DESCRIBING PATTERNS OF INTERNATIONAL TRADE IN TRANSITION ECONOMIES: GRAVITY MODEL EXTENSION

by

Kurganov Yuriy

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Abstract

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by Kurganov Yuriy

Head of the State Examination Committee: Mr. Serhiy Korablin,
Economist, National Bank of Ukraine

This paper evaluates the change in patterns of international trade in transition countries attributed to countries' participation in common economic clusters (poles of economic gravity) by utilizing gravity model specification. To achieve this goal we attempt to extend existing measures of economic distance on both theoretical grounds and for empirical estimation. In doing so, measure of regional institutional development is proposed as an important indicator for change in economic distance between transition countries entering common economic areas. Using the extensive set of econometric methods the developed measure is proved to be positive, highly statistically significant and quite robust for different types of models. Hence we showed that high level of regional governance decreases economic distance between countries and thus increases trade between them and vice versa. We also provided quantitative estimates of this effect, which should be useful for county policy-makers. For example we found that in case of Ukraine's membership in the EU common trade area its trade with EU countries would increase by about 21%, while it will loose only about 0,43% in trade with countries like Russia, Belarus, Moldova, which in turn provides for straightforward policy implication.

We also incorporate in this study recently developed econometric modeling technique (3-stage GMM) to allow for spatially correlated error terms, which though, turned out to be not present for the considered set of countries.

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GLOSSARY

AC	Acceding Countries
CE	Central Europe
CEB	Central Europe and Baltic states
CES	Common Economic Space
CIS	Commonwealth of Independent States
FSU	Former Soviet Union countries
FTA	Free trade agreement
IRS	Increasing returns to scale
OLS	Ordinary least squares
FEM	Fixed effects model
REM	Random effects model
FGLS	Feasible GLS model
EU	European Union

Chapter 1

INTRODUCTION

The main goal of this paper is to study the consequences of country being part of common economic space (pole of economic gravity), on change in patterns of international trade. Specifically it will draw its main attention to determining and explaining change in patterns of trade between transition countries, namely newly accessed EU, other Central European countries and countries of the CIS block over the recent period. This target is planned to be achieved by extending the conventional gravity model (Anderson, 1979) on theoretical ground, as well as for empirical testing, utilizing the concept of *economic remoteness.* The concept as such is thought of as one that represents a set of factors that are entitled to capture the effect of "economic distance" that is formed between countries due to creation and development of different types of economic institutions, on trade flows. Development of the proper measure of distance has always been an issue of much concern not only for economists interested in international trade. But yet it seems that the problem is still only on the way to the right solution.

Studying how economically distant and/or different are countries in terms of determinants of trade, we can outline a set of factors that is already accounted for in the conventional gravity model specification and a set of factors that point to the importance of economic, institutional arrangement within single countries and their blocks, and is not controlled for. The following table summarizes some major determinants discussed above:

Table 1. Determinants of trade.

Economic size (proxied by real GDP or GDP per capita)	Gravity Model
Transportation costs (proxied by geographic distance)	
Economic size relative to distance or relative distance measure	*"geographic remoteness"*
Participation in different economic/trading blocks	*"economic remoteness"*
Economic institutional infrastructure: - fiscal institutions - legal institutions - financial institutions - economic practices	
Other control factors: - trade barriers - natural resources and initial conditions - country-specific characteristics (i.e. speaking common language, sharing common border, using the same currency etc.)	

While the control factors, economic size and geographic distance determinants seem to be quite intuitive in nature, others would probably call for explanation. The notion of geographic remoteness was first introduced by McCallum (1995) as an additional variable in gravity equation $REM_i = \sum_{m \neq j} d_{im} / y_m$, where d_{im} – is the distance between country *i* and country *m*, and y_m is the indicator of income (i.e. GDP) of respective country other than *i*. This geographical remoteness index is entitled to capture the effect on trade flows between some regions *i* and *j* of average distance of region *i* from all other regions not including *j*. Putting it in simple terms the idea was to incorporate the understanding of importance of relative distance as compared to absolute distance into the model. That is, if for some pair of regions/countries the distance to the rest of the world is relatively high, then they will trade with each other more[1].

[1] For example of relative distance concept see Choi and Harrigan (2003, p. 106).

In contrast economic remoteness concept that we have intended to incorporate into this study generally implies that when absolute and relative distance factors for any pairs of countries are the same or controlled, the fact that specific country belongs to or becomes a member of common economic space will in specific way influence its trading patterns with countries within this area and outside it. As an example consider the effect of the fact that Baltic countries have become members of EU on their trade with European countries and Russia. During 1993-1996 period, when these three countries received the AC status, their total trade with Russia was growing at about 40-45% per annum, over 1997-2004 the average growth declined to only 8% annually. At the same time the growth rate of trade with the other 7 AC countries were at about 40% during the considered period (1997-2004). Thus in this case the statistical data suggests that as those countries entered free-trade agreements with the EU their growth of trade with Russia has declined significantly, whereas EU countries have instead became one of their main trading partners (over 1997-2003 the amount of their trade with 7 other AC countries relative to trade with Russia has increased from 45% to 96%). Note that the relative as well as absolute distance between them did not change, and Russia remained the major exporter of gas and oil (world prices of which have been experiencing roughly a steady growth). Besides we would express some doubt that the extent of shifts in relative tariff rates was large enough to fully explain the phenomena. Furthermore, we would not be able to explain this empirical observation within the conventional gravity model framework. So our ultimate goal here will be to allow for such trade improvement/diversion effects and to provide their careful empirical estimations, making the theoretical hypothesis that the change in local and regional economic institutional infrastructure has to play the role.

In case of Ukraine, the parameters entitled to capture the "economic distance" would clarify what will be the effect on Ukrainian trade flows of the fact that its trading partners belong to common economic space (different free-trade agreements between each other, custom unions etc.), whereas Ukraine does not, or how the trading patterns of our country might change as it enters one or the other trading block.

As it was already noted above, in order to study this issue we incorporate into our analysis a well-known gravity model. Many researchers in international trade have been extensively using it for explaining the volumes of trade flows between countries and in these attempts have extended its conventional specification. Others tried to provide theoretical grounds for its empirical success, showing that fundamental equations of different theoretical models of international trade can be reduced to gravity-like ones. Nevertheless there are a lot of theoretical and empirical puzzles to the model that still remain unsolved and work is currently in progress. So the other goal of this paper is to contribute to the process of theoretical and empirical study of international trade using gravity model. And in this paper we will provide an attempt to propose a novel extension to specification and estimation of gravity model and will try to justify those by empirical testing of the theoretical hypothesis that we make. Moreover taking into consideration Ukraine's integration aspirations, the effect of integration process, specifically concerning neighboring countries, on its trade flows and welfare undoubtedly needs evaluation. So in this paper we will provide corresponding policy implications as to necessity of participation in regional trading agreements, as far as their effect on change in trade flows is concerned.

Hence we believe that this research will be of high interest to researchers, because it will provide possibly valuable extension of the conventional gravity model especially for disaggregated level data where gravity performance is much weaker; to policymakers, because significance and magnitude of effects would call for important policy actions; to entrepreneurs, because its conclusions would provide necessary insight for making decisions on appropriate lobbying actions on FTAs membership status of the country.

Keeping in mind that Ukraine is very open to and significantly depends on international trade flows (alone exports account for over 60% of GDP according to Dean et al. (2003)), it is straightforward that analysis of international trade conditions needs particular attention.

As noted above the approach we are going to utilize in this paper is novel and has not been studied in the literature so far. So in our literature review section first we will address theoretical foundations of the gravity model itself, then we will proceed with some recent empirical studies related to our topic of interest, that provided some useful extensions to the model. Afterwards we will focus on discussing geographic remoteness measure as a useful point of reference to develop a similar measure of relative block distance indicator that will be incorporated into the model. Then we will touch upon other existing theories that can be used to explain development of patterns of international trade, i.e. economic geography and institutional theory, concluding that preference should be given to institutional approach as it is capable to explain sudden changes in patterns of trade due to formation of integration structures with new institutions coming into place. Hence a measure of development of local and regional institutional infrastructure should be included into the model in order to capture the effect of change in "economic distance". Finally, we will present the relevant CIS literature on the topic.

Overall we may conclude that the existing literature provides us with a few alternative measures of geographic remoteness, and alternative theories explaining adjustment of patterns of trade, which would therefore grant us with the necessary insight on formulating a mathematical description of measures of "economic distance" (remoteness) formed between countries, which is one of the major goals of this paper.

We will further develop and utilize such indicators in the data and methodology section of the paper extending the conventional gravity model specification. Apart from the typical set of econometric methods used with panel data to estimate the developed model (pooled OLS, FE, RE, MLE, FGLS etc.), the intuition behind the proposed measures of economic remoteness outlines the necessity to account for their spatial effects on countries within common trade areas. At the same time acknowledging the presence of autoregressive and heteroscedastic disturbances in our panel data we utilize a new methodology developed by Kapoor, Kelejian, and Prucha (1999, 2006), namely the 3 stage GMM procedure to estimate the model coefficients, which has the desirable properties of consistency and efficiency even in relatively small samples.

The results section will then describe the empirical results obtained using different estimation techniques. Afterwards we will provide overall conclusions and discuss major findings in the final section of the paper.

Chapter 2

LITERATURE REVIEW

Gravity equation has been truly a work horse of empirical research in international trade for at least during last four decades, mainly due to its outstanding empirical success. It was originally proposed by Linder (1961) and Linnemann (1966) and then further developed by many other economists. The basic idea of developed gravity models is quite simple: volume of bilateral trade is expressed as a function of economic size of the trading countries and distance between them: $M_{cd} = k\frac{Y_c Y_d}{D_{cd}}$, where M_{cd} denotes the value of imports by country *c* from country *d*, D_{cd} is the distance between the two countries, *Y* is a measure of economic size such as GDP, and *k* is a constant. Though, the major criticism of the model was that it seemed to have no theoretical foundation. One of the earliest is due to Anderson (1979), with contributions from Bergstrand (1985, 1989), Helpman and Krugman (1985). These researchers have shown that the gravity equation is consistent with many standard models of international trade or they can be transformed into gravity-like equations under certain assumptions. For example Helpman and Krugman (1985) formulate the model of international trade caused by IRS and monopolistic competition on the production side, which transforms into gravity provided Armington preferences assumption on the demand side (CES identical utility function - Armington, 1969). Anderson (1979) derives gravity equation using the Cobb-Douglas expenditure system with identical preferences, implying identical expenditure shares and Keynesian-type trade model, where countries fully specialize in production of single commodity (thus goods are differentiated by the place of origin). He therefore receives gravity-type equation with income elasticities constrained to be unity.

As noted above, one of the key assumptions of the gravity model was that goods are differentiated by the country of origin, hence countries specialize in producing disjoint sets of goods, and therefore theoretically the model should be applicable only to trade in differentiated goods. Though, Eaton and Kortum (2002) develop multi-country Ricardian model that does produce a gravity-like equation for trade in homogeneous goods. Also, despite Helpman-Krugman's monopolistic competition model, it has been empirically shown that gravity works well for developed countries, as well as poor ones where increasing returns to scale would be a doubtful assumption (see Hummels and Levinsohn, 1995).

So plenty of theoretical foundations witness for theoretical soundness of gravity equation. Nevertheless some of its problems and criticism are still barely close to resolution, as for instance a well known puzzle that gravity works remarkably well on aggregated level, whereas it does poorer job already with data disaggregated by sectors. Feenstra et al. (2001) show that this maybe due to the fact that GDP elasticities in gravity equation should be different because of different entry barriers for different types of goods. Specifically the reasoning goes as follows: if there is a free entry into a sector then we should observe home-market effect, so that exporter's GDP will have higher effect on trade than importer's, and vice versa if entry barriers are substantial than we should observe reverse home bias, so that now importer's GDP would play a more important role in explaining patterns of sectoral trade. Therefore as we may expect different entry barriers in different sectors, we should have different income (GDP) elasticities in gravity equations for different sectors. Though the drawback of Feenstra et al. paper is that they disaggregate only one side of gravity equation – disaggregated imports and exports are always explained by importers/exporters GDP, whereas our logic would imply that bilateral trade flow should depend on importers GDP and exporters sectoral output (see Choi and Harrigan, 2003).

The impact on trade patterns of free trade areas was the other important issue where researchers tried to utilize and extend gravity. Common approach here was to try to show the impact of preferential trade blocs by appending conventional gravity with dummy variable set to be equal 1 for intrabloc trade and zero otherwise (see Linneman, 1966; Frankel, 1993; McCallum, 1995; Ivus, 2004). Though this approach is seen to be artificial and too simplistic, as dummy may also capture border effect, reduced custom's duties, technical barriers to entry and at the same time would not allow to account for relative size of the block (its market potential), gradually increasing relative distance etc. It is worthwhile to note here that significant amount of literature is devoted solely to resolving so called border effect puzzle (first evidence provided by Wei, 1996; Head and Mayer, 2000). In most of the studies though, the border itself was associated with technical barriers and protectionism (Manchin and Pinna, 2003) and then its effect was estimated with set of dummies, which is again seems to be simplistic. If the border effect is a direct consequence of protectionist measures or technical barriers, than it should disappear on the intranational level, which is not the case in practice (Wolf, 1997). Hence other factors may be attributable to explaining trade patterns, i.e. spatial distribution of production (Wolf, 2000), pure home bias in preferences of consumers and firms or presence of social and business networks, or in other words specific arrangements of economic institutions, which would be of interest to us in this paper.

So there are considerable efforts to improve the specification of gravity model and extend the equation to include theoretically and empirically important variables and relations. One of such extensions to the original model was inclusion of remoteness measure, which was due to recognizing the fact that relative as well as absolute distance matters in determining the trade flows. The development of remoteness indicator itself originates in studies on migration (Foot and Mike, 1984), where researchers used distance weighted by income level to explain regional migration decisions. However, recently the indicator was more commonly used in gravity models assessing trade flows.

There have been used several indices/proxies for this measure. Polak (1996) introduces the measure as average distance between importing and exporting country, with weights that are determined by the exporting capacity of respective countries. Following Linnemann (1966) exporting capacity was calculated as function of the GNP and population of countries. Specifically his average distance or remoteness was specified as: $R_i = \sum_j Y_j^{0.8} P_j^{-0.24} d_{ij}$, where Y is GNP of respective country other than *i*, P is population of that country, d_{ij} is topographic distance between country *i* an *j*. Anderson and van Wincoop (2001) derived their "centrality index" from the CES price index in the form: $\Psi_c = \sum_{b=1}^{c} \frac{S_b}{t_{cb}}$, or as a GDP-weighted average of the inverse of transportation costs of shipping imports to country *c* (here S_b – is a respective country's share of the world income, t_{cb} is an "iceberg" transportation cost[2] between countries). Thus as centrality of location of two countries increases their bilateral trade should fall as there are a lot of alternative sources for exports and imports. Coe et al. (2002) used similar by construction index in their gravity model aimed at explaining the non-decreasing effect of transport costs over time.

[2] Here and in subsequent papers on the issue "iceberg melting" transport cost structure is adopted: for every $t > 1$ units shipped from the exporter, importer gets only 1 unit, the other $t - 1$ units are "melted" in transit, hence *t* is assumed to be a monotonically increasing function of distance. Such formulation is not too realistic, but quite handy as in such a way we don't need to model separately transport sector in the economy.

Wei (1996) specifies two different remoteness indexes for exporter and importer country, but then for empirical purposes proceeds with an assumption that they are equal and simplifying their form formulates, as follows: $\mathrm{Re}mote_i = \sum_h w_h Dis\tan ce_{hi}$, where w_h is a country h's share in the world's income. So basically this index is a weighted sum of distances between exporter/importer and other countries (which are used as proxies for transportation costs), with weights as incomes of those countries. This index is somewhat similar to the one constructed by Anderson and van Wincoop, even though it cannot be obtained from any simplification of CES price index. Helliwell (1997) uses the following remoteness measure: $R_c = \sum_{b=1}^{C} \frac{t_{cb}}{s_b}$, which though doesn't make a lot of sense, as here relative distance from small countries matter more than relative distance from large countries.

In each of aforementioned papers the main goal of authors was to design appropriate weights for distance, so that this measure could be used more effectively as independent variable in the gravity model.

Although note, that one of the drawbacks of those indicators was that they implicitly assume that geographic distance has a linear impact on the remoteness of the country, whereas gravity model itself would suggest that there is nonlinear relationship between distance and trade. So it is common in the literature to suggest that the effect of increasing distance should be discounted at some rate when constructing a weighting matrix for such index, which then will allow for some nonlinear dependence (Baltagi et al., 2005). But nonetheless controlling for relative distance is necessary and important, so we do consider employing similar measure into our model.

At the same time gravity model as such and relative distance outlined above do not provide an opportunity to explain sudden diversion of trade flows as a result of country's entrance into the common economic space such as trade or customs union. Hence we will incorporate into our model relative distance measure which would allow for such effect.

Alternatively, concentration and direction of trade flows can be explained by economic geography theory and/or institutional theory approach. Let us now consider relevance of each of them for our specific case.

Modern economic geography theory was developed in some sense in response to well-known Lucas(1990) critique to standard neo-classical approach, where the researcher was arguing that over the whole course of history empirically it is not true that poor countries grow faster than rich ones and overall they tend to reach the same steady state, even though neo-classical models would predict this result. Economic geography approach then would underline that geographic location and availability of natural resources (initial conditions) actually do matter for economic development and economic activity tends to cluster in space. Basic intuition here is the following: as economic centers are formed due to favorable initial conditions agglomeration effects or increasing returns to scale would attract even more resources here, i.e. investment, labour force, trade flows etc. Furthermore, as these centers grow, steadily increases their market potential (market size), which in turn again attracts more investment resources and trade flows (so called home bias effect Wolf H.C., 2000). The other obvious reason for clustering of economic activity is transaction costs (transportation costs, search costs, costs of time used in transportation, control and management costs). As those costs increase with distance cost-minimizing incentives make economic agents cluster in space. But in fact this approach is unable, at least explicitly, to explain why historically one economic centers appear while the others go into ruin, or for example why Baltic countries increased their merchandize exchange with the EU while all geographic factors (namely distance) remained at roughly the same level[3].

So let us see whether institutional theory, whose foundations were developed by North (1971) in 70's, can provide us with the prominent insight on the issue. One of the main paradigms of this approach is to put emphasis on the role that institutions (set of formal and informal rules) play in economic development. Institutional theory underlines that the way that societies are organized (formal rules), incentives are created within them (formal and informal rules), and also how well this structure can adjust to internal and external shocks are one of the main factors of economic development (Shepotylo, 2006). Then the advocates of this theory would argue that trade improvement/diversion effects as a result of integration of countries to common trade areas should be attributed to the evolution and adjustment of economic institutional local and regional (block-wide) infrastructure. Roland (2000) underlines particular importance and validity of this theoretical hypothesis for transition countries development.

Taking into consideration everything outlined above we then are able to make the following theoretical hypothesis drawn from the postulates of institutional approach: institutional changes are one of the major causes for the improvement/diversion of trade flows in case of any country entering the common economic space with its own set of institutions, informal rules and incentive creation mechanisms that agents of this country have to adjust to (you may recall again the case of Baltic countries and Russia). So then logically we conclude that changes of economic distance between countries and hence their trade flows can be attributed to local and regional institutional changes. Therefore

[3] For an interesting example of the model that would at least theoretically allow for such consequences see Krugman (1991).

in order to capture this effect we need to develop relevant institutional infrastructure measures, which we do by utilizing the governance indices developed by EBRD for transition countries under study, after controlling for trade tariffs, natural resources (initial conditions), market potentials and absolute as well as relative distances.

Gravity model has also been extensively used to study international trade patterns by the researchers in CIS, but their specifications did not include measures of relative geographic or economic distance. Several papers used conventional gravity model specification to infer on potential levels or trade of transition countries. For example paper by Dean et al. (2003) provides such estimations for Ukraine. Also authors include into their gravity model trade index that is constructed to account for tariff and non-tariff barriers for trade between countries and conclude that according to their estimation results imports barriers imposed on Ukrainian goods do not play any significant role in determining the volume of Ukrainian exports.

Ivus (2004) utilizes the gravity model to investigate the affect of EU enlargement on trade flows from excluded developing countries over a considerable time horizon. The author appends the conventional model by the extended set of dummy variables to account for the effect of EU enlargement on trade flows of acceding countries and provides possible implications for Ukraine. Though, the developed specification does not allow determining the effect of relative geographic/economic distance between countries on their trade patterns as trade blocks are formed.

Overall we may conclude that existing literature provides us with a few alternative measures of geographic remoteness, and alternative theories explaining adjustment of patterns of trade, which both grant us with the necessary insight on formulating a theoretical hypothesis and constructing mathematical description of measures of “economic distance” (remoteness) formed between countries.

Chapter 3

DATA AND METHODOLOGY

3.1 Data description

In order to study determinants of trade flows between transition countries this paper considers a sample of 24 of them for the twelve year period (1993-2004). Namely they are: Albania, Armenia, Azerbaijan, Belarus, Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Poland, Republic of Moldova, Romania, Russian Federation, Slovakia, Slovenia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan. Annual data on bilateral trade flows between these countries, which is the explanatory variable in our model, is taken from UN COMTRADE and NBER-UN trade database. Full description of methodology and properties of the used data can be found in Feenstra et al. (2005) and on UN Statistics Division web site: unstats.un.org/unsd/comtrade/.

Data for Real Gross Domestic Product, openness to trade measure, and natural resources dummy (major exporters of oil and gas) were also obtained from UN COMTRADE database and UN National Accounts Main Aggregates Database. Country-specific variables, i.e. language, bordering countries are adopted from the CIA's World Factbook. All monetary values are measured in US dollars.

As a measure of distance following Wei (1996) and other authors we use the topographic distance (great circle distance) between the economic centers, which are usually capitals of respective countries. Though geographical distance may not be a very good proxy for trade costs (transport and transaction costs), as it does not take into account such factors as geographical land-shaft, time needed for transportation, mode of transport, quality of infrastructure etc. Concerning this fact Bajoumi (1995) noted, that as economic distance is still mismeasured, its effects most likely are loaded into the dummy variables included into the gravity specifications in order to capture the effects of regionalism. Insofar due to data availability issue we still use here a topographic distance between capitals of respective countries. Data is computed using the online calculator at: weber.ucsd.edu/~kgledits/capdist.html.

Average tariff rate data, which is the share of taxes on imports in their total value, as well as indices of development of institutional infrastructure, are taken from EBRD transition report. Some descriptive statistics of the data used in this research are presented in the Appendix A.

3.2 Basic model description

The main theoretical hypothesis we would like to test in this paper can be stated as follows: controlling for distance, income level (market potential), average tariff rate and other factors, trade between countries should depend on economic distance between countries proxied by local and block-wide institutional development measures, as well as on GDP-weighted distance to other countries of the block. Specifically we expect that trade should increase with improvement of local and regional institutional arrangement of the countries that belong to the same economic space and decrease as GDP-weighted relative distance to the block-members GDP falls.

As outlined above, in order to test this hypothesis we extend the conventional gravity model specification in commonly used log-linearized form with the corresponding measures.

Then the basic specification of our model can be represented as follows:

$$\ln X_{ijt} = \alpha_0 + \alpha_1 \ln D_{ij} + \alpha_2 \ln GDP_{it} + \alpha_3 \ln GDP_{jt} + \qquad \textbf{\textit{(1)}}$$

$$+ \beta \cdot index_i + \varphi \sum_{j=1}^{N} w_{ij} \cdot index_{jt} + \omega \sum_{b \neq j} d_{ib} / y_{bt} + \sum_{k=1}^{K} \gamma_k z_{ik} + \varepsilon_{ij}$$

where *i,j* = 1,2,…N;

$\boldsymbol{X_{ijt}}$ is log of imports of country *i* from country *j* at some period *t*;

$\boldsymbol{D_{ij}}$ is a measure of distance between countries, expected to have negative sign as trade decreases with increase in transportation costs;

$\boldsymbol{GDP_{it}}$ – proxy for income of country *i*, being proxy for market size is expected to have positive effect on trade with elasticity being close to unity;

$\boldsymbol{index_i}$ is an index of local governance infrastructure in a country *i* in period *t*. Following Shepotylo (2006) we construct $\boldsymbol{index_i}$, by taking simple average of 9 EBRD development indices in the following spheres: price, trade and foreign exchange liberalization, large and small scale privatization, infrastructural reform, competitiveness and restructuring of enterprises, banking and security markets reform. Clearly positive influence is expected as more developed institutional infrastructure should decrease transaction costs, hence decrease distance, improve efficiency and promote trade.

$\boldsymbol{w_{ij}}$ is a time invariant weight which together with parameter φ is intended to nonlinearly describe how the economic infrastructure in other countries that belong to the same region (country *j)* influences the log of imports of country *i* (note: the obtained variable would be termed regional remoteness in the empirical estimation). These weights will be specified in more details below, for now we note that they have the following properties:

$$w_{ii} = 0, \ \ \forall i \ \ and \ \ \sum_{j=1}^{N} w_{ij} = 1, \ \ i, j = 1,2,...N$$

ω, parameter which is intended to provide the effect of the measure which describes the GDP-weighted relative distance of country i to other countries of its trading block $\sum_{b \neq j} d_{ib} / y_{bt}$ and is similar to McCallum's (1995) geographic remoteness indicator. Here d_{im} is distance b/w country *i* and *b*, y_m is the indicator of economic size of the respective country (i.e. GDP), *b* – country of *i's* block (the obtained variable would be termed geographic remoteness in the empirical estimation). Note that by inclusion of this variable we intending to incorporate into the model hypothesis of diminishing marginal effect on trade flows as a result of more countries entering the common economic space. This argument is indeed a straightforward extension of geographic centrality index. As common economic space includes larger number of countries its effect on trade flows is supposed to decrease, as new acceding countries appear to be at larger distance from the "center" of such free-trade area and thus their nearby trading opportunities remain quite attractive. Hence coefficient should have positive sign.
z_{ikt} , k=1,2,…,K are K exogenous variables that influence log of imports of country *i* in period *t* (set of variables, effect of which we control for, i.e. import tariffs, country-specific characteristics, other fixed-country pair effects).
ε_{ijt} is a corresponding disturbance term in country *i* in period *t*, which is suggested to have a spatial autoregressive structure, for more details see below.

The weighting matrix has a commonly used structure, which is modified to be in line with theoretical hypothesis that me make here. Specifically it describes the spatial effect of countries that belong to the same economic space on their trade flows. Clearly such effect would decrease with distance. Then logically we start by considering the following matrix of weights:

$$W^* = \begin{bmatrix} 0 & 1/d_{12_s} & \dots & 1/d_{1N_s} \\ 1/d_{21_s} & 0 & \dots & 1/d_{2N_s} \\ \dots & \dots & 0 & \dots \\ 1/d_{N1_s} & 1/d_{N2_s} & \dots & 0 \end{bmatrix}$$

where $\boldsymbol{d_{ijs}}$ is topographic distance between countries *i* and *j* if they belong to the same region (bloc) and is zero otherwise. By doing so we assume that there is no spatial effect of countries in one region on the other. It is also useful to raw-normalize this matrix, this is done to simplify the calculations and more importantly to make this measure comparable to local or country-specific measure of institutional development. This is achieved by multiplying each raw of W* by coefficient

$$k_i = \frac{1}{\sum_{\substack{j=1 \\ j \neq i}}^{N} 1/d_{ij_s}}$$ to get: $$W_1 = \begin{bmatrix} 0 & k_1/d_{12_s} & \dots & k_1/d_{1N_s} \\ k_2/d_{21_s} & 0 & \dots & k_2/d_{2N_s} \\ \dots & \dots & 0 & \dots \\ k_N/d_{N1_s} & k_N/d_{N2_s} & \dots & 0 \end{bmatrix}$$

Hence by multiplying these weights by $index_j$ we receive the measure of regional spatial effect of economic institutions of countries in the common economic space on their bilateral trade flows.

Control factors

First we would need to control for trade barriers as it is well known that they would necessarily influences amount of trade flows between countries. We do so by including their direct measure: *average import tariff rate*, which we do by including the average collected tariff rate, estimated as share of import taxes collected in total value of imports. Clearly expected effect of increase in tariff rate is negative. But such tariffs are not the only trade restrictions that exist between countries, hence following Blonigen and Davies (2001) we also include *openness to trade* measure proxied by ratio of trade turnover to the respective country's GDP. The higher the ratio the more country is open to trade and thus estimated coefficient is expected to be positive.

To control for "initial conditions" which would be justified by the economic geography theory we construct a dummy variable for countries rich in natural resources. Following Shepotylo (2006) it is set to unity for major exporters of gas and oil, i.e. Azerbaijan, Kazakhstan, Russia and Turkmenistan and zero otherwise. Such countries would clearly be expected to trade more on average. Pursuing the same goal, DeMelo et al. (1997) suggests using the log of GDP in some previous base year. Here, due to some country specifics concerning their recent independence status we would use just log of GDP in 1991.

Besides, in order to control for other country-specific characteristics it is common in the literature to use the following set of dummies: sharing common border, speaking common language, using the same currency etc. As each of countries under consideration still uses its own currency unit we would use first two dummies in our estimation (their effect is generally expected to be positive).

In some empirical specifications we also include a dummy variable for financial crises in 1998, whose effect is ex ante unknown, since currency devaluations could cause trade expansion, but financial and payment crises could instead lower the trade flows.

Further on we specify three different country block groupings, according to the set formal and informal country characteristics, they are:

- Order 1: 2 blocks – CEB and CIS
- Order 2: 3 blocks – CEB, Western FSU (Russia, Belarus, Ukraine, Moldova), Eastern/Asian FSU (Central Asia and Caucuses).

- Order 3: 4 blocks – EU (newly accessed countries), South CE (Albania, Romania, Bulgaria), CES + Moldova, Eastern/Asian FSU (Central Asia and Caucuses)

By doing so we explicitly assume that there are no spatial effects of regional institutional infrastructure in say Turkmenistan on trade flows in Poland. This assumption, being somewhat restrictive, though is quite commonly used in literature, rather intuitive and allows for testing non-linear effects which have been discussed above. Therefore we would adjust our weighting matrix and "block-wide" relative distance measure according to outlined above groupings in our empirical estimation.

3.3 Methodology

Provided that empirical estimation is going to be done on bilateral trade data over the specified period we will clearly have panel data, so we are to utilize a conventional set of methods to estimate derived regressions, i.e. pooled OLS, random effects, fixed effects, FGLS etc. These methods are thoroughly illustrated in Wooldridge (2001) and Stata cross-sectional time-series reference manual.

Traditional approach for testing different gravity specifications was to run pooled cross-section regressions for selected time periods, allowing for some country-specific effects through inclusion of dummy variables. Though Cheng and Wall (2004) note that such models are subject to serious heterogeneity biases, thus proposing to estimate simple two-way FEM as a better option (as here each country pair is allowed to have its own source of heterogeneity). At the same time it is natural to think of the necessity of country-pair REM, which allows accounting for heteroscedasticity in error terms and produces more efficient estimates. Besides it is common to find serial correlation when estimating trade panel data models. Hence ideally our econometric model should account for heteroscedasticity, autocorrelation in error terms (in case those are revealed by a set of standard tests) and allow for country pair (or host country) source of heterogeneity. Therefore we would consider FGLS methodology with inclusion of dummy variables for country pairs or host countries to control for fixed effects. And as basic model together with outlined above set of control variables is well theoretically and empirically justified, inclusion of fixed-effects is supposed to capture all the omitted variables. Furthermore, by incorporating all these types of models into our empirical study, we would also be able to check for robustness of our estimates.

At the same time, stressing the importance of inclusion and appropriate estimation of the spatial autoregressive error term that can be present due to spatial effect of regional governance on trade flows in our basic model, we need to utilize the methodology that would allow for such effect. Shepotylo (2006) suggests that a 3-stage generalized method of moments (GMM) for estimation of spatial autoregressive models with autoregressive and heteroskedastic disturbances developed by Kapoor, Kelejian, and Prucha (2004) should be used in this case.

Empirical spatial econometric models have been first developed back in 70's (see Cliff and Ord, 1981), but have not received much attention until the mid of 90's when spatial dimension has become an important focus in modern economic research. Comprehensive review of classification and implementation aspects of recently developed models that incorporate spatial externalities into error structure have been provided by Anselin (2003). Though, we have to note that estimation of developed spatial econometric models required inversion of matrices with high dimensions, which in its turn sometimes made methods computationally not feasible. Instead 3-stage GMM technique is computationally reasonable even in case of large datasets and is proved to be consistent and efficient by Kelejian and Prucha (1999, 2006) under a set of not very restrictive assumptions.

In our empirical estimation of 3-stage GMM we are going to follow the proposed by Kapoor, Kelejian, and Prucha (2004) model structure. We are going to assume the presence of spatially correlated random effects, specifically this implies that in each time period *t*=1,…,T the DGP is in line with the following general model specification:

$$\begin{aligned} y_N(t) &= X_N(t)\beta + u_N(t), \\ u_N(t) &= \rho W_N u_N(t) + \varepsilon_N(t), \quad |\rho| < 1 \end{aligned} \qquad (2), (3)$$

where $y_N(t)$ is the *Nx1* vector of observations of dependent variable in time period *t*, $X_N(t)$ is *Nxk* matrix of k exogenous variables at time *t*, W_N is *NxN* time-invariant spatial weighting matrix (also included into x's, see (1)), ρ is spatial autoregressive parameter and $\varepsilon_N(t)$ is *Nx1* vector of innovations in period *t*. Then stacking observations in (2) and (3) for *t* time periods we get:

$$\begin{aligned} y_N &= X_N\beta + u_N \\ u_N &= \rho(I_T \otimes W_N)u_N + \varepsilon_N \quad where \\ y_N &= [y'_N(1),\ldots,y'_N(T)]', \\ X_N &= [X'_N(1),\ldots,X'_N(T)]', \\ u_N &= [u'_N(1),\ldots,u'_N(T)]', \\ \varepsilon_N &= [\varepsilon'_N(1),\ldots,\varepsilon'_N(T)]'. \end{aligned}$$

Furthermore, we assume that our innovations consist of a country specific error component and an error component that varies across countries and time periods. Hence

$$\begin{aligned} \varepsilon_N &= (e_T \otimes I_N)\mu_N + v_N \\ v_N &= [v'_N(1),\ldots.v'_N(T)]' \end{aligned}$$

, where μ_N is Nx1 vector of country specific error components, v_N is is a *NTx1* vector of error components that varies over country pairs and time periods. Among other things assumptions on error term structure proposed by Kapoor, Kelejian, and Prucha (2004) imply:

$$E\mu_N = 0 \;\; E\mu_N \mu'_N = \sigma_\mu^2 I_N$$

$$Ev_N = 0 \;\; Ev_N v'_N = \sigma_v^2 I_{NT}$$

$$E(\varepsilon_N \varepsilon'_N) = \sigma_\mu^2 (\varepsilon_T \varepsilon'_T \otimes I_N) + \sigma_v^2 I_{NT} \;\; and \;\; E(\varepsilon_{it} \varepsilon'_{js}) = \begin{bmatrix} \sigma_\mu^2 + \sigma_v^2 \;\; if \;\; i = j, t = s \\ \sigma_\mu^2 \;\; if \;\; i = j, t \neq s \\ 0 \;\; otherwise \end{bmatrix}$$

Further on Kapoor, Kelejian, and Prucha (2004) suggest a 3-stage GMM empirical procedure, which is well outlined in the above mentioned work. Its general intuition is as follows: first we run usual pooled OLS on our model and predict residuals; we use the obtained residuals to estimate the structure and variances of the spatial autoregressive error term under assumptions of their moments provided by Kapoor, Kelejian, and Prucha (2004); finally we use these estimates to run FGLS of our basic model to obtain coefficients of interest. Sample code for doing this procedure in Stata was provided by Ingmar Prucha at his web-site[4] and then we further developed it to fit our model's specification. The final version of the code can be found in Appendix B. Then judging on the significance of the estimated ρ coefficient we can conclude whether the error term exhibits random spatial autocorrelation dynamics (if this coefficient would turn out to be statistically significant than the use of 3-stage GMM procedure is justified and its estimates should be used for interpretation of the results of the proposed model).

[4] http://www.econ.umd.edu/~prucha/Research_Prog3.htm

Chapter 4

EMPIRICAL TESTS AND RESULTS

Descriptive statistics of initial data and for computed measures of regional institutional infrastructure development and relative distance to GDP of other country members of the common trade area, according to defined above country block groupings, can be found in Appendix A. Now we will proceed by running different types of models discussed above and discriminate among them on the basis of standard tests.

First we run pooled OLS regression for all three orders of country groupings and then test this model versus FEM on the basis of F test (Greene, 2000) in order to see whether there are differences across panel data groups or whether pooled OLS experiences heterogeneity bias. F test is standard and specified as follows: $F(n-1, nT-n-K) = \frac{(R_u^2 - R_p^2)/(n-1)}{(1-R_u^2)/(nT-n-K)}$, where n is a number of panel groups (country pairs here), T is a number of time periods, K is number of independent variables, *u* denotes unrestricted FE model, while p – restricted pooled OLS. If the obtained value is greater than critical one for given degrees of freedom we should not use OLS regression. As we found heteroscedasticity in error terms of this regression we provide adjusted for heteroscedasticity estimates. The following table provides obtained results. In all cases we indeed reject pooled OLS model specification.

Table 2. Pooled OLS results corrected for heteroscedasticity.

Dependent variable	*Expected sign*	Pooled OLS		
		O(1)	*O(2)*	*O(3)*
LnGDPi	+	0.9702	0.8953	0.8837
LnGDPj	+	1.1896	1.1942	1.1974
LnDistij	-	-0.9200	-0.9605	-0.8472
Import tariff	-	-0.0494	-0.0539	-0.0479
index i	+	0.0024595**	-0.0645**	-0.0905*
reg.remoteness	+	0.0478	0.0322*	0.1822
border	+	0.6240	0.5773	0.5821
common language	+	1.5629	1.6082	1.5725
d_oil_gas_j	+	0.3253	0.3399	0.3248
openness to trade	+	0.0502	0.0798	0.0683
g.remoteness	+	0.0322	0.0591	0.0438
log_1991	+	-0.0354**	0.0724**	0.0901**
dCrises	?	0.1325*	0.1338*	0.1321*
_c		-27.3975	-27.79459	-28.80035
Adj. R^2		0.7013	0.7016	0.7065
BP hettest (p), before robust		0.0000	0.0000	0.0000
F test vs. FEM		0.0001	0.0000	0.0000

Note: All displayed coefficient are statistically significant at 5% level, those with * are significant at 10% level, ** are insignificant at 10% level (this holds here and from now on).

All significant coefficients are of expected sign and robust for different choice of groupings. Order of magnitude for conventional gravity variables is similar to theoretically predicted (logs of GDP are close to unity). Adj. R^2 is measure rather high, conditional on panel data. The fact that on basis of F test for all country groupings we have given preference to FEM model is quite general and expected result, found by many researchers in gravity model estimations. FEM allows to capture the presence of country-pair or host country fixed effects that are unobservable or cannot be directly included into the model (f.e. common traditions, cultural and historical background, political ties etc.).

Suspecting serial correlation in error terms and also noting found evidence of heteroscedasticity we would then consider REM as a possible remedy measure. REM outputs, as well as formal Breusch/Pagan LM test for presence of random effects, are presented in the following table.

Table 3. Random effects model results.

Dependent variable	*Expected sign*	REM		
		O(1)	*O(2)*	*O(3)*
LnGDPi	+	0.9002	0.6926	0.7310
LnGDPj	+	1.1360	1.1749	1.1639
LnDistij	-	-1.0154	-0.9470	-0.9755
Import tariff	-	-0.0177	-0.0225	-0.0207
index i	+	0.2776	0.2283	0.2249
reg.remoteness	+	0.0893	0.1248	0.2054
border	+	0.5116	0.5062	0.4118*
common language	+	1.5147	1.7812	1.6631
d_oil_gas_j	+	0.5220	0.4573	0.4743
openness to trade	+	0.1235	0.1465	0.1392
g.remoteness	+	0.1107	0.1065	0.1381
log_1991	+	-0.0855**	0.2233**	0.2002**
dCrises	?	0.0434**	0.0595**	0.0605**
_c		-24.04315	-27.59468	-27.41486
R-square overall		0.6931	0.6937	0.6992
BP LM test (p)		0.0000	0.0000	0.0000

All significant coefficients are of expected sign and robust for different choice of groupings, but regional remoteness measure. We interpret the observed increase in the value of this coefficient as a sign of the fact that countries do cluster in space and economic institutional infrastructure is significantly different in different blocks. Hence our theoretical hypothesis of the non-linearity of effects of regional institutional development on trade flows is strengthened by this empirical observation. Overall R^2 measure is reasonably high. Results of Breusch/Pagan LM test indicate presence of serial correlation and thus REM should be used instead of pooled OLS. When controlling for autocorrelation in error terms by using REM we have implicitly assumed that there is no correlation between error terms and exogenous variables. If this is not the case REM would produce inconsistent estimates even though being more efficient under H0 of no correlation. Hence we are to engage in FEM estimation and then would need to test REM vs. FEM on the basis of Hausman specification test to see whether there is indeed non-zero correlation between individual effects and exogenous variables. FEM model estimates are presented in the following table.

Table 4. Fixed effects model results.

Dependent variable	*Expected sign*	FEM		
		O(1)	*O(2)*	*O(3)*
LnGDPi	+	1.0751	0.8219	0.9223
LnGDPj	+	0.5719	0.4097	0.4059
LnDistij	-	-	-	-
Import tariff	-	-0.0022**	-0.0078**	-0.0087**
index i	+	0.3756	0.3617	0.4089
reg.remoteness	+	0.1667*	0.4402	0.3854
border	+	-	-	-
common language	+	-	-	-
d_oil_gas_j	+	-	-	-
openness to trade	+	0.3529	0.2855	0.2864
g.remoteness	+	0.1689	0.1205*	0.1944
log_1991	+	-	-	-
dCrises	?	0.0011**	0.0067**	0.0104**
_c		-24.63937	-14.73018	-16.92087
R-square overall		0.3944	0.3535	0.3691
F test that all u_i=0 (p)		0.0000	0.0000	0.0000
corr(u_i, Xb)		-0.0487	0.0517	0.0779
Hausman test stat. (p)		0.0000	0.0000	0.0000
Modified Wald test for groupwise heteroscedasticity (p)		0.0000	0.0000	0.0000
Wooldridge test for autocorrelation (p)		0.0000	0.0000	0.0000

Proposed dummy variables, as well as distance measure and log of GDP in 1991 (to control for initial conditions) have been dropped due to lack of variation over time. All significant coefficients are of expected sign and robust for different choice of groupings, but regional remoteness measure and intuition behind this observation was already noted above. Somewhat surprising are the results for the estimated coefficient of market potential of trading partner (exporting country here), as it is well below theoretically predicted value around unity and is significantly different from the results of previous models. Also import tariff is now insignificantly different from zero already at 10% level. This maybe due to inclusion of openness to trade measure which estimates similar effect, though collinearity problem doesn't seem to be severe here as correlation coefficient between these two variables is only about 0.3. As given by the outcome of Hausman test statistics we should prefer FEM model. But as noted by Wald test for groupwise heteroscedasticity (Green, 2000) and Wooldridge test for autocorrelation (Wooldridge, 2001) computed after models estimation, data experiences both heteroscedasticity and autocorrelation. So obtained estimates might not be very reliable and as we still would want to account for both heteroscedasticity and autocorrelation. In order to do so we are going to utilize panel data Feasible GLS technique, which allows to account for autocorrelation within panels, cross-sectional correlation and heteroskedasticity across panels. As we do not have fully balanced panel this estimation technique does not allow us to model the cross-sectional correlation. Though we assume that missed values are distributed randomly, thus this issue is not severe as far as estimation results are concerned. As a result we estimate FGLS model with autocorrelation and heteroscedasticity across panels. Estimation output is presented in the following table.

Table 5. FGLS model with modeled heteroscedasticity and autocorrelation results

Dependent variable	*Expected sign*	FGLS, AR(1), heteroscedastic		
		O(1)	*O(2)*	*O(3)*
LnGDPi	+	1.1055	0.8748	0.9446
LnGDPj	+	1.1292	1.1501	1.1583
LnDistij	-	-0.8641	-0.8220	-0.7747
Import tariff	-	-0.0170	-0.0215	-0.0191
index i	+	0.3818	0.2359	0.1984
reg.remoteness	+	0.0758	0.0632	0.1936
border	+	0.5722	0.6008	0.4855
common language	+	1.3253	1.5282	1.5540
d_oil_gas_j	+	0.2671	0.2132	0.1840
openness to trade	+	0.0375	0.0793	0.0722
g.remoteness	+	0.0939	0.0486	0.0641
log_1991	+	-0.2919	0.0007**	-0.0482**
dCrises	?	0.0711	0.0760	0.0714
_c		-24.6752	-26.3440	-27.3089
Log Likelihood		-4486.1310	-4514.2610	-4483.4200
AR(1) coefficient for panels		0.7373	0.7395	0.7378
Wald chi^2, (p)		0.0000	0.0000	0.0000

Again we see that results of the model are quite robust. All estimated coefficients are of expected sign. We still observe increase in regional remoteness coefficient which again stresses the validity of our initial hypothesis and set up of the measure. Further on, as it was noted above both theoretically and empirically (even though *(u_i, Xb)* correlation coefficient is not high up to about 0.08) presence of fixed effects is suggested. Therefore we still need to incorporate them into our final specification. As suggested by Dr. Tom Coupe this could be done simply by including country-pair or host country dummy variables into our FGLS model. We indeed perceive this technique as a valid one for capturing such effects (see Greene, 2000 p.560), thus we utilize outlined above set up of FGLS model including into specification country-pair/host country dummy variables. The estimated results are practically the same and joint significance of included dummy variables on basis of standard F test in both cases proves the presence of fixed effects in our model. The results as usually follow below.

Table 6. Estimation results of FGLS model with heteroscedasticity, autocorrelation and host-country dummy variables.

Dependent variable	*Expected sign*	FGLS, AR(1), heteroscedastic with FE		
		O(1)	*O(2)*	*O(3)*
LnGDPi	+	1.3642	0.9464	1.0774
LnGDPj	+	1.1082	1.1215	1.1329
LnDistij	-	-1.0020	-1.0103	-0.8902
Import tariff	-	-0.0055**	-0.0107	-0.0100
index i	+	0.4481	0.4771	0.4588
reg.remoteness	+	0.0680	0.0563	0.2146
border	+	0.4173	0.4283	0.3530
common language	+	1.2663	1.2778	1.3616
d_oil_gas_j	+	0.3741	0.3827	0.3328
openness to trade	+	0.2707	0.2446	0.2208
g.remoteness	+	0.1881	0.0748*	0.2406
log_1991	+	-0.6394**	-0.1452**	-0.8609**
dCrises	?	0.0542	0.0499	0.0498
_c		-22.0640	-23.5981	-12.1796
Log Likelihood		-4373.6650	-4400.9680	-4364.6580
AR(1) coefficient for panels		0.7434	0.7442	0.7403
Wald chi^2, (p)		0.0000	0.0000	0.0000
F, joint significance of FE (p)		0.0000	0.0000	0.0000

Results of the model are again quite robust, all estimated coefficients of interest are significant at 1% and 5% levels and also are of expected sign, but log of GDP in 1991 (and import tariff for Order 1). Order of magnitude of conventional gravity variables are in line with a priory theoretical expectations. We do observe increase in regional remoteness coefficient which is to support the validity of our initial hypothesis and set up of the measure. Non-linearity of the effect of regional institutional governance on trade flows of countries that belong to different integration blocks is also reassured by inclusion into the above specification of $index_j$ with weights strictly proportional to distance (no explicit effect of assumed common areas) and observing the statistical insignificance of this indicator (p-value is about 15%). This is also true for the EU countries dummy (p-value is about 40%). This provides an additional check for robustness of our model and proves it to be so.

As it was noted in the methodology in our case we might suspect the presence of spatial effect of autocorrelated error term, which can be modeled by recently developed 3-stage GMM procedure. Though, as it turned out after estimation the spatial autocorrelated coefficient ρ is statistically insignificant for our data sample and for all country block groupings. The lowest p-value observed was about 15%, thus empirical data suggests that there is actually no spatial effect in the error term in the considered sample. Results of this estimation procedure for Order 3 of country blocks and the code of program used to do the assessment are presented in the Appendix B, C. As you can see that results provided there are very similar to those obtained above. Hence we conclude that econometric model that should be used to provide inferences on the estimated coefficients of interest is FGLS with heteroscedasticity, autocorrelation and FE dummy variables.

Interpretation of results

Here we will present our main results and focus on the interpretation of the coefficients for the 3rd country grouping as one that represents current economic (political, cultural) clustering most fully. For convenience recall Table 6. Namely we found positive and significant effect of economic size of trading partners on their trade flows. Elasticity of imports/exports with respect to importer/exporter GDP is close to unity as theoretically predicted. Geographic distance, being proxy for transportation costs, negatively influences trade – its elasticity in absolute value is also close to unity. Trade barriers discourage trade, i.e. increase in average tariff rate by 1% would lead to about 1% decrease in imports on average, while increase in openness to trade measure by 1% would on average lead to about 22% increase in imports. As explanatory variable is taken in natural logarithm, than in order to interpret dummy coefficients in our model we need to take the antilog of the coefficient and than subtract one. Hence, in case if countries share a common border they would trade by about 42% more than if it is not so. Speaking common language also improves trade ties between countries. If the country is a major exporter of oil and gas (has extensive amount of natural resources), than it would on average trade by about 41% more compared to other countries. Interestingly it turned out that initial conditions proxied by log of GDP of countries in 1991 on average do not matter much for trade for the sample countries, which drops some shadow on postulates economic geography. Though, this may also be due to the fact that such proxy is not quite appropriate in this context. Proxy for Russian and Asian financial crises in 1998 turned out to have a positive impact on trade flows in the region. This may be intuitively attributed to observed significant currency devaluations (especially in CIS countries), which increased competitiveness of export oriented industries and on average lead to some immediate trade expansion. Also we find that rise in relative distance of country to others that belong to the same block increases trade with neighboring entities. In other words, if the country is far from the "center" of the common economic space than it is more likely that it will trade with nearby nations including non-block ones. This accounts for decreasing marginal effect of enlarging the common trade area.

The coefficient of local institutional development is positive and highly significant for all country groupings. The sample average of this measure is about 2.65 and as value of the estimated coefficient in the final model is 0.4588, then the elasticity of log of imports with respect to index of local institutional infrastructure is about 1.21. Even more importantly we find that the measure for regional economic infrastructure is positive and significant. In other words being part of regional (block-wide) economic institutional infrastructure decreases economic distance and hence positively influences trade. Elasticity of trade with respect to institutional development of suggested blocks on average over the sample is 0.14 (Order 3). The obtained coefficient shows that there is positive spillover effect of improving institutional infrastructure in, for example, Czech Republic on its trade with Hungary, Poland and other countries that enter the bloc and vice versa. The elasticity of trade in Czech Republic with respect to the index of regional governance is about 0.7. Elasticity is calculated for the sample average value of regional governance for Czech Republic 3.25 times the coefficient of regional governance estimated to be equal to 0.2146. At the same time, a contribution of economic institutions in each particular country j to FDI in Czech Republic is proportional to the weight the country j has. For example, Polish governance infrastructure enters the equation for trade in Czech Republic (grouping 3) with the weight 0.112. Therefore, an improvement in local governance in Poland by 1% increases trade in Czech Republic with countries of the bloc by 0.08%, as average index of local governance in Poland was about 3.4 during the considered period. Evidence of presence of such positive spatial effect points out to the importance of being part of common economic area on the trade flows of countries of this area: a country's trade is increased if it is located in a region where other countries have good economic institutions. However, it also works in the opposite direction: trade of a country located in a region with poor governance is develops in a slower motion. For example in 2003, regional governance infrastructure indices in Poland (EU) and Ukraine (CES) were equal to 3.2602 and 2.2691 (Order 3). Had Ukraine been located where Poland is it would increase its trade within EU by about 21% and at the same time decrease its trade with former block members by 0,43% (due decrease in average regional governance measure by about 0,02). Had Lithuania moved to where Belarus is than its trade with EU area would decrease by about 17.7% (3.3095 and 2.4858 respective average regional indices) and increase its trade with new block members by about 3,1% (due to increase in regional governance index by about 0,15). Hence in this respect our results suggest that for instance Ukraine does not have to loose much from integration to EU, whereas there is no need for Lithuania to join the Common Economic Space.

Chapter 5

CONCLUSIONS

The main goal of this paper was to evaluate the change in patterns of international trade in transition countries by extending conventional gravity model specification with developed measures of economic distance. We found that regional institutional infrastructure has to play the important role here and demonstrated theoretical soundness of such hypothesis. Then, using extended set of econometric techniques this paper revealed a significant positive spillover effect of the level of development of economic institutions in countries that belong to the same economic area. In other words we showed that high level of regional governance decreases economic distance between countries and thus increases trade between them. So this paper succeeded to explain change in patterns of trade flows as a result of countries becoming integrated into common economic clusters by extending measures of economic distance. In this respect this paper should be of particular interest to researchers.

Found results are quite robust to different model specifications and use of spatial weighting matrices, thus might provide for reliable quantitative inferences. Specifically for the selected 24 transition countries over 1993-2004 period average elasticity of trade with respect to regional institutional infrastructure of proposed country clusters is about 0.14 and is comparable with the importance of local institutional development. Hence it turns out that in this respect the development of countries that you integrate with is as important for promotion of trade as your own level of development. Our model predicts that if Ukraine would become a part of EU its trade with countries of this common economic space would increase by 21%, while it will loose only about 0,43% in trade with countries like Russia, Belarus, Moldova. Therefore, if increased volumes of trade with EU country-members is thought by Ukrainian policy-makers to be a favorable outcome (due to technological transfers; increased competitiveness of enterprises etc.) than EU membership would significantly increase trade flows in this direction, while old trade ties will be only slightly disrupted. Although, if increased trade with EU is deemed to be not socially optimal, than measures should be undertaken to develop existing local and regional institutional infrastructure so that to decrease economic distance (and thus costs associated with it) between say CES countries. Of course the above assertions are based on the assumption that EU would be capable to immediately place Ukraine into the similar institutional infrastructure that has been developed among country-members, which may not be the case. As Aslund and Werner (2003) underlined, "The EU has been surprisingly successful in accommodating CEE countries' trade interests, but has done very little for the CIS countries… Fortunately there many reasons to believe that this situation cannot continue forever".

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APPENDIX A

Descriptive statistics of data.

Variable	*Mean*	*Std. Dev.*	*Min*	*Max*	*Observations*
LnTrade overall	15.96725	2.878148	6.37332	23.17884	N = 5059
between		2.933745	6.907755	22.7086	n = 532
within		0.9360788	9.868689	20.96473	T-bar = 9.5094
LnGDPi overall	23.04689	1.453245	20.62656	26.90748	N = 6624
between		1.4457	20.88977	26.67586	n = 552
within		0.1591959	22.68252	23.52834	T = 12
LnGDPj overall	23.04689	1.453245	20.62656	26.90748	N = 6624
between		1.4457	20.88977	26.67586	n = 552
within		0.1591959	22.68252	23.52834	T = 12
LnDistij overall	7.348613	0.818566	3.367296	8.485909	N = 6624
between		0.8192466	3.367296	8.485909	n = 552
within		0	7.348613	7.348613	T = 12
im_tarif overall	3.864338	3.826149	0	21.1	N = 6256
between		3.141635	0.05	12.55	n = 552
within		2.310561	-1.585662	13.431	T-bar = 11.3333
price liberalisation overall	3.452431	0.7307282	1	4.3	N = 6624
between		0.4038554	2.241667	3.783333	n = 552
within		0.6092088	1.119097	4.235764	T = 12
trade & forex liberalisation overall	3.433333	1.089775	1	4.3	N = 6624
between		0.9354668	1	4.275	n = 552
within		0.560326	1.058333	4.441667	T = 12
smal-scale privatization overall	3.503125	0.8500789	1	4.3	N = 6624
between		0.6965886	1.783333	4.225	n = 552
within		0.4880619	1.811458	4.511458	T = 12
large-scale privatization overall	2.740278	0.8849961	1	4	N = 6624
between		0.7248609	1.175	3.916667	n = 552
within		0.5085937	0.9569445	3.756944	T = 12
enterprise reform overall	2.175	0.6868823	1	3.3	N = 6624
between		0.6082468	1.116667	3.175	n = 552
within		0.32009	0.7083333	2.758333	T = 12
competition policy overall	2.108333	0.5737738	1	3	N = 6624
between		0.4880075	1	3	n = 552
within		0.3024245	1.158333	2.775	T = 12
infrastructure overall	1.960417	0.7647489	1	3.7	N = 6624
between		0.5974191	1	3.291667	n = 552
within		0.4780419	0.4854167	3.060417	T = 12
banking sector overall	2.392708	0.8299612	1	4	N = 6624
between		0.7270676	1	3.666667	n = 552
within		0.4013555	0.8510416	3.392708	T = 12
non-banking fin. institutions overall	2.057292	0.7048106	1	3.7	N = 6624
between		0.5890244	1	3.2	n = 552
within		0.3877943	0.765625	2.898958	T = 12
opennes to trade overall	1.273251	1.230289	0.1936679	8.008504	N = 6302
between		1.209108	0.2221685	6.674614	n = 552
within		0.3237047	-0.638987	2.727343	T-bar = 11.4167
common border overall	0.1467391	0.3538724	0	1	N = 6624
between		0.3541666	0	1	n = 552
within		0	0.1467391	0.1467391	T = 12
com language overall	0.3965882	0.489226	0	1	N = 6624
between		0.4894912	0	1	n = 552
within		0.0117646	-.5200785	0.4799215	T = 12
oil and gas exporter overall	0.1666667	0.3727061	0	1	N = 6624
between		0.373016	0	1	n = 552

within		0	0.1666667	0.1666667	T =	12
index_i overall	2.646991	0.682451	1	3.844445	N =	6624
between		0.575292	1.273148	3.578704	n =	552
within		0.36787	1.509954	3.25162	T =	12
index_j overall	2.646991	0.682451	1	3.844445	N =	6624
between		0.575292	1.273148	3.578704	n =	552
within		0.36787	1.509953	3.251621	T =	12
regional remoteness 1 overall	1.213204	1.397566	0	3.844445	N =	6912
between		1.376292	0	3.578704	n =	576
within		0.249049	0.076167	1.817834	T =	12
b_geographic reensess 1 overall	3.985004	3.173414	0.392806	12.00008	N =	6624
between		3.096872	0.491516	10.11005	n =	552
within		0.70418	1.273789	5.875039	T =	12
regional remoteness 2 overall	0.966053	1.38157	0	3.844445	N =	6912
between		1.365671	0	3.578704	n =	576
within		0.21598	-0.17098	1.570683	T =	12
b_geographic reensess 2 overall	1.998734	1.574724	0	6.291712	N =	6648
between		1.520074	0	5.220311	n =	554
within		0.415877	0.322829	3.070136	T =	12
regional remoteness 3 overall	0.633452	1.190747	0	3.844445	N =	6912
between		1.178173	0	3.578704	n =	576
within		0.178874	-0.50359	1.238082	T =	12
b_geographic reensess 3 overall	1.56692	1.757344	0.007759	6.291712	N =	6624
between		1.716194	0.010775	5.220311	n =	552
within		0.38448	-0.10899	2.638322	T =	12

APPENDIX B

Results of 3-stage GMM procedure

Dependent variable	*Expected sign*	3-stage GMM (Order 3)		
		Coef.	*s.e*	*p-value*
LnGDPi	+	0.9138	0.0308	0.0000
LnGDPj	+	1.0667	0.0269	0.0000
LnDistij	-	-1.0728	0.0652	0.0000
Import tariff	-	-0.0226	0.0054	0.0000
index i	+	0.2772	0.0512	0.0000
reg.remoteness	+	0.3275	0.0380	0.0000
border	+	0.7156	0.1296	0.0000
d_oil_gas_j	+	0.8590	0.0970	0.0000
openness to trade	+	0.1310	0.0232	0.0000
g.remoteness	+	0.1935	0.0236	0.0000
dCrises	?	0.0569**	0.0548	0.2990
_c		-22.4406	1.0359	0.0000
pho		0.1728	0.0426	0.1540
sigma v		0.9580	0.0308	0.0200

APPENDIX C

```
set more off
capture clear
capture log close
set maxvar 20000
set mem 20m
set matsize 576
log using "C:\tmp\GMM\years\PROGRAM_yearDR.log", replace
*************************************************************
*                                                           *
*      THIS COMPUTER PROGRAM IS FOR THE PANEL DATA          *
*      SPECIFICATION WHERE THE DISTURBANCES ARE BOTH        *
*      SPATIALLY AND TIME-WISE AUTOCORRELATED               *
*                                                           *
*        Y=ALPHA+X*BETA+U, U=(IT#(RHO*WEIGHTINGMATRIX))*U+E, *
*        E=(eT#MU)+V                                        *
*                                                           *
**************************************************************
**************************************************************
*EXPLANATION OF THE VARIABLES USED IN THE PROGRAM            *
*Y.......VECTOR OF DEPENDENT VARIABLE                        *
*X.......VECTOR OF EXOGENOUS EXPLANATORY VARIABLE            *
*U.......VECTOR OF DISTURBANCES                              *
*MMAT....SPATIAL WEIGHTING MATRIX(REMAINS SAME FOR ALL TIME  *
*E.......VECTOR OF INNOVATIONS                               *
*RHO.....SPATIAL AUTOREGRESSIVE PARAMETER                    *
*AHOLS...OLS ESTIMATE OF ALPHA                               *
*AHGLS...GLS ESTIMATE OF ALPHA                               *
*BHOLS...OLS ESTIMATE OF BETA                                *
*BHGLS...GLS ESTIMATE OF BETA                                *
*RHOHGM..GENERAL MOMENTS ESTIMATOR OF RHOH                   *
*NS......NUMBER OF CROSS SECTIONAL UNITS                     *
*T.......NUMBER OF TIME PERIODS                              *
*NT......TOTAL SAMPLE SIZE                                   *
**************************************************************
**************************************************************
*                       READ THE DATA                        *
**************************************************************
infile m1-m576 using "C:\tmp\GMM\years\W2.txt"
compress
save "C:\tmp\GMM\years\W2.dta", replace
*use "E:\Thesis Kurganov\TEMP\GMM\W1.dta"
scalar NS=576
scalar T=11
scalar NT=NS*T
mkmat m1-m576, mat(MMAT)
drop m1-m576
mat MMM=trace(MMAT'*MMAT)/_N
discard
memory
mat IMAT=I(NS)
mat TMAT=I(T)
mat JMAT=J(T,T,1/T)
discard
memory
set matsize 6336
mat MMAT1=TMAT#MMAT
discard
memory
mat Q0=(TMAT-JMAT)#IMAT
discard
memory
mat Q1=JMAT#IMAT
discard
memory
mat MW=MMAT'*MMAT
discard
memory
```

```
mat MWT=trace(MW)/NS
discard
memory
mat MWTT1=MW*(MMAT+MMAT')
discard
memory
mat MWTT=trace(MWTT1)/NS
mat MWW=MMAT*MMAT
discard
memory
mat MWWW=MW*MW
mat MWWWW=MW+MWW
mat MQ0=trace(MWWW)/NS
mat MQ1=trace(MWWWW)/NS
***************************************************************
*         IN THE FIRST STEP ESTIMATE THE MODEL BY OLS         *
*              AND GET THE ESTIMATED DISTURBANCES             *
***************************************************************
*infile y x1 x2 using y:\temp\var3.dat
use "C:\tmp\GMM\years\VAR_1_93.dta"
merge using "C:\tmp\GMM\years\W2.dta"
reg LnTrade LnGDPi LnGDPj LnDistij im_tarif index_i regr_1 border d_oil_gas_j
dCrises open_trade wGDPj gremot c, noconstant
predict r_1, resid
gen r2=r_1^2
egen ss=sum(r2)
scalar SHOLS=ss/(NS-1)
scalar cOLS=_b[c]
scalar LnGDPiOLS=_b[LnGDPi]
scalar LnGDPjOLS=_b[LnGDPj]
scalar LnDistijOLS=_b[LnDistij]
scalar im_tarifOLS=_b[im_tarif]
scalar index_iOLS=_b[index_i]
scalar regr_1OLS=_b[regr_1]
scalar borderOLS=_b[border]
scalar d_oil_gas_jOLS=_b[d_oil_gas_j]
scalar dCrisesOLS=_b[dCrises]
scalar open_tradeOLS=_b[open_trade]
scalar wGDPjOLS=_b[wGDPj]
scalar gremotOLS=_b[gremot]

***************************************************************
*       STEP 1:  OLS ESTIMATORS OF REGRESSION PARAMETERS      *
***************************************************************
scalar  list  cOLS  LnGDPiOLS  LnGDPjOLS  LnDistijOLS  im_tarifOLS  index_iOLS
regr_1OLS regr_1OLS borderOLS d_oil_gas_jOLS dCrisesOLS open_tradeOLS wGDPjOLS
gremotOLS

***************************************************************
*   IN THE SECOND STEP USE THE ESTIMATES OF DISTURBANCES      *
*          FOR THE GENERAL MOMENTS(GM) ESTIMATOR              *
***************************************************************
****************************************************************
* SET FLAG L FOR CHOICE OF PROCEDURE TO ESTIMATE RHO AND SIGMA *
*                                                              *
* F = 1..  SELECT INITIAL GM ESTIMATORS                        *
*   = 2..  SELECT PARTIALLY WEIGHTED GM ESTIMATORS             *
*   = 3..  SELECT FULLY WEIGHTED GM ESTIMATORS                         *
****************************************************************
scalar F=1
capture program drop nlequ
program define nlequ
if "`1'"== "?" {
global S_1 " rho sigma2 "
global rho=1
global sigma2=1
exit
}
replace `1'=v1*$rho +v2*$rho^2 +v3*$sigma2
end

capture program drop nlpanel
program define nlpanel
if "`1'"== "?" {
```

```
global S_1 " rhog sigv sig1 "
global rhog=1
global sigv=1
global sig1=1
exit
}
replace `1'=V1*$rhog +V2*$rhog^2 +V3*$sigv +V4*$sig1
end

capture program drop gmproc3
program define gmproc3

if F==1 {
display("  ")
display("                       INITIAL GM ESTIMATORS")
}
if F==2 {
display("  ")
display("                   PARTIALLY WEIGHTED ESTIMATORS")
}
if F==3 {
display("  ")
display("                        WEIGHTED ESTIMATORS")
}

*GMPROC PROCEDURE HAS BEEN DEFINED BELOW;
*****************************************************************
*GENERAL MOMENTS ESTIMATION PROCEDURE FOR ESTIMATION OF RHO     *
*MOMENT EQUATIONS INVOLVING                                     *
*E’E, (ME)’(ME),  AND (ME)’E, WHERE ME=WEIGHTINGMATRIX*E        *
*****************************************************************
syntax [varlist]
mkmat r_1, mat(UVEC)
mat VVEC=MMAT1*UVEC
mat WVEC=MMAT1*VVEC
mat UQVEC=Q0*UVEC
mat VQVEC=Q0*VVEC
mat WQVEC=Q0*WVEC
mat UQ1TDE1EC=Q1*UVEC
mat VQ1TDE1EC=Q1*VVEC
mat WQ1TDE1EC=Q1*WVEC
svmat UVEC, n(US)
svmat VVEC, n(VS)
svmat WVEC, n(WS)
svmat UQVEC, n(UQS)
svmat VQVEC, n(VQS)
svmat WQVEC, n(WQS)
svmat UQ1TDE1EC, n(UTS)
svmat VQ1TDE1EC, n(VTS)
svmat WQ1TDE1EC, n(WTS)
*****************************************************************
*CALCULATE VARIOUS SAMPLE MOMENTS APPEARING IN THE SYSTEM       *
*OF EQUATIONS FOR RHOH FROM ESTIMATED DISTURBANCES              *
*****************************************************************
gen UQ2=UQS*UQS
gen VQ2=VQS*VQS
gen WQ2=WQS*WQS
gen UQVQ=UQS*VQS
gen UQWQ=UQS*WQS
gen VQWQ=VQS*WQS
gen UQ12=UTS*UTS
gen VQ12=VTS*VTS
gen WQ12=WTS*WTS
gen UQ1VQ1=UTS*VTS
gen UQ1WQ1=UTS*WTS
gen VQ1WQ1=VTS*WTS
****************************************************************
*CALCULATE TR(MMAT'MMAT)/(SAMPLE SIZE)                         *
****************************************************************
*mat MMM=trace(MMAT'*MMAT)/_Nmat

scalar T1=T/(T-1)
scalar T2=T
egen UQ2M = mean(UQ2)
```

```
egen VQ2M = mean(VQ2)
egen WQ2M = mean(WQ2)
egen UQVQM = mean(UQVQ)
egen UQWQM = mean(UQWQ)
egen VQWQM = mean(VQWQ)
egen UQ12M = mean(UQ12)
egen VQ12M = mean(VQ12)
egen WQ12M = mean(WQ12)
egen UQ1VQ1M = mean(UQ1VQ1)
egen UQ1WQ1M = mean(UQ1WQ1)
egen VQ1WQ1M = mean(VQ1WQ1)
scalar SUQ2M=UQ2M*T1
scalar SVQ2M=VQ2M*T1
scalar SWQ2M=WQ2M*T1
scalar SUQVQM=UQVQM*T1
scalar SUQWQM=UQWQM*T1
scalar SVQWQM=VQWQM*T1
scalar SUQ12M=UQ12M*T2
scalar SVQ12M=VQ12M*T2
scalar SWQ12M=WQ12M*T2
scalar SUQ1VQ1M=UQ1VQ1M*T2
scalar SUQ1WQ1M=UQ1WQ1M*T2
scalar SVQ1WQ1M=VQ1WQ1M*T2

gen h11=2*SUQVQM
gen h12=-SVQ2M
gen h13=1
gen h21=2*SVQWQM
gen h22=-SWQ2M
gen h23=trace(MMM)
gen h31=(SVQ2M+SUQWQM)
gen h32=-SVQWQM
gen h33=0
gen hy1=SUQ2M
gen hy2=SVQ2M
gen hy3=SUQVQM

collapse h11 h12 h13 hy1 h21 h22 h23 hy2 h31 h32 h33 hy3
mkmat h11 h21 h31, matrix(h1t)
mkmat h12 h22 h32, matrix(h2t)
mkmat h13 h23 h33, matrix(h3t)
mkmat hy1 hy2 hy3, matrix(hyt)
drop h11 h12 h13 hy1 h21 h22 h23 hy2 h31 h32 h33 hy3
mat h1=h1t'
mat h2=h2t'
mat h3=h3t'
mat hy=hyt'
set obs 3
svmat h1, n(v1)
svmat h2, n(v2)
svmat h3, n(v3)
svmat hy, n(z)
*****************************************************************
*PREPARE ESTIMATION OF RHO  AND SE FROM THREE EQUATIONS BY NLS  *
*****************************************************************
nl equ z, init(rho=0.7, sigma2=1)
*set obs 100
scalar RHOH=$rho
scalar SIGV=$sigma2
scalar SIG1=SUQ12M-(2*SUQ1VQ1M*RHOH)-(-1*SVQ12M*(RHOH^2))
scalar VAR1= ((SIGV^2)/(T-1))^0.5
scalar VAR2 = (SIG1^2)^0.5
scalar list RHOH SIGV SIG1
scalar list F
if F == 1 {
scalar RHOGM=RHOH
scalar SIGVV=SIGV
scalar SIG11=SIG1
gen RhoGM=RHOH
}

if F == 2 {
scalar VAR11=NS*((1*(SIGV^2)/(NS*(T-1))))
scalar VAR22=NS*((1*(SIGV^2)/(NS*(T-1))))
```

```
scalar VAR33=NS*((1*(SIGV^2)/(NS*(T-1))))
scalar VAR44=NS*((1*(SIG1^2)/NS))
scalar VAR55=NS*((1*(SIG1^2)/NS))
scalar VAR66=NS*((1*(SIG1^2)/NS))
scalar VAR12 = 0
scalar VAR23 = 0
scalar VAR45 = 0
scalar VAR56 = 0
}
if F == 3 {
scalar VAR11 = NS*((2*(SIGV^2)/(NS*(T-1))))
scalar VAR22 = NS*((2*(SIGV^2)/(NS*(T-1)))*trace(MQ0))
scalar VAR33 = NS*((1*(SIGV^2)/(NS*(T-1)))*trace(MQ1))
scalar VAR44 = NS*((2*(SIG1^2)/NS))
scalar VAR55 = NS*((2*(SIG1^2)/NS)*trace(MQ0))
scalar VAR66 = NS*((1*(SIG1^2)/NS)*trace(MQ1))
scalar VAR12 = NS*(2*(SIGV^2)/(NS*(T-1)))*trace(MWT)
scalar VAR23 = NS*(1*(SIGV^2)/(NS*(T-1)))*trace(MWTT)
scalar VAR45 = NS*(2*(SIG1^2)/NS)*trace(MWT)
scalar VAR56 = NS*(1*(SIG1^2)/NS)*trace(MWTT)
}
if F > 1 {
mat VCOV=I(6)
mat VCOV[1,1]=VAR11
mat VCOV[1,2]=VAR12
mat VCOV[2,1]=VAR12
mat VCOV[2,2]=VAR22
mat VCOV[2,3]=VAR23
mat VCOV[3,2]=VAR23
mat VCOV[3,3]=VAR33
mat VCOV[4,4]=VAR44
mat VCOV[4,5]=VAR45
mat VCOV[5,4]=VAR45
mat VCOV[5,5]=VAR55
mat VCOV[5,6]=VAR56
mat VCOV[6,5]=VAR56
mat VCOV[6,6]=VAR66
mat VCOV=inv(VCOV)
mat P = (cholesky(VCOV))'

scalar P11 = P[1,1]
scalar P12 = P[1,2]
scalar P21 = P[2,1]
scalar P22 = P[2,2]
scalar P23 = P[2,3]
scalar P32 = P[3,2]
scalar P33 = P[3,3]
scalar P44 = P[4,4]
scalar P45 = P[4,5]
scalar P54 = P[5,4]
scalar P55 = P[5,5]
scalar P56 = P[5,6]
scalar P65 = P[6,5]
scalar P66 = P[6,6]

gen HM11  = 2*SUQVQM*P11+2*SVQWQM*P12
gen HM12  = -SVQ2M*P11-SWQ2M*P12
gen HM13  = 1*P11+trace(MMM)*P12
gen HM14  = 0
gen HMY1  = SUQ2M*P11+SVQ2M*P12

gen HM21  = 2*SUQVQM*P21+2*SVQWQM*P22+(SVQ2M+SUQWQM)*P23
gen HM22  = -SVQ2M*P21-SWQ2M*P22-SVQWQM*P23
gen HM23  = 1*P21+trace(MMM)*P22
gen HM24  = 0
gen HMY2  = SUQ2M*P21+SVQ2M*P22+SUQVQM*P23

gen HM31  = 2*SVQWQM*P32+(SVQ2M+SUQWQM)*P33
gen HM32  = -SWQ2M*P32-SVQWQM*P33
gen HM33  = trace(MMM)*P32
gen HM34  = 0
gen HMY3  = SVQ2M*P32+SUQVQM*P33

gen HM41  = 2*SUQ1VQ1M*P44+2*SVQ1WQ1M*P45
```

```
gen HM42  = -SVQ12M*P44-SWQ12M*P45
gen HM43  = 0
gen HM44  = 1*P44+trace(MMM)*P45
gen HMY4  = SUQ12M*P44+SVQ12M*P45

gen HM51  = 2*SUQ1VQ1M*P54+2*SVQ1WQ1M*P55+(SVQ12M+SUQ1WQ1M)*P56
gen HM52  = -SVQ12M*P54-SWQ12M*P55-SVQ1WQ1M*P56
gen HM53  = 0
gen HM54  = 1*P54+trace(MMM)*P55
gen HMY5  = SUQ12M*P54+SVQ12M*P55+SUQ1VQ1M*P56

gen HM61  = 2*SVQ1WQ1M*P65+(SVQ12M+SUQ1WQ1M)*P66
gen HM62  = -SWQ12M*P65-SVQ1WQ1M*P66
gen HM63  = 0
gen HM64  = trace(MMM)*P65
gen HMY6  = SVQ12M*P65+SUQ1VQ1M*P66
collapse HM11 HM12 HM13 HM14 HMY1 HM21 HM22 HM23 HM24 HMY2 HM31 HM32 HM33 HM34
HMY3 HM41 HM42 HM43 HM44 HMY4 HM51 HM52 HM53 HM54 HMY5 HM61 HM62 HM63 HM64 HMY6
mkmat HM11 HM21 HM31 HM41 HM51 HM61, matrix(HM1t)
mkmat HM12 HM22 HM32 HM42 HM52 HM62, matrix(HM2t)
mkmat HM13 HM23 HM33 HM43 HM53 HM63, matrix(HM3t)
mkmat HM14 HM24 HM34 HM44 HM54 HM64, matrix(HM4t)
mkmat HMY1 HMY2 HMY3 HMY4 HMY5 HMY6, matrix(HMYt)
mat HM1=HM1t'
mat HM2=HM2t'
mat HM3=HM3t'
mat HM4=HM4t'
mat HMY=HMYt'
set obs 6
svmat HM1, n(V1)
svmat HM2, n(V2)
svmat HM3, n(V3)
svmat HM4, n(V4)
svmat HMY, n(VY)

nl panel VY, init(rhog=0, sigv=1, sig1=1)
*set obs 400
gen RhoGM=$rhog
scalar RHOGM=$rhog
scalar SIGVV=$sigv
scalar SIG11=$sig1
}
end
gmproc3 r_1

**************************************************************
* STEP 2, 1st. Part:                                         *
* INITIAL GM ESTIMATES FOR RHO AND THE VARIANCE COMPONENTS   *
**************************************************************
scalar list RHOH SIGV SIG1

**************************************************************
*    IN THE THIRD STEP USE THE GM ESTIMATES FOR SPATIAL      *
*  AUTOREGRESSIVE PARAMETER, CORRECT FOR SPATIAL CORRELATION *
*  IN DISTURBANCES AND  ESTIMATE THE CORRECTED MODEL BY OLS  *
**************************************************************
merge using "C:\tmp\GMM\years\VAR_1_93.dta"

capture program drop glsproc3
program define glsproc3
**************************************************************
* GLSPROC PROCEDURE HAS BEEN DEFINED BELOW                   *
*                                                            *
* GENERALIZED LEAST SQUARES PROCEDURE                        *
**************************************************************
syntax [varlist]
*mat IMAT=I(NS)
*mat TMAT=I(T)
*mat JMAT=J(T,T,1/T)
*mat list JMAT

*set matsize 400
*****************************
* Model Specification       *
```

```
*****************************
mat drop hy h3 h2 h1 hyt h3t h2t h1t WQ1TDE1EC VQ1TDE1EC UQ1TDE1EC WQVEC VQVEC
UQVEC WVEC VVEC UVEC MQ1 MQ0  MWWWW  MWWW  MWW  MWTT MWTT1 MW MMAT1 JMAT MMM
mkmat LnTrade, mat(YMAT)
mkmat LnGDPi, mat(X1MAT)
mkmat LnGDPj, mat(X2MAT)
mkmat LnDistij, mat(X3MAT)
mkmat im_tarif, mat(X4MAT)
mkmat index_i, mat(X5MAT)
mkmat regr_2, mat(X6MAT)
mkmat border, mat(X7MAT)
mkmat d_oil_gas_j, mat(X8MAT)
mkmat dCrises, mat(X9MAT)
mkmat open_trade, mat(X10MAT)
mkmat wGDPj, mat(X11MAT)
mkmat gremot, mat(X12MAT)
mkmat c, mat(X13MAT)
scalar RhoGM=RhoGM
discard
memory

mat GMAT=TMAT#(IMAT-RhoGM*MMAT)
memory
mat drop TMAT IMAT MMAT
mat YSMAT=GMAT*YMAT
mat X1SMAT=GMAT*X1MAT
mat X2SMAT=GMAT*X2MAT
mat X3SMAT=GMAT*X3MAT
mat X4SMAT=GMAT*X4MAT
mat X5SMAT=GMAT*X5MAT
mat X6SMAT=GMAT*X6MAT
mat X7SMAT=GMAT*X7MAT
mat X8SMAT=GMAT*X8MAT
mat X9SMAT=GMAT*X9MAT
mat X10SMAT=GMAT*X10MAT
mat X11SMAT=GMAT*X11MAT
mat X12SMAT=GMAT*X12MAT
mat X13SMAT=GMAT*X13MAT
mat drop GMAT
discard
memory
mat OMGINV   = (1/(SIGVV^0.5))*Q0 + (1/(SIG11^0.5))*Q1
memory
mat drop Q0 Q1
discard
mat YTSMAT   = OMGINV*YSMAT
mat X1TSMAT  = OMGINV*X1SMAT
mat X2TSMAT  = OMGINV*X2SMAT
mat X3TSMAT  = OMGINV*X3SMAT
mat X4TSMAT  = OMGINV*X4SMAT
mat X5TSMAT  = OMGINV*X5SMAT
mat X6TSMAT  = OMGINV*X6SMAT
mat X7TSMAT  = OMGINV*X7SMAT
mat X8TSMAT  = OMGINV*X8SMAT
mat X9TSMAT  = OMGINV*X9SMAT
mat X10TSMAT  = OMGINV*X10SMAT
mat X11TSMAT  = OMGINV*X11SMAT
mat X12TSMAT  = OMGINV*X12SMAT
mat X13TSMAT  = OMGINV*X13SMAT

svmat YTSMAT, n(YTS)
svmat X1TSMAT, n(X1TS)
svmat X2TSMAT, n(X2TS)
svmat X3TSMAT, n(X3TS)
svmat X4TSMAT, n(X4TS)
svmat X5TSMAT, n(X5TS)
svmat X6TSMAT, n(X6TS)
svmat X7TSMAT, n(X7TS)
svmat X8TSMAT, n(X8TS)
svmat X9TSMAT, n(X9TS)
svmat X10TSMAT, n(X10TS)
svmat X11TSMAT, n(X11TS)
svmat X12TSMAT, n(X12TS)
svmat X13TSMAT, n(X13TS)
```

```
************************************************************
*              STEP 3:  FEASIBLE GLS ESTIMATORS              *
************************************************************
reg YTS X1TS X2TS X3TS X4TS X5TS X6TS X7TS X8TS X9TS X10TS X11TS X12TS X13TS,
noconstant
predict u, resid
gen u2=u^2
egen ss2=sum(u2)
scalar SHFGLS=ss2/(NS-1)
end
glsproc3  LnTrade  LnGDPi  LnGDPj  LnDistij  im_tarif  index_i  regr_2  border
d_oil_gas_j dCrises open_trade wGDPj gremot c RhoGM
scalar list SHFGLS RhoGM
log close
```