

Busch, Christian J.

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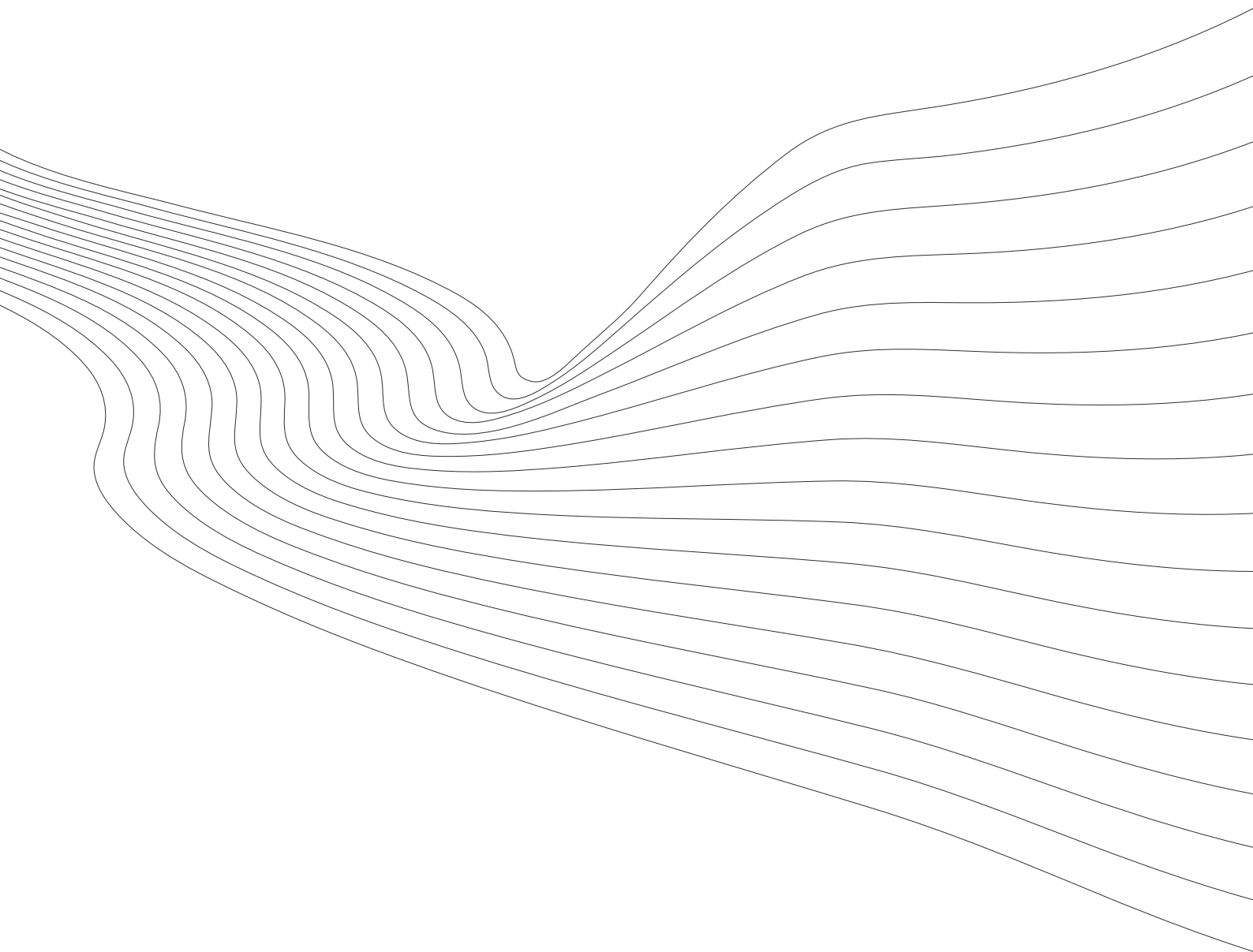
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Christian J. Busch



KOF

ETH Zurich
KOF Swiss Economic Institute
WEH D 4
Weinbergstrasse 35
8092 Zurich
Switzerland

Phone +41 44 632 42 39
Fax +41 44 632 12 18
www.kof.ethz.ch
kof@kof.ethz.ch

Does Export Concentration Cause Volatility?

Christian J. Busch*

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Abstract

This paper investigates the causal influence of export concentration on measures of aggregate volatility. Geographically disadvantaged countries often have a concentrated export structure which makes them more vulnerable to external shocks. Identifying causal effects of export concentration on volatility faces severe problems of endogeneity, however. Based on a gravity approach, we suggest an inequality decomposition method which allows the construction of an aggregate measure of export concentration where all of its components are determined entirely by countries' geographic characteristics. Since this measure is plausibly uncorrelated with other determinants of volatility, it is used as an instrument for export concentration to obtain instrumental variables estimates of the effect of export concentration on volatility. Results from two-stage least squares instrumental variables regressions reveal that export concentration has a particularly strong effect on volatility in terms of trade and on volatility in export growth rates but we cannot confirm a casual influence on the volatility of exchange rates.

*KOF Swiss Economic Institute, ETH Zurich, Switzerland

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1 Introduction

Macroeconomic volatility is a major concern for policy makers and the adverse consequences of volatility are potentially serious. Volatility may be associated with direct welfare loss of deviating from a smooth path of consumption. More importantly, it also has a negative impact on growth in output and thus on future consumption (Ramey and Ramey (1995); Loayza et al. (2007)). On the aggregate level, the uncertainty associated with larger volatility results in lower private investment and, consequently, leads to slower growth (see Malik and Temple (2008) for a discussion). Adverse consequences have not only been identified for the volatility of growth rates of output but also for other macro-variables such as exchange rates, terms of trade, or inflation rates. Yet, fluctuations of macroeconomic aggregates are systematically larger in some countries than others. In particular, developing countries which lack well functioning credit markets to diversify external risks and public insurance systems to smooth income and consumption are hit hardest by the instability in their macroeconomic environment. Not only are the effects of volatility larger in these countries, but they are also much more often confronted with episodes of high volatility than industrial countries where the institutional environment mitigates the impact of volatility (Rodrik (1999)).

A growing literature tries to identify the determinants of macro-volatility. While many determinants have been proposed, the identification of their influence is plagued by the fact that most of these determinants themselves should be regarded as endogenous to other, more fundamental explanations. As a consequence of the manifold influences and complex relationships, the analysis of the determinants of aggregate volatility has thus shifted towards trying to identify causal determinants of volatility, and, much in line with the growth and development literature in general, has isolated institutions and trade as the most promising fundamental explanations. However, the attempt to evaluate their causal influences faces problems of endogeneity as well. Countries facing more volatile environments may prefer a different structure and extent of trade and may have different institutions. Similarly, countries with higher incomes have different institutions and export structures for other reasons, while income levels - and many omitted determinants of income - are highly correlated with volatility. Thus, there are many omitted determinants of income differences that will also be correlated with institutions and trade.

Some geographic characteristics, such as distance from trading partners or size, have been identified as strong predictors of export structure across countries. In this paper, we make use of these relationships and explore the variation of export concentration that can be explained by geographic determinants alone. Export concentration is reasonably one of the major channels through which geography influences volatility, and remote countries are hampered in their ability to diversify exports. We will show that the geographic component of export concentration is plausibly uncorrelated with institutions, thereby allowing the construction of a valid instrument for export concentration.

The paper is organized as follows. Section 2 discusses previous approaches to explaining volatility and the approaches used to identify causal determinants of

volatility. Section 3 summarizes the mechanisms linking geography to volatility through export concentration, which emerged from this literature and explains the empirical strategy. Section 4 theoretically derives the constructed export concentration measure. Section 5 describes the data and variables used. Section 6 presents gravity regressions used to construct an aggregate measure of export concentration. Section 7 gives results from OLS and IV regressions for volatility, and Section 8 concludes.

2 Related Literature

2.1 Determinants of Volatility

What are the reasons for the large variation in volatility across countries? Among the explanations proposed in the literature, several approaches stand out (see Loayza et al. (2007)). The first views volatility as a matter of policy mismanagement. This is especially the case if the discretion of policymakers is large (for the example of fiscal policy discretion, see Fatás and Mihov (2003)). In a second view, countries with underdeveloped financial markets have fewer options to diversify external risks and are unable to insure themselves against shocks. Access to capital markets would induce more risk sharing and would allow the smoothing of income and consumption over time (see, e.g. Easterly et al. (2000); results in Beck et al. (2006) are more ambiguous, however). A third argument relates to sectoral specialization and levels of development. Poor countries specialize in fewer and more volatile sectors and as countries develop, their productive structure moves from more volatile to less volatile sectors (Koren and Tenreyro (2007)).

However factors such as policies and financial institutions are only intermediate determinants of volatility, themselves being determined by other, more fundamental factors. In line with progress made in research of development economics, some studies have focused on more fundamental explanations, or deep determinants, of volatility. Acemoglu et al. (2003) find a strong case for the overall institutional environment as being the ultimate cause of volatility (see also Chong and Gradstein (2009)). In institutionally weak societies, the combination of social conflicts, inefficient redistributive and other policies lead to increased overall volatility. In this view, policy mismanagement, for instance, is simply a symptom of the more fundamental institutional system that determines incentives in society. Unless institutions are improved, there will always be another channel through which conflicts will result in larger volatility.

A second fundamental determinant of volatility is geography and the natural propensity to mitigate external risks through trade. Malik and Temple (2008) and Bacchetta et al. (2007) argue that geographically remote countries lack the potential to diversify their export structures and, as a consequence, may be more vulnerable to external shocks. Geography (including factors related to resource endowments) can be regarded as fundamental because countries' geographic conditions are essentially immutable. Thus, unlike the institutional

environment, geography is more or less a country's fate. A related argument, more closely intertwined with the institutional argument, relates to the so-called Dutch Disease. Natural resource dependence can de-industrialize countries and leave them more prone to exogenous shocks of resource prices (for a recent, volatility-related version of the resource-curse argument, see van der Ploeg and Poelhekke (2009)). However, a favorable institutional environment may mitigate the negative impact of the resource curse as shown, for instance, by Mehlum et al. (2006).

2.2 Causality of the Determinants

Conceptually related to the identification of fundamental determinants of volatility is the question whether influences can be identified as causal. Establishing causality with regard to the influence of either institutional settings or trade and export structure on volatility is difficult as their influences are likely to suffer from problems of endogeneity, omitted variables, and attenuation biases. For instance, sectoral specialization could be a result of an unstable economic environment when large fluctuations limit production to certain industries which are better capable to deal with uncertainties in prices or demand. Similarly, poor countries export a smaller variety of products, while the number of export sectors typically increases with income levels. There is also some evidence of non-linearity where the degree of sectoral concentration declines with development at early stages, and increases at later stages (Koren and Tenreyro (2007); Kraay and Ventura (2007)). Therefore, any attempt to isolate the influence of export concentration on outcomes such as growth in income or its volatility may simply capture an omitted influence that is correlated with the level of income (Acemoglu and Zilibotti (1997)). Similarly, a richer country may be able to afford better institutions or may simply have a preference for a different institutional setting. Thus, there are good reasons to believe that both, volatility and its determinants depend on income and the level of development, while many omitted (and often unmeasurable) determinants of income differences are likely to be correlated with these determinants. Finally, there is also a rich literature demonstrating how institutions and the structure of production evolved in accordance. The domestic effects of external shocks are likely to be amplified or mitigated by policy responses or institutional set-ups (Rodrik, 2000; Rodrik, 1999). As institutions cannot truly be observed, we may falsely attribute part of the explanation to institutions which should actually be attributed to the structure of exports. All of these problems may introduce considerable bias in simple OLS estimates.

2.3 Empirical Approaches

Among the many econometric approaches to dealing with problems of causality of the determinants of volatility and the uncertainty of the model specification, three approaches are particularly common. The first approach consists of the use of instrumental variable estimations. Acemoglu et al. (2003) separate institutional from other explanations by using an instrument for institutions that

is plausibly orthogonal to any other omitted determinant of volatility. In particular, they exploit the “natural experiment” of colonization. In places where European settlers during the period of colonization faced high mortality rates, they only settled in small numbers and were more likely to set up extractive institutions, exploiting natural resources and labour for directing wealth primarily to their home countries. In places with more favorable climate, on the other hand, European settlers stayed in larger numbers and implemented institutions resembling much more their European counterparts. As these institutional structures persisted to the present, using settler mortality rates faced by colonialists yields an intuitive instrument for present-day institutions. In Acemoglu et al. (2003), this instrument is used to analyze the separate roles of institutions and policies on volatility. Their results indicate a much stronger role for institutions while policies do not seem to matter. Since there is no plausible instrument for policies, they do not account for the endogeneity of policies, thereby imposing a downward bias on institutions. This approach allows analyzing the causal effect of institutions, but does not establish whether the policy variables may have a truly independent effect. In effect, this approach does not allow separating institutional from other fundamental explanations. In particular, it ignores the channel through which geography may as well influence volatility proposed in this paper: Geographically disadvantaged countries trade less with others and are, therefore, limited in their ability to diversify their export structure.

For instance, Malik and Temple (2008) explore the separate effects of institutions and geography, through export concentration, on output volatility. Their findings support the view that both, institutions as well as geography exert strong effects on output volatility after controlling for a wide range of alternative influences. However their approach does not solve issues of causality since they treat institutions as being exogenous. Their focus lies on model uncertainty by relying on Bayesian methods which allows dealing effectively with problems of omitted variables but less so for problems of endogeneity and reverse causality. Given that better institutions promote output stability, their institutional variables are likely to be biased away from zero. More importantly, they ignore the many channels through which their geographic variables may influence institutions and economic outcomes as will be described in the next section.

Finally, another common approach is to use dynamic panel data techniques, as in Yang (2008) and also in Acemoglu et al. (2003). These approaches are valid alternatives to establish causal influences, and we regard their results as complementing the evidence found in this paper using instrumental variables techniques. Yet with regard to the issue of causality, panel data approaches should be interpreted with great caution. In particular, using lagged values as internal instruments does not ensure that these are not direct determinants of the dependent variables or that they are uncorrelated with omitted determinants (see Durlauf et al., 2005 for a discussion).

This paper adds to the existing literature by suggesting a new instrumental variable that allows to analyze the influence of export concentration on external volatility. To this end, we construct a measure of export concentration which is based entirely on countries’ geographic characteristics, and thus plausibly uncorrelated with institutions, income and policies. The proposed measure is

based on the Frankel and Romer (1999) approach to measure the effects of trade on income. To construct the variable for export concentration, we first estimate a gravity equation for bilateral export concentration based on bilateral trade flows. Using a decomposition procedure for the proposed concentration measure, we then aggregate the fitted values to obtain a geographic component of countries' overall export concentration. Since countries' geographic characteristics are not affected by volatility or by other factors that influence volatility, this constructed measure of concentration can then be used as a valid instrument to separate the influence of concentration on volatility from other influences. Thus, in a second stage, the geographic component of export concentration is used as an instrumental variable for export concentration to obtain instrumental variables estimates of the effect of export concentration on volatility.

3 Geography and Export Concentration

The hypothesis that geography matters for the overall level of trade has been extensively analyzed. Malik and Temple (2008) extend this approach to explain export structures and show that the impact of external volatility on the domestic economy strongly depends on import and export structures. Export structure, in turn, are partly determined by geographic characteristics. In short, they argue that - although variation in world prices may be exogenous for a given country - the impact of external fluctuations on the domestic economy depends not only on countries' overall level of trade but on their export and import structures as well. The work of Romeu and Camanho da Costa Neto (2011), who demonstrate that export concentration negatively affected the resilience of exports during the global financial crisis, is a recent confirmation of this argument.

The findings of Malik and Temple (2008) indicate that remote countries have a more concentrated export structure. The reason why this is the case, is that geographic distance is an important determinant of transport costs. Natural barriers to trade, that emerge for countries that are remote from major trading partners, are landlocked, or have low-quality transport networks, induce high transport costs. If these transport costs are more important for certain sectors than for others, countries may be unable to open up new export sectors.

For instance, the development of manufacturing sectors requires the use of additional input goods. However, intermediate goods may be too costly to import if countries face high transport costs, which, in turn, renders manufacturing production unprofitable at world prices. The existence of high transport costs may thus be an important constraint on the development of the manufacturing sector. Similar reasoning can be applied to the shipment of final goods. Countries that are geographically disadvantaged may, therefore, become locked in the production of a narrow range of export goods which results in a highly concentrated structure of exports.

Why would we expect a country with a more concentrated export structure to exhibit greater volatility? Essentially this is due to the hypothesis that export

concentration determines how external shocks are absorbed. If those sectors that are hurt by an external shock have a relatively larger weight in the economy, the aggregate volatility that we observe will be larger as well. For instance, countries that specialize in a relatively narrow range of goods tend to be more vulnerable to changes in world prices, and thus we would observe a larger volatility in their terms of trade.

Thus, geography is a powerful determinant of export concentration. If we can extract the geographic component of export concentration, we can build an instrument that is plausibly uncorrelated with income, and other determinants of volatility, including institutions and policies. Because we are interested in the impact of geography on volatility through its influence on export concentration, the present study will be limited to variables that determine how external shocks are absorbed by the domestic economy rather than studying domestic volatility.

3.1 Empirical Strategy

In our main empirical specification, we are interested in identifying empirical relationships of the following form:

$$V_i = \theta + \alpha GE_i + \beta T_i + Z_i' \gamma + \epsilon_i, \quad (1)$$

where V_i is the volatility measure of interest for country i , GE_i is a measure of export concentration, T_i is a measure of trade openness, and Z_i is a vector of additional control variables, including among other things, the quality of the institutional environment. As will be explained in detail below, it is always necessary to control for trade openness when we include trade structure (i.e. export concentration) in our regressions.

Our first empirical strategy is to estimate the model in Equation (1) using OLS regression. The problems with this strategy are that export concentration as well as trade openness are endogenous, and we may be capturing reverse causality or the effects of omitted variables. More important, because the volume and structure of trade are correlated, the influence of the variable that is measured with greater error will show up in the effects of the other independent variable. As a result, OLS regressions are unlikely to reveal any causal relationships.

Information about the distance from a country to other countries offers a structural explanation for the export structure of a country. However, this argument relates to bilateral trade relationships; empirically, the information that we are interested in comes from bilateral trade. To measure remoteness - and countries' natural potential to diversify their exports - we thus need an appropriately weighted average of the distance between countries. As in Frankel and Romer (1999), we choose the weights by first estimating bilateral trade concentration ratios including only geographic variables as determinants, where bilateral concentration is defined as a function of distance between trading partners, population, area, as well as dummy variables indicating whether a country

is landlocked or an island state.¹ In this first step, our results point to very strong effects of geographic variables on export concentration, in line with the recent literature described above. We then aggregate the fitted values to obtain a purely geographic component of countries export concentration ratios.

When we try to aggregate bilateral export concentration ratios, we face a severe problem, however. In contrast to the estimation of bilateral trade in Frankel and Romer (1999), bilateral export concentration ratios cannot be easily aggregated across trading partners since common concentration ratios are not additively separable across subgroups. The solution we suggest to this problem below is to use a specific inequality measure that is additively decomposable across subgroups and which can be constructed by using only geographic information.

Having derived a reasonable instrumental variable (henceforth IV) for export concentration, we then proceed to separate its influence on volatility from those of competing explanations including trade, institutions or policies. Therefore, our second empirical strategy is to estimate Equation (1) by means of two-stage least squares using predicted export concentration as an instrumental variable for actual export concentration. This instrument should be correlated with actual export concentration but orthogonal to any other omitted determinant of external volatility. The second strategy thus allows to omit institutions and other influences from the equation. Export concentration is treated as endogenous in Equation (1) and the first-stage regression for the instrumental variables strategy, in which export concentration is regressed on the exogenous variables is:

$$GE_i = \lambda_1 + \sigma_1 \hat{GE}_i + \beta_1 T_i + Z_i' \delta_{1i} + u_{1i}, \quad (2)$$

where \hat{GE}_i is predicted export concentration. The exclusion restriction maintains that $\text{Cov}(\epsilon_i, \hat{GE}_i) = 0$, where ϵ_i is the error term in the second stage Equation (1). Put differently, the exclusion restriction requires that the instrument does not appear in Equation (1). While the exclusion restriction seems reasonable for most competing explanations, there is one notable exception. We are primarily concerned with a possible influence of the instrument on volatility through overall trade but not through its effects through institutions. Countries' geographic characteristics apparently influence both, level and structure of trade. Remote countries may be exposed to a less diversified structure of exports, but also may trade less which reduces their exposure to external shocks. Thus, it is clearly important to control for the overall level of trade in the empirical section.

Since a plausible instrumental variable for trade openness has been proposed by Frankel and Romer (1999), the instrumental variables strategy can be extended to account for endogeneity of both regressors. Thus, our third empirical strategy is to re-estimate Equation (2) again by two-stage least squares but using distinct instruments for each of the explanatory variables and which we exclude from the regression. The instrument for trade openness is the constructed trade share

¹For simplicity, we subsume size of the population under the term geography.

from Frankel and Romer (1999), as described above, and which we re-estimate to make use of the more comprehensive dataset available. The corresponding first stages for the instrumental variables regression are:

$$\begin{aligned} GE_i &= \lambda_2 + \sigma_2 \hat{GE}_i + \rho_2 \hat{T}_i + \phi_2 M_i + Z_i' \delta_{2i} + u_{2i}, \\ T_i &= \lambda_3 + \sigma_3 \hat{GE}_i + \rho_3 \hat{T}_i + \phi_3 M_i + Z_i' \delta_{3i} + u_{3i}, \end{aligned} \quad (3)$$

where \hat{T}_i is predicted trade openness and the exclusion restriction maintains that $\text{Cov}(\epsilon_i, \hat{GE}_i) = \text{Cov}(\epsilon_i, \hat{T}_i) = 0$.

Finally, as there is also an instrument for the estimation of institutional quality readily available, we repeat the same exercise where we also account for the potential endogeneity of institutions. The instrument for institutions is the settler mortality in countries that were colonized by European nations during the period of colonization as suggested by Acemoglu et al. (2001). In principle, we could instrument for all three regressors. However, as will be shown below, and as a result of regressions following Equation (3), the geographic components of trade and those of export concentration measure distinct aspects making such an extended approach unnecessary. Thus, we will simply re-estimate 2 with the instruments for export concentration and institutions excluded. The corresponding first-stage regressions are defined as

$$\begin{aligned} GE_i &= \lambda_2 + \sigma_2 \hat{GE}_i + \rho_2 \hat{T}_i + \phi_2 M_i + Z_i' \delta_{2i} + u_{2i}, \\ I_i &= \lambda_4 + \sigma_4 \hat{GE}_i + \rho_4 \hat{T}_i + \phi_4 M_i + Z_i' \delta_{4i} + u_{4i}, \end{aligned} \quad (4)$$

where M_i denotes the log mortality rate of European settlers, and where we define $\text{Cov}(\epsilon_i, \hat{GE}_i) = \text{Cov}(\epsilon_i, M_i) = 0$,

4 Inequality Decomposition

The approach suggested by Frankel and Romer (1999) first decomposes trade into its bilateral components, derives fitted values of the trade share from a gravity equation and aggregates these over all bilateral trade flows to obtain a geographic component of a country's overall (predicted) trade share. Unfortunately, this procedure is not as straightforward for export concentration, because the most commonly used measures of concentration are not additively decomposable into their components across different sub-populations, i.e. overall concentration cannot be obtained from the sum of concentration measures of all subgroups (see Cowell (2011)).

As it turns out, only concentration measures of the class of generalized entropy measures allow for a perfect additive decomposition of concentration. The most

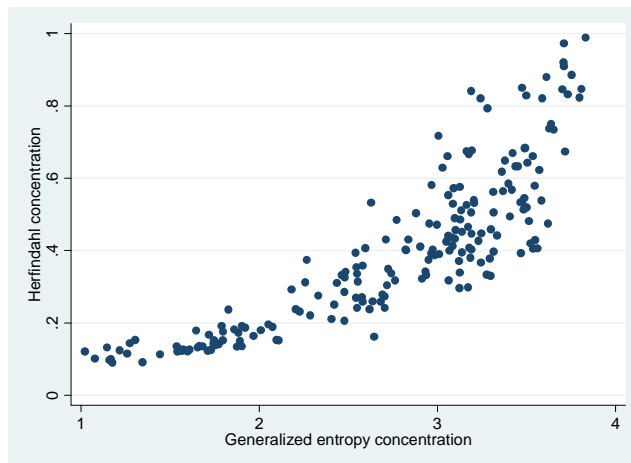
commonly used and easy to handle generalized entropy measures include inequality weighting parameters of 1 or 0 (known as Theil's T and Theil's L). Although additively decomposable, these measures cannot be used here since they are not defined for sectors with zero values. Yet, export concentration needs to be measured across all possible export sectors rather than across all actually observed export sectors for each country. It is essential to include zero-value sectors as otherwise countries with evenly distributed exports across only few sectors, such as it may be the case in developing countries, might be erroneously attributed a low value of concentration (see also Helpman et al. (2008)). Therefore, the use of a more generalized - yet more difficult to handle - entropy measure of the following form is required (see Litchfield, 1999):

$$GE(\alpha) = \frac{1}{\alpha(\alpha - 1)} \left[\frac{1}{n} \sum_{h=1}^n \left(\frac{x_h}{\mu} \right)^\alpha - 1 \right], \quad (5)$$

where n is the number of export sectors, x_h is the export volume of export sector h , μ is the average trade value across all sectors, and α is an inequality weighting parameter that is set to 0.5 for the calculation. This equation highlights that a generalized entropy measure of inequality is a weighted sum of the deviation of each export flow from the mean.

Calculating concentration measures based on (5), we obtain a variable that varies from zero to infinity with zero representing an equal distribution. This measure has almost the same desirable properties as the more commonly used concentration indices. In addition, the bi-variate correlation between common measures of concentration and the generalized entropy (henceforth GE) coefficients is relatively high. Calculated for the example of a Herfindahl concentration measure in Figure 1, the correlation is around 0.9 in the baseline sample.

Figure 1: Measures of Concentration compared



In order to derive predicted export diversification for country i , we first need to build GE concentration measures for each country pair i, j according to:

$$GE_{i,j} = \frac{1}{\alpha(\alpha-1)} \left[\frac{1}{n_{i,j}} \sum_{h=1}^{n_{i,j}} \left(\frac{x_{h,i,j}}{\mu_{i,j}} \right)^\alpha - 1 \right].$$

where $n_{i,j}$ is the total number of export sectors from country i to country j , x is the trade value of an individual sector h , and μ is the mean of bilateral trade values across sectors. As noted above, generalized entropy measures of concentration allow for a decomposition across subgroups. In order to obtain an overall concentration ratio of country i 's export sectors, the bilateral export concentration ratios can be aggregated to a “within” component GE_W , consisting of the concentration within each bilateral trade relationship, and a “between” component GE_B , the concentration between different bilateral trade flows for country i . The GE index is then simply the sum of these two components (see Cowell (2011); Conceição and Ferreira (2000)):

$$GE = GE_W + GE_B.$$

For the calculation of export concentration, the within and between group concentration ratios can be easily obtained from the relative trade and product shares, according to:

$$GE_i = \frac{1}{\alpha(\alpha+1)} \sum_j \left[1 - \left(\frac{X_{i,j}/X_i}{N_{i,j}/N_i} \right)^\alpha \right] + \sum_j \frac{N_{i,j}}{N_i} \left(\frac{X_{i,j}/X_i}{N_{i,j}/N_i} \right)^\alpha GE_{i,j}, \quad (6)$$

where $X_{i,j}$ is the sum of exports in a bilateral trade relationship, X_i are total exports of country i , and N represents the number of export sectors. The first term in (6), the within concentration, gives the contribution of each bilateral export concentration ratio to country i 's overall export concentration. For a weighting parameter of $\alpha = 1$, the weight of each sub-population's within concentration is the sub-population's export share, while for $\alpha = 0$ the weight derives from its population share (i.e. the number of export sectors as a share of total export sectors). As a consequence, only three components have to be estimated by means of gravity equations in order to obtain a purely geographic estimate of export concentration: $X_{i,j}$, $N_{i,j}$, and $GE_{i,j}$.

5 Data and Variables

The main variables used in this study are chosen by following the relevant literature. For export concentration, we use export data from 1980 to 2000 as

in Malik and Temple (2008) which eases comparison and seems a reasonable confinement, given the fact that earlier data is less reliable and trade has increased rapidly over the second half of the 20th century. The data comes from the United Nation's Commodity Trade Statistics Database (Comtrade) which is the most capacious trade database available. In this database, sectors are classified according to the Standard International Trade Classification (SITC). The analysis is restricted to SITC revision 2 at the 4-digit level of disaggregation, resulting in 786 product categories. Given the choice of the sample period, the 4-digit level seems a reasonable compromise between sectoral resolution and data availability across countries.

The focus of this paper lies on external measures of volatility rather than on the more common measure of growth volatility because, as argued above, export concentration determines how external shocks are absorbed and overall patterns of specialization depend largely on the extent of integration in the world economy which seems less intriguing for domestic volatility. The exclusion restriction implied by the instrumental variables regression maintains that, conditional on the controls included, the constructed measure of export concentration has no effect on volatility other than through its effect on export concentration. Although we argued that export structures are likely to be the major channel through which the set of geographic characteristics affect volatility, this argument has more rationale if applied to external volatility.² Thus, as dependent variables we use the following:

1. Terms of trade; as undiversified countries are hit more severely by price shocks
2. Export growth; since diversification dampens exposure to demand shocks
3. Exchange rates; since currency demand fluctuates with actual exports

Volatility of these variables is calculated as the standard deviations of the first log-differences of the terms of trade, of export volume growth, and of an index of real effective exchange rates. The terms of trade index measures the ratio of an export price index to the corresponding import price index relative to the base year 2000. The real effective exchange rate is the nominal effective exchange rate (a measure of the value of a currency against a weighted average of several foreign currencies) divided by a price deflator. All three variables are commonly used in the literature dealing with external volatility. The variables are calculated from the World Development Indicators.

For the first-stage geographic determinants of bilateral export concentration, we follow Frankel and Romer (1999) in defining a gravity specification. Besides distance, as suggested by Malik and Temple (2008), other gravity variables used by Frankel and Romer (1999), should also apply to the case of export concentration. For instance, smaller countries tend to specialize more often in a

²Since Easterly et al. (1993) argue that shocks to terms of trade play a major role in explaining output volatility, this approach could, in principle, be applied to volatility of output growth rates as well.

narrower range of goods due to economies of scale. In the current paper, we regard the direction of influence and whether these variables contain enough information as an entirely empirical matter. Thus, we include information on distance between trading partners, population, area, as well as dummy variables indicating whether a country is landlocked or an island state and whether two countries share a common border. The data for countries' geographic characteristics comes from Frankel and Rose (2002).

In principle, there is a large set of alternative, geography-based variables that can be used to explain export concentration. Malik and Temple, for instance, use a variety of geographic dimensions, including proximity to markets, coastal access, and tropical characteristics. Many of these variables seem to be even more appealing and have often been employed as instrumental variables in the context of trade, institutions, and development. However, for the purpose of deriving an instrument for export concentration, these variables are flawed, as a variety of alternative channels for how these determinants may influence long-run growth rates, and through this channel volatility of growth, have been proposed in the literature. Sokoloff and Engerman (2000) have shown that tropical location, or determinants affecting the structure of production in general, has shaped the institutional development. Also, tropical location is a strong determinant of the prevalence of Malaria, as shown by Sachs (2003). As a consequence, tropical location, and similarly, variables such as distance from the equator should not be used as instrumental variables for either institutional arrangements or for export concentration, as they may influence outcomes through the prevalence of malaria, for instance. In a similar vein, Acemoglu et al. (2005) argue that coastal access has amplified the rise of the bourgeoisie in Europe and, by shifting the balance of power, led to sustained changes in the institutional environment. Thus, many of these variables may influence volatility through institutions rather than through export concentration. For these reasons, we limit the geographic determinants of export concentration to only a few variables that are unproblematic, as will be described in the next section.

In contrast, it is necessary to always include trade openness of countries as a control variable since geographic variables may affect volatility not only through export concentration but through its impact on overall trade as well. It is well known that remoteness reduces trade. For a remote country, the adverse effects of geography on export diversification may be offset by a reduction in the level of trade which, in turn, limits exposure to external shocks. In principle, more trade increases exposure to global shocks if trade leads to increased specialization and proximity increases trade. But more ambiguous forces may be at work. For instance, if increased specialization induces more volatility but the (more volatile) export sectors are less correlated with the rest of the economy, trade may as well reduce volatility (di Giovanni and Levchenko (2009)).

Finally, we also include common measures of institutional quality to directly compare the relative contributions of export concentration and institutions. We consider an encompassing measure of the institutional quality from Kaufmann et al. (1999) which averages six measures relating to voice and accountability, political stability, absence of violence, government effectiveness, regulatory burden, rule of law, and absence of graft. To account for the possible endogeneity

of institutions, we use settler mortality rates as an instrument as suggested by Acemoglu et al. (2001).³

6 The Gravity Equation and Predicted Export Concentration

Frankel and Romer (1999) substantiate their argument that geography exerts a strong influence on trade levels with two interesting examples. The first claims that the fact that New Zealand is far from most other countries reduces its trade with other countries considerably. Figure 2 (a) illustrates this point for the case of bilateral export concentration where the hypothesis claims that remoteness has an adverse influence on the ability to diversify the export structure. It plots New Zealand's bilateral export concentration ratios versus the partial effects of log distance from a gravity equation as described below. It clearly shows that New Zealand's export structure is biased towards a relatively concentrated structure due to its large distance to most of its trading partners. Only those island states that are in close proximity to New Zealand have reasonably diversified imports.

Figure 2: Illustration of the Influence of Geography on Export Concentration



(a) Influence of distance on bilateral export concentration of New Zealand

(b) Influence of trading partner's size on bilateral export concentration in Belgium (controlling for distance)

The second example states that the fact that Belgium is close to many of the world's most populous countries increases its trade. An illustration of their argument means that we have to look at trading partner's population conditional on distance. As shown in Figure 2 (b), there is also something to that argument in the context of export concentration. This means that trade with a larger partner generally helps to have more export sectors, but also a more balanced export structure.

³We also use other measures to account for the institutional quality which capture the constitutional constraints on arbitrary exercise of power by political elites from Henisz (2000) and from the Polity IV dataset. The logic behind the use of constraints indices is that in institutionally weak societies, infighting between groups may lead to larger economic instability (see Acemoglu et al. (2003)). Since we obtained similar results, we limit the presentation to the encompassing institutional measure.

6.1 How does Geography Influence Concentration?

Table 1 presents estimates for different variants of the gravity equation. All bilateral trade flows are averaged over the period 1980 to 2000. As the calculation of concentration ratios is more sensitive to changes in the number of sectors compared with the estimation of absolute trade values, we include only bilateral trade flows with at least 50 sectors available in Column (2). This is also important as the calculation of concentration ratios with only few observations tends to be unreliable. The specification in (2) will also be the benchmark estimation to be used below. As a comparison of Columns (1) and (2) indicates, both estimates yield similar results.

The first two rows of Table 1 confirm that the geographic variables are major determinants of bilateral export concentration, explaining 35 percent of the variation with all export sectors included and still more than 30 percent with the restriction on the minimal number of sectors imposed. The explained variance thus lies within the range obtained by Frankel and Romer (1999) for trade openness. The results are generally as expected and confirm the findings in Malik and Temple (2008). Export concentration increases with distance and a larger population as well as a larger trading partner predicts a country to be more diversified. The remaining variables yield results that are comparable to standard trade gravity regression results.

Table 1: Gravity Equations

Dependent Variable	Bilateral export concentration		Bilateral exports		Bilateral trade flows	
	Number of sectors all	> 50	ln Export value	ln Number of sectors	Frankel/Romer original values	Comtrade values
ln distance	0.213*** (0.007)	0.212*** (0.008)	-0.583*** (0.033)	-0.243*** (0.011)	-0.85*** (0.04)	-1.225*** (0.036)
ln population (country i)	-0.262*** (0.003)	-0.246*** (0.005)	0.663*** (0.020)	0.270*** (0.006)	-0.24*** (0.03)	-0.411*** (0.030)
ln area (country i)	0.100*** (0.003)	0.094*** (0.003)	-0.164*** (0.016)	-0.094*** (0.005)	-0.12*** (0.02)	-0.012 (0.023)
ln population (country j)	-0.042*** (0.004)	-0.025*** (0.005)	0.718*** (0.019)	0.085*** (0.007)	0.61*** (0.03)	1.400*** (0.028)
ln area (country j)	0.010*** (0.003)	-0.005 (0.004)	-0.184*** (0.016)	-0.011** (0.005)	-0.19*** (0.02)	-0.307*** (0.023)
Landlocked dummy	0.107*** (0.011)	0.033** (0.014)	-0.905*** (0.060)	-0.148*** (0.021)	-0.36*** (0.08)	-1.149*** (0.103)
Common border dummy	-0.231*** (0.039)	-0.075** (0.038)	0.426*** (0.156)	0.123*** (0.045)		
Constant	4.800*** (0.068)	4.275*** (0.086)	7.103*** (0.351)	3.120*** (0.120)	-6.38*** (0.42)	-7.725*** (0.469)
R ²	0.358	0.304	0.319	0.226	0.360	0.455
Observations	12'503	6'773	6'773	6'773	3'220	6'284

Levels of statistical significance indicated by: *** p<0.01; ** p<0.05; * p<0.1.

Numbers reported in parentheses are heteroscedasticity-robust standard errors.

The two columns in the center present results for predicted number of export sectors and predicted export values. Both variables are necessary to derive aggregate bilateral concentration ratios for each exporting country such that

the final export concentration measure is a fully exogenous source of variation. The geographic variables used as regressors on these two variables show effects comparable to standard gravity equation estimates with an exception for the exporting country's population sign. This difference stems from the exclusion of import data in the dependent variable (i.e. we only use exports, rather than the sum of exports and imports).

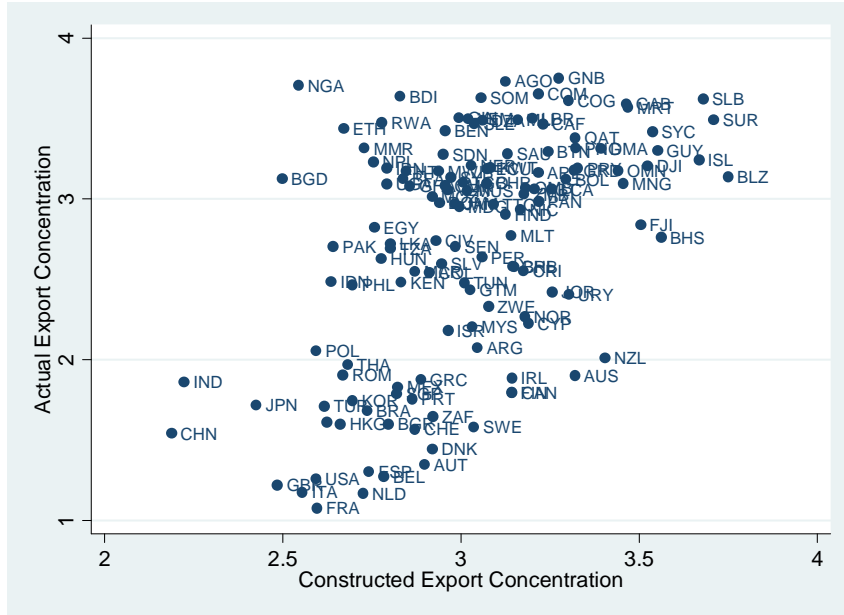
The final two columns report the values from the original Frankel and Romer paper and the values obtained by re-estimating their gravity model with the Comtrade dataset. I re-estimate the FR-predicted trade share as an additional control variable in the instrumental variables regression used below. The variation of bilateral trade flows that can be explained with the Comtrade data is much higher compared with the original dataset, even though a relatively large number of observations have been excluded. Considering the FR gravity model, it is not surprising that particularly the point estimates of the trading partner countries (distance to and size of country j) rise, as the Comtrade data is much richer along the lines of available bilateral data. Interestingly, the correlations for diversification are distinct from the estimates of the predicted trade share. This reassures that the diversification parameter does not simply proxy for the level of trade between countries.

6.2 Predicted Export Concentration

The next step is to aggregate the fitted bilateral export concentration ratios across countries using fitted values for the number of export sectors and export volumes to obtain a purely geographic component of export concentration. Making use of the decomposition Equation (6), we obtain an estimate of the geographic component of a country's export concentration that explains actually observed export concentration fairly well.

Figure 3 shows a scatter plot of the true overall export concentration ratio GE against the constructed concentration ratio $\hat{G}E$ calculated from the Comtrade dataset. The figure shows that geographic variables account for a large share of the variation in actual concentration. The correlation between GE and $\hat{G}E$ is 0.5 and a regression of GE on $\hat{G}E$ and a constant yields a coefficient of 1.2 and a value of the t-statistics of 6.6.

Figure 3: Actual Versus Predicted Export Concentration



7 Results

Table 2 presents OLS estimates of different measures of volatility regressed on export concentration and trade openness. As noted above, accounting for trade openness is always necessary. Using OLS, export concentration is highly significant in all cases, as indicated by columns (1), (3), and (5). These regressions also indicate that - together with trade openness, the specifications explain a relatively large share of external volatility. In fact, export concentration accounts for most of this variation.

As these results do not establish causal relationships, we next turn to instrumental variables regressions. The exclusion restriction implied by the instrumental variables regressions maintains that, conditional on the control variables included, the constructed measure of export concentration has no effect on volatility other than its effect through actually observed export concentration. As argued above, the major concern is that the geographic components influence volatility through the level of trade, rather than through its structure. Therefore, trade openness is always included as a control variable.

Columns (2), (4), and (6) of Table 2 repeat the same estimates using two-stage least squares. Export concentration is treated as endogenous, and predicted export concentration is used as an instrumental variable for actual export concentration. As expected, the lower coefficients on export concentration indicate that reverse causality and omitted variables biases are potentially serious and OLS overstates the true effect of export concentration. The coefficient is also

Table 2: Regressions of Volatility

Dependent Variable	Regressions of Volatility					
	Terms of Trade		Real Effective Exchange Rate		Export Growth	
	OLS (1)	IV (2)	OLS (3)	IV (4)	OLS (5)	IV (6)
Export Concentration	0.068*** (0.008)	0.043*** (0.013)	0.054*** (0.012)	0.006 (0.023)	0.076*** (0.010)	0.054*** (0.019)
Trade Openness	-0.040*** (0.009)	-0.038*** (0.009)	-0.066*** (0.019)	-0.056*** (0.019)	-0.040*** (0.012)	-0.035*** (0.013)
Constant	0.087** (0.039)	0.143*** (0.055)	0.248*** (0.071)	0.326*** (0.098)	0.121** (0.047)	0.161*** (0.058)
R ²	0.404	0.353	0.323	0.139	0.324	0.296
N	110	110	73	73	127	127
Excluded Instrument		Predicted Concentration		Predicted Concentration		Predicted Concentration

Levels of statistical significance indicated by: *** p<0.01; ** p<0.05; * p<0.1
Numbers reported in parentheses are heteroscedasticity-robust standard errors.

less precisely estimated under IV compared with the OLS estimate. Nevertheless, the influence of export concentration remains surprisingly robust for the regressions of terms of trade and export growth, which indicates a causal role of export concentration in determining volatility in these variables. Surprisingly, such a causal influence cannot be found for volatility in the real effective exchange rates, as depicted in Column (4) after we account for the endogeneity of concentration. Using other measures for the exchange rate, including nominal exchange rates, give similar results. Thus, our results are not driven by domestic price movements. An explanation may be that exchange rates are often highly distorted. For instance, in our sample we also included fixed exchange rate regimes. Exchange rates may also be primarily determined by global developments rather than by factors emerging in the countries under examination. Given the relatively strong effects found for the other variables this result is surprising and requires additional explanations which will be addressed in further research.

A major concern with regard to the exclusion restriction is that export concentration may in fact capture the influences that should be attributed to natural resource abundance. Although we extract the geographic component of export concentration that should be unrelated to these influences, we performed several robustness checks where we included various measures of natural resource dependence in our regressions. We included separately the share of fuel, metal, and agricultural exports in total merchandise exports from the World Development Indicators, the share of (gross and net) exports of primary products (SITC categories 0, 1, 2, 3, 4, and 68) in GNP in 1970, following Sachs and Warner (1999), as well as indicators classifying countries according to their main export products (including point-source, agricultural, or tropical). The latter variables are constructed following Leamer et al. (1999) and Isham et al. (2005). Of the total of 26 IV-regressions, our export concentration variable turns out to become insignificant only in three cases (when we include a variable that measures the share of tropical exports for volatility in terms of trade and for volatility in exports, and a variable measuring point-source exports for volatility in terms

of trade). Overall we interpret these findings as confirming the validity of our approach and as an approval of the causal influence of export concentration.

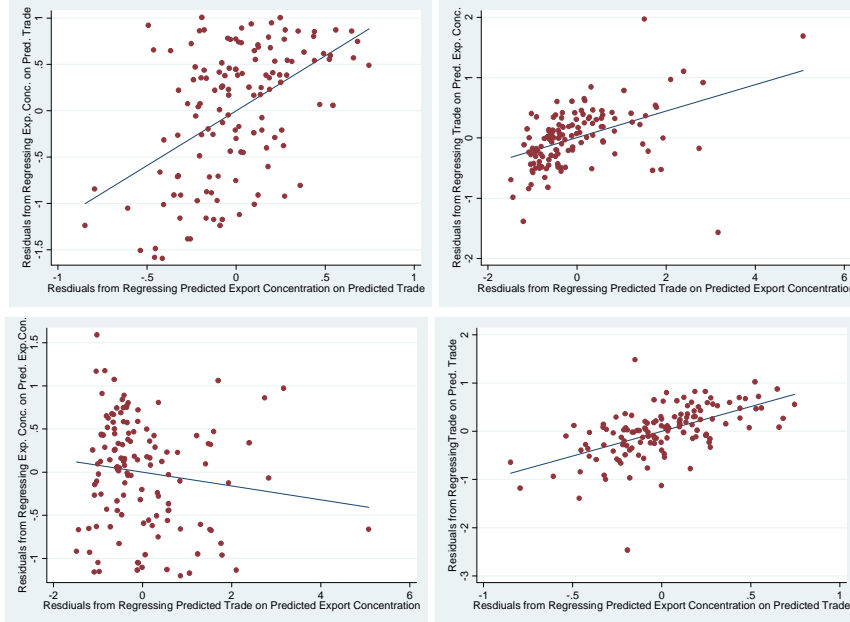
We also tested whether the results may be due to the omission of service exports. However, we also do not find evidence that supports this concern. Finally, we added a control variable to account for the size of the manufacturing sector in total exports (taken from the World Development Indicators) and the shares of labour- and capital- intensive manufactures (Leamer et al. (1999)). In these regressions, export concentration (instrumented using predicted export concentration) becomes insignificant while the variables indicating the importance of the manufacturing sector are significant in all cases. These results hold for both dependent variables, volatility in terms of trade and in exports. While the size of the manufacturing sector is strongly related to export concentration, we believe that the validity of the instrument cannot be rejected by inclusion of the manufacturing sector. A first objection is that the size of the manufacturing sector is highly correlated with levels of income per capita. Thus, our estimates are likely to be biased by the omission of factors determining income levels. Also, the opening up of new manufacturing sectors is also the major channel through which export concentration influences volatility in the argument of Malik and Temple (2008). Thus, diversification may take place primarily through the manufacturing sector. Since we lack an appropriate instrument to account for the endogeneity of the development of manufacturing, we cannot test this hypothesis, however. Given the strong influence, the importance of the manufacturing sector seems a promising avenue for further research.

7.1 Export Concentration versus Trade

As argued above, it is theoretically and methodologically important to account for the potential influence of geography on volatility through trade. As a result, we control for trade openness in the IV estimations. Since Frankel and Romer (1999) have proposed a plausible IV for trade openness, we can use their instrument to evaluate the plausibility of the instrument proposed here by including both endogenous variables in the same regression and instrument for these variables as described above. Unfortunately, as we expect these IV to account for different dimensions of trade, we cannot perform overidentification tests directly.

Consider Figure 4 which gives an illustration for the example of volatility in the terms of trade. The panel on the upper left-hand side in Figure 4 shows the residuals from regressing export concentration on predicted trade versus the residuals from regressing predicted export concentration on predicted trade (i.e. the Frankel and Romer (1999) instrumental variable). This is the partial relationship between export concentration and predicted export concentration purged from the influence of predicted trade. This is simply a visual representation of the corresponding first stage relationship where the slope of the regression line corresponds to the estimated coefficient on predicted concentration in the first stage. The panel shows that after partialling out the influence of predicted trade, there is still a strong relationship between export concentration and predicted export concentration. The panel below presents the partial correlation

Figure 4: Importance of Controlling for Trade



between actual export concentration and predicted trade; as you can see, there is approximately no relationship between these two, indicating that the Frankel Romer variable does not affect volatility through its influence on export concentration. This confirms that the two dimensions of trade do in fact account for separate aspects, giving further confidence in the validity of the instrument.

The above panel of the right-hand side of Figure 4 depicts the partial influence of predicted trade on actual trade in a similar way as before and, below, the partial influence of predicted concentration on trade. These figures show that the proposed instrument of export concentration also influences volatility in terms of trade through its impact on overall trade. This is not too surprising given the many interrelationships between export concentration and trade that have been highlighted in the literature as described above. Taken together, Figure 4 clearly demonstrates that we always need to take care of the influence of geography on volatility through its effects on trade, while the instrument for trade does not influence concentration.

7.2 Export Concentration versus Institutions

A major advantage of having an instrument for export concentration is that it allows to evaluate the independent effects of export concentration on external volatility. As argued above, it is unlikely for the geographic component of export concentration to influence volatility of external variables through institutions, policy, or influences that are correlated with levels of income. Yet,

since Acemoglu et al. (2001) suggested an intriguing IV for the institutional environment, we can evaluate this hypothesis more formally with an additional robustness check where we exclude an additional instrument from the regression as defined in Equation (4) above. We use the expected settler mortality rates of European colonizers as an instrument for the institutional environment as in Acemoglu et al. (2001). The idea behind this instrument is that – depending on the climate the colonizers faced, they set up an institutional environment of either protected property rights or extractive institutions. The authors show that this institutional environment persisted until today in broad terms. Expected mortality rates are a plausibly exogenous source of variation in today’s institutional environment, making the expected settler mortality rates a convincing IV for today’s institutions. In principle, we could also include all three endogenous regressors at the same time. However, as Dollar and Kraay (2003) showed, this poses problems due to the high correlation between the instruments for institutions and trade. Thus, we do not instrument for trade, acknowledging that this imposes a downward bias on our estimates of the remaining variables.

Table 3 again shows the estimation results for volatility in terms of trade. We obtain similar results for the other volatility measures. Our measure of the institutional quality is the aggregate governance indicator from Kaufmann et al. (1999). A major problem with the settler mortality instrument is the small sample size. As a result, the influence of the institutional variable is not overwhelmingly large, as is shown by comparing Columns (1) and (2), which limits the sample to countries with data on settler mortality rates available, resulting in a weaker influence of institutions. In fact, in both columns, the stronger influence comes from export concentration. This leaves our previous results remarkably little changed with the inclusion of institutions.

In Column (3) we exclude both instruments. While the overall explanatory power remains almost constant, both of our endogenously determined explanatory variables become insignificant at conventional levels of statistical significance. In order to shed light on this results, Columns (4) and (5) present the corresponding first-stage relationships of both endogenous variables. For governance, the predicted export concentration variable is irrelevant (Column (5)). However, for export concentration, both instrumental variables jointly have a strong and significant influence. This means that the instrument we use for institutions also appears to have a strong influence on volatility through its effects on export concentration.

We also used alternative institutional measures of constraints on decision makers from Beck et al. (2000), Henisz (2000), and from the POLITY IV database, as well as the risk of expropriation from the International Country Risk Guide. In these regressions, which we conducted for volatility in terms of trade and exports, we obtained very similar results with small differences only. In two estimations, export concentration became significant, yet with predicted concentration also influencing institutions in one case. And in two cases, predicted concentration was found to be not significant in the first-stage regressions. Other than that, the first- and second-stage results remained comparable throughout all regressions.

Table 3: IV Regressions of Volatility

Method	Regressions of Volatility in Terms of Trade				
	OLS (1)	OLS (2)	IV 2SLS (3)	IV First Stage Exp. Conc. (4)	IV First Stage Governance (5)
Export Concentration	0.046*** (0.010)	0.047*** (0.014)	0.042 (0.030)		
Trade Openness	-0.017** (0.008)	-0.011 (0.008)	-0.011 (0.007)	0.008 (0.107)	1.130 (0.928)
Aggregate Governance	-0.005*** (0.001)	-0.004** (0.002)	-0.003 (0.004)		
Predicted Exp. Concentration				0.505** (0.230)	2.540 (2.067)
Settler Mortality				0.323*** (0.044)	-2.394*** (0.458)
Constant	0.057* (0.034)	0.024 (0.036)	0.042 (0.067)	-0.302 (0.964)	-1.394 (6.893)
R ²	0.468	0.384	0.374	0.512	0.431
N	104	58	58	58	58
Excluded Instrument			Predicted Concentration, Settler Mortality	Predicted Concentration, Settler Mortality	Predicted Concentration, Settler Mortality

Levels of statistical significance indicated by: *** p<0.01; ** p<0.05; * p<0.1
Numbers reported in parentheses are heteroscedasticity-robust standard errors.

Do these results render the geographic component of export concentration as an IV invalid? Not necessarily. First, notice that there is no influence of predicted concentration on the institutional variable after partialling out the effect of settler mortality. Thus, the most important criterion confirms the validity of the instrument. Second, theoretically, we would expect the structure of exports to be determined not only by adverse geographic influences, but also being endogenous to the institutional environment. The IV suggested by Acemoglu et al. (2001) is based on a convincing literature on comparative development by economic historians that shows how institutions and the structure of production evolved in close accordance (see, e.g., Sokoloff and Engerman (2000)). Thus, it seems reasonable for the instrument for institutions to also have an impact on volatility through the structure of trade. By using geographic determinants, we extract specific information about only one aspect of export concentration while we do not neglect that institutions do also determine export structures. This simply means that the instrument is not well suited to separate these two effects.

Dollar and Kraay (2003) used a similar approach with regard to the influence of trade and institutions on income levels. Their results indicate that the fitted values of institutions and trade from the first stages are highly correlated because the set of instruments have high explanatory power for both endogenous variables. They conclude that instrumental variables are not very informative in this case. Nevertheless, and in contrast to Dollar and Kraay, our results indicate a strong role for export concentration that is not affected by institutions. Overall, these findings confirm that export concentration has considerable influence

on the volatility of terms of trade across countries. And we cannot reject the hypothesis that this influence is causal.

8 Concluding Remarks

Using a new instrument for export concentration, we confirm findings in recent literature that export concentration has a strong effect on differences in aggregate measures of volatility across countries. Advancing previous research, we suggested a measure of export concentration that is derived entirely from countries' geographic characteristics and, therefore, plausibly orthogonal to other determinants of volatility, such as institutions. We found that the suggested geographic determinants, including distance from trading partners, population, and size are strong determinants of bilateral trade structures and export concentration. Using inequality decomposition methods allowed us to aggregate the estimated bilateral concentration ratios to an overall index of export concentration. This measure allows us to perform instrumental variables estimations to evaluate causal influences of export concentration on volatility.

We found that our constructed measure of export concentration does indeed contain substantial information about actual export concentration and the proposed instrument measures an aspect that is distinct from the influence of overall trade levels on volatility.

Overall, our results point to a very strong influence of both, the level and the structure of trade on macroeconomic volatility. Using the measure of predicted export concentration in two-stage least squares regressions of various measures of volatility confirmed a causal influence of export concentration on volatility in terms of trade and on volatility in export growth rates. However, and in contrast to OLS estimates, we did not find a significant influence on volatility in exchange rates. Also, since export concentration seems to work primarily through opening up additional industries in the manufacturing sector, our results are clouded by the inclusion of indicators related to the size of the manufacturing sector. Preliminary evidence suggests that the inclusion of this variable may give rise to substantial biases. Thus, our approach does not allow us to reject the validity of the instrument. The importance of the manufacturing sector in explaining volatility seems a promising avenue for further research, however.

Finally, trying to separate the distinct influences of export concentration and institutions yields an ambiguous picture, possibly due to collinearity of the instruments. Theoretical reasoning suggests that the findings are consistent with multiple explanations. While the institutional environment partly explains export concentration, our instrument does not affect institutions directly. This leads us to conclude that our findings reveal an independent effect of export concentration on volatility that is determined by geographic disadvantage. Overall, an interpretation of strong interdependence between institutions and export concentration is most reasonable. However, the proposed instrumental variable is not suited to elucidate the separate roles of institutions and export concentration in determining aggregate volatility.

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