The impact of immigration on international trade: a meta-analysis[1]

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Abstract

Since the early 1990s many studies have been conducted on the impact of international migration on international trade, predominantly from the host country perspective. Because most studies have adopted broadly the same specification, namely a log-linear gravity model of export and import flows augmented with the logarithm of the stock of immigrants from specific source countries as an additional explanatory variable, the resulting elasticities are broadly comparable and yield a set of estimates that is well suited to meta-analysis. We therefore compile and analyze in this paper the distribution of immigration elasticities of imports and exports across 48 studies that yielded 300 estimates. The results confirm that immigration boosts trade, but its impact is lower on trade in homogeneous goods. An increase in the number of immigrants by 10 percent increases the volume of trade by about 1-2 percent The migrant elasticity of imports is on average similar to that of exports. The estimates are affected by the choice of some covariates, the nature of the data (cross-section or panel) and the estimation technique. Elasticities vary between countries in ways that cannot be explained by study characteristics; host country differences in immigration policies do apparently matter for the trade impact. The trade-enhancing impact of migration appears to be greater for migration between countries of different levels of development than between developed countries.

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1. Introduction

The rapid growth in the foreign-born population in many high and middle income countries (mainly OECD countries) in recent decades has prompted considerable research on the socio-economic impacts of immigration. Among this research activity there have been a number of econometric studies conducted since the 1990s that suggest that immigration has a statistically significant impact on merchandise trade, starting with Gould (1994). Such a result is theoretically plausible because of both macro and micro considerations.

At the macro level, it can be argued that immigration-induced population growth increases aggregate demand and output, which – in turn – increases the demand for imports. Exports may increase as well if the presence of immigrants in export industries lowers unit production costs. At the micro level, immigrants may be expected to have ongoing links with the home country that can help businesses in the host country to develop networks that can facilitate exporting to, or importing from, the migrant home country. Immigrants also have a good understanding of the institutional and legal arrangements in their home country and, where their native language is different from that of the host country, they can improve communication in trading relationships. Having migrants involved in trade can also enhance the trust in the business relationships between the home and host countries. Moreover, migration could lead to lower unit production costs through enhancing productivity and labor mobility. At the same time, migrants often have a greater preference than the host country population for certain goods (particularly, but not exclusively, food items) and from the home country. Such goods are sometimes referred to as ethnic products.

The trade facilitation effect of migration applies to both imports and exports, while the "home preference" effect applies only to imports. The balance of these effects could therefore boost imports more than exports, if the trade facilitation effect would be "symmetric". However, if migrants play a key role in expanding exports to their home country, while there are import barriers in the form of tariffs in place in the host country, the impact of immigration on host country exports may exceed that on imports. Most studies to date have focused on developed host nations.[2] It is clear that, bilaterally, the increase in trade due to immigration applies to the migrant home country as well, whereas the balance of trade effect would be the opposite of that in the host country.

Estimated magnitudes of effects of international migration on trade vary considerably across several applied studies. Because most studies have adopted broadly the same model specification, namely a log-linear gravity model of export and import flows augmented with the logarithm of the stock of immigrants from specific source countries as an additional explanatory variable, the resulting elasticities are broadly comparable and yield a set of estimates that is well suited to meta-

[2] The study by Bacarezza and Ehrlich (2006) on Bolivia is a rare exception.

analysis. We therefore compile and analyze in this paper the distribution of import and export elasticities of immigration across 48 studies that yielded some 300 estimates.

Most empirical studies focus on merchandise data and few have explicitly considered trade in services, although some studies have been conducted on the impact of immigration on outbound and inbound tourism (e.g. Gheasi et al. 2011, Law et al. 2009). Others have looked at the effect of immigration on Foreign Direct Investment (e.g. Kugler and Rapoport 2007, Javorcik et al. 2010, Gheasi et al. 2010). However, in the present paper the focus is predominantly on merchandise trade. Several authors have considered a distinction between differentiated consumer goods and undifferentiated producer goods (such as raw materials). It is plausible that for more 'complex' commodities migrants can play a more important role in trade facilitation. The meta-analysis in fact confirms that the migrant elasticities of trade are larger for differentiated goods rather than for homogeneous goods.

The next section provides a short narrative review of the salient literature and also motives the use of meta-analysis as an effective means of quantitatively synthesizing this literature. Section 3 describes how the meta-analytic dataset of 300 estimates (also referred to as effect sizes) derived from 48 studies has been put together. Section 4 provides a first exploration of the data by means of descriptive statistics. Meta-regression models are discussed in Section 5. Section 6 sums up.

2. Literature review

There is a relatively large literature that considers the two-way interaction between international trade and international migration (reviewed in e.g. Poot and Strutt 2010, and White 2010). Of the studies that focus on the impact of migration on trade, most suggest that migration increases bilateral trade (examples are Gould 1994, Head and Ries 1998, Parsons 2005, and White 2009a). The trade facilitation literature makes it clear that the costs of international trade are not only determined by factors such as geographical distance and physical infrastructures, but that there are also other fixed costs, for example the cost of obtaining general trade skills, specific knowledge of the foreign markets, foreign language ability, trust etc. The employment of immigrants may reduce such costs. Immigrants have a comparative, if not absolute, advantage in gathering and conveying reliable information about foreign markets in which institutional systems (formal and informal), language and culture differ significantly from the host country. Such markets can be the migrant's home country but also include of course countries that are culturally very similar to the migrant's home country.

While migrants can reduce the cost of international trade by using their knowledge of language, customs, and laws to conduct business with their country of birth or similar countries, they also impact on international trade through the consumption (imports) channel, because immigrants have preferences in favor of the products of their country of birth, and their incomes in the host country give them sufficient purchasing power to afford those goods. However, migration may also create incentives for domestic firms to produce relevant substitutes (see e.g. Dunlevy and Hutchinson 1999, Girma and Yu 2002).

It should be noted that traditional trade theory (like Heckscher-Ohlin) predicts that migration and trade are substitutes but the aforementioned empirical evidence that migration boost trade suggest that there is a complementarity between migration and trade (see Nana and Poot 1996 for a review of this issue). In any case, the growth in both trade and migration in recent decades suggests that the traditional theory of trade probably cannot accurately capture the complete relationship between migration and trade (Lewer and Van den Berg, 2009). In practice, the influence of immigration on trade flows has been primarily estimated through the gravity equation. It is therefore, important to discuss briefly the gravity model in the next sub-section.

2.1 The gravity model

The use of the gravity model in estimating the bilateral flows of trade between the countries has grown considerably since Tinbergen (1962) and Pöyhönen (1963) were the first to use this model to explain international trade patterns. The theory of gravitational forces or the Newtonian law in physics states that the gravitational attraction exerted on an object by a body, declines with the (squared) distance between the objects attracted and is proportional to the masses of the bodies. This gravity model has been long recognized for its consistent empirical success in explaining different types of flows, such as migration, commuting, shopping trips, tourism, and trade. The model assumes that the amount of trade between two countries is increasing in the economic size of the countries (measured by their national income) and decreasing in the cost of transportation between them (measured in geographical distance). This model provides an estimate of the volume of bilateral trade between two countries *j* and *i*. Newton's gravity law applied to trade is:

$$F_{ij} = G\frac{E_i E_j}{D_{ij}^2} \qquad (1)$$

in which F_{ij} is the trade (exports, imports, or gross trade) between countries (or regions) *i* and *j*; E_i is the "economic mass" (e.g. GDP) of *i*; E_j is the economic mass of *j*; D_{ij} is the distance between *i* and *j*; and G is the gravitational constant. According to this equation trade is always positive and balanced and the model is log-linear. As stated above, the elasticity of trade with respect to E_i or E_j is identical and equal to 1, while the elasticity of trade with respect to D_{ij} is -2. There are no economic reasons why these coefficients should in empirical applications take on these values in fact in most applications much smaller coefficients for E_i, E_j and D_{ij} have been estimated.

The gravity model has a very high explanatory power, which makes it an attractive specification to test the marginal influence of additional explanatory variables. The popularity of this model increased since some theoretical justifications have been formulated by e.g. Linnemann (1966), Anderson (1979), Bergstrand (1985), Nijkamp and Reggiani (1992), Deardorff (1998) and Helpman et al. (2008). Moreover, there have been numerous studies since the gravity model of international trade was developed and economists have consistently found that the gravity equation explains a very large proportion of the variation in international trade.

The influence of immigration on international trade has been estimated primarily through a log-linear gravity model of export and import flows augmented with the logarithm of the stock of immigrants from specific source countries as an additional explanatory variable. In addition, after careful reviewing of the literature, in our meta-analysis we focus mainly on studies that are estimating the gravity equation with migration as an explanatory variable. The standard gravity equation specification for testing the impact of migration between country *i* and country *j* is:

$$lnM_{ij} = \alpha_0 + \alpha_1 \ln I_{ij} + \alpha_2 \ln \frac{Y_i Y_j}{Y_w} + \alpha_3 \ln D_{ij} + \sum_{k=4}^{K} \alpha_k \ln Z_{ij}^k + \varepsilon_{ij} \quad (2)$$

$$lnX_{ji} = \beta_0 + \beta_1 \ln I_{ij} + \beta_2 \ln \frac{Y_i Y_j}{Y_w} + \beta_3 \ln D_{ij} + \sum_{k=4}^{K} \beta_k \ln Z_{ij}^k + \delta_{ij} \quad (3)$$

where,

M_{ij} is imports from migrant source country *i* into migrant host country *j*

X_{ij} is exports from migrant host country *j* into migrant source country *i*

I_{ij} is the number of immigrants of country *i* living in country *j* (or their share of population)

D_{ij} is a measure of the distance between countries *i* and *j*

Z_{ij}^k represent *k* other explanatory variables

ε_{ij} and δ_{ij} are stochastic error terms

Recent empirical studies show a variety of amendments of the basic gravity equation, many of which are explicitly considered in the meta-analysis. Such studies have also incorporated other determinants of trade, such as language similarity, colonial ties, access to coastlines, prices or exchange rate, adjacency and trade agreements. Most studies confirm that language, colonial ties, borders and access to coastlines have effects on bilateral trade between countries. Moreover, distance enters the bilateral trade equation in most studies with a negative sign with an elasticity in the vicinity of -2 and is almost always statistically significant, despite the inclusion of a multitude of other dependent variables.

In the present study we are interested in obtaining and understanding the distribution of the estimated $\hat{\alpha}_1$ and $\hat{\beta}_1$. We distinguish between import and export elasticities, because for any given host country the impact of immigrants on exports may differ from that on imports. In the literature, the impact on exports is considered more frequently than the impact on imports. From the 48 studies we used for our meta-analysis, we extracted 284 elasticities for exports and 229 elasticities for imports. Before discussing the insights from the meta-analysis, we will first briefly review this approach to the quantitative synthesis of empirical research results.

2.2 Introduction to meta-analysis

Meta-analysis is an increasingly popular and valuable tool to offer a statistical synthesis of quantitative studies that address largely the same impact question. One objective of meta-analysis is to test the null hypothesis that a pooled combination of different point estimates is equal to zero when findings from the entire area of research are combined (Cipollina and Salvatici, 2010). Alternatively, meta-analysis may provide a stylized average quantity in a popular area of investigation, such as the price elasticity in the demand for gasoline or the rate of convergence of income across regions or countries. Meta-analysis was initially applied in the medical and natural sciences to compare and synthesize quantitative impact results. Nowadays, this method is applied in many different research fields in economics. For example Nijkamp and Vindigni (2000) studied the agriculture sector in several countries; Longhi et al. (2005) studied the impact of immigration on wages; Brander et al. (2007) studied eco-tourism; Cipollina and Salvatici (2010) studied the impact of trade agreements on trade flows; Card et al. (2010) carried out an analysis of evaluations of active labor market policy; and in 2005 the *Journal of Economic Surveys* devoted a whole special issue (Vol. 19, No.3) to this approach.

Meta-analysis can produce interesting summary results when empirical findings reported in original research publications differ in magnitude and sometimes in direction. Clearly, the extraction of uniform results from different studies may be problematic when decision makers are trying to use background research as a basis for decisions without having available actual case-study records specific to their own situation (Holmgren, 2007). This problem is more common in economics, because the set of independent explanatory variables is often different across studies, while the decision maker may wish to assess the joint effect of the full range of variables. The problem can also be observed at different geographical scale levels. For example, the effect of immigration on intra-regional trade may be different compared to its effect on at the international level. Furthermore, in meta-analysis the presence of publication bias is often a source of concern. This can arise when results that are not statistically significant are less likely to be reported in journals and books, and more likely to be discarded by the researcher. Therefore it is important to search for studies published in various kinds of publication outlets (e.g. journals, books, research papers and reports) so that at least some of the unpublished results are retrieved. Another issue is that even within the gravity model context several econometric specification decisions still have to be made and the results may be sensitive to such specification decisions, such as how to deal with zero trade flow.[3]

While the points made above suggest that scientifically sound meta-analysis of a wide range of empirical research findings on a specific issue in economics is challenging, the number of applications has been growing fast and a set of procedures and software has evolved that have become established practice.[4] Before applying such procedures to estimates of the impact of migration on trade, we first describe in the next section the meta-analytic database.

3. Data

In order to acquire a representative set of journal articles, we selected from various economic literature databases all refereed articles that contain an estimation of a gravity model of trade in which immigration has been included as an explanatory variable. While only publications written in English language were selected, we do not expect this to be a source of bias in the present application. Papers were selected also via extensive search by means of Google Scholar; in this way, we obtained also a large number of downloadable relevant working papers that are not (yet) published in academic journals. We also used the technique of snowballing, viz. carefully scanning through the references of the already included studies. It is noteworthy, that there is a high degree of comparability of results between the published and unpublished papers in our database. As will be shown in the next section, although the mean impact of migration on trade is somewhat larger in the unpublished papers than in the refereed journal articles, the distributions are very similar.

Our final sample includes 48 papers (31 published in academic journals, 1 in a book, and 16 working papers or unpublished studies). These yielded up to 600 regressions from which the migrant elasticity of exports and/or imports could be derived, half of these representing equation (2) and

[3] Such as: discarding these observations; adding "1" to the observed volume of trade; treating zero trade as corner solution and use Tobit estimation; using Heckman-type sample section model; estimating the model in non-linear form by means of Poisson Pseudo-Maximum Likelihood.

[4] We use a set of procedures developed in *Stata*, see Sterne (2009).

half representing equation (3). However, some authors focused only on exports while others focused only on imports. Moreover, the studies by Rauch and Trindade (2002) and by Felbermayr et al. (2008), which is an extension of the work by Rauch and Trindade, did not yield estimates that were comparable with those of the other studies, even after converting the reported coefficients into elasticities.[5] Consequently, the final dataset included 233 elasticities for exports and 178 elasticities for imports. Table 1 lists the studies, the countries to which the analysis pertains, the number of pairs of equations (2) and (3) provided by each study, and whether the data refer to national of sub-national levels of trade. Almost all studies utilize data from the post 1980 period. The exception are Gould (1994) who used US data 1970-1986; Bruder (2004) who used German data 1970-1998, and Dunlevy and Hutchinson (1999) who used historical US data between 1870 and 1980.

Table 1 about here

After the selection of studies has been made, the meta-analyst must decide on what attributes of the studies to record and the form in which such attributes should be coded. Many study characteristics are coded as dummy variables, equal to one for each regression that has a particular attribute. Other study characteristics are numerical, such as the dates of the observations of the primary study. The decision which study characteristics to code, and how to code these, is not straightforward and time consuming. The quality of the meta-analysis dataset is therefore enhanced by independent verification of the dataset. For the present dataset, the original dataset was independently verified by two co-authors. [6]

To account for the possibility of differences in findings between those published in refereed journal articles, which are subject to some quality control, and those in online working paper series or available through other outlets such as conference papers, the data set includes a dummy variable equal to 1 for published articles. We recorded the econometric methodology employed to estimate the gravity model. A distinction was made between OLS, the Heckman selection model, the Tobit model, the pseudo Poisson model, IV/3SLS/GMM and other methods (such as FGLS). With

[5] The regression equations estimated by Rauch and Trindade (2002) and Felbermayr et al. (2008) focus on particular migrant groups (predominantly the Chinese), and estimate the impact of the global ethnic network on global bilateral trade. The reported coefficients compare the case of the existing global network with the case of a complete absence of such a network. Most other studies focus on bilateral trade from a host country perspective and provide an elasticity that can be interpreted as the percentage change in trade when the number of immigrants increases by 1 percent from the current mean level.

[6] In case of disagreement, a consensus opinion was reached on the final coding. The process of generating the final meta-analytic dataset is very time consuming, requiring several months of selecting and coding papers. The verification process following construction of the initial database took 150 person hours in the present application.

respect to the specification, it was also noted whether a fixed effects or random effects panel data generating process was assumed, and whether the model was static or allowed for autocorrelation.

The dimensions of the panel data (First year, final year, number of cross sections, observations per cross section, number of host countries or regions, number of home countries) are also taken into account. Dummy variables also coded whether the study estimated both import and export elasticities both estimated, or not; the host country of the migrants; the use of national-level data or sub-national regions; the nature of goods (Consumer / Differentiated goods; Producer / Homogeneous goods; All goods); and finally whether the model was estimated for trade with LDCs only.

While the core specification was very similar across most studies, following equations (2) and (3), some covariates did vary between studies. Dummy variables therefore indicated the presence of the following covariates: distance; geography (adjacency, landlocked, remoteness); cultural similarity, incl. language; trade agreements; migrant skill composition; colonial ties; relative prices or exchange rates; temporary migration or duration of stay. Finally, account was taken of the use of migration as a single independent variable, or whether migration was interacted with other explanatory variables.

One issue that needs addressing is that most studies in our database yielded multiple estimates of the migration impact on trade. The presence of more than one estimate per study can be problematic, because the assumption that multiple observations from the same study are independent is too strong. Furthermore, counting all estimates equally would tend to give too much weight to studies with many estimates (Stanley, 2001). There are different solutions in the literature to address this problem. Jarrell and Stanley (1990) used the dummy variables for each study that provides more than one observation and Disdier and Head (2004) used a panel specification. In our meta-regression estimation, we take account of this in some estimators by using a clustered approach with each study representing one cluster, irrespective of the number of estimates the study generated.

In the empirical literature in economics there is unlikely to be homogeneity of effect sizes. The hypothesis that there is a single "true" effect that underlies every study is unlikely to be correct. Instead there is both observed and unobserved heterogeneity. Observed heterogeneity can be accounted for by running meta-regression models in which study characteristics explain some of the variation in study outcomes. In such meta-regression models, the weighted least squares approach is used, with the weights being equal to the reciprocal of the estimated variances of the individual effect sizes. If no study characteristics matter and there is no unobserved heterogeneity, a weighted least squares regression is run of the elasticities on a constant term only and the resulting weighted average of the elasticities is referred to as the Fixed Effect (FE) estimator.[7] Unobserved heterogeneity cannot be summarized by the FE estimator. In this case, the Random Effects (RE) model is a more appropriate choice, because a random model considers both between and within study variability and assumes that the studies are a random sample from all possible studies (Sutton et al., 2000). When combining the RE model with the use of a set of deterministic observed study characteristics, a regression model results that can be estimated with the Hedges Residual Maximum Likelihood (REML) approach (see Harbord and Higgins, 2000) or other methods. In the next section, we turn to a descriptive analysis of the available evidence, while the following section reports the meta-regression models.

4. Descriptive results

The range of estimates that were obtained from the primary studies suggests a great degree of heterogeneity across studies. Table 2 provides the basic descriptive statistics by country. While the vast majority of export and import elasticities are positive, for some countries some negative elasticities have been obtained. The most negative elasticity of exports is obtained for the US (-0.14). The largest positive elasticity can be found among estimates for Australia and the EU, 0.65 in both cases. For imports, the most negative elasticity is obtained for the US, -0.18, and the largest positive one for Portugal, 0.56. The mean elasticity for the effect of immigration on exports is positive for all countries except in the study that uses US/Canada regional trade data (Helliwell, 1997) with the largest mean elasticity of export of 0.43 for Australia. The mean elasticity of imports is also positive for all countries except Greece and Italy, with the largest in magnitude for Portugal namely, 0.35.

Table 2 about here

The overall mean of estimated elasticity of exports and imports is the same, 0.17. The equality of the average elasticity of imports and exports is a plausible result because, averaged over a large number of migrant sending and receiving countries, the effect of international migration on imports should be identical to the effect on exports, given balanced trade across the world. Figure 1 shows the quantile plot of the migration elasticities of exports and imports. Although the mean is about 0.17 for both exports and imports, the mode is somewhat greater for imports (0.15 versus 0.12). The interquartile range is between 0.06 and 0.28 for exports and between 0.07 and 0.26 for imports.

[7] This is a different concept from the fixed effects estimator in panel regression models.

Figure 1 here

The data suggest that there is a difference in impacts between different types of goods. The mean value of the impact of migration on imports of differentiated goods is higher (0.23) than the mean value for exports (0.19), while for homogenous goods the elasticity with respect to export is higher (0.17) than with respect to imports (0.12).

The means reported in Table 2 do not take into account the statistical significance of the estimated elasticities. As noted in the previous section, weighted averages that incorporate the statistical significance of effect sizes (elasticities in this case) in meta-analysis can be calculated in two ways. The first is the fixed effect (FE) model where it is assumed that there is one true effect size that underlies all the studies and all differences in observed effect sizes (elasticity estimates) are due to sampling errors. The weight assigned to each effect size is then the inverse of its variance (called the within-study variance). The second is the random effects (RE) model where it is assumed that the true effect size varies from study to study in a stochastic way, and the summary effect is the estimate of the mean of the distribution of effect sizes. The weight assigned to each effect size in this case incorporates both the within-study variance and the between-studies variance.

Table 3 shows the FE and RE weighted means effect sizes of the impact of immigration on exports and imports. It is not straightforward to explain the difference between countries. For Australia, which has a significant trade deficit, the FE means show that the impact of immigrants is higher on exports (0.44) rather than on imports (0.15), while for New Zealand, which has also trade deficit, immigrants have a slightly higher impact on imports (FE is 0.09) than on exports (0.06). Multi-country studies focusing on the EU show a slightly greater effect on exports than on imports. Figure 2 shows that where studies estimated both effects jointly (2/3 of all observations), there is a clear positive correlation between the effects on imports and exports. The correlation coefficient is 0.44.

Table 3 about here

Figure 2 about here

We also observe from Table 3 that incorporating the statistical significance of the elasticity estimates generally reduces the means for all the countries, for both exports and imports, when the fixed effect model is used. However, summary effects calculated by the random effects approach are lower in just a few cases. A general result is that random effects estimates are always closer to the unweighted means. This is indeed the case in Table 3. The FE elasticity of exports is positive for all countries except for Helliwell (1997) who combines data from Canadian provinces and US states. The largest FE weighted mean elasticity of exports is found for Australia (0.44). The FE elasticity of imports is also positive for all countries except Greece and Italy, with the largest in magnitude for Portugal, 0.42 (FE) or 0.37 (RE). The overall weighted mean of the estimated elasticities of exports is the same as the one for imports in both the FE and RE calculations, but the weighted mean is lower if the FE model is used (0.10 versus 0.17).

The studies also differ by the estimation method used. Table 4 summarizes the mean elasticity estimates obtained by different estimation methods. For exports, 110 out of 233 estimates (47.2 percent) are obtained by OLS, and 85 out of 233 (36.5 percent) by Tobit. For imports, 84 out of 178 (47.2 percent) of the estimates are obtained by OLS, and 61 out of 178 (34.3 percent) by Tobit. For exports, the ordinary and weighted (FE, RE) estimates obtained by OLS are larger than those obtained with the Tobit method. For imports, the opposite is the case.

Table 4 about here

The primary studies we identified include both published journal articles and unpublished working and conference papers. Of the 233 effect sizes for exports, 165 (70.8 percent) come from journal articles. For imports, 133 out of 178 (74.7 percent) come from journal articles. The mean elasticities by publication type are provided in Table 5. We observe that the means (weighted or unweighted) do not differ that much by publication type, with the FE estimates being the smallest. This is also illustrated by Figure 3. Roughly, all means estimated (unweighted, FE and RE) are between 0.1 and 0.2, irrespective of whether based on published results or unpublished results. This provides informal evidence than publication bias may not be a big issue in this literature. In the next section we shall show that after controlling for observed heterogeneity in a random effects meta-regression model, there is little evidence of publication bias.

Table 5 about here

Figure 3 about here

5. Meta-regression modelsType equation here.

A meta-regression model is estimated to investigate the extent to which the differences in the results between studies can be related to the characteristics of these studies. Let y_i denote the effect size from study *i*, and σ_i the reported standard error of it. If we assume that the true effects vary between studies and denote these by θ_i, a random-effects meta-regression analysis is the regression model

$$y_i = \mathbf{x}_i\boldsymbol{\beta} + u_i + \varepsilon_i, \qquad (4)$$

in which $\theta_i = \mathbf{x}_i\boldsymbol{\beta}$, $u_i \sim N(0, \tau^2)$ and $\varepsilon_i \sim N(0, \sigma_i^2)$. Here τ^2 is the between-study variance, which is estimated from the data, $\mathbf{x}_i$ is the set of study characteristics that are considered to have an impact on the effect sizes, and σ_i^2 represents the within-study variance. The standard approach to estimating equation (4) is to estimate the between-study variance, τ^2, first, and then the coefficients, $\boldsymbol{\beta}$, by weighted least squares by using the weights $1/(\sigma_i^2 + \tau^2)$. The algorithm we use to estimate τ^2 is the restricted maximum likelihood (REML) method, which maximises the residual log likelihood function. (See Harbord and Higgings 2000 for details.)

The study characteristics we include in $\mathbf{x}_i$ are listed in Table 6.[8] We have also included country dummy variables to differentiate between the host countries for which the studies are carried out. We estimate equation (4) separately for effect sizes for imports and for imports. The results are reported in columns (1) and (2) of Table 7.

Table 6 about here

Table 7 about here

[8] Variables referring to the first year, or the last year, of the data are not included in this table. It was noted in the main text that the period to which the data referred was relatively short in most cases. Moreover, regression analysis showed that the estimated effect sizes did not vary systematically with the time period of analysis.

The first set of variables in Table 7 captures the heterogeneity due to variation in estimation method with OLS being the reference category. We see that estimation methods matter, particularly for exports. The tobit elasticities are greater than OLS (but not significantly for imports). The censored Least Absolute Deviation estimator of the tobit model in Herander and Saavedra (2005) and the nonlinear least squares estimator in Gould (1994) also yield larger elasticities. However, employing other estimation methods such as PPML or a Heckman procedure does not seem to make a difference. Interestingly, apart from the two methods used in Herander and Saavedra (2005) and Gould (1994) the estimation method does not seem to matter when it comes to elasticities of imports. The coefficients on all the other methods are not statistically significant.

Almost all of the coefficients on country dummy variables are statistically significant for export elasticities. For import elasticities there are a few more statistically insignificant coefficients but the majority of them still indicate that the effect sizes vary with the host country. The reference category is the study by Lewer and van den Berg (2009) who pool data from 16 OECD countries and a large set of immigrant source countries. We conclude that, even after controlling for other factors, there are inter-country differences in the immigrant elasticities of imports and exports. This is plausible given relatively large differences between countries in immigration and trade policies.

Table 7 suggests that the trade facilitation effect of immigrants is less for homogeneous / producer goods. These are also goods for which there is unlikely to be a home bias effect. The drop in elasticity for homogeneous goods is bigger for imports than for exports.

There is some evidence that the impact of immigrants on trade is greater for trade with developing countries than for trade with other countries. However, the same cannot be said for imports as the coefficient on *ldctrade* is not statistically significant for imports. We also find that panel models that include the lagged volume of trade in their specification find a smaller impact of immigration, particularly for imports. The use of a physical or cultural distance variable in the gravity model of trade increases the immigrant elasticity of exports but not of imports. Likewise, the use of a trade agreements variable reduces the immigrant elasticity of imports but not significantly of exports.

The use of an exchange rate or price ratio variable in the regression equation lowers the migrant elasticity of exports, but increases it of imports. Accounting for migrants' duration of residence lowers the impact of immigration on exports.

As mentioned in Section 3, there are many cases where we have multiple effect sizes from a study which makes the assumption of independence of the effect sizes questionable. In order to relax the assumption of independence within studies we re-estimate equation (4) by treating each study as a cluster. Columns (3) and (4) of Table 7 report the estimation results from this alternative estimation. Comparing the different meta-regression techniques (column (1) of Table 7 with column (3) and column (2) with column (4), we see that the greatest difference between the techniques is in the calculation of the standard errors. The standard errors are generally larger with the REML estimator than with the clustered FE estimator. However, the coefficients are often of a similar magnitude and the two types of model tell qualitatively similar stories.

Figures 4 and 5 show the funnel plots for the original estimates and for the estimates of the mean effect after removing the observed heterogeneity (as predicted by the regressors in the RE meta-regression model). A funnel plot is a scatter plot of the observed elasticities against their standard errors. A large set of observations outside the 95 percent confidence intervals is indicative of a wide range of estimates even when the precision of the estimates is great. This is clearly evidence of unobserved heterogeneity or publication bias (where statistically insignificant effects, which have large standard errors, are not reported). The meta-regression model appears to be better at removing the heterogeneity in the case of imports (Figure 5) than in the case of exports (Figure 4).

Figure 4 about here

Figure 5 about here

6. Conclusions

In this paper we analyzed the distribution of immigration elasticities of imports and exports across 48 studies that yielded 300 estimates. The results confirm that immigration boosts trade, but the impact is less on trade in homogeneous goods. An increase in the number of immigrants by 10 percent increases the volume of trade by about 1-2 percent. The migrant elasticity of imports is on average similar to that of exports. The estimates are affected by the choice of some covariates, the nature of the data (cross-section or panel) and the estimation technique. Elasticities vary between countries in ways that cannot be explained by study characteristics; host country differences in immigration policies may matter for the trade impact. The trade-enhancing impact of migration appears to be greater for migration between countries of different levels of development than between developed countries.

There are several possibilities for further research. First of all, in estimating the regression for migration effects on imports and exports, no account has been taken of the fact that many studies estimate these effects in pairs. It would therefore be useful to develop a Seemingly

Unrelated Regression (SUR) model extension of the random effects meta-regression model. Moreover, while the results informally suggest that publication bias may not be a big issue in this literature, this can be formally tested by applying the Hedges Maximum Likelihood Publication Selection Estimator (MLPSE) such as used by Nijkamp and Poot (2005).

Finally, the literatures on the impact of immigration on FDI and on the impact on tourism are now emerging. When at a future data sufficient primary studies are available, it will be fruitful to consider a meta-analysis of those topics also.

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Table 1: The papers used in the meta-analysis

Study	# pairs of estimated equations[a]	Time period	Country	National/sub-national
Gould (1994)	3	1970-1986	US	National
Helliwell (1997)	2	1990-1990	US/Canada	Sub-national
Head and Ries (1998)	4	1980-1992	Canada	National
Dunlevy and Hutchinson (1999)	6	1870-1910	US	National
Ching and Chen (2000)	1	1980-1995	Canada	Sub-national
Girma and Yu (2002)	9	1981-1993	UK	National
Rauch and Trindade (2002)	12	1980-1980	World	National
Wagner, Head and Ries (2002)	3	1992-1995	Canada	Sub-national
Piperakis, Milner and Wright (2003)	2	1981-1991	Greece	National
Bardhan and Guhatkakurta (2004)	4	1994-1996	US	Sub-national
Bruder (2004)	1	1970-1998	Germany	National
Bryant et al. (2004)	5	1981-2001	New Zealand	National
Co et al. (2004)	6	1993-1993	US	Sub-national
Herander and Saavedra (2005)	8	1993-1996	US	Sub-national
Jansen and Piermartini (2005)	2	2000-2002	US	National
Parsons (2005)	2	1994-2001	EU	National
Bacarreza and Ehrlich (2006)	1	1990-2003	Bolivia	National
Blanes (2006)	18	1995-2003	Spain	National
Dunlevy (2006)	5	1990-1992	US	Sub-national
Hong and Santhapparaj (2006)	6	1998-2004	Malaysia	National
Ghatak and Piperakis (2007)	4	1991-2001	UK	National
White (2007- a)	28	1980-2000	Denmark	National
White (2007- b)	3	1980-2001	US	National
White and Tadesse (2007 – a)	1	1996-2001	Italy	National
White and Tadesse (2007 – b)	15	1989-2000	Australia	National
Bandyopadyay et al. (2008)	2	1990-2000	US	Sub-national
Blanes-Cristóbal (2008)	5	1995-2003	Spain	National
Faustino and Leitao (2008- a)	1	1995-2003	Portugal	National
Faustino and Leitao (2008- b)	1	1995-2003	Portugal	National
Felbermayr et al. (2008)	36	1980-1980	World	National
Ivanov (2008)	4	1996-1998	Germany	National
Partridge and Furtan (2008)	2	2003-2004	Canada	Sub-national
Qian (2008)	8	1980-2005	New Zealand	National
Tadesse and White (2008)	3	2000-2000	US	Sub-national
White and Tadesse (2008)	8	2000-2000	US	Sub-national
Faustino and Peixoto (2009)	1	1995-2006	Portugal	National
Ghatak, Silaghi and Daly (2009)	2	1996-2003	UK	National
Gonçalves and Africano (2009)	6	1995-2007	EU	National
Jansen and Piermartini (2009)	12	1996-2004	US	National
Law et al. (2009)	2	1981-2006	New Zealand	National
Lewer and van den Berg (2009)	2	1991-2000	World	National
Murat and Pistoresi (2009)	1	1990-2005	Italy	National
Peri and Requena (2009)	9	1995-2008	Spain	Sub-national
White (2009a)	3	1993-1993	US	Sub-national
White (2009b)	24	1980-1997	US	National
Coughlin and Wall (2010)	4	1990-2000	US	Sub-national
Hatzigeorgiou (2010)	9	2007-2007	World	National
Tadesse and White (2010)	3	2000-2000	US	Sub-national

[a] In most cases equations (2) and (3) were both estimated. However, some authors only estimated equation (2) or equation (3).

Table 2: Descriptive statistics

	Exports				Imports			
Country	**nr obs**	**mean**	**min**	**max**	**nr obs**	**mean**	**min**	**max**
Australia	15	0.43	0.24	0.65	15	0.21	-0.05	0.44
Bolivia	1	0.08	0.08	0.08	1	0.09	0.09	0.09
Canada	10	0.09	-0.07	0.27	10	0.26	0.08	0.41
Denmark	28	0.16	0.05	0.57	28	0.13	0.04	0.34
EU	8	0.27	0.02	0.65	2	0.14	0.13	0.14
Germany	5	0.13	0.11	0.15	1	0.01	0.01	0.01
Greece	2	0.13	0.05	0.20	2	-0.03	-0.04	-0.04
Italy	2	0.05	0.01	0.08	2	-0.03	-0.09	0.04
Malaysia	5	0.11	0.00	0.33	5	0.15	0.00	0.40
New Zealand	15	0.07	-0.02	0.14	15	0.19	-0.04	0.49
Portugal	3	0.31	0.05	0.60	3	0.35	0.23	0.56
Spain	32	0.22	0.02	0.47	23	0.17	-0.05	0.36
UK	14	0.05	-0.03	0.16	10	0.05	-0.01	0.23
US	90	0.16	-0.14	0.57	50	0.19	-0.18	0.47
US/Canada	2	-0.03	-0.11	0.06	2	0.33	0.32	0.34
World	1	0.37	0.37	0.37	9	0.13	0.05	0.28
Total	**233**	**0.17**	-0.11	0.65	**178**	**0.17**	-0.18	0.56

Table 3: Weighted mean effect sizes by country

	Exports			Imports		
Country	**nr obs**	**FE**	**RE**	**nr obs**	**FE**	**RE**
Australia	15	0.44	0.44	15	0.15	0.20
Bolivia	1	0.08	0.08	1	0.09	0.09
Canada	10	0.06	0.09	10	0.19	0.25
Denmark	28	0.12	0.15	28	0.12	0.13
EU	8	0.15	0.27	2	0.14	0.14
Germany	5	0.13	0.13	1	0.01	0.01
Greece	2	0.09	0.12	2	-0.03	-0.03
Italy	2	0.04	0.04	2	-0.02	-0.03
Malaysia	5	0.02	0.04	5	0.02	0.05
New Zealand	15	0.06	0.07	15	0.09	0.19
Portugal	3	0.13	0.30	3	0.42	0.37
Spain	32	0.17	0.22	23	0.06	0.17
UK	14	0.04	0.05	10	0.05	0.06
US	90	0.09	0.15	50	0.16	0.19
US/Canada	2	-0.03	-0.03	2	0.33	0.33
World	1	0.37	0.37	9	0.11	0.13
Total	**233**	**0.10**	**0.17**	**178**	**0.10**	**0.16**

Table 4: Unweighted and weighted mean elasticities by estimation method

	Exports				Imports			
Method	**Freq.**	**Mean**	**FE**	**RE**	**Freq.**	**Mean**	**FE**	**RE**
Heckman	10	0.10	0.10	0.10	10	0.28	0.23	0.27
IV/3SLS/GMM/FGLS	20	0.35	0.16	0.35	17	0.21	0.16	0.21
OLS	110	0.16	0.12	0.16	84	0.15	0.07	0.14
Pseudo Poisson	1	0.11	0.11	0.11	3	0.07	0.08	0.07
Tobit	85	0.14	0.08	0.14	61	0.17	0.14	0.17
Other	7	0.23	0.21	0.23	3	0.30	0.32	0.32
Total	**233**	**0.10**	**0.10**	**0.17**	**178**	**0.10**	**0.10**	**0.16**

Table 5: Unweighted and weighted mean elasticities by publication type

	Exports				Imports			
Outlet	**Freq.**	**Mean**	**FE**	**RE**	**Freq.**	**Mean**	**FE**	**RE**
Journal	165	0.17	0.09	0.16	133	0.16	0.10	0.16
Unpublished	68	0.18	0.13	0.18	45	0.18	0.09	0.18
Total	**233**	**0.10**	**0.10**	**0.17**	**178**	**0.10**	**0.10**	**0.16**

Table 6: The study characteristics included in meta-regression

heckman	Equals 1 if the estimation method is Heckman, 0 otherwise
iv	Equals 1 if the estimation method is IV/3SLS/GMM/FGLS, 0 otherwise
tobit	Equals 1 if the estimation method is Tobit, 0 otherwise
poisson	Equals 1 if the estimation method is pseudo Poisson, 0 otherwise
other	Equals 1 if some other estimation method is used, 0 otherwise
countrydata	Equals 1 if country-level data are used, 0 if regional or state-level data
diffgoods	Equals 1 if the elasticity is estimated for differentiated goods, 0 otherwise
homgoods	Equals 1 if the elasticity is estimated for homogeneous goods, 0 otherwise
ldctrade	Equals 1 if the elasticity is estimated for trade between ldc coutries only, 0 otherwise
lagdepvar	Equals 1 if the lagged dependent variable is included in the specification, 0 otherwise
migintercat	Equals 1 if the migration variable is interacted with other variables, 0 otherwise
incomepc	Equals 1 if a measure of per capita GDP or income as a standard of living is used in the specification, 0 otherwise
scale	Equals 1 if GDP or population is included in the specification, 0 otherwise
distance	Equals 1 if distance is included in the specification, 0 otherwise
geography	Equals 1 if a variable for adjacency, landlocked, or remoteness is included in the specification, 0 otherwise
cultnlang	Equals 1 if a cultural similarity variable (including common language) is included in the specification, 0 otherwise
colonial	Equals 1 if a variable indicating presence of colonial ties is included in the specification, 0 otherwise
pnxtrade	Equals 1 if exchange rate (or a measure of relative prices) is included in the specification, 0 otherwise
homefe	Equals 1 if fixed effects for migrant home countries are included in the specification, 0 otherwise
migdur	Equals 1 if a variable that measures the duration of migrants' stay is included in the specification, 0 otherwise
tradeagree	Equals 1 if a variable indicating presence of a trade agreement is included in the specification, 0 otherwise
migskills	Equals 1 if migrant skill composition is accounted in the specification, 0 otherwise

Table 7: Meta-regression models

VARIABLES	(1) xb	(2) mb	(3) xb	(4) mb
tobit	0.0813**	0.0668	0.0162	0.0925***
	(0.0344)	(0.0525)	(0.0390)	(0.0289)
iv	-0.0790	0.168	-0.0782**	0.197***
	(0.0632)	(0.108)	(0.0333)	(0.0491)
heckman	-0.0607	0.167	-0.0101	0.225***
	(0.0688)	(0.118)	(0.108)	(0.0531)
other	0.207***	0.451**	0.0769*	0.461***
	(0.0718)	(0.187)	(0.0402)	(0.0801)
poisson	-0.0672	-0.0390	-0.0561***	
	(0.108)	(0.0756)	(0.0154)	
Australia	0.224	-0.608*	0.246***	0.0297
	(0.162)	(0.309)	(0.0616)	(0.117)
Bolivia	-0.429**	-0.497**	-0.337***	0.285***
	(0.213)	(0.243)	(0.0787)	(0.0687)
Canada	-0.450**	-0.327	-0.360***	0.339***
	(0.177)	(0.216)	(0.0590)	(0.0920)
Denmark	-0.361**	-0.261	-0.310***	0.333***
	(0.175)	(0.226)	(0.0699)	(0.0752)
EU	-0.282*	-0.370	-0.325***	0.282***
	(0.160)	(0.246)	(0.0366)	(0.0853)
Germany	-0.297	-0.532***	-0.265***	0.390***
	(0.180)	(0.192)	(0.0981)	(0.108)
Greece	-0.444**	-0.609**	-0.425***	0.144**
	(0.176)	(0.239)	(0.0477)	(0.0631)
Italy	-0.452**	-0.691**	-0.388***	
	(0.175)	(0.269)	(0.126)	
Malaysia	-0.448**	-0.385**	-0.551***	0.344***
	(0.191)	(0.177)	(0.101)	(0.0933)
New Zealand	-0.349**	-0.555*	-0.334***	0.0781
	(0.167)	(0.295)	(0.0993)	(0.0741)
Portugal	-0.193	-0.229	-0.214***	0.328***
	(0.164)	(0.238)	(0.0706)	(0.103)
Spain	-0.371**	-0.180	-0.248***	0.619***
	(0.171)	(0.182)	(0.0514)	(0.0829)
UK	-0.418**	-0.474**	-0.307***	0.299***
	(0.161)	(0.226)	(0.0453)	(0.0607)
US	-0.286*	-0.553*	-0.179***	0.115
	(0.164)	(0.296)	(0.0601)	(0.0889)
US/Canada	-0.486**	-0.280	-0.498***	0.462***
	(0.201)	(0.189)	(0.0940)	(0.0875)
countrydata	0.0544*	-0.104	0.0750**	-0.174***
	(0.0307)	(0.113)	(0.0341)	(0.0488)

Table 7: Meta-regression models – continued

VARIABLES	(1) xb	(2) mb	(3) xb	(4) mb
diffgoods	-0.0306	0.0184	0.000888	0.00712
	(0.0259)	(0.0297)	(0.0255)	(0.0377)
homgoods	-0.0769***	-0.0958***	-0.00927	-0.0631***
	(0.0287)	(0.0301)	(0.0204)	(0.0163)
ldctrade	0.0460*	0.0331	-0.00595	0.00210
	(0.0259)	(0.0314)	(0.0436)	(0.0552)
lagdepvar	-0.0667**	-0.143***	-0.0183	-0.0919**
	(0.0323)	(0.0471)	(0.0202)	(0.0392)
miginteract	0.0289	0.0339	0.0136	0.0492
	(0.0261)	(0.0386)	(0.0133)	(0.0466)
incomepc	-0.114	0.207	-0.0773	0.276***
	(0.0688)	(0.127)	(0.0495)	(0.0589)
scale	0.0689	0.123	-0.0441	0.188**
	(0.0780)	(0.158)	(0.0756)	(0.0727)
distance	0.101**	-0.0192	0.118***	0.0834*
	(0.0439)	(0.0763)	(0.0374)	(0.0415)
geography	-0.0331	-0.0395	-0.0561**	-0.0238**
	(0.0252)	(0.0407)	(0.0265)	(0.0113)
cultnlang	-0.0536*	0.0209	-0.0621	-0.00559
	(0.0297)	(0.0398)	(0.0626)	(0.0216)
tradeagree	-0.0314	-0.0921**	0.000864	-0.0440***
	(0.0285)	(0.0405)	(0.0304)	(0.0137)
migskills	-0.0322	-0.0664	-0.0247	-0.0547
	(0.0473)	(0.0572)	(0.0381)	(0.0430)
colonial	-0.0613	-0.0371	-0.0796*	-0.0890*
	(0.0480)	(0.0587)	(0.0425)	(0.0472)
pnxtrate	-0.138***	0.165*	-0.129**	0.203***
	(0.0459)	(0.0989)	(0.0550)	(0.0537)
homefe	-0.0149	-0.0331	-0.00194	0.0306
	(0.0239)	(0.0347)	(0.0197)	(0.0475)
migdur	-0.133***	0.0466	-0.149**	0.136*
	(0.0503)	(0.120)	(0.0588)	(0.0792)
Constant	0.489***	0.443***	0.456***	-0.479***
	(0.180)	(0.134)	(0.0841)	(0.131)
Observations	233	178	233	163
R-squared #	0.505	0.407	0.610	0.596

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
# adjusted R-squared in columns (1) & (2); ordinary R-squared in columns (3) & (4)

Figure 1: Quantile plots of the migration elasticities of exports and imports

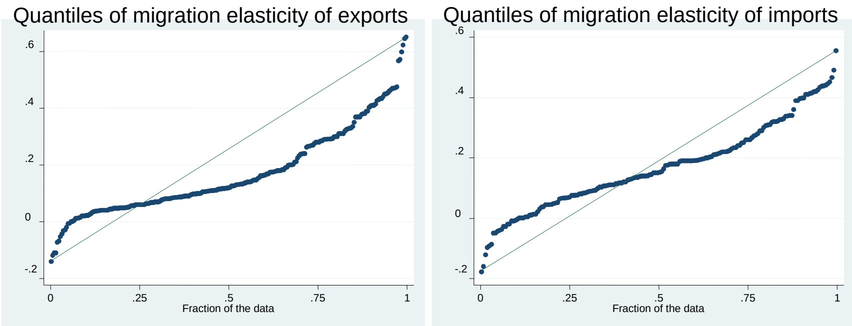


Figure 2: Scatter plot of the migration elasticity of imports and exports when estimated jointly

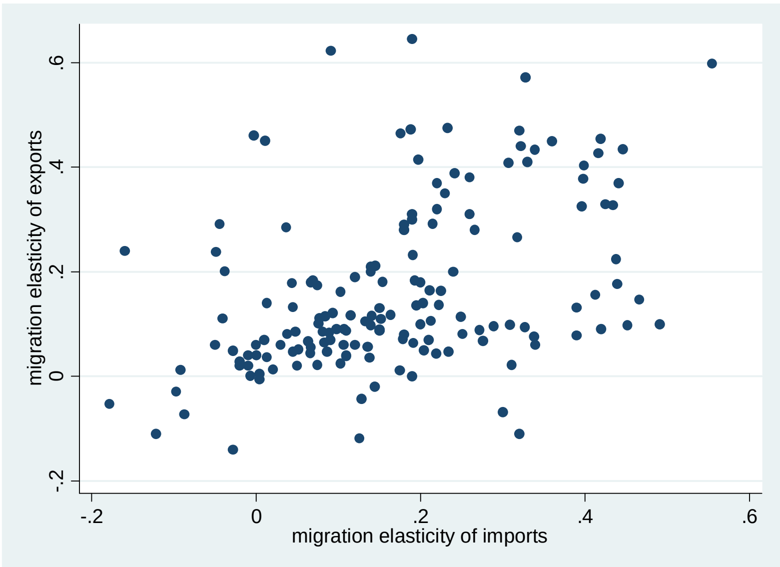
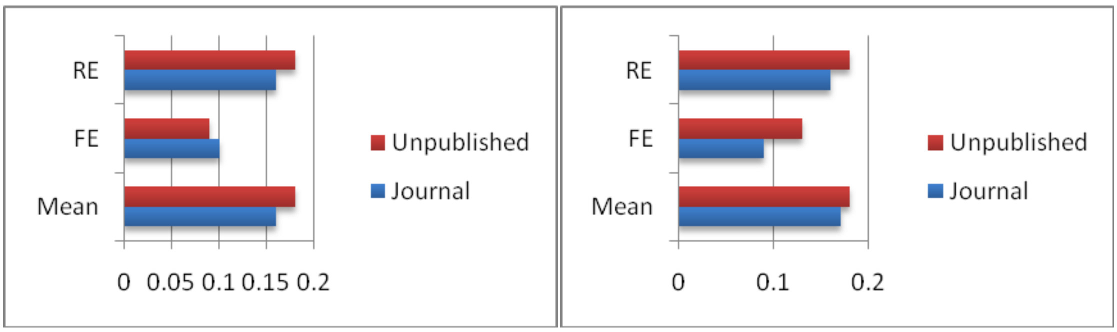


Figure 3: A comparison of estimates from journal articles and unpublished papers



Imports: migration impact from the studies

Export: migration impact from the studies

Figure 4: The impact on publication bias of controlling for heterogeneity in the random effects meta regression model – exports

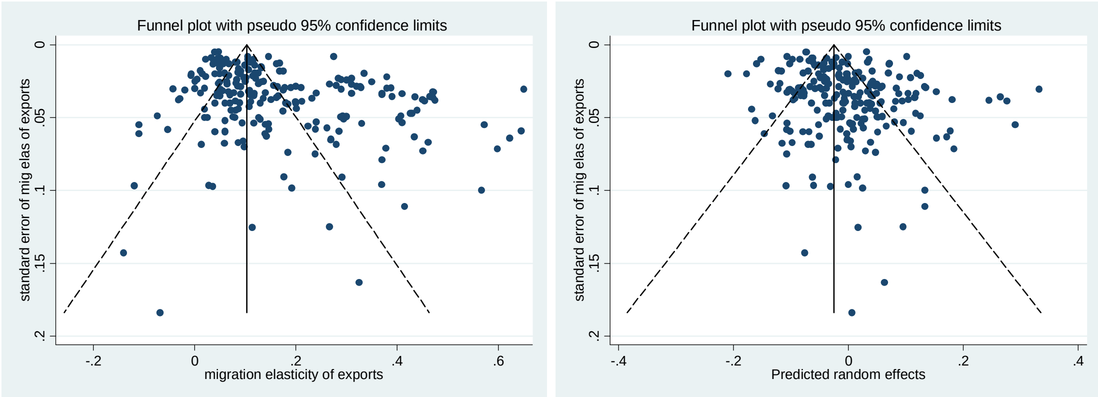


Figure 5: The impact on publication bias of controlling for heterogeneity in the random effects meta regression model - imports