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BY

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Educational Attainment as a Determinant of International Trade Flows

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ABSTRACT

International differences in educational attainment rates affect the volume of trade through several channels. According to the factor proportions model of trade, the ratio of highly educated workers to less educated workers in each country determines the national product mix. In this model, the volume of bilateral trade is decreasing in the similarity of the countries’ factor proportions. On the other hand, educational attainment may shift the relative demands of consumers toward education-intensive goods. In this case, countries with similar ratios of highly educated consumers to less educated consumers have a relatively larger volume of trade. These relative supply and relative demand effects of education are not mutually exclusive. However, they are likely to offset each other in an empirical analysis of the effect of educational attainment on international trade. In this study, we attempt to disentangle the two effects. We provide evidence that both effects are empirically relevant by utilizing gender-specific measures of educational attainment and labor force participation.

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1. Introduction

The factor proportions model of Heckscher and Ohlin is a useful framework for examining how international differences in educational attainment affect the volume of international trade flows. The simplest application of this framework is a two-factor, two-country model, with highly educated workers and less educated workers as two separate factors of production. The Heckscher-Ohlin model predicts that the volume of international trade is relatively large if there are relatively large differences in the countries’ factor proportions (in this case, the countries’ shares of workers who are highly educated).\(^1\) Recall that the volume of trade is the absolute difference between a country’s production and consumption of each good. Countries with larger factor proportions differences are more specialized in the set of goods that they produce. This greater specialization in production implies a greater volume of trade, since preferences (and therefore the shares of expenditure of the consumers goods) are identical across countries in conventional model of trade.

The Heckscher-Ohlin model focuses on the effect of international differences in educational attainment on relative supplies and the pattern of comparative advantage. However, it does not consider the possibility that educational attainment may shift the relative demands of consumers. For example, consumers with higher levels of educational attainment may prefer to consume larger shares of goods that are education-intensive in their production, such as computers. In this case, an increase in the difference between the educational attainment rates of the two countries may actually decrease the volume of trade. The reason is that larger differences in factor proportions imply a greater divergence in relative demand as well as a greater divergence in relative supplies. Since relative demands become more similar to relative supplies, this relative demand effect of educational attainment at least partially offsets the relative supply effect that

\(^1\) Helpman and Krugman (1985), Deardorff (1997), and Keller (1998) are recent applications of the factor proportions theory that specifically analyze its implications for the volume of international trade.
characterizes the Heckscher-Ohlin model. The relationship between relative demand and factor proportions that we have described is similar to the Linder effect that is formalized in Markusen (1986). The details are formally specified below.

These relative supply and relative demand effects are reflected in opposite predictions for the sign of the correlation between international differences in educational attainment and the volume of trade. Empirical studies of gravity models have utilized these “diametrically opposite” predictions to construct tests that distinguish between the Heckscher-Ohlin model and Linder-type models in which countries’ relative demands vary with their factor proportions. For example, Frankel, Stein, and Wei (1995) include absolute differences in relative factor endowments in their bilateral gravity regressions. They find that international differences in relative endowments of skilled and less skilled workers have a significantly positive effect on the volume of trade. This finding supports the prediction of the traditional factor proportions model. Thursby and Thursby (1987), Bergstrand (1989), Frankel (1997) examine the effect of absolute difference in GNP per capita (which they interpret as a proxy for relative factor endowments) on the volume of trade. In gravity regressions that control for the standard set of regressors, these studies find a negative effect of the absolute differences in GNP per capita on the volume of trade. This negative correlation supports the idea that the countries’ factor proportions are reflected in their relative demands.

Of course, the relative demand and relative supply effects described above are not mutually exclusive. The studies that we have cited estimate the net effect of international

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2 In Markusen’s model, a non-homotheticity in demand that is related to factor proportions implies a relationship between the volume of international trade and the countries’ per capita incomes. The similarity of our model to the Linder effect is the emphasis on demand-side motivations for trade.

3 Leamer (1974) is an earlier study that also includes factor endowments as an explanator of the volume of trade.

4 Hunter and Markusen (1988) also find evidence that consumer demands are non-homothetic, and then they examine the implications of this demand-side asymmetry for the volume of trade.
differences in relative factor proportions on the volume of trade. At best, they indicate whether a relative supply effect or a relative demand effect dominates the empirical correlation. In contrast, this paper attempts to disentangle the two effects. Our goal is to determine whether either or both of the effects are empirically relevant.

To motivate our empirical methodology, we present a theoretical framework that includes the relative demand and relative supply effects of educational attainment. We first relate the volume of trade to the educational attainment rates within the countries’ labor forces and to the educational attainment rates of consumers who do not participate in the labor force. We then relate these comparative static results to gender-specific measures of educational attainment, since measures of educational attainment by labor force participation are not available for the broad cross-section of countries that we examine. The result is an empirical specialization that utilizes gender-specific measures of educational attainment and labor force participation rates to isolate empirical evidence of the two effects.

There are two steps to the empirical analysis. In the first step, we estimate the effect of international differences in educational attainment on the volume of trade using general rather than gender-specific measures of educational attainment. In this case, we find that the relative supply effect proposed by Heckscher and Ohlin dominates: the volume of trade is increasing in international differences in educational attainment, though the correlation is not significantly different from zero.

However, when we examine gender-specific measures of education attainment in the second step of the empirical analysis, we find statistically significant evidence of both effects. The international divergence of the educational attainment rates of the female populations (within countries that have low rates of female labor force participation) has a negative effect on the volume of bilateral trade. This result reflects a dominant relative demand effect. On the other
hand, the international divergence of educational attainment rates of the male populations has a positive effect on the volume of bilateral trade. This reflects a dominant relative supply effect.

The rest of the paper is organized as follows. In Section 2, we present the details of the theoretical framework and derive a set of comparative static results. In Section 3, we describe the regression specification and the econometric issues that we confront. In Section 4, we describe the data set. Section 5 reports the core regression results, and Section 6 reports a sensitivity analysis of these results. Section 7 offers concluding remarks.

2. Theoretical Framework

2.1 The Basic Model

In order to model the relationship between educational attainment and international trade, we extend a two-good, two-factor, two-country factor proportions framework. This simple model provides theoretical predictions for the empirical analysis. The two countries in the model are labeled Home and Foreign. We use upper-case letters to describe the economy in Home and lower-case letters to describe the economy in Foreign.

There are four types of agents in the model. The agents vary by their level of educational attainment (High or Low) and whether they participate in the labor force (in or out). All agents are consumers. All of the agents that participate in the labor force are employed. We define $E_{in}$ as the share of the labor force in Home who have attained a higher education. Similarly, $E_{out}$ is the share of the consumers outside of the labor force who have attained a higher education. The corresponding shares for Foreign are $e_{in}$ and $e_{out}$. We assume that these educational attainment rates are fundamental parameters of the model, as is the case in the conventional factor proportions framework. We define Home as the country that is relatively abundant in highly educated workers, so $E_{in} > e_{in}$. We assume that this ranking of national educational attainment rates is mirrored in
the educational attainment of consumers outside of the labor force, so $E_{out} > e_{out}$. These assumptions about the relative factor proportions of the two countries are made without loss of generality. If they were reversed, we would simply redefine the countries, such that Foreign would be relatively abundant in highly educated workers. The total labor force in each country is $\bar{L}$, which is less than the total population. The workers are free to move between the sectors in each country, but there is no international labor mobility.

For the sake of simplicity, the model does not include physical capital as a factor of production. This abstraction is not problematic if there is a high degree of international capital mobility. In the case of perfect international capital mobility, the countries’ relative supply of capital is not a fundamental source of comparative advantage.

There are two goods, $X$ and $Y$. Each good is produced in either country using highly educated and less educated workers and a common constant-returns-to-scale technology. The production of good $X$ is relatively intensive in highly educated workers. The production of good $Z$ is relatively intensive in less educated workers. Good $Y$ is the numeraire good, and $p$ is the relative price of good $X$.

We consider two extensions of this conventional Heckscher-Ohlin framework. The first extension is a bias in relative demands. In particular, we assume that consumers’ preferences for the two goods are homothetic but vary with the consumer’s level of educational attainment. A consumer’s share of expenditure on the education-intensive good $X$ is decreasing in its relative price, $p$, and is increasing in the level of educational attainment of the consumer. Among highly educated consumers, the expenditure share on good $X$ is $\mu_H(p) < 1$. Among less educated consumers, the expenditure share on good $X$ is $\mu_L(p) < \mu_H(p)$. This education-related bias in
relative demands can be viewed as a primitive assumption of the model, i.e., preferences vary with the individual’s level of educational attainment.\(^5\)

The second extension of the conventional Heckscher-Ohlin framework is a fiscal policy that transfers income within each country, from workers to consumers who do not participate in the labor force. In particular, we assume that there is a per-capita transfer to non-participants that is equal to \(\theta\). We assume that the transferred income is evenly distributed (regardless of the educational attainment of the transferees) and that these transfers are financed by a poll tax on workers. These assumptions on the structure of the system of transfers – that the taxes and grants are independent of an individual’s level of educational attainment – simplify the analysis. The assumptions guarantee that the geographical distribution of consumers by level of educational attainment does not affect the relative prices of the integrated world product market. The total value of the transfers in Home is \(T\).

There is perfect competition in the product and factor markets.\(^6\) Free trade integrates the product markets of the two countries. We assume that the countries’ factor proportions lie within the Factor Price Equalization (FPE) set, so there is incomplete specialization in production. We also assume that highly educated workers are relatively scarce in the integrated economy, such that there is an education premium in relative factor prices. As long as there is an education premium in wages, highly educated workers choose not to work in the jobs that are open to less educated workers, though they are qualified to do so. In this case, there is an exact match between the educational attainment of workers within the labor force and the supplies of the two factors of production.

\(^5\) Alternatively, the bias in relative demands can be interpreted as a complementarity between an individual’s consumption of good \(X\) and the consumption of the individual’s endowment of education services.

\(^6\) We discuss an extension that includes monopolistic competition in Section 2.2.
The production of goods $X$ and $Y$ in the Home country is determined by Home’s educational attainment rate, the unit factor requirements of the two goods, and the equilibrium relative price of good $X$. We define $a_{ij}(p)$ as the quantity of factor $j$ that is used to produce a unit of good $i$, given the relative factor prices that are implied by the relative product price $p$. The full-employment resource constraints of Home are represented in [1] and [2].

\[
\begin{align*}
  a_{XL}(p)X(E_{in}) + a_{ZL}(p)Y(E_{in}) &= (1 - E_{in})L \\ 
  a_{XH}(p)X(E_{in}) + a_{ZH}(p)Y(E_{in}) &= E_{in}L 
\end{align*}
\]

The corresponding supply relations are given in [3] and [4].

\[
\begin{align*}
  X(E_{in}) &= \frac{E_{in}[a_{ZH}(p) + a_{ZL}(p)] - a_{ZL}(p)}{a_{ZL}(p) \cdot a_{XH}(p) - a_{XL}(p) \cdot a_{ZH}(p)} L \\ 
  Y(E_{in}) &= \frac{a_{XH}(p) - E_{in}[a_{XH}(p) + a_{XL}(p)]}{a_{ZL}(p) \cdot a_{XH}(p) - a_{XL}(p) \cdot a_{ZH}(p)} L 
\end{align*}
\]

The denominators on the right-hand sides of [3] and [4] are positive, since the production of good $X$ is relatively intensive in highly educated workers. An identical set of supply relations can be derived for Foreign. We define $S_X$ and $S_Y$ (for use below) as the absolute values of the slopes of these supply relations for relative price $p$.

\[
\begin{align*}
  S_X(p, L) &= \frac{dX(E_{in})}{dE_{in}} = \frac{a_{ZH}(p) + a_{ZL}(p)}{a_{ZL}(p) \cdot a_{XH}(p) - a_{XL}(p) \cdot a_{ZH}(p)} L \\ 
  S_Y(p, L) &= -\frac{dY(E_{in})}{dE_{in}} = \frac{a_{XH}(p) + a_{XL}(p)}{a_{ZL}(p) \cdot a_{XH}(p) - a_{XL}(p) \cdot a_{ZH}(p)} L 
\end{align*}
\]

The Heckscher-Ohlin theorem defines the pattern of comparative advantage. The country that is relatively abundant in highly educated workers is a net exporter of the good that is relatively intensive in highly educated workers. The country that is relative abundant in less educated workers is a net exporter of the other good. Therefore, Home is a net exporter of good $X$ and
Foreign is a net exporter of good $Y$. We assume that the trade flows between the two countries are balanced, so the aggregate income of producers in Home, $pX(E_{in}) + Y(E_{in})$, is equal to the aggregate expenditure of consumers in Home.

The total value of international trade flows, $VT$, is the sum of the exports of good $X$ from Home and the exports of good $Y$ from Foreign. Assuming that trade is balanced, $VT$ is equal to twice the exports of Home.

$$VT = 2 \cdot [X(E_{in})p + Y(E_{in}) - T] \cdot \{E_{in} [l - \mu_H(p)] + [l - E_{in}] \cdot [l - \mu_L(p)]\} +$$

$$+ 2 \cdot T \cdot \{E_{out} [l - \mu_H(p)] + [l - E_{out}] \cdot [l - \mu_L(p)]\} - 2 \cdot Y(E_{in}) \quad [7]$$

This expression for the value of international trade flows takes into account the pattern of comparative advantage, the transfer of income from labor force participants to non-participants, and the effect of educational attainment on the relative demands of consumers.

### 2.2 Comparative Statics

The first comparative static experiment that we consider is an increased divergence in the educational attainment rates of the countries’ labor forces (holding constant the countries’ relative populations). To analyze this change, we totally differentiate [7] and assume that $dE_{in}$ highly educated workers from Home are replaced by an equal number of less educated workers from Foreign, such that there is no change in the total labor force of the integrated economy or of either country ($dE_{in} = -de_{in} > 0$ and $dE_{out} = de_{out} = 0$). This relocation of highly educated workers increases the difference between the educational attainment rates of the national labor forces, since we have assumed that $E_{in} > e_{in}$. We also assume that this change in relative educational attainment rates is small enough that the countries’ factor proportions remain within the FPE set. Under these conditions, the equilibrium relative price $p$ does not change with the
shift in relative factor proportions, and therefore the total relative demands in the integrated product market remain unchanged. On the other hand, national expenditure shares and national relative supplies change. Home reduces the share of its income that it spends on the imported good \( Y \) (since the average level of educational attainment of its consumers rises), and it increases its relative output of good \( X \) (since the average level of educational attainment of its workers rises). The total effect on the value of international trade flows is a combination of these two effects.

\[
\frac{dVT}{dE_{in}} = 2 \cdot p \cdot S_X \cdot \left[ E_{in} (I - \mu_H) + (I - E_{in}) \cdot (I - \mu_L) \right] + \\
+ 2 \cdot S_Y \cdot \left[ I - E_{in} (I - \mu_H) - (I - E_{in}) \cdot (I - \mu_L) \right] + \\
- 2 \cdot (\mu_H - \mu_L) \cdot [Xp + Y - T]
\]  

[8]

To abbreviate the notation in [8], we have suppressed the relative price argument in the various functions. The first and second terms in [8] are positive. These positive terms, which we label the relative supply effect, reflect the shift in the product mixes of the two countries. In contrast, the third term in [8] is negative. This negative term, which we label the relative demand effect, reflects the reduction in the national expenditure share of the good that are imported. The magnitude of this effect depends on the difference in the expenditure shares of workers with different levels of educational attainment, \( \mu_H - \mu_L \). The sign of the derivative in [8] is ambiguous. Equation [8] demonstrates that a positive derivative is possible even if there is a relative demand effect. The derivative is positive as long as the relative demand effect is more than offset by the relative supply effect. On the other hand, it is not possible to have a negative derivative in a conventional Heckscher-Ohlin model with \( \mu_H = \mu_L \).

The second comparative static experiment that we consider is an increase in the difference between the national educational attainment rates of consumers who are not in the labor force (holding constant the countries’ relative populations). Again, we totally differentiate [7] and set
\[ dE_{out} = -de_{out} > 0 \text{ (and } dE_{in} = de_{in} = 0). \] This relocation of consumers does not affect the total expenditure shares of the two goods in the integrated product market (since the income transfers take the non-distortionary form specified in Section 2.1). Consequently, there is no change in the equilibrium relative price \( p \), as before. Each country’s total expenditure share on the good that it imports increases with this divergence of the educational attainment rates of consumers. However, the relative supply of each country does not change, since there is no relocation of productive resources. Therefore, the total value of international trade flows unambiguously declines as long as \( \mu_H > \mu_L \) and the income is transfer \( T \) is positive.

\[
\frac{dVT}{dE_{out}} = -2 \cdot T \cdot (\mu_H - \mu_L) \quad [9]
\]

The derivative in [9] reflects a pure relative demand effect, while the derivative in [8] compounds the relative demand effect with a relative supply effect in the opposite direction. This distinction between [8] and [9] is important for our investigation of whether the relative demand effect of educational attainment is empirically relevant. The theoretical result suggests that it may be possible to isolate the relative demand effect by distinguishing between the educational attainment of workers who are in the labor force and the educational attainment of consumers who are outside of the labor force. However, as an empirical matter, we do not directly observe educational attainment by labor force participation. We do observe gender-specific measures of educational attainment and gender-specific measures labor force participation.

In anticipation of these data constraints, we translate the theoretical predictions in [8] and [9] into predictions about the effect of gender-specific measures of educational attainment on the total value of international trade flows. To do this, we define \( E_j \) as the share of the gender \( j \) population in Home who have attained a higher education. By the chain rule,
\[ \frac{dVT}{dE_j} = \frac{dVT}{dE_{in}} \left( \frac{dE_{in}}{dE_j} \right) + \frac{dVT}{dE_{out}} \left( \frac{dE_{out}}{dE_j} \right) \]  

[10]

The derivatives in parentheses are the weights that determine the relative importance of the relative supply and relative demand effects described in [8] and [9].

To illustrate this relationship, we first discuss a polar case. Suppose that the male labor force participation rate in both countries is one, while the female labor force participation rate is zero. In this case, the first term disappears when \( j \) refers to the female populations (leaving the pure relative demand effect in [9]). On the other hand, the second term disappears when \( j \) refers to the male populations (leaving the compounded effect in [8]). In this case, we can isolate the relative demand effect by examining the correlation between international differences in female educational attainment and the value of international trade flows.

In more realistic intermediate cases, however, it is difficult to translate changes in educational attainment by gender into changes in educational attainment by labor force participation. As a constructive though imperfect approach to this problem, we outline the conditions under which we can derive a precise prediction for the limited data. We define \( \phi_j \) as the (gender-specific) ratio of the education attainment rate within the labor force to the educational attainment rate outside of the labor force, and we define the parameter \( \lambda_j \) as the labor force participation rate of the gender \( j \) population. We assume that the labor force participation rates are fixed parameters.\(^7\) If the ratio \( \phi_j \) is invariant to changes in the educational attainment of either group, then [10] can be rewritten as:

---

\(^7\) This simplifying restriction is also motivated by data restrictions. We discuss these data restrictions in Section 4 below.
\[ \frac{dV_T}{dE_j} = \frac{dV_T}{dE_{in}} \left[ \frac{\lambda_j}{\lambda_j + \lambda_{i \neq j}} \left( I - \lambda_j \left( I - \phi_j \right) \right) \right] + \frac{dV_T}{dE_{out}} \left[ \frac{1 - \lambda_j}{2 - \lambda_j - \lambda_{i \neq j}} \left( I - \lambda_j \left( I - \phi_j \right) \right) \right] \]

[11]

The Appendix provides an explicit derivation of equation [11]. The weights on the two derivatives are functions of the gender-specific labor force participation rates. For example, the relative demand effect will receive more weight in the derivative \( \frac{dV_T}{dE_{female}} \) if the female labor participation rate is low. Therefore, the negative correlation that corresponds to the relative demand effect is more likely in a sample of countries that have low rates of female labor force participation.

### 2.3 An Extension to Include Intra-Industry Trade

At this point, we extend the model to include monopolistic competition and intra-industry. The objective of the extension is to demonstrate that the comparative static results in [8] and [9] are not sensitive to our previous assumption that product markets are perfectly competitive.

The extension of the model follows Helpman and Krugman (1985). We assume that there are many differentiated varieties of good \( X \), the education-intensive good, though good \( Y \) is still a homogeneous good. There is monopolistic competition in the supply of good \( X \) and intra-industry trade. We define \( \psi \in (0,1) \) as the share of the varieties of good \( X \) that are produced in Home and exported to Foreign. Assuming again that trade is balanced, the total value of trade is

\[ VT = 2 \cdot \left[ X \left( E_{in} \right) p + Y \left( E_{in} \right) - T \right] \cdot \left[ E_{in} \left( I - \mu_H \left( p \right) \right) + \left[ I - E_{in} \right] \cdot \left[ I - \mu_L \left( p \right) \right] \right] + \]

\[ + 2 \cdot T \cdot \left[ E_{out} \left( I - \mu_H \left( p \right) \right) + \left[ I - E_{out} \right] \cdot \left[ I - \mu_L \left( p \right) \right] \right] - 2 \cdot Y \left( E_{in} \right) + \]

\[ + \left( I - \psi \right) \cdot 2 \cdot \left[ X \left( E_{in} \right) p + Y \left( E_{in} \right) - T \right] \cdot \left[ E_{in} \mu_H \left( p \right) + \left[ I - E_{in} \right] \mu_L \left( p \right) \right] + \]

\[ + \left( I - \psi \right) \cdot 2 \cdot T \cdot \left[ E_{out} \mu_H \left( p \right) + \left( I - E_{out} \right) \mu_L \left( p \right) \right] \]

[12]
The equation for the total value of trade in [12] is identical to [7] if $\psi = 1$. The derivatives for the comparative static exercises are:

$$\frac{dVT}{dE_{in}} = 2 \cdot (pS_X - S_Y) \cdot [E_{in} (1 - \psi \cdot \mu_H) + (1 - E_{in}) (1 - \psi \cdot \mu_L)] + 2 \cdot S_Y +$$

$$- \left( \frac{d\psi}{dE_{in}} \right) \cdot 2 \cdot (Xp + Y - T) \cdot [E_{in} \mu_H + (1 - E_{in}) \mu_L] +$$

$$- \left( \frac{d\psi}{dE_{in}} \right) \cdot 2 \cdot T \cdot [E_{out} \mu_H + (1 - E_{out}) \mu_L] +$$

$$-\psi \cdot 2 \cdot (\mu_H - \mu_L) \cdot (Xp + Z - T) \quad [13]$$

$$\frac{dVT}{dE_{out}} = -\psi \cdot 2 \cdot T \cdot (\mu_H - \mu_L) \quad [14]$$

To abbreviate the notation in [13] and [14], we again suppressed the relative price argument of the various functions. The share of the varieties of good $X$ that are produced in Home, $\psi$, is increasing in the share of highly educated workers in Home, $E_{in}$. The first four terms in [13] represent the relative supply effect, while the fifth term represents the relative demand effect.

Helpman and Krugman (1985) prove that the sum of the first four terms is positive, i.e., that the volume of trade is increasing in the difference in factor proportions if $\mu_H - \mu_L = 0$. The derivative in [14] is the pure relative demand effect in [9], multiplied by the scalar $\psi$. Therefore, we can conclude that the qualitative results that are derived in Section 2.2 apply even when the model includes monopolistic competition.
3. Econometric Issues

In this Section, we discuss the measurement issues that we face, the regression specification that we adopt, and the potential econometric problems that we address.

3.1 International Comparability of the Measures of Educational Attainment

The data on educational attainment is from Barro and Lee (1993). The first measurement issue is the definition of educational attainment. In the empirical analysis in Sections 4 and 5, we consider two definitions for classifying the populations as highly educated. By the first definition, an individual is classified as highly educated if he or she has attained some post-secondary education. By the second, weaker definition, an individual is classified as highly educated if he or she has attained some post-primary education. We define the gender-specific rate of educational attainment as the share of the population who have attained a higher education (by either measure).

The second measurement issue is the international comparability of the educational attainment measures. Clearly, there is unobservable heterogeneity across countries in the quality of education as well as the methods of measuring educational attainment. A constructive though imperfect approach to this comparability problem is to focus our empirical analysis on within-country changes in educational attainment rates. To do so, we analyze the log-differences in the educational attainment rates constructed by Barro and Lee. If international differences in the measurement and quality of education can be approximately represented by country-specific multiplicative factors that are constant over the short sample period, then this heterogeneity has no effect on within-country log-differences of the educational attainment rates.

The final measurement issue is how to measure the divergence in national educational attainment rates, since international comparison of the levels of this variable is problematic. We measure this divergence as the difference between the growth of the educational attainment rate of the country with the relatively higher initial educational attainment rate and the growth of the
educational attainment rate of its trading partner. This difference in the growth of the educational attainment rates of the two countries, which may be positive or negative, measures divergence in educational attainment rates if and only if there is no change in the countries’ relative ranking (in terms of their educational attainment rates). If there is a change in their relative ranking, then the difference in the growth rates does not necessarily correspond to the divergence in their educational attainment rates. To avoid this ambiguity, we omit from sample the country-pairs for which there is a change in their relative ranking over the sample period.\textsuperscript{8} Fortunately, this reduces the sample by only five percent.

3.2 The Regression Specification

The theoretical framework suggests that the value of international trade flows can be represented in a bilateral gravity model that is augmented to include measures of education attainment.

\[
\log(VT_{ij,t}) = \alpha_{ij} + \beta \cdot \log(GNP_{it} \cdot GNP_{jt}) + \gamma \cdot \log(POP_{it} \cdot POP_{jt}) +
\]

\[
+ \left[ I_{ij, MH} \cdot \delta_{MH} + I_{ij, ML} \cdot \delta_{ML} \right] \left| E_{i,t}^M - E_{j,t}^M \right| +
\]

\[
+ \left[ I_{ij, FH} \cdot \delta_{FH} + I_{ij, FL} \cdot \delta_{FL} \right] \left| E_{i,t}^F - E_{j,t}^F \right| + \varepsilon_{ij,t}
\]

\[\text{[15]}\]

\(VT_{ij,t}\) is the value of bilateral merchandise trade flows between countries \(i\) and \(j\) in year \(t\). \(POP_{it}\) is the population of country \(i\) in year \(t\). \(GNP_{it}\) is the national income of country \(i\) in year \(t\). \(I_{ij, gH}\) is a dummy variable that is equal to one if countries \(i\) and \(j\) have a high average labor force participation rate within their gender \(g\) populations. Similarly, \(I_{ij, gL}\) is a dummy variable that is equal to one if countries \(i\) and \(j\) have a low average labor force participation rate within their

\textsuperscript{8} This methodology still requires international comparison of the educational attainment rates to measure the countries’ relative ranking. However, the comparison is used only for sample selection. It is not used
gender $g$ populations. (The empirical distinction between high and low labor force participation is discussed below.) In other words, this dummy variable formulation represents a set of pooling restrictions. We assume that the labor force participation rates are constant over the sample period (to abide by data constraints described in Section 4). This assumption implies that the coefficients $\delta_{MH} \cdot \delta_{ML} \cdot \delta_{FH} \cdot \delta_{FL}$ are fixed over the sample period as well, since the labor force participation rates are implicit in the regression coefficients.

Equation [16] applies a difference transformation to [15]. This removes unobservable characteristics of the country-pairs that do not change over time (represented in [15] by $\alpha_{ij}$).

$$\Delta \log(V_{ij,t}) = \beta \cdot \Delta \log(GNP_{it} \cdot GNP_{jt}) + \gamma \cdot \Delta \log(POP_{it} \cdot POP_{jt}) +$$

$$+ \left[I_{ij,MH} \cdot \delta_{MH} + I_{ij,ML} \cdot \delta_{ML}\right] \cdot \Delta Z^M_t +$$

$$+ \left[I_{ij,FH} \cdot \delta_{FH} + I_{ij,FL} \cdot \delta_{FL}\right] \cdot \Delta Z^F_t + \Delta \epsilon_{ij,t} \quad [16]$$

where $Z^M_t = \left|E^M_{i,t} - E^M_{j,t}\right|$ and $Z^F_t = \left|E^F_{i,t} - E^F_{j,t}\right|$. Recall that $\Delta Z^g_t$ measures the divergence in the growth of educational attainment rates of the gender-$g$ population (within the sample of country-pairs that do not change their relative ranking). We assume that the error term, $\Delta \epsilon_{ij,t}$, is independently, normally distributed over the cross-section of country-pairs, though we do not assume that the errors are homoskedastic.

Hummels and Levinsohn (1995) also estimate a fixed effects version of the gravity model in order to control for unobserved sources of “trade resistance”. The foremost example of trade resistance is geographic distance. Frankel, Stein, and Wei (1995) and Frankel (1997) provide empirical evidence that there is no significant time trend in the effects of distance on the volume of
bilateral trade flows. This evidence supports the appropriateness of the fixed effects approach to controlling for trade resistance. Other sources of trade resistance that have been suggested in the literature and may be captured by the country-pair fixed effect are historic cultural links and policy-based trade barriers.

The theoretical framework in Section 2 does not provide a rationale for including GNP growth as an exogenous regressor in the gravity models in [15] and [16]. Anderson (1979), Helpman and Krugman (1985), Bergstrand (1989), Deardorff (1997) and others have demonstrated that a wide range of trade theories are consistent with a gravity specification that includes the countries’ GNPs. However, these theories do not suggest that GNP (or GNP growth) is appropriate as an exogenous regressor. Despite the lack of theoretical foundations (for exogeneity), we include GNP growth in some versions of the regression specification to facilitate comparison of our results to those in the gravity literature. As a number of authors have pointed out (e.g., Frankel (1997)), we are also controlling for the countries’ levels of economic development (as proxied by GNP per capita) by including both GNP and population terms in the specification.

3.3 Pooling Restrictions

The next methodological issue is whether we should restrict the coefficients in specification [16] to be equal across all of the country-pairs in the sample. To relax this restriction in a tractable way, we define sets of country-pairs by whether the average female labor force participation rate is high or low (according to a specified cut-off). Specification [16] is fairly flexible, in that it allows the coefficients on the measures of educational attainment to vary by the average labor force participation rate of the countries. On the other hand, we could pool all of the country-pairs together by imposing the restrictions that $\delta_{MH} = \delta_{ML}$ and $\delta_{FH} = \delta_{FL}$. Based
on $F$-tests of these restrictions, we impose the first restriction but not the second. We also examine the sensitivity of the results to variation in the cut-off rate of female labor force participation that distinguishes high from low. We also consider a specification that is even less restrictive than [16], in which the parameters $\beta$ and $\gamma$ vary for sets of country-pairs. We are not able to reject the pooling restrictions in [16] in favor of this less restrictive specification. The details of these tests of pooling restrictions are reported in Section 5.

3.4 Heterogeneity

We use White’s heteroskedasticity-consistent covariance matrix estimator to calculate the standard errors in all of the regressions, since heteroskedasticity is a common problem in cross-country regressions.

3.5 Endogenous educational attainment

The final methodological issue that we discuss is the appropriateness of treating measures of educational attainment as exogenous regressors in the model of trade flows. If educational attainment responds endogenously to idiosyncratic shocks to the bilateral volume of trade, then the estimation strategy is invalid. However, there is precedence for dismissing this concern. A number of papers in the gravity literature use human capital and other factors of production as instruments for GNP. In other words, the gravity literature typically assumes that the supplies of these factors of production are not in fact correlated with the residuals in [16]. Prominent examples of this IV strategy include Harrigan (1996), Hummels and Levinsohn (1995), and Frankel (1997).
4. Data description

The bilateral trade flow data are drawn from various issues of the IMF’s *Direction of Trade Yearbook*. The total value of bilateral trade is measured as the sum of the countries’ bilateral imports. The GNP and population measures are drawn from the World Bank’s WORLD*DATA database. The gender-specific measures of secondary and post-secondary educational attainment are drawn from Barro and Lee (1993). Their educational attainment measures are available at five-year intervals. The measures of gender-specific labor force participation rates are drawn from the ILO’s *Yearbook of Labor Statistics: Retrospective on Population Censuses 1945-1989*. The labor force participation rate is based on population censuses at irregular intervals. For this reason, we do not have time series variation in the labor force participation rate for the broad cross-section of countries. To accommodate this data constraint, the regression specification assumes that the labor force participation rates vary across countries but that the country-specific rates do not vary over the sample period.

We constructed the sample using the following criteria. We use data from 1980 and 1985 to construct five-year growth rates of GNP, population, and the educational attainment rates. All of the country-pairs in the sample report a positive amount of bilateral merchandise trade in both years. The sample excludes country-pairs in which either of the countries is a member of OPEC (since the merchandise trade flows of these countries are irregular between 1980 and 1985). This restriction reduces the sample by only 2.69 percent. The sample also excludes country-pairs that switched the relative ranking of their educational attainment rates. The reason for this last constraint is

---

9 Technically, we measure the labor force participation rate as the share of the “economically active” population in the total population.

10 Recent empirical studies of gravity relationships use zero-valued observations of trade flows and estimate the model using Tobit. However, we do not observe whether the non-positive values reported in the *Direction of Trade Yearbook* are zeroes or simply missing values. Therefore, we cannot implement the Tobit methodology. Frankel (1997) reports that both empirical methodologies generate similar values for the coefficients of gravity models.
exclusion is discussed in Section 3 above. This last exclusion reduces the sample by a further 5.22 percent. The final sample is a cross-section of 1579 country-pairs.

Before reporting the regression results, we provide a few summary statistics. Table 1 reports the pair-wise correlations between male and female labor force participation rates and higher educational attainment rates within the same country. There is a very high correlation (0.9254) in the educational attainment rates of the male and female populations within the same country. In contrast, the correlation in the labor force participation rates of male and female populations within the same country is relatively low (0.3034). Finally, the correlation between the labor force participation rate and the educational attainment rate within a country is relative low for the male populations (0.2983) and even lower for the female populations (0.1899).

The national female labor force participation rates are much lower on average than their male counterparts: the sample means are 25.57 for females and 52.18 for males, respectively. On the other hand, there is more international variation in the female rates: the sample standard deviations are 7.61 for females and 3.73 for males.

These statistics suggest that there is a sizeable amount of international variation in female labor force participation rates that is not closely related to educational attainment. Unfortunately, the data does not directly relate each individual’s labor force participation to his or her level of educational attainment. At best, the statistics are only suggestive, so the assumptions that link labor force participation to gender (described in detail in Section 2.2 and the Appendix) remain unproven assertions.

5. Regression Results

Before estimating the coefficients in [16], we report a benchmark model that does not include gender-specific coefficients on the divergence in national educational attainment rates. This simpler benchmark model is:
\[
\Delta \log(V_{ij,t}) = \beta \cdot \Delta \log(GNP_{it} \cdot GNP_{jt}) + \gamma \cdot \Delta \log(POP_{it} \cdot POP_{jt}) + \\
+ \delta \cdot \Delta Z_t + \Delta e_{ij,t}
\]  
[17]

where \( Z_t = |E_{i,t} - E_{j,t}| \). It is important to note that the specification in [17] is a non-nested version of specification [16].

Table 2 reports estimates of the coefficients in [17]. The regressions use the stricter definition of higher educational attainment (i.e., post-secondary). The first coefficient in columns I and II of Table 2 represents the net effect of an international divergence in educational attainment rates. The coefficient compounds the relative demand effect and the relative supply effect, since it represents a combination of the derivatives in [8] and [9]. The estimated value of \( \delta \) is positive, which suggests that the relative supply effect dominates the relative demand effect. It is not significantly different from zero in the column I, but it is marginally significant in column II. Column III is a restricted version of the model that omits the educational attainment term.

In contrast, it is possible to disentangle the relative demand supply and relative demand effects when we estimate the gender-differentiated specification in [16]. Table 3 reports the estimates of the coefficients in [16]. We distinguish between High female labor force participation (LFP) rates and Low female LFP rates by using a cut-off average LFP rate of 0.20 to construct the dummy variables \( I_{ij, FH} \) and \( I_{ij, FL} \) (the mean value in the sample of country-pairs is 0.25). The \( F \)-test of the pooling restriction that the second and third coefficients are equal is easily rejected by the data. We also estimated a more general specification in which the restriction \( \delta_{MH} = \delta_{ML} \) is not imposed. (In this case, the cut-off average male LFP rate was 0.45. The mean value in the sample of country-pairs is 0.50). However, we could not reject the pooling restriction that \( \delta_{MH} = \delta_{ML} \). Therefore, columns I and II report the estimates with the pooling restriction
imposed for the male populations but not for the female populations. The $p$-values of these $F$-tests are reported at the bottom of the Table.

The coefficient on $\Delta Z_t^M$ (the international divergence in the growth of male educational attainment) is significantly greater than zero, reflecting the dominance of the relative supply effect. The coefficient on $\Delta Z_t^F$ varies by the average female LFP of the country-pairs. It is significantly less than zero for country-pairs with Low female LFP rates. On the other hand, it is not significantly different from zero for country-pairs with High female LFP rates. These results suggest that we have isolated evidence of both the relative demand effect and the relative supply effect.

At the bottom of Table 3, we compare the specification in Table 3 (which includes the gender-specific measures of educational attainment) with the specification in Table 2 (which does not include the gender-specific measures of educational attainment). The two specifications are non-nested, so we compare them using the $J$-test proposed by Davidson and MacKinnon (1981). We find strong evidence in favor of the gender-differentiated specification in Table 3, regardless of which specification we designate as the null.

6. Sensitivity Analysis

In this Section, we analyze the sensitivity of the regression results to variation in the definition of low female labor force participation and the definition of higher educational attainment.

Table 4 reports a sensitivity analysis of the results in column I of Table 3. We estimate the model using various cut-off levels of the average female labor force participation rate to construct the dummy variables $I_{ij, FH}$ and $I_{ij, FL}$. The relative demand effect reflected in the
estimates of $\delta_{FL}$ becomes only marginally significant when the cut-off is reduced to 0.15, because the pool of country-pairs with Low LFP rates is too small for precise estimation. At the other end, the effect is not statistically significant when the cut-off is raised to 0.30, because the pool with Low LFP rates is too large (i.e., it includes country-pairs with an average female LFP rate that is above the sample average). In terms of overall fit, the specification that sets the cut-off average LFP rate at 0.20 performs the best. This is the cut-off that produces the results reported in Table 3.

Table 5, 6, and 7 reproduce the results in Tables 2, 3, and 4, respectively, using the weaker measure of higher educational attainment (which classifies all individuals with a post-primary education as highly educated). The sample is slightly larger when we use this weaker measure of educational attainment, because fewer country-pairs are excluded because of a change in the relative ranking of their educational attainment rates.

The results using this alternative measure of educational attainment are qualitatively similar, though they are less precisely estimated. The countries’ educational attainment rates have an insignificant effect on the total value of trade in Table 5, where the coefficients are not differentiated by gender or labor force participation. Table 6 reproduces the gender-differentiated results using the weaker measure of higher educational attainment. The signs of the coefficients are identical to the signs in the earlier tables. The $t$-statistics are lower, but the coefficients are still significantly different from zero. On the other hand, we cannot reject the pooling restriction that $\delta_{FH} = \delta_{FL}$ at the ten percent significance level.\textsuperscript{11} Table 7 reproduces the result that the significance level of the estimate of $\delta_{FL}$ is sensitive to the cut-off level of average female labor force participation.

\textsuperscript{11} However, we can reject the pooling restriction at the fifteen percent significance level.
7. Concluding Remarks

This paper examines two ways in which international differences in educational attainment determine the total value of international trade flows. The relative demand effect predicts that countries with dissimilar educational attainment rates should trade less. On the other hand, the relative supply effect predicts that countries with dissimilar levels of educational attainment should trade more. The two effects are not mutually exclusive, though they tend to offset each other in the data. Rather than estimating the net effect of international differences in educational attainment on the value of trade flows, we have attempted to disentangle the two effects. We have provided evidence that both effects are empirically relevant by examining the interaction of gender-specific measures of educational attainment and gender-specific measures labor force participation rates.

References


APPENDIX

In this appendix, we construct \( \frac{dE_{in}}{dE_j} \) and \( \frac{dE_{out}}{dE_j} \), the derivatives that are used in equation [13] in the text. Recall that \( j \in \{M, F\} \) is the index for gender. We define \( E_{in}^j \) and \( E_{out}^j \) as gender-specific versions of \( E_{in} \) and \( E_{out} \). We assume in the text that

\[
E_{in}^j = \phi_j E_{out}^j \tag{A1}
\]

Assuming that the total population share of each gender is one-half, we have the following accounting identities that relate the various measures of educational attainment.

\[
E_j = \lambda_j E_{in}^j + (1 - \lambda_j) E_{out}^j \tag{A2}
\]

\[
E_{out} = \frac{\lambda_M E_{in}^M + \lambda_F E_{in}^F}{\lambda_M + \lambda_F} \tag{A3}
\]

\[
E_{out} = \frac{(1 - \lambda_M) E_{out}^M + (1 - \lambda_F) E_{out}^F}{2 - \lambda_M - \lambda_F} \tag{A4}
\]

Equations [A5] and [A6] are the result of totally differentiating [A1], [A2], [A3] and [A4].

\[
dE_{in} = \frac{\lambda_M \phi_M}{(\lambda_M + \lambda_F)(1 - \lambda_M (1 - \phi_M))} dE_M + \frac{\lambda_F \phi_F}{(\lambda_M + \lambda_F)(1 - \lambda_F (1 - \phi_F))} dE_F \tag{A5}
\]

\[
dE_{out} = \frac{1 - \lambda_M}{(2 - \lambda_M - \lambda_F)(1 - \lambda_M (1 - \phi_M))} dE_M + \frac{1 - \lambda_F}{(2 - \lambda_M - \lambda_F)(1 - \lambda_F (1 - \phi_F))} dE_F \tag{A6}
\]

### TABLE 1: Pairwise Correlations between National Labor Force Participation Rates and National Post-Secondary Educational Attainment Rates by Gender

<table>
<thead>
<tr>
<th></th>
<th>MHED</th>
<th>FHED</th>
<th>MLFP</th>
<th>FLFP</th>
</tr>
</thead>
<tbody>
<tr>
<td>MHED</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FHED</td>
<td>0.9254</td>
<td>1.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MLFP</td>
<td>0.2983</td>
<td>0.2587</td>
<td>1.0000</td>
<td></td>
</tr>
<tr>
<td>FLFP</td>
<td>0.1826</td>
<td>0.1899</td>
<td>0.3034</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

---

**Key to the Variables:**

MHED = Share of Male Population that has attained a Post-Secondary Education

FHED  = Share of Female Population that has attained a Post-Secondary Education

MLFP  = Share of Male Population who Participate in the Labor Force

FLFP  = Share of Female Population who Participate in the Labor Force
TABLE 2: The Gravity Model with Post-Secondary Educational Attainment Rates

*Regressand:* The Growth of Bilateral Trade Flows

<table>
<thead>
<tr>
<th></th>
<th>I.</th>
<th>II.</th>
<th>III.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Regressors:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Divergence in</td>
<td>0.1067</td>
<td>0.1290</td>
<td></td>
</tr>
<tr>
<td>Educational Attainment Rates</td>
<td>(1.188)</td>
<td>(1.461)</td>
<td></td>
</tr>
<tr>
<td>GNP Growth</td>
<td>0.3867</td>
<td>0.3820</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(5.551)</td>
<td>(5.466)</td>
<td></td>
</tr>
<tr>
<td>Population Growth</td>
<td>0.7528</td>
<td>0.3993</td>
<td>0.4144</td>
</tr>
<tr>
<td></td>
<td>(1.777)</td>
<td>(0.911)</td>
<td>(0.941)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.1422</td>
<td>-0.0653</td>
<td>-0.0830</td>
</tr>
<tr>
<td></td>
<td>(-2.719)</td>
<td>(-1.173)</td>
<td>(-1.498)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.0039</td>
<td>0.0250</td>
<td>0.0235</td>
</tr>
</tbody>
</table>

The White-corrected $t$-statistics are reported in parentheses. The sample includes 1579 country-pair observations.
TABLE 3: Core Regressions with a Gender Distinction

**Regressand: The Growth of Bilateral Trade**

**Regressors:**

Divergence in Educational Attainment Rates

<table>
<thead>
<tr>
<th></th>
<th>I.</th>
<th>II.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Male</strong></td>
<td>0.1975</td>
<td>0.1368</td>
</tr>
<tr>
<td></td>
<td>(2.228)</td>
<td>(1.539)</td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High LFP Rates</td>
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<td>0.0902</td>
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<tr>
<td></td>
<td>(-0.210)</td>
<td>(1.011)</td>
</tr>
<tr>
<td>Low LFP Rates</td>
<td>-0.4624</td>
<td>-0.3877</td>
</tr>
<tr>
<td></td>
<td>(-2.289)</td>
<td>(-1.943)</td>
</tr>
</tbody>
</table>

GNP Growth

|          | 0.3866        |
|          | (5.465)       |

Population Growth

|          | 0.6861        | 0.2654        |
|          | (1.626)       | (0.603)       |

Constant

|          | -0.1364       | -0.0425       |
|          | (-2.588)      | (-0.743)      |

\( R^2 \)

|          | 0.0096        | 0.0299        |

**J-Tests**

- \( H_0: \) Specification in Table 2
  - Reject \( H_0 \) \( (0.009) \)
  - Reject \( H_0 \) \( (0.017) \)

- \( H_0: \) Specification in Table 3
  - Do Not \( H_0 \) \( (0.877) \)
  - Do Not \( H_0 \) \( (0.659) \)

**F-Tests of Pooling Restrictions (p-values)**

- Divergence (Female) \( (0.0359) \)
- Divergence (Male) \( (0.9569) \)
- GNP Growth \( (0.8010) \)
- Population Growth \( (0.6954) \)

The White-corrected t-statistics for the coefficient estimates and the p-values for the \( J \) and \( F \) tests are reported in parentheses. The sample includes 1579 country-pair observations.
### TABLE 4: Core Regression for Alternative Cutoff Values

**Regressand:** The Growth of Bilateral Trade

**Cutoff Value for the Average Female LFP Rate**

<table>
<thead>
<tr>
<th>Cutoff Value</th>
<th>0.15</th>
<th>0.20</th>
<th>0.25</th>
<th>0.30</th>
</tr>
</thead>
<tbody>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Divergence in Educational Attainment Rates</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Male</strong></td>
<td>0.1919</td>
<td>0.1975</td>
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<td>0.1876</td>
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<tr>
<td>(2.149)</td>
<td>(2.228)</td>
<td>(2.109)</td>
<td>(2.093)</td>
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</tr>
<tr>
<td><strong>Female</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High LFP Rates</td>
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<td>-0.0185</td>
<td>-0.0012</td>
<td>-0.1463</td>
</tr>
<tr>
<td>(-0.889)</td>
<td>(-0.210)</td>
<td>(0.013)</td>
<td>(-1.173)</td>
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</tr>
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<td>Low LFP Rates</td>
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<td>-0.4624</td>
<td>-0.2380</td>
<td>-0.0869</td>
</tr>
<tr>
<td>(-1.628)</td>
<td>(-2.289)</td>
<td>(-1.774)</td>
<td>(-0.888)</td>
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</tr>
<tr>
<td>Population Growth</td>
<td>0.8026</td>
<td>0.6861</td>
<td>0.6940</td>
<td>0.8743</td>
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<tr>
<td>(1.889)</td>
<td>(1.626)</td>
<td>(1.571)</td>
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<td>$R^2$</td>
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<td>0.0096</td>
<td>0.0075</td>
<td>0.0057</td>
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</tbody>
</table>

The White-corrected t-statistics are reported in parentheses.
The sample includes 1579 country-pair observations.
TABLE 5: The Gravity Model with Post-Primary Educational Attainment Rates

Regressand: The Growth of Bilateral Trade Flows

<table>
<thead>
<tr>
<th></th>
<th>I.</th>
<th>II.</th>
<th>III.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Div. in Educ. Attainment Rates</td>
<td>0.1775</td>
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<tr>
<td></td>
<td>(0.788)</td>
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<tr>
<td>GNP Growth</td>
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<tr>
<td></td>
<td>(5.506)</td>
<td>(5.539)</td>
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<td>Pop. Growth</td>
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<tr>
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<td>(1.053)</td>
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<td>$R^2$</td>
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<td>0.0276</td>
</tr>
</tbody>
</table>

The White-corrected $t$-statistics are reported in parentheses.
The sample includes 1607 country-pair observations.
TABLE 6: The Gravity Model with Post-Primary Educational Attainment Rates and Gender

<table>
<thead>
<tr>
<th></th>
<th>I.</th>
<th>II.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Regressand:</strong></td>
<td>The Growth of Bilateral Trade</td>
<td></td>
</tr>
<tr>
<td><strong>Regressors:</strong></td>
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<td></td>
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<td>Divergence in</td>
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<td></td>
</tr>
<tr>
<td>Educational Attainment Rates</td>
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<td></td>
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<td>Male</td>
<td>0.3243</td>
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<tr>
<td></td>
<td>(2.110)</td>
<td>(1.204)</td>
</tr>
<tr>
<td>Female</td>
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<td></td>
</tr>
<tr>
<td>High LFP Rates</td>
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<td>0.0140</td>
</tr>
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<td>(0.057)</td>
</tr>
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<td>Low LFP Rates</td>
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<td>(-1.771)</td>
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<td>GNP Growth</td>
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</tr>
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<td></td>
<td>(5.589)</td>
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<td>Population Growth</td>
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</tr>
<tr>
<td></td>
<td>(1.860)</td>
<td>(0.870)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.1509</td>
<td>-0.0708</td>
</tr>
<tr>
<td></td>
<td>(-2.721)</td>
<td>(-1.162)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.0074</td>
<td>0.0303</td>
</tr>
</tbody>
</table>

**J-Tests**

- $H_0$: Specification in Table 2
- $H_1$: Specification in Table 3
- $H_0$: Specification in Table 3
- $H_1$: Specification in Table 2

<table>
<thead>
<tr>
<th></th>
<th>Reject $H_0$</th>
<th>Reject $H_0$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(0.026)</td>
<td>(0.057)</td>
</tr>
<tr>
<td></td>
<td>Do Not</td>
<td>Do Not</td>
</tr>
<tr>
<td></td>
<td>Reject $H_0$</td>
<td>Reject $H_0$</td>
</tr>
<tr>
<td></td>
<td>(0.842)</td>
<td>(0.892)</td>
</tr>
</tbody>
</table>

**F-Tests of Pooling Restrictions (p-values)**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Divergence (Female)</td>
<td>(0.1320)</td>
<td>(0.1357)</td>
</tr>
<tr>
<td>Divergence (Male)</td>
<td>(0.7190)</td>
<td>(0.6415)</td>
</tr>
<tr>
<td>GNP Growth</td>
<td></td>
<td>0.6028</td>
</tr>
<tr>
<td>Population Growth</td>
<td></td>
<td>(0.6640)</td>
</tr>
</tbody>
</table>

The White-corrected t-statistics for the coefficient estimates and the p-values for the $J$ and $F$ tests are reported in parentheses. The sample includes 1607 country-pair observations.
TABLE 7: The Gravity Model with Post-Primary Educational Attainment Rates and Alternative Cutoff Values

**Regressand:** The Growth of Bilateral Trade

<table>
<thead>
<tr>
<th>Cutoff Value for the Average Female LFP Rate</th>
<th>0.15</th>
<th>0.20</th>
<th>0.25</th>
<th>0.30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>0.3130</td>
<td>0.3243</td>
<td>0.3162</td>
<td>0.3110</td>
</tr>
<tr>
<td></td>
<td>(2.045)</td>
<td>(2.110)</td>
<td>(2.064)</td>
<td>(2.026)</td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High LFP Rates</td>
<td>-0.3253</td>
<td>-0.0587</td>
<td>-0.2426</td>
<td>-0.4249</td>
</tr>
<tr>
<td></td>
<td>(-1.477)</td>
<td>(-0.239)</td>
<td>(-0.855)</td>
<td>(-1.140)</td>
</tr>
<tr>
<td>Low LFP Rates</td>
<td>0.2578</td>
<td>-0.6025</td>
<td>-0.2580</td>
<td>-0.1947</td>
</tr>
<tr>
<td></td>
<td>(0.526)</td>
<td>(-1.776)</td>
<td>(-0.976)</td>
<td>(-0.858)</td>
</tr>
<tr>
<td>Population Growth</td>
<td>0.9278</td>
<td>0.7923</td>
<td>0.8889</td>
<td>0.9440</td>
</tr>
<tr>
<td></td>
<td>(2.190)</td>
<td>(1.860)</td>
<td>(2.084)</td>
<td>(2.207)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.1770</td>
<td>-0.1509</td>
<td>-0.1688</td>
<td>-0.1766</td>
</tr>
<tr>
<td></td>
<td>(-3.234)</td>
<td>(-2.721)</td>
<td>(-3.054)</td>
<td>(-3.213)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.0067</td>
<td>0.0074</td>
<td>0.0059</td>
<td>0.0061</td>
</tr>
</tbody>
</table>

The White-corrected t-statistics are reported in parentheses. The sample includes 1607 country-pair observations.