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THE CYCLICALITY OF THE INCOME ELASTICITY OF TRADE

by Alessandro Borin*, Virginia Di Nino*[§], Michele Mancini* and Massimo Sbracia*

Abstract

In the five years 2011-2015 global trade fell short of expectations to a much larger extent than global GDP. We show that two key features of real trade flows − their high volatility and their procyclicality − are the cause behind the cyclicality of the income elasticity of trade. This property implies that when real GDP growth is positive but below its long-run trend, then the income elasticity of trade is also below its own long-run trend. Therefore, when real GDP growth turns out to be weaker than expected, the forecast error on trade volumes is amplified by the fact that the income elasticity of trade also happens to be lower than predicted. We then analyze the implications of our findings for cross-country differences in the elasticity, the role played by long-run and cyclical factors in the weakness of trade in the aftermath of the Great Recession, and the accuracy of existing trade forecasts, which we significantly improve by exploiting real-time data on business conditions.

JEL Classification: E32, F1, F4.
Keywords: global trade, trade elasticity, trade forecasts, trade slowdown, international business cycle.

Contents

* Bank of Italy.
§ European Central Bank.

1 Introduction[1]

In 2011-2015, global trade has regularly disappointed expectations. Figure 1 shows, for example, that while the International Monetary Fund (IMF) estimated world trade volumes to grow at an annual average of 5.3%, their actual growth rate turned out to be just 3.5% per year. World trade growth fell short of expectations in each year of the quinquennium, by a size ranging from 0.9 percentage points in 2011 to almost 3 points in 2012.[2] While this systematic forecast error has reflected, in part, lower-than-expected real GDP growth, the economic and policy debate has focused on the surprising fall of the income elasticity of trade — here defined as the ratio between real import growth and real GDP growth ("income elasticity" hereafter).[3] Income elasticity has, in fact, decreased from a predicted level of 1.4 (a value close to its historical average), to around 1.0, apparently accounting for almost two-thirds of the forecast error.[4]

In this paper we put the income elasticity at the center stage, in order to streamline the mechanisms that explain the behavior, along the business cycle, of aggregate trade flows compared to GDP. Although the income elasticity is not a parameter in modern microfounded models of international trade, it is a key indicator usually mon-

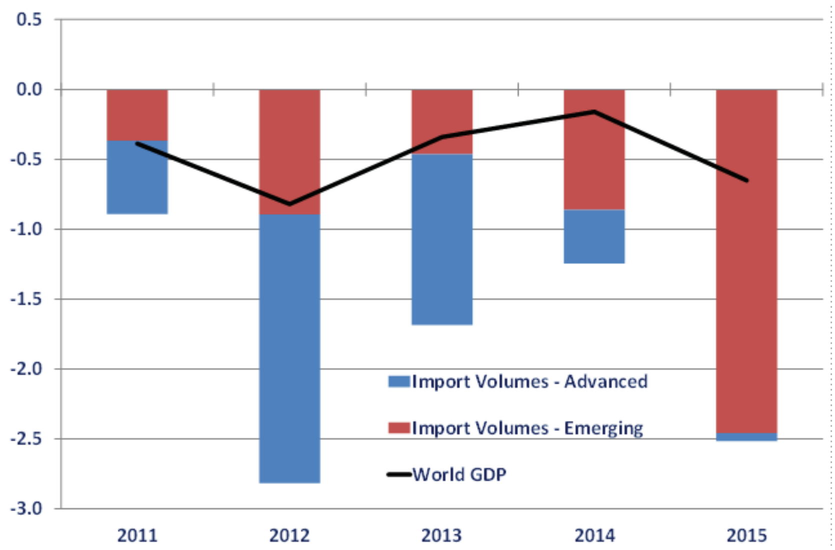
[1]The views expressed in this paper are those of the authors and do not necessarily reflect those of the Bank of Italy. We thank George Alessandria, Lorenzo Caliendo, Pietro Catte, Ric-cardo Cristadoro, Andrea Finicelli, Brent Neiman, Walter Steingress and seminar participants at the Banque de France-ECB Workshop, the European Trade Study Group 2016 Conference and DEGIT 2016 Conference in Nottingham for many useful comments. E-mail: alessandro.borin@bancaditalia.it, virginia.di_nino@ecb.europa.eu, michele.mancini@bancaditalia.it, massimo.sbracia@bancaditalia.it.

[2]The IMF was not alone in overestimating world trade. The forecast errors made by other international financial institutions, such as the OECD and the WTO, were, in fact, of the same sign and of similar magnitude.

[3]Throughout the paper we will focus only on the income elasticity of trade using the ratio, observed in each year or quarter, between real *import* growth and real *GDP* growth. At the world level, focusing on imports or exports is essentially the same thing, although, in practice, the two variables are never completely identical, due to statistical discrepancies. In the period 1980-2015, for example, IMF data report that the difference between the annual growth of real exports and that of real imports was between −1.7 (in 1994) and 2.8 percentage points (in 1980), although it was on average nil over the whole period. Similarly, in 2011-2015 the difference was in a range between −0.2 and 0.3 percentage points and was on average nil in the quinquennium. At the country level, focusing on imports or exports makes a more significant difference. Yet, using one or the other would leave the main results of this paper unaltered, due to the strong correlation between their volumes, documented by Engel and Wang (2011). Analogously, placing at the denominator the growth rate of domestic demand (instead of GDP) provides very similar, albeit not identical, results.

[4]Real GDP growth fell short of expectations by an annual average of 0.5 percentage points in 2011-2015. By using the elasticity of 1.4 implicit in the IMF forecasts, lower GDP growth then accounted for 0.7 percentage points of the forecast error. Hence, the remaining 1.1 percentage points, i.e. over 60% of the forecast error, is accounted for by the decline of the income elasticity of trade.

Figure 1: Forecast errors on the growth of world import and world GDP volumes (1)



(1) Percentage-point difference between the growth rate at year t as measured in the IMF WEO (World Economic Outlook) published in October at year *t+1* (actual data) and the growth rate at year t as predicted in the IMF WEO published in October at year *t-1* (forecast). This difference is further decomposed into the part due to advanced economies ("advanced") and the part due to the rest of the world ("emerging"). Source: our elaborations on IMF data.

itored in order to gauge how trade evolves relative to the rest of the economy. In particular, in assessing the dynamics of the trade-to-GDP ratio, policy makers and practitioners typically assume that changes in the income elasticity reflect structural factors, such as changing trade barriers. Not surprisingly, similarly to what happened during the so-called Great Trade Collapse of 2008-09, the recent dismal performance of international trade has been attributed to various structural factors, such as a resurgence of protectionist measures, a shortening of global value chains, the weakness of trade credit, or to possible composition effects, either geographic or sectoral.[5]

Recent studies have argued, for example, that the income elasticity can be larger than 1 only to the extent that trade volumes grow faster that real GDP, as they do when trade barriers decline. If, instead, trade volumes and real GDP grow at the same speed, then the income elasticity should lie at the equilibrium level of 1. The post-crisis reduction of the income elasticity is then interpreted as a return to its equilibrium value, as the secular decline in tariff and non-tariff protectionist measures

[5] Most hypotheses about the causes of the Great Trade Collapse have been presented in Baldwin (2009) and Baldwin and Evenett (2009); for other important contributions not included in those books, see also Eaton, Kortum, Neiman and Romalis (2016) and the extensive literature surveyed therein. Hoekman (2015) gathers several explanations for the post-crisis performance of trade; for other views, see also Borin and Mancini (2015), IMF (2016) and IRC Trade Task Force (2016).

and in transportation costs is gradually waning (see Gaulier, Mayer, Steingress and Zignago, 2016).[6]

Our analysis suggests a new explanation, complementary to those that are based on the role of trade barriers and other structural factors: we argue that the level of the income elasticity is affected not only by a long-run trend, but also by business cycle conditions. Specifically, we show that, even when trade volumes and GDP grow at identical (and positive) rates in the long-run, in the short-run one should expect a greater income elasticity when GDP growth is strong and a smaller income elasticity when GDP growth is weak. This effect can cyclically bring the income elasticity above and below 1, even in the absence of changes in trade barriers.

The cyclicality of the income elasticity, which emerges even if trade volumes and real GDP increase at identical long-run rates, is the consequence of two standard features of real trade flows (and, in particular, of imports), documented in the literature on the international real business cycle and revisited in this paper. Namely, their *high volatility* and their *procyclicality*.[7]

To provide a first intuitive example of why these two properties may push the income elasticity above 1, suppose for a moment that the trend growth rates of GDP and import volumes are both nil. If real import growth is more volatile than real GDP growth, then when the latter is positive, the former is either positive and very high or negative and very low. But the positive correlation between import and GDP volumes suggests that the relevant case is the one in which the two growth rates have the same sign. By the same token, when real GDP growth is negative, real import growth is also negative and very low. Thus, at a positive (negative) real GDP growth corresponds a positive (negative) and higher (lower) real import growth. In other words, the income elasticity can settle at a value that is always greater than 1.

Now consider the more relevant case in which both GDP and import volumes have a positive trend growth and let us provide an example in which the income elasticity can not only be greater than 1, but also be affected by business conditions. To separate the "pure trend effect" on the income elasticity related to declining trade barriers (i.e. to imports growing faster than GDP), suppose that these trend growth rates are

[6]Note that our focus on the plain definition of the income elasticity (ratio between real import growth and real GDP growth) distinguishes our analysis from other recent contributions (such as Gaulier, Mayer, Steingress and Zignago, 2016, or Bussière, Callegari, Ghironi, Sestieri and Yamano, 2013), which aim, instead, at evaluating how demand affect trade and how these effects should be captured by using alternative measures of the elasticity.

[7]Because the volumes of trade flows and GDP increase over time, the international real business cycle literature consider HP filtered series. As the focus of our paper is the income elasticity, which is a ratio between growth rates, our empirical analysis will tackle the time trend by focusing on growth rates, complementing that literature. Thus, in particular, by *high volatility* of imports we mean that the standard deviation of real import growth is higher than that of real GDP growth. Similarly, with *procyclicality* we refer to the positive contemporaneous correlation of real import growth with the business cycle (as measured by the growth rate of real GDP or of real investment).

identical, say set at 3%. In addition, to build a simple intuition about the reasons why the income elasticity is affected by the business cycle, let us also focus only on positive growth rates. As real import growth is more volatile than and positively correlated with real GDP growth, when the latter is above its average (say 4%), the former is even higher (say 5%); when real GDP growth is instead low (say 2%), real import growth is even lower (say 1%). The income elasticity is then greater than 1 when real GDP growth is high, and smaller than 1 when real GDP growth is low (respectively 5/4 and 1/2 in our simple example). Thus, in this example the income elasticity is procyclical.

While this intuitive example works well in a neighborhood of the trend growth rate of real imports and real GDP (provided that real GDP growth is not zero, a value at which the elasticity is not defined), in the whole domain of these variables the relationship between the income elasticity and the business cycle is more complex and necessitates a full-fledged model to be illustrated. Procyclicality, for example, does not hold across the full spectrum of growth rates. Yet, two results keep standing out also in the more general case: (1) business cycle conditions affect the level of the income elasticity; (2) high volatility and positive correlation of imports with GDP will, in particular, cyclically bring the elasticity to levels above its long-run trend.

To develop our argument, we proceed in three steps. In the first step, we consider a sample of 161 advanced and emerging economies and, using annual data from 1970 to 2015, we describe two sets of stylized facts. The former set includes the facts that we intend to explain; namely: the income elasticity is on average greater than 1 and positively correlated with the business cycle. While the fact that the income elasticity tends to be greater than 1 confirms the findings of previous literature (which we review in the next section), its positive correlation with the business cycle is for the first time documented in this paper. The latter set describes two standard features of open economies that are key to explain the former set: the growth rate of real imports is more volatile than that of real GDP and is positively correlated with the business cycle.

In the second step, we consider a simple theoretical model of international trade, based on Bems, Johnson and Yi (2013), with the purpose of deriving the main empirical implications about the level and cyclical properties of the income elasticity. We start by showing that, in the standard case in which all goods are tradeable (one-sector model), the income elasticity is not affected by the business cycle. In this context, it is greater (smaller) than 1 if and only if trade barriers decrease (increase), otherwise it is equal to 1. We then consider tradeable and non-tradeable goods (two-sector model) and assume, consistently with the facts discussed above, that the former are more volatile than, and correlated with, the latter. We prove two main results. First, if the trend growth rates of the volumes of tradeable and non-tradeable goods are nil, then the income elasticity is persistently greater than 1, even in the absence of a decline in trade barriers. Second, if tradeables and non-tradeables have instead a positive trend growth, then the income elasticity is affected by the cycle. In particular, the income elasticity is procyclical for both positive and negative growth rates of real GDP, even though not across the whole spectrum of growth rates, as it is not defined when real GDP growth is zero, while in the neighborhood of zero it approaches infinity.

In the last step, we analyze three main implications of the model, concerning: (i) the values taken by the income elasticity in the *cross-section* of countries; (ii) the behavior of the income elasticity of world trade *over time*; (iii) the accuracy of the *forecasts* about world trade growth. In particular, we first explain how the high volatility and procyclicality of real trade flows, together with the size of the non-tradeable-goods sector, contribute to determine cross-country differences in the income elasticity of trade. We then argue that failing to recognize the cyclicality of the income elasticity implies understating the role of the business cycle; by taking it into account, instead, we find that cyclical forces have given the main contribution to the unexpected weakness of trade in 2011-2015. We finally show that existing trade forecasts do not account for the cyclicality and, then, that their accuracy can be significantly improved by exploiting real-time data on business conditions.

The rest of the paper is organized as follows. Section 2 briefly reviews the literature. Section 3 presents the main stylized facts. Section 4 analyzes a simple theoretical framework. Section 5 discusses the implications of the model. Section 6 summarizes the main conclusions and offers some suggestions for future research.

2 Related literature

The study of the elasticities of trade to either prices or income has a long tradition in international economics, the classic example being the Marshall-Lerner condition. The existing literature, however, has focused exclusively on the *level* of the elasticities, while their *business cycle properties* have been generally overlooked. In a pioneering paper, for example, Houthakker and Magee (1969) estimated the value of the income elasticity of imports and exports for a number of economies, with the purpose of analyzing their differences across countries — a possible source of balance-of-payments problems in old-Keynesian approaches. Their empirical analysis documented that the income elasticity of imports was larger than 1 for essentially all the countries included in their sample, although with relevant cross-country differences.[8]

Previous studies have also analyzed the behavior of the income elasticity across very long time spans, relating them to the evolution of trade barriers, as reflected in changes either in tariff and non-tariff policies or in transportation costs. Irwin (2002), in particular, analyzed the income elasticity for the world economy since 1870, distinguishing three main phases: (i) in the pre-World War I era (1870-1913), characterized by very stable tariff rates (which were also very low in Western Europe), the elasticity

[8]Another classical reference is Hooper, Johnson and Marquez (2000), who updated Houthakker and Magee (1969) and provided an extensive analysis of income as well as price elasticities of imports and exports for the G-7 countries, using data from the mid-1950 to the mid-1990s.

tended to lie around 1; (*ii*) in the interwar era (1920-1938), the rise of protectionism and the introduction of foreign exchange restrictions brought the elasticity down, to levels close to zero; (*iii*) in the post-World War II era (1950-2000), when the GATT and the WTO encouraged a sustained reduction in trade barriers, the elasticity rose well above 1. Interestingly, a study by the World Bank (1987) with data going back to 1720 finds that the period in which the income elasticity reached its peak was between 1820 to 1870, when a sharp fall of freight costs occurred, favored by a wide diffusion of railways and steamships as well as by the wave of trade liberalizations that followed the Napoleonic wars. Our paper departs from these studies by analyzing the income elasticity at both the low and the business cycle frequencies.

Another strand of the literature related to our paper includes the studies focusing on the international real business cycle. The classic paper by Backus, Kehoe and Kydland (1995) documented the high volatility of imports (and exports) relative to that of GDP. Heathcote and Perri (2002) add to that finding the sharp procyclicality of trade flows. The paper that is closest to our own, however, is Engel and Wang (2011), in which the high volatility and the procyclicality of imports and exports (and their positive correlation) gain the spotlight. Their paper builds a model of international real business cycle that reproduces these features of the data, by introducing two different stochastic processes that generate technology shocks: a high-volatility process for durable consumption goods (which are assumed to be tradeable) and a low-volatility process for non-durable consumption goods (non-tradeable). It then simulates the model and analyzes its implications for the *price* elasticity of trade. Our approach is quite similar, as it assumes shocks with different volatility affecting tradeable and non-tradeable goods, but we build a much simpler model with the purpose of deriving an analytical expression for the *income* elasticity of trade.[9]

Our paper also contributes to the debate concerning the weakness of trade that first emerged during the global crisis of 2008-09 and then persisted during the subsequent economic recovery. Within this very extensive literature (briefly recalled in the previous section), the contributions that are most closely related to our own are those of Bems, Johnson and Yi (2013) and Eaton, Kortum, Neiman and Romalis (2016). The former work (from which we borrow the theoretical framework) relates the sharp fall of trade relative to GDP in 2008-09 to the composition of expenditure and, in particular, to the fact that the global recession saw an especially large decline in the production of highly-traded durable goods as opposed to that of lowly-traded services. The latter study builds an extremely rich framework by embedding a multi-sectoral general equilibrium model of trade into a multi-country real business cycle model. Their quan-

[9] The high volatility and procyclicality of trade flows could be generated not only by the different volatility of the processes generating durables and non-durables, as in Engel and Wang (2011), but also by inventory adjustment, as in Alessandria, Kaboski and Midrigan (2015), or simply by consumption smoothing, as trade is less intensive than GDP in consumption goods. In our paper, however, we focus only on the *consequences* of these two features, irrespectively of their underlying *causes*.

tification shows that a shock hitting efficiency in the durable-goods sector provided the major contribution to the fall of trade relative to GDP recorded in 2008-09. Our paper suggests that the same mechanisms are more generally at work also outside the single episode of the global recession. In other words, the higher volatility and the procyclicality of trade flows normally determine an income elasticity that varies along the business cycle. This cyclical component adds to the trend component, which is instead determined by changes in trade policies and transportation costs that occur at lower frequencies.

The different cyclical behavior of the various components of aggregate demand, together with their different import content, is also central to the analysis of Bussière, Callegari, Ghironi, Sestieri and Yamano (2013). These authors note that investment and exports, which are more procyclical, have a higher import content than consumption and government spending, which are less procyclical. As a result, by focusing on the Great Trade Collapse, these authors show that trade tends to fall more that GDP during recessions, a result which corresponds to a larger-than-unity income elasticity. In this paper we expand over this idea by showing that the different cyclicality of GDP and imports imply a cyclicality of the income elasticity. This is such that trade not only falls more than GDP during recessions, but increases more than GDP during strong expansions and increases less than GDP during weak expansions.

Our paper is also related to the empirical literature that uses Error Correction Models (ECMs) in order to estimate a long-run and a short-run income elasticity. In the context of international trade, however, ECMs are affected by two main problems. The first is that these models assume a stable long-run relationship between income and trade flows, whereas changing trade barriers would instead imply a time-varying long-run relationship. For this reason, recent papers such as Constantinescu, Mattoo and Ruta (2015) estimate ECMs over rolling 10-year windows. This solution partially addresses the problem affecting the long-run income elasticity, which, in facts, turns out to be similar to the trend elasticity that we derive from our model. It does not addresses, however, the second problem, which is the assumption of a constant short-run impact of income on trade flows. Our analysis shows, in fact, that the contemporaneous response of imports to income is cyclical – a result that cannot emerge by estimating a short-run elasticity over a 10-year rolling windows, a time-span during which cyclical effects are net out.

Finally, our analysis contributes to reconcile the findings of the recent literature, which documents the decline of the income elasticity in the current weak conjuncture, with those of Freund (2009), who instead shows that the income elasticity tends to be high in global downturns. Our results, in fact, demonstrate the non-linearity of the response of trade to GDP. In particular, income elasticity is high for large negative cyclical shocks, such as those that take place during strong recessions, as well as for positive shocks, and it is instead low for small negative shocks, such as when GDP growth is weak, but still positive.

3 Stylized facts

In this section we use annual data from the IMF in period 1970-2015, in order to document both the facts that we intend to explain and those that will serve as assumptions for the theoretical model.[10] We focus on two different groups of countries. One is the full sample of 161 advanced, emerging and developing economies, and includes annual data on GDP, investment and trade flows (all at constant prices). The other is a restricted sample of 35 OECD countries, for which available data on volumes are considered to be of better quality and for which we have performed robustness tests using, in addition to annual data, also quarterly data (until the fourth quarter of 2015).

We stress that the results presented in this section are extremely robust to the choice of the data source, the sample of countries, the time period, and the method used to retrieve volumes from values. Results are, in fact, confirmed using data from the World Bank for 148 countries starting in 1960 (World Bank, 2016) and data from the Penn World Table for 167 countries, which go back to 1950 and consider volumes evaluated at 2005 Geary-Khamis dollars (Feenstra, Inklaar and Timmer, 2015).[11]

3.1 Properties of the income elasticity

The income elasticity of trade is computed, for each country and year, as the ratio between the growth rates of import and GDP volumes. It is important to recall that the elasticity is not defined when the denominator is zero. Although real GDP growth is never exactly equal to zero, at the country level it is relatively close to this value in some years. The extreme values that the elasticity takes in those cases would strongly distort summary statistics. For example, in our sample the elasticity is between -10 and 10 for more than 90% of the observations. Yet, there are a few observations in which the elasticity is above $1,000$ (or below $-1,000$) which would completely distort standard descriptive statistics, such as the mean and the linear correlation. For this reason, we will focus on *robust statistics*, such as the median and the rank correlation.[12]

Table 1 reports the median values of the income elasticity for the restricted sample of OECD countries (first column). The elasticity is larger than 1 for all the countries

[10] We use data from the April 2016 release of the World Economic Outlook (WEO), which go back to 1980 and which we extend back to 1970 using an older release of the WEO (May 2003).

[11] Versions of the tables 1 and 2 presented in this section and obtained using these two alternative data sources are available from the authors upon request.

[12] As an alternative, we also consider standard statistics after cleaning the dataset for the presence of outliers. An important consequence of the presence of large outliers is that the positive correlation between the income elasticity and the business cycle that we find using robust statistics does not emerge as neatly when one focuses only on Pearson's standard linear correlation. This is probably the reason why, despite the long tradition of studies on the income elasticity of trade, its relationship with the business cycle has been overlooked in the previous literature.

and its cross-country average is 2.1, the same value as the cross-country median.[13] We obtain very similar statistics by using other methods to deal with the outliers. In particular, we find a cross-country average elasticity close to 2 also if we restrict the analysis to the income elasticities computed only when the growth rate of GDP is outside the interval $[-0.5, 0.5]$ as well as if we exclude the observations for which the absolute value of the income elasticity is larger than 10.

The statistics concerning the full sample are consistent with these findings, although elasticities turn out to be somewhat lower — an issue on which we return in Section 5. The average of the median elasticities across all countries is 1.5 (just like the cross-country median) and over 70% of the economies show a median income elasticity above 1. In addition, different methods for dealing with the outliers provide similar results.

We now turn to the relationship between the income elasticity and the business cycle. This question entails an additional problem, besides that of dealing with the outliers, which is the identification of an appropriate cyclical indicator. The growth rate of GDP is, in fact, the denominator of the elasticity and, therefore, its increase entails, *ceteris paribus*, a decrease of the elasticity, inducing a negative correlation. In principle, one would like to analyze the cyclicality by considering the correlation of the elasticity with the technology or demand shocks that drive the business cycle. Alternatively, one can resort to the variables that are known to be mostly affected by these shocks. The sharp procyclicality of import volumes unveiled in the international business cycle literature, for example, suggests that imports themselves are a candidate variable to represent the cycle. By calculating the correlation between the income elasticity and the growth rate of real imports, however, we would face the opposite problem: the latter is the numerator of the income elasticity and its increase determines, *ceteris paribus*, an increase in the elasticity, inducing a positive correlation. For this reason, we use the growth rate of real investment as the main cyclical indicator.

Table 1 reports, for the restricted sample of OECD countries, the correlation of the income elasticity with the growth rate of real GDP, investment and imports, as measured by Spearman's rank correlation, a robust statistics (second to fourth column). The correlation with the growth rate of GDP is, not surprisingly, negative for half of the countries. At the other extreme there is the correlation with the growth rate of real imports, which is positive for all the countries. The correlation with the growth rate of real investment, which is unaffected by the problems discussed above, is positive for 80% of the countries, with an average level of about 20%.

Analogously, for the full sample the correlation with the growth rate of real investment is 22% and is positive for 84% of the countries. The latter is an intermediate value between the 61% of countries that have a positive correlation with the growth rate of real GDP and the 98% of countries that have a positive correlation with the

[13] To be precise, the reported values are the average of the country medians and the median of the country medians.

Table 1: Income elasticity: main facts

OECD countries:	Median	Correlation with the growth rate of: GDP	Investment	Imports
Australia	2.5	8.1	35.6	69.5
Austria	2.2	-21.5	8.5	55.9
Belgium	2.5	-23.6	-5.3	23.0
Canada	2.2	-15.6	0.0	35.9
Chile	2.1	-7.0	14.2	35.2
Czech Republic	2.4	29.6	27.5	56.4
Denmark	1.7	35.8	30.7	68.2
Estonia	2.0	-1.9	5.0	37.7
Finland	1.7	32.2	14.1	58.2
France	2.7	-24.2	-6.3	22.9
Germany	2.2	-0.6	9.2	46.2
Greece	1.7	21.6	47.2	49.3
Hungary	2.3	27.9	42.4	60.6
Iceland	1.8	-0.5	42.1	42.9
Ireland	1.7	5.9	16.1	50.2
Israel	1.2	30.9	47.3	78.8
Italy	2.9	9.2	12.9	47.3
Japan	2.2	9.6	6.6	43.4
Korea	1.6	-0.9	13.0	63.2
Latvia	1.4	19.7	57.8	19.2
Luxembourg	1.5	-4.3	14.4	33.6
Mexico	3.1	-4.4	9.7	34.5
Netherlands	2.0	-9.0	5.9	36.2
New Zealand	1.9	1.7	27.5	60.6
Norway	1.6	-36.6	27.2	51.7
Poland	2.0	35.4	49.3	51.5
Portugal	2.7	2.9	21.8	45.5
Slovak Republic	2.3	-51.7	-0.7	30.7
Slovenia	2.2	5.5	15.9	64.0
Spain	3.0	-11.9	-2.7	29.6
Sweden	1.8	15.0	34.1	39.8
Switzerland	2.0	-12.6	-0.4	49.5
Turkey	2.2	16.3	28.0	59.0
United Kingdom	2.2	-42.7	-14.8	32.9
United States	2.1	10.2	13.8	52.8
Summary statistics: OECD countries				
Mean	2.1	1.4	18.5	46.7
Median	2.1	1.7	14.2	47.3
Min	1.2	-51.7	-14.8	19.2
Max	3.1	35.8	57.8	78.8
% >0	100	51	80	100
% >1	100	-	-	-
Summary statistics: full sample (161 countries)				
Mean	1.5	4.6	20.3	53.9
Median	1.5	5.6	21.8	55.6
Min	-0.3	-57.1	-71.4	-7.5
Max	3.5	61.5	66.7	97.3
% >0	99	61	84	98
% >1	74	-	-	-

Source: authors' calculations on IMF annual data from 1970 to 2015.

growth rate of real imports.

3.2 Some features of open economies

Table 2 describes some standard characteristics of import flows, unveiled by the literature on the international business cycle, which are confirmed in our sample. For the restricted sample of OECD countries the growth rate of real imports is, in the cross-country average, 3 times more volatile than that of real GDP (first column). The higher volatility of imports holds for about 90% the countries in our sample. Real imports have a volatility broadly comparable to that of real investment: the standard deviation of the latter (second column) is, in the cross-country average, 2.6 times higher than that of GDP (third column).

If we turn to the full sample we find that the growth rate of real imports is, in the cross-country average, 3.6 times more volatile than that of real GDP, while real investment are 4.3 times more volatile. For more than 90% of the countries real imports are more volatile than real GDP, about the same percentage as for real investment.

The second half of Table 2 focuses on the correlations that, consistently with those of Table 1, are still computed referring to the growth rates of the relevant variables. As the presence of outliers is minimal for growth rates (as opposed to elasticities), we report both the linear and the rank correlation (measured, respectively, by Pearson's and Spearman's coefficients).

For the OECD countries, the correlation between the volumes of imports and GDP is equal to over 60% in the cross-country average (fourth and fifth column of Table 2), slightly lower than the correlation between investment and GDP (over 70%; sixth and seventh column). The correlation between the volumes of imports and GDP is, in particular, positive for essentially all countries (97% when measured by the Pearson coefficient and 100% when measured by the Spearman coefficient), similarly to what is observed for the correlation between investment and GDP volumes. Table 2 also reports, for completeness, the linear and rank correlation between real imports and real investment, which are close to 70% for the average of OECD countries and are positive for virtually all of them (last two columns).

The full sample shows that the correlation between the volumes of imports and GDP is equal to over 40% for the cross-country median (with both Pearson's and Spearman's coefficients), somewhat lower than the over 50% recorded for the correlation between investment and GDP volumes (again with both measures). The former is, however, positive for about 90% of the countries in the sample.

Table 2: Features of import, investment and GDP volumes

	Standard deviation relative to that of GDP		Standard deviation of GDP	Correlations:					
				Imports-GDP		Investment-GDP		Imports-Investment	
OECD countries:	Imports	Investment		lin.	rank	lin.	rank	lin.	rank
Australia	4.9	3.8	0.02	62.7	57.1	79.4	76.6	78.2	73.2
Austria	3.3	2.5	0.02	62.9	52.1	51.9	57.8	62.0	50.4
Belgium	2.8	3.8	0.01	85.2	80.4	74.1	71.6	69.4	69.8
Canada	3.1	2.7	0.02	80.1	73.7	76.7	64.6	69.9	57.9
Chile	0.9	1.0	0.16	29.3	81.9	55.9	70.7	78.5	78.0
Czech Republic	2.5	2.0	0.03	78.8	81.1	88.6	90.2	68.3	69.5
Denmark	2.6	3.6	0.02	76.7	62.9	82.3	78.6	69.1	63.4
Estonia	2.2	2.7	0.06	78.2	67.0	84.3	75.9	81.1	72.0
Finland	2.0	2.7	0.03	83.6	76.0	64.4	74.6	66.6	72.2
France	1.3	1.9	0.04	56.7	72.8	96.8	81.0	63.8	76.3
Germany	0.6	1.2	0.08	17.8	72.5	97.4	86.6	32.0	70.3
Greece	2.3	3.1	0.04	67.7	60.0	85.7	82.5	73.1	74.0
Hungary	2.6	1.9	0.03	60.2	57.9	66.2	64.7	60.0	61.5
Iceland	3.3	4.8	0.03	60.3	58.8	63.6	58.1	90.1	90.6
Ireland	1.8	2.7	0.04	78.7	80.8	79.9	81.2	66.7	69.0
Israel	3.1	4.3	0.02	65.7	71.1	52.2	66.2	62.1	68.7
Italy	3.3	2.4	0.02	82.0	79.8	85.6	80.0	79.5	66.8
Japan	2.9	1.9	0.03	65.4	50.6	90.3	82.2	71.9	61.7
Korea	2.3	1.8	0.06	84.0	70.4	82.3	83.6	82.1	71.3
Latvia	2.2	2.8	0.07	28.2	22.0	70.9	50.5	50.8	54.7
Luxembourg	1.7	3.3	0.03	65.1	62.9	53.1	46.6	42.3	44.1
Mexico	0.2	0.1	0.90	76.3	79.6	89.1	85.5	87.4	81.3
Netherlands	2.2	2.6	0.02	77.4	72.9	74.3	65.2	67.2	63.4
New Zealand	3.3	3.8	0.02	63.1	59.8	78.9	81.2	73.5	68.6
Norway	2.8	3.6	0.02	55.4	48.1	41.2	40.8	59.1	61.6
Poland	20.1	2.0	0.04	-65.9	14.7	73.5	78.9	-23.9	29.2
Portugal	2.9	3.0	0.03	83.4	80.2	87.0	90.3	84.7	83.2
Slovak Republic	2.7	3.3	0.03	66.1	53.1	60.7	47.5	69.7	67.8
Slovenia	2.4	2.9	0.03	87.5	69.6	84.3	73.8	78.4	68.5
Spain	3.6	3.0	0.02	85.1	81.1	92.5	90.8	88.2	81.6
Sweden	2.5	2.6	0.02	59.7	54.6	71.9	64.2	74.5	70.1
Switzerland	2.9	2.3	0.02	55.4	61.9	78.6	78.0	50.5	54.6
Turkey	3.7	3.1	0.04	78.4	75.5	88.8	85.6	74.7	73.4
United Kingdom	0.6	1.7	0.08	48.5	59.0	97.6	57.8	54.3	61.2
United States	1.4	1.6	0.05	37.3	78.2	91.0	89.1	62.5	75.0
Summary statistics: OECD countries									
Mean	3.0	2.6	0.06	62.2	65.1	76.9	72.9	66.2	67.3
Median	2.6	2.7	0.03	65.7	69.6	79.4	76.6	69.4	69.0
Min	0.2	0.1	0.01	-65.9	14.7	41.2	40.8	-23.9	29.2
Max	20.1	4.8	0.90	87.5	81.9	97.6	90.8	90.1	90.6
% >0	100	100	100	97	100	100	100	97	100
% >1	89	94	-	-	-	-	-	-	-
Summary statistics: full sample (161 countries)									
Mean	3.6	4.3	0.09	42.7	44.1	53.0	52.5	54.3	53.7
Median	2.9	3.3	0.05	42.2	43.3	58.9	55.9	61.6	57.9
Min	0.1	0.1	0.01	-65.9	-47.8	-33.1	-18.7	-79.0	-60.0
Max	20.1	51.4	1.33	97.7	92.7	99.2	95.5	93.8	93.8
% >0	100	100	100	89	96	93	97	97	98
% >1	90	92	-	-	-	-	-	-	-

Source: authors' calculationson IMF annual data from 1970 to 2015.

4 A simple theoretical framework

In this section, we present two variants of a simple theoretical model, based on Bems, Johnson and Yi (2013). We first consider a one-sector model in which all goods are tradeables. In this model, a prototype for traditional studies on international trade, the value of the income elasticity can differ from 1 only to the extent that the trade-to-income ratio grows or falls, for example as a result of decreasing or increasing trade barriers. We then extend the previous model to include the non-tradeable-goods sector. This extensions shows that the higher volatility of imports with respect to GDP and their procyclicality cause the income elasticity to be higher than 1 even in the absence of any long-run trend in trade flows and income (and, therefore, in the trade-to-income ratio). Moreover, if trade flows and income have a positive long-run trend — and irrespectively of whether this trend is common or not (i.e. irrespectively of any trend in the trade-to-income ratio) — then the value taken by the income elasticity depends on business cycle conditions.

4.1 One-sector model

Let us assume that the volume of goods imported from the source country i by the destination country n at time t, $m_{in,t}$, takes the CES form:

$$m_{in,t} = \left(\frac{\tau_{in,t} \cdot p_{i,t}}{P_{n,t}} \right)^{-\sigma} D_{n,t} \ , \tag{1}$$

where $\tau_{in,t} \geq 1$ is the iceberg cost of delivering one unit of good from country i to country n at time t, $p_{i,t}$ is the factory-gate price of the goods produced in country i at time t, $P_{n,t}$ is the aggregate price level of country n, $D_{n,t}$ is the real aggregate expenditure of country n, and $\sigma > 0$ is the elasticity of substitution between different goods. We assume that trade is balanced, so that income and expenditure coincide and there are no transfers between countries. By taking log-variations, equation (1) becomes:

$$\hat{m}_{in,t} = -\sigma \cdot \hat{\tau}_{in,t} - \sigma \cdot \left(\hat{p}_{i,t} - \hat{P}_{n,t} \right) + \hat{D}_{n,t} \ . \tag{2}$$

The income elasticity of country n at time t, $\eta_{n,t}$, is defined as the ratio between the percentage change of its imports and the percentage change of its aggregate income. Using a log approximation, we can write:

$$\eta_{n,t} \equiv \frac{\hat{m}_{in,t}}{\hat{D}_{n,t}} = 1 - \sigma \frac{\hat{\tau}_{in,t}}{\hat{D}_{n,t}} - \sigma \frac{\left(\hat{p}_{i,t} - \hat{P}_{n,t} \right)}{\hat{D}_{n,t}} \ , \text{ for } \hat{D}_{n,t} \neq 0 \ , \tag{3}$$

where the condition $\hat{D}_{n,t} \neq 0$ grants that the elasticity exists and is finite.

Equation (3) provides two interesting insights about the income elasticity. First, it shows that, in a steady state in which trade barriers and relative prices are constant, the income elasticity is equal to 1: in other words, changes in aggregate income always translate into proportional changes in imports. Second, although the level of trade barriers does not affect the trade elasticity, changes in trade barriers do. Thus, by ignoring all the short run fluctuations of relative prices (i.e. $\hat{p}_{i,t} = \hat{P}_{n,t}$) and by assuming a positive trend for the aggregate income ($\hat{D}_{n,t} > 0$), equation (3) shows that a trade liberalization and/or a decline in transportation costs ($\hat{\tau}_{in,t} < 0$) will add a positive wedge to the income elasticity ($-\sigma\hat{\tau}_{in,t}/\hat{D}_{n,t} > 0$). Clearly, this positive effect fades out when the liberalization process stalls and turns negative in the case, for example, of a resurgence of trade protectionism.

4.2 Two-sector model

Absent changes in trade costs and relative prices, the one-sector model returns a unitary income elasticity, because changes in aggregate demand translate one-to-one into changes in imports. Key to this result is the fact that the composition of income does not matter. In reality, however, the composition of income differs from the composition of imports in one important respect: trade flows are much more intensive in manufacturing goods (from the point of view of the supply composition) and capital goods (demand composition).[14] As the output of manufacturing goods and capital goods is, in turn, much more volatile than the output of non-manufacturing goods and consumption goods, it turns out that imports are more volatile than GDP, as documented in the previous section.

In order to assess how the different composition of trade flows and GDP affect the income elasticity, the benchmark one-sector model is then extended to incorporate also the non-tradeable goods sector, with preferences across goods taking a nested CES form. We assume that the goods of sector M are tradeable and those of sector S are non-tradeable and, for the sake of simplicity, we refer to the former as manufacturing goods and to the latter as services.

As in Bems, Johnson and Yi (2013), for each sector $j \in \{M, S\}$ of country n, the demand for domestic and foreign goods, $d_{nn,t}(j)$ and $d_{in,t}(j)$, are aggregated to form a composite sector-level good, denoted by $d_{n,t}(j)$. These sector-level goods $d_{n,t}(M)$ and $d_{n,t}(S)$, in turn, can be further aggregated into a composite final good, denoted by $D_{n,t}$.

We focus only on the effects of the different demand composition by making two additional simplifying assumptions: (i) within each sector, changes in demand across domestic and foreign varieties are symmetric (i.e. $\hat{d}_{nn,t}(j) = \hat{d}_{in,t}(j)$); (ii) trade costs and relative prices are constant.

[14] See Eaton and Kortum (2001), Levchenko, Lewis and Tesar (2010), Engel and Wang (2011), Bussière, Callegari, Ghironi, Sestieri and Yamano (2013), and Constantinescu, Mattoo and Ruta (2015).

In this framework, the income elasticity of country n becomes:

$$\eta_{n,t} \equiv \frac{\hat{d}_{n,t}(M)}{\hat{D}_{n,t}} = \frac{\hat{d}_{n,t}(M)}{\omega_{n,t}(M) \cdot \hat{d}_{n,t}(M) + \omega_{n,t}(S) \cdot \hat{d}_{n,t}(S)} \text{ , for } \hat{D}_{n,t} \neq 0 \text{ ,} \tag{4}$$

where $\hat{d}_{n,t}(j)$ is the log-change of the demand for the goods of sector j for country n at time t, $\omega_{n,t}(j) \in [0,1]$ is the weight of sector j on the total expenditure of country n at time t (where $\omega_{n,t}(M) = 1 - \omega_{n,t}(S)$).

Equation (4) shows that, in general, the income elasticity is no longer equal to 1, unless manufacturing goods and services change in exactly the same way at any time t. We now use this equation to analyze what happens to the income elasticity, when we add in specific hypotheses about the procyclicality, the volatility and the trend growth rates of the volumes of manufacturing goods and services.

Let us start from assuming that there is no long-run trend in the growth of manufacturing goods and services and that the two sectors differ only in the volatility of their output, which is higher for the former sector. In addition, to keep things as simple as possible, we assume that shocks are perfectly correlated across the two sectors. Hence, if we let ε_t be the shock hitting the economy at time t, we assume that:

$$\begin{cases} \hat{d}_{n,t}(M) = \beta \cdot \varepsilon_t \\ \hat{d}_{n,t}(S) = \varepsilon_t \end{cases} \quad ,$$

where $\beta \geq 1$ reflects the higher volatility of the demand for tradeable goods. The income elasticity then becomes:

$$\eta_{n,t} = \frac{\beta}{\beta - \omega_{n,t}(S) \cdot (\beta - 1)} \text{ , for } \varepsilon_t \neq 0 \text{ ,} \tag{5}$$

where the condition $\varepsilon_t \neq 0$ is necessary to ensure that income growth is not nil and that the elasticity is properly defined.

Despite its simplicity, equation (5) yields three important implications. First, it shows that the income elasticity depends not only on the trend growth of imports relative to GDP, but also on the relative volatility of these two variables. In particular, if output in the manufacturing sector is more volatile than output in the services sector (which implies that imports are more volatile than GDP), then the income elasticity is greater than 1 (i.e. $\eta_{n,t} > 1 \Leftrightarrow \beta > 1$). Second, the larger is the difference in volatility between the two sectors, the higher is the elasticity (i.e. $\eta_{n,t}$ is increasing in β). Third, a larger share of non-tradeables in final demand yields a larger income elasticity (i.e. $\eta_{n,t}$ increasing in $\omega_{n,t}(S)$).

The intuition behind the last result is that the dynamics of imports and income differ along the business cycle because of the presence of low-volatility non-tradeable goods. If imports and income, instead, converge — for example because the weight of tradeable goods tends to 1 or because its volatility tends to that of services — then the elasticity returns to 1. Notice, in fact, that the income elasticity is 1 when there are no services ($\omega_{n,t}(S) = 0$ and $\omega_{n,t}(M) = 1$, assumptions that bring the model back to one-sector) or when manufacturing goods and services have the same volatility ($\beta = 1$).

We now introduce a long-run trend growth for the two sectors and, for the sake of simplicity, we assume that this is the same for both sectors, so that the trade-to-income ratio is stable over time. Hence, we set:

$$\begin{cases} \hat{d}_{n,t}(M) = g + \beta \cdot \varepsilon_t \\ \hat{d}_{n,t}(S) = g + \varepsilon_t \end{cases},$$

where $g \geq 0$ is the long-run trend growth.

Under these assumptions the elasticity becomes:

$$\eta_{n,t} = \frac{g + \beta \cdot \varepsilon_t}{g + [\beta - \omega_{n,t}(S) \cdot (\beta - 1)] \cdot \varepsilon_t} \text{ , for } \varepsilon_t \neq \bar{\varepsilon}_t \text{ ,} \tag{6}$$

where $\bar{\varepsilon}_t = -g/\left[\beta - \omega_{n,t}(S) \cdot (\beta - 1)\right]$.

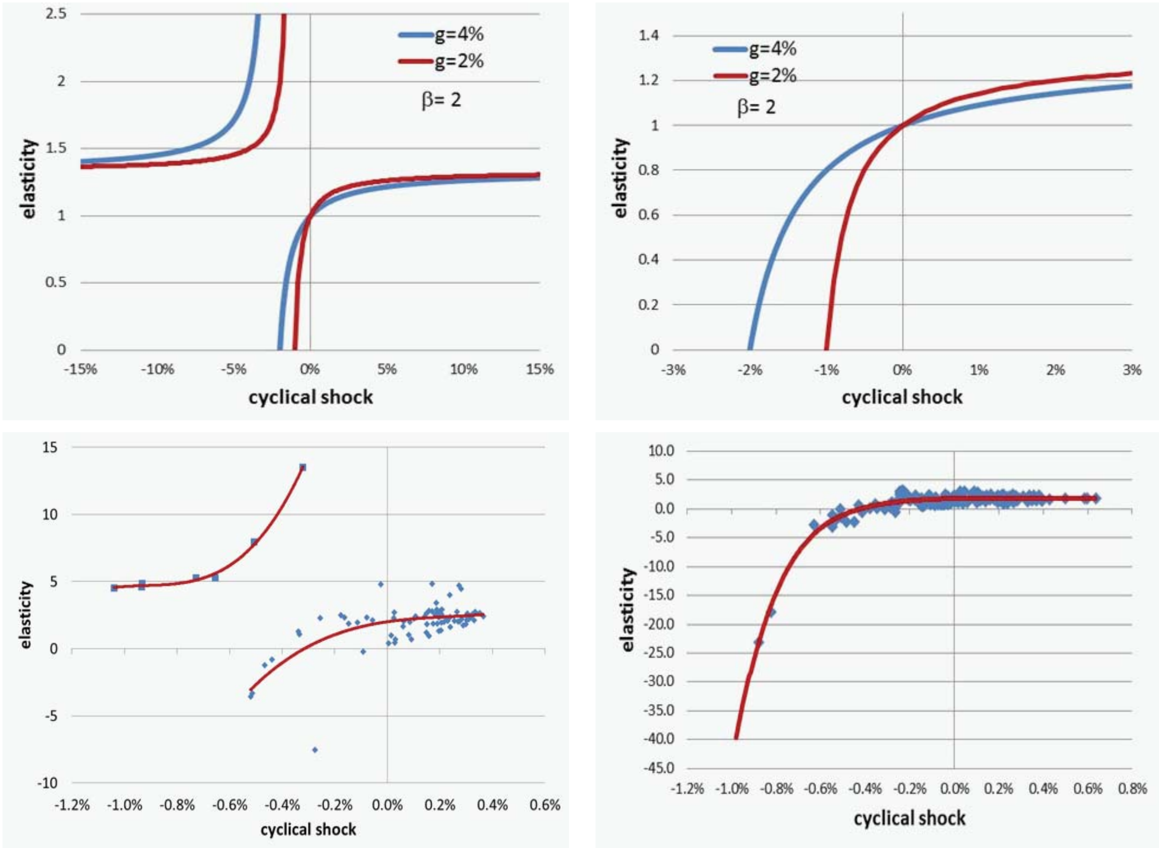
The north-west panel of Figure 2 shows the behavior of $\eta_{n,t}$ from equation (6) as a function of ε_t, for $g = 2\%$ and $g = 4\%$ and with $\beta = 2$. The most important finding is that $\eta_{n,t}$ now depends on ε_t. For $\varepsilon_t = \bar{\varepsilon}_t$ the elasticity is not defined and, in a neighborhood of this value, it takes very high values (for $\varepsilon_t < \bar{\varepsilon}_t$) or very low values (for $\varepsilon_t > \bar{\varepsilon}_t$). Notice that the elasticity is procyclical both in $(-\infty, \bar{\varepsilon}_t)$ and in $(\bar{\varepsilon}_t, +\infty)$, as it is increasing in ε_t in those two intervals, but it is not procyclical across the whole domain of the cyclical shock. Similarly, notice that the elasticity is greater than 1 over almost the entire domain of the cyclical shock, except that in the right neighborhood of $\bar{\varepsilon}_t$ (that is for $\varepsilon_t \in (\bar{\varepsilon}_t, 0]$). At $\varepsilon_t = 0$, in particular, the elasticity is equal to one; more precisely, absent the cyclical shock the elasticity only depends on the relative trend growth of manufacturing and services, which we have assumed to be equal to 1.

It is worth examining the north-west panel of Figure 2 also to understand, in light of equations (5) and (6), what happens when the common trend growth rate of manufacturing and services converges to zero. As g goes to zero, the two branches of the hyperbole get closer, the vertical asymptote eventually wanes and the function becomes an horizontal line, set at the value given by equation (5). In other words, absent the trend in the volumes of manufacturing and services, the cyclicality disappears and the elasticity stabilizes at a constant level, which is larger than 1. Thus, the presence of a positive trend growth in volumes is necessary for the cyclicality of the elasticity, just like the procyclicality of imports and their high volatility.

The north-east panel of Figure 2 zooms on values of the cyclical shock larger that -2%. This is a realistic lower bound for the world economy: the lowest value in our sample for world GDP growth is, in fact, -1%. In this branch of the hyperbole, to higher values of ε_t, which determine higher GDP growth, correspond greater values of the income elasticity. In other words, $\eta_{n,t}$ tends to be procyclical.

Figure 2 provides also a first visual comparison between the implications of the

Figure 2: Income elasticity and cyclical shocks: the model and the data (1)



(1) The north-west and north-east panel show the values of $\eta_{n,t}$ (vertical axes) from equation (6), for different values of ε_t (horizontal axes), for g =2%(red line) and g =4%(blue line), with β=2. The south-west (south-east) panel shows, for the U.S. (world economy), real GDP growth (horizontal axes). The south-east panel excludes a single outlier (2008-Q4), when the estimated cyclical shock was -1% and the elasticity was 109. Source: our elaborations on IMF data and simulated data.

model (that are in the upper half of the figure) and the data (lower half).[15] The south-west panel shows for the Unites States — the world's largest economy — the behavior of the income elasticity with respect to the cyclical component of real GDP growth.[16] Despite the restrictive assumptions made in the theoretical framework, the two arms of the hyperbole that are apparent in U.S. data match quite well those of the model simulations. Similarly, the south-east panel shows the behavior of the income elasticity

[15] Appendix A tests another prediction of the model concerning the fact that the cyclicality of the income elasticity emerges when imports and GDP have a positive long-run trend growth. Results show that this prediction is confirmed by the data.

[16] The cyclical component of real GDP growth is derived by applying an HP filter on quarterly data. We defer to Section 5, where we produce further analysis on quarterly data, the description of the details on the filtering procedure.

with respect to the cyclical component of real GDP growth for the world economy. Again, the match between the model simulations and the data emerges neatly.

The expression of $\eta_{n,t}$ remains similar to equation (6) even if we relax the assumption of equal trends for the demand of tradeable and non-tradeable goods. Given a long-rung growth rate equal to g_m for tradeables and to g_s for non tradeables, it is easy to obtain:

$$\eta_{n,t} = \frac{g_m + \beta \cdot \varepsilon_t}{g_m + \omega_{n,t}(S)(g_s - g_m) + [\beta - \omega_{n,t}(S) \cdot (\beta - 1)] \cdot \varepsilon_t}$$
$$\text{for} \quad \varepsilon_t \neq -\frac{[g_m + \omega_{n,t}(S)(g_s - g_m)]}{[\beta - \omega_{n,t}(S) \cdot (\beta - 1)]} \ .$$

As expected, the income elasticity is relatively lower whenever $g_s > g_m$. This condition is often met in developing countries, as they move from middle- to high-income groups and experience a structural transformation which favors the consumption and production of non-tradeables. As we will see in Section 5.1, this difference in trend growth rates could be one of the reasons for the cross-country differences in the elasticity documented in Table 1 (as well as in many other previous contributions).

5 Some empirical implications

In this section we focus on the implications of the model about three important questions. We first analyze *cross-country* differences in the income elasticity, focusing on the role played by the size of the non-tradeable-goods sector. We then turn to the world economy and study the behavior *over time* of the income elasticity, in order to provide an interpretation of the recent weakness of global trade. Last, we examine whether it is possible to improve well-known *forecasts* about trade growth (those provided by the IMF) using information about business conditions.

5.1 Cross-country differences

Almost 50 years ago, in their pioneering contribution, Houthakker and Magee (1969) noted that advanced economies tended to have higher income elasticities than emerging economies.[17] Do those differences persist today? And, in case, what factors determine them? The empirical and theoretical results of the previous two sections provide some new insights about these important questions.

Let us start by splitting the full sample of 161 countries between advanced economies (37 countries) and non-advanced economies (124): the average elasticity is 1.9 for the former group and 1.4 for the latter. Similarly, the median elasticity is 2.0

[17] See, in particular, Table 3 in Houthakker and Magee (1969).

for the advanced countries and 1.3 for the remaining countries. Thus, the differences between the two groups of economies seem to persist today.

In the previous literature, differences in income elasticities between advanced and non-advanced economies could only be explained by cross-country heterogeneities either in the trend growth of imports relative to GDP or in the composition of imports between, for example, primary and non-primary goods. Our theoretical section offers, instead, some interesting insights about other possible causes for these differences. For example, the degree of volatility of imports and the extent of their procyclicality are two candidate variables. Here, however, we focus on the peculiar role played by the size of the non-tradeable goods sector, which exerts two distinct effects on the income elasticity.

The first, discussed above, suggests that countries with a larger non-tradeable-goods sector have, *ceteris paribus*, a greater elasticity, because this is the sector that, due to the lower volatility of its output, makes imports differ from GDP. This "static effect" is contrasted by a "dynamic effect", which has the opposite sign: countries in which the size of the tradeable goods sector rises (i.e. the non-tradeable-goods sector shrinks) are also countries in which imports tend to increase relative to GDP, raising the income elasticity. Thus, to a *larger* non-tradeable-goods sector should correspond a *greater* elasticity (static effect), but a *growing* non-tradeable goods sector should *reduce* the elasticity (dynamic effect).

To shed some further light on these two effects, Table 3 presents the result of two exercises. For different sizes of the non-tradeable-goods sector reported in the first column, the second column shows the values of the income elasticity, assuming that the trend growth rates of imports and GDP are both nil. Consistently with equation (5), to a smaller size of the non-tradeable-goods sector corresponds a lower income elasticity. The third column assumes, instead, a positive trend growth in the tradeable goods sector, equal to 4.8% per year, a value which is 1.4 percentage points higher than the one set for GDP growth, and reports the values of the income elasticity as the size of the non-tradeable-goods sector decreases due to the difference in the two growth rates. Notice that, as the weight of the non-tradeable-goods sector on GDP shrinks, the income elasticity still declines, but, with respect to the static case, the effect is very much attenuated.

To empirically check whether the size of the non-tradeable-goods sector contributes to determine the income elasticity in our extended sample of countries, we approximate the former with the size of the services sector (i.e. with its share in GDP). We then run a simple regression, with the income elasticity as a dependent variable and the share of services as independent variable. Results show that the coefficient has the expected positive sign and is significant at the 5% threshold (with a p-value of 1.4%).

Table 3: Income elasticity and size of the non-tradeable-goods sector

Share of non-tradeables in GDP	Mean elasticity: static effect	Mean elasticity: dynamic effect
99%	4.81	1.30
95%	4.17	1.28
90%	3.57	1.26
85%	3.13	1.24
80%	2.78	1.22

(1) Values of the income elasticity for different weights of the non-tradeable goods sector. In the second column it is assumed a nil trend growth in both the non-tradeable goods sector and in GDP (static effect). In the third column the weight of the non-tradeable goods sector declines (dynamic effect), as a result of a trend growth in the tradeable-goods sector higher than that in GDP (4.8% against 3.4% per year).

5.2 The dynamics of global trade

The theoretical and empirical results of the previous sections indicate that the behavior of the income elasticity over time is affected by business cycle conditions as well as by the trend growth of imports relative to GDP. We now attempt to disentangle the role played by these two factors, focusing on the recent weakness of global trade.

For this purpose, we consider quarterly data on real imports and real GDP for the world economy from the first quarter of 1971 to the second quarter of 2016 and set up the following procedure.[18] We first use an HP filter to retrieve the trend, the cycle and the noise component separately for imports and GDP.[19] Note that we consider, together with the standard trend and cycle component, also a noise component, due to the measurement error that typically affects import and export data. This error is such that these two variables, which should always coincide at the world level, often display significant differences in the data, even though these differences usually cancel out over time.[20]

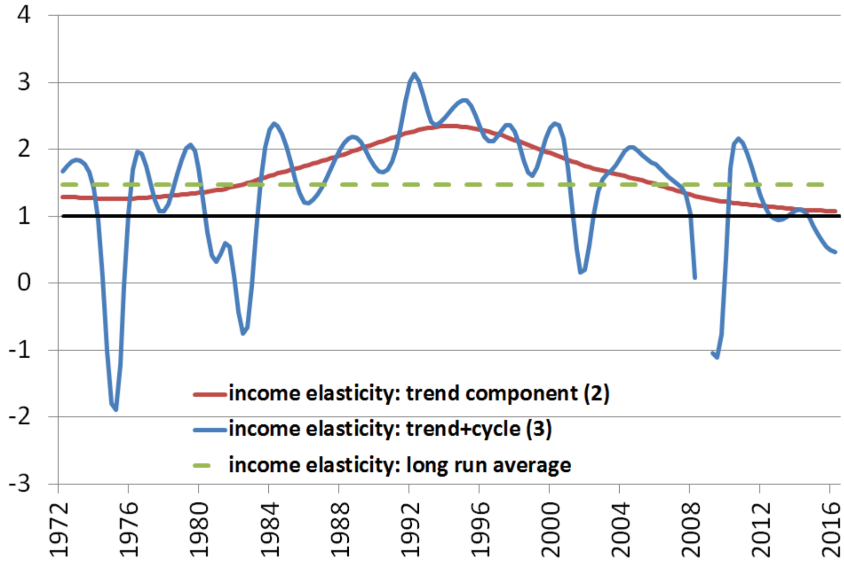
We then construct two quarterly series: (i) a "trend component" of the income elasticity, by dividing the growth rate of the trend component of real imports by the growth rate of the trend component of real GDP; (ii) a "trend-plus-cycle" component of the income elasticity, as the ratio between the sums of the growth rates of the trend and the cycle components of real imports at the numerator, and the sums of growth

[18]Quarterly data are from the National Institute of Economic and Social Research (NIESR) and, since 1995, from ECB (2016).

[19]More specifically, we use the HP filter in two stages. In the first stage we extract the trend component of real imports and real GDP by using a multiplier $\lambda = 16,000$. In the second stage we separate the cycle component from a noise component, using a multiplier $\lambda = 10$.

[20]Footnote 3 provides further details on this issue.

Figure 3: Decomposition of the income elasticity of world trade (1)



(1) Quarterly data, 4-quarter moving averages. The picture excludes three consecutive out-liers, from 2008-Q4 to 2009-Q2. (2) Trend component of the income elasticity from HP ltered series. (3) "Trend+cycle" component of the income elasticity from HP ltered series. Source: our elaborations on NIESR and ECB data.

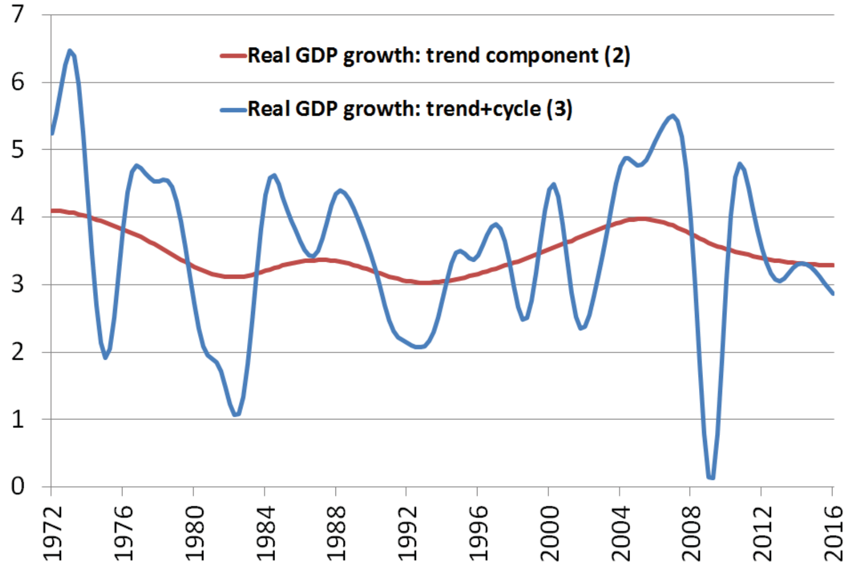
rates of the trend and the cycle components of real GDP at the denominator.[21] We do not filter directly the income elasticity because the model suggests that its long-run trend and cyclicality are not "genuine", but are just the by-product of the long-run trend and cyclicality of imports and GDP.

The theoretical model suggests that the trend component of the income elasticity should be related to trade barriers and that, absent changes in their levels, it should converge to an equilibrium value of 1. Figure 3 shows that this component of the income elasticity (red line), which had gradually risen until the second half of 1990s, is now returning towards its equilibrium level. This behavior is presumably due to the fact that the secular decline of tariffs, information and transportation costs that has supported global trade until the late 1990s is currently fading. The cyclical component — which is conveniently added to the trend component in Figure 3 (blue line) — is instead related to strength of business conditions. Our results then show that also this component is currently contributing to depress trade, bringing the income elasticity below 1.

The reason why also the cyclical component has contributed negatively to global trade is clarified in Figure 4. World real GDP growth, which has been on a downward trend since the outset of the global recession (red line), is currently running below its trend (blue line), weakening the income elasticity due to the mechanisms described in

[21] We take a log approximation to measure growth rates, in order to preserve additivity; see Appendix A for the details.

Figure 4: Decomposition of world real GDP growth (1)



(1) Percentage points, quarterly data, 4-quarter moving averages. (2) Trend component of world GDP growth from HP filtered series. (3) "Trend+cycle" component of world GDP growth from HP filtered series. Source: our elaborations on NIESR and ECB data.

the previous sections.

These results allow us not only to assess the relative importance of cyclical and structural factors in determining the recent weakness of global trade, but also to provide some ground in order to speculate about its future. In particular, Figure 3 suggests that, with respect to its historical average of 1.5 (in our sample period), the income elasticity has been reduced by 0.4 points by structural forces and by further 0.4 points by cyclical forces, down to 0.7 in the average of 2015.[22] Thus, structural and cyclical factors have contributed to a similar extent to the recent weakness of international trade *relative to GDP*. But given that lower-than-expected GDP growth has also contributed directly to the forecast error for about one-third (see footnote 3), this simple back-of-the-envelope calculation suggests that cyclical forces have caused about two thirds of the forecast error. Figure 3 also shows that the trend component of the income elasticity appears to be stabilizing at 1, a value around which it could lie for some time, until new impetus comes from further trade liberalizations or from technological progress in transportations.[23] Nevertheless, the exceptional weakness of global trade observed since 2011, which has gradually brought the income elasticity below 1, is also the result of lackluster business conditions. Therefore, one should expect that, as real GDP growth returns to its trend, global trade growth recovers more strongly, with the

[22] In the first two quarters of 2016, the elasticity has slipped further, to 0.5, whereas the trend component has remained at 1.1.

[23] For the key role, in particular, of technological progress in the transport sector for the dynamics of international trade, see Estevadeordal, Frantz and Taylor (2003).

income elasticity first returning towards 1 and then, presumably, exceeding this value, once that real GDP goes above its own trend growth.

5.3 Forecasting trade

Our analysis on the dynamics of the income elasticity has led us to speculate about the future of global trade in the medium-long term, but what about the very short term? Can we exploit real-time information about business conditions to improve existing trade forecasts? We now examine these questions focusing on the forecasts about world import growth formulated by the IMF, undoubtedly the most used in the business community and among policy makers.[24]

The IMF provides data on the actual growth rate of imports and GDP at time t ($g_{M,t}$ and $g_{Y,t}$, respectively) and the predicted values of these variables ($g^p_{M,t}$ and $g^p_{Y,t}$). The forecast error on import growth, $\varepsilon^p_{M,t} = g^p_{M,t} - g_{M,t}$, can be decomposed into a forecast error on GDP growth, $\varepsilon^p_{Y,t} = g^p_{Y,t} - g_{Y,t}$, and a forecast error on the income elasticity, $\varepsilon^p_{\eta,t} = \eta^p_t - \eta_t$, where $\eta_t = g_{M,t}/g_{Y,t}$ and $\eta^p_t = g^p_{M,t}/g^p_{Y,t}$; namely:

$$\varepsilon^p_{M,t} = \varepsilon^p_{Y,t} \cdot \eta^*_t + \varepsilon^p_{\eta,t} \cdot g^*_{Y,t} \ ,$$

where $\eta^*_t = (\eta^p_t + \eta_t)/2$ and $g^*_{Y,t} = \left(g^p_{Y,t} + g_{Y,t}\right)/2$.

The total mean squared forecast error on import growth (*Total MSFE*) can then be written as:

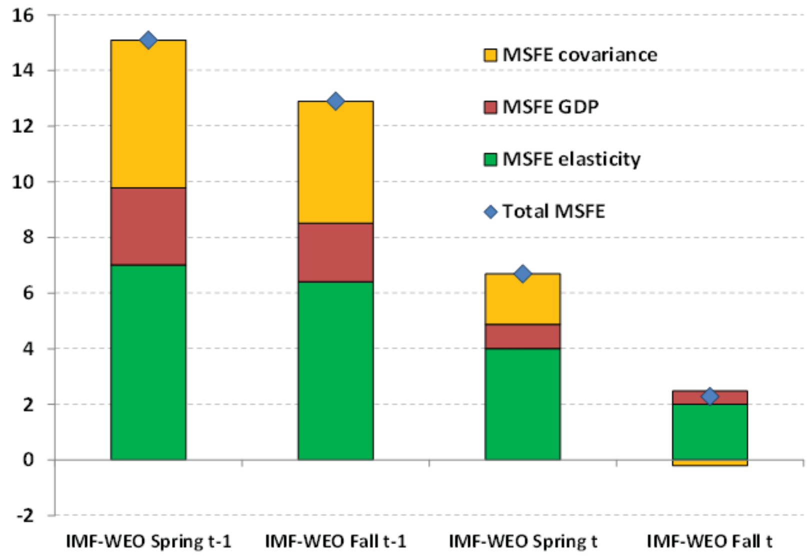
$$\frac{\sum_{t=1}^{T}\left(\varepsilon^p_{M,t}\right)^2}{T} = \frac{\sum_{t=1}^{T}\left(\varepsilon^p_{Y,t}\cdot\eta^*_t\right)^2}{T} + \frac{\sum_{t=1}^{T}\left(\varepsilon^p_{\eta,t}\cdot g^*_{Y,t}\right)^2}{T} + \frac{2\sum_{t=1}^{T}\varepsilon^p_{Y,t}\cdot\varepsilon^p_{\eta,t}\cdot g^*_{Y,t}\cdot\eta^*_t}{T} \ , \tag{7}$$

where T is the number of years for which actual data and forecasts are available (the period 1986-2015 in our sample). Equation (7) thus shows that the mean squared forecast error on import growth can be decomposed into three terms that measure the importance of: the forecast error on GDP growth (first addendum, *MSFE GDP*), the forecast error on the income elasticity (second addendum, *MSFE elasticity*), and the interaction between these two errors (third addendum, *MSFE covariance*).

The IMF provides, for each calendar year t, four main forecasts on world real import growth and world real GDP growth: one is published in the spring of year $t-1$ (usually in mid-April), one in the fall of year $t-1$ (usually in mid-October), the other two in the spring and fall of year t. We can therefore apply the decomposition (7) to these four different forecast series. Figure 5 plots the results. Three main findings are apparent. The first is that the forecast error on the income elasticity (the green

[24] Focusing on global trade has another important advantage: because world import growth has generally been positive in the post-war period, observations will be distributed only on the right branch of the hyperbole (see fig. 2), in which the relationship between the income elasticity and the cyclical shock is monotonic. We can therefore avoid using more complex non-linear estimations.

Figure 5: Mean squared forecast error on world import growth and its components (1)



(1) Decomposition of the total mean squared forecast error on world import growth from equation (7). Source: our elaborations on IMF data.

shaded area) is the largest component at all forecast horizons. The second is that, not surprisingly, the mean squared forecast error declines as the forecast horizon shortens (from spring $t-1$ to fall t). The third is that, as the forecast horizon shortens, the IMF seems to improve significantly its forecasts on world real GDP growth, but not its forecast on the income elasticity. Compare, in particular, the mean squared forecast error for the fall of $t-1$ with that for the spring and fall of year t: as more information becomes available, the forecast error on world real GDP growth abates, while the forecast error on the income elasticity does not decline substantially, remaining the only sizeable component.

Given these results, it is worth analyzing whether the IMF forecasts about the income elasticity take into account information about the business cycle and, in case they do not, whether we can attack this key component of the forecast error by using such information. We focus, in particular, on the forecasts on world import growth in year t, produced in the spring and the fall of year t, which are those for which the forecast error on the income elasticity remains sizeable. We first perform a preliminary test by running the following regression:

$$\eta_t = \alpha + \beta \cdot \eta_t^p + \gamma \cdot cycle_t + \xi_t \ , \tag{8}$$

where η_t is the actual elasticity, α, β and γ are constant, $cycle_t$ is a proxy for the cyclical shock (i.e. the variable denoted with ε_t in the theoretical model) and ξ_t is an error term. A first proxy for the cyclical shock is to use $cycle_t^1 = g_{Y,t} - g_{Y,t-1}$, a

Table 4: Income elasticity: correcting the forecasts for the cycle (1)

			$cycle^1$		$cycle^2$		$cycle^3$	
	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
α	0.684*	0.478*	0.655**	0.651***	0.695**	0.66***	0.504*	0.526*
	(0.358)	(0.253)	(0.286)	(0.236)	(0.303)	(0.235)	(0.267)	(0.21)
β	0.563***	0.693***	0.559***	0.576***	0.541***	0.585***	0.776***	0.682***
	(0.199)	(0.14)	(0.159)	(0.133)	(0.169)	(0.13)	(0.153)	(0.116)
γ			0.246***	0.164**	0.283***	0.183***	0.729***	0.705***
			(0.061)	(0.06)	(0.083)	(0.065)	(0.151)	(0.192)
Adjusted R^2	0.20	0.46	0.48	0.56	0.42	0.57	0.57	0.63
# of obs.	29	29	29	29	29	29	28	29

(1) OLS estimates of equation (8), for different proxies of the cyclical shock $cycle_t$. Standard errors in parenthesis.

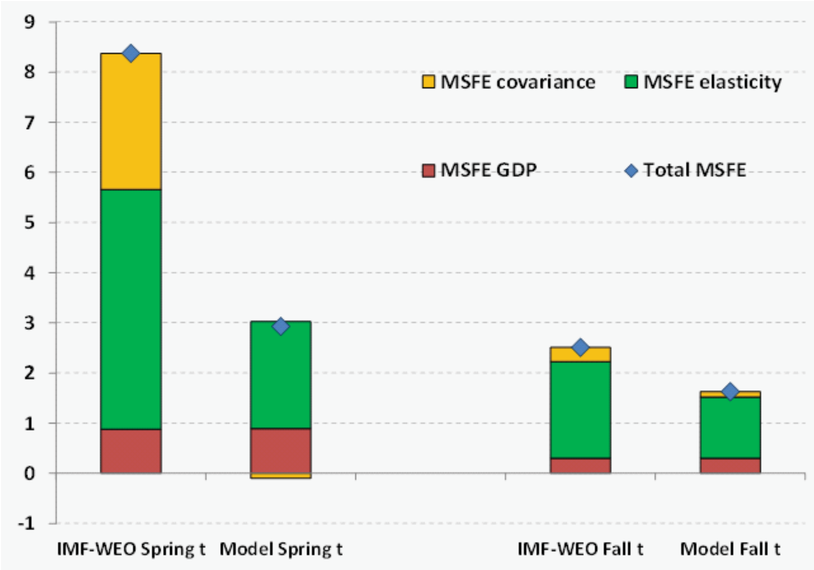
measure that, however, would not be available in real time.[25] An alternative proxy, which is instead available in real time, is to use the corresponding predicted values, that is $cycle_t^2 = g_{Y,t}^p - g_{Y,t-1}^p$. A final "momentum" proxy is to use the difference between the most recently formulated forecasts, that is: $cycle_t^3 = g_{Y,t}^p - g_{Y,t}^{p-1}$, where $g_{Y,t}^p$ is the "current forecast" for $g_{Y,t}$ and $g_{Y,t}^{p-1}$ is the forecast for the same variable formulated in the preceding forecasting exercise. Notice that if the IMF forecasts already take into account business cycle conditions, than we should expect $\gamma = 0$; if, instead, they do not incorporate information about the business cycle and if the prediction of the theoretical model is correct, then we should expect $\gamma > 0$.

Table 4 reports the result of different estimates of equation (8), relative to the forecasts produced in the spring and the fall of year t. The first two columns suggests that the IMF provides unbiased forecasts of the income elasticity, as a joint test verifying the null that $\alpha = 0$ *and* $\beta = 1$ fails to reject this hypothesis. The last six columns indicate that information about business cycle conditions is generally neglected: the estimate of γ is always significant and with the expected positive sign, with all the proxies used for the cyclical shock. Using, in particular, $cycle_t^3$ as a measure of the cyclical shock returns a high and strongly significant estimated coefficient (above 0.70, for both the spring and the fall forecasts) and the largest goodness of fit: the adjusted R-squared is around 60% for both the spring and the fall forecasts against, respectively, 0.20 and 0.46 using only the IMF forecasts.

These encouraging preliminary results warrant an attempt to improve the IMF forecast on world import growth. In particular, we perform an out-of-sample exercise in the following way. Given that the estimates of equation (8) do not reject a joint test

[25] Actual real world GDP growth for the current year, $g_{Y,t}$ is not available at any forecast horizon; actual real world GDP growth for the previous year, $g_{Y,t-1}$, is not available in the forecasts formulated on the spring and fall of year $t-1$, while in the spring of year t there is available only as a very preliminary estimate.

Figure 6: Comparison between forecast errors: IMF vs. model predictions (1)



(1) Total mean squared forecast error on world import growth in year t (and its components from equation (7)) for the predictions made by the IMF in the spring and fall of year t and for the corresponding predictions from the model (10). Source: our elaborations on IMF data.

of $\alpha = 0$ and $\beta = 1$, we first run the following regression on a 12-year rolling window:

$$\eta_t = \eta_t^p + \gamma \cdot \left(g_{Y,t}^p - g_{Y,t}^{p-1}\right) + \xi_t \ . \tag{9}$$

We then make the following out-of-sample prediction for the growth rate of world imports:

$$g_{M,t}^* = g_{Y,t}^p \cdot \left[\eta_t^p + \hat{\gamma} \cdot \left(g_{Y,t}^p - g_{Y,t}^{p-1}\right)\right] \ , \tag{10}$$

in which $\hat{\gamma}$ is the OLS estimate of γ from equation (9); our first (last) forecast $g_{M,t}^*$ is produced for the year 1998 (2015), where $\hat{\gamma}$ is estimated using data for the period 1986-1997 (2003-2014).

Figure 6 compares the mean squared forecast error computed using the predictions of the IMF ($g_{M,t}^p$) and using the model predictions ($g_{M,t}^*$, from equation (10)). The results show that, by using $g_{M,t}^*$, the forecast error declines substantially with respect to using $g_{M,t}^p$. For the forecasts produced in the spring, the total MSFE is cut by 70%, with the half of the reduction coming from the improvement in predicting the elasticity and half from the lower covariance between the error on the elasticity and the error on GDP. For the fall forecasts, the total MSFE is cut by 40%, with the reduction coming almost entirely from the improvement in predicting the elasticity. The effectiveness of our correction for the business cycle is reflected in the fact that, for both forecast series, the covariance between the error on the elasticity and the error on GDP becomes essentially nil.

Finally, to assess the statistical significance of the improvement, we can apply the encompassing test of Hendry and Clements (2004) and run the following regression:

$$g_{M,t} = a + b \cdot g^{p}_{M,t} + (1 - b) \cdot g^{*}_{M,t} + \upsilon_t \ ,$$

where a and b are constant and υ_t is an error term. We perform these estimates for the forecasts produced in both the spring and the fall of year t. The OLS estimates of the coefficients show that b is not statistically different from zero (its point estimates are -0.1 for the spring and 0.1 for the fall forecasts, with a p-value of 0.58 and 0.75, respectively), indicating that our cycle-corrected forecasts encompass the IMF original predictions.[26] These results then confirm that the accuracy of existing forecasts can be improved by using information about business conditions.

6 Conclusion

This paper has shown that the income elasticity of trade is affected by business cycle conditions. In particular, in a neighborhood of the long-run growth rate of real imports and real GDP, the elasticity tends to be lower when business conditions are weak. A similar prediction arises for both positive rates of real GDP growth and, separately, for negative rates, although not across the full spectrum of growth rates. This overlooked property of the income elasticity, which emerges when trade volumes and real GDP have a positive trend growth, is the result of two standard features of trade flows: their high volatility and their procyclicality.

Our analysis also provides an interpretation of the recent weakness of international trade. By computing a trend and a cycle component of the income elasticity, as suggested by the theory, results show that the former has been decreasing towards 1, most likely because the secular decline of trade barriers has been gradually fading away in the last 15 years. At the same time, however, the weakness of global trade observed since 2011, which has brought the income elasticity substantially below 1, is also the result of lackluster business conditions.

By focusing on a simple theoretical framework, we have been able to derive a useful analytical expression for the income elasticity. We have, however, neglected the role of changes in relative prices as well as the precise sources of the cyclical shocks (whether, for example, they hit preferences or technologies). This is consistent with the target of our analysis: changes in the income elasticity of trade at yearly or quarterly frequency, which take place, then, before a full adjustment of prices. Thus, further research would be needed to prove that the cyclicality of the income elasticity carries over also in a full-fledged general equilibrium setting.

[26] OLS estimates also show that a is not statistically different from zero (its point estimates are 0.0 for the spring and 0.4 for the fall forecasts, with a p-value of 0.92 and 0.40, respectively), suggesting that estimates are unbiased.

Future research is also needed for a more extensive analysis about the causes of the cross-country disparities observed in the income elasticity. While we have provided suggestive evidence about the key role played by the size of the non-tradeable goods sector, any in-depth empirical study should also consider more traditional factors, such as the trend growth of imports relative to GDP and the composition of trade flows, as well as other factors identified in this paper — such as the degree of volatility of imports and the extent of their procyclicality.

Appendix

A A test on the cyclicality of the elasticity

One important implication of the theoretical model is that the cyclicality of the income elasticity emerges when import and GDP volumes have a positive trend growth, but it is not necessarily present when their trend growth is nil.[27] We can test this implication on a restricted sample of 38 countries, for which we have quarterly data on real imports and real GDP from the first quarter of 1995 to the fourth quarter of 2015.[28]

We apply to each country the same type of filtering described in Section 5; namely, we retrieve the trend, the cycle and the noise component separately for real imports and for real GDP.[29] Then we compute, for each country, two quarterly series: (i) a "cycle component" of the income elasticity, by dividing the growth rate of the cycle component of real imports by the growth rate of the cycle component of real GDP; (ii) a "trend-plus-cycle" component, as the ratio between the sums of growth rates of the trend and the cycle components of real imports at the numerator and the sums of growth rates of the trend and the cycle components of real GDP at the denominator.

The rationale for this methodology is the following. It is assumed that the total imports of country n at time t are given by the product of the different components, that is: $I_{n,t} = I_{n,t}^T \cdot I_{n,t}^C \cdot I_{n,t}^N$, where the superscripts T, C and N denote, respectively, trend, cycle and noise. By taking a log-approximation, the growth rate of imports can then be written as:

$$\Delta \ln I_{n,t} = \Delta \ln I_{n,t}^T + \Delta \ln I_{n,t}^C + \Delta \ln I_{n,t}^N \ .$$

By making the same assumptions for the GDP of country n at time t, denoted by $Y_{n,t}$, the trend, cycle and "trend+cycle" component of the income elasticity can be written, respectively, as:

$$\eta_{n,t}^T = \frac{\Delta \ln I_{n,t}^T}{\Delta \ln Y_{n,t}^T},\ \eta_{n,t}^C = \frac{\Delta \ln I_{n,t}^C}{\Delta \ln Y_{n,t}^C},\ \eta_{n,t}^{TC} = \frac{\Delta \ln I_{n,t}^T + \Delta \ln I_{n,t}^C}{\Delta \ln I_{n,t}^T + \Delta \ln I_{n,t}^C} \ .$$

For each country, we can now consider the correlation between the cycle component of imports — our preferred indicator for the business conditions — and the

[27] The assumption that the positive trend growth rates of imports and GDP are identical is not necessary: it is easy to check that the income elasticity would be affected by business cycle conditions even if the two trend growth rates were different.

[28] This is the set of countries considered by the ECB (2016), for its macroeconomic projections.

[29] The same discrepancies between import and export data that are present at the world level and that have induced us to compute a noise component (in addition to the trend and the cycle) are also present at the country level, as shown by the well-known discrepancies between bilateral import and bilateral export data.

Table 5: Correlations of the cycle component of the income elasticity with different components of the growth rate of imports (1)

A. Rank correlation

	trend+cycle	cycle
% > 0.25	92	38
% > 0.33	92	18
% > 0.50	82	3
% > 0.66	59	0
% > 0.75	44	0

B. Linear correlation

	trend+cycle	cycle
% > 0.25	79	5
% > 0.33	72	5
% > 0.50	46	0
% > 0.66	31	0
% > 0.75	21	0

(1) Correlations of the cycle component of the income elasticity with different components of imports, indicated in the first row, from HP filtered series. The table shows the percentage of countries with correlations higher than those reported in the first column.

corresponding component of the income elasticity. As both imports and GDP data have been cleared by any noise, we can consider both the linear and the rank correlations. The theory suggests that, if there is no trend growth in imports and GDP, the income elasticity and business conditions are not necessarily correlated. Table 5 shows, in fact, that the cycle component of the income elasticity and the cycle component of imports are only weekly correlated (despite the latter being the numerator of the former): only 38% of the countries have a rank correlation that is significantly different from zero (i.e., given the size of our sample, above 25%); similarly, using Pearson's coefficient, we find that only 5% of the countries have a linear correlation significantly different from zero. The theory also suggests that correlation between the income elasticity and business conditions should instead emerge when there is a positive trend growth in imports and GDP. In fact, when we consider both the trend and the cycle components of imports, the rank and linear correlation with the cycle component of the income elasticity are significantly larger than zero for 92% and 79% of the countries, confirming the prediction of the model.

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