COLLEGIUM OF ECONOMIC ANALYSIS
WORKING PAPER SERIES

Institutional determinants of export competitiveness among the EU countries: evidence from Bayesian model averaging

Beata K. Bierut and Piotr Dybka

Institutional determinants of export competitiveness among the EU countries: evidence from Bayesian model averaging

Beata K. Bierut* Piotr Dybka†

Abstract

Although the impact of institutions has been broadly studied in the literature on economic growth, their impact on international trade is less well-established. We aim to fill this gap by creating an extended database that, apart from price and non-price factors traditionally analyzed as determinants of exports, also includes measures of institutional development. Next, we introduce the Bayesian Model Averaging to establish which factors play the most important role for the export performance. Our results show that institutions have two types of effects on exports: a direct positive effect on the overall export performance (e.g. regulation) as well as a transformational impact on the export structure (from less to more technologically advanced exports, e.g. freedom to trade internationally). Our results also confirm that technological factors (e.g. patents) have a much greater impact on export performance than price factors. Moreover, some technological factors only have a significant transformational impact on the export structure (e.g. R&D expenditure). Human capital also seems to have only a transformational, rather than direct, impact on exports.

Keywords: Trade, price competitiveness, technological competitiveness, institutional environment, Bayesian Model Averaging

JEL: C11, C33, F14, F15

*Narodowy Bank Polski

†Warsaw School of Economics, This project was financed by the National Science Centre, Poland, grant No. 2017/25/N/HS4/01424. Corresponding author (pd50409@sgh.waw.pl).

1 Introduction

International trade has played an important role in the economy, spreading the benefits of global integration and growth (Krueger, 2006). It has therefore been the object of deep study for centuries. (Krugman et al., 2012) even say that the study of international trade and finance is where the discipline of economics as we know it began (p. 1).

While the importance of export for growth is clear, there are some open questions regarding the key drivers of the country's export performance. From the theoretical viewpoint, price factors such as the relative unit labor costs intuitively seem to be the major source of international competitiveness. However, (Kaldor, 1978) pointed to the fact that countries experiencing faster growth in relative unit labor costs and export prices had often outperformed other countries in terms of their export value. This finding has sparked interest in non-price sources of international competitiveness. Although (Fagerberg, 1996) reports that such analyses were undertaken already in the late 1960s following the advent of the neo-technological trade theories, over time, and with the increased availability of more detailed data, the literature evolved to span from analyses focusing on differences across countries (Magnier and Toujas-Bernate, 1994; Madsen, 2008), sectors (Amable and Verspagen, 1995; Montobbio and Rampa, 2005), and finally firms (for a review of firm-level studies see (Dosi et al., 2015)).

Although the importance of institutions is well-established in the economic growth literature (North, 1989; Acemoglu et al., 2005; Rodrik, 2008), the question remains whether institutions are also important for international trade. Only a few most recent studies also look for sources of competitive advantage in other characteristics of exporting countries, and in particular the environment faced by exporters, such as the institutions. (Bournakis and Tsoukis, 2016) and (Bierut and Kuziemska-Pawlak, 2017) provide evidence that price and non-price factors traditionally highlighted as important determinants of export performance, i.e. relative unit labor costs, R&D expenditure as a share of GDP and patent applications per million population, maintain their significance. Both papers also document the significance of institutional factors (overall regulatory quality, barriers to entry, barriers to competition, barriers to FDI, quality of the legal system and protection of property rights) for export performance. (Bournakis and Tsoukis, 2016) also show the importance of human capital and a non-linear, hump-shaped impact of government size (measured by tax receipts as a share of GDP) on export activity.

The lack of consensus on major determinants of export performance is our main motivation to attempt a unification of previous findings. Our main contribution to existing literature involves the application of Bayesian Model Averaging (BMA) that, according to our best knowledge, has not been used in the context of export performance before. The attractiveness of this approach consists mainly in the fact that it allows estimation of the probability of their inclusion in the optimal model. This way we can verify, which variables have a high probability of inclusion and constitute major determinants of export market share. Furthermore, instead of estimating just

one model, we test all the possible combinations of models within the BMA framework, which means that our results are robust with respect to variable selection uncertainty. To fully utilize the BMA approach we have created a large database with various potential determinants of export performance identified on the basis of a literature review.

Bayesian model averaging (BMA) is a well-established tool in studies of economic growth. For example, the seminal contribution by (Sala-I-Martin et al., 2004) (where the proposed approach is called Bayesian Averaging of Classical Estimates - BACE) shows evidence of a significant impact of human capital, the relative price of investment goods and the initial level of income on long-term growth of GDP per capita in a cross-country comparison. Later, the BMA was introduced to the context of current account analysis by (CaZorzi et al., 2012), followed by (Moral-Benito and Roehn, 2016) and (Dybka and Rubaszek, 2017). Since trade account is a part of the balance of payments, export performance directly affects the current account balance. From this perspective, factors affecting trade should also have an impact on the current account and vice versa. It is worth noting that (Dybka and Rubaszek, 2017) show that REER cannot be regarded as the main driver of the external balance, and implicitly international competitiveness. Their results show that the intertemporal factors (i.e. stage of development, fiscal balance, demographics) are crucial to understanding current account developments.

The article is structured as follows. Section 2 provides the general outline of the economic theory underlying our analysis and section 3 describes the econometric methodology. In section 4 we discuss potential determinants of export market share and their expected signs, whereas section 5 presents our results. Section 6 concludes.

2 The economic theory

We begin with the well-established gravity equation of international trade (see e.g. Fratianni, 2009; Krugman et al., 2012). (Head and Mayer, 2014) present the following simple general formulation of gravity equations:

$$X_{n,i} = GS_i M_n \phi_{n,i} \tag{1}$$

where $X_{n,i}$ denotes bilateral trade between exporter i and importer n, S_i measures capabilities of exporter i as a supplier to all destinations, M_n captures all characteristics of destination market n that promote imports from all sources, $\phi_{n,i}$ measures bilateral accessibility of n to exporter i and G denotes gravitational constant (p. 137). In the analysis of the overall performance of exporter i the whole world becomes the destination market n. In order to remove the need to specify the characteristics of the world demand for exports from country i, we express the model in relative terms (see also e.g. Carlin et al., 2001; Bierut and Kuziemska-Pawlak, 2017):

$$\frac{X_{n,i}}{X_{n,EU}} = \frac{GS_i M_n \phi_{n,i}}{GS_{EU} M_n \phi_{n,EU}} = \frac{S_i}{S_{EU}} * \frac{\phi_{n,i}}{\phi_{n,EU}} \tag{2}$$

which implies that the trade performance of the EU country i relative to the whole group (the export market share) depends on its relative export capabilities and relative ease of access to world markets. Apart from its simplicity, such an empirical approach has two major advantages. The first one is essential: since the seminal model by David Ricardo, the drivers of international trade are seen in relative, rather than absolute, terms (the concept of comparative advantage in international trade). Falling unit labor costs or increasing patents can still lead to a lower export performance if other countries reduce their labor costs or increase their number of patents at a faster rate. The second one is technical: expressing the variables in relative form diminishes the multicollinearity problem that we would face in models with a large number of explanatory variables later assessed in the BMA framework. Additionally, expressing variables in relative terms also means that any impact a global shock may have on export performance cancels out; hence, our results are robust to global shocks.[1]

In our empirical analysis we will consider three types of export capabilities: measures of relative price competitiveness, measures of relative innovativeness/technological capability and production potential of the home economy. We also consider measures of the relative quality of the institutional environment, some of which can be seen as related to export capabilities (e.g. measures of the flexibility of labor and product markets), some related to the relative ease of access to world markets (e.g. measures of trade openness). Specifically, we will estimate models in the following relative form:

$$X_{i,t} = \alpha_i + \beta_1 P_{i,t} + \beta_2 T_{i,t} + \beta_3 Y_{i,t} + \beta_4 I_{i,t} + ... + \epsilon_{i,t} \tag{3}$$

where $X_{i,t}$ denotes the export market share of country i in time t, $P_{i,t}$ - a measure of relative cost/price competitiveness, $T_{i,t}$ a measure of relative innovativeness/technological capability, $Y_{i,t}$ a measure of relative production potential, $I_{i,t}$ a measure of the relative quality of the institutional environment, α_i the individual constant and $\epsilon_{i,t}$ - an error term. Furthermore, in a sensitivity analysis, we also consider interaction terms as well as the squares of the institutional variables (to account for any potential non-linearities).

3 Econometric methodology

Instead of estimating a single model, where results can be significantly influenced by the selection of the variables, we use the Bayesian model averaging (BMA) framework, which allows accounting for model uncertainty. Since there is an open discussion on what determines export performance, BMA seems to be an appropriate method to investigate this issue.

The general idea of BMA is to compute the posterior probability of model j, $P(M_j|y)$. This probability is conditional on the marginal likelihood of the model j, $l(y|M_j)$, prior beliefs regarding the probability of the model j, $P(M_j)$, as well as marginal likelihoods and prior probabilities of

[1] Although country-specific shocks remain the element of the error term.

the remaining models.[2] The formula for the posterior probability is:

$$P(M_j|y) = \frac{l(y|M_j)P(M_j)}{\Sigma_{i=1}^{2^K} l(y|M_i)P(M_i)} \tag{4}$$

The first important decision within the BMA framework relates to the choice of the model prior probability $P(M_j)$. The most intuitive choice would be to assume that each variable is independently included in the model with probability θ (and omitted with probability $1-\theta$). Under such an assumption the prior probability of M_j is given by Binomial distribution and depends on the number of regressors included in the model (K_j):

$$P(M_j) = \theta^{K_j}(1-\theta)^{K-K_j} \tag{5}$$

It should be noted that for a given θ the expected model size is θK and therefore, if we want the expected model size to be K^*, then we need to fix the inclusion probability at:

$$\theta = \frac{K^*}{K} \tag{6}$$

Another possible approach is to assume that θ is a random variable and is drawn from a Beta distribution (Binomial-Beta prior, see Ley and Steel (2007)):

$$\theta \sim \ Beta(a, b) \tag{7}$$

This change allows for reducing the impact of prior assumptions regarding the expected model size on the posterior probabilities $P(M_j|y)$. The reason is that the prior probability of models with different number of regressors becomes flatter in comparison to the situation in which we take the fixed value of θ. Furthermore, if we set $a = 1$ and $b = 1$, we get a (discrete) uniform prior probability for each model size, which minimizes the influence of prior assumptions on the results.

The second important decision within the BMA framework relates to the framework of prior assumptions regarding the estimation of the coefficients. We use the set of assumptions called *Zellners g-prior* (Zellner, 1986). In general, this approach focuses on a g hyperparameter that denotes the strength of the researchers prior belief that the estimated coefficients are equal to 0 (higher value of g means that our prior assumptions have a lesser impact on the results). Discussion of the optimal choice of the g-prior can be found in (Ley and Steel, 2007). In our estimations, we use the codes provided by (Zeugner and Feldkircher, 2015). Our baseline scenario takes discrete uniform prior probability for each model size and the Unit Information Prior.

In our analysis we follow the rule used by (Moral-Benito and Roehn, 2016), based on (Jaffreys, 1961; Kass and Raftery, 1995), stating that if the posterior inclusion probability lies between 95%

[2]The number of models assessed in the BMA framework is equal to 2^K, which is the number of possible combinations of K explanatory variables.

and 100% it constitutes evidence of the regressor having a strong impact.

Finally, in order to verify the robustness of our results, we conduct the sensitivity analysis concerning the choice of the prior assumptions in the BMA framework. In the first alternative (named conservative) we choose the most conservative set of prior assumptions, which means that reaching the PIP threshold of 95% is more difficult for each variable. We assume a fixed and a low number of expected variables (three) to be included in the model and we also use the Risk Inflation Criterion (RIC) for the choice of the optimal g-prior proposed by (Foster and George, 1994). Such criterion results in lower values of g-prior and thus strengthens our prior assumption that estimated coefficients are equal to 0. The second alternative set of assumptions is the least conservative, where we assume a fixed and a high number of expected variables (number of variables available for selection minus three) to be included in the model.

4 Potential determinants of export performance

The list of potential export market share determinants that we use in our regressions, and their expected impact, is as follows:

- **Unit Labour Cost (ULC)**. Increase in the production costs per unit of output reduces price competitiveness of exports. Expected sign: negative (see also: Amable and Verspagen, 1995; Carlin et al., 2001; Bournakis and Tsoukis, 2016).
- **Std. dev. of NEER**. High volatility of the value of the currency increases the volatility of export revenues (and potentially input costs) and hence makes it more difficult and risky to plan export production and sales, discouraging export activity. Expected sign: negative.
- **Potential GDP**. The increase in production capacities allows increasing exports. Expected sign: positive (see e.g. Bierut and Kuziemska-Pawlak, 2017).
- **Capital output ratio**. The more capital is available for production, the more productive can the economy be. Expected sign: positive (see e.g.: Madsen, 2008).
- **FDI stock**. Larger accumulated FDI stock means that the country was successful in attracting additional - foreign - investment, which should increase production and technological potential of its economy, and therefore its exports. Expected sign: positive (see e.g. Magnier and Toujas-Bernate, 1994; Amable and Verspagen, 1995; Dosi et al., 2015).
- **R&D expenditure**. Increased investment in the development of new technologies should increase the technological competitiveness of exports. Expected sign: positive (see e.g. Magnier and Toujas-Bernate, 1994; Dosi et al., 2015; Bournakis and Tsoukis, 2016).
- **Patent applications**. Development of new technologies should increase the technological competitiveness and therefore the export capacity of the country. Expected sign: positive

(see also: Amendola et al., 1993; Amable and Verspagen, 1995; Bierut and Kuziemska-Pawlak, 2017).

- **School life expectancy**. Higher human capital should boost productivity of the economy and thereby also exports. Expected sign: positive (see e.g. Carlin et al., 2001).
- **Population with tertiary education**. As in the case of school life expectancy, higher human capital should boost productivity of the economy and thereby also exports. Expected sign: positive (see e.g. Bournakis and Tsoukis, 2016).
- **Size of Government**. This variable broadly measures the extent to which the government and politics affect economic processes. Significant interference of government in the economy can lead to market distortions and inefficient asset allocation and hence can negatively affect exports. Expected sign: positive (higher values mean more economic freedom; see also Bournakis and Tsoukis, 2016).
- **Legal System and Property Rights**. High-quality legal and judicial systems, as well as strong protection of (property) rights, decrease the operating risks for firms and can increase their exports. Expected sign: positive (see e.g. Ma et al., 2010).
- **Sound Money**. This variable broadly measures the stability of the value of money and hence aids planning of production and sales, also for exports; moreover, it supports cost competitiveness and provides mechanisms to reduce the volatility of export revenues. Expected sign positive.
- **Freedom to Trade Internationally**. This freedom is the necessary condition for the existence of exports. Expected sign: positive.
- **Regulation**. Higher quality of regulation, i.e. lower restrictions on the functioning of market mechanisms, boosts economic activity, and potentially also exports. Expected sign: positive (see also: Crozet et al., 2016; Bierut and Kuziemska-Pawlak, 2017).

To provide the highest possible coverage of various measures of economic and institutional development we used data from several sources. In general, data for manufactures exports and FDI comes from UNCTAD databases, whereas technological and macroeconomic variables come from Eurostat, AMECO and the World Bank. Institutional indices are obtained from the Fraser Institutes Economic Freedom of the World Index database. Our dataset covers the period 1995-2016 for 28 countries. The variables used in the analysis were stationary (see Table 5 in the Appendix for the results of the (Levin et al., 2002) panel unit root test).

Table 1: Definitions of variables used in the analysis

Variable	**Description**	**Source**
Total manufactures	Value of manufactured goods exports in USD	UNCTAD
Labour-intensive and resource-intensive manufactures	Value of Labour-intensive and resource-intensive manufactured goods (UNCTAD classification) exports in USD	UNCTAD
Low-skill and technology-intensive manufactures	Value of Low-skill and technology-intensive manufactured goods (UNCTAD classification) exports in USD	UNCTAD
Medium-skill and technology-intensive manufactures	Value of Medium-skill and technology-intensive manufactured goods (UNCTAD classification) exports in USD	UNCTAD
High-skill and technology-intensive manufactures	Value of High-skill and technology-intensive manufactured goods (UNCTAD classification) exports in USD	UNCTAD
ULC	Real Unit Labour Cost, AMECO definition: (Compensation of employees/Number of employees)/(GDP at market prices/Total number of employed)	Eurostat
Capital output ratio	Net capital stock per unit of Gross Domestic Product at constant prices (%)	AMECO database
Potential GDP	Potential Gross Domestic Product at 2010 reference levels	AMECO database
R&D expenditure	Value of Research & Development expenditure (% of GDP)	Eurostat
FDI stock	Foreign direct investment, stock (% of GDP)	UNCTAD
Patent applications	Number of patent applications to the European Patent Office (per million population)	Eurostat, EPO
Std. dev. of NEER	Standard deviation of Nominal Effective Exchange Rate	Eurostat
School life expectancy	School life expectancy, primary to tertiary (years)	The World Bank
Population with tertiary education	Share of population with tertiary education attainment (%)	Eurostat
Size of Government	Fraser Institute, Economic Freedom of the World Index dataset	
Legal System and Property Rights	Fraser Institute, Economic Freedom of the World Index dataset	
Sound Money	Fraser Institute, Economic Freedom of the World Index dataset	
Freedom to Trade Internationally	Fraser Institute, Economic Freedom of the World Index dataset	
Regulation	Fraser Institute, Economic Freedom of the World Index dataset	

Notes: BMA methodology requires that a change in the specification (i.e. selecting different variables) does not alter the dataset composition. This means that for each variable in the sample, the same range of the data must be available. Otherwise, it would not be possible to evaluate whether a change in the posterior inclusion probability is the result of a better fit of the selected variables or a change in the sample (e.g. increase in the number of available observations). As a result, in some cases we had to impute the data (using linear trend if data were available before and after the missing value) or use forecasts.

Figure 1 presents percentage point changes in export market shares for the EU countries between 1995 and 2016. Around half of the EU countries did not experience any substantial changes in their export positions over this period. However, some countries (notably Poland, the Czech Republic and Hungary, marked green in the figure) substantially increased their export market shares, while

others (the United Kingdom, France and Italy, marked red) saw a significant deterioration of their export position.

Figure 1: Changes in export market shares of the EU countries (1995-2016)

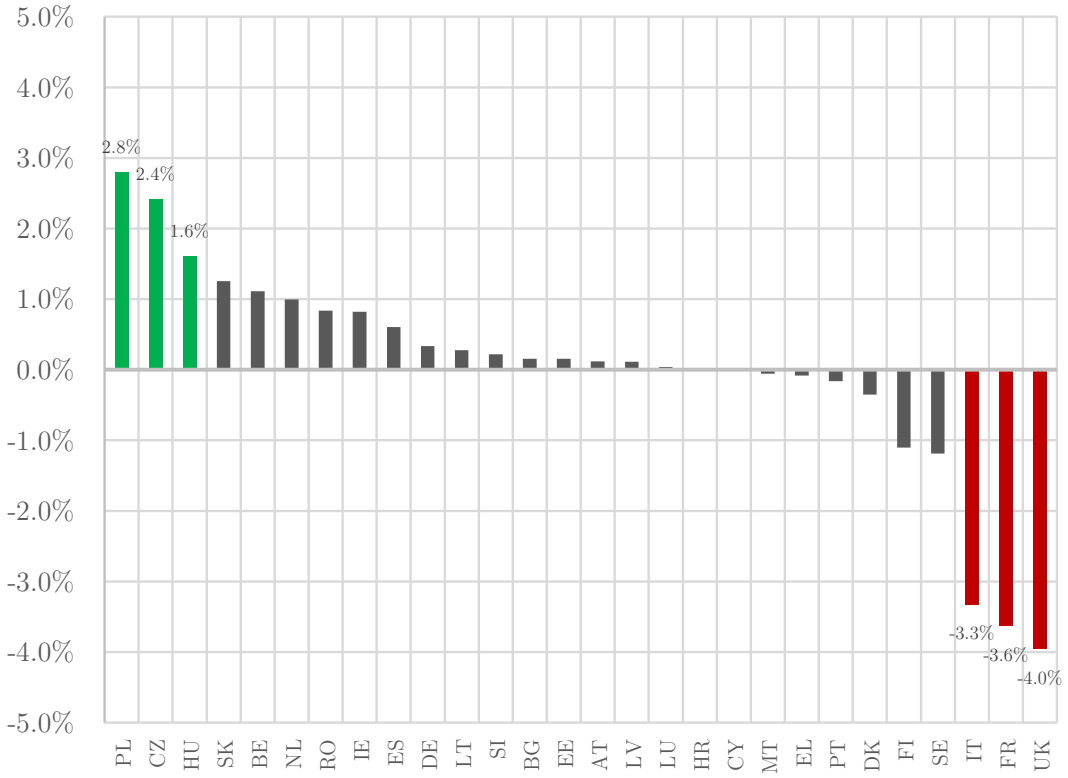
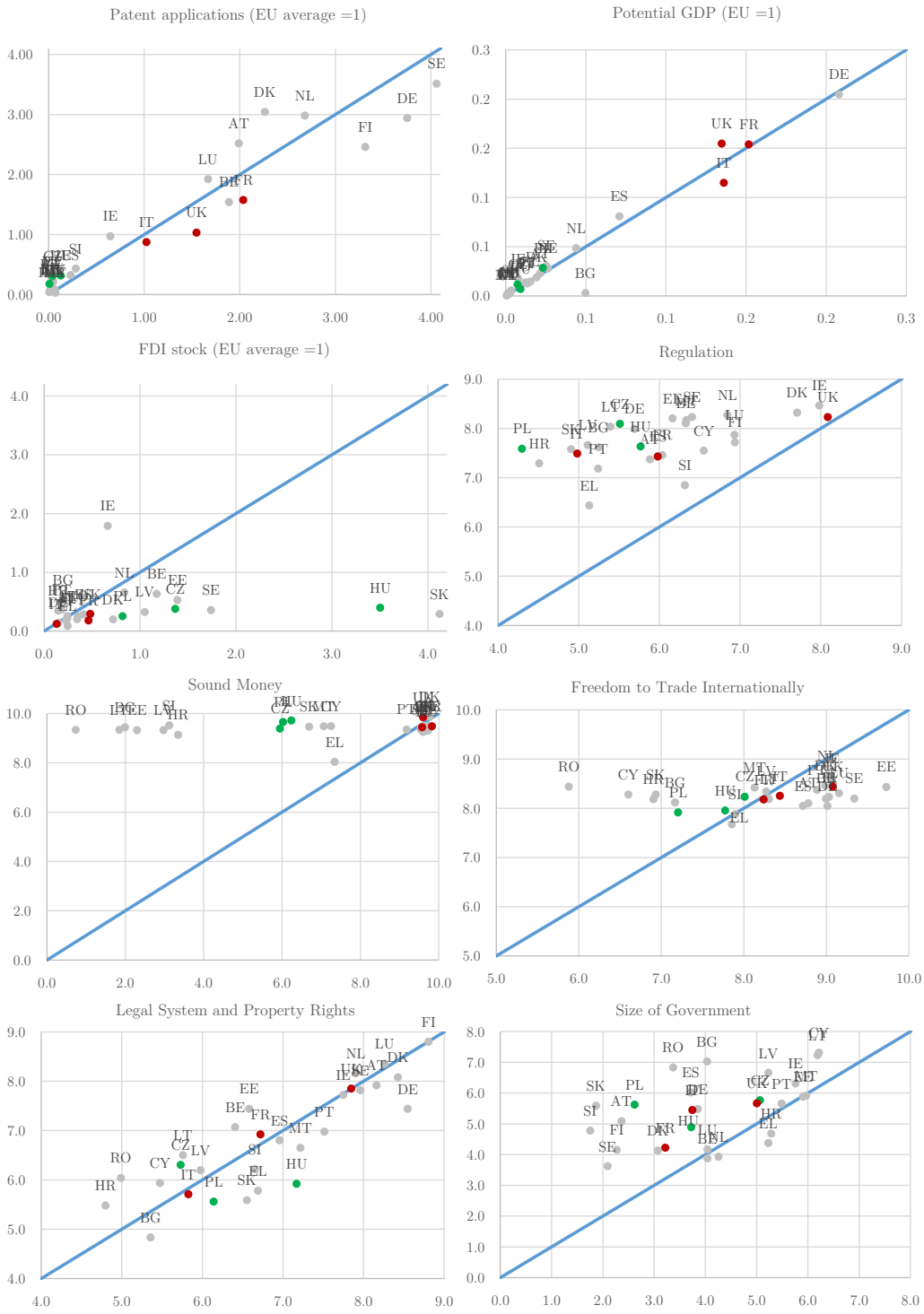


Figure 2 illustrates the development of selected export market share drivers over the same 20-year period of time. The charts show that the success of the countries that noticeably increased their export market shares was mainly associated with improvements in their institutional environment, in particular Regulation, Sound Money and Size of Govermnent. Moreover, Poland, the Czech Republic and Hungary also improved their relative position in terms of patent applications and openness to trade. The large deterioration in the export position of the United Kingdom, France and Italy also seems to have been mainly associated with relatively worse performance in patenting activity.

Figure 2: Develoment of selected export market share drivers in the EU countries (2016 versus 1995)



Notes: The x axes denote the level of the export market share driver in 1995, and the y axes - the level in 2016. Countries depicted by the points lying above the 45-degree line experienced an improvement in the particular export driver.

5 The results

We begin this section with our baseline results and their sensitivity analysis. Next, we investigate the impact of institutional factors on exports in more detail. We employ two approaches. First, we investigate the impact of narrower categories of institutional factors, as defined by the Fraser Institute. Secondly, we discuss whether the institutional factors have a non-linear or indirect impact on exports.

5.1 Baseline results

Our results presented in Table 2 indicate that price factors have a limited impact on the overall export performance of the EU countries. This is in contrast to our hypothesis and can be due to the specific characteristics of the analyzed group of countries. In the case of the Western European countries, low price sensitivity of exports is most likely related to their specialization in high-tech exports (which is also confirmed by a highly significant impact of the technological factors on their export performance). In the case of the catching-up Eastern European countries, the results may be stemming from the paradox discussed in (Kaldor, 1978).

Table 2: Baseline results for different categories of exports

	Total manufactures		**Labour-intensive and resource-intensive manufactures**		**Low-skill and technology-intensive manufactures**		**Medium-skill and technology-intensive manufactures**		**High-skill and technology-intensive manufactures**	
	PIP	P. mean	PIP	P. mean	PIP	P. mean	PIP	P. mean	PIP	P. mean
Price competitiveness										
Std. dev. of NEER	0.17	-0.003	0.10	-0.001	0.1	0	0.78	-0.035	0.15	-0.003
ULC	0.06	-0.003	0.08	-0.003	0.92	-0.503	0.08	0.006	0.08	0.009
Technological factors and human capital										
Patent applications	**1.00**	**0.270**	**1.00**	**0.220**	**1.00**	**0.279**	**1.00**	**0.338**	**1.00**	**0.322**
Potential GDP	**1.00**	**0.278**	0.09	0.002	**1.00**	**0.203**	**1.00**	**0.297**	**1.00**	**0.457**
FDI stock	**1.00**	**-0.092**	**1.00**	**-0.210**	0.34	-0.013	**1.00**	**-0.153**	**0.95**	**-0.091**
Capital output ratio	0.28	-0.057	0.13	-0.014	**0.99**	**-0.426**	0.11	0.013	0.24	-0.063
School life expectancy	0.21	0.067	0.80	-0.432	**1.00**	**0.871**	0.16	0.047	0.54	0.313
R&D expenditure	0.14	0.009	**1.00**	**-0.241**	0.75	0.107	0.62	0.093	0.94	0.225
Population with tertiary education	0.11	0.007	0.90	-0.175	0.77	-0.137	0.14	0.013	0.68	0.151

Institutional factors										
Regulation	**1.00**	**0.852**	**1.00**	**1.107**	0.54	0.208	**1.00**	**1.205**	**0.99**	**0.920**
Sound Money	**1.00**	**0.238**	**1.00**	**0.374**	0.37	0.039	**1.00**	**0.411**	0.12	0.009
Freedom to Trade Internationally	0.70	0.458	**1.00**	**-1.344**	0.71	-0.463	**1.00**	**1.364**	**1.00**	**1.771**
Legal System and Property rigths	0.47	-0.201	0.08	0.000	0.21	0.058	0.13	-0.035	0.60	-0.390
Size of Government	0.46	0.073	**1.00**	**0.293**	0.52	-0.083	0.88	0.241	0.22	0.037

Notes: PIP and P. mean denote posterior inclusion probability and posterior mean, respectively. The results for regressors with a strong impact on exports (PIP between 0.95 and 1.00) were bolded for convenience.

In our study, we have used both the data on the number of patent applications as well as expenditure on research and development (R&D). Earlier literature often focused on either R&D expenditure (e.g. Magnier and Toujas-Bernate, 1994; Anderton, 1999)) or number of patents (e.g. Amendola et al., 1993; Amable and Verspagen, 1995) and usually showed positive and statistically significant results. However, when both R&D expenditure and patents were used the obtained results were less clear - (Wakelin, 1998) showed that both variables had a positive and statistically significant effect on export performance, whereas (Carlin et al., 2001) reported that neither R&D expenditure nor the number of patents had a statistically significant impact. Our results provide some insight into this discussion. In general, the measure of patent applications proves to be a much better variable to analyze technological competitiveness as regards trade in manufactured goods, as its posterior inclusion probability (PIP) is equal to 1 (meaning that among the top 500 models, this variable was included in all the cases), whereas R&D expenditure has a very low PIP. Such results can be viewed as evidence that R&D investment is more likely to be only indirectly beneficial for export performance, i.e. when it is successful, resulting in a large number of patent applications. The analysis of exports of different types of manufactured goods shows that patent applications have a strong impact on all types of exports and that it increases with their technological intensity. As far as the R&D expenditure is concerned, its impact is strong only in the case of labor-intensive and resource-intensive manufactures. The estimated effect is negative, confirming the R&Ds indirect impact on exports: R&D expenditure appears to be rather used to specialize in the production and exports of more technologically advanced goods. As a result, the increase in R&D expenditure can be associated with the process of a technological upgrading of the manufactures, thus resulting in a decrease in the value of low skill and technology intensive exports.

In addition to technological factors, the potential GDP also has a strong positive impact on export performance. The strength of this effect increases with the level of technological intensity of exports, which indicates that higher potential GDP is often associated with more technology-intensive manufactures. The results for the other two variables related to the productive potential of the economies are in contrast to our hypotheses. The impact of the capital output ratio on

exports is insignificant, while the impact of the FDI stock is significantly negative; its strength decreases with the technological intensity of exports. It, therefore, seems that the negative impact of FDI stock on exports stems from the type of FDI inflows into the EU countries (mainly into services and manufacturing) and their transformational impact on the production structure in host countries (away from agriculture, mining and quarrying and into manufacturing and services). For a general discussion on the impact of FDI on home and host countries, see (Lipsey, 2002). The results regarding human capital are also in contrast to our hypotheses: human capital does not have a strong direct impact on export performance of the EU countries. However, it seems again to have an indirect impact, as a factor transforming their production and export structure. Longer school life expectancy appears to reduce exports of labour- and resource-intensive exports, while increasing exports of other types of manufactures (especially the low-skill and technology-intensive ones). The share of the population with tertiary education has a similar, albeit not strong, impact on the export performance.

Our analysis shows that institutional factors also play an important role in shaping the international manufacturing export competitiveness. Similarly to some of the factors discussed above, institution can affect the export performance in two ways: directly stimulating exports or transforming export structures.

The regulatory environment belongs to the first category, as we can observe a significant positive impact of the quality of regulations on the export performance. Sound Money, which supports and preserves gains from trade, also appears to have a strong positive impact on exports.

Contrary to our hypotheses, Legal System and Property Rights as well as the Size of Government do not seem to strongly affect exports. The link between Freedom to Trade Internationally and export performance also seems to be rather weak. The explanation of that result unravels when specific types of goods are considered. Freedom to Trade Internationally has a strong and negative impact on the labor-intensive and resource-intensive manufactures. This result stems from the fact that there is little room for differentiation in case of such goods. As a result, lack of trade barriers (such as tariffs, quotas etc.) means that domestic producers of such goods face fierce competition from foreign producers, mostly focusing on price, thus decreasing their profit margins. This, in turn, provides incentives to move to more skill- and technology-intensive production. Indeed, our results present strong evidence that higher Freedom to Trade Internationally stimulates exports of the medium and high-skill and technology-intensive manufactures. In the context of the EU, this result is also related to the emergence of the European supply chains and their impact on production and export structures in participating countries. It seems therefore that Freedom to Trade Internationally can be associated with the transformation of the export structures - removing obstacles to trade pushes producers to specialise in more skill- and technology-intensive manufactures.

Table 3: Sensitivity analysis of baseline results for total manufactures exports

	Baseline assumptions		**The most conservative assumptions**		**The least conservative assumptions**	
	PIP	P. mean	PIP	P. mean	PIP	P. mean
Price competitiveness						
Std. dev. of NEER	0.17	-0.003	0.08	-0.001	0.01	0.32
ULC	0.06	-0.003	0.02	-0.001	0.02	0.14
Technological factors and human capital						
Patent applications	**1.00**	**0.27**	**1.00**	**0.271**	**1.00**	**0.266**
Potential GDP	**1.00**	**0.278**	**1.00**	**0.279**	**1.00**	**0.274**
FDI stock	**1.00**	**-0.092**	**1.00**	**-0.088**	**1.00**	**-0.096**
Capital output ratio	0.28	-0.057	0.13	-0.026	0.53	-0.106
School life expectancy	0.21	0.067	0.11	0.037	0.37	0.109
R&D expenditure	0.14	0.009	0.04	0.002	0.34	0.024
Population with tertiary education	0.11	0.007	0.06	0.005	0.20	0.011
Institutional factors						
Regulation	**1.00**	**0.852**	**1.00**	**0.866**	**1.00**	**0.84**
Sound Money	**1.00**	**0.238**	**1.00**	**0.249**	**1.00**	**0.223**
Freedom to Trade Internationally	0.70	0.458	0.50	0.322	0.89	0.588
Legal System and Property rigths	0.47	-0.201	0.28	-0.124	0.67	-0.274
Size of Government	0.46	0.073	0.37	0.063	0.61	0.088

Notes: PIP and P. mean denote posterior inclusion probability and posterior mean, respectively. The results for regressors with a strong impact on exports (PIP between 0.95 and 1.00) were bolded for convenience.

The results presented in Table 3 show that our findings are largely robust to different prior assumptions used in the BMA. The same holds true for the results obtained for different categories of exports: they are also robust with respect to the prior assumptions in the BMA framework.

5.2 Results on the basis of extended sets of regressors

In this section, we add to our analysis more detailed sub-indices measuring different aspects of institutional quality from the Fraser Institute. At the same time, we drop the general institutional quality measures, as they are often (linear) combinations of the included sub-indices. The findings presented in Table 4 show that including more detailed institutional sub-indices does not lead to significant changes in results obtained for price competitiveness, technological factors as well as human capital.

Table 4: Results for the extended set of regressors

	Total manufactures		**Labour-intensive and resource-intensive manufactures**		**Low-skill and technology-intensive manufactures**		**Medium-skill and technology-intensive manufactures**		**High-skill and technology-intensive manufactures**	
	PIP	P. mean	PIP	P. mean	PIP	P. mean	PIP	P. mean	PIP	P. mean
Price competitiveness										
Std. dev. of NEER	0.05	-0.001	0.04	0.000	0.02	0.000	0.31	-0.011	0.04	0.000
ULC	0.04	0.004	0.04	-0.001	0.67	-0.340	0.13	0.045	0.29	0.149
Technological factors and human capital										
Patent applications	**1.00**	**0.240**	**1.00**	**0.197**	**1.00**	**0.262**	**1.00**	**0.321**	**1.00**	**0.304**
Potential GDP	**1.00**	**0.351**	0.05	0.003	**0.99**	**0.204**	**1.00**	**0.400**	**1.00**	**0.518**
FDI stock	0.98	-0.074	**1.00**	**-0.143**	0.04	-0.001	**0.99**	**-0.086**	0.40	-0.028
Capital output ratio	0.18	-0.033	0.04	-0.001	0.56	-0.188	0.07	0.011	0.20	-0.062
School life expectancy	0.05	0.007	0.90	-0.566	**1.00**	**0.928**	0.03	0.004	0.10	0.042
R&D expenditure	0.04	0.001	**1.00**	**-0.300**	0.43	0.054	0.11	0.010	0.57	0.103
Population with tertiary education	0.04	0.001	0.76	-0.156	0.19	-0.028	0.10	0.012	0.59	0.161
Institutional factors										
Regulatory trade barriers	**1.00**	**0.815**	**1.00**	**0.644**	0.61	0.214	**1.00**	**0.985**	**1.00**	**1.066**
Tariffs	**1.00**	**0.712**	0.04	-0.001	0.04	-0.006	**1.00**	**1.018**	**1.00**	**1.565**
Inflation	**1.00**	**0.240**	**0.99**	**0.255**	0.03	0.001	**1.00**	**0.346**	0.25	0.052
Judicial independence	**0.99**	**-0.252**	0.34	-0.054	0.03	-0.001	0.23	-0.043	0.30	-0.078
Credit market regulations	0.86	0.174	0.62	0.127	0.06	0.006	**1.00**	**0.446**	0.05	0.005
Labor market regulations	0.74	0.148	0.25	0.043	0.17	0.028	0.05	-0.005	0.72	0.260
Government consumption	0.70	-0.070	0.05	0.002	0.47	-0.052	0.10	-0.007	0.27	-0.031

Business regulations	0.53	0.158	0.85	0.371	0.03	0.002	0.25	0.080	0.74	0.408
Money growth	0.48	0.035	**1.00**	**0.184**	0.86	0.081	0.04	0.001	0.09	0.010
Top marginal tax rate	0.15	0.008	0.33	0.023	0.09	-0.004	0.04	0.001	0.16	0.012
Integrity of the legal system	0.14	-0.022	0.18	-0.034	0.10	0.017	0.94	-0.409	0.03	-0.001
Government enterprises and investment	0.13	0.007	0.07	0.003	0.03	-0.001	0.46	0.046	0.15	0.013
Controls of the movement of capital and people	0.10	-0.005	1.00	-0.185	**0.98**	**-0.110**	0.05	-0.002	0.05	-0.002
Standard deviation of inflation	0.09	-0.005	0.05	0.003	0.05	0.001	0.08	0.005	0.11	-0.016
Transfers and subsidies	0.05	0.002	0.08	0.005	0.31	-0.040	0.08	0.006	0.04	-0.002
Impartial courts	0.04	-0.001	0.06	-0.004	0.05	-0.003	0.06	-0.005	0.71	-0.190
Protection of property rights	0.04	0.001	0.04	0.001	0.07	0.008	0.19	0.045	0.09	-0.018

Notes: PIP and P. mean denote posterior inclusion probability and posterior mean, respectively. The results for regressors with a strong impact on exports (PIP between 0.95 and 1.00) were bolded for convenience.

As regards the result for institutional factors, the more detailed analysis confirms the general conclusion that some institutions play an important role in driving manufacturing exports' competitiveness on international markets, both directly stimulating exports as well as transforming export structures. The strong direct impact of Regulation on the export performance appears to mainly stem from the importance of credit market regulations (which affect the ease of access to financing), while labor, and in particular business, market regulations are less important. Low and stable inflation appears to be the most important sub-index of sound monetary conditions for boosting the export performance of the EU countries. As regards Freedom to Trade Internationally, both regulatory trade barriers and tariffs have a significant impact on the overall export performance. They also have some transformational effect on exports as their importance varies with the skill- and technology-intensity of exports. The reduction of regulatory trade barriers and tariffs is more beneficial for exports of more technologically advanced goods. As regards the sub-indices of Legal System and Property Rights, most of them (Impartial courts, Protection of property rights, Integrity of the legal system) do not have an important impact on the export performance, while the impact of higher Judicial independence appears to be negative. These results are highly puzzling and in contrast to our hypotheses. Finally, as in the case of the overall measure of the Size of the Government, its sub-indices (Government consumption, Transfers and subsidies, Government enterprises and investment, Top marginal tax rate) do not seem to strongly affect exports.

We have also studied the effect of potential non-linearities and interactions terms (see the Appendix), however our results indicate that there is a rather limited evidence of (selective) non-

linear effects of institutions on export performance. Interactions appear to have some meaning in the case of the more skill-intensive and technology-intensive manufactures, where institutions can indirectly affect the export performance by modifying the impact of non-price factors such as the R&D expenditure and the FDI stock. These results are stable with respect to the prior assumptions within the BMA framework.

6 Conclusions

Economic literature analyzing export performance focuses mostly on price competitiveness and, since the seminal finding of (Kaldor, 1978), on technological factors. Our results confirm that it is indeed incorrect to look at international competitiveness only in terms of price factors. We show that technological factors have a much greater impact on the export market share. Our results provide some insight into the discussion in the earlier literature as to whether patent applications or R&D expenditure should be more important as a driver of exports. We provide evidence that R&D is more likely to be only indirectly beneficial for export performance, i.e. when it is successful, resulting in a higher number of patent applications. We also prove the significance of the size of the production capacity, measured by potential GDP, for exports of the EU countries.

A more detailed analysis of different types of manufactures exports allows us to add an important new finding to the literature on the technological drivers of exports. We show that technological factors can have a significant transformational impact on the export structure, even those that do not have a significant positive impact on overall exports. Our results indicate that R&D expenditure tends to decrease the share of less technology intensive exports, while patent applications and potential GDP give a stronger boost to more skill- and technology-intensive exports.

Our results moreover show that institutions should be analyzed as important factors determining export performance, especially as regards the EU countries. Similarly to the technological factors, institutions can have both a direct positive effect on overall exports as well as a transformational impact (from less to more technologically advanced exports). We show that overall manufactures exports benefit most from higher quality of regulation (especially of the credit market) and institutions safeguarding the stability of the value of money (especially those keeping inflation low and stable). The positive impact of sound regulation on exports is actually the highest among all the factors included in our analysis. At the same time, freedom to trade internationally has a significant transformational impact on the structure of the exports of the EU countries.

We also show that human capital has a transformational, rather than direct, impact on exports. Finally, we find little evidence for non-linearities or interactions regarding the influence of institutions on export performance.

Acknowledgements: We would like to express our deep gratitude to Professor Micha Rubaszek for his support and valuable comments. This paper also benefited from discussions with participants of 10th International Conference Economic Challenges in Enlarged Europe in Tallinn and participants of the seminar organised by Financial Markets Modelling Unit at SGH Warsaw School

of Economics. Any remaining errors remain ours. The views expressed are those of the authors and do not necessarily reflect the views of Organizations that Authors are affiliated with. This project was financed by the National Science Centre, Poland, grant No. 2017/25/N/HS4/01424.

References

Acemoglu, D., Johnson, S., and Robinson, J. A. (2005). Chapter 6: Institutions as a Fundamental Cause of Long-Run Growth. volume 1 of *Handbook of Economic Growth*, pages 385 – 472. Elsevier.

Amable, B. and Verspagen, B. (1995). The role of technology in market shares dynamics. *Applied Economics*, 27(2):197–204.

Amendola, G., Dosi, G., and Papagni, E. (1993). The dynamics of international competitiveness. *Review of World Economics (Weltwirtschaftliches Archiv)*, 129(3):451–471.

Anderton, B. (1999). Innovation, product quality, variety, and trade performance: an empirical analysis of Germany and the UK. *Oxford Economic Papers*, 51(1):152–167.

Bierut, B. K. and Kuziemska-Pawlak, K. (2017). Competitiveness and Export Performance of CEE Countries. *Eastern European Economics*, 55(6):522–542.

Bournakis, I. and Tsoukis, C. (2016). Government size, institutions, and export performance among OECD economies. *Economic Modelling*, 53:37 – 47.

Carlin, W., Glyn, A., and Van Reenen, J. (2001). Export Market Performance of OECD Countries: An Empirical Examination of the Role of Cost Competitiveness. *Economic Journal*, 111(468):128–162.

CaZorzi, M., Chudik, A., and Dieppe, A. (2012). Thousands of models, one story: Current account imbalances in the global economy. *Journal of International Money and Finance*, 31(6):1319 – 1338.

Crozet, M., Milet, E., and Mirza, D. (2016). The impact of domestic regulations on international trade in services: Evidence from firm-level data. *Journal of Comparative Economics*, 44(3):585 – 607.

Dosi, G., Grazzi, M., and Moschella, D. (2015). Technology and costs in international competitiveness: From countries and sectors to firms. *Research Policy*, 44(10):1795 – 1814.

Dybka, P. and Rubaszek, M. (2017). What Determines the Current Account: Intratemporal versus Intertemporal Factors. *Czech Journal of Economics and Finance (Finance a uver)*, 67(1):2–14.

Fagerberg, J. (1996). Technology and Competitiveness. *Oxford Review of Economic Policy*, 12(3):39–51.

Foster, D. P. and George, E. I. (1994). The risk inflation criterion for multiple regression. *The Annals of Statistics*, 22(4):1947–1975.

Fratianni, M. (2009). *The Gravity Equation in International Trade*. Oxford University Press.

Head, K. and Mayer, T. (2014). Chapter 3: Gravity Equations: Workhorse,Toolkit and Cookbook. In Gopinath, G., Helpman, E., and Rogoff, K., editors, *Handbook of International Economics*, volume 4 of *Handbook of International Economics*, pages 131 – 195. Elsevier.

Jaffreys, H. (1961). *Theory of Probability*. 3rd Edition, Oxford University Press.

Kaldor, N. (1978). The effects of devaluations on trade in manufactures. volume 6 of *Further essays on applied economics*, pages 99–116. Duckworth, London.

Kass, R. E. and Raftery, A. E. (1995). Bayes Factors. *Journal of the American Statistical Association*, 90(430):773–795.

Krueger, A. O. (2006). A Remarkable Prospect: Opportunities and Challenges for the Modern Global Economy. McKenna Lecture at Claremont McKenna College by Anne O. Krueger, First Deputy Managing Director, IMF; accessed 05.03.2019. `https://www.imf.org/en/News/Articles/2015/09/28/04/53/sp050206`.

Krugman, P. R., Obstfeld, M., and Melitz, M. (2012). *International Economics*. Pearson.

Levin, A., Lin, C.-F., and Chu, C.-S. J. (2002). Unit root tests in panel data: asymptotic and finite-sample properties. *Journal of Econometrics*, 108(1):1 – 24.

Ley, E. and Steel, M. F. J. (2007). On the effect of prior assumptions in Bayesian model averaging with applications to growth regression. Policy Research Working Paper Series 4238, The World Bank.

Lipsey, R. (2002). Home and Host Country Effects of FDI. NBER Working Papers 9293, National Bureau of Economic Research, Inc.

Ma, Y., Qu, B., and Zhang, Y. (2010). Judicial quality, contract intensity and trade: Firm-level evidence from developing and transition countries. *Journal of Comparative Economics*, 38(2):146 – 159.

Madsen, J. B. (2008). Innovations and Manufacturing Export Performance in the OECD Countries. *Oxford Economic Papers*, 60(1):143–167.

Magnier, A. and Toujas-Bernate, J. (1994). Technology and trade: Empirical evidences for the major five industrialized countries. *Review of World Economics*, 130(3):494–520.

Montobbio, F. and Rampa, F. (2005). The impact of technology and structural change on export performance in nine developing countries. *World Development*, 33(4):527–547.

Moral-Benito, E. and Roehn, O. (2016). The impact of financial regulation on current account balances. *European Economic Review*, 81:148 – 166.

North, D. C. (1989). Institutions and economic growth: An historical introduction. *World Development*, 17(9):1319 – 1332.

Rodrik, D. (2008). *One Economics, Many Recipes: Globalization, Institutions, and Economic Growth*. Princeton University Press, Princeton, NJ.

Sala-I-Martin, X., Doppelhofer, G., and Miller, R. I. (2004). Determinants of Long-Term Growth: A Bayesian Averaging of Classical Estimates (BACE) Approach. *American Economic Review*, 94(4):813–835.

Wakelin, K. (1998). The role of innovation in bilateral OECD trade performance. *Applied Economics*, 30(10):1335–1346.

Zellner, A. (1986). *On assessing prior distributions and Bayesian regression analysis with g-prior distributions*, chapter 15, pages 233–243. North-Holland.

Zeugner, S. and Feldkircher, M. (2015). Bayesian Model Averaging Employing Fixed and Flexible Priors: The BMS Package for R. *Journal of Statistical Software, Articles*, 68(4):1–37.

Appendix: Additional tables

Table 5: Results of (Levin et al., 2002) panel unit root test

Variable	**p-value**
Total manufactures	0.0009
Labour-intensive and resource-intensive manufactures	0.0012
Low-skill and technology-intensive manufactures	0.0048
Medium-skill and technology-intensive manufactures	0.0000
High-skill and technology-intensive manufactures	0.0173
ULC	0.0896
Capital output ratio	0.0016
Potential GDP	0.0074
R&D expenditure	0.0000
FDI stock	0.0000
Patent applications	0.0000
Std. dev. of NEER	0.0000
School life expectancy	0.0000
Population with tertiary education	0.0000
Size of Government	0.0000
Legal System and Property Rights	0.0519
Sound Money	0.0000
Freedom to Trade Internationally	0.0008
Regulation	0.0000

Notes: Alternative hypothesis - Panels are stationary.

Table 6: Posterior inclusion probabilities for baseline results with interaction terms and non-linearities

			Interaction with:												
Id	Name	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Std. dev. of NEER	0.52														
2	ULC	0.03														
3	Patent applications	**1.00**														
4	Potential GDP	**0.99**														
5	FDI stock	**0.99**														
6	Capital output ratio	0.21														
7	School life expectancy	0.04														
8	R&D expenditure	**1.00**														
9	Population with tertiary education	0.03														
10	Regulation	0.10	0.15	**1.00**	0.09	0.29	**0.96**	0.06	0.08	0.52	0.33	0.04				
11	Sound Money	0.93	0.09	0.04	0.20	0.09	0.06	0.04	0.93	0.34	0.05		0.11			
12	Freedom to Trade Internationally	0.94	0.14	0.07	0.32	**0.96**	0.07	**1.00**	0.16	0.08	0.27			0.31		
13	Legal System and Property rigths	0.46	0.82	0.46	0.60	0.46	0.57	0.83	0.04	**0.95**	0.48				0.05	
14	Size of Government	0.06	0.04	0.18	0.05	0.07	0.47	0.04	0.31	0.17	**0.95**					**0.98**