DISEI - Università degli Studi di Firenze

Working Papers - Economics

International competitiveness and investment: simulations with a bilateral trade model

R. Bardazzi and L. Ghezzi

Working Paper N. 01/2017

DISEI, Università degli Studi di Firenze
Via delle Pandette 9, 50127 Firenze, Italia
www.disei.unifi.it

International competitiveness and investment: simulations with a bilateral trade model

Rossella Bardazzi (University of Florence)
Department of Economics and Management
University of Florence
Via delle Pandette 21, 50127, Florence (Italy)
phone +39-055-2759492
rossella.bardazzi@unifi.it

Leonardo Ghezzi (IRPET)
Regional Institute of Economic Planning of Tuscany
Via Pietro Dazzi, 1, 50141, Florence (Italy)
pphone +39-055-4591228
leonardo.ghezzi@irpet.it

Abstract

The Eurozone crisis has exposed several weaknesses of the European Monetary Union economies. Slow productivity growth and competitiveness losses on international markets have been growing since the beginning of the 2000s and became evident during the recent downturn. A policy action to increase capital stock accumulation through investment could generate a double dividend: increasing domestic demand and stimulating the competitive position of European economies on international markets. This paper aims to assess the impact of an expansionary capital stock policy on the external competitiveness of EU. The analysis employs a Bilateral Trade Model built at INFORUM with several distinguishing characteristics: a comprehensive bilateral dataset, econometric estimation of key parameters, and emphasis on sectoral details. Our findings show that a capital stock increase is effective in enhancing EU trade shares although differences between sectors and markets are significant in two key destinations of European commodity exports: China and the US.

Keywords: Bilateral trade, multisectoral modelling, EU competitiveness, policy simulation

JEL CODES: F14, C51, C55

Acknowledgments

We like to thank Dr. Douglas E. Nyhus (INFORUM) for his generous assistance on previous versions of the BTM. His experience has been invaluable for the work presented here. We also benefited from the help and encouragement of Dr. Douglas S. Meade (INFORUM) who has supported this project since the beginning. The usual disclaimers apply.

Introduction

The share of European economies in total world trade has been declining since the late 1990s. This loss of market share partly reflects a decline in price competitiveness against other advanced competitors but it has mainly been to the benefit of emerging cost-competitive economies, especially those in Asia. The recent crisis seems to have accelerated this shift, with the sharp drop in global exports that occurred in 2008-2009 – the Great Trade collapse (Bems et al., 2013) – amplifying pre-crisis weaknesses, particularly in some sectors where competition from China intensified. However, important differences in export performance across European countries have been observed due to differences in sectoral specialisation and market destination. These differences have been accompanied by additional macroeconomic divergences and imbalances and long-term economic growth stagnation. After a double-dip recession there is still high uncertainty about the prospects for recovery, the rebalancing process between countries is not yet complete, and wide disparities in economic performances persist. Therefore, policy actions to foster economic growth and reduce disequilibria are strongly needed. One legacy of the crisis – in addition to unemployment, increasing social inequalities and high levels of public and private indebtedness – is certainly low investment. Beyond the temporary cyclical impact related to weak demand, weak investment hampers long-run potential growth, limits innovation and technological change, and has a negative effect on productivity. In the medium run, an Investment Plan for Europe, such as that proposed by the European Commission, accompanied by the deployment of national resources and other funds at the EU level (OECD, 2016a), could play a crucial role in fostering economic growth.

In this paper, we aim to investigate the impact of a policy that increases the capital stock in European countries. Our empirical analysis is focused on the effects on external competitiveness that could change the trend of market share losses and help European exporters to recover their competitive role in international markets. Since in the present situation domestic demand in Europe is only performing very modestly, economic growth should still be mainly export-led and it is of interest to find evidence about the effectiveness of an increase in capital stock in improving the technological content and the quality of European exports and therefore in increasing trade shares. To explore this issue empirically, a trade model is needed that represents the linkages among the main players in international markets at the bilateral level. We use a Bilateral Trade Model (BTM) to simulate the effects of increasing the capital stock and to quantify how the import shares of European countries and their competitors respond to this stimulus sector by sector. The main features of the BTM are (i) a dataset of bilateral trade flows, (ii) a detailed disaggregation of commodity classifications, (iii) econometric estimation of import shares, and (iv) a system linking national multi-sectoral models. A high level of disaggregation of trade flows is particularly useful to fully capture the complex interrelations between economies, to investigate issues of international competitiveness, and to simulate the detailed aspects of trade policies which are often tailored to specific commodity categories. Unlike other multi-country models where trade shares are exogenously assumed, either with parameters drawn from the existing literature or with exogenous hypotheses, in the BTM import shares are endogenous and estimated econometrically as a function of a set of explanatory variables at the commodity level. Finally, the BTM system linking national models enables understanding of the transmission channels of shocks via international trade to detailed industries at the national level, with country models designed so that they mirror the specific characteristics of the national economic systems.

The results of our simulations show that in general the loss of external competitiveness in Europe could be effectively recovered through capital stock deepening and a consequent increase in productivity improving the price competitiveness of exports. However, the impact on trade shares differs according to the commodity group and to the destination market.

The paper is organized as follows. In Section 1, some stylized facts regarding macroeconomic imbalances in Europe and difficulties concerning slow economic recovery and investment gaps are described. The Bilateral Trade Model and the data used are presented in Section 2 and the results of the trade share estimations are also summarized. The simulation scenarios for our empirical analysis are explained in Section 3. Finally, the simulation results are presented in Section 4 and some conclusions are drawn in Section 5.

1. Macroeconomic imbalances and slow growth in the Eurozone: some stylized facts

The Eurozone crisis triggered by the 2008 global financial downturn exposed several macroeconomic imbalances that had accumulated in member states in the first period of EMU. Beside public finance difficulties, current account imbalances within the European countries and internal competitiveness losses coincided with a reduction in the export market shares of goods and services in the international markets. A divergence of current account balances was observed, with core European countries in surplus and periphery countries showing growing deficits. Current-account imbalances resulted in corresponding changes in net international asset positions, with growing liabilities accumulated in peripheral countries financed by the two main lenders, Germany and the Netherlands (EC, 2015a). Therefore, the structural imbalances intensified, with the central European economies relying more and more on tradable commodities and the peripheral countries dominated by construction and non-tradable activities. International capital started to flow to finance these growing imbalances. These dynamics were thought to be part of the natural real convergence within a monetary union: the peripheral European nations had abundant investment opportunities, good prospects for future growth, but low savings. Therefore, they were attracting investors from savings-rich northern Eurozone countries where capital faced diminishing returns (Blanchard and Giavazzi, 2002; Lane and Pels, 2012).

It is widely agreed that since the creation of the European Union growth patterns have been very different in the different countries, mainly being influenced by competitiveness. It is frequently claimed that the problems of southern Europe, beside the high levels of public debt, are caused by insufficient productivity growth. Indeed, competitiveness issues have often been held responsible for the internal imbalances between member states and for the ongoing debt crisis (Barbosa and Alves, 2011; De Grauwe, 2012; Salvatore, 2015). Others argue that competitiveness losses in southern Europe were caused by the expansion of internal demand financed by capital inflows, thus being a symptom rather than an additional cause of imbalances (Gros, 2012).

The overall picture is that the non-tradable sector has been driving unit labour cost developments in the member states which have lost competitiveness relative to the Euro area, while low wage developments in the tradable sector in northern Europe have improved competitiveness. European Monetary Union has caused a significant change in relative factor prices for many countries because wage developments have broadly converged to the price stability objective of the European Central Bank, while nominal interest rates have come down, especially in southern European countries, where the low credibility of previous monetary policy led to high-risk premiums in financial markets. This effect is much less pronounced in the northern member states. In Germany, Finland and the Netherlands, labour productivity, average capital efficiency and total factor productivity have largely evolved in synchrony. Thus, if competitiveness was gained or lost in these countries, it was due to wage developments. However, in Italy, France, Ireland, Portugal and Spain the deterioration in competitiveness has been strongly correlated with the reduction in capital efficiency since the monetary union started. In Italy, Spain and Portugal, and to a lesser extent in France, labour productivity has effectively been stagnant for more than a decade. These countries suffered major wage increases and high inflation with domestic export companies being put at a competitive disadvantage and trade shares lost. At the same time, the increase in liabilities did not correspond to the building up of export capacities. Bayoumi *et al.* (2011) suggest that the intra-euro exports of peripheral countries suffered more from these competitiveness losses as the estimated price elasticities were at least double those of extra-euro exports.

A structural divergence took place and the economic structures of the member states became increasingly different (Marelli, 2007). Mongelli, Reinhold and Papadopoulos (2016) find evidence at the macro and micro levels of increasing country specialization in the euro area (especially in manufacturing, where the degree of specialisation is more than double that of the average economy). This process started before the launch of the euro and continued until 2008, when the financial crisis seemed to reverse it. However, heterogeneity across countries and sectors is also evident: one group of countries (Austria, Belgium, Germany and Portugal) became more specialised compared to the EA12 while another group (Finland, the Netherlands, Luxembourg, Ireland, Italy and Spain) was gradually moving towards the EA's production structure. A deeper trade integration within EMU partially explains the increasing structural diversification to pursue comparative advantages and economies of scale.

With the crisis, capital started flowing in the opposite direction, with a sudden stop of cross-border lending and rising risk premiums (Baldwin *et al.* 2015). The correction of current account imbalances was accompanied by a reduction in domestic demand in the peripheral countries and by a re-composition of production towards tradable activities rather than the construction and financial sectors. The current account imbalances between the member states narrowed, and most of the countries which used to run deficits before the crisis are now close to balance or in surplus. Conversely, the current account surpluses in the creditor countries remain large. In Germany, the surplus is currently the largest at the world level in value terms (EC, 2015a). On the other hand, competitiveness is still an issue in some peripheral member states.

The Great Recession and then the Euro sovereign debt crisis hit all the final demand components, but, while private consumption recovered and in 2014 was roughly at the same level as in 2007, average total investment in the euro area is still more than 10 per cent below previous levels, with a more serious situation in the distressed countries (Figure 1). The weakness of investment is broad-based and affects all sectors, not only the construction and real estate sectors. Although both equipment and construction investment accelerated at the end of 2015, its growth is expected to remain modest due to lower growth outside the EU, which will reduce export growth. Moreover, aggregate demand in the Euro area is also expected to grow slowly and these expectations mitigate the very favourable financing conditions (EC, 2016a).

Figure 1 – Real gross fixed capital formation and private consumption (index 2007=100)

Note: Peripheral countries include Greece, Ireland, Italy, Portugal and Spain
Source: AMECO

Deleveraging by households and non-financial corporations is the main reason behind this global evidence, but in the Eurozone additional factors must be taken into account. The dim prospects for economic growth, the high level of uncertainty, and the reduction in public investment due to public budget constraints are seriously affecting capital formation (Buti and Mohl, 2014).

1.1. Investment for more growth: the transmission channel of international trade

Several measures, including structural reforms in labour and product markets, a sound fiscal stance and the completion of the banking union, are needed to address this capital shortfall in the European economies.[1] However, the overall picture explains the rationale behind the investment plan designed by the European Commission (EC, 2014) as a policy response for strengthened growth. Indeed, the weakness of investment not only implies high economic costs in the short term but it also hampers potential economic growth in the long run.

Lewis et al. (2014) estimate that investment gaps are large in most OECD countries, not only compared to pre-crisis levels but also relative to potential future steady-state levels, with a gap of two or more GDP percentage points. They suggest that a recovery of investment could be boosted not only by increasing demand using macroeconomic policies – through the accelerator effect – but also by undertaking structural reforms of product market regulations and corporate taxation and by upgrading or replacing ageing infrastructure through public investment.

On the other hand, van Ark (2015) focuses on a shift from physical to knowledge-based capital, such as ICT and innovative property and work-place reorganisation, to revive long-term productivity growth in the EU countries. The European Commission's Investment Plan – the so-called Juncker plan – aims to overcome the difficulties of private investment projects by relieving them of part of the financial risk through co-financing from the EFSI (European Fund for Strategic Investments) (Claeys, 2015). Although the effectiveness of the plan could be questioned (Le Moigne, et al., 2016) in terms of its timing (too late) and the amount of resources (too little), there is no doubt that in a situation of weak aggregate demand a revival of public and private investment has the short-term effect of stimulating demand and the long-run effect of increasing potential growth. Moreover, by affecting economic growth in Europe as a whole, increased private and public investment should help to regain market shares in the international arena. In particular, the European Commission (2015b) and others (DIW, 2013, 2016; OECD, 2016b) advocate stronger investment demand in countries, such as Germany, with fiscal space, a large account surplus or low deleveraging pressures. Increasing demand in a leading European economy would not only benefit domestic growth but also generate positive spillovers in neighbouring countries (Simonazzi et al., 2013). Because of the trade linkages between member states, this policy action would contribute to rebalancing the asymmetries within the EU and to make recovery more self-sustaining. International trade plays a crucial role in the transmission of effects following an increase in investment and a build-up of capital stock. The spillover effects of demand between countries could amplify the initial stimulus and act as an international multiplier. This is the transmission channel that we explore in this analysis by using a bilateral trade model to estimate the effects on the bilateral trade shares of alternative policy scenarios in European countries.

2. The INFORUM international system of models

International models linking several economies through trade flows have greatly developed in recent decades. However, building and maintaining international multi-country models is still a daunting task

[1] The Commission has set out an approach based on three pillars: structural reforms, fiscal responsibility and investment (EC, 2015b).

and so only a small number of these models are still maintained and used for simulation and forecasting.

A first system linking national models was designed at INFORUM (Interindustry Forecasting at the University of Maryland) at the end of the 1970s. The main purpose of this project developed at the University of Maryland was to build a model of international trade featuring adequate commodity detail for national multi-sectoral econometric models to be linked (Nyhus, 1991). As Almon (1991) explains, country models built according to the INFORUM approach share the use of input-output tables as the main core data, a common accounting structure (given by dual pair of Leontief equations) and a common software that facilitates linkage with similar models of other countries. However, the behavioural equations are not centrally determined and the estimating techniques may be different: each model is designed by national researchers so as to represent the underlying economy as closely as possible.

2.1. The Bilateral Trade Model

The main feature of the INFORUM type-I international system built in the 1970s was a high disaggregation of trade flows for 10 countries. This is a unique characteristic of this linking system. However, the system did not produce bilateral trade flows and so the model was further developed in that direction. The INFORUM type-II international system is a Bilateral Trade Model (BTM) and it is presented by Ma (1996) as "a unique international and general equilibrium framework that is particularly suited to address quantitatively sector- and country-specific issues" (p.5).

The core of the trade module is a square trade share matrix M with as many rows as countries in the system, obtained using the imports for each country. S_{ij} is a generic element in the trade share matrix M and is computed as:

$$S_{i,j,t} = {M_{i,j,t}}/{M_{\cdot,j,t}}\ , \quad (1)$$

where $M_{i,j}$ is imports to country *j* from origin *i* and $M_{\cdot,j}$ is total imports to country *j*. Viewed from the country of origin, $S_{i,j}$ is the proportion of goods exported in the *jth* market. There are as many trade share matrices as the number of products in the bilateral trade model. Two constraints must be satisfied at every time *t*: (i) no element $S_{i,j}$ should be negative; (ii) the sum of all the $S_{i,j}$ in the *jth* market should be equal to one. As the shares are not stable over time, an important feature of BTM is that it models and forecasts the S matrices. The basic equation for the generic element S_{ij} in the trade share matrix of each product is the following:

$$S_{i,j,t} = \beta_{i,j,0} * \left(\frac{P_{e,i,t}}{P_{w,j,t}}\right)^{\beta_{i,j,1}} * \left(\frac{K_{e,i,t}}{K_{w,j,t}}\right)^{\beta_{i,j,2}} * e^{\beta_{i,j,3} \cdot T_t} \quad (2)$$

The first variable captures price competitiveness as expressed by the ratio between the effective price of the product in question in country *i* (exporters' domestic price) in year t, P_{eit}[2] and the commodity-specific world price as seen from country *j* (importer) in year t, P_{wjt}.[3] The second variable is the relative capital stock, used as a proxy for non-price factor competitiveness such as quality and technology improvements. K_{eit} is built from capital investment data as an index of effective capital stock in the industry in question in the exporting country, defined as a moving average of the capital stock indices for the last three years to allow for lagged effects, and K_{wjt} is the same index of world average

[2] This is defined as a moving average of domestic market prices for the last three years and not five as in the type-I version. The price is corrected using exchange rates.

[3] The commodity-specific world price is defined, as it was in Type-I, as a fixed-weighted average of the effective prices in all exporting countries: $P_{wjt} = \sum_i S_{ij0} P_{eit}$, where the trade shares for the base year are assumed to sum to unity to satisfy the homogeneity condition.

capital stock as seen from the importing country.[4] Finally, other non price factors – such as preferences, habits and trade restrictions – are assumed to follow a time trend, the so-called 'Nyhus' trend, T_t , which is added as an exponential to the share equation. The parameters β_{ij0}, β_{ij1}, β_{ij2}, β_{ij3} are estimated using a logarithmic functional form.

Imports, prices by commodity and capital investment by industry are estimated by each country model in the system and then are passed to the trade module. The model allocates national sectoral imports to the exporting countries within the system through the import share matrices. Country's imports from all its trading partners equal the countries' exports at the commodity level to that market. Summing across the importers then yields the exports by country and commodity. These estimates are then used in the country models as indicators of exports. In addition, the BTM gives the importing country information on its import prices by commodity.

This model was further developed by Wang (2001) to include bilateral tariff rates in the import share equations by modifying the relative price as in the following equations:

$$S_{i,j,t} = \beta_{0,i,j} * \left(\frac{P_{e,i,t}*(1+\tau_{i,j,t})}{P_{w,j,t}}\right)^{\beta_{1,i,j}} * \left(\frac{K_{e,i,t}}{K_{w,j,t}}\right)^{\beta_{2,i,j}} * e^{\beta_{3,i,j}*T_t} \quad (3)$$

and

$$P_{w,j,t} = \sum_i S_{i,j,0} * P_{e,i,t} * \left(1 + \tau_{i,j,t}\right), \quad (4)$$

where $\tau_{i,j,t}$ is the tariff rate applied by importer j to exporter i at time t.

More recently, an INFORUM type-III international system has been further updated and developed (Bardazzi and Ghezzi, 2015) with a new geographical coverage including countries which have become major trading partners at the global level,[5] a new dataset of bilateral trade flows, and upgraded and re-estimated trade share equations.

This modelling approach has some advantages but also certain limits. The main feature is the reference to bilateral trade flows for destination markets, which allows the effects of alternative scenarios to be estimated by commodity and by looking at the relative competitiveness of exporters in specific markets. The high level of disaggregation (66 commodity groups) of the units of analysis is also very important for investigating the effects of shocks and policies that are specific to certain markets and exporting countries. The model is intended for simulation and forecasting. Therefore, it is important that all relevant explanatory variables are considered, but their number must also be limited for practical purposes. Notwithstanding the very large number of trade share equations estimated, the model is parsimonious in the choice of regressors. Moreover, these sectoral variables are not exogenously assumed but are endogenously estimated by the country models. Finally, the linkage between the trade module and the national multi-sectoral models allows the estimation of direct and indirect effects of simulation scenarios through the feedback mechanism within the international

[4] The world average capital stock, K_{wjt}, is defined as a fixed-weighted average of capital stocks in all exporting countries: $K_{wjt} = \sum_i S_{ij0} K_{eit}$, where the same constraint is applied to the fixed weights S_{ij0}. It should also be noted that in any forecast period each trade share must be non-negative, and the sum of shares from all the sources in a given market must add up to 1 (i.e. $\Sigma_i S_{ij} = 1$ for all j and t). The non-negativity condition is automatically satisfied through the use of the logarithmic functional form, but the adding-up condition is not. Therefore, a procedure needs to be found to modify the forecast trade shares so that the adding-up condition is met. Estimates of all the *n* shares are made separately and subsequently adjusted to meet the adding-up condition. In this way, the forecast shares in each market will satisfy both the adding-up condition and the non-negativity condition. In scaling the forecast shares to meet the adding-up condition in each import market, those with the best fits will require less adjustment than those with poor fits. One way to tackle the problem is to use the standard errors of the estimated equations as weights. Thus, the adding-up condition in each import market is imposed by distributing the residuals in proportion to the standard error of each estimated share equation.

[5] The countries in the system are: Austria, Belgium, France, Germany, Italy, Spain, the United Kingdom, Russia, Canada, the United States, Mexico, China, South Korea, Japan, Rest of the Eurozone, Rest of the EU, Middle-East Oil producers, and Rest of the World. The total trade of the 14 individual countries, excluding the four aggregate regions, accounts for about two-thirds of the total world commodity trade in 2014.

system. The main limits of the model concern trade in services and international financial flows, which are not yet modelled in the system but will be included in a further development of the BTM.

2.2. The data

A new dataset of bilateral trade flows has been built from two international statistical sources. For EU countries, the data are drawn from the COMEXT database (Eurostat) and cover the import flows for each EU country from all possible countries of origin. COMTRADE data (United Nations) are used to collect information about import flows for all other destinations in the world. The consistency of the total amount of trade for a specific destination[6] with respect to each country's national accounts has been checked to allow the integration of many different national models in the same international system. Import flows are used to calculate exports by aggregating the data on all the countries importing from a specific nation.[7] The dataset covers the period 1995-2012[8] for all transactions at the 2-digit SITC classification level (66 commodity groups; see Table 1 in the Appendix) for the set of 18 countries which are included in the updated version of BTM. Flows are organized in 66 bilateral trade matrices with dimensions 18x18. Flows are deflated using national export prices obtained from each country model, and then share matrices are produced both in current and constant prices.

The estimation of equation (2) requires the use of domestic prices (by exporting country) and capital investment at the country level. These two variables are crucial to compute the relative prices and the relative capital stock, which are the main explanatory variables of the model. In order to compute the international prices as seen from each destination market, we need to calculate a commodity-specific weighted average price based on the national information. The same is true for capital stocks, for which we compute a commodity-specific weighted average stock using information on national investments. Relative prices and relative capital stocks are the main channels connecting the country models with the BTM. Disaggregated export prices for each country must be used to capture price competitiveness in international markets. On the other hand, disaggregated investments in equipment are used to build capital stocks[9] as a proxy for non-price competitiveness factors such as commodity quality and technological content. These variables are collected at the national level in the country model classification and are then converted into the BTM SITC 2-digit classification. This step is based on country-specific bridge matrices with weights built from import flows at the 3-digit SITC level. Therefore, time-series of matrices are available for each country and the last-year matrix is used in the forecasting mode to convert imports between the BTM and the country model classifications. This feedback between national and international models is an outstanding feature of this modelling approach.

2.3. Trade share estimation: a brief summary of results

BTM is estimated for the period 1999-2012. In estimating the share equations, a 'search' procedure is applied according to the method designed by Ma (1996) and upgraded by Wang (2001). This procedure has the aim of exploring the parameter space and only selecting estimates with correct signs and reasonable magnitude to be used in simulations. In particular, constraints are put on the parameters for relative prices and relative capital stock, as explained below. Depending on whether the constraints are binding, 17 different equation specifications are selected and estimated as summarized in Table 1.

---

[6] Considering just the fourteen countries explicitly included in the international system of models.

[7] We consider the imports of the first 90 reporting countries in UN Comtrade ranked by total imports in 2012, which account for more than 99 per cent of total world imports (Bardazzi and Ghezzi, 2015).

[8] For extra-European countries data are available from 1999 to 2012.

[9] Capital stocks by industry are built from investments according to the unit bucket method (Almon, 2014). This method applies distributed lags to compute stocks from flows computing capital replacement as a lagged effect of investment (see Appendix A for more details).

Table 1. Different specifications in the trade share equation

No.	Variable(s) Included	Constraint(s) Imposed
1	P, K, T	None
2	P, K, T	$\beta_p = B_p$
3	P, K, T	$\beta_k = B_k$
4	P, K, T	$\beta_p = B_p$ and $\beta_k = B_k$
5	P, K	None
6	P, K	$\beta_p = B_p$
7	P, K	$\beta_k = B_k$
8	P, K	$\beta_p = B_p$ and $\beta_k = B_k$
9	P, T	None
10	P, T	$\beta_p = B_p$
11	K, T	None
12	K, T	$\beta_k = B_k$
13	P	None
14	P	$\beta_p = B_p$
15	K	None
16	K	$\beta_k = B_k$
17	T	None

Note: P is the relative price; K is the relative capital stock; T is the Nyhus time trend; β_P is the estimated parameter for P and B_p is its constraint; β_K is the estimated parameter for K and B_k is its constraint.

Source: Wang (2001)

For each of the 66 trade sectors, there are 310 possible share equations (=18x18-14), one for each off-diagonal cell of the trade-share matrices plus the diagonal elements representing the intra-regional trade for the rest of the Eurozone, the rest of the EU-28, the oil-producing countries, and the rest of the world. Therefore, as shown in the last rows in Table 2, for the whole trade model there are 20,460 possible trade-share equations, which reduce to about 17 thousand significant share equations after eliminating cells with few significant or zero observations in the sample period.[10] The breakdown of the equations by functional form resulting from the 'search' procedure described above is reported in the same table. It should be noted that the full specification including relative price, relative capital stock and Nyhus time trend (P, K, T) applies in about 23 per cent of the equations, while in 13 per cent the time trend effect is not relevant. Overall, 64 per cent of the trade share equations have at least the relative price term, while 62 per cent of the equations have at least the relative capital stock term.

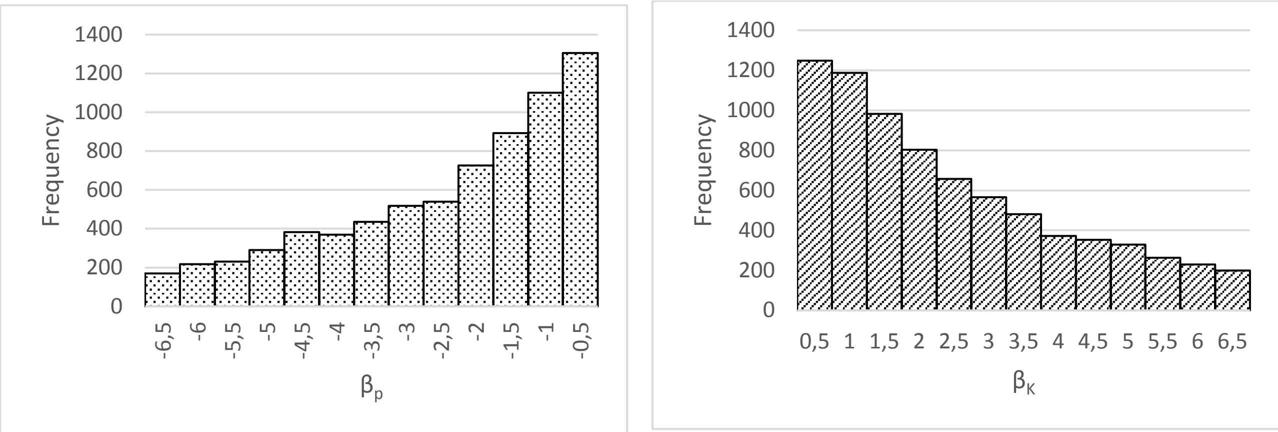
Table 2 – Estimated trade share equations by functional form

Equation Specification	# equations		
P, K, T	3,906	22.8%	
P, K	2,260	13.2%	
P, T	3,595	21.0%	
K, T	3,292	19.2%	
P	1,419	8.3%	
K	1,361	7.9%	
T	1,280	7.5%	
Constant	27	0.2%	
Total # estimated equations	17,140	100.0%	83.7%
zero shares	913		4.5%
Not enough significant shares	2,407		11.8%
# of potential equations	20,460		100.0%

[10] A threshold value for defining an import share as significant is set at 0.01 per cent.

We perform both an unconstrained and a constrained estimation of equation (2). For the first case, the estimated relative price and the relative capital stock elasticities – β_p and β_K respectively – are summarized in Figure 2. The price elasticity ranges from zero to -6.5, while the capital elasticity varies from zero to +6.5. There are also some parameters outside these limit values that refer to equations for sectors with very low and volatile import shares at the bilateral level – such as Live Animals, Dairy Products, Feeding Stuff for Animals, Hides, Oil Seeds – that are not relevant in terms of world commodity trade volumes.

Figure 2 – Estimated Price and Capital Elasticities



For simulation purposes, constrained estimates of elasticities are produced according to the constrained specifications already shown in Table 1, with β_p=B_p=-6 and β_K=B_K=+6. With these assumptions, we aim to constrain the volatility of some equations representing small bilateral flows and to avoid implausible results of policy simulations. However, the unconstrained parameters refer to the import shares of roughly four-fifths of total world imports in the year 2012.

3. Simulation scenarios with BTM

The Bilateral Trade Model is first used to simulate the level of bilateral sectoral flows up to 2025 according to a baseline exogenous scenario. The results of this simulation are used as a benchmark against an alternative scenario to estimate the impact of a policy aimed to improve the level of competitiveness of the EU as whole with respect to its main competitors (i.e. China and the US).

3.1. The baseline scenario

The baseline scenario for the decade 2015-2025 should reflect as closely as possible the economic development trend expected for the economies explicitly included in the BTM, and in general for the world economy. Expectations for the future of the international economy could be based on two different sources of evolution: the economic trends of the main drivers; and the expected policy implications for the main variables. In order to keep the simulation as simple as possible, and considering the large number of countries involved in the model, we perform a 'business as usual' simulation considering only the first source of changes.

The results of the baseline scenario are based on an extrapolation of the exogenous variables as described in Appendix A based on IMF projections. The level of capital stock for the Eurozone should increase annually by 0.34 per cent on average, ranging from the lowest rate of growth in Austria

(0.21%) to the highest in Italy (0.54%) and France (0.37%). North America's capital stock is assumed to increase slightly more than Europe's (0.4 per cent) thanks to Mexico, which is projected to show an average increase of 0.4 per cent while the US capital stock should grow at a rate of 0.25 per cent per year. The east Asian countries are characterized by a divergent evolution of capital stock. On the one hand, China and Korea should increase their capital annually by 0.4 per cent. On the other hand, Japan is expected to exhibit capital stagnation.

The relative price projections are derived from assumptions on the dynamics of national producers' prices. For the Eurozone this variable is expected to increase annually by 1.6 per cent on average, with the lowest rate of growth in Spain (1.4%) and the highest inflation in Austria and Germany (1.6%). The average annual inflation growth rate of the European Union in the period 2015-2025 is roughly the same (1.5%). In North America, producers' price inflation is assumed to increase with an annual rate higher than that assumed for Europe: the US will show 1.6 per cent annual growth on average; for Mexico, a rate of 2.4 per cent is assumed; while in Canada lower annual inflation is expected (1.7 per cent). In Russia, a strong producer price inflation is assumed (i.e. 3.4 per cent annual growth). As we observed for capital stocks, east Asian Countries are also characterized by divergent paths for prices. Chinese and Korean prices are expected to increase by 1.6 and 1.8 per cent respectively while in Japan inflation should be very low (1.0 per cent annual growth).

Both capital and prices come into equation (2) in relative terms and, generally, their effect is not immediate. Capital stock is based on cumulated past investment and, according to the permanent inventory method, new investment updates the stock level (also according to yearly depreciation). However, new investment is not immediately fully operative: there is a 'time-to-build' process with lags between the investment decision and its completion. We introduce a smooth profile to integrate new investment into the existing capital stock with a three-year time-to-build, which we consider, on average, to be an adequate time to fully exploit the potential of new equipment.

Likewise, a similar 'smoother' is envisaged for prices because international trade relationships are often conducted within a set of agreements that usually set the prices adopted and the nominal exchange rate used to convert them. Therefore, we consider not just the current year's prices but also a delayed effect of the previous years' prices. A moving average of the current and last two years' values, with decreasing weights, is computed to calculate an average effective price as the explanatory variable in the import share equation.

3.2. The policy scenario: capital deepening and price competitiveness

The alternative policy scenario is intended to evaluate the effect of increasing investments in the EU – financed by the public sector and by private businesses – on the external competitiveness of the area. We compare the baseline with the results obtained by simulating capital stock increases of 3 percent every year in the period 2015-2020 with respect to the benchmark, and then of 2 per cent up to 2025. Because of the smoothing mechanism, in the initial stage of the simulation the effect is expected to be relatively small and it is expected to increase in the last part of the simulation horizon

The aim of this paper is to estimate the direct effect of a policy, and so only the first round impact of new investment is considered, which is usually the largest part of the final result.[11] Two transmission channels operate when the EU economies raise their investment levels. Obviously, the most direct impact comes from an increase in the production capacity of European countries, primarily in terms of what can be produced using the new technologies embedded in new equipment. Through this channel, 'non-price competitiveness' is affected and so this is one of the determinants included in our trade share equations. Estimation of the equation parameters gives us the elasticity of the trade share with respect to relative capital stock, which is used to calculate the initial impact of the policy. However, this is not the only direct impact to take into account. There is an additional channel that must be

[11]In order to evaluate the overall outcome, the feedback effects from the national models after the first round effect also need to be considered.

considered to estimate the whole first-round effect produced by new investments and this is based on the immediate reaction of exporters, not in terms of the kind of goods they will produce but in terms of the volume of production they are able to activate. *Ceteris paribus*, new equipment should allow production of a higher level of output. Therefore, the variable costs per unit of output are lower with respect to old equipment. For this reason, we also consider the impact of new investments on European export prices, and, in our policy simulation, beside the 'non-price competitiveness' effect a 'price competitiveness' impact is also considered. We introduce the hypothesis that new investments push down the price level in EU countries by 0.5 per cent with respect to the benchmark in 2015-2020 and then by 1.0 per cent in the following five years. The price and non-price effects can be summed. All things considered, we estimate the overall direct impact of new investments in terms of import shares as described in the following section.

4. Simulation results

In this analysis of the simulation results we focus on selected BTM sectors and destination markets for EU exports. The European area has a comparative advantage in machinery, in research-intensive sectors such as chemicals, and in some labour-intensive sectors. Therefore, we investigate the response to our policy of selected commodity groups that are relevant for the EU or strategic on international markets: General industrial machinery and equipment (Sector 50), Machinery specialized for particular industries (Sector 48), Organic chemicals (Sector 29), and Iron and steel (Sector 44). As for export destination, the US and Chinese markets are considered since they represent the largest importers outside Europe.

For the US market, we compare how sectoral import shares from the EU and China react to our policy shock. Similarly, for the Chinese destination market we compare the effect of the European policy on import shares from the EU with the effect on American shares. This selection is for the purpose of displaying our results, but it should be remembered that the estimation is based on simulation of the full model. Parameters are estimated for each trade share equation, but to meet the 'exhaustiveness' condition, which requires the sum of the shares to be one, a constraint on the evolution of each single share in a specific market for a specific sector is implicitly required. In the case of a sum larger or smaller than one, a 'spreader' distributes the difference proportionally among the shares. Therefore, the equations give just the initial estimate of import shares and then a balancing procedure is used to obtain the final estimate. For this reason, at the end of the simulation all the parameters of the equations estimated for a specific market and for a specific commodity determine the final impact, and it is not just the parameters of the single equation regarding a specific origin of trade flows explaining the movement of the corresponding share. Therefore, the perspective for analysing the results is that of the destination market and not that of the exporter. At the end of the process, the effect of a variation in the capital stock of one country involves all the others, and in general terms it is determined by the following elements:

a) the weight in the base year of the country that changes the level of its capital stock. The higher this weight is, the higher will be the impact on $K_{w,j,t}$, the world capital stock as seen from the destination market considered, and so the higher will be, *ceteris paribus*, the impact on all the other shares estimated at time t;

b) the range of variation of all the countries' specific β estimated for the capital stock indexes (for each destination market and for a specific commodity). The greater the distance between a country parameter and the average capital stock parameter estimated for the whole market (defined as a 'specific commodity in a specific destination') is, the greater will be the impact produced by a change in the relative capital stock variable of each exporter. As can be seen from equation (2), it is not just the country that changes its capital stock which is affected but also all the other countries with a non-zero β for the indirect effect produced on $K_{w,j,t}$;

c) the number of zeros for the β estimated in each market. The higher the number of zero parameters is, the more concentrated is the initial effect that will affect just the countries with non-zero parameters.

Obviously, all these elements influence just the first parameter estimate that is introduced in the balancing procedure. It is evident that this initial unconstrained estimation will shape the final results, but, as we have suggested, the whole set of the shares in a market will be affected by the process.

4.1. The US market

Our results include the estimate of the import share parameters (in table format) and two simulation scenarios: the baseline and the alternative policy. The simulation results are presented with graphs. The first of these shows the behaviour of import shares in history (2000-2014) and with the benchmark hypotheses (2015-2025). The second graph shows the impact on trade shares as the difference from the baseline figures to highlight the changes entailed by the policy shock.

The first market under scrutiny is the US and the first sector is 'General Machinery' imported in that market. The parameters estimated for this commodity group are presented in Table 3.[12] From these estimates we can see that the average price elasticity in this market is -0.49 and the average capital stock elasticity is +0.77.[13] For the 'Special Machinery' sector in the US, the average price elasticity is -0.78 and the capital elasticity is +1.30. Therefore, a price change by some exporters would produce an impact on the market share of this first sector that is relatively smaller than that on the second commodity group. The same is true for a capital increase: a one per cent increase in capital stock by one of the competitors on average produces a variation in the market shares of the others which are larger in the second sector than in the first.

Table 3 – General Machinery import share in the US: estimated parameters

	Share in 2014	constant	price elasticity	capital elasticity	trend
Canada	0.10	-1.98	0	0.085	-0.059
Mexico	0.16	-1.82	-0.793	0	0.061
Austria	0.01	-4.51	-1.034	0	0.014
Belgium	0.01	-4.26	-1.375	0	-0.023
France	0.02	-3.49	-0.719	0	-0.028
Germany	0.11	-2.06	-0.251	1.508	0.038
Italy	0.04	-3.13	0	2.232	0.114
Spain	0.01	-5.05	0	0.663	-0.001
UK	0.03	-3.20	0	0.403	-0.046
Japan	0.11	-1.48	-1.65	1.38	0
China	0.21	-2.06	0	1.187	0
Korea	0.03	-3.18	-1.293	0	0.059
Russia	0.00	-7.71	-0.526	1.156	0.078
REZ	0.02	-3.14	-1.795	1.42	0
REU	0.04	-2.91	-1.1	0.043	0
OIL	0.00	-8.06	0	6.755	0.145
ROW	0.10	-2.21	0	0.562	-0.005

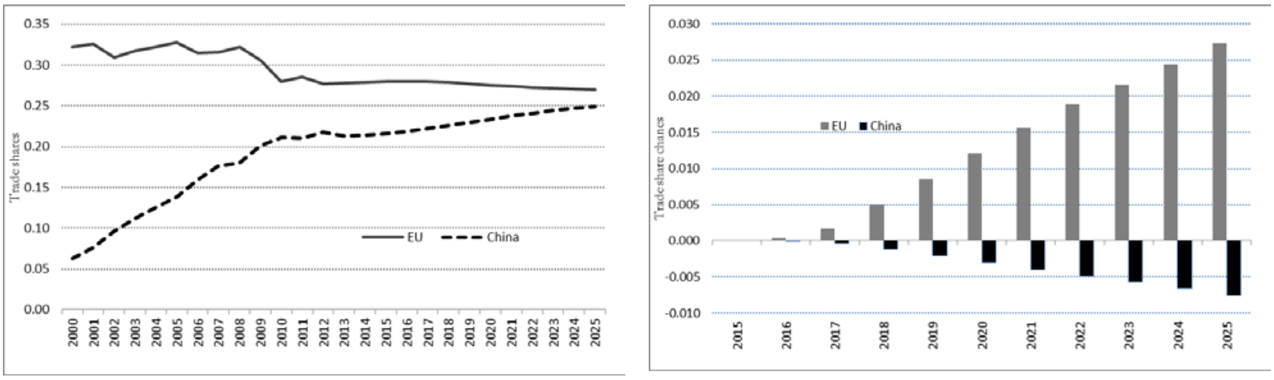
[12] For all other sectors, the parameters estimated are presented in Appendix B.

[13] These elasticities are computed as the weighted average of the parameters estimated for all the countries and areas in the BTM.

There are some exporters characterized by a capital elasticity equal to zero (i.e. Mexico and Korea), meaning that a change in their price produces no direct effect, either on them or on the other competitors, although a variation in the capital stock of some other exporters with a non-zero price elasticity (e.g. Japan) also affects Mexico' share. For this reason, according to the parameter estimations shown in the table, a capital stock increase in the Austrian machinery sector will have no impact either on the share of Austria or on the shares of all the other competitors in the US market. Nevertheless, if Russia raises investment in its general machinery production sector, it will generate a large impact on the US market, and also on the import share from Austria.

The main competitor of the EU is China, which in the last twenty years has greatly increased its power in international markets. This a trend that was emphasized by the financial crisis in 2009 as is clearly shown in Figure 3 (left-hand graph), but the long-term path of the Chinese share also shows a catching-up process before the financial turmoil.

Figure 3 – General machinery in the US Market – Baseline Scenario (left) and simulation results (right)



From our baseline simulation, we should stress that the consequences of the last period of recession have some structural effects: the EU trade share would still be below the level reached in the pre-crisis period after ten years of simulation (in 2025). Convergence between the market shares of the EU and China will still be an active process, but in the near future we expect a slower pace.

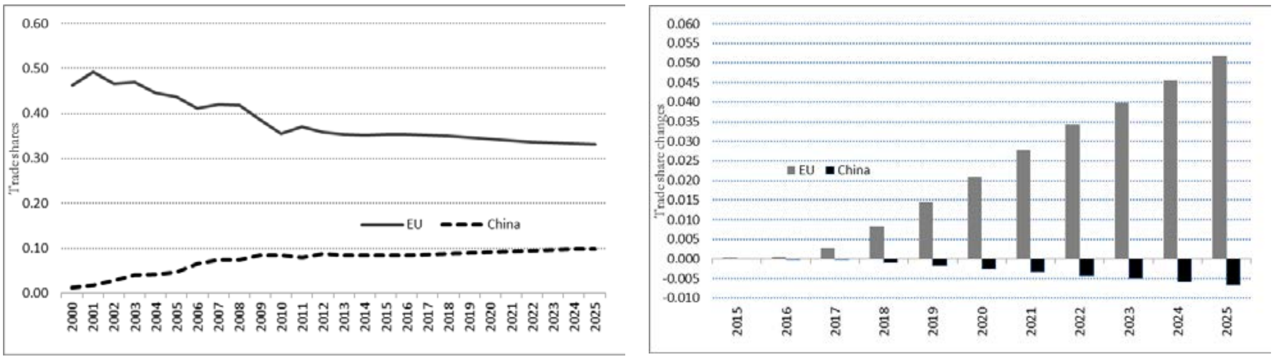
The effect of the policy shock can be evaluated by considering the graph on the right. Each bar measures the positive or negative response in terms of US import shares from the EU and China after the introduction of the stimulus. The results presented here include just the direct effect of the capital stock increase in Europe without considering the movements of the prices induced by this new capital stock. The main result is that by adopting such a policy the EU share at the end of the simulation period would increase by 2.5 per cent in absolute terms, and so it would be close to the pre-crisis level but still slightly below it. The increase in the European import share to the US would be accompanied by a relative drop in the Chinese share, which can be estimated as a 1 per cent loss in 2025 with respect to the baseline. Some other countries would also suffer from this European policy, especially Japan, which would reduce its share by 0.5 per cent. If we also consider the price competitiveness effect, based on the hypothesis described above, the policy simulation results should take into account a further 1.5 per cent increase in the share of American imports from the EU in 2025, reaching a level similar to that observed at the beginning of the millennium.[14]

In the 'Specialized Machinery' sector, the US market represents 12 per cent of total world trade for these commodities. In this case, the catching-up process observed for general purpose machinery is less evident but still relatively clear (Figure 4, left-hand graph). What is very evident is the reduction in the

[14] Detailed sectoral results on price competitiveness increases are available from the authors upon request.

European share before the crisis too. The financial catastrophe that started in 2009 produced a further drop in the EU share, which from the level of 50 per cent of the destination market in 2001 fell to the current level of 35 per cent. According to our baseline simulation, the share would also be reduced in the next ten years and stabilize around 30 per cent of all imported specialized machinery in the US. According to the average parameters described above, we expect that the impact of a policy aimed to increase the capital stock by 3 per cent in ten years would give a big push to EU competitiveness with a stronger effect than that observed for general purpose machinery. The final results obtained from the simulation of the policy scenario fulfil this expectation (right-hand graph). The impact in 2025 would produce a share in absolute terms 5 per cent higher than in the baseline simulation. As a consequence, China would lose only 0.5 per cent of its share while a higher impact is estimated on the NAFTA partners and on Japan, which will lose roughly 1.5 per cent of its share. When also considering the price effect induced by new investment determined by the policy, we need to take into account an additional gain in the EU share, which we estimate at 3 percentage points. Therefore, with this policy the EU should come back to its pre-crisis position.

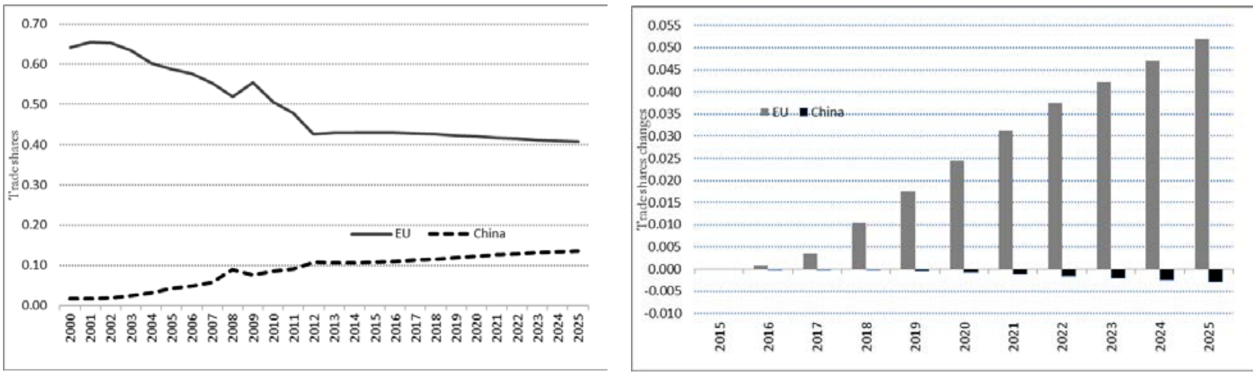
Figure 4 – Specialized machinery in the US Market – Baseline Scenario (left) and simulation results (right)



In the 'Organic Chemicals' commodity group, the US is the second most important importer in the world (the US market absorbs 12.5 per cent of the total trade in this commodity). Its evolution is similar to that of Specialized Machinery, but the drop observed in the last twenty years is larger than that in the mechanical sector (Figure 5, left-hand graph).

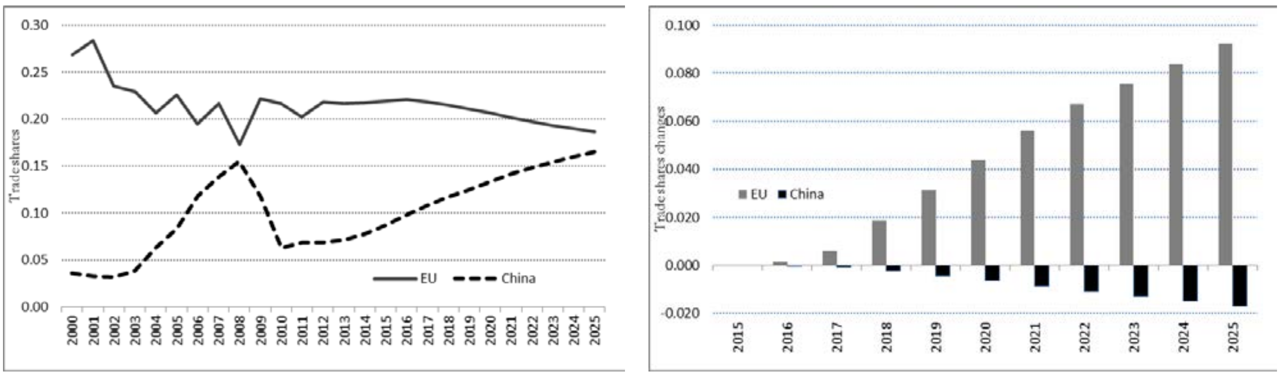
Starting in 2000, the share of the US market held by European firms was close to 70 per cent, and at the end of the historical period its level is just slightly above 40 per cent. A large part of this slump happened during the second phase of the recent crisis, after 2010. Chinese producers are not the most aggressive competitors in the recent period because the Rest of the World currently holds an important share. Nevertheless, the Chinese share in the US market increased to 11 per cent of the market in 2013. According to our baseline simulation, the European position will be stable in the near future and so Europe would not be able to recover what was lost in the recent past. Chinese exporters would increase their presence in the United States following a relatively sluggish path. One of the most important features for this sector is the significant role of capital stock in competition. Our estimates give us a clear indication on this point: the average capital stock elasticity is very high (2.1) and therefore a strategy oriented to increasing the endowment of the European chemical sector would produce noticeable effects. As a matter of fact, the policy simulation suggests that an increase of 3 per cent in the capital stock would increase the EU share in the US market by more than 5 per cent with respect to the baseline (right-hand graph). If we also simulate the effect of the new investment on export prices using the hypothesis described above, a further increase of 2 percentage points is obtained, so that the negative effect of the financial crisis would be partially eliminated.

Figure 5 – Organic chemicals in the US Market – Baseline Scenario (left) and simulation results (right)



The last sector we consider is 'Iron and Steel', a relevant part of manufacturing that links the primary to the industrial sector. The US market represents more than 10 per cent of the world imports in this commodity group and it is the largest importer compared with the other BTM individual countries. According to the historical data, the European Union held a large part of the US market, higher than 25 per cent, at the beginning of the millennium (Figure 6, left-hand graph). As we also observed for the other sectors, before the financial crisis a progressive shrinking of the EU position took place leading to a share close to 15 per cent in 2008. In the same period, the Chinese market position improved and, starting with a share of 4 per cent in 2000, the quota of the US market that China held in 2008 was 15 per cent. In 2009, new import barriers for Chinese steel were introduced in the US and this could explain the sharp drop in the share observed in the graph. During the last five years, Europe has gained positions and stabilized around 22 per cent. The baseline simulation suggests that this stability is not for ever and, according to our results, China would achieve the same share as 2008 before 2025 at the expense of the European Union. For this reason, a policy oriented to stimulating investment is extremely important for this key sector. The alternative policy scenario gives us some empirical evidence of the impact of this stimulus (right-hand graph): a stable increase of 3 per cent in the capital stock would increase the US import share from the EU with respect to the baseline by about 9 percentage points, thus allowing the same level as in 2001 to be regained. The effect of price competitiveness derived from the new equipment further improves the European position, since it would increase the trade share in the US by an additional 4.3 per cent.

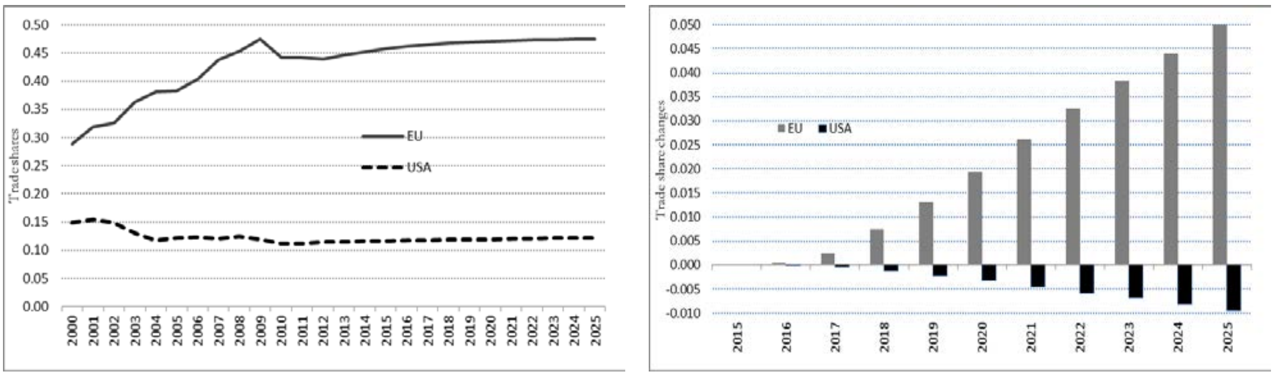
Figure 6 – Iron and Steel in the US Market – Baseline Scenario (left) and simulation results (right)



4.2. The Chinese market

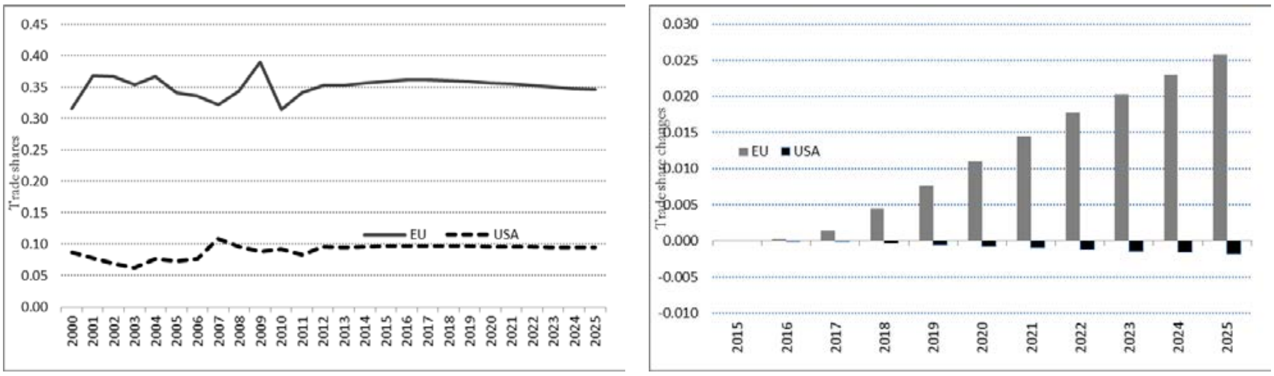
The simulation scenarios of an increase in investments in European countries also produce effects on trade shares in the Chinese market. If we look at the results for the same selected sectors that have been analysed for the US market, as a general finding the EU as a whole becomes more competitive, and gains in terms of trade shares with respect to the baseline are significant. For 'General Industrial Machinery,' the Chinese market represents an import share of 7.7 per cent of the world market, which is the second largest among the BTM countries after the US (14 per cent). In the baseline scenario (Figure 7, left-hand graph), after a significant rise in the EU share in China with the highest value reached before the crisis (0.47 per cent), this share is forecast to stabilize after the drop in 2010 and to go back to the pre-crisis level at the end of the simulation period. In the right-hand graph of the same figure, it can be seen that the increase in capital stock allows a gain in terms of market share, with an increase of 0.05 (in absolute value) in 2025 with respect to the baseline. This positive effect comes at the expense of US and Japanese producers, who lose part of their market shares. An additional albeit small positive contribution is produced by simulating an increase in EU price competitiveness.

Figure 7 – General industrial machinery and equipment in the Chinese Market – Baseline Scenario (left) and simulation results (right)



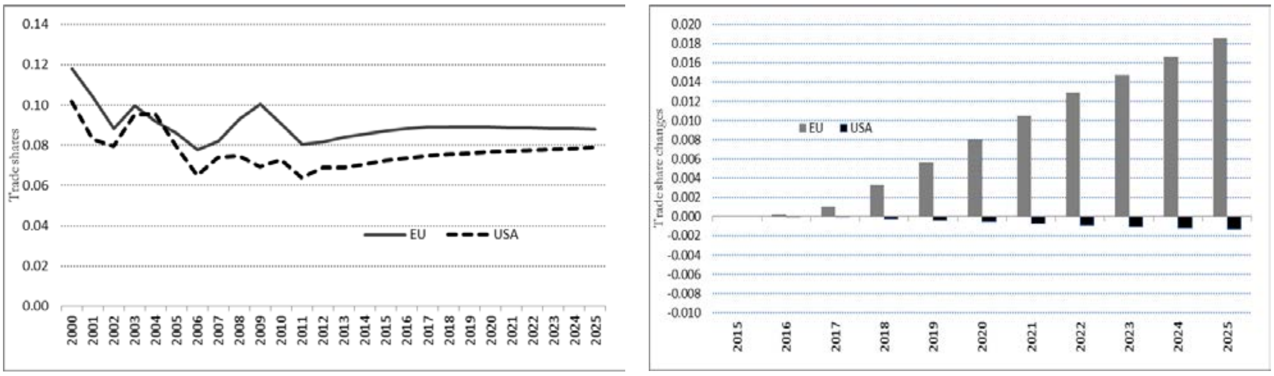
The Chinese market in 'Specialized Machinery' accounts for about 9 per cent of world imports in this sector and the EU countries cover the largest part of these imports with a share of 36 per cent, which is followed by Japan (31 per cent). In the baseline scenario, this share is expected to slightly decrease after the shock of the recent crisis and never recover to the pre-crisis level before 2025 if no policy is implemented (Figure 8, left-hand graph). On the other hand, by increasing their capital stock the EU economies could gain 3 per cent in absolute value on their total market share in China at the end of the simulation horizon (right-hand graph). Indeed, in this commodity sector the Chinese economy is quite sensitive to quality and technology factors. This is captured by the weighted average capital elasticity of 1.92. Korea and Japan would be the competitors who lose some of their market shares in China, as well as the US. Notwithstanding this expansionary policy, the EU would not recover its pre-crisis share in the Chinese market. A cost reduction and an increase in price competitiveness are needed to reach this target. The simulation of this additional effect implied by new capital endowments allows the 2009 position with respect to the other competitors to be regained, with a share of 0.39.

Figure 8 – Specialized machinery in the Chinese Market – Baseline Scenario (left) and simulation results (right)



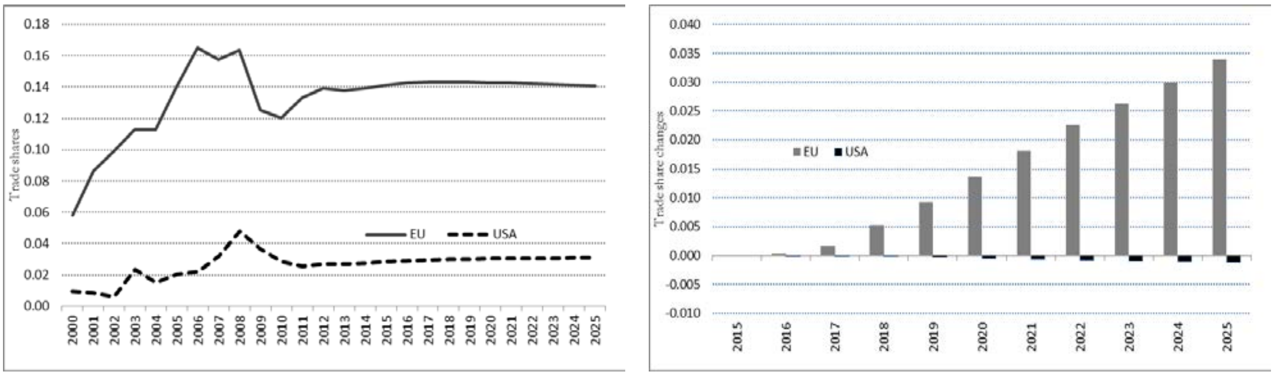
For 'Organic Chemicals', China is the top importer, with a share of 14 per cent of world imports, while the United States rank second. Several suppliers contend the market with the EU, with Korea as the main competitor. The EU and the US cover shares of 9 and 7 per cent respectively in 2014. The historical data show a declining path of these shares since the beginning of 2000 (Figure 9, left-hand graph) and a slight increase in the baseline scenario during the simulation period. However, the drop in the market share after the crisis would not be recovered without an expansionary policy. The capital increase would allow the EU to be more competitive and increase its market share in the Chinese market (right-hand graph). On the other hand, this policy is more effective than an increase in price competitiveness as the Chinese economy in this commodity market is more elastic to changes in technological than price factors, as shown by the estimated elasticities.

Figure 9 – Organic chemicals in the Chinese Market – Baseline Scenario (left) and simulation results (right)



Finally, in terms of imports, China absorbs 5 per cent of total trade in the 'Iron and steel' commodity group (about half the share of the US) and its main suppliers are Japan (0.36) and Korea (0.19) followed by the EU (0.14). As Figure 10 (left-hand graph) shows, the EU share almost tripled before 2009 when Chinese economic development in manufacturing took off. Then, the crisis produced a sharp drop and in the baseline scenario the share is expected to remain stable around the most recent value. The investment policy in the EU would make the European countries more competitive and help to gain back 3 per cent in their total market share in China, while the increase in price competitiveness would produce an additional positive contribution (+2 per cent) with a final market share of 0.19 in 2025, higher than the pre-crisis level. This is because the estimated price and capital elasticities for European countries are always higher than those for the competitors in this market in China.

Figure 10 – Iron and Steel in the Chinese Market – Baseline Scenario (left) and simulation results (right)



5. Conclusions

In the European Union, the dynamics of domestic demand are somewhat constrained by requirements of fiscal sustainability and by an uncertainty over future economic growth that dampens private consumption and investment. Foreign demand is more dynamic, even though the recent slowdown in China and other emerging market economies could weaken demand in Europe. On international markets, a progressive loss of competitiveness by EU commodities was taking place even before the crisis to the benefit of emerging economies, with export volumes growing less rapidly than foreign demand from the beginning of the 2000s, reflecting losses in market shares. In a world scenario characterized by evolving behaviours, with the Chinese administration progressively more oriented toward rebalancing domestic income distribution and the European Union facing new challenges in terms of governance, it is increasingly important to return to playing a key role in international markets by recovering lost market shares in a less dynamic environment. Therefore, an expansionary policy aimed at increasing investment could generate a double dividend, increasing both a component of domestic demand that was deeply affected by the crisis and improving the quality of an increasingly ageing capital stock, and stimulating the competitive position of European economies as exporters.

Our simulation scenarios have aimed at empirically investigating the effects of such an expansionary policy on external EU competitiveness. These policy effects have been estimated for detailed commodity groups that are traded at the bilateral level. In specific markets and for specific commodities, price and non-price factors play different roles in shaping the behaviour of import shares. In some cases, capital deepening could be the right channel along which to improve the quality of commodities and defeat competitors in the international markets. In others, price competitiveness is the most important determinant of a country's imports. Moreover, these two determinants could jointly combine to achieve the final effect on some trade shares. Our analysis covers 18 countries and regions, which, together, cover the global trade flows. Simulations have been made with a disaggregation of 66 commodity category details. These features have been achieved by employing a bilateral trade model with several distinct characteristics that contribute to better understanding the impact of a policy shock: a comprehensive bilateral dataset, econometric estimation of key parameters, emphasis on sectoral details. The estimation period covers also the recent double dip experienced by the EU countries, thus elasticities embody the most recent structural characteristics of the economic systems.

We have presented our results on the effect of an increase in investment in the EU from two perspectives: country and industry. European exporters benefit from an investment stimulus that helps to expand the capital stock and to better compete in international commodity markets. Our findings show that this policy is effective for an increase in EU trade shares, although differences between sectors and markets are noticeable. In machinery (both for general and specialized industries), capital deepening is effective in increasing the EU market share both in the US and in China, since import demand in these markets is sensitive to the technological quality of machinery produced by European countries. A different result is obtained for exported organic chemicals: in the US market, EU firms control half of the market while China is slowly increasing its presence. Chinese imports of this commodity group are supplied by American and EU producers with similar shares, and an improvement in the capital endowment of European firms will contribute to widen the gap and leave US exporters behind. Finally, imports of iron and steel in the US from Europe would benefit the most from this increase in the technological quality of EU producers, and help to challenge competition from Chinese producers which are taking advantage of government subsidies to keep their export prices low.

There is a general consensus on the necessity to spur investment to overcome the weak economic growth in the EU. Our findings show that economic policy could help the economic recovery to increase its pace and that external competitiveness should not be overlooked as a transmission channel of a policy shock. However, private and public resources are scarce, and a sound selective perspective must be adopted to choose the optimal set of investment projects. The impact of an investment plan can be very heterogeneous in terms of productivity and competitiveness effects. Our model is able to take into account this heterogeneity in terms of commodity groups and destination markets and could aid the preparation of such an investment strategy.

References

Almon C. (1991), "The INFORUM approach to interindustry modeling", *Economic Systems Research*, Vol. 3, Issue 1, 1-7.

Almon C. (2014), *The Craft of Economic Modeling*, Fifth Edition, www.inforum.umd.edu.

Baldwin, R., Beck T., Bénassy-Quéré A., Blanchard O., Corsetti G., De Grauwe P., Den HaanW. et al. (2015), "Rebooting the Eurozone: Step 1 – agreeing a Crisis narrative.", *CEPR Policy Insight*, 85, November.

Bems, R., Johnson, R. C., and Yi, K. M. (2013),"The Great Trade Collapse", Annual Review of Economics, 5, 375-400.

Barbosa, J. R., and Alves, R. H. (2011), "Divergent competitiveness in the Eurozone and the optimum currency area theory", (No. 436). Universidade do Porto, Faculdade de Economia do Porto.

Bardazzi R., L.Ghezzi (2015), "Towards a New INFORUM Bilateral Trade Model: Data Issues and Modelling Equations", in Meade D.S. (Ed.), *In Quest of the Craft: Economic Modeling for the 21st Century*, Firenze University Press, 3-42.

Bayoumi, T., Harmsen, R. T. and Turunen, J. (2011),"Euro area export performance and competitiveness", *IMF Working Papers*, 140, 1-16.

Blanchard, O. and F.Giavazzi (2002), "Current Account Deficits in the euro Area: The End of the Feldstein-HoriokaPuzzle?", *Brookings Papers on Economic Activity*, 2: 147–186.

Buti, M. and P. Mohl (2014), "Lacklustre investment in the Eurozone: Is there a puzzle?", VoxEU.org, 4 June.

Claeys, G., Darvas, Z., and Leandro, A. (2016), "A proposal to revive the European Fiscal Framework", *Bruegel Policy Contribution* , issue 7/2016.

De Grauwe, P. (2012), "In search of symmetry in the Eurozone", CEPS Policy Brief, 268.

DIW (2013), "Investment for More Growth. An Agenda for Germany's Future", *DIW Economic Bulletin* 8.

DIW (2016), "Weak Corporate Investment Requires Immediate Action", *DIW Economic Bulletin* 15.

European Commission (2014), "An Investment Plan for Europe", Communication from the Commission to the European Parliament, the Council, the European Central Bank, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank, COM(2014) 903 final, 26 November.

European Commission (2015a), "Macroeconomic Imbalances. Main Findings of the In-Depth Reviews 2015", *Occasional Papers*, 228.

European Commission (2015b), "Annual Growth Survey 2016. Strengthening the recovery and fostering convergence", Communication from the Commission to the European Parliament, the Council, the European Central Bank, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank, COM(2015) 690 final, November.

European Commission (2016), "European Economic Forecast – Spring 2016", *European Economy Institutional Paper* 025, May.

Giavazzi, F. and L. Spaventa (2011), "Why the current account may matter in a monetary union: lessons from the financial crisis in the euro area", in Miroslav Beblavý, David Cobham, L'udovít Ódor (eds) *The Euro area and the financial crisis*, Cambridge University Press, 199-221.

Gros, D. (2012), "Macroeconomic Imbalances in the Euro Area: Symptom or cause of the crisis?",*CEPS Policy Brief*, 266.

Lane, P. R. and B. Pels (2012), "Current Account Imbalances in Europe", CEPR Discussion Paper No. DP8958.

Le Moigne, M., Saraceno, F., and Villemot, S. (2016), "Probably Too Little, Certainly Too Late. An Assessment of the Juncker Investment Plan", Observatoire Francais des Conjonctures Economiques (OFCE), n. 2016-10.

Lewis, C., et al. (2014), "Investment Gaps after the Crisis", OECD Economics Department Working Papers, No. 1168, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/5jxvgg76vqg1-en

Ma Q. (1996), *A Multisectoral Bilateral World Trade Model*, Ph.D. Thesis, University of Maryland.

Marelli, E. (2007), "Specialisation and convergence of European regions", *The European Journal of Comparative Economics*, 4(2), 149-178.

Mongelli, F. P., Reinhold, E., and Papadopoulos, G. (2016), "What's so Special About Specialisation in the Euro Area?", *ECB Occasional Paper*, (168).

Nyhus, D. E. (1991) "The Inforum International System," *Economic Systems Research*, Vol. 3, 1, 55-64.

OECD (2016a), *OECD Economic Surveys: Euro Area 2016*, OECD Publishing, Paris.

OECD (2016b), "Boosting investment performance", in OECD, *OECD Economic Surveys: Germany 2016*, OECD Publishing, Paris.

Salvatore, D. (2015), "Europe's euro and competitiveness crises." *Journal of Policy Modeling* 37, no. 3: 445-449.

Simonazzi, A., Ginzburg, A., and Nocella, G. (2013), "Economic relations between Germany and southern Europe", *Cambridge Journal of Economics*, *37*(3), 653-675.

van Ark, B. (2015), "From Mind the Gap to Closing the Gap. Avenues to Reverse Stagnation in Europe through Investment and Productivity Growth", Directorate General Economic and Financial Affairs (DG ECFIN), European Commission, n.6.

Wang Q. (2001), *Trade Flows And Trade Protection: A Multi-Country And Multi-Sectoral Investigation*, Ph.D. Dissertation, University of Maryland, US.

APPENDIX A

Table A.1 SITC 2 digit and BTM commodity classification

BTM code	SITC rev 4	DESCRIPTION	BTM code	SITC rev 4	
1	0	LIVE ANIMALS	34	56	FERTILIZERS (OTHER THAN THOSE OF GROUP 272)
2	1	MEAT	35	57	PLASTICS IN PRIMARY FORMS
3	2	DAIRY PRODUCTS	36	58	PLASTICS IN NON-PRIMARY FORMS
4	3	FISH	37	59	CHEMICAL MATERIALS AND PRODUCTS, N.E.S.
5	4	CEREALS	38	61	LEATHER, LEATHER MANUFACTURES, N.E.S., AND DRESSED FURSKINS
6	5	VEGETABLES AND FRUIT	39	62	RUBBER MANUFACTURES, N.E.S.
7	6	SUGARS, AND HONEY	40	63	CORK AND WOOD MANUFACTURES (EXCLUDING FURNITURE)
8	7	COFFEE, TEA, COCOA, SPICES	41	64	PAPER, PAPERBOARD AND ARTICLES
9	8	FEEDING STUFF FOR ANIMALS	42	65	TEXTILE YARN, FABRICS, MADE-UP ARTICLES, N.E.S.
10	9	MISCELLANEOUS EDIBLE PRODUCTS	43	66	NON-METALLIC MINERAL MANUFACTURES, N.E.S.
11	11	BEVERAGES	44	67	IRON AND STEEL
12	12	TOBACCO	45	68	NON-FERROUS METALS
13	21	HIDES, SKINS AND FURSKINS, RAW	46	69	MANUFACTURES OF METALS, N.E.S.
14	22	OIL-SEEDS AND OLEAGINOUS FRUITS	47	71	POWER-GENERATING MACHINERY AND EQUIPMENT
15	23	CRUDE RUBBER	48	72	MACHINERY SPECIALIZED FOR PARTICULAR INDUSTRIES
16	24	CORK AND WOOD	49	73	METALWORKING MACHINERY
17	25	PULP AND WASTE PAPER	50	74	GENERAL INDUSTRIAL MACHINERY AND EQUIPMENT, N.E.S.
18	26	TEXTILE FIBRES (OTHER THAN WOOL)	51	75	OFFICE MACHINES
19	27	CRUDE FERTILIZERS, AND CRUDE MINERALS (Excluding Coal, petroleum)	52	76	TELECOMMUNICATIONS
20	28	METALLIFEROUS ORES AND METAL SCRAP	53	77	ELECTRICAL MACHINERY
21	29	CRUDE ANIMAL AND VEGETABLE MATERIALS, N.E.S.	54	78	ROAD VEHICLES
22	32	COAL, COKE AND BRIQUETTES	55	79	OTHER TRANSPORT EQUIPMENT
23	33	PETROLEUM, PETROLEUM PRODUCTS AND RELATED MATERIALS	56	81	PREFABRICATED BUILDINGS; SANITARY, PLUMBING, HEATING AND LIGH
24	34	GAS, NATURAL AND MANUFACTURED	57	82	FURNITURE
25	35	ELECTRIC CURRENT	58	83	TRAVEL GOODS, HANDBAGS AND SIMILAR CONTAINERS
26	41	ANIMAL OILS AND FATS	59	84	ARTICLES OF APPAREL AND CLOTHING ACCESSORIES
27	42	FIXED VEGETABLE FATS AND OILS	60	85	FOOTWEAR
28	43	ANIMAL OR VEGETABLE FATS AND OILS, WAXES	61	87	PROFESSIONAL, SCIENTIFIC AND CONTROLLING INSTRUMENTS
29	51	ORGANIC CHEMICALS	62	88	PHOTOGRAPHIC APPARATUS AND OPTICAL GOODS
30	52	INORGANIC CHEMICALS	63	89	MISCELLANEOUS MANUFACTURED ARTICLES, N.E.S.
31	53	DYEING, TANNING AND COLOURING MATERIALS	64	93	SPECIAL TRANSACTIONS AND COMMODITIES NOT CLASSIFIED ACCORDI
32	54	MEDICINAL AND PHARMACEUTICAL PRODUCTS	65	96	COIN (OTHER THAN GOLD COIN), NOT BEING LEGAL TENDER
33	55	ESSENTIAL OILS AND RESINOIDS AND PERFUME MATERIALS;	66	97	GOLD, NON-MONETARY (EXCLUDING GOLD, ORES AND CONCENTRATES)

The exogenous variable projections

The aim here is to describe the exogenous assumptions that we use to create the independent variables used in the equations for the import shares. In particular, we need to use projections of investments to update the capital stock for each country and each product, and we have to include in our scenario an annual rate of growth in the production price level to update the relative prices.

In order to meet this necessity we decide to use the projections produced by the IMF. These data are forecast for each country and so we are able to consider the specific evolution of the national economies. The information produced by the International Monetary fund cover just the first part of the period considered by this exercise (i.e. projections include data up to 2021 at the date of this report) and so we calculate a trend growth in the period 2012-2021 and we use it to simulate the variables in 2022-2025. Unfortunately, the projections by the IMF are not disaggregated by sector and so, with an exception for the prices of some products (energy products and raw material), we are forced to assume a homogenous evolution inside each country, both for prices and for investments.

The information we collect is specific for each country included in the BTM but, as we describe in the previous sections, the model is 'closed' by also using four different area groups and so we also introduce some assumptions for these 'aggregated economies.' In particular, we decide to consider that the 'rest of the EZ' will move in the same way as the average of the countries included in the BTM that are part of the EZ (Austria, Belgium, France, Germany, Italy, Spain). We also do the same for the other groups.[15]

Capital stock dynamics could not be obtained directly using the data produced by the IMF and so we start with information on investments in each country. The problem here is that the time series are not so long and using a simple cumulating function is not feasible. For this reason, we use a technique called a 'unit bucket' procedure to translate flows into stocks. The procedure could be described by considering that cumulating the new investment with a spill rate *s* to obtain a stock could be considered like filling an empty bucket with a hole. At the very beginning, if we put 1 unit in the bucket s are eliminated and so the level rises rapidly; after some periods (i.e. n periods) we again put 1 unit into the bucket but we spill out $s*n$ units, where $s*n>s$ obviously, and this means that the level does not rise as fast as in the initial steps. The process reaches a steady state when the input is equal to the outflow, and so 1 (the input) is equal to $s*neq$ (where *neq* is the number of periods to reach the equilibrium but it is also the level of water that implies a leakage equal to the inflow). It is easy to see that

$neq = \frac{1}{s}$.

Obviously, after some periods *nef*, let us say $nef<neq$, we have a level that is just a portion of the equilibrium level and we can compute the ratio in order to use it as an adjustment factor:

$$adjust = \frac{\sum_{i=1}^{nef}[(1-s)*input_i]}{neq}$$

In this way, using the adjustment factor we can calculate the equilibrium level using a simple cumulating function. Everything here could be translated to transform the cumulating function applied to investment into the 'hypothetical' equilibrium capital stock, avoiding in this way spending some years before reaching a good estimation of the capital.

[15] For the 'Rest of UE' we use the countries included in the 'Rest of EZ' plus the UK. For the 'Rest of the World' we use the average of all the 14 countries in the BTM. For 'Oil producers' we use the same as the rest of the world except for the price of petroleum.

APPENDIX B

Table B1 – Specialized Machinery import share in the US: estimated parameters

	Share in 2014	constant	price elasticity	capital elasticity	trend
Canada	0.11	-2.13	0	0.244	-0.026
Mexico	0.06	-3.28	0	1.634	0.079
Austria	0.01	-3.77	-1.427	1.374	0.027
Belgium	0.01	-4.36	0	0	-0.066
France	0.03	-3.29	-0.022	3.362	0.02
Germany	0.11	-1.62	-0.56	5.244	0
Italy	0.04	-2.71	0	0.029	-0.044
Spain	0.01	-5.10	0	0.846	-0.018
UK	0.04	-2.83	-0.423	0	-0.042
Japan	0.23	-1.15	-1.156	1.09	0
China	0.08	-3.18	0	1.611	0
Korea	0.07	-3.40	0	0	0.135
Russia	0.00	-7.75	-2.339	6.000	-0.031
REZ	0.06	-2.01	-3.164	0	0
REU	0.04	-3.36	0	1.413	0
OIL	0.00	-6.20	-5.475	6.000	0.153
ROW	0.10	-1.51	-2.075	0.196	0.005

Table B2 – Organic Chemicals import share in the US: estimated parameters

	Share in 2014	constant	price elasticity	capital elasticity	trend
Canada	0.08	-2.652	0	0	0.033
Mexico	0.01	-4.623	0	1.082	-0.055
Austria	0.00	-6.167	-0.103	0	-0.015
Belgium	0.02	-2.307	-6.501	2.896	-0.126
France	0.02	-3.513	-0.313	0	-0.082
Germany	0.05	-2.868	0	2.173	0
Italy	0.02	-3.839	-0.78	3.01	0
Spain	0.01	-4.681	0	0	-0.021
UK	0.06	-2.523	0	0.139	0
Japan	0.06	-2.762	-0.111	3.278	0
China	0.11	-2.941	0	2.987	0
Korea	0.02	-4.082	-1.398	1.701	0.111
Russia	0.00	-6.136	-0.211	0	0
REZ	0.25	-1.098	0	4.524	-0.035
REU	0.01	-4.065	0	6.000	-0.076
OIL	0.01	-3.042	0	6.000	-0.101
ROW	0.29	-1.671	-0.18	0	0.059

Table B3 – Iron and Steel import share in the US: estimated parameters

	Share in 2014	constant	price elasticity	capital elasticity	trend
Canada	0.16	-1.7	-0.4	0	-0.023
Mexico	0.06	-2.447	-0.551	2.676	0
Austria	0.01	-4.527	0	1.606	0.071
Belgium	0.01	-4.502	-0.136	0.401	-0.116
France	0.01	-3.643	-0.514	0	-0.083
Germany	0.05	-2.935	0	0.531	0
Italy	0.04	-3.53	-0.875	0	0.024
Spain	0.01	-3.988	-1.841	0	-0.063
UK	0.02	-3.741	0	0.718	0
Japan	0.08	-2.674	-0.705	0	0.009
China	0.08	-1.883	-4.492	0	0
Korea	0.08	-2.575	-1.614	0	0.077
Russia	0.05	-3.279	0	0	0.052
REZ	0.02	-3.653	-0.233	0.436	0
REU	0.04	-3.265	0	0.245	0
OIL	0.00	-3.465	0	6.000	0.408
ROW	0.28	-1.251	0	0.959	0.007

Table B4 – General Machinery import share in China: estimated parameters

	Share in 2014	constant	price elasticity	capital elasticity	trend
Canada	0.01	-4.65	-0.906	0.473	-0.015
USA	0.12	-2.05	-0.31	0	-0.028
Mexico	0.00	-6.36	0	6.000	0.029
Austria	0.01	-4.60	-2.279	0	0.05
Belgium	0.01	-4.62	-0.322	0	0.016
France	0.04	-3.60	-0.476	0	0.031
Germany	0.24	-1.63	-1.958	0	0.045
Italy	0.05	-3.00	-4.55	0	0.016
Spain	0.01	-4.39	0	5.245	-0.169
UK	0.02	-3.40	0	6.000	-0.216
Japan	0.21	-1.51	-1.247	1.487	0
Korea	0.08	-2.72	0	0.398	0
Russia	0.00	-7.68	-1.515	0.429	0.085
REZ	0.02	-3.61	-6.000	1.762	0
REU	0.04	-3.15	-6.134	0	0.009
OIL	0.00				
ROW	0.12	-1.76	-4.774	1.042	-0.071

Table B5 – Specialized Machinery import share in China: estimated parameters

	Share in 2014	constant	price elasticity	capital elasticity	trend
Canada	0.01	-5.20	0	0.136	-0.024
USA	0.10	-2.49	0	0	0.016
Mexico	0.00	-7.94	0	20	0
Austria	0.02	-4.48	-0.914	0	0.012
Belgium	0.01	-4.61	0	0.458	-0.044
France	0.02	-4.07	0	6.006	0
Germany	0.20	-1.66	-0.523	0.732	0
Italy	0.05	-3.19	-2.602	5.404	0.113
Spain	0.00	-5.73	0	1.212	-0.027
UK	0.01	-4.34	-2.998	0	-0.018
Japan	0.31	-1.13	0	0	0.011
Korea	0.10	-2.58	0	6.000	-0.047
Russia	0.00	-7.77	0	6.000	-0.394
REZ	0.03	-3.43	-1.382	0	0.015
REU	0.02	-3.90	-4.464	0	0.003
OIL	0.00				
ROW	0.13	-1.87	0	6.18	-0.093

Table B6 – Organic Chemicals import share in China: estimated parameters

	Share in 2014	constant	price elasticity	capital elasticity	trend
Canada	0.01	-3.95	-0.283	0	0
USA	0.07	-2.54	-2.075	2.848	-0.02
Mexico	0.00	-5.74	0	3.103	0
Austria	0.00	-8.58	-1.713	2.43	-0.064
Belgium	0.01	-4.22	-0.44	0	-0.03
France	0.01	-4.34	-1.374	0	-0.053
Germany	0.02	-3.69	-1.831	3.214	-0.049
Italy	0.00	-5.92	-0.87	6.000	0.089
Spain	0.01	-5.12	-1.099	0.71	-0.033
UK	0.00	-5.38	0	4.963	-0.02
Japan	0.14	-1.72	-0.074	0	0
Korea	0.23	-1.44	-0.811	1.037	-0.011
Russia	0.01	-3.81	-0.112	0	-0.075
REZ	0.02	-4.14	-1.107	0	-0.058
REU	0.01	-4.51	-1.26	0	-0.026
OIL	0.14	-2.48	-6.000	5.35	0
ROW	0.31	-1.24	-1.669	0.697	0

Table B7 – Iron and Steel import share in China: estimated parameters

	Share in 2014	constant	price elasticity	capital elasticity	trend
Canada	0.00	-6.25	-1.001	0	-0.001
USA	0.03	-3.99	0	0	0.111
Mexico	0.00	-5.55	0	6.000	-0.216
Austria	0.00	-5.26	-5.157	4.206	-0.027
Belgium	0.01	-5.14	0	1.632	-0.027
France	0.02	-4.52	-1.794	1.3	0.066
Germany	0.05	-3.04	-0.951	6.000	0.209
Italy	0.01	-4.24	-4.413	3.04	0
Spain	0.00	-5.53	0	6.000	-0.129
UK	0.01	-4.83	-1.442	2.232	0
Japan	0.36	-1.21	0	0	0.031
Korea	0.19	-1.76	0	0	0
Russia	0.00	-3.70	-1.706	0	0
REZ	0.01	-4.55	-1.403	4.399	0
REU	0.03	-4.06	0	4.88	0.129
OIL	0.00	-13.68	-6.000	0	0
ROW	0.27	-1.12	0	0.236	-0.035