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Abstract

Theoretical and empirical research in economics suggests that bilateral migration triggers bilateral trade through a number of channels. This paper assesses the functional form of the impact of migration on trade flows in a quasi-experimental setting. We provide evidence that the relationship is not log-linear. In particular, at small levels of migration (stocks) the elasticity of trade to migration is quite high, and it declines to zero at about 4,000 immigrants. If migration stocks exceed such a level, the evidence suggests that trade will not increase anymore. This suggests that cross-country network and other effects flowing from migration materialize at relatively low levels of migration, but there appears to be satiation as immigrant numbers increase by much.

JEL-Code: C210, F140, F220.

Keywords: migration, bilateral trade, quasi-randomized experiment, generalized propensity score estimation.

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1. INTRODUCTION

At least since the classic papers of Rybczynski (1955) and Mundell (1957), international economists have been interested in the link between trade and factor mobility. The great majority of this work has been concerned primarily with capital mobility (and FDI in particular), however, a considerable amount of work has also focused specifically on migration. As we shall note in more detail in the next section, theoretical work on the link between migration and trade produces no particularly robust results. Thus, a complement to this theoretical work is a sizable body of essentially ad hoc empirical work. In this paper, we take a distinctive methodological approach to the empirics of trade and migration based on generalized propensity scoring.

While the pure general equilibrium effects that drive the work of Rybczynski and Mundell are the focus of most trade theoretic research, sociologists, demographers and even some economists have begun to emphasize the importance of networks in both trade and migration. These considerations fit naturally in the gravity-based empirical approach commonly used in the study of both trade and migration. We build on this body of work by developing a semiparametric approach to the evaluation of the functional form of the relationship between migration stocks and bilateral imports. Specifically, we view bilateral migration stocks (in logs) as a continuous treatment and bilateral imports as an outcome. We provide strong evidence of a positive link between migration and trade consistent with the significant network effects. However, we also find that these effects are exhausted at fairly low levels of migration.

The next section provides an overview of the literature on trade and migration. This is followed by a discussion of our method, a description of our data, and a presentation of our results.

2. RESEARCH ON TRADE AND MIGRATION[1]

There are two, very broadly construed, accounts of the link between trade and migration: the first sees migration as real factor arbitrage in the context of neoclassical trade theory; the second sees migration as a socially constructed activity in the context of network/human capital theory. The former body of work is primarily theoretical, while the latter is primarily empirical. This paper is most closely related to the empirical literature, so this section will focus on that work. Before discussing the empirical literature on the link between trade and migration, we comment briefly on the trade theoretic literature.

[1]For a more detailed survey of the literature on trade and migration, see Gaston and Nelson (2011); from which this section draws.

Beginning with Mundell (1957), trade economists raised the question of whether trade in goods and trade in factors are complements or substitutes. Mundell proved what was essentially a converse to Samuelson's (1948, 1949) factor-price equalization theorem: that, under the conditions of the the Heckscher-Ohlin-Samuelson model, free movement of factors can substitute for free movement of goods (i.e. once factor-price are equalized, commodity-prices will be equalized). Taken together with the factor-price equalization theorem, Mundell's commodity-price equalization theorem implies that, in an HOS world, trade in goods and trade in factors are substitutes.[2] As we move away from the assumptions that define the HOS model, the nature of the relationship is easily reversed (i.e. trade and factor mobility can easily be complements). The fundamental paper on this topic is Markusen (1983). This wealth of possible relationships opens the door to empirical evaluation.

Most trade theoretic work on the trade-migration link treats international labor mobility as formally identical to international capital mobility. Occasionally a difference between the two is seen in the location of consumption–with foreign investment leading to repatriation of earnings and consumption in the origin country and migration leading to consumption in the host country. If we permit immigrants to have a preference for goods produced in their country of origin, this creates a very direct mechanism linking trade to migration.[3] Not only does this have a direct effect on demand for the immigrant-preferred goods, but we would also expect that demonstration effects would increase the demand for these goods among natives as well. Given that non-immigrants from a given country (i.e., natives and immigrants from other countries) will generally dramatically outnumber immigrants from a given country, we might expect the indirect effect to be larger than the direct effect.

In the last decade or so, empirical work suggesting the presence of large border effects (Helliwell, 1998, McCallum, 1995) and missing trade (Trefler, 1995) has spurred extensive research on the role of trade costs as a source of these findings (Anderson, 2004, Anderson and VanWincoop, 2004) and networks as a response

[2]Wong (1986) shows that "complementarity" in this context is more subtle that we might have initially suspected. His analysis is well-worth reading. Gaston and Nelson (2011) also present Wong's analysis. Since this paper is primarily empirical in nature, we now leave this topic.

[3]Most of the theoretical research on the complements vs. substitutes questions abstracts from taste differences by assuming globally common, homothetic preferences. Once we permit either systematically different preferences or heterogeneity/monopolistic competition, the analysis becomes more complex. In the HOS world, the obvious assumption is that natives have a strong preference for their exportable commodity (thus immigrants carry a stronger preference for the exports of their home country, increasing the host country's demand for imports from the immigrant's home); but this pattern of preferences can yield the Opp et al. (2009) reverse Rybczynski effect. Similarly, once we enter the world of country-specific varieties of goods, we are in a world where results are sensitive to details of market structure (Ethier, 1996).

to these costs (Combes et al., 2003, Rauch, 2001). A standard tool for evaluating the effects of such trade costs is the gravity model. Analysis using gravity models has provided strong support for the notion that social and political differences, and poor enforcement of contractual rights, act as barriers to trade. We are particularly interested here in the evidence of the role of immigrant networks in alleviating these transaction costs. Of particular interest for us is the way that networks affect the relationship between migration and trade. Broadly speaking, networks of migrants might affect international trade by responding to two sources of transaction costs: uncertainty/incomplete information; and asymmetric information/opportunism.

With respect to the former, the idea is that trade in some commodities requires search and that the cost of such search varies systematically across countries. Especially for the case of specialised/differentiated goods, the lack of a deep, well-developed arms-length market can require costly search. When this search must occur across international borders, especially between countries with very different social and/or political structures, those costs can be quite high (Portes and Rey, 2005, Rauch, 1999, Rauch and Casella, 2003). In this situation, migrants can act as weak ties in Granovetter's (1973, 1983, 2005) sense of providing an information bridge between two dense networks (in this case, suppliers in the home market and demanders in the host market). That is, because migrants possess economic, cultural and institutional knowledge about both the home and the host markets, they are able to mediate economic exchange between those markets, thus increasing trade above what it would be in the absence of such migration. In this case, migrants engage in market *creation*. Because such information problems are expected to be more severe for differentiated products, we would expect to find strong positive effects for trade in such products, especially between countries with very different economic, cultural and political environments. Arguably, once such a bridge has been constructed, the need for additional migrants might well be expected to decline.

Unlike transactions costs that emerge through simple lack of knowledge, those related to asymmetric information, imperfect enforcement of contracts and opportunism create a more fundamental role for networks.[4] In an environment characterized by these problems, the opportunity for mutually beneficial trades may be foregone (Anderson and Young, 2006). In the limit, these problems can cause the collapse of markets. This, in turn, creates an opportunity for non-market (or market replacing) institutions, which, of course, is the opening wedge for Williamson's

[4]As Rauch (2001) points out, effective networks need not be immigrant or ethnic networks. Any group of people that share information and are related by bonds of trust, the violation of which are costly to members of the network, can serve at least as well. However, immigrant-ethnic networks have served this purpose historically and, unlike old school tie networks, they are relatively easily identifiable at the aggregate level.

(1975, 1985, 1996) Nobel prize winning development of transaction cost economics. However, independently of transaction cost economics' emphasis on the role of asymmetric information and opportunistic behavior in understanding the creation and operation of firms; anthropologists, sociologists and historians used essentially the same factors in explaining the role of ethnic networks and diasporas in the organization of trade across political jurisdictions or, more generally, in the absence of effective protection of contractual/property rights (Bonacich, 1973, Cohen, 1969, 1971, Curtin, 1984, Geertz, 1963, 1978, Polanyi, 1957, 1968). More recently the analytical structures of transaction cost economics (Landa, 1981, 1994) and game theory (Dixit, 2003a, b, 2004, 2009, Greif, 1989, 1991, 1993, 1997) have provided more formal frameworks for examining these relationship-based trade links. The basic idea here is that ties of trust and social capital more generally, built up among co-ethnics in the migration process can substitute for imperfect contract enforcement (whether a function of incomplete contracts or lack of effective judicial systems). The enforcement mechanism in this case is exclusion from the social and economic benefits of the community/network.[5] As with the case of transaction costs deriving from informational problems, where migrants engage in market creation, we would expect contracting problems to be most severe in the case of goods for which a deep, arms-length market does not exist. However, unlike that case, where we might expect the need for a weak-link to decline once the information bridge has been built; as long as the contracting problem remains in a given market, the need for the contract enforcement role of the network will remain in place. Furthermore, to the extent that the role of the ethnic community declines with successive generations, we might even expect a need for continuing flows of migrants to support that role.

Gravity modeling of trade, with the variables extended to include a migration variable, takes the form

$$I_{ijt} = \alpha M_{ijt} + G_{ijt}\beta + \lambda_{ijt} + \varepsilon_{ijt}, \qquad (1)$$

where I_{ijt} is the value of dyadic trade (exports or imports) between partner country i and reference country j at time t in logs, M_{ijt} is the flow or stock of immigrants in logs from country j in country i at time t, G_{ijt} is a row vector of standard gravity

[5] While economists tend to stress exclusion from economic benefits (e.g., Greif, 1993), one of the reasons that ethnic communities play such an important role here (rather than simply repeated interaction of more-or-less randomly generated networks) is the broader role of social solidarity. This social solidarity is often linked to distinctiveness relative to the native community induced via common language and religion, as well as ghetto-ization and endogamy. Thus, to be excluded from the community implies substantially higher costs than simple exclusion from trading networks. Epstein and Gang (2006) develop an interesting analysis of the tension between the benefits of the social network and those of assimilation in the context of a model of international trade.

variables in logs (e.g., reference and target country GDP, distance and other trade cost variables), λ_{ijt} is a vector of (country or country-pair and/or time) fixed effects and ε_{ijt} is an error term. The parameter of interest in this work is α. Since these models are commonly estimated in logs, this can be interpreted as an estimate of the elasticity of trade volume with respect to immigration.

The seminal paper here is Gould's (1994) study of the effect of immigrants on trade between the United States and 47 trading partners that were also sources of US immigrants, for the years 1970-1986. In addition to estimating a gravity model, extended to include stocks of immigrants from the foreign country residing in the United States, for bilateral aggregate imports and exports; Gould also estimated separate regressions for imports and exports of producer and consumer goods. With respect to aggregate imports and exports, Gould found immigrants increased trade (though at lower levels than much of the later literature); and, somewhat unusually given later results, found a larger effect on exports than on imports. The usual inference from this pattern is that preference effects explain the difference between the import effect and the export effect (since the network effects are apparently taken to be symmetric). Thus, this is taken as evidence against a significant role for preference effects. When the analysis was done on consumer and producer goods separately, Gould found the effect on consumer goods was larger for both imports and exports. Gould's presumption was that consumer goods are more differentiated than producer goods and took this as evidence of network effects. For our purposes, an important element of Gould's analysis is the attempt to identify the level of immigration associated with reduced effect on trade. To do this, Gould estimates a specific functional form for the effect of immigrants on transaction costs which is decreasing at a decreasing rate. While this permits him to estimate the point at which the positive effect of immigrants on trade begins to decline, it is also apparently responsible for the sizable difference between Gould's results and those of other work with otherwise similar specifications. In the event, Gould finds that the effect of immigrants on exports is exhausted at a quite small level ($12,016$ immigrants), while the effect on imports is exhausted at a substantially larger level ($370,879$ immigrants).

Building on Gould's original work, a sizable literature of gravity-based estimates of the effect of migration on trade has developed. The single most studied reference country is the US (Bandyopadhyay et al., 2008, Co et al., 2004, Dunlevy, 2006, Dunlevy and Hutchinson, 1999, Herander and Saavedra, 2005, Hutchinson and Dunlevy, 2001, Jansen and Piermartini, 2009, Millimet and Osang, 2007, Mundra, 2005, Tadesse and White, 2008, 2010, White, 2007b, 2009, White and Tadesse, 2008a, b); but there are also analyses featuring Canada (Ching and Chen, 2000, Head and Ries, 1998, Helliwell, 1997, Jiang, 2007, Partridge and Furtan, 2008, Wagneret al., 2002); the UK (Ghatak et al., 2009, Girma and Yu, 2002); Switzerland (Kandogan, 2009, Tai, 2009); Germany (Bruder, 2004); Denmark (White, 2007a); France (Briant et al., 2009); Spain (Blanes-Cristóbal 2004, 2005, 2008); Greece (Piperakis et al., 2003); Italy (Murat and Pistoresi, 2009); the EU 15 (Parsons, 2005); Australia (White and Tadesse, 2007); New Zealand (Bryant et al., 2004); and Malaysia (Hong and Santhapparaj, 2006). Very broadly, and with very few exceptions, these papers consistently find significant positive effects of immigration on trade - whether measured as imports or exports. Furthermore, of the papers that report results for both imports and exports, it was about twice as common to find the estimated effect of immigration on imports greater than that on exports. Again, this is taken as evidence that preference effects and network effects are both operating.

A number of papers have taken advantage of the existence of trade and migration data collected at sub-national levels: Canadian provinces (Helliwell, 1997, Partridge and Furtan, 2008, Wagner et al., 2002); French *départements* (Briant et al., 2009, Combes et al., 2005); and US states (Bandyopadhyay et al., 2008, Bardhan and Guhathakurta, 2004, Co et al., 2004, Dunlevy, 2006, Millimet and Osang, 2007, Tadesse and White, 2008, 2010, White, 2009). The first benefit of using sub-national data is that it permits the analysis to focus on more specifically defined geographic regions, thus achieving greater precision in estimation. A related benefit is that analysts can control for national level common determinants of trade and migration using country-level fixed effects, but still retaining sub-national level variation for identifying the effect of migrants. A particularly interesting paper in this group is Herander and Saavedra's (2005), which attempts to identify the relative effects of both state- and national-level migrant stocks. Consistent with the motivation for all of these papers, Herander and Saavedra find strong evidence that the local effects are larger than the national effects. This suggests that, whether they are mainly market creating or market replacing, network links are about proximity. Herander and Saavedra also test for whether size of previous immigrant stock reduces the effect of current immigrants on trade flows. Consistent with Gould's result, these authors find that previous immigrant stock does reduce the effect of current immigrants. Given the discussion above (i.e., that market creating networks should experience such a decline, while market substituting links do not), this would appear to be strong evidence in favor of the relatively greater importance of market creation.

To summarize: there is strong and consistent support for immigration having a positive effect on trade; that link appears to be stronger for commodities whose trade is likely to involve informational problems; and, in turn, that link appears to be stronger for trade with countries that are different from the reference country on a number of dimensions; and that link appears to be stronger when the partner country is characterized by institutional problems.[6] This would seem to be strong evidence for the network story. However, since these analyses are never carried out in the context of a structural analysis that permits an evaluation of the relative price effects that drive the general equilibrium analysis standard in the trade theoretic accounts, these results neither permit comparison with the trade theoretic claims, nor do they speak directly (or unambiguously) to the issues of whether trade and migration are substitutes or complements.

The remainder of the paper is structured as follows. The next section introduces the econometric methodology utilized for identification of the causal effect of immigration stocks on bilateral imports and its functional form. Section 3 presents details on the sources and the construction of data on dependent and independent variables. Also, that section summarizes descriptive statistics. Section 4 summarizes the results and interprets the findings in the light of previous research. The last section concludes with a summary of the most important findings.

3. GENERALIZED PROPENSITY SCORES

For estimation of causal effects of bilateral immigration stocks on bilateral imports, we resort to so-called generalized propensity score (GPS) estimation. This method which was introduced by Hirano and Imbens (2004) and Imai and van Dyk (2004) allows us to identify the impact of migration on imports without imposing strong assumptions about the functional form of the relationship. Intuitively, the appealing property of the propensity score approach is to incorporate all information necessary for avoiding potential biases in one scalar. This allows matching on one dimension only instead of controlling for numerous covariates that may enter in different functional forms. The method is particularly suitable when it comes to addressing economic issues that are expected to feature non-monotonic relationships as the GPS can be used to derive a flexible dose-response function. Applications of the generalized - continuous - propensity score deal with labor market programs (see Kluve et al. 2007), regional transfer schemes (see Becker et al. 2010), and FDI (see Du and Girma, 2009).

Let us use index $i = 1, \dots, N$ to refer to a sample of country-pairs[7] and denote the *unit-level dose-response function* of log imports $I_i(\mu)$ as a function of (log

[6]Corruption and low institutional quality would, presumably, also be a problem for the reference country. There is essentially no evidence of this side of the link given that virtually all of the reference countries are characterized by globally quite high institutional quality.

[7]Immigration stocks for pair i represent the number of immigrants residence in country m with origin x. We will consider their impact on imports of m from x. The indexation distinguishes between pair a pair involving, say, Canada as the source country and the United States as the residence country from a pair with Canada as the residence country and the United States as the source country.

immigration) treatments by $\mu \in \mathscr{M}$. Empirically $\mathscr{M}$ is an open interval with full support in real space. We are interested in estimating the average dose-response function across all country-pairs i, $\mathscr{D}(\mu) = E[I_i(\mu)]$. Estimation uses information on three sets of data: observable variables determining log immigration (or treatment intensity) X_i, log immigration which we refer to as treatment M_i, and the outcome in terms of bilateral imports corresponding to the level of treatment received, $I_i = I_i(M_i)$. For the sake of simplicity of notation, we may drop index i in what follows and assume that $I(\mu)_{\mu \in \mathscr{M}}, M, X$ are defined on a common probability space, that μ is continuously distributed with respect to a Lebesgue measure on $\mathscr{M}$, and that $I = I(M)$ is a well defined random variable.

In this setting, the definition of unconfoundedness for binary treatments generalizes to *weak unconfoundedness* for continuous treatments

$$I(\mu) \quad \perp \quad M|X \quad \text{for all} \quad \mu \in \mathscr{M}. \tag{2}$$

Country-pairs differ in their characteristics representing columns of X so that they are more or less likely to host a certain number of immigrants. By Assumption (2), conditional on X, any remaining difference in the number of immigrants M across country pairs is independent of the potential imports $I(\mu)$. Assumption (2) establishes weak unconfoundedness because it does not require joint independence of all potential levels of import outcomes, $I(\mu)_{\mu \in \mathscr{M}}, M, X$. Instead, it requires conditional independence to hold per treatment (immigration) level.

Following Hirano and Imbens (2004), the generalized propensity score may be defined as

$$R = r(\mu, X), \tag{3}$$

where $r(\mu, X)$ is the conditional density of the treatment given the covariates. R is a valid compact measure of similarity or dissimilarity across country-pairs if it fulfills a *balancing property* in the following sense: within strata with the same value of $r(\mu, X)$, the probability that $M = \mu$ does not depend on the value of X. In other words, when looking at two country pairs with the same probability (conditional on observable characteristics X) of hosting a certain number of immigrants, their treatment level is independent of X. That is, the generalized propensity score summarizes all information in the multi-dimensional vector X so that

$$X \quad \perp \quad 1\{M = \mu\}|r(\mu, X).$$

Combining this mechanical property of the GPS with the assumption of unconfoundedness, the balancing property implies that assignment to treatment is *weakly unconfounded given the GPS* (see Hirano and Imbens, 2004). Then, we can evaluate the GPS at a given treatment level by considering the conditional density of the respective treatment level μ. Hence, each and every number of immigrants in a pair i translates into a unique propensity score.

We reduce (if not eliminate) the biases associated with differences in the observables X in two steps (see Hirano and Imbens, 2004). First, we estimate the conditional expectation of I as a function of two scalar variables, the number of bilateral immigrants M and GPS R, $\beta(\mu, r) = E[I|M = \mu, R = r]$. Second, we estimate the dose-response function at a particular level of immigration stock by averaging $\beta(\mu, r)$ over the GPS at that particular level of immigration, $\mathscr{D}(\mu) = E[\beta(\mu, r(\mu, X))]$.[8] Finally, we estimate the treatment effect function $\mathscr{T}(\mu)$, which is the first derivative of $\mathscr{D}(\mu)$ with respect to the argument.

4. DATA AND DESCRIPTIVE STATISTICS

We employ three sets of variables in this paper. First, bilateral imports of a country from a partner country (measured in the year 2007) as the outcome of interest.[9] The bilateral import data stems from the IMF's Direction of Trade Statistics. Second, we use the largest existing data-set on bilateral stocks of immigrants collected and published by Parsons et al. (2007). Third, we use a large number of determinants of bilateral migration (and trade) as elements of X.

Specifically, we employ the following observables in X. First of all, we use a third-order polynomial function for log GDP, log population, and log GDP per capita. Each of these variables enter as exporter (country of origin) and importer (country of residence) term. This models in a fairly flexible way the role of economic market size, per-capita income, and population. Second, we control for the residence and country of origin's unemployment rate and GINI coefficients (in a log-linear fashion) as measures of unemployment risk and inequality. We resort to the World Bank's WDI database for data on GDP, population, unemployment rate as well as GINI coefficients. Third, we employ geographical variables such as log bilateral distance, and a number of indicator variables such as for location of the countries of origin and residence at the same continent, a common border between them, a common language between them, and whether the country of origin is a member of OECD or not. Fourth, we include dummy variables for whether two countries have ratified a goods trade agreement (GTA) or a services trade agreement (STA) with each other. Finally, we employ three variables indicating the political situation between two

[8]Notice that we do not average over the GPS $R = r(\mu, X)$ but over the score evaluated at the immigration level of interest, $r(\mu, X)$. Hence, we fix μ and average over X_i and $r(\mu, X_i)$ $\forall i$.

[9]We have experimented with using other years or averages of years around 2005. There seems to be little role to play for the timing of measurement of the data. However, we chose imports to be measured subsequent to immigration stocks to eliminate at least correlation of trade and migration through time-specific shocks.

countries in a pair: the absolute difference in the PolityIV index between the country of origin and the country of residence as a measure of differing degrees of political freedom between the two economies (Δ Polity4 score); one pertaining to differences in regime durability (how long governments are in office on average) between the two countries (Δ Regime durability); and one measuring the number of years that elapsed since the last armed conflict between the two countries. The data on political regimes we use stems from the Polity IV Project of the Center for Systemic Peace while the information on armed conflicts stems from the Armed Conflict Database provided by the International Institute For Strategic Studies. Altogether, we cover 130 countries of origin and 27 countries of residence in our analysis (see the Appendix for a list). Table 1 provides the mean, minimum, maximum, and standard deviation for all variables we use in our study.

— Table 1 here —

5. RESULTS

We will present the results from our empirical analysis in two subsections. The first one will summarize estimation of the GPS and shed light on the balancing property before and after conditioning on similar levels of the GPS. After that, we will estimate and discuss the dose-response function suggesting how log immigrant stocks are related to log import flows and the derivative of that function, which is referred to as the treatment effect function in the literature.

a. Estimating GPS and the Balancing Property

To construct the GPS we have to assume a certain distribution function for the treatment, i.e. the bilateral migration stocks. The log transformed migration stocks turn out to be approximately normally distributed with skewness -0.11 and kurtosis 2.62 such that we base our GPS scores on a normal distribution. Hence, the GPS is calculated as

$$\hat{R}_i = \frac{1}{\sqrt{2\pi\hat{\sigma}^2}} exp\left(-\frac{1}{2\hat{\sigma}^2}(M_i - \hat{\beta}_0 - X_i\hat{\beta}_1)^2\right). \quad (4)$$

where we estimate $\hat{\beta}$ by ordinary least squares. Table 2 provides the result for an OLS resgression using the covariates described above. It turns out that we can explain different treatment intensities fairly well, which is important for constructing a powerful GPS. Yet, the individual effects of the covariates reported in Table 2 are only of minor importance for our analysis.

For proving that our GPS performs well in absorbing the information crucial for assignment of different treatment intensities it is instructive to organize the data in groups and blocs. In particular, such a structure allows us to test the so-called balancing property. The latter is required for the GPS to be a suitable measure of comparability among observations. Once the balancing property is met, conditioning on the GPS (i.e., considering observations with a similar GPS), eliminates the differences in the covariates across units of observation. Then, the (immigration-imports) dose-response function can be estimated consistently.

Groups are determined on the basis of the variation in continuous (log) bilateral immigration stocks, while blocs are based on the estimated GPS. To which extent comparability of country pairs with a specific immigration level and control pairs is achieved becomes evident from balancing property tests on unconditional versus conditional comparisons of country pairs across log immigration groups of the data. The latter compares country pairs across different log immigration groups only for units within a specific bloc of predicted bilateral log immigration whereas the former disregards the information incorporated in the GPS scores. Ideally, the significant differences in covariates across treatment groups that indicate a critical selection bias vanish completely after controlling for the GPS.

— Tables 3 here —

Table 3 summarize t-tests about mean comparisons for all covariates used to determine the level of (log) immigration between pairs with a particular observable level of immigration. The treatment groups are created according to the distribution of log immigrants and comply with almost identical group size where Group 1 and Group 2 feature the lowest and highest immigration levels, respectively. Note that we disregard country pairs with zero immigration which diminishes our sample by 11 observations. We compare each group's covariates with the covariates of all other groups and report the test statistics from two-sided t-tests. The relevance of a selections into treatment intensities, i.e. different immigration levels becomes obvious from the t-values which with only few exception indicate significant differences across groups.

In order to ensure a sample that consists of country pairs with sufficiently similar characteristics for achieving suitable matches, we establish a common support condition. This means that we keep only comparable units with a common probability support in GPS-space. In doing so we calculate the probability to receive the median immigration level of group M_M^j for each country pair i and for all groups $j \in \{1, 2, 3\}$, $\hat{R}_i(M_M^j, X_i)$ using equation 4 and the estimated coefficients from Table 2. We plot these GPS values for country pairs in group j against country pairs not in group j. Now, we keep only control country pairs in other groups than j if they share a common GPS support with treated pairs in group j. Since this is done for each of the three groups, we ensure that each country pair within a certain group lies within the range of observable characteristics of each other group. This procedure is illustrated in Figure 1 where the grey bars represent the GPS scores of country pairs within the respective group and the black bars represent the control group's GPS scores. All observations in black that lie outside the range of grey bars are dropped. Thereby we exclude 651 country pairs but ensure comparability of the ones left in the sample.

— Table 4 and Figure 1 here —

Before we test whether conditioning on the GPS indeed improves the balancing of covariates, we impose a bloc structure on the estimated GPS value. That is, we condition on the ex-ante probability of receiving a certain immigration level. We assign each observation to one out of six blocs *within* each group based on the estimated GPS. We define these six blocs for each group on the basis of the distribution of GPS scores evaluated at the median immigration level of the respective group. The blocs are generated such that they consist of approximately the same number of group members and Bloc 1 always contains the country pairs with lowest probability of receiving the median treatment intensity of the respective group. By design, the sum of observations over blocs in a group yields the total number of observations in that group after enforcing the common support condition. Once we have determined the blocs, not only the group members but also the control units – not belonging to the same group – are assigned to a bloc on the basis of their individual probability of receiving the median treatment intensity of the respective group. Using this structure we perform t-tests for treatment and control units belonging to the same bloc. We experimented with different numbers of groups and blocs, and it turns out that distinguishing three groups and six blocs is capable of avoiding a violation of the balancing property in terms of mean comparisons of the covariates underlying the GPS within each of the groups. Table 4 illustrates the cell size (i.e., the number of country-pairs) across the three groups and six blocs for treated country pairs with a certain level of log immigration and control pairs with different levels thereof.

Table 5 summarizes t-tests about mean comparisons for all covariates accounting for the estimated GPS evaluated at the respective group's median treatment intensity relying again on equation 4 and the estimated coefficients from Table 2. Accordingly, we run separate t-tests for each bloc and group in the matrix presented in Table 4. For instance, we compare the observations in cell Group 1/Bloc 1 to observations in cell Control 1/Bloc 1 and test for equality of covariates in terms of their means.[10] Table 5 displays the mean t-statistics for each group and all covari-

[10] One could even test for equality of higher moments. However, with the number of observations at hand, these tests would have very small power.

ates, where the t-statistics are weighted by the number of observations in order to calculate the mean t-statistic.

— Table 5 here —

Comparing the results in Tables 3 and 5 we can assess the quality of the GPS as follows. First, highlighting mean comparisons which exhibit a t-statistics which are significantly different from zero when using two-tailed test statistics and a nominal test size of 10% suggests that the covariates are largely different unconditional on (i.e., before imposing) the bloc structure in Table 5. Both the average and the median t-statistic in that table are way higher than 2.58 which is the critical value for a significance level of one percent or less with as many country-pairs as underlying the t-tests in Table 3 (the the figure at the bottom of the table). Conditioning on the structure of six blocs and ensuring common support improves the balancing dramatically, according to Table 5. When using only comparable units with a common probability support in GPS-space we are left with $1,340$ country pairs. Regarding the balancing property, the median and average t-statistic drop from 6.05 and 7.43 in Table 3 to 0.70 and 0.75 in Table 5, respectively. There is only one covariate, namely continuity (a binary indicator variable) in Group 3, for which balancing is rejected. Even that problem could be avoided by using a larger number of groups or blocs. However, we have decided against that for presentation, since there is no effect on the estimates of the dose-response function $\mathscr{D}$ and its derivative, the treatment effect function $\mathscr{T}$.

b. Estimating the Dose-response and Treatment Effect Functions

The dose-response function can be estimated by regressing log bilateral imports and log immigration stocks conditional on the GPS as a control function. This can be done quite flexibly by employing a polynomial parametrization of the nexus between (log) immigration and (log) imports, a polynomial about the GPS, and interactive terms between the GPS and (log) immigration. We experimented with various polynomials of log immigration and the GPS as well as with their interactions. We chose to disregard polynomial terms that turned out to remain insignificant and chose a third-order polynomial of log immigration stocks, a linear GPS term and a linear interaction between log immigration and GPS as the preferred specification. Also, using even higher-ordered polynomial functions does not add relevant information to the process.[11] The corresponding results for the parsimonious, semi-parametric dose-response function are summarized in Table 6. The dose-response function is

[11]The inclusion of additional polynomials does not qualitatively affect the run of the dose-response curve.

estimated from $1,322$ country pairs,[12] and it is estimated at an R^2 of 0.257 which is quite remarkable given the parsimonious specification.

— Table 6 and Figure 2 here —

A better way of assessing the dose-response function than by way of Table 6 is by graphical representation of the point estimates together with a confidence interval. For the latter, we pick the 90% level and split the function into two separate graphs. Due to the wide range of immigration levels splitting up the dose-response function into two graphs facilitates the understanding of the relationship. In Figure 2, we do so in panel A, considering the nexus between log migration and log exports for all country pairs below the observed median immigration level on the left-hand side and for the sub-set of pairs with a log immigration stock beyond the median on the right-hand side. This is useful, since most of the nonlinear action between log bilateral immigration stocks and log bilateral imports happens at lower levels of immigration. Quite clearly, there is a positive impact of (log) immigration on (log) imports at the country-pair level. However, only if immigration stocks exceed a level of about 100 persons does a marginal increase in immigrants trigger significantly more bilateral imports than before. This can be seen from the treatment effect functions in the two graphs in panel B of Figure 2, which are the derivatives of the dose-response functions in panel A.

Interestingly, the treatment effect function is only positive – i.e., the dose-response function is only significantly positively sloped – for levels of immigration stocks between about 100 and about $4,000$ persons. If log immigration stocks exceed the latter upper bound, immigrants do not trigger additional imports anymore.

In the Appendix, we provide figures pertaining not only to *immigration* as a driver of imports but to *emigration and immigration* as to exert network effects on trade. However, it turns out that neither the qualitative nor the quantitative conclusions drawn above change in a substantial way.

6. CONCLUSIONS

This paper has assessed the functional form of the relationship between bilateral migration stocks and bilateral imports by using semiparametric methods for causal inference in quasi-experimental settings with continuous treatments. We do this by viewing bilateral migration stocks (in logs) as a continuous treatment and bilateral imports as an outcome. The functional form of the impact of migration on imports was identified under the assumption of weak unconfoundedness, meaning that the

[12]Even though $1,340$ country pairs fulfill the common support condition, we loose another 18 observations due to zero trade flows.

systematic information in bilateral migration can be conditioned out by controlling for observable determinants of bilateral migration, achieving quasi-randomization. We provide an informal theoretical background in terms of two hypotheses. First, bilateral migration may generate information about source and host countries and, hence, create markets for goods beyond levels implied by other fundamental variables determining goods trade. Second, bilateral migration may provide for contract enforcement if moral hazard due, for example, to weak institutions impedes cross-border goods transactions. The latter does not imply that the trade-stimulating effect of migration declines with the number of migrants. Using cross-sectional data on migrants into and out of 27 OECD countries in 130 OECD and non-OECD economies for the year 2000, we found that imports react to migration in accordance with the market creation hypothesis: a larger number of migrants stimulates additional imports with at least about 100 migrants, but the effect declines with the number of migrants. If the number of migrants exceeds about 4,000, there is no evidence of a proportional increase of imports with migration. These findings suggested that the critical mass of migrants needed to stimulate imports and the maximum amount of migrants beyond which no further imports are stimulated are much smaller than suggested in previous research which imposed much stronger functional forms than we did and for the most part looked at individual countries..

7. APPENDIX

a. Country Sample Composition

In all of the paper except Figure 3 we consider immigration into OECD countries and its impact on imports of 27 OECD countries from 130 economies. In Figure 3, we have allow emigrants beyond immigrants to have a network effect on those imports. However, then the 27 OECD countries are not only residence but also source countries and so are the 130 economies. However, we generally focus on an impact of migration on imports of the OECD economies.

27 OECD residence countries: Australia; Austria; Belgium; Canada; Czech Republic; Denmark; Finland; Greece; Hungary; Ireland; Italy; Japan; Korea, Rep.; Mexico; Netherlands; New Zealand; Norway; Poland; Portugal; Slovak Republic; Spain; Sweden; Turkey; United States; Spain; Switzerland; United Kingdom.

130 OECD and non-OECD source countries: Angola; Albania; United Arab Emirates; Argentina; Armenia; Australia; Austria; Azerbaijan; Burundi; Belgium; Benin; Burkina Faso; Bangladesh; Bulgaria; Bahrain; Bosnia and Herzegovina; Belarus; Bolivia; Brazil; Central African Republic; Canada; Switzerland; Chile; China; Cote d'Ivoire; Cameroon; Congo, Rep.; Colombia; Comoros; Costa Rica; Cuba; Czech Republic; Denmark; Dominican Republic; Algeria; Ecuador; Egypt, Arab Rep.; Spain; Estonia; Finland; France; Gabon; United Kingdom; Georgia; Ghana;

Guinea; Gambia, The; Greece; Guatemala; Honduras; Croatia; Haiti; Hungary; Indonesia; India; Ireland; Iran, Islamic Rep.; Iraq; Israel; Italy; Jamaica; Jordan; Japan; Kazakhstan; Kenya; Kyrgyz Republic; Cambodia; Korea, Rep.; Kuwait; Lebanon; Sri Lanka; Lithuania; Latvia; Morocco; Moldova; Madagascar; Mexico; Macedonia, FYR; Mali; Mongolia; Mozambique; Mauritania; Mauritius; Malawi; Malaysia; Niger; Nigeria; Nicaragua; Netherlands; Norway; Nepal; New Zealand; Oman; Pakistan; Panama; Peru; Philippines; Poland; Portugal; Paraguay; Romania; Russian Federation; Rwanda; Saudi Arabia; Sudan; Senegal; Singapore; Sierra Leone; El Salvador; Slovak Republic; Slovenia; Sweden; Syrian Arab Republic; Togo; Thailand; Tajikistan; Turkmenistan; Trinidad and Tobago; Tunisia; Turkey; Tanzania; Uganda; Ukraine; Uruguay; United States; Venezuela, RB; Vietnam; Yemen, Rep.; South Africa; Zambia.

b. Immigration plus Emigration as Drivers of Imports

Here, we present Figure 3 which is analogous to Figure 2, except that it displays the dose-response and treatment functions with respect to stocks of immigrants plus emigrants rather than immigrants only. However, the finings are quite similar to Figure 2 both in qualitative as well as in quantitative terms.

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Table 1: Descriptive Statistics

	Mean	Std. dev.	Min	Max
	(1)	(2)	(3)	(4)
ln(Imports$_i$)	4.97	3.29	-6.908	12.737
Migration$_i$	27.699	232.379	.001	9336.719
ln(GDP$_m$)	26.486	1.336	23.629	29.853
ln(GDP$_x$)	24.504	1.93	20.712	29.853
ln(Population$_m$)	16.772	1.181	15.103	19.447
ln(Population$_x$)	16.566	1.423	13.866	20.949
ln(GDP per capita$_m$)	9.653	.687	8.062	10.51
ln(GDP per capita$_x$)	7.915	1.468	5.125	10.51
Unemployment$_m$	7.6	3.533	2.421	20.625
Unemployment$_x$	9.417	5.7	1.48	36
Common border$_i$	.025	.156	0	1
Common language$_i$	.08	.271	0	1
ln(Distance$_i$)	8.511	.976	4.088	9.885
Continent$_i$	.301	.459	0	1
GTA$_i$	.117	.299	0	1
STA$_i$	.095	.274	0	1
OECD$_x$	.229	.421	0	1
Δ Polity4 score$_i$	6.157	5.186	0	17.6
Gini$_m$	32.737	5.955	23.573	54.107
Gini$_x$	40.51	10.332	21.8	64.099
Δ Regime durability$_i$	42.821	28.511	0	91.125
Years since war$_i$	.69	5.861	0	98.5
Observations	1,931			

Notes: Subscripts m and x refer to importer (residence country) and exporter (source country) variables, respectively. Variables with subscript i refer to covariates with bilateral variation. Our data-set consists of 27 residence (import) countries and 130 countries of origin which yields 3,510 potential country pairs. After dropping country pairs with missing data on log migration and, especially, determinants thereof, we are left with 1,931 observations.

Table 2: Estimation of the Generalized Propensity Score (GPS)

	Coef.	Std. err.	
$\ln(\text{GDP}_m)$	66.009	43.120	
$\ln(\text{GDP}_x)$	7.007	6.363	
$\ln(\text{GDP}_m)^2$	-2.660	1.646	
$\ln(\text{GDP}_x)^2$	-.260	.250	
$\ln(\text{GDP}_m)^3$	.036	.021	*
$\ln(\text{GDP}_x)^3$	.003	.003	
$\ln(\text{Population}_m)$	142.715	31.847	***
$\ln(\text{Population}_x)$	1.765	6.468	
$\ln(\text{Population}_m)^2$	-7.853	1.914	***
$\ln(\text{Population}_x)^2$	-.006	.369	
$\ln(\text{Population}_m)^3$	.143	.038	***
$\ln(\text{Population}_x)^3$	-.0008	.007	
$\ln(\text{GDP per capita}_m)$	-464.6617	56.962	***
$\ln(\text{GDP per capita}_x)$	4.347	2.742	
$\ln(\text{GDP per capita}_m)^2$	49.873	6.066	***
$\ln(\text{GDP per capita}_x)^2$	-.494	.357	
$\ln(\text{GDP per capita}_m)^3$	-1.773	.214	***
$\ln(\text{GDP per capita}_x)^3$	.019	.015	
Unemployment_x	.012	.009	
Unemployment_m	.078	.015	***
Common border_i	1.278	.335	***
Common language_i	2.073	.149	***
$\ln(\text{Distance}_i)$	-.646	.085	***
Continent_i	.459	.159	***
GTA_i	.632	.251	**
STA_i	-1.149	.250	***
OECD_x	-.207	.160	
Δ Polity4 score_i	-.054	.009	***
Gini_x	-.020	.006	***
Gini_m	.129	.015	***
Δ Regime durability_i	.014	.001	***
Years since war_i	.018	.005	***
Constant	-69.723	264.961	
Observations	1931		
R^2	.691		

Notes: ***, **, * denote significance at the 1, 5, and 10% level, respectively.

Table 3: Treatment Groups and Covariates

	Group 1	Group 2	Group 3
$\ln(\text{GDP}_m)$	**14.592**	**2.853**	**-18.052**
$\ln(\text{GDP}_x)$	**18.103**	-1.674	**-16.036**
$\ln(\text{GDP}_m)^2$	**14.320**	**3.027**	**-17.977**
$\ln(\text{GDP}_x)^2$	**17.936**	-1.588	**-15.979**
$\ln(\text{GDP}_m)^3$	**14.036**	**3.194**	**-17.877**
$\ln(\text{GDP}_x)^3$	**17.717**	-1.496	**-15.881**
$\ln(\text{Population}_m)$	**5.308**	**6.654**	**-12.310**
$\ln(\text{Population}_x)$	**12.850**	**.357**	**-13.256**
$\ln(\text{Population}_m)^2$	**5.331**	**6.617**	**-12.296**
$\ln(\text{Population}_x)^2$	**12.670**	.471	**-13.204**
$\ln(\text{Population}_m)^3$	**5.354**	**6.580**	**-12.280**
$\ln(\text{Population}_x)^3$	**12.441**	.578	**-13.095**
$\ln(\text{GDP per capita}_m)$	**18.511**	**-4.994**	**-12.578**
$\ln(\text{GDP per capita}_x)$	**10.047**	**-2.420**	**-7.482**
$\ln(\text{GDP per capita}_m)^2$	**18.444**	**-5.028**	**-12.482**
$\ln(\text{GDP per capita}_x)^2$	**10.197**	**-2.524**	**-7.518**
$\ln(\text{GDP per capita}_m)^3$	**18.342**	**-5.055**	**-12.362**
$\ln(\text{GDP per capita}_x)^3$	**10.287**	**-2.605**	**-7.521**
Unemployment_x	**-3.250**	1.110	**2.134**
Unemployment_m	1.751	-.362	-1.388
Common border_i	**4.986**	**3.741**	**-8.860**
Common language_i	**7.645**	.790	**-8.477**
$\ln(\text{Distance}_i)$	**-11.236**	**2.591**	**8.449**
Continent_i	**10.810**	**-3.861**	**-6.725**
GTA_i	**6.050**	-.523	**-5.513**
STA_i	**3.159**	.275	**-3.437**
OECD_x	**9.453**	-1.265	**-8.111**
Δ Polity4 score_i	**-5.207**	-.999	**6.233**
Gini_x	**-11.399**	**2.064**	**9.163**
Gini_m	-.458	**3.003**	**-2.544**
Δ Regime durability_i	**10.025**	**-4.302**	**-5.532**
Years since war_i	**3.099**	**1.763**	**-4.885**
Observations	643	645	643
Median t-value	**6.05**		
Mean t-value	**7.43**		

Notes: The three groups of approximately the same size are generated according to the distribution of migration stocks. t-values reported in bold face indicate significance at the 5% level.

Table 4: Cell size for comparison of treated and control units in the matrix of 6 blocs and 3 groups

Bloc	Group 1	Control 1	Group 2	Control 2	Group 3	Control 3
1	82	639	95	345	47	710
2	81	105	96	130	47	111
3	81	54	96	86	46	110
4	80	27	95	69	46	69
5	82	20	96	58	48	35
6	81	9	95	79	46	26

Notes: The three groups of approximately the same size are generated according to the distribution of migration stocks. The bloc-assignment is carried out on the basis of the GPS distribution evaluated at the median treatment intensity of the respective group.

Table 5: Balance of Covariates accounting for the GPS

	Group 1	Group 2	Group 3
$\ln(\text{GDP}_m)$	-.923	.390	-.407
$\ln(\text{GDP}_x)$	1.850	-.933	.363
$\ln(\text{GDP}_m)^2$	-.976	.404	-.359
$\ln(\text{GDP}_x)^2$	1.871	-.952	.382
$\ln(\text{GDP}_m)^3$	-1.031	.417	-.311
$\ln(\text{GDP}_x)^3$	1.889	-.967	.397
$\ln(\text{Population}_m)$	-1.189	1.304	-.088
$\ln(\text{Population}_x)$	1.028	-.329	-.298
$\ln(\text{Population}_m)^2$	-1.193	1.265	-.035
$\ln(\text{Population}_x)^2$	1.009	-.319	-.281
$\ln(\text{Population}_m)^3$	-1.199	1.225	.019
$\ln(\text{Population}_x)^3$	.987	-.309	-.260
$\ln(\text{GDP per capita}_m)$	.322	-1.296	-.612
$\ln(\text{GDP per capita}_x)$	1.158	-.778	.698
$\ln(\text{GDP per capita}_m)^2$	.332	-1.333	-.582
$\ln(\text{GDP per capita}_x)^2$	.341	-1.368	-.552
$\ln(\text{GDP per capita}_m)^3$	1.301	-.865	.701
$\ln(\text{GDP per capita}_x)^3$	1.425	-.937	.693
Unemployment_x	-1.394	.770	-.142
Unemployment_m	-.254	.287	.342
Common border_i	1.353	1.029	**-2.249**
Common language_i	1.017	-.632	-.068
$\ln(\text{Distance}_i)$	-1.185	.919	.549
Continent_i	1.103	-1.049	-.347
GTA_i	1.331	-.790	.056
STA_i	1.218	-.507	-.098
OECD_x	1.477	-.949	.668
Δ Polity4 score_i	-.705	-.158	.093
Gini_x	-.701	.100	1.254
Gini_m	-.328	.404	.536
Δ $\text{Regime durability}_i$	.830	-1.297	-.587
Years since war_i	-.058	.687	-.007
Observations	487	573	280
Median t-value	0.70		
Mean t-value	.75		

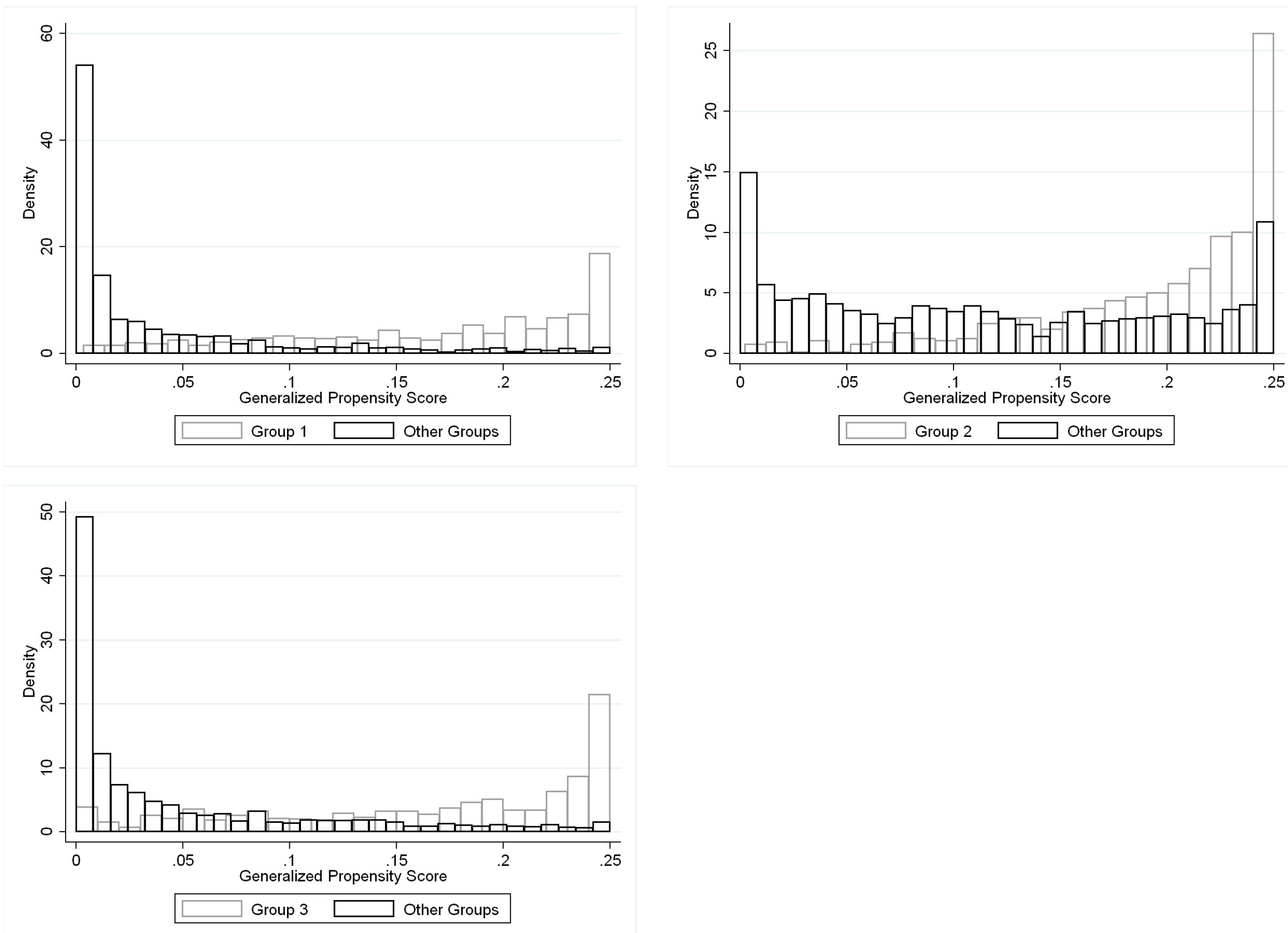
Notes: The three groups of approximately the same size are generated according to the distribution of migration stocks. Observations which do not satisfy the common support condition are excluded from the respective groups. In order to account for the GPS values we discretize the GPS values evaluated at the median treatment intensity of the respective group into six blocs of approximately same size according to the GPS distribution. t-values reported in bold face indicate significance at the 5% level.

Table 6: Estimation of the Dose-Response Function

	Coef.	Std. err.	
$\ln(M_i)$	-.160	.003	***
$\ln(M_i)^2$	.022	.0003	***
$\ln(M_i)^3$	.009	.0001	***
R_i	3.149	.028	***
R_i*ln(Migration$_i$)	4.601	.015	***
Constant	4.240	.006	***
Observations	1,322		
R^2	.257		

Notes: ***, **, * denote significance levels at 1, 5, and 10%, respectively. $\ln(M_i)$ refers to logarithm of the stock of immigrants in importer country m which originate from exporter country x. R_i refers to generalized propensity score calculated according to equation (4) using the coefficients from the first stage regression in Table 2. We estimate the standard errors of the dose-response function by bootstrapping with 2,000 iterations that take into account that the second-stage estimates involve imprecision from first-stage estimates. We loose 18 observations due to zero bilateral trade flows.

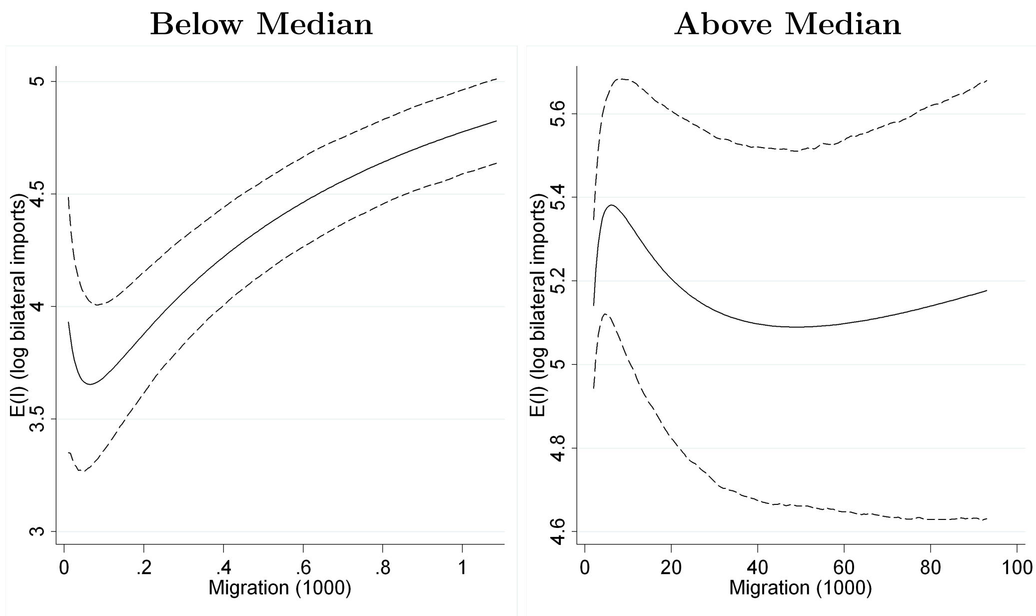
Figure 1: Common Support of the Generalized Propensity Score



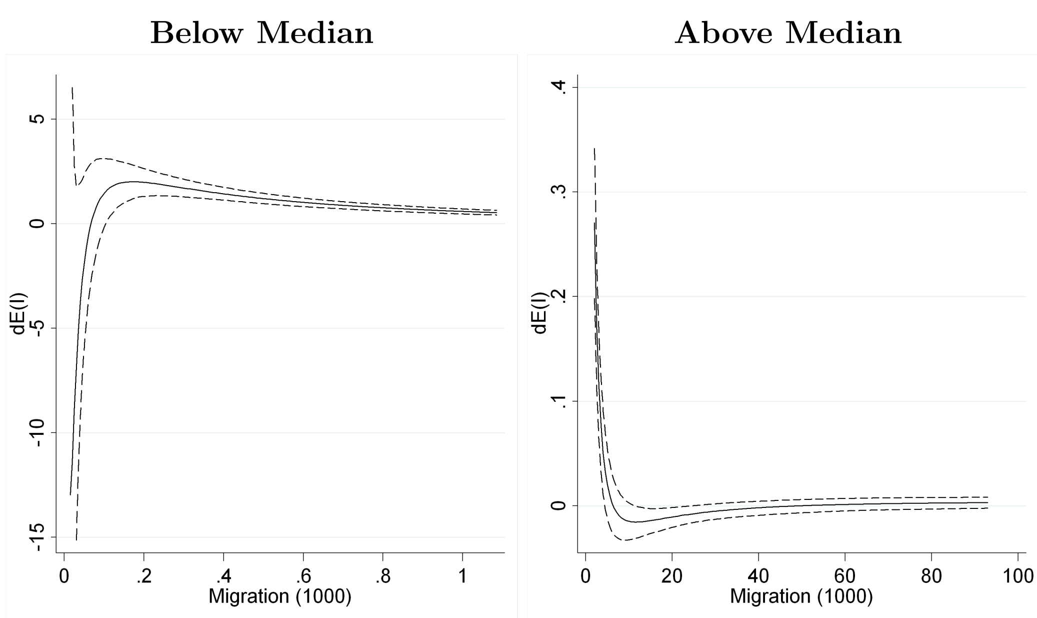
Notes: The groups are generated according to the distribution of migration stocks such that the three groups are approximately of the same size. Country pairs with relatively low migration belong to Group 1 whereas pairs with high migration belong to Group 3. In each histogram, the generalized propensity scores are evaluated at the median migration level of the respective group, for both the observations within that particular group as well as for the respective control observations belonging to all other groups.

Figure 2: Effects of Immigration on Imports

A. Dose-Response Functions



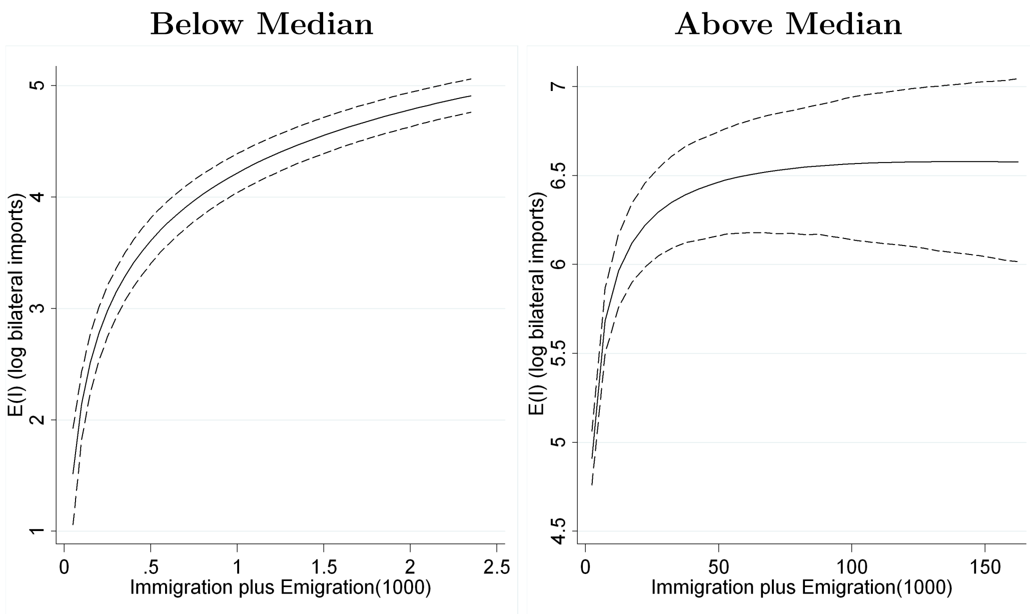
B. Treatment Effect Function



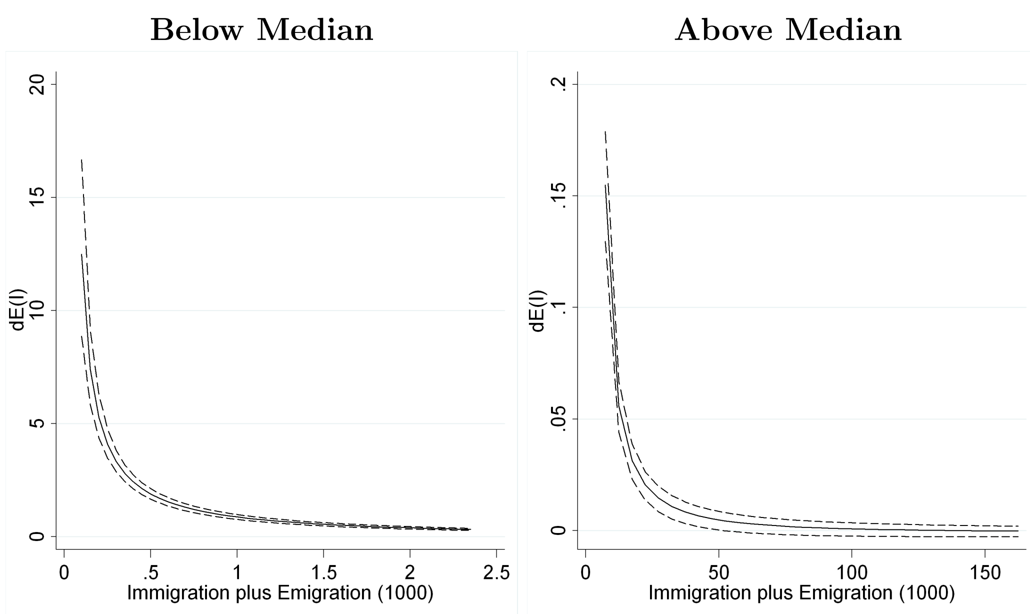
Notes: Observations with treatment level in the highest and lowest 5% are trimmed. The 90% confidence intervals (indicated by the dashed lines) are based on bootstrapped standard errors with 2,000 replications.

Figure 3: Effects of Immigration and Emigration on Imports

A. Dose-Response Functions



B. Treatment Effect Function



Notes: Observations with treatment level in the highest and lowest 5% are trimmed. The 90% confidence intervals (indicated by the dashed lines) are based on bootstrapped standard errors with 2,000 replications.