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IES Working Paper: 19/2014

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Bibliographic information:
Paulus, M., Michalíková, E., Benáček V. (2014). "German International Trade: Interpreting Export Flows According to the Gravity Model" IES Working Paper 19/2014. IES FSV. Charles University.

This paper can be downloaded at: http://ies.fsv.cuni.cz

German International Trade: Interpreting Export Flows According to the Gravity Model

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May 2014

Abstract:
The paper applies the gravity model of international trade in its analysis of German exports. The added value of our research is derived from the innovative shift in focus from the traditional gravity model specifications to the national level in order to interpret its estimations in a non-traditional way, but remain consistent with data structure and thus bring new insights into the analysis of German export performance. Our panel dataset includes German exports to 176 countries and 22 control variables including institutional factors over the period 1995-2011. We estimated a Random Effects model and also a Least Trimmed Squares model to control for the heterogeneity between countries. We distinguish two panel data specifications: time-series and cross-section. This allows us to examine long-term

and short-term decision horizons. The general conclusion of our model is that German exporters are more prone to expand the trade to countries that are more distant from their European neighbourhood relative to the world average. Exports are sensitive to both the real exchange rate movements and the price levels of partner countries, even though their elasticity is significantly less than unity, which suggests that German exports would not be impacted very much if the Euro appreciated in real terms. The position of the Euro in German trade seems to be rather ambiguous since not all tests revealed its role as a catalyst.

Keywords: Germany, export, gravity model, fixed effects, random effects, least trimmed squares

JEL: C13, C23, F10, F12, F14

Acknowledgements:
This research was supported by the Grant Agency of the Czech Republic, grant no. P402/12/0982.

1. Introduction

At the end of World War I Thomas Mann contemplated "German loneliness between the East and the West" in his essay *Betrachtungen eines Unpolitischen*. The essay was a reflection on the situation, which had again become relevant in the 1930s until it was ultimately discarded in early 1950s, when the Federal Republic of Germany became a leader of the West European integration for the following sixty years. Now that Germany has been recognized as the strongest and most viable European economy and when, at the same time, the EU cannot find a way out of its deepest socio-economic crisis (Darvas et al., 2013), the role of Germany in Europe is again at cross-roads (Buras, 2013). It has become a wide-spread belief both inside and outside of Germany that the German economy and its reliance on intensive international trade is a model for the way out of the European crisis. However, the question remains: can the much admired trade performance of Germany be transformed into an instrument, which is capable of stabilising the whole EU and Eurozone by transforming them into a politically cohesive union? Or, will the German hegemony in trade convert Germany into a stand-alone economic hub aligned by intensive regional trade exchanges with its close neighbours and thus deflecting benefits from the rest of the Eurozone? Can we then expect the rise of an economic fortress of a German Mitteleuropa, as a surrogate for the failing pan-European integration?

This paper is concerned with the geography of trade flows as modelled by an extended gravity equation. It has been surmised in the media that German economic power, which materialised due to the county's undoubtedly high level of export competitiveness, is such a dominant force that Germany is bound to become a natural European leader that is strong enough to bring the withering EU back to economic prosperity in a similar way to how it succeeded amongst the Visegrad countries (Gross, 2012). We presume in this study that such expectations are not based on an adequate assessment of German trade potential. Germany's successful export-driven development, based mainly on its manufacturing sector, is still not strong enough to become the growth engine for all of Europe, even though it can retain that role in Central Europe.

It is not only the European public that is entitled to a more detailed and accurate explanation of the two sets of problems that are related to our analysis of the German export sector. The first concerns the world outside of Germany and the other is the German economy itself:

a] What is the potential for diffusing German high export competitiveness universally among its commercial partners abroad and what kind of mechanisms should be implemented in such transfers? Some speculative answers that usually come from outside of Germany suggest that behavioural patterns of German exporters are non-replicable and the German institutional environment is non-portable. Indeed, this could be the case of those rare European partner countries whose exports to Germany are not able to benefit from intra-industrial specialisation and innovation spillovers, and whose decision-making processes are institutionally very different. But, what about those countries which have trade mechanisms similar to those of Germany? What are some such countries?

b] How is the German export sector (or tradable sector, in general) related to the German non-tradable sector? This presents a more rigorous perspective to observe the potential of the transferability of German export competitiveness. What if we found that spinoffs of

export dominance simply cannot automatically trickle down from the German production of tradables to the domestic production of non-tradables because these two sectors are incompatible? That could be so provided they are subject to different incentives and diverse competitive environment. Then the watershed mark between "selling at home only" and "going out to the world" could be even more antagonistic than the costs of entry considered in the model proposed by Melitz, 2003. For example, the theory of the Balassa-Samuelson effect is based on behaviour that shows the incompatibility of tradable and non-tradable sectors (Bahmani-Oskooee and Nasir, 2005). Therefore, our findings about the behaviour of German exporters striving to increase sales could turn out to be irrelevant in explaining how the stagnant domestic sales might receive a boost.

The absence of automatic positive spillovers derived from expanding German exports into the competitiveness of external environment (i.e., productivity gains in trade partners) and into the German internal environment (i.e., similar gains in the remaining parts of national economy) can thus turn expectations of German leadership to mere wishful thinking. It is apparent that in times of recession, economic development driven by exports requires additional conditions in order to achieve success. German trade competitiveness is insufficient, even for sustaining German growth itself. The ambition to expand trade into a model for the entire Eurozone would require further reforms; the majority of which would have to go beyond the traded sector and the underpinnings of Germany's institutional environment, as well as the rest of the EU (see Aiginger and Leoni, 2012; Dauderstädt, 2012, 2013).

To our surprise while searching for papers which analysed the most recent German export performance, we did not find any extensive economic literature (in contrast to business literature) covering this topic. There have been papers concentrating on the microeconomic aspects of competitiveness and efficiency (see Etzel et al., 2013) but we did not find analyses dealing explicitly with that problem by applying gravity models. Thus, our ambition is to present a gravity equation as an instrument of country-specific analyses of exports.

The primary objective of this research is to contribute to the empirical research of the determining factors of exports, which we apply in this case to the exceptionally high performance of German exports. We aim to acquire quantitative information regarding trends in the German exports between 1995 and 2011, and particularly the influential forces within the decision-making processes underlying such trends by using the gravity equation from a less orthodox angle of interpretation. Our empirical analysis concentrates on testing the hypothesis using two perspectives, which can be interpreted as if the agents of German international trade made decisions regarding German exports in two rounds: firstly we presume that they selected their partners abroad in a trade-off between opportunity costs in different countries, which is a static problem of economic geography. The second perspective assumes that they decided how much to export to these pre-selected countries within a given time frame, which is a problem of trade dynamics. We presume that both problems can be approached by the gravity equation as applied to identical data sets, but both their estimators and results will differ because the two tested hypotheses analyse data in different causal structures.

Our second objective is to assess how the contributions of purely economic determining factors interact with parallel impacts of policies and institutional influence on the decisions about exports. We raise a hypothesis (H1) that although institutions play an indispensable role in facilitating or impeding the trade, their total contribution to decision-

making about exports is auxiliary. Our third objective is to assess how changes in the exchange rate, tariff and non-tariff concessions, and the adoption of the euro could influence trade flows. We therefore test the hypothesis (H2) that these four economic factors that are closely related to policies are less important in the German case than what was presumed generally in past research or, alternatively, that their role has been weakened over time. At the end of the paper, we test a hypothesis (H3) that our estimations are robust, (i.e. that our results are not unduly affected by outliers or other small departures from the model's assumptions.)

In theory, it is assumed that the trade-driven strategy of development in a single large country will ideally induce a chain of dynamic inter-county trade multiplier effects (Matsuyama, 1992) and thus raise the GDP within all trading countries. This will consequently reduce domestic costs due to cheaper inputs from imports (Halpern et al., 2011). The reduction will spawn new investments and thus foster innovation, higher employment, rising incomes and increased consumer spending. The authors of this paper are not aware of any recent empirical study in general equilibrium that tested the effects of German trade on the interactions among the EU economies. If our guess is correct, then it is paradoxical that such high expectations about the crucial role of German trade in Europe have not been empirically tested for their feasibility and are no more than intuitive speculations. Although our claims are more modest, we aim to contribute to the debate on the trade-driven strategies of growth in Europe.

Most papers based on the gravity equation provide an introductory review of how the originally simple and purely empirical model has been expanded theoretically into an environment compatible with world-wide general equilibrium, different factor endowments, multilateral relative prices, heterogeneity in enterprise productivities, trade costs and enterprise behaviour, among others. Such a backdrop offers a demonstration of the links between its two GDP masses and the dummy variables depicting the resistance (or attraction) to trade, on the one hand, and fundamental microeconomic theories of rational specialisation in trade on the other hand; while providing fundamental references to Anderson, 1979; Bergstrand, 1985, 1989; Deardorff, 1998; Eaton and Kortum, 2002; Anderson and Van Wincoop, 2003; Cieslik, 2009; Chaney, 2013, et al. Nevertheless, the "distance" between the pure microeconomic theories of GM and the final empirical specification is based on the available data that refer almost exclusively to macroeconomics is so large that, "…it is not all that difficult to justify even simple forms of the gravity equation from standard trade theories" Deardorff (1998, p. 21). Also, the previous provisos about the factual autonomy between microeconomic theoretical models of trade specialisation and practical applications of gravity equation raised by Leamer and Levinsohn, 1995, remain valid.

In this paper we will avoid such a theoretical detour.[1] Instead, before specifying our model for testing the behaviour of German exporters, we shall turn to two aspects of our research:

[1] The reason why we do not present a full literature review in this paper is following: The main contribution of this research rests in empirical analysis of the German trade so that its functional characteristics can be compared with similar past or forthcoming research focused on other countries. See for example the studies of Babecka-Kucharcukova et al. 2012; Prusa and Prusa, 2013; or Davidova and Benacek, 2014, which are based on traditional specifications of GM (such as those explained in Baldwin and Taglioni, 2006) and where the literature review is covered in more detail. The comparability of our results depends on interpretations of model output that was derived by applying similar methods on different data. That is why the next two sections deal with issues of GM methodology and their interpretative relevance.

- GM procedural knowledge – methodological issues in applying the GM techniques to some of which we respond by our innovative design.
- GM propositional knowledge – the epistemology of gravity models contributing to our understanding of the world of trade that has its limits, especially if the real decision-makers are its ultimate users.

The remainder of this paper is organized as follows: in the second section we discuss the methodology of gravity models, while also pointing out its weaknesses on the technical side in terms of the choice of data and estimators. In the third section we present a less conventional view on the problems in the interpretation of gravity models that are centred on the puzzle of "cognitive bias" where personal projections in the interpretation of results may distort the explanatory power of otherwise technically unimpeachable models and thus hinder the relevance of gravity models for practical decision-making. The fourth section describes the data and methodology of our estimations. Section 5 presents the results and their economic interpretations. In section 6 the previous results are verified by testing their robustness. The final section offers a concise conclusion of this paper.

2. Reflections on the methodology of applied gravity models

Despite the theoretical and the technical imperfections, the "gravity equation in international trade is considered one of the most robust empirical findings in economics." (Chaney, 2013, p. 2) The meta-analysis of Disdier and Head (2008) offer evidence that GM estimations, notwithstanding their shortcomings (which may be due to omitted variables, endogeneity or problems with logarithmic bias in predictions) offer robust material for explaining how open economies function. The weaknesses of searches for a remote theoretical nexus to econometrics of gravity equations as cited above are revealed when the theoretical deliberations are included in model specifications that have not brought any substantial modification (except for some new dummies and new estimation techniques) to the original intuitively derived equation. The theoretical backdrop refers mostly to data selection, estimation techniques and interpretation of results.

The seminal study by Egger, 2002, showed that gravity equations estimated by traditional methods were particularly prone to misspecification and bias, and thus led to projections whose precision was to some extent illusionary. Not only that the "out-of-sample" (*ex ante*) projections assign counter-intuitive trends to some partners, moreover theoretical values are also those seemingly less error-prone "in-sample" projections are not free of such systematic deviations.[2] Egger also observed that too many estimated

[2] An interesting observation occurs when we plot an incidence matrix of model „theoretical values" and real data of exports onto a graph whose values are expected to be evenly spread around the slope of 45 degrees. Although the reported R^2 of the given estimation is usually very high (fluctuating between 0.7 and 0.9) and the fit for the most intensively trading countries is highly satisfactory, the most controversial results are located at the bottom of the slope line where the model typically overshoots (Egger and Nigai, 2013). The evident bias can be explained to a large extent by the logarithmic linearization of the original power function underpinned by country and time-specific dummies in an environment where there is a natural endogeneity (e.g. in the GDPs that are not completely independent from exports) and an unobserved heterogeneity in the behaviour of participating agents (exporters and importers). The important message is that the bias is caused mainly by countries with marginal trade. In Germany's case, this could include trade that covers 2-4% of total exports.

coefficients of GM lack robustness and proposed several explanations for their underperformance:

a) Coefficients depend on the techniques of estimation (e.g., fixed effects versus random effects, Hausman-Taylor with iv, between versus within-group, Poisson or AR1 estimators). Each technique "explains" the tested hypothesis from a different point of view on mutual causality. Their users often disregard such differences and do not choose the most appropriate one.

b) Many studies rely on a cross-sectional analysis referring to the geographic dimension of "where to export?" and thus disregard the time-dimension of decision-making focused on growth (i.e. "how much to export?") or estimate that time dimension incorrectly, which was also criticised by Mátyás, 1997.

c) Large differences between the theoretical and observed values of exports (especially when the delusory trends belong systematically to some group of countries) demonstrate that the selection of the sample for analysis was in conflict with statistical principles. The pool-ability tests are often neglected and the estimation is exercised on heterogeneous panels. Mixing two or more data subpopulations with incompatible behaviour cannot lead to reliable predictions.

c.a) Inclusion of countries whose institutional history differed from the rest of the sample is a particular problem for subpopulations that are small and thus subordinate. Such inclusions were found in the Egger's case of post-Communist countries whose trade was systematically undershooting the predictions until a proper specification was found while the predictions for dominant developed countries performed much better.

c.b) Inconsistency in the quality of data had another adverse effects, for instance, some statistical offices report the value of exports via different methodology. Such is the case when re-exports and outward processing traffic are omitted from statistics or when trade with marginal countries is not reported but replaced by a zero, which confuses small trade with non-trade.

c.c) Bilateral trade between all observed countries results in an assumption that, for instance, exports from Germany to Costa Rica should be subject to identical behavioural patterns as imports of Germany from Costa Rica. Such a model is wrongly specified and thus biased.

We must agree with Egger, 2002, who concluded that, "…properly specified econometric models cannot obtain systematic variations in residuals at all" (p. 299). In order to reinforce and strengthen the methodological relevance of our analysis, we narrowed the heterogeneity of data by concentrating on one "home" country only, (i.e. Germany) and its exports. We have thus avoided a clash between export and import effects, and minimised the risk of mixing trade flows with the diversity of product range and factor requirements such as natural resources, land, capital, simple labour and human capital that is typical for German imports. The problem with missing or zero exports was avoided by using a dataset that had practically none missing.

The heterogeneity and poolability of our panel was addressed by extensive tests of the robustness of our regressions. The two-pronged impact of exchange rate on relative costs and prices between the German exportables and non-tradables, and changing price levels between Germany and trading partners that acts as facilitator (via depreciation) or inhibitor (via appreciation) of exports, was captured by including the real exchange rate in the list of explanatory variables. Since both GDPs are in purchasing parity standards (i.e., in values free of exchange rate changes), there was no danger of co-linearity.

In order to avoid the clash between time-specific and country-specific effects we worked strictly with one-way models to apply specifications for the cross-section dimension and the time-series dimension. This problem is illustrated by comparing Figure 2 and Figure 1. Figure 1 illustrates the case where the structure of data is free from time-specific and country-specific effects where the dependence of German exports (X^{DE}_{jt}) on j-partners' GDP (Y_{jt}) in time t evolves in a form of a causal relationship independent of time and location (typical of natural science laws where only the random error exempts the relationship from determinism). Four ellipses mark the location of four time series for countries A, B, C and D (where only the first and the last observations are shown). Such panels can be estimated by one-way or two-way models without revealing large differences between time-series and cross-section specifications. That means that the time and the country behavioural characteristics estimated by coefficients τ and β are identical. The laws of nature are supposed to be parsimonious since there are no superfluous varieties of causes (in this particular case, there is just one), which would otherwise preclude the projection of results from parts to wholes and across time horizons.

However, social objects of analysis differ from natural objects due to an agents' subjectivity that allows for free will, trial and error, learning, bluffing, speculation, changing coalitions, historical path-dependency, hysteresis, changing objectives and expectations, switching between exogeneity and endogeneity, and alternatives in policy-making and institutional imperfections. Figure 2 illustrates socially-determined data where cross-sections of countries A through Z (with solid fitted lines) have different ordering than time-series data (with intermittent fitted lines for each country). In addition, individual fitted lines have to be neither parallel nor all of them statistically significant, nor showing the same direction of the slope (i.e., with exclusive upward or downward trends). There can be subpopulations of data that are subject to different and changing behavioural patterns (van Brabant, 1993, p. 275-76), which is a feature typical for social systems.

Figure 1: Estimation of the panel data (in logs) where time-specific and country-specific effects of the partners' GDP (Y_{jt}) on exports (X^{DE}_{jt}) are identical.

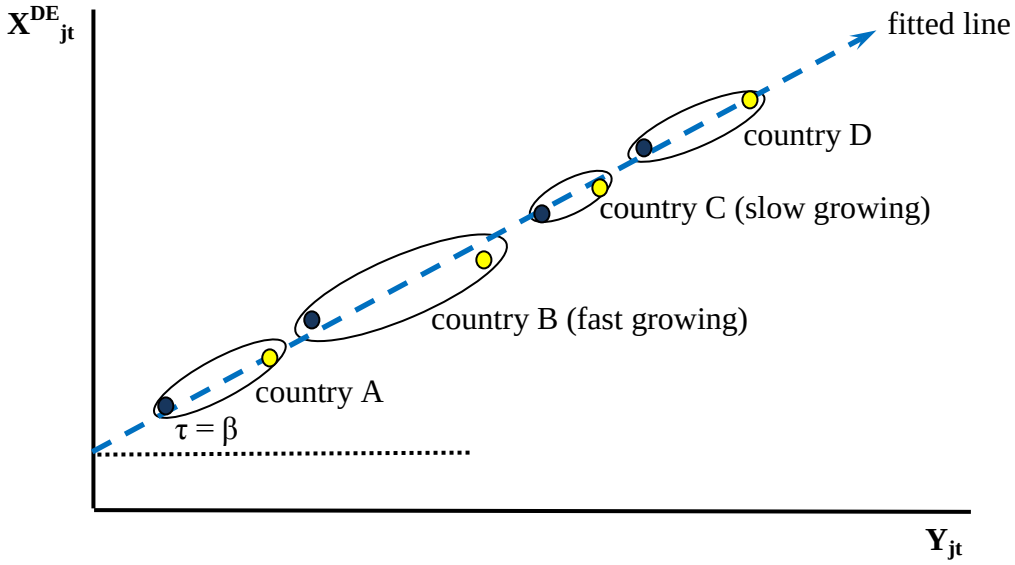
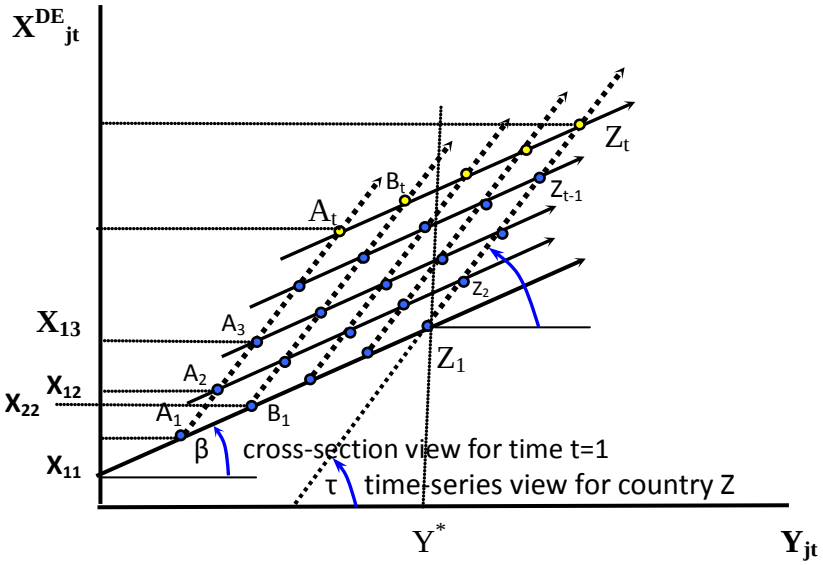


Figure 2: Estimation of the panel data where time-specific and country-specific effects of the partners' GDP (Y_{jt}) on exports (X^{DE}_{jt}) differ.



Thus, in Figure 2 it can be quite complicated to explain why the GDP Y^* generated such a different scale of exports X (which differ both in location and time) or why the intercepts of fitted lines are so different or why the slopes of solid and intermittent fitted lines are not identical (e.g. $\tau < \beta$). Of course, a great deal of that can be ascribed to the impacts of distance (for instance, where countries A through Z are ranked in its a descending order) and to the fact that German GDP is growing in time, as was presumed to be the case in the original versions of the GM. However, modern versions of GM allow for the existence of a much richer prism of the relevant factors. Thus, techniques for capturing their mutual impacts in panels became much more sophisticated. Our most important contribution in dealing with these methodological problems is that we strictly distinguish between cross-section specification and time-series specification of estimations that are interpreted as two different aims in decision-making. Qualitative differences between gravity applied in physics and international economics are crucial. Nevertheless, that does not imply that quantifiable regularities in social behaviour do not exist. The objective of this paper is to unveil such regularities among variables.

3] Relevance of GM from the point of view of their users

One of the drawbacks in practical applications of GM has been that its pursuit of perfection was biased by technical innovations that led to constructs of enormous complexity whose contributions to knowledge were impaired by diminishing returns to scale. It is time we pay attention also to the limits of GM relevant to their users' decision-making.

Gravity models of trade, which are inspired by the Newtonian equation, offer the broadest set of guidelines and criteria to explain mechanisms, which drive trade, and quantify trade potentials. Thus, GMs are candidates which may prove very useful as formal instruments of exporters' decision-making. The demand on GMs´ scope of operability would then be very complex for they would have to be able to provide answers to the four

fundamental structural questions concerning the “what?”, “for whom?”, “how much?” and “when?”. Using the terminology of Kahneman, 2011, solutions offered by GM are „anchored” in the evolution of the three crucial estimators: the two masses of GDP and the distance. In contrast to Newtonian gravity, their inadequate explanatory potential due to the fact that often crucial missing data is covered up by the inclusion of more varied additional real causes of trade; the model is therefore appended by supplementary anchors such as population and explanatory dummies (e.g., common borders, currency, similar languages, trade agreements, policies, etc.) and technical dummies absorbing country-specific and/or time-specific effects (see Baldwin and Taglioni, 2006).

But not even these corrections can compensate for the loss of accuracy because subsequent inferences of the model (as a simplified abstraction of reality) cannot eliminate the „cognitive bias“ caused by the theoretical „focusing illusion“ (Kahneman et al., 2006). Their study concluded that attempts to explain social phenomena (e.g. contracted quantities between exporters and importers) by a fixed list of factors whose value is “locked” within narrow time limits (e.g. years) exaggerates their importance since they are not the exclusive direct causes. Although the three dominant explanatory variables, underpinned by technical dummies, correlate highly with exports (e.g. their resultant R^2 ranges between 75% and 95%), the real decision-making about thousands of export contracts in a given year with a given partner country is far from dealing directly with these variables.

Traders decide according to strategic deliberations (e.g. about investments, R&D, relative prices) anchored both in past experiences and future expectations whose time-span is longer than a year. Both are thus perceptions and intuitive judgments where the roles of current GDPs and distances (or common currency or culture) are highly intermediated and transformed into mere subjective guesses. The relationship between exports and GDP is thusly more similar to the “soft” relationship between happiness and income in the Kahneman´s study than to the much more rigorous attraction of masses of interacting physical bodies according to Newton´s law.

The standard econometric solution to the existence of estimated interactions that are not deterministic of simply inputting an error term into otherwise deterministic set of explanatory equations has its drawbacks as well. The vindication provided by rational expectations (which are supposed to be correct in averages and leading to empirically consistent long-run trends) need not apply here. The problem is not only that long-run predictions may be of lesser relevance to decision-makers since “in the long run we are all dead”. There is a case that agents (producers, exporters and importers) take into account information about other relevant factors related to both the past and the future, while GMs are too simple for such a task. GMs omit too many factors of seemingly incidental relevance and, in addition, process them incorrectly by presuming that analysed processes are stationary while in reality the omitted variables pollute the model with non-stationarity.

This can be illustrated by the trade puzzle of inter-country versus the intra-country trade, where traders behave differently when they deal within national borders instead of outside of them (see McCallum, 1995; Anderson and Van Wincoop, 2003). The high intensity of Czech and Slovak trade is also difficult to explain, if one does not take into account the special historical linkages between these two countries. A similar puzzle arises if we attempt to explain why some countries practically do not trade with each other or why German exports to Asia are subject to different behavioural parameters than similar exports to the American continent.

GM operators (i.e., researchers) should be expected to bridge the gap between technical solutions full of strategic abstractions that are not exposed to ensuing cognitive bias and influential illusions, on the one hand, and their affiliation with subjective "frames of reference" encompassing decisions about export business, on the other hand. While the GMs' methodological objective is to derive a maximum of quantifiable generalisations about how trade functioned in the past from the data; real decision-making is supposed to be based on personal states of cognizance that are from 80 % non-verbal and non-numerical (Wilson and Sperber, 2004). Hence, the success of GM will be accomplished only if its quantified information stimuli are consistent with the reference frames of decision-makers, (i.e., with their contexts of past experience, values, customs, myths, expectations, anticipations, guesses and conjectures, by means of which these inputs are re-interpreted and classified as relevant). The pragmatic communicative features of GM do not only provide the most authentic (and least biased) numeral explanation of past processes, but also by stimulating the minds of decision-makers in order that their objectives may be achieved more efficiently.

The results of GM that only impact the frames of reference of other narrowly specialised academia, actually fail in their crucial task to provide an output of knowledge that is found to be relevant to real decision-making processes regarding exports. Therefore, the conclusion of this section is pragmatic as well. There should be a balance in the trade-off between technical perfection and end-user value. The former statement means that the aim for the most precise compatibility level of GM estimations with true forces driving their studied outcomes derived from the selected input data (i.e., statistics that contain errors and omissions and cannot cover all real driving forces). The latter concerns the aim of providing authentic decision-makers with such data, procedures and results that are compatible with their way of thinking so that GM applications add value to their professional work. We presume that there is much left in order to optimise the trade-offs by giving more space to the latter at the expense of efforts invested into the former.

Thus, not only are the theories problematic due to their incomplete specification of relevant factors, inadequate choices of estimation techniques and errors in data but also real-life decision-making full of heterogeneous heuristics, intransitivity in preferences and uncertainties (Kahneman and Tversky, 1979). Consequently, decisions and surrounding conditions are not repeatable and their outcomes projected from past observations are thus neither optimal nor precisely predictable. The application of technically more sophisticated modelling is neither sufficient nor a necessary condition for a final improvement in real decision-making, if it increases its distance to the frames of reference of its end-users.

According to the theorists of constructivism (such as T. Kuhn, D. Kahneman, V. Smith or H. Simon) there is no single valid „correct" (and thus objective) methodology available to scientists, but rather a diversity of approximating methods of reasoning for turning perceptions into socially satisfying knowledge, which can decrease the uncertainty (entropy) in decision-making. In economic systems of production and trade such methods could be useful in directing decision-makers to seek higher profit margins. The GMs of trade are typical methods, which, notwithstanding their weak theoretical underpinning and limited predictive capacity, can access the frames of reference of practical users easier than other trade theories. We treat the GM as an analytical instrument that helps constructing valuations (explanations) about why some German export destinations were socially preferred over others, even though we neither aspire to explain their every individual export transaction nor explain which trade could be universally optimal and why. The GM is

therefore a mere instrument of Simonian bounded rationality (or formalisation) of past decisions the majority of which were intuitively made and subject to social „guidelines“ (i.e., trends, fashions, imitation, „good choices and practices“ prescribed by opinion makers, et al.) or mere outcomes of trial and error.

Trade GMs that aspire to estimate the probability of outcomes of real decision-making are based on an explicit list of determining factors whose data can be subjected to statistical scrutiny and a set of alternative algorithms of estimation. The majority of explanatory variables are in fact mere proxies, (i.e., instruments whose high correlation with unknown real factors of decision-making is expected). Such a correlation gives no assurance that these variables are causes rather than effects of the “explained” variable. Additionally, the mechanism of interaction among real social entities is rife with natural circular causalities, which pollute the models with autocorrelation, multi-collinearity and endogeneity that may be neither complete nor permanent and whose impact model users must keep under control in order to get rid of estimation bias.

The pretence that models of axiomatic social thinking (e.g., in economics or econometrics) could become identical with the human decision-making is a misunderstanding. The aspiration for an absolute positive knowledge is an overestimation of the powers of science and rationality. Social models cannot act as a *de facto* “normative imperative” superordinate to real processes, which would directly conflict with the aspiration of science to be descriptive and value free. In contrast to the natural sciences, we should distinguish between descriptive aspirations *ex post* (on historical data) and *ex ante* (on predictions) where only the latter are crucially relevant to decision-making. In this paper we therefore admit that our models are not perfectly specified, which implies that their inferences and predictions cannot replace creative decision-making.

For that reason, economics cannot replace entrepreneurship or aspire to be superior to practical decision-making; as models, due to their formal perfection, often seem to be. Analyses ex post are based on data, i.e., subject to narrow formal records of past reality full of information flaws that are lacking information required for decisions ex ante. Our aspiration is pragmatic and auxiliary: to offer an instrument of analysis, the interpretation of whose results is close to practical thinking and that offers a wide space for inspiration and further learning by intuition gained, among others, from the pursuit of data samples.

This paper is a part of a larger comparative project that is analysing the behaviour of German exporters. At this stage we are concentrating exclusively on the characteristics unveiled by GM that is focused on German bilateral export data. We therefore are working with a subset of conventional GM data where export effects are not mixed with behaviourally different import effects and different country export effects. Thus we are able to concentrate on the idiosyncrasy of German exporters only.

4] Data and methodology of estimation

Our dataset covers time period of 1995-2011 for Germany and its 176 partner countries.[3] Such a panel data structure is important for approximating the formal analysis to real decision-making. For example, cross-sectional data themselves would not be able to distinguish between the choice of a partner and the choice how much to export in time. Adding more repeated transactions to the data set makes it possible to introduce additional heterogeneity and work with higher degrees of freedom. However, panels are more likely to

[3] List of German partner countries can be found in the Appendix – see Table 6

contain atypical observations, errors and omissions. Thus, it is necessary to employ methods of estimation that respect data's panel structure.

Our data come from various sources. Table 6 (in Appendix) gives the summary of variables in the panel dataset and covers exports and its 22 determining factors.

Remark: we work with the following subscripts: i = Germany; j = 1,…176 are partner countries; t = 1995, 1996, …, 2011.

We estimate the parameters of the following form of gravity model after taking natural logarithms of the variables in cardinal scale whose coefficients were originally set as powers:

$$\log(X_{ijt}) = \beta_0 + \beta_1 \log(Y_{jt}) + \beta_2 \log(Y_{it}) + \beta_3 \log(D_{ij}) + \beta_4 C_{ijt} + \beta_5 \log(L_{jt}) + \beta_6 R_{jt} +$$
$$+ \beta_7 PTA_{ijt} + \beta_8 \log(RER_{ijt}) + \beta_9 GEF_{jt} + \beta_{10} BUS_{jt} + \beta_{11} TRA_{jt} + \beta_{12} FIS_{jt} + \beta_{13} GOV_{jt} + \beta_{14} MON_{jt} +$$
$$+ \beta_{15} INV_{jt} + \beta_{16} FIN_{jt} + \beta_{17} PRO_{jt} + \beta_{18} COR_{jt} + \beta_{19} EDU_{jt} + \beta_{20} BORD_{ijt} + \varepsilon_{ijt}$$

ε_{ijt} is a random error term which consists of two parts. Therefore we can write $\varepsilon_{ijt} = \mu_{ij} + u_{ijt}$ for time series specification, where μ_{ij} is an unobserved country-specific effect and u_{ijt} is an error term with zero mean and constant variance. For cross section specification we write $\varepsilon_{ijt} = \nu_{it} + u_{ijt}$, where ν_{it} is an unobserved time-specific effect.

Table1: Descriptive statistics of the variables tested in the models.

	Mean	Std. Dev.	Min	Max	Number of observations
X_{ijt}	3963	11278	0.54	101496	3009
Y_{jt}	234226	864210	231.76	$1.16*10^7$	3009
Y_{it}	2009286	290670	1541367	2458944	3009
D_{ij}	5749	3682	377.74	18219.9	3009
C_{ijt}	1.18	0.49	1	3	3009
L_{jt}	35.101	130.56	0.03	1347.7	3009
R_t	0.24	0.42	0	1	3009
PTA_{ijt}	6.30	2.37	1	5.26	3009
RER_{ijt}	1.86	0.72	0.45	100	3009
GEF_{jt}	51.23	29.59	0.48	100	3009
BUS_{jt}	64.89	17.04	0	100	3009
TRA_{jt}	66.13	17.12	0	95	3009
FIS_{jt}	69.10	16.48	0	99.9	3009
GOV_{jt}	63.79	25.37	0	99.3	3009
MON_{jt}	71.38	18.21	0	95.4	3009
INV_{jt}	52.72	20.56	0	95	3009
FIN_{jt}	51.88	21.66	0	90	3009
PRO_{jt}	50.73	25.21	0	95	3009
COR_{jt}	42.74	25.25	4	100	3009
EDU_{jt}	61.81	20.61	5.10	100	3009
$BORD_{ijt}$	0.05	0.22	0	1	3009
T_{ijt}	71.43	16.02	9.07	100	3009

NT_{ijt}	61.08	18.59	1.30	97.59	3009

Descriptive statistics of the dependent variable (logarithm of real exports from Germany) and 22 determining factors (explanatory variables of our model) are summarized in Table 1. The measure of interdependences between variables is described in the correlation matrix in the Appendix (Table 8). We have divided our explanatory variables into four groups: traditional economic (GDPs, distance and population), monetary (Euro dummy C, RER, MON), trade barriers (PTA, T, NT) and institutional factors (proxies for corruption, fiscal burden, etc.). The explanatory variables in the theoretical GM are traditionally derived from expenditure (demand), production and cost functions. The explanatory variables are as follows:

Log(Y_{jt}) is a logarithm of partner country´s GDP (in mil. EUR at nominal purchasing power standards) and represents the demand. Y_{jt} measures the absorptive import power of that country. The higher is its GDP (both in time and in space) the higher is the potential for German export flow in that direction. Thus we expect positive sign of the coefficient $\beta_{1,}$ expected to be close to unity. Coefficients of paired logarithmic variables can be interpreted as elasticites.

Log(Y_{it}) is a logarithm of German GDP (in mil. EUR at nominal purchasing power standards). This variable represents the production potential. It is a proxy for an exporter´s economic driving force by engaging local production factors. We expect a positive sign for parameter β_2 by presuming that the increasing German GDP is bound to trickle down by stimulating its exports, too. It retains its full power in time-series panel specification only. In the cross-section specification this variable becomes a dummy without variance vis-à-vis partners.

Log(D_{ij}) is a logarithmic measure of distance between countries that is a proxy for increasing transaction costs stemming from the increasing distance. This variable represents the trade cost function. In contrast to the previous case, it has its full power in cross-section specifications, while in time-series specifications becomes a dummy with no variance in time. [4] We expect a negative sign for the coefficient $\beta_{3,}$ whose value in other studies has been found to be very often around unity (Chaney, 2013). We have no reason to expect different findings.

The remaining explanatory variables are auxiliary representing factors impeding or facilitating the trade.

C_{ij} is a dummy variable measuring the effects of exchange rate nominal stability or partners´ currency vis-à-vis Euro, where 1 = non-member of the Eurozone with floating rates to Euro, 2 = country with exchange rate fixed to Euro, 3 = member of the Eurozone. The meta-analysis of Havránek (2010) would suggest negligible or even zero effect of the common currency on the German exports.

Log(L_{jt}) is a population (measured in logs of million Inhabitants). It is a proxy for market size fulfilling an ambivalent role. On the one hand, larger markets can attract more imports than smaller ones but, on the other hand, larger markets can be more self-sufficient where rising domestic import-substitution impedes the export penetration. Therefore, we can expect positive or negative signs of estimated parameter $\beta_{5.}$

[4] In such cases where a variable contains within-sample values without variation, there is a restriction in the usage of fixed effects for estimation because there arises its perfect collinearity with some of the other dummies. For example, this is the case of variables Y_{it} and D_{ijt} in the mentioned two specifications.

R_{jt} is a dummy variable and reflects the presence of financial or economic crisis. We assume that the crisis hit all countries in 2008-2011, which is indicated by R_{jt}=1. We can intuitively expect negative effect of crisis on the German trade. The trade barriers are approximated by the dummy PTA_{ijt}. This variable reflects the level of preferential trade agreements between a partner country and Germany. The dummy may exhibit a value between 1 and 9[5] where 1 is EU member and hence the lowest trade barriers with Germany and 9 reflects the situation where there were no preferential agreements and the trade was hindered by high non-tariff barriers (e.g., embargos). We expect a negative sign for parameter β_7. We have experimented also with additional tariff data (T_{ijt} and NT_{ijt}) provided by Frazer Institute where T_{ijt} reflects freedom from tariffs (higher number means lower trade barriers) and NT_{ijt} measures freedom from regulatory trade barriers (for more details, see Gwartney et al. (2012, p. 277)). However, these variables were proven to be statistically insignificant and hence excluded from the subsequent estimations.

$Log(RER_{jit})$ is the logarithm of index or real exchange rate approximated by the ERDI (exchange rate deviation index). It monitors the deviations of the exchange rate from purchasing power parity, i.e., bilateral nominal exchange rates depreciation/appreciation due to impacts of different domestic price changes. A rise in the index means that Euro in Germany appreciated relative to the currency in the partner country. In the cross-section estimation this variable tests the impact of different national price levels (relative to Germany) on its imports. In both cases we expect a negative sign for parameter β_8.

All institutional factors tested in this paper are policy-oriented. Their choice was aimed at capturing the tenor of the EU accession negotiations according to the present 35 chapters of *acquis*. We test therefore a hypothesis that their institutional criteria are important factors of free trade. Our data is compiled from surveys provided by the Heritage Foundation, the World Bank and United Nations (see Table 1). Their values vary from 0 to 100, where 100 describes the maximum level of efficiency or "freedom" that characterises ideal free markets. We can expect that the higher value of the institutional variables (i.e. implying a more pro-market institutional or policy performance) would stimulate more trade because of transaction costs reduction. Institutional explanatory variables are as follows:

GEF_{jt} (Government Effectiveness) captures perceptions of the quality of public governance, its civil services, independence from political pressures and credibility of governmental policies.

BUS_{jt} (Business Freedom) measures the capability of starting and operating a business. Hence it is also a proxy for regulation of businesses.

TRA_{jt} (Trade Freedom) is a composite measure of ease of market penetration, including the absence of tariff and non-tariff barriers that affect German exports.

FIS_{jt} (Fiscal Freedom) is a proxy for the tax burden which is imposed by the governments that could discriminate free business.

GOV_{jt} (Government Spending) is a score based on the level of expenditures by government and state-owned enterprises. Its low index implies the danger that the government prefers to spend on domestic products and discriminates imports.

MON_{jt} (Monetary Freedom) combines a measure of price stability with an assessment of price controls. Both inflation and price controls distort market activity.

[5] List of dummy values and their meaning is in the Appendix in Table 7.

INV_{jt} (Investment Freedom) concerns the obstacles to free flow of capital, especially foreign capital that often acts as a facilitator of high trade exchanges.
FIN_{jt} (Financial Freedom) measures the banking efficiency and security. State ownership of banks and other financial institutions is seen as an impediment to import penetration.
PRO_{jt} (Property Rights) reflects the level of protection of private property. Laws in partner countries that do not enforce trade contracts (e.g. conditions of payments) make German exports more costly and thus less intensive.
COR_{jt} (Freedom from Corruption) measures the perception of legal, judicial and administrative corruption in the partner country.
EDU_{jt} (Education Index) is adopted from the UN Human Development Report. It measures years of schooling (adults 25 years) and the standards of education, which altogether reflect the endowments of human capital.
$BORD_{ijt}$ (Common Border) where the value equals 1, when a country has a common border with Germany; otherwise $BORD_{ijt} = 0$.

Our estimates of the GM proceeded in several steps. First, we tested the data for potential problems with collinearity by means of VIF (variance inflation factor analysis, see O'Brien, 2007). Its results did not suggest problems with collinearity in any of the cases. The tests of non-stationarity in our time-series by the Levin-Lin-Chu procedure resulted in rejecting the hypothesis.

Next, we had to decide about the use fixed effects (FE) versus the random effects (RE) model. We opted for the latter and the RE became our benchmark for the estimation of a static regression model. The selection of RE as a model appropriate for the data characteristics was based on a Hausman test. Its p-values are close to one (i.e. by far greater than the critical value of 0.05) implied that the data do not reject the random effects model (Hausman, 1978). Moreover, the random effect model will not exclude two important variables: distance as a proxy for bilateral trade costs which is "sluggish" in the dimension across time, and German GDP which is "sluggish" in the dimension across countries. Our panel data are identified as a problem which is solid either by time-series or by cross-sections, as explained in Figures 1 and 2. Additional information about this innovative approach to the interpretation of GM panels can be found in Benáček et al. (2014, p. 12-14).

5] Empirical Results

In this section we present the estimations. The 2nd column of Table 2 presents the estimates of time-series specification while the third column of Table 2 presents the estimates of cross-section. The parameters are estimated using a random effects approach; the insignificant institutional variables were dropped out of the model.

Table 2: Random effects estimation – time-series and cross-section panel estimations

Dep. Variable: **Log(X_{ijt})**	Time-series		Cross-section	
Log(Y_{jt})	1.042***	(0.044)	0.976***	(0.028)
Log(Y_{it})	0.272**	(0.124)	0.274*	(0.151)
Log(D_{ij})	-0.859***	(0.059)	-0.894***	(0.024)
C_{ijt}	-0.049**	(0.024)	0.169***	(0.031)
Log(L_{jt})	-0.056	(0.054)	0.005	(0.029)
R_t	-0.089***	(0.025)	-0.098**	(0.046)
PTA_{ijt}	-0.016	(0.012)	0.0243*	(0.002)
Log(RER_{ij})	-0.389***	(0.049)	-0.239***	(0.071)
GEF_{jt}			0.0048***	(0.0022)
BUS_{jt}	0.0023**	(0.0011)	–	
FIS_{jt}	–	–	0.0061***	(0.0011)
GOV_{jt}	0.0028***	(0.00085)	0.0035***	(0.0007)
INV_{jt}	0.0021**	(0.00092)		
FIN_{jt}	0.0021***	(0.00078)		
MON_{jt}			-0.0036***	(0.0007)
PRO_{jt}	0.0039***	(0.0012)	0.0030*	(0.0016)
COR_{jt}			0.0057***	(0.0015)
EDU_{jt}	0.0080***	(0.0028)	0.0105***	(0.0012)
No. of observations	3009		3009	
No. of groups	177		17	
R^2	0.900		0.900	
Hausman (*p*-value)	0.976		0.996	

Notes: * significant at 10%, ** significant at 5%; *** significant at 1%.
Robust (White heteroskedastic consistent) standard errors in brackets.
Hausman test does not reject the random effects model.
Response variable: logarithm of German bilateral exports. Constant and country / time specific effects included but not shown.

Table 3: Effects of statistically significant institutional and policy variables

Variables	Time-series				Cross-sections			
Log (X_{ij}) exports as dependent variable	% change of exports (1 unit change in explanatory variable)		% change of exports (10 unit change in explanatory variable)		% change of exports (1 unit change in explanatory variable)		% change of exports (10 unit change in explanatory variable)	
GEF_{jt}					0.50	***	5.13	***
BUS_{jt}	0.20	**	2.02	**				
FIS_{jt}					0.61	***	6.29	***
GOV_{jt}	0.20	***	2.02	***	0.30	***	3.05	***
INV_{jt}	0.20	**	2.02	**				
FIN_{jt}	0.20	***	2.02	***				
MON_{jt}					-0.30	***	-2.96	***
PRO_{jt}	0.40	***	4.08		0.30	*	3.05	*
COR_{jt}					0.60	***	6.18	***
EDU_{jt}	0.80	***	8.33	***	1.01	***	10.52	***

Remark: Institutional and policy variables (IP) are quantified in percentages <0, 100>. Effects of their unit changes (i.e. changes in 1 or 10 percentage points) were computed using the relationship $\%\Delta X = 100 \cdot \left[exp\ \left(\hat{\beta} \cdot \Delta IP\right) - 1\right]$*, where on the left hand side of the equation is the percentage change in the dependent variable and on the right hand side is the unit change in independent variable. The relationship is derived at the end of the Appendix.*

Time-series specification posts a question about exporters´ long-term decision making and dynamic developments in German trade. It should reveal the factors influencing German exports that are similar for all countries across years.

The model performs very well. The overall R^2 equals 90% and the results are mostly in line with our expectations. Our main finding is that economic factors are the fundamental drivers of the progress of German exports where the dominance of attractors (represented by the mass of GDPs) towards more trade over impediments to trade (such as transaction costs D) need not be always guaranteed and many seemingly marginal non-permanent factors (such as real exchange rate or various institutional factors) could disturb such a fragile balance if they would not be under control of German policy makers. Contrary to results dealing with other countries, population (L), common borders (BORD) or preferential trade agreements (PTA) did not reveal any significant impacts. We may presume that German export success has been subjected to specific national conditions different from the rest of Europe.

We have found several significant institutional variables as well. First of all, education (EDU) has a relatively high effect and four other factors each have lower impacts. Therefore, the other important finding is that institutions play their recognized supportive role in the model although their role in trade is not dominant. In contrast, some intuitively important institutions were found to be insignificant, such as government effectiveness (GEF), trade freedom (TRA), fiscal (FIS) and monetary (MON) policies, and corruption issues (COR).

A] Time-series one-way estimation results

Let us start with the results of panel time-series responding to the question "how much to export" considering the long-run time perspective. If we focus on economic determinants then German exports depend primarily on foreign "demand-pull effect" proxied by the partners' GDP. Its elasticity above unity implies that a 1% increase in partner country GDP increases its imports from Germany 1.04 %. It is the highest elasticity in the whole estimation and hence, the economic power in terms of total GDP appears to be the most important factor for German traders. This is in sharp contrast to the low elasticity of exports in relation to German GDP whose "supply push effect" is much smaller than what was observed for other countries (Chaney, 2013). German exports reflect the world requirements and retain a high autonomy outside the internal state of the German economy. This signals that the linkage between traded and non-traded sectors in Germany is not of vital importance.

The second highest elasticity in absolute value is the distance. A 1% increase in the partner distance decreases the export by 0.86%. The German distance elasticity is markedly lower than in the case of averages for the rest of the world (e.g. 1.07 according to Chaney, 2013). We can presume that German exports are therefore more long-range oriented than exports in other European countries.

The RER is the third economic variable that was highly significant in all models. It signals that a 1% real bilateral depreciation of Euro is bound to increase exports to that country by 0.39%.[6] In sum, the most important target countries for German exports in the long run are those that are wealthy, large and/or fast growing while their remoteness is less detrimental than in other countries. Therefore neighbouring countries whose own distance elasticity is higher could find it attractive to serve as providers of outsourced German inputs to exports.

All other significant economic/geographical variables provide elasticities or coefficient levels lower than 0.1 in the absolute value. Their small size does not imply that their impact is negligible. The most interesting factor in this group is related to the euro (C_{ijt}) whose coefficient is negative, which is a paradox. This important finding can be interpreted as follows. In the long-run (or as an aftermath of the financial crisis), the common currency depleted its initial role as a catalyst of trade creation and trade diversion, especially if the transaction costs outside of Eurozone could be internalised by the long-term interest in that trade. It still need not imply that Eurozone countries ceased to be important German trade partners. The non-Eurozone markets simply keep offering new windows of opportunities (such as lower level of competition) that could not be "explained" by other explanatory variables.

It is no surprise that the coefficient of recession dummy is negative, even though it is relatively lower than expected. The effect of the financial crisis was painful mainly in 2009 and quite soon German exporters re-directed their exports to countries with more stable growth (e.g., since 2009 the share of Eurozone in total German exports declined from 43% to 37% in 2013).

[6] It is a well-known fact that the so-called Hartz reforms of German labour market flexibility and wage moderation retained its positive effect on export competitiveness long after of 2003-2005, while domestic demand lacked that vigour until recently. This was a powerful instrument that brought huge current account surpluses, which turned Germany into a world leader in capital lending.

In institutional factors the level of education in the partner countries is the most influential variable. German exports are sophisticated products and their usage requires well prepared customers. An increase by 10 percentage points in the education variable stimulates exports by 8.3%. The other significant variables only play a minor role (business freedom, government spending, investment freedom and financial freedom). The impact of 10 percentage points´ increase on exports is about 2%, which is significantly lower than in the previous two cases.

There can be several explanations for the minor effect of institutional variables. First, the low effect may be caused by measurement problems. For example, the index measuring corruption reflects the level of its perception and not the real level of corruption. Secondly, the relevance of institutional factors can vary by circumstances; in some countries, the same institutions can act as catalysts while elsewhere they become inhibitors. Thirdly, even though institutions can play an important role, their partial co-linearity with other explanatory variables are able to conceal their importance (Shepherd, 2013, p. 36). For example, the regulatory institutions can altogether be negatively correlated with distance. Since German exporters concentrate on countries that are near and the nearest countries have high institutional scores (except for the U.S., Canada, Australia and Japan) their importance can be "captured" by the distance.

B] Cross-section one-way estimation results

The third column of Table 2 responds to the question of "where to export?". The cross section specification asks a different question than time-series model and examines the short-term (1 year) decision-making of German exporters, which is rather static. It examines factors behind German exports that are common for all investigated years across partner countries. Hence this specification simulates the decision of a German exporter about the selection of the destination market once the stock of his/her products has been already fixed by capacity.

The significant factors can be again divided into economic/geographic and institutional. As previously observed, the most important economic/geographic factor is the GDP of the partner country (Y_{jt}). Its elasticity of 0.976 is slightly lower compared to the preceding figure of 1.042, which implies that short-term decisions are less responsive to the size of external demand. This opportunistic bias is again visible in distance (D_{ijt}), the second most influential factor where its negative elasticity (-0.98) is higher. The two main influential factors reveal that the behaviour of German exporters does not differ much in the long and short run. Similar coefficients and significance are also displayed by German GDP, recession dummy, government spending and education.[7]

However, the differences (considering the distribution of coefficient error statistics) do not appear small enough to reduce the view presented in Figure 2 to the abstraction depicted in Figure 1 and estimate our data differently (e.g. as a two-way model). Nevertheless, there are ample dissimilarities which lead to a diversity of decision-making. Our two technically incompatible estimations point to three cases that make these models

[7] It should be noted that the behaviour of German exporters differed significantly from the behaviour of European exporters of foreign direct investment that was tested by Benáček et al., 2014, using a similar two-pronged way of estimation. There the differences in coefficients related to short and long-term decision-making were markedly more diverse, implying that the sensitivity of investors to long time horizons of yields was more decisive than the importance of time to exporters.

non-interchangeable. First, in the short-term dimension the common currency (euro via C_{ij}) plays a significant positive role as a trade facilitator while in the long-term its role is the reverse. The difference in results between both specifications is essential because in short-term exporters cannot internalize the transaction costs stemming from different currencies. Hence, the Eurozone members are momentarily more attractive trading partners due to zero currency transaction costs. That advantage, however, has little impact on the long-term development of German export growth that has mainly been fuelled since 2006 by non-Eurozone countries.

Second, the role of RER is also incompatible since in the cross-section analysis the exporters do not respond to appreciation/depreciation trends but to price level disparities between foreign countries and Germany. The coefficient of -0.239 suggests that low prices abroad discourage exports that should be sold preferably in countries where non-tradables are highly priced and where the purchasing power of buyers is high as well.

The third difference between our two basic models is caused by institutional variables. Amongst them, government spending and education in partner countries run parallel because they are stable over time. The remaining seven factors take different roles in time and space. For example, low government effectiveness, high corruption and high fiscal burden stand as inhibitors of trade in the short-term decision-making only, while price instability in partner countries acts as a short-term attractor.[8] All these factors have an impact on transaction costs in the short-run, however, in the long-run they can be internalised by exporters. The ability to internalise adverse institutional conditions abroad is an important characteristics of the success of German exporters. Thus, the state of institutions abroad must be well accounted for in their plans for development.

Pertaining to the counter-intuitive permanent insignificance of some variables, we had to drop some variables that were determined in other studies to comprise bilateral exports between all countries as highly significant, such as population size, common border and tariff and non-tariff barriers. German exports are indeed characterised by idiosyncrasies that point to specifics in their management.

6] Testing the Robustness of Our Results

In the literature of GM there are many provisos which claim that estimation results could be biased to the degree of getting spurious regressions due to incorrect treatment of data, which is rife with endogeneity, non-stationarity or heteroskedasticity and/or the reliance on techniques that were inappropriate (Baldwin and Taglioni, 2006; Egger, 2002; Fidrmuc, 2009; Mátyás, 1997 or Shepherd, 2013). We used data from 177 countries gathered over 17 years. Our regressions were opened to a possibility that the pattern of behaviour of explanatory variables in the dynamic data generating process was not uniform and the data set could conflict with poolability. Although we have lowered such a risk by distinguishing between time-series and cross-sections in the treatment of the panel we could not eliminate the risk that the data collection was methodologically incompatible or that we pooled together subpopulations of data from countries whose behaviour was heterogeneous and mutually incompatible (Benáček and Víšek, 2000, and Janda, Michalíková and Skuhrovec, 2013). Thus it is difficult to estimate models using an estimator which includes all observations in a single model in order to obtain unambiguous estimates.

[8] This may be a rational strategy if the nominal exchange rate depreciation falls behind the gain in prices.

Therefore, in this final step, our previous results are verified by testing their robustness. The applied technique of Least Trimmed Squares (LTS) has been developed as an estimator for solving the problem of behaviourally heterogeneous data patterns. This method tests the critical values of high breakdown points (i.e., smallest fraction of outlying observations that can cause a breakdown of the estimator such as a change in the plus/minus sign, the value of coefficient or its significance). The estimator also allows excluding all the "polluting" countries or several polluting years from the data set, which signal an error in data or a systemic difference in behaviour.

LTS estimator is defined as $\widehat{\beta}^{LTS}$, which minimizes the sum of the smallest h-squared residuals: $\widehat{\beta}^{LTS} = \arg\min_{\beta}(\sum_{k=1}^{h}(\tilde{y}_k - \tilde{x}_k^{'}\beta)^2{}_i$

where

$$[(\tilde{y}_k - \tilde{x}_k^{'}\beta)^2]_1 \le [(\tilde{y}_k - \tilde{x}_k^{'}\beta)^2]_2 \le \ldots \le [\tilde{y}_k - \tilde{x}_k^{'}\beta)^2]_i \le \ldots \le [(\tilde{y}_k - \tilde{x}_k^{'}\beta)^2]_{NT}$$

are the ordered squared residuals (Rousseeuw, 1983). The value $1 \le h \le NT$ is a trimming value. This estimator has a breakdown point at 50%. Moreover, for *h= [NT/2]+[(K+1)/2]* the LTS reaches the maximal possible value for the breakdown point. However, in practice it appears that we do not need maximal breakdown point and can select *h* larger. A default choice can be *h=[3NT/4]* or *h=[4NT/5]*, making it possible to cope with up to 25% of outliers (or 20%, respectively) or we can select *h* sufficiently small to reach an acceptable coefficient of determination of the model. However, in practice it appears that we do not need a maximum breakdown point and can select *h* larger. In this paper we use this technique as a diagnostic tool. We decided to report results of LTS estimation with h equal to 0.9, 0.8 and 0.7. This means that LTS algorithm excluded 10%, 20% and 30% of the observations.

This technique makes it possible to recognize any outliers which are not able to be detected by eye or by any other means of traditional regression diagnostics. Once we have separated the observations we can monitor whether certain excluded subpopulation of data are subject to certain behavioural regularity incompatible with the main sample. We may also test whether the removal of outliers brings an improvement to the estimated regression model (e.g. decrease in the residual sum of squares or increase in the coefficient of determination that signal a convergence to homogeneity and thus an improvement in the quality of the basic model). Finally, we monitor stability of estimated coefficients in the case of increasing h or examine whether *p*-values are improving while the outliers are dropped out of the model. It should be stressed that LTS does not mark off countries or years whose performance leads directly to trade being too small or too large but those whose complex behavioural pattern is not compatible with the mainstream countries.

Table 4: Random effect estimation after application of LTS estimation – time series

Dep. variable: **Log(Xij)**	*h*=0.9 time series		*h*=0.8 time series		*h*=0.7 time series	
$Log(Y_{jt})$	1.042***	(0.035)	1.087***	(0.031)	1.088***	(0.027)
$Log(Y_{it})$	-0.198***	(0.077)	-0.129**	(0.064)	-0.061	(0.057)
$Log(D_{ijt})$	-0.834***	(0.037)	-0.845***	(0.032)	-0.844***	(0.025)
C_{ijt}	0.003	(0.019)	0.035**	(0.018)	0.0341**	(0.015)
$Log(L_{jt})$	-0.062***	(0.029)	-0.314***	(0.033)	-0.163***	(0.028)
R_{jt}	-0.050***	(0.008)	-0.043***	(0.016)	-0.041***	(0.014)
PTA_{ijt}	-0.024***	(0.008)	-0.020***	(0.007)	-0.021***	(0.007)
$Log(RER_{ijt})$	-0.444***	(0.036)	-0.361***	(0.032)	-0.339***	(0.029)
BUS_{jt}	0.003***	(0.0007)	0.0029***	(0.0007)	0.0007	(0.0006)
GOV_{jt}	0.002***	(0.0006)	0.0009	(0.0006)	0.0009*	(0.0005)
INV_{jt}	-0.00004	(0.0006)	-0.0001	(0.0005)	0.00003	(0.0005)
FIN_{jt}	0.0009	(0.0006)	0.001***	(0.0005)	0.001**	(0.0005)
PRO_{jt}	0.002**	(0.0008)	0.002***	(0.0006)	0.003***	(0.0006)
EDU_{jt}	0.012***	(0.002)	0.008***	(0.001)	0.008***	(0.001)
No. observ.	2708		2407		2106	
No. groups	176		171		165	
R^2	0.959		0.974		0.983	

*Notes: * significant at 10%, ** significant at 5%; *** significant at 1%.*
Robust (White heteroskedatic consistent) standard errors in brackets.
Hausman test does not reject the random effects model.
Response variable: logarithm of export. Constant and country / time specific effects included but not shown.

In Table 4 we present the results of tests by the LTS technique. Our first general observation is that parameters are mostly significant. In all three cases, the coefficient of determination has increased and thus the quality of the model has been improved. By deleting 30% of observations, the R^2 shoots up markedly. The homogeneity of data has improved with each step toward the end of a large core subgroup of countries that behaved in conformity with the theoretical expectations. Partners' GDP (whose elasticity increased), distance and RER remained to be dominant factors sufficiently "robust" to various subpopulations of partners. In other words, according to the model, German exporters react to these factors in a highly similar intensity regardless the partner. Other stable factors with lesser impact are the recession dummy and trade barriers.

However, several economic factors, among them variables L_{jt} and $PTA_{ijt,}$ are less robust and their effect depends on the subpopulation. The former has a negative sign which points to the tendency that countries with a larger population increase their self-sufficiency at the expense of exports. A similar behaviour can be ascribed to the rise of German GDP that crowds out exports by giving more space to their domestic absorption. A similar reversal of the sign occurred to the Euro (C_{ijt}), which reveals that in the trade of "core countries" the benefits of the common currency prevail, despite numerous exceptions.

We can hardly qualify institutional factors as being as a robust factor as the economic variables. Their role as subsidiary decision-making factors becomes even more transparent since their significance and the values of coefficients slightly decreased in the model. The

most robust institutional variables are education and property rights. All other institutional variables experience non-robust behaviour when we change *h*. Business freedom becomes insignificant when we exclude 30% of outliers; financial freedom exhibits the opposite pattern, and the significance of government spending varies is without a clear pattern.

We can get a better understanding of the behaviours of German exports when we look in more detail at the geographic structure of excluded subpopulations. The results suggest that the countries least akin to the pattern of behaviour in the "core countries" are mostly located in Africa, Asia and Latin America.[9] In addition, these are often countries with marginal economic importance and non-standard institutional infrastructure (e.g., they are tax havens or stricken by social conflicts). An interesting observation was found by LTS tests run separately for three continents (Asia, Africa and America) revealing that their outliers (as continental groups) do not share common characteristics. They represent autonomous social models of trade behaviours. Characteristically, only few of the outliers are European countries. Particular attention should be given to removed countries that have opposite characteristics, such as Austria (closest German trade partner with a share of 5.5% in German exports in 2011), Norway (0.7% share) or Canada (0.7% share) that are important and highly developed but still "overshooting" the dominant standards set by other similar countries. The other important excluded countries are China (6% share), Hungary (1.5% share), Japan (1.4% share) or South Africa (0.8% share). The total share of excluded countries and their years in German export is 2% (*h*=0.9), 4% (*h*=0.8) and 11% (*h*=0.7).

Conclusions

Our results have shown a high degree of stability regarding the dominant economic variables that explain the behaviour of German exporters. Compared with the results of other countries (Fidrmuc, 2009 or Davidová and Benáček, 2014) our analysis pointed at characteristics that made German trade specific and different from features relevant both to the averages of the rest of world and seemingly similar, but smaller countries. At the same time, it was apparent that the modern trend in research that stresses the importance of the institutional infrastructure in economic behaviour is founded upon phenomena that may be to a large extent transitory and subject to concomitant conditions that may be difficult to quantify or predict.

The aim of gravity model (GM) theorists to explain the trade by searching for a universal system of causal links valid for the whole world has its trade-offs. It decreases in accuracy in relation to individual "home" countries that act so idiosyncratically that final decision-makers (i.e., exporters and importers) may find such results of little relevance. Our partial approach targeting one exporting country only and based on two parallel specifications, aims at providing more information to such users.

We have examined the German export flows for 1995-2011 using an adjusted gravity model. We have used random effects model with two parallel one-way specifications: time-series that is focused on long-term decisions about export growth and cross-section

[9] The list of all excluded countries and their year is in Annex in Table 9. For example countries where the most of years are denoted to be outliers for h=80% are: Andorra, Antiqua and Barbados, Albania, Burkina-Fasso, Bermuda, Bahamas, Botswana, Faroe Islands, Gabon, Grenada, Greenland, Eq. Guinea, Guyana, Hong-Kong, Cambodia, Cayman Islands, Liberia, Marshall Islands, Burma, Malaysia, Nepal, Singapore, San Marino, Swaziland, Chad, Virgin Islands and South Africa.

capturing short-term decisions. The results were cross-checked for robustness and the poolability by the least trimmed squares (LTS) estimation since the risk of behavioural heterogeneity of analysed countries is always high in GM that cover world-wide data.

The general result of the random effects model is that German exporters are more prone to expand the trade to countries that are more distant from their European neighbourhood than what is the world average. Exports are sensitive to both the real exchange rate movements and the price levels of partner countries, even though their elasticity is significantly less than unity, which suggests that German exports would not be impacted very much if the Euro appreciated in real terms. The position of the Euro in German trade seems to be rather ambiguous since not all tests revealed its role as a catalyst. Characteristically, German exports target countries with high standards of education.

The main difference between the time-series and cross-section specifications rests in the interpretation of euro dummy, real exchange rate and institutional factors. Their relevance seems to attenuate the short-term decision-making turns into long-term. The latter is much more open to economic factors.

The LTS estimator has not changed our main findings, in particular those concerning the economic core of the model. However, the exclusion of outliers pointed to transiency in some important details such as the role of population (market size) or common currency. Hence the European and Eurozone countries were still found to be in the hard core of German exports, notwithstanding their losses in shares.

If we return back to our three hypotheses we can conclude that institutions play significant but not the key role (H1 confirmed). We cannot confirm extensive role of Euro or mutual tariffs for German trade even though the variables are significant (H2 confirmed). The core economic factors are much more dominant. At the end the third hypothesis (H3) was partly confirmed but also falsified. We have found robust results for core economic variables but the opposite is true for institutional factors.

The results lead us back to our introductory question about the ability of highly competitive German exports to lead the EU from the recession. The German export sector is definitely an indispensable part of the European economy. This is reflected in the importance of general gains from the close proximity of European markets, the central geographic position of Germany in Europe, low trade costs due to the EU *acquis* and intra-industry specialisation based on the inputs of high skilled labour (provided we agree that European countries are well educated and their education standards are not rapidly declining). Unsurprisingly, with the fading of the Rose effect the existence of Euro did not turn out to be unequivocally positive in the aim of uniting Germany with Europe. German internal appreciation could strike a difference, particularly if a melt-down of significant German surpluses would lead to an environment in which Southern partners gain more time and space to catch up.

Given that we can propound that positive spillovers, due to adjusted Europe trade with Germany, were able to launch a long-expected recovery in the European tradable sector, combined with gains throughout the whole EU from trade with the rest of the world where countries with intensive German presence (China, US, Japan and BRICS) could play an important role. That scenario might boost GDP growth throughout Europe causing multiplied mutual repercussions via new waves of trading. The one great unknown is whether the success in tradables could trickle down and resuscitate the EU´s non-tradable sectors, which is rife with bureaucracy, rent-seeking and dreams of a welfare state, and thus alien to the standards of efficient exports. Our research that has dealt exclusively with tradables cannot

determine any constructive observation here. We can only presume that German exports alone cannot be regarded as a self-sufficient tool leading the EU out of the crisis, but it can serve only as a good start for much more fundamental changes that Europe needs.

References

Aiginger K. and Leoni T. 2012. Germany Needs a New Growth Path. Paper of F. Ebert Stiftung, "Perspectives", October.

Anderson, J. E. 1979. A Theoretical Foundation for the Gravity Equation. American Economic Review, 69(1): 106–16.

Anderson, J. E., and van Wincoop, E. 2003. Gravity with Gravitas: A Solution to the Border Puzzle. American Economic Review, 93(1): 170–92.

Babecká-Kucharčuková, O., Babecký, J. and Raiser, M. 2012. Gravity Approach for Modelling International Trade in South-Eastern Europe and the Commonwealth of Independent States: The Role of Geography, Policy and Institutions. Open Economies Review, 23(2): 277-301.

Bahmani-Oskooee, M. and Nasir, A. 2005. Productivity Bias Hypothesis and the Purchasing Power Parity: A Review Article, Journal of Economics Surveys 19 (4): 671–696.

Baldwin, R. and Taglioni D. 2006. Gravity for Dummies and Dummies for Gravity Equations. Cambridge MA, NBER, Working Paper no. 12516.

Benáček, V. and Víšek, J.Á. 2000. Přímé zahraniční investice v české ekonomice: praxe, teorie a aplikace. Politická Ekonomie, 1:7-24.

Benáček, V., Michalíková E. et al. 2014. Political Risk, Institutions and Foreign Direct Investment: How Do They Relate in Various European Countries? The World Economy, forthcoming (available as the on-line version of September 2013).

Davidová, L. and Benáček V. 2014. Determinants of Austrian International Trade: Analysis Based on the Gravity Model. Working Papers of IES, Charles University, no. 5.

Bergstrand, J.H. 1985. The Gravity Equation in International Trade: Some Microeconomic Foundations and Empirical Evidence, Review of Economics and Statistics, 67(3): 474-81.

Bergstrand, J. H. 1989. The Generalised Gravity Equation Monopolistic Competition, and the Factor-Proportions Theory in International Trade. *Review of Economics and Statistics 71:* 143-153.

Buras, P. 2012. Europe and the German Dilemma. Aspen Review, July, 9-16.

Chaney, T. 2013. The Gravity Equation in International Trade: An Explanation. Cambridge, MA, NBER, Working Paper no. 19285.

Cieslik, A. 2009. Bilateral Trade Volumes, the Gravity Equation and Factor Proportions. *The Journal of International Trade & Economic Development 18 (1):* 37–59.

Darvas, Z., Pisani-Ferry J. and Wolff G. 2013. Europe´s Growth Problem (and What to Do about It). Brussels, Bruegel Policy Brief, no. 3.

Dauderstädt, M. 2013. Germany's Socio-economic Model and the Euro Crisis. Review of Econonomics and Polit. 33(1).

Dauderstädt, M. 2012. Germany's Economy: Domestic Laggard and Export Miracle. F.E Stiftung, International Policy Analysis, April.

Davidová, L. and Benáček, V. 2014. Determinants of Austrian International Trade: Analysis Based on the Gravity Model. Prague, Charles University, IES Working Paper no. 4.

Deardorff, A. 1998. Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World? In: *The Regionalisation of the World Economy*, J.A. Frankel (editor). University of Chicago Press, 7–32.

Disdier, A.-C. and Head, K. 2008. The Puzzling Persistence of the Distance Effect on Bilateral Trade. Review of Economics and Statistics, 90(1): 37-48.
Eaton, J. and Kortum, S. 2002. Technology, geography, and trade. Econometrica 70, 1741–1779.
Egger, P. 2002. An Econometric View on the Estimation of Gravity Models and the Calculation of Trade Potentials. The World Economy 25(2): 297–312.
Egger, P. and Nigai, S. 2013. Gravity with Dummies Only. Prague, paper presented at the IES, Charles University research seminar.
Etzel, D., Hauptmann D. and Schmerer H.-G. 2013. Dissecting the German Export Miracle: Plant-level Evidence. Economic Systems, 37 (3): 387–403.
Fidrmuc, J. 2009. Gravity Models in Integrated Panels. Empirical Economics 37(2), 435-446.
Gross, S. 2013. The German Economy Today: Exports, Foreign Investment, and East-Central Europe. Working Paper, New York University, NYU CEMS. http://cems.as.nyu.edu/docs/CP/4751/MWFinal.ac.pdf (2 October 2013)
Gwartney, J., Lawson, R. and Hall, J. 2012. The 2012 Economic Freedom Dataset. In Economic Freedom of the World: 2012 Annual Report, Fraser Institute http://www.freetheworld.com/datasets_efw.html (14 June 2013)
Halpern, L., Koren M. and Szeidl A. 2011. Imported Inputs and Productivity. Budapest: Center for Firms in the Global Economy, Working Paper no. 8.
Hausman, J. A. 1978. Specification Tests in Econometrics. Econometrica 46(6): 1251-71.
Janda, K., Michalíková, E. and Skuhrovec, J. 2013. Credit Support for Export: Robust Evidence from the Czech Republic. The World Economy, 36 (12): 1588–1610.
Havránek, T. 2010. Rose effect and the euro: is the magic gone? Review of World Economics, 146(2), 241-261.
Kahneman, D. 2011. Thinking, Fast and Slow. London, Allen Lane.
Kahneman, D., Krueger A. B., Schkade D., Schwarz, N., and Stone, A. A. 2006. Would You Be Happier If You Were Richer? A Focusing Illusion. Science, 312: 1908-1910.
Kahneman, D., and Tversky A. 1979. Prospect Theory: An Analysis of Decision Under Risk. Econometrica. 47: 263-291.
Leamer, E. E. and Levinsohn, L. 1995. International Trade Theory: The Evidence. In: G. M. Grossman & K. Rogoff (eds), *Handbook of International Economics,* vol 3: 1339-1394, Amsterdam, Elsevier.
Matsuyama, K. 1992. Imperfect Competition, Foreign Trade, and the Multipliers: Machlup-Metzler Fifty Years Later. Stanford, Hoover Institution, Working Paper no. E-92-4.
Mátyás, L. 1997. Proper Econometric Specification of the Gravity Model. The World Economy 20(3): 363-368
McCallum, J. 1995. National Borders Matter: Canada-U.S. Regional Trade Patterns. American Economic Review, 85(3): 615-623.
Melitz, M. 2003. The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. Econometrica, 71: 1695-1725.
McCallum, J. 1995. National Borders Matter: Canada-U.S. Regional Trade Patterns. American Economic Review, 85(3): 615-623.
O'Brien, R.O. 2007. A Caution Regarding Rules of Thumb for Variance Inflation Factors. Quantity and Quality, 41:673-690.
Průša, J. and Průša P. 2013. Dynamic Gravity Model: Evidence from Austria, Germany and Switzerland. IACSS Conference Proceedings, Instanbul: 250-262._

Rousseeuw, P. and Leroy, A. 1987. Robust Regression and Outlier Detection. Somerset, Wiley Publ.

Sperber, D. and Wilson, D. 2004. Relevance Theory. In G. Ward and L. Horn (eds): *Handbook of Pragmatics*. Oxford, Blackwell, 607-632.

van Brabant, J. 1993. New East, Preferred Trade Regimes and Designing the Transiton. In: The Political Economy of the Transition Process in the Eastern Europe, edit. L. Somogyi. Aldershot, E. Elgar Publishing, pp. 262-288.

Wooldridge, J. M., 2003. Introductory Econometrics: A Modern Approach. Mason: Thomson SW Publishing.

Appendix

Table 5: List of partner countries

Code	Partner countries	Code	Partner countries	*Code*	*Partner countries*	Code	Partner countries
AFG	Afghanistan	EGY	Egypt	LBR	Liberia	SAU	Saudi Arab
ALB	Albania	SLV	El Salvador	LBY	Libya	SEN	Senegal
DZA	Algeria	GNQ	Eq. Guinea	LIE	Liechtenstein	XSE	Serbia
AND	Andorra	ERI	Eritrea	LTU	Lithuania	SYC	Seychelles
AGO	Angola	EST	Estonia	LUX	Luxembourg	SLE	Sierra Leone
ATG	Antigua & B.	ETH	Ethiopia	MAC	Macau	SGP	Singapore
ARG	Argentina	FRO	Faroe Isl	MKD	Macedonia	SVK	Slovakia
ARM	Armenia	FJI	Fiji	MDG	Madagascar	SVN	Slovenia
AUS	Australia	FIN	Finland	MWI	Malawi	ZAF	South Africa
AUT	Austria	PYF	Fr. Polynesia	MYS	Malaysia	ESP	Spain
AZE	Azerbaijan	FRA	France	MDV	Maldives	LKA	Sri Lanka
BHS	Bahamas	GAB	Gabon	MLI	Mali	VCT	St Vincent
BHR	Bahrain	GEO	Georgia	MLT	Malta	SDN	Sudan
BGD	Bangladesh	GHA	Ghana	MHL	Marshall Isl	SWZ	Swaziland
BRB	Barbados	GRC	Greece	MRT	Mauritania	SWE	Sweden
BLR	Belarus	GRL	Greenland	MUS	Mauritius	CHE	Switzerland
BEL	Belgium	GRD	Grenada	MEX	Mexico	SYR	Syria
BLZ	Belize	GTM	Guatemala	MDA	Moldova	TWN	Taiwan
BEN	Benin	GIN	Guinea	MNG	Mongolia	TJK	Tajikistan
BMU	Bermuda	GUY	Guyana	MAR	Morocco	TZA	Tanzania
BOL	Bolivia	HTI	Haiti	MOZ	Mozambique	THA	Thailand
BIH	Bosnia	HND	Honduras	PRK	N. Korea	TGO	Togo
BWA	Botswana	HKG	Hong Kong	NAM	Namibia	TTO	Trinidad &T.
BRA	Brazil	HUN	Hungary	NPL	Nepal	TUN	Tunisia
BRN	Brunei	TCD	Chad	NLD	Netherlands	TUR	Turkey
BGR	Bulgaria	CHL	Chile	NZL	New Zealand	TKM	Turkmenistan
BFA	Burkina Faso	CHN	China	NIC	Nicaragua	UGA	Uganda
MMR	Burma	ISL	Iceland	NER	Niger	UKR	Ukraine
BDI	Burundi	IND	India	NGA	Nigeria	URY	Uruguay
KHM	Cambodia	IDN	Indonesia	ANT	NL Antilles	USA	USA
CMR	Cameroon	IRN	Iran	NOR	Norway	ARE	Utd Arab Emir
CAN	Canada	IRQ	Iraq	OMN	Oman	GBR	Utd Kingdom
CYM	Cayman Isl	IRL	Ireland	PAK	Pakistan	UZB	Uzbekistan
COL	Colombia	ISR	Israel	PAN	Panama	VEN	Venezuela
COG	Congo	ITA	Italy	PNG	Papua NG	VNM	Viet Nam
COD	Congo DR	JAM	Jamaica	PRY	Paraguay	VII	Virgin Isl US
CRI	Costa Rica	JPN	Japan	PER	Peru	YEM	Yemen
CIV	Côte d'Ivoire	JOR	Jordan	PHL	Philippines	ZMB	Zambia
HRV	Croatia	KAZ	Kazakhstan	POL	Poland	ZWE	Zimbabwe
CAF	Ctl African Rep.	KEN	Kenya	PRT	Portugal		
CUB	Cuba	KWT	Kuwait	QAT	Qatar		
CYP	Cyprus	KGZ	Kyrgyzstan	ROM	Romania		
CZE	Czech Republic	LAO	Laos	RUS	Russia		
DNK	Denmark	LVA	Latvia	RWA	Rwanda		

DOM	Dominican Rep	LBN	Lebanon	KOR	S. Korea
ECU	Ecuador	LSO	Lesotho	SMR	San Marino

Table 6: List of all variables used in the GM estimations

Indicator	Variable	Unit	Source
X_{ijt}	German exports (the dependent variable)	mil. EUR	Eurostat
Y_{it}	GDP PPS (Germany)	mil. EUR	Eurostat
Y_{jt}	GDP PPS (Partner)	mil. EUR	IMF and Eurostat
D_{ij}	Distance	km (adjusted)	CEPII
C_{ijt}	Euro (degree of exchange rate flexibility)	dummy (1-3)	Own estimation
L_{jt}	Population (partners)	mil. inhabitants	IMF
R_{t}	Recession dummy	dummy (0,1)	Own estimation
PTA_{ijt}	Preferential Trade Agreement intensity	dummy (1-9)	WTO, UNCTAD & own estimate
RER_{ijt}	Real exchange rate	index of ERDI	IMF, World Bank & own estimate
GEF_{jt}	Government Effectiveness	per cent (0-100)	World Bank
BUS_{jt}	Business freedom	per cent (0-100)	Heritage Foundation
TRA_{jt}	Trade freedom	per cent (0-100)	Heritage Foundation
FIS_{jt}	Fiscal freedom	per cent (0-100)	Heritage Foundation
GOV_{jt}	Government spending	per cent (0-100)	Heritage Foundation
MON_{jt}	Monetary freedom	per cent (0-100)	Heritage Foundation
INV_{jt}	Investment freedom	per cent (0-100)	Heritage Foundation
FIN_{jt}	Financial freedom	per cent (0-100)	Heritage Foundation
PRO_{jt}	Property rights	per cent (0-100)	Heritage Foundation
COR_{jt}	Freedom from Corruption	per cent (0-100)	Heritage Foundation
EDU_{jt}	Education index	per cent (0-100)	United Nations (HD Reports)
$BORD_{ijt}$	Common border	dummy (0,1)	Own estimation
T_{ijt}	Tariff barriers	per cent (0-100)	Gwartney et al. (2012)
NT_{ijt}	Non-tariff barriers	per cent (0-100)	Gwartney et al. (2012)

Table 7: Trade barriers dummy

1 = EU member
2 = European Economic Area member
3 = Agreement on Customs Union
4 = Association Agreement
5 = Free Trade Area agreement
6 = Neighbourhood and partnership policies
7 = GSP+ and EBA (Everything but arms)
8 = GSP a MFN.
9 = Not indicated in the Tradoc-list.pdf. It implies that this trade is without any special institutional relieves.

Table 8: Correlation matrix

Tabl	Xij	Yj	Yi	Dij	Cij	Lj	Rj	PTAij	RERij	GEFj	BUSj	TRAj	FISj	GOVj	MONj	INVj	FINj	PROj	CORj	EDUj
Xij	1																			
Yj	0.586	1																		
Yi	0.102	0.067	1																	
Dij	-0.286	0.034	0.000	1																
Cij	0.437	0.027	0.131	-0.429	1															
Lj	0.194	0.532	0.016	0.074	-0.061	1														
Rj	0.068	0.049	0.660	0.000	0.089	0.012	1													
PTAij	-0.492	-0.062	-0.127	0.624	-0.694	0.098	-0.0768	1												
RERij	-0.313	-0.153	-0.161	0.084	-0.334	0.072	-0.1800	0.4343	1											
GEFj	0.371	0.193	0.003	-0.121	0.384	-0.001	0.0048	-0.5577	-0.633	1										
BUSj	0.233	0.125	0.014	-0.020	0.241	-0.092	0.0491	-0.3616	-0.525	0.724	1									
TRAj	0.261	0.105	0.333	-0.126	0.299	-0.154	0.276	-0.4610	-0.390	0.484	0.441	1								
FISj	-0.212	-0.030	0.233	0.195	-0.227	0.018	0.159	0.284	0.082	-0.090	0.032	0.168	1							
GOVj	-0.287	-0.012	0.043	0.359	-0.362	0.121	0.0153	0.4993	0.259	-0.365	-0.138	-0.184	0.523	1						
MONj	0.172	0.095	0.219	0.046	0.181	-0.002	0.0588	-0.2858	-0.431	0.503	0.442	0.384	0.166	0.026	1					
INVj	0.234	0.063	-0.042	-0.068	0.311	-0.090	-0.0130	-0.4397	-0.399	0.626	0.649	0.437	0.007	-0.113	0.447	1				
FINj	0.251	0.079	0.045	-0.039	0.274	-0.113	0.013	-0.414	-0.473	0.649	0.671	0.497	0.061	-0.143	0.502	0.760	1			
PROj	0.305	0.141	-0.114	-0.045	0.312	-0.073	-0.0793	-0.4472	-0.576	0.814	0.781	0.432	-0.104	-0.291	0.459	0.704	0.724	1		
CORj	0.321	0.139	0.025	-0.063	0.321	-0.081	0.0180	-0.4888	-0.641	0.828	0.716	0.487	-0.122	-0.399	0.491	0.595	0.656	0.859	1	
EDUj	0.333	0.182	0.156	-0.165	0.368	-0.078	0.1094	-0.5089	-0.482	0.692	0.535	0.506	-0.084	-0.439	0.241	0.424	0.491	0.565	0.606	1

Table 9: Excluded years of countries for particular h.

Country	h=0.7	h=0.8	h=0.9
Andorra	15	13	0
Utd Arab Em.	11	9	2
Afghanistan	15	7	2
Antigua	17	16	10
Albania	17	15	1
Armenia	4	0	0
Antilles	3	3	1
Angola	6	4	0
Austria	6	0	0
Bosnia	1	1	0
Barbados	14	6	1
Bangladesh	2	0	0
Burkina Faso	15	12	0
Burundi	1	1	0
Benin	2	0	0
Bermuda	13	13	13
Brunei	9	7	2
Bolivia	11	2	0
Bahamas	12	10	9
Botswana	17	17	16
Belize	8	4	2
Canada	13	3	0
Congo DR	6	1	0
Ctl Afr. Rep.	15	8	4
Congo	2	0	0
China	9	1	0
Cuba	2	1	1
Cyprus	2	1	0
Dominican R.	9	0	0
Algeria	14	7	2
Ecuador	1	0	0
Eritrea	5	1	1
Fiji	10	8	2
Faroe Island	17	17	15
Gabon	16	11	3
Grenada	17	15	13
Georgia	1	0	0
Greenland	17	16	16

Country	h=0.7	h=0.8	h=0.9
Eq. Guinea	17	17	12
Guinea	17	13	2
Hong Kong	17	17	3
Honduras	2	0	0
Haiti	4	2	0
Hungary	7	0	0
Indonesia	4	3	1
Ireland	6	1	0
Iraq	10	10	8
Jamaica	15	14	3
Jordan	16	7	1
Japan	2	0	0
Cambodia	13	10	5
N. Korea	9	8	2
Cayman Isl.	15	12	8
Laos	10	5	0
Lebanon	1	0	0
Sri Lanka	3	0	0
Liberia	16	16	16
Marshall Isl.	15	14	14
Mali	2	0	0
Burma	11	10	2
Mongolia	4	2	2
Macau	9	5	3
Mauritania	12	5	3
Mauritius	7	1	0
Maldives	4	2	1
Malawi	3	0	0
Malaysia	17	16	9
Mozambique	2	1	0
Namibia	1	1	0
Niger	4	1	0
Nigeria	1	0	0
Nicaragua	8	4	0
Norway	14	0	0
Nepal	14	10	4
Oman	1	0	0
Panama	4	3	2

Country	h=0.7	h=0.8	h=0.9
Peru	2	0	0
Papua NG	7	3	2
Philippines	6	2	0
Seychelles	4	2	2
Singapore	17	17	17
Sierra Leone	6	5	4
San Marino	17	15	2
El Salvador	3	1	0
Swaziland	16	16	10
Chad	13	12	8
Togo	16	7	2
Thailand	7	4	0
Tajikistan	12	4	0
Trinidad	4	1	1
Uganda	8	1	1
Uzbekistan	3	2	0
St Vincent	11	8	2
Venezuela	1	0	0
Virgin Isl	15	15	15
Vietnam	12	8	0
Serbia	4	2	1
Yemen	1	0	0
South Africa	17	17	13
Zambia	9	2	0
Zimbabwe	13	7	1

Interpreting the coefficients of the non-log explanatory variables:
The derivation of the generalised formula for log-level models where the exogenous variable is already in percentages and the coefficient interpretation is close to semi-elasticity.

$$\%\Delta y = 100 \cdot \left[\exp\left(\hat{\beta} \cdot \Delta x\right) - 1\right]$$

The equation is taken from Wooldridge (2003, p. 188). The derivation is following:

$$\Delta \log(y) = \hat{\beta}\Delta x$$

$$\log(y_2) - \log(y_1) = \hat{\beta}(x_2 - x_1)$$

$$\log\left(\frac{y_2}{y_1}\right) = \hat{\beta}(x_2 - x_1)$$

$$\frac{y_2}{y_1} = e^{\hat{\beta}(x_2 - x_1)}$$

$$\frac{y_2 - y_1}{y_1} = e^{\hat{\beta}(x_2 - x_1)} - 1$$

$$100 * \frac{y_2 - y_1}{y_1} = 100 * \left[e^{\hat{\beta}(x_2 - x_1)} - 1\right]$$

$$\%\Delta y = 100 \cdot \left[\exp\left(\hat{\beta} \cdot \Delta x\right) - 1\right]$$

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