based equations would perform better.

Figure 6: Actual and predicted evolution of real goods and services import growth: full sample



Note: The blue line shows the weighted average of country-specific actual real import growth. The green line shows the weighted average of country-specific fitted value based on panel regression, using GDP as a measure of demand. The red line shows the weighted average of country-specific fitted value based on panel regression, using IAD as the measure of demand.

IV.2 Explaining the trade collapse during the global financial crisis (GFC) and during the COVID-19 crisis, by demand components

We broke the sample period into four sub-periods, before and during the COVID crisis (2012-2019 and 2020) and before and during the GFC (2000-2008 and 2009), to evaluate which determinant (including within IAD) explains large trade swings during that period.

For each country, we estimated the import growth predicted by each component of IAD, based on the coefficients of the panel performed according to equation (5). We averaged it for the overall economy, to obtain the import growth predicted, globally, by each component of

IAD, throughout the time series. By doing this, we thus were able to compare different periods of time, and in these periods, the way in which each IAD component had influenced trade weighted import growth.

The results are summarized in Table 4: on average, 77% of the trade collapse during the global financial crisis could be "predicted" by the model and is attributable to IAD. 97% of the difference in global import growth between 2012-2019 and 2020 is also attributable to IAD.

Table 4: Individual contribution of IAD components in real import growth slowdown during GFC and COVID

| | Percentage of trade slowdown explained by: | | | | | | |
|--------------------------------|--|-----|-----|-----|-----|------------|--------------|
| | IAD | C | G | I | X | Direct IAD | Indirect IAD |
| Trade fall during GFC | 77% | 7% | -1% | 33% | 38% | 7% | 70% |
| Trade fall during COVID crisis | 97% | 23% | 1% | 29% | 44% | 23% | 74% |

Source: Authors' calculations based on panel regressions of equation (5).

In the 97% of the variations (fall) of real global imports explained by IAD at the height of the Covid-19 pandemic, 44% is explained by exports and 29% by investment, the two most trade intensive elements of demand. The variations of consumptions also accounted for a significant share of global real import's large swing at this period. The results are relatively consistent with that found for global import changes during the global financial crisis – with exports and investment explaining most of it (consumption explained a smaller part, 7% out of 77%, than during the Covid-19 crisis).

A common feature of the two periods is that indirect IAD is largely responsible for the changes (fall) in real trade, when breaking IAD between direct IAD and indirect IAD.

The observation of the higher contribution of exports in IAD, and that of the higher contribution of indirect imports in IAD may, in combination, illustrate the supply side impact of large trade swings (both during the global financial crisis and Covid-19). This is a plausible illustration, not certain. The model in itself does not say so. The logic of this "plausible illustration" would be as such: indirect IAD represents the share of imported inputs in overall trade-weighted aggregate expenditure. Its variation accounts for most of the variation of trade-weighted imports in periods of shock.

This is to say that disruptions in intermediate inputs (recorded from input-output tables, rather than that of direct imports, explain most of the overall movements of such imports (up and down) at the time of large swings. This could be consistent with the idea that "supply chain" trade is shocked. When looking at the expenditure components of IAD, one observes that the variation of exports, explain around 40% of total real import growth. Hence, intermediate inputs contained in anyone country's exports tend to explain the highest share of the overall import variation during the periods of shock considered.

IV.3 Dealing with exports at global level

One country can take the external demand and exports as given, but for the world, only the sum of domestic demand component determinates import growth. In order to investigate how much of the global variation during the covid pandemic was driven completely by domestic demand (i.e. each country's domestic demand and the domestic demand of its trading partners), we have estimated an alternative import demand equation relation to Equation (5), estimated in Section IV.1.

In this model, absorption is proxied by domestic IAD (DIAD) and exports predicted by trading partners' domestic IAD (see Box 4 for details of the methodology). The DIAD is constructed in the same ways as the IAD, but focusing only on the domestic components of aggregate demand, i.e. excluding the export.

Table 5 shows the decomposition of the difference between average real import growth between 2012-2019 and 2020 into domestic demand, external demand predicted by trading partner's domestic demand. When excluding exports and relying on the concept of domestic import intensity adjusted demand, the model's predictive power falls somewhat to 87% (instead of 97%) of the actual trade variations between 2012-2019 and 2020.

Table 5: Individual contribution of IAD components in real import growth slowdown during GFC and COVID

| | Percentage of trade variations during Covid-19 explained by: | |
|------------------------------------|--|--|
| | IAD | Predicted by own and partners ' domestic IAD |
| Trade slowdown during COVID crisis | 97% | 87% |

Source: Authors' calculations based on panel regressions of equation (5).

IV.4 Statistical Robustness

We conducted a wide range of robustness and sensitivity analyses on our equations, some of them being directly run with regressions, as for example in footnote 8 and 9, in Section IV.1. These tests confirmed that our results were robust to various alterations to our baseline models (unit root tests, correcting for heteroskedacity and autocorrelation,).

We also regard the previous Section (IV.3) as being one more robustness check, since we are in effect attempting to "neutralize" the role of "global" exports – as said above, for the world as a whole only the sum of domestic demand would determine import growth. Hence, we had used an alternative to Equation 5 to estimate how much of global trade changes are driven by domestic demand, i.e. each country's domestic demand and the domestic demand of its trading partners. Focusing only on the domestic demand approach, the model explains 87% of imports variations (fall in 2020), against 97% when using IAD.

V. CONCLUSION

In our view, this paper provides reasonable albeit robust evidence that estimating the standard global macroeconomic import equation, using an import intensity-adjusted measure of aggregate demand (IAD), calculated from input-output tables at country level, provides particularly good forecasting and analytical results at country and global levels. It does not lead to forecasting errors in determining global trade trends over the short or medium terms – as evidenced by the long forecasting period (1995 Q1 – 2021 Q2), and performs well during shocks. The use of the non-trade weighted GDP, as a proxy for income, was challenged in the mid-2010's for having failed to predict significant change to import or trade-to-GDP/income elasticities. We found, though, that GDP-based import models did not perform so badly during the pandemic.

Still, with IAD we found a lower and less volatile, long-term elasticity of imports to demand (about 1.5 instead of 2 for GDP); besides, the integration of IAD into the standard global import equation helps predict 68% to 79% (for country level regressions) of the changes in values of global imports over the entire period, a better performance than if using GDP (55% with panel and 69% with country level regressions).

The use of IAD enables us to measure the relative importance of each component of demand, according to their trade intensity. The model is able to account for over 97% of the recent trade cycle during the Covid-19 pandemic. The composition of demand is the primary explanation of the trade slowdown because the most trade-intensive components were the ones slowing down the most (such as investment).

In the future, though, such analyses are likely to benefit from current efforts to improve world input-output databases. We were able to rely on data covering 38 countries accounting for 75% of global exports, and to calculate trade-weights based on mid 2010's data. However, progress in input-output tables from other projects (such as the OECD's TiVA project) will help calculating updated weights, with a slightly higher share of global trade. Another challenge would be on the aggregate demand side, as all countries in the world do not have expenditure-based data on a monthly or even quarterly basis. Finally, the importance of financial factors, e.g. the contraction of cross-border financial flows (foreign direct investment, trade finance) might be tested as explanatory variables, but measurements of such flows are still subject to significant data gaps.

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Box 1: Calculating the import content of aggregate demand components.

The National I-O tables (NIOT), from WIOD, illustrate flows between the sales and purchases, both final and intermediate, of industry output at country level. This is illustrated by the schematic outline for a NIOT involving only three industries in Figure 1. A useful feature of the NIOT is that intermediate inputs are divided into goods and services that are domestically-produced and those that are imported. Therefore, for each country, there are two main matrices: one focusing on domestically provided flows (domestic matrix, the green part in Figure 1) and the other focus on imported flows (import matrix, the yellow part in Figure 1).¹¹ Each of these two matrices is divided into two parts: the first part describes the flows of intermediate inputs used in domestic production (Z), the second describes the flows into final demand expenditures (F).

Figure 1: Input-output table

| | | Intermediate | | | Final Demand | | | |
|----------|--------|--------------|--------|--------|--------------|----|------|---------|
| | | Ind. 1 | Ind. 2 | Ind. 3 | PC | GC | GFCF | Exports |
| Domestic | Ind. 1 | Z^d | | | F^d | | | |
| | Ind. 2 | | | | | | | |
| | Ind. 3 | | | | | | | |
| Import | Ind. 1 | Z^m | | | F^m | | | |
| | Ind. 2 | | | | | | | |
| | Ind. 3 | | | | | | | |
| | VA | | | | | | | |
| | Output | | | | | | | |

PC: private consumption, GC: government consumption, GFCF: Gross Fixed Capital Formation
VA: Value Added

In the part of the domestic matrix that describes flows of intermediate inputs (Z^d), the cell z_{ij}^d contains the value of domestically produced intermediate inputs from industry i (row) purchased by industry j (column) for domestic production throughout the year of reference.¹² Similarly, the cell z_{ij}^m of the import matrix contains the value of imported intermediate inputs from industry i (row) needed by industry j (column) for domestic production throughout the year of reference. Since the NIOT contains 35 sectors Z^d and Z^m are a 35x35 matrix.

As far as the matrix containing information on the final demand (F) is concerned, f_{ik}^d reports the final demand of domestically produced goods and services from industry i by the final expenditure component k while f_{ik}^m reports the direct import of goods and services from industry i needed by the final expenditure component k . Both F^d and F^m are 35x4 matrix. Let assume that output from each industry is used both as intermediate input by other industries and as final products by households and government (consumption) or firms (stocks and gross fixed capital formation). Using the domestic and import matrices, we can easily construct the value of direct and indirect imports and consequently the import content of each of the four expenditure components for each country and year.

The value of direct imports from each sector for each expenditure components (M^{dir}) can be computed directly from the import matrix:

$$M^{dir} = F^m$$

¹¹ It does not indicate the country of origin of the imported intermediate inputs. This information is included in the inter-country matrix.

¹² Values in WIOD are in current prices, expressed in millions of US dollars and market exchange rates were used for currency conversion.

Note that the value of direct import of exports is assumed zero as re-exports are excluded from analysis.¹³

The value of indirect imports (M^{ind}) is the amount of imports induced by the expenditure on domestically produced goods and services. They include imports of intermediate goods and services from foreign suppliers or imports included in intermediate inputs acquired from domestic suppliers. In order to compute the indirect import, we need matrices A^d and A^m instead of Z^d and Z^m . A^d and A^m are obtained simply dividing the value of each cell in Z^d and Z^m by the sum of the respective column (output in each sector). Then, the domestic input coefficient a_{ij}^d , in matrix A^d , contains the value of domestically produced intermediate inputs from sector i needed to produce one unit of domestic output in sector j , and analogously, the import input coefficient a_{ij}^m contains the value of imported intermediate inputs from sector i needed to produce one unit of domestic output in sector j .

The imports of intermediate inputs from sector i induced by the expenditure on domestically provided goods and services for the expenditure component k , m_{ik}^{ind} , can be computed as follows:

$$m_{ik}^{ind} = \sum_{j=1}^{35} a_{ij}^m * x_{jk}$$

In matrix form:

$$M^{ind} = A^m * X$$

Where x_{ik} is the domestic output from sector i needed to satisfy the final demand from expenditure component k and it is given by:

$$x_{ik} = \sum_{j=1}^{35} a_{ij}^d * x_{jk} + f_{ik}^d$$

In matrix form:

$$X = A^d * X + F^d \Rightarrow X = (I - A^d)^{-1} * F^d$$

Therefore, substituting the matrix X of domestic output induced by each spending component k in the equation of the indirect import, we get:

$$M^{ind} = A^m * (I - A^d)^{-1} * F^d$$

It is important to highlight the difference between matrix F^d and X . The latter is a broader concept, it includes the final demand of domestically produced goods and services by each spending component k (F^d), as well as the value of domestically produced intermediate inputs needed to produce one unit of domestic output multiplied by the domestic output needed to satisfy the final demand from the expenditure k .

Once we have the direct and indirect imports, we can compute the direct and indirect import content of each expenditure component k as follows:

¹³ We are aware that for some countries, such as China, this assumption might be a bit problematic due to the high amount of processing trade.

$$\omega_k^{dir} = \frac{u * M^{dir}}{u * F^m + u * F^d}$$

$$\omega_k^{ind} = \frac{u * M^{ind}}{u * F^m + u * F^d}$$

Where the first represents the share of imported final goods and services, and the second the share of intermediate imported inputs per unit of final demand.

The total import of each expenditure components is simply the sum of the direct and indirect imports:

$$M = M^{dir} + M^{ind}$$

Therefore, the total import content of each expenditure component k is simply given by the sum of direct and indirect import content:

$$\omega_k = \omega_k^{dir} + \omega_k^{ind} = \frac{u * M^{dir} + u * M^{ind}}{u * F^m + u * F^d}$$

Source: Bussiere et al. (2013)

Box 2: Calculating the contribution of aggregate demand components' in trade slowdown

Using the estimated coefficients from regression (5), we calculated the contribution of each of the aggregate demand components and that of the real effective exchange rates in the real import slowdown.

The import slowdown decomposition requires a few steps. First, for each country (c) and year (t), we computed the import growth predicted by each demand component k ($\Delta \ln \widehat{M}_{c,t}^k$) as follow:

$$(7) \Delta \ln \widehat{M}_{c,t}^k = \widehat{\beta}_{IAD} * \omega_{c,k,t} * \Delta \ln K_{c,t} + \widehat{\beta}_{IAD,I} * \omega_{c,k,t-1} * \Delta \ln K_{c,t-1}$$

Where:

$$k = C, G, X, I$$

$\widehat{\beta}_{IAD}$ and $\widehat{\beta}_{IAD,I}$ are the estimated coefficients of equation (5)

Similarly, we computed the import growth predicted by REER as follows:

$$(8) \Delta \ln \widehat{M}_{c,t}^{REER} = \widehat{\beta}_{REER} * \Delta \ln REER_{c,t} + \widehat{\beta}_{REER,I} * \Delta \ln REER_{c,t-1}$$

Secondly, taking the weighted average of the import growth predicted by each demand component k across countries and then between 2012-2019 and 2020, we get the import growth for the average economy predicted by each demand component k, in 2012-2019 (i.e. $\Delta \ln \widehat{M}_{12-19}^k$) and in 2020 (i.e. $\Delta \ln \widehat{M}_{2020}^k$). In a similar way we get the import growth for the

average economy predicted by REER in 2012-2019 (i.e. $\Delta \ln \widehat{M}_{12-19}^{REER}$) and 2020 (i.e. $\Delta \ln \widehat{M}_{2020}^{REER}$). Finally, dividing the predicted slowdown in real import growth from each demand component k by the actual slowdown in real import growth we get the contribution of each aggregate demand component k in the real import slowdown, γ_k , for the average economy:

$$(9) \quad \gamma_k = \frac{\Delta \ln \widehat{M}_{2020}^k - \Delta \ln \widehat{M}_{2012-19}^k}{\Delta \ln M_{2020} - \Delta \ln M_{2012-19}}$$

The percentage of import slowdown explained by the REER, γ_{REER} , is computed in a similar way:

$$(10) \quad \gamma_{REER} = \frac{\Delta \ln \widehat{M}_{2020}^{REER} - \Delta \ln \widehat{M}_{2012-19}^{REER}}{\Delta \ln M_{2020} - \Delta \ln M_{2012-19}}$$

Source: Bussiere et al. (2013)

Box3: Calculating the contribution of direct and indirect IAD in trade slowdown

First, for each country (c) and year (t), we computed the year-on-year direct (11) and indirect (12) IAD growth:

$$(11) \quad \ln IAD_t^{dir} = \omega_{C,t}^{dir} * \ln C_t + \omega_{G,t}^{dir} * \ln G_t + \omega_{I,t}^{dir} * \ln I_t + \omega_{X,t}^{dir} * \ln X_t$$

$$(12) \quad \ln IAD_t^{indir} = \omega_{C,t}^{indir} * \ln C_t + \omega_{G,t}^{indir} * \ln G_t + \omega_{I,t}^{indir} * \ln I_t + \omega_{X,t}^{indir} * \ln X_t$$

We computed the import growth predicted by direct IAD ($\Delta \ln \widehat{M}_{c,t}^{IAD,dir}$) as follow:

$$(13) \quad \Delta \ln \widehat{M}_{c,t}^{IAD,dir} = \widehat{\beta}_{IAD} * \Delta \ln IAD_t^{dir} + \widehat{\beta}_{IAD,l} * \Delta \ln IAD_{t-1}^{dir}$$

Where:

$\widehat{\beta}_{IAD}$ and $\widehat{\beta}_{IAD,l}$ are the estimated coefficients of equation (5)

Similarly, we computed the import growth predicted by indirect IAD ($\Delta \ln \widehat{M}_{c,t}^{IAD,indir}$).

Secondly, taking the weighted average of the import growth predicted by direct IAD across countries and then between 2012-2019 and 2020, we get the import growth for the average economy predicted by direct IAD, in 2012-19 (i.e. $\Delta \ln \widehat{M}_{12-19}^{IAD,dir}$) and in 2020 (i.e. $\Delta \ln \widehat{M}_{2020}^{IAD,dir}$). In a similar way we get the import growth for the average economy predicted by indirect IAD in 2012-2019 (i.e. $\Delta \ln \widehat{M}_{12-19}^{IAD,indir}$) and 2020 (i.e. $\Delta \ln \widehat{M}_{2020}^{IAD,indir}$). Finally, dividing the predicted slowdown in real import growth from direct IAD by the actual slowdown in real import growth we get the contribution of direct IAD in the real import slowdown, $\gamma_{IAD,dir}$, for the average economy:

$$(14) \quad \gamma_{IAD,dir} = \frac{\Delta \ln \widehat{M}_{2020}^{IAD,dir} - \Delta \ln \widehat{M}_{12-19}^{IAD,dir}}{\Delta \ln M_{2020} - \Delta \ln M_{12-19}}$$

The percentage of import slowdown explained by the indirect IAD, $\gamma_{IAD,indir}$ is computed in a similar way:

$$(15) \quad \gamma_{IAD,indir} = \frac{\Delta \ln \widehat{M}_{2020}^{IAD,indir} - \Delta \ln \widehat{M}_{12-19}^{IAD,indir}}{\Delta \ln M_{2020} - \Delta \ln M_{12-19}}$$

Source: Bussiere et al. (2013)

Box4: Calculating an alternative model of import demand for dealing with exports

We estimated an alternative model of import demand using domestic IAD and exports predicted by trading partners' domestic IAD.

Domestic IAD is defined as:

$$(16) \quad \ln DIAD_t = \omega_{C,t}^d * \ln C_t + \omega_{G,t}^d * \ln G_t + \omega_{I,t}^d * \ln I_t$$

Where the weights ($\omega_{k,t}^d$, with $k = C, G, I$) are the total import content of each of the domestic demand expenditure components and are normalised in each year so that they sum up to 1.

In order to compute the exports predicted by partners' DIAD, we followed the methodology of IMF (2016). First, we got for each country the real import growth predicted by DIAD ($\Delta \ln \widehat{M}_{c,t}^{DIAD}$) by estimating the following equation:

$$(17) \quad \Delta \ln M_{c,t} = \beta_{DIAD} * \Delta \ln DIAD_{c,t} + \beta_{REER} * \Delta \ln REER_{c,t} + \beta_{DIAD,l} * \Delta \ln DIAD_{c,t-1} + \beta_{REER,l} * \Delta \ln REER_{c,t-1} + \beta_M * \Delta \ln M_{c,t-1} + \gamma_c + \varepsilon_{c,t}$$

Second, since exports of a country are the sum of imports of its trading partners, we estimated a model where the export demand of a country is a function of trade weighted average of its five most important trading partners' real import growth predicted by DIAD.

$$(18) \quad \Delta \ln X_{c,t} = \beta_D \sum_{j=1}^5 \alpha_{cj} * \Delta \ln \widehat{M}_{j,t}^{DIAD} + \gamma_c + \varepsilon_{c,t}$$

Where α_{cj} is the share of total exports of country c going to country j at time t.¹⁴ These export shares vary for each year and are reweighted to sum to 1.

From the estimation of the equation above, we got the exports predicted by trading partners' DIAD ($\Delta \ln \widehat{X}_{c,t}^{DIAD}$). Finally, we linked the real import growth of each country to the

¹⁴ We consider only the top five export partners from World Integrated Trade Solution (WB).

growth rate of its DIAD and its exports predicted by trading partners' DIAD, controlling for relative import prices:

$$(19) \quad \Delta \ln M_{c,t} = \beta_{DIAD} \Delta \ln DIAD_{c,t} + \beta_{REER} \Delta \ln REER_{c,t} + \beta_X \widehat{\Delta \ln X_{c,t}^{DIAD}} + \beta_{DIAD,l} \Delta \ln DIAD_{c,t-1} + \beta_{REER,l} \Delta \ln REER_{c,t-1} + \beta_M \Delta \ln M_{c,t-1} + \gamma_c + \varepsilon_{c,t}$$

Source: IMF (2016)