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Trade and Health Linkages: A Global Panel Data Analysis using the Gravity Model

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This paper provides empirical evidence on the effect of trade openness on child health using the data from 171 countries between the mid-1990s to mid-2000s. Using an instrumental variable approach with a geographic gravity model framework, this study finds that a 1% increase in openness leads to a 0.2% decrease in infant mortality rates across countries, which at the sample mean is about 8 infant deaths per 1000 live births. The result is robust to country-specific time-invariant heterogeneity as well as outliers. The main channels of operation seem to be through increasing incomes, increasing health expenditures, and decreasing inequality.

Keywords: Infant Mortality; Child Health; Trade Openness; Inequality.
JEL Codes: F13, I15, J21, J82, O15, O24.

INTRODUCTION

Across the world, many infants (1 year of age or younger) suffer and die, the most common causes being diarrhea, pneumonia, and malaria. The global child mortality rates are 3.9% (World Bank Indicators). According to World Health Organization, around 4.1 million deaths occur within the first year of life, annually around the world. This statistic is captured by infant mortality rate (IMR), which is the number of infant deaths per 1000 live births. Though, for the world, IMR has declined over time from 65 deaths in 1990 to 29 deaths in 2017 (WHO estimates), it still is a considerable problem for the least developed countries located in sub-Saharan Africa and South Asia. IMR is considered a strong indicator of health status of a country and is included in standard of living evaluations. Reducing under-5 mortality rate to under 25 deaths per 1000 live births is also stated as one of the Sustainable Development Goals. Hence, it is imperative to look at the factors affecting the growth and decline of infant mortality across the world.

Overtime, the world has also seen a growth in globalization. Along with bringing in different fiscal, banking and monetary reforms, many countries have opened their gates to more trade. Economists generally argue that openness is a good thing. Many studies have gone into studying the effects of trade policy and volume of exports on GDP per capita (Frankel and Romer, 1999; Dollar and Kraay, 2002) and its effect on child health (Barlow, 2018; Levine and Rothman, 2006; Panda, 2020). The effect of trade on child health is not conclusive and depends on the country context. Given this, the paper looks at developing a more holistic relationship between trade openness and infant mortality rates by using a panel of 171 countries in a decade that saw increased rates of globalization (between 1995 to 2005) to study the effect of changes in trade openness on changes in child health. The wide sample of countries followed over a decade would help shed some light on the long-term effects of trade and the pathways through which openness impacts the economy.

Recent literature has focused on analyzing the effect of particular trade policies on child health (Panda, 2020; Olper et al., 2018). Olper et al. (2018) studies trade policies around the world and finds a 17-percentage point decrease in infant mortality on an average for 50% of their sample to no significant decrease in other parts of the sample. Panda (2020) studies the effect of a trade policy for 30 countries in sub-Saharan Africa and finds a fall in infant mortality by about 9% of the sample mean. This paper on the other hand would focus on the impact of trade openness and therefore impact of increasing trade volumes on child health rather than the effect of a specific trade policy on child health. Correspondingly, the indicator used is that of trade volumes (exports and imports as a share of GDP at current prices) in a decade that saw increased globalization, between 1995 and 2005. The paper closest to this analysis is by Levine and Rothman (2006) which uses the data for about 100-130 countries in 1990 to obtain a cross-sectional effect of trade on children's health. They find that for an average country, an increase of about 1 standard deviation in predicted trade as a share of GDP corresponds to approximately 4 fewer infant deaths per 1000 births. However, they do not use a panel data set like this study and hence are unable to capture how the change in trade affects change in infant mortality and this study extends the analysis to a period when a lot of South Asian and sub-Saharan African countries were undergoing trade liberalization. There are specific concerns of using cross-country growth regressions (Levine and Renelt, 1992) and by utilizing a panel data this study alleviates some of these concerns. The country specific effects are taken care by using a panel dataset to control for country level time invariant unobservables.

Theoretically, trade can affect child health either positively or negatively. Trade can improve health via increasing incomes and spurring economic growth or increasing public and private spending, and on the other hand deteriorate child health by overpopulation, decreasing environmental quality, or increasing inequality. It could also change the composition of employment and affect women's labor force participation in these sectors (Panda, 2020). Given the various pathways, it may be difficult to disentangle the effect of trade empirically. Using the gravity model to devise an instrumental variable approach, this study parses out the exogenous portion of trade and finds beneficial effect of trade on child health. This approach is similar to using the gravity models in the growth and trade literature by Frankel and Romer (1999) and Levine and Rothman (2006). Specifically, a 1% increase in openness leads to a 0.2% decrease in infant mortality across countries. There is considerable heterogeneity across countries, regions, and time. Both fixed effects and instrumental variable specification are used to test the robustness of the results. The main channels of operation are via increasing income, increasing health expenditures, and decreasing inequality.

DATA

A balanced panel has been obtained for carrying out this analysis. Panel Data or Longitudinal Data contains both the time and individual (or state or country) dimension with the same cross-sectional unit being surveyed overtime. This paper observes decadal changes and data from 171 countries over 2 years (1995 and 2005) are collected to achieve our objective. This time period is chosen as this decade saw both an acceleration of globalization activities as well as a considerable decline in infant mortality rates. Countries not included in the analysis are due to inconsistent/non availability of data. Some of the data on variables like primary education for females was missing and hence their values were imputed. The list of countries and variable definitions used in the analysis are given in the Appendix Table A1 and A2.

The country level statistics are taken from the World Development Indicators provided by the World Bank (The World Bank, 2012). Additional data on Trade openness, income, area, and population are collated from Penn World Table (PWT) 7.0 (Heston, Summers, and Aten, 2011) and CIA World Factbook. To measure child health, the main indicator used is infant mortality rates from the World Bank database. Infant mortality rate is the number of infants dying before reaching one year of age per 1,000 live births in a given year. There is a wide variation in infant deaths ranging from 2 to 160 in our dataset with mean infant deaths being 41 deaths per 1000, as shown in Table 1. The wide heterogeneity in infant deaths among regions is depicted in Appendix Table A3. While OECD, East Asia, and Europe experience much lower than average infant deaths, higher infant mortality rates are concentrated in Africa, South Asia, and the Middle East. The main variable of interest is openness at current prices; where openness is defined as volume of exports and imports as a percentage of current GDP, taken from PWT 7.0. The average openness in the sample is around 87%.

TABLE 1
SUMMARY STATISTICS

Variable	Observations	Mean	Min	Max
IMR	342	41.36	2.1	159.4
GDP Per Capita	342	7681.95	64.36	80959.44
Health Exp/GDP	342	5.94	1.01	16.25
Gini	342	40.31	19.49	74.33
Education	342	80.11	44.54	102.15
Sanitation	342	68.19	4	100
Urban	342	52.76	7.2	100
Muslim	342	0.26	0	1
Openness	342	86.66	0	442.47

EMPIRICAL ANALYSIS

As a first step, to understand the relationship a multivariate regression analysis (OLS) with panel data is carried out. The basic semi log regression is that of log IMR on Openness, log GDP per capita, log health expenditures as a share of GDP, women's LFPR, education of women, Gini coefficient, access to sanitation, Percentage of urban population, and dummy for Muslim dominated country and region. We are interested specifically in β_1:

$$\ln IMR_{it} = \beta_0 + \beta_1 Openness_{it} + \beta_2 \ln GDP_{it} + \beta_3 \ln Healthexp_{it} + \beta_4 LFPR_{it} + \beta_5 Urban_{it} + \beta_6 Gini_{it} + \beta_7 Primaryeduc_{it} + \beta_8 Sanitation_{it} + \beta_9 Muslim_i + \beta_{10} Region_i + \mu_t + e_{it} \quad (1)$$

The above specification controls for regional and time heterogeneity. Since infant mortality rates were falling in this decade, it is imperative to control for time trends (μ_t). Any heteroscedasticity is accounted for and robust standard errors are calculated. However, the OLS specification maybe prone to the problem of omitted variable bias. In such type of cross-country analysis, there might be country specific characteristics that affect both IMRs and Trade like country's ethnic makeup, colonial history, stance of government, whether democratic or not etc. which vary little overtime. If this is the case, then the coefficient on trade openness will be biased away from zero as it will capture these effects. By using *Fixed Effects Model*, we may be able to capture the time invariant country specific differences. Country specific dummies are introduced to capture the country specific impact on IMR. The fixed effects model can be written as:

$$\ln IMR_{it} = \lambda Openness_{it} + X_{it}\beta + \alpha_i + \mu_t + e_{it} \quad (2)$$

Where, αi is country specific heterogeneity, μ_t is a year dummy, X_{it} captures all the other independent variables included in OLS regression (1), i denotes country, and t denotes time. We are interested in estimating λ. As an additional robustness, both a fixed effects and random effects model specification is carried out and a Sargan-Hansen test is performed to determine the best fit.

Moreover, it may be argued that OLS estimates may be biased due to measurement error or endogeneity and reverse causality. It is well documented in the literature that both IMR, income and trade volumes are prone to mis-measurement. Though measurement error in the dependent variable is not a big problem, measurement error in independent variables may bias the coefficient down to zero. Since, we are interested in trade; it may be useful to employ an Instrumental Variable Estimation to try to resolve this problem. There may also exist reverse causality since healthy children tend to become more productive adults, earning higher incomes and demanding greater variety of goods and services, spurring trade. Therefore, to get unbiased estimates there is a need to develop an instrument which is correlated with trade but does not directly affect IMRs. The instrument needs to be valid and relevant.

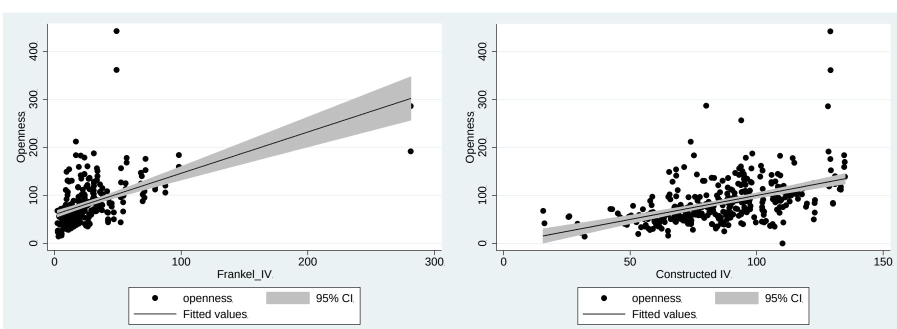
In the literature, geographical component of predicted trade has been used to predict trade as geography forms a vantage point for developing trade routes. Frankel and Romer (1999) developed a geographic cross-sectional gravity model. They argued, bilateral flows between countries i and j can mostly be modeled as a function of the distance between them (*Dij*), their populations (*Ni*), their areas (*Ai*), whether or not they are landlocked (*Li*), whether or not they share a common border (*Bij*), and several interactions:

$$\ln\left(\frac{T_{ij}}{GDP_i}\right) = b_0 + b_1 \ln D_{ij} + b_2 \ln N_i + b_3 \ln A_i + b_4 \ln N_j + b_5 \ln A_j + b_6 (L_i+L_j) + b_7 B_{ij} + b_8 B_{ij} \ln D_{ij} + b_9 B_{ij} \ln N_i + b_{10} \ln B_{ij} \ln A_i + b_{11} B_{ij} \ln N_j + b_{12} B_{ij} \ln A_j + b_{13} B_{ij} (L_i + L_j) + e_{ij} \quad (3)$$

The fitted values from the above equation are the predicted geographic component of each country's trade with each other in the world. For each country, these fitted values are summed to obtain the total predicted geographic component of trade. This fitted value of trade is used as an instrument. The Frankel and Romer's IV is available for only a subset of countries for the analysis. The data is taken from the AER paper by Frankel and Romer (1999). We need to drop our sample to 137 countries to run this analysis. This study instruments trade openness by this IV and re-estimates the effect of trade on child health.

Lastly, since it might be the case that Frankel's IV was developed for a cross section and it does not match the years that this analysis is looking at; it may not be the best fit. Considering that, this analysis also uses an own-constructed IV of predicted trade based on geographical features of the country. We use the data for total trade as a percentage of GDP as our left-hand side variable to predict the amount of trade these countries would have based on certain geographic features. We obtain the predicted trade share by modeling openness on population, area, if the country has a coastline, and interactions between population and areas. The fitted values provide a predicted trade share, which is used as an IV in subsequent analysis. A good IV should be relevant and valid. This is an instrument which is strongly correlated with trade openness but uncorrelated with the error term. We can check that the IV strongly correlates with actual trade by observing the F-statistic and correlation graph below. Validity is more difficult to check but there is no apparent reason why infant mortality rates will affect a country's geographical characteristics and consequently these geographic characteristics will affect IMR, apart from via trade.

FIGURE 1
FIT OF THE INSTRUMENTAL VARIABLES



Note: The graphs present the fit of the data with the Frankel IV (left) and the constructed IV (right). The black line is the linear prediction with the 95% confidence intervals represented by the gray shaded area.

RESULTS

Fit of Instruments

Figure 1 presents the fit of the IVs with the measure of trade openness used in the analysis. We observe that The Frankel IV is correlated when the trade openness is low but the confidence bandwidth increases as we move to higher level of openness. Especially for Singapore, with an openness at current prices of 450%, Frankel IV only predicts it to be around 80%. The constructed IV does better in fitting the data, with tighter confidence intervals.

Empirical Estimates

Table 2 presents the main results with different specifications. Across the specifications, we observe that higher openness leads to a decrease in infant mortality rates. Table 2, columns (1) and (2) are the OLS estimation results from the panel data. We see in both specifications (irrespective of inclusion of time trend), on average, a 1% increase in openness decreases IMR by 0.001 log points or 0.1%, holding other things constant. Other significant variables in the model are GDP per capita and inequality. An increase in GDP per capita leads to a decrease in IMR while increasing inequality increases infant deaths. Both female labor force participation and primary education for females lead to a lower infant mortality rate, but are statistically insignificant. It is possible that the effect of these two variables are actually captured via openness or increasing GDP per capita, leading us to not observe any significant individualized effects.

Since country heterogeneity and omitted variables maybe a concern, Table 2, (3) and (4) carry out a within-country fixed effects analysis (with and without time control) and observe a significant effect of openness in reducing infant mortality. The magnitude in (4) is similar to that observed in OLS specification. Interestingly, within a country, higher inequality leads to lower infant mortality rates. This is consistent with the Kuznets inverted U hypothesis, where initial levels of development lead to higher level of inequality. Moreover, female education and sanitation become a significant determinant of infant mortality rates across time within a country. This may point towards a greater level of heterogeneity across countries in these variables which could not be captured via OLS. A Random Effects model is also carried out. However, Sargan-Hansen statistics leads us to choose the Fixed Effects specification over the Random Effects specification. The Sargan-Hansen statistic is 44.253, overwhelmingly supporting the fixed effects specification over the Random Effects specification.

Lastly, Table 2 (5) and (6) present the Instrumental Variables estimates. First, we ensure that the instruments are valid. The corresponding F-statistics of the first stage regression are noted in Table 2. Both the instruments are valid, but the constructed IV is stronger, as was also seen in terms of fitting the data better in Figure 1. Both the equations are exactly identified. Using the Frankel IV, we observe that in Table 2 (5), openness has a smaller magnitude in decreasing infant mortality and is not significant. This could be because of the higher standard errors in the IV specification as Frankel IV may not be the best fit to the current data. Using the own constructed IV and controlling for regional and time heterogeneity in Table 2 (6), we see openness has a slightly higher impact on decreasing infant mortality, indicating OLS results may be slightly biased downwards. The magnitudes and signs of other variables are similar to the OLS specification. The Chi-Square statistic to test for endogeneity of regressor leads to reject the null of endogenous regressor being exogenous at 5% level. IV estimation in Table 2 (6) is preferred over OLS.

An increase in openness by 1% leads to a decrease in infant mortality rates by 0.2%, keeping everything else constant. With the sample mean at about 41 deaths per 1000, this leads to a reduction of about 8 infant deaths per 1000 live births. This is consistent with findings across the literature. Panda (2020) finds a particular trade policy affecting sub-Saharan Africa leads to a reduction of around 7 infant deaths per 1000 births. Levine and Rothman (2006) find 4 fewer infant deaths per 1000 live births in a cross-sectional setting.

TABLE 2
MAIN RESULTS

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Dependent Variable	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**
Openness	-0.0011** (0.0005)	-0.0011** (0.0005)	-0.0029*** (0.0008)	-0.0013** (0.0006)	-0.0008 (0.0008)	-0.0024*** (0.0007)
Log GDP per capita	-0.358*** (0.032)	-0.345*** (0.031)	-0.263*** (0.045)	-0.047 (0.046)	-0.332*** (0.034)	-0.335*** (0.031)
Health expenditure per capita	-0.132* (0.069)	-0.1102 (0.071)	-0.069 (0.095)	-0.0032 (0.072)	-0.097 (0.078)	-0.127* (0.069)
Inequality	0.016*** (0.0028)	0.016*** (0.0028)	-0.016** (0.063)	-0.0089* (0.005)	0.0136*** (0.0026)	0.016*** (0.0028)
Female LFPR	-0.0014 (0.0015)	-0.0009 (0.0015)	-0.0006 (0.0032)	0.0461 (0.022)	-0.0014 (0.0015)	-0.0008 (0.0015)
Female Education	-0.0085 (0.0065)	-0.0076 (0.0066)	0.087** (0.031)	0.046** (0.022)	-0.0087 (0.0068)	-0.0065 (0.0066)
Sanitation	-0.0031 (0.0028)	-0.0036 (0.0029)	-0.049*** (0.014)	-0.025** (0.106)	-0.0042 (0.0032)	-0.0035 (0.0028)
Time Trend	NO	YES	NO	YES	YES	YES
Region FE	YES	YES	NO	NO	YES	YES
Country FE	NO	NO	YES	YES	NO	NO
Specification	OLS	OLS	FE	FE	FRANKEL IV	CONSTRUCTED IV
F-Stat					41.31	84.85
Number of countries	171	171	171	171	137	171
Observations	342	342	342	342	274	342

Note: Other control variables included in the regressions are percentage of urban population, if it is a Muslim population dominated country, and region dummies. Robust standard errors are reported in brackets. Data are taken from PWT 7.0 and World Bank Development Indicators. Inequality is measured by Gini Index and varies from 0 to 100 with 0 being perfect equality. Female education is the primary education for females. Even though primary education numbers are available from World Bank, the data is sparse between years and therefore appropriate imputation has been carried out. Frankel IV data in (5) is taken from Frankel and Romer (1999). Other variable definition is described in the data section and the Appendix. Number of observations and number of countries varies depending on availability of data from different data sources.
*** Significant at 1% level, ** significant at 5% level, * significant at 10% level.

Robustness

I check that the robustness of the results in Table 3. In Table 3 (1), I drop Singapore from the estimation as it has very high openness levels and check if the outlier is driving the result. The estimates remain virtually unchanged from before. In Table 3 (2), I drop OECD countries which typically have much lower level of infant mortality rates and find that openness has a stronger impact on IMR. In Table 3 (3), I add nonlinearities in openness, both as the squared variable and squared IV. I still find significant and stronger effects of trade on health. In Table 3 (4), I restrict the sample to countries having openness below 200%, and by removing these outliers, I find similar effects on the remaining sample. Lastly, in Table 3 (5), I undertake fixed effects IV regression to account for country heterogeneity and find much larger effects in magnitude. However, it needs to be kept in mind that the constructed IV may actually perform best on a cross country sample rather than within country as geographical features will help in predicting trade across the nations better.

TABLE 3
ROBUSTNESS RESULTS

	(1)	(2)	(3)	(4)	(5)
Dependent Variable	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**
Openness	-0.0023***	-0.0028***	-0.0081**	-0.0026***	-0.0172***
	(0.0008)	(0.0008)	(0.0041)	(0.0008)	(0.0061)
F-Stat	107.31	51.76	49.36	122.46	5.39
Robustness	Drop Singapore	Drop OECD	Add Squared Trade	Restrict Openness< =200	Fixed effects IV
Number of countries	170	136	171	170	171
Observations	340	272	342	336	342

Note: The control variables are the same as the Constructed IV regression in the main results. Robust standard errors are reported in brackets. Number of observations and number of countries varies depending on restrictions placed on the data.
*** Significant at 1% level, ** significant at 5% level, * significant at 10% level

PATHWAYS

This paper also looks at four possible channels through which trade affects child's health: income, health expenditures, women's labor force participation, and inequality. For these channels, I regress each of them on constructed IV, region, and time dummy. This shows the importance of each channel. Then, I get the predicted value of these channels that the constructed IV predicts, to observe the effect on IMR, after controlling for other regressors. The results are presented in Table 4.

Table 4 (Panel 1) suggests that trade increases GDP per capita and health expenditures. The income result is consistent with Dollar (1992) and Dollar and Kraay (2002) who find a strong positive effect of trade on growth after controlling for changes in other policies and addressing endogeneity with internal instruments. Levine and Rothman (2006) also find similar channels by which trade affected health i.e. increasing incomes and public health expenditures. In this large sample of countries, trade leads to a decrease in inequality, controlling for year and region effects as shown in Table 4 (Panel 1). Dobson & Ramlogan (2009) show that in Latin American countries, inequality increases with trade openness until a critical level of openness is reached after which inequality begins to fall. Dollar and Kraay (2002) find no systematic relationship between changes in trade and changes in inequality. At the macro level, trade masks the within-sector movement of employment and the study finds no significant effects on women's labor force participation rates.

In Table 4 (Panel 2), I show the effect of the predicted income, health expenditures, inequality, and women's labor force participation due to the constructed trade share on infant mortality. Trade increases incomes and leads to a reduction in infant deaths. Similarly, by increasing health expenditures, trade may help reduce infant mortality through increased access to better health care facilities as seen in Table 4 (Panel 2 (2)). Trade reduces inequality and since higher inequality leads to higher infant deaths (Table 4, Panel 2 (3)), we see an overall beneficial effect of trade. Fosu (2017) describe the importance of inequality that may limit the effectiveness of growth in reducing poverty and provide evidence of growing inequality increasing poverty. Given that trade is able to increase incomes and reduce inequality, it acts as a double-edged sword in reducing infant mortality. Lastly, if trade increases women's labor force participation, that may lead to reduced infant deaths due to either increasing household income or increasing bargaining power of women in the household. The study finds an insignificant increase in women's labor force participation rate.

TABLE 4
PATHWAYS

Panel 1:

	(1)	**(2)**	**(3)**	**(4)**
Dependent Variable	GDP per capita	Health Exp	Inequality	Women's LFPR
Constructed IV	0.0136***	0.0018**	-0.037*	0.0030
	(0.0025)	(0.0008)	(0.021)	(0.034)
Region and Time Dummy	YES	YES	YES	YES
Observations	342	342	342	342

Panel 2:

	(1)	**(2)**	**(3)**	**(4)**
	GDP per capita	Health Exp	Inequality	Women's LFPR
Predicted Variables on IMR	-0.401***	-1.55***	0.073***	-0.877***
	(0.069)	(0.395)	(0.021)	(0.256)
Region and Time Dummy	YES	YES	YES	YES
Observations	342	342	342	342

Note: In Panel 1, Each of the channel is regressed on the constructed IV and therefore are all separate regressions. In Panel 2, the predicted share of the channel due to trade as calculated through Panel 1 is regressed on IMR along with other control variables as in the main results. Robust standard errors are reported in brackets.
*** Significant at 1% level, ** significant at 5% level, * significant at 10% level

CONCLUSION

This paper finds a beneficial effect of trade on child health by utilizing a sample of 171 countries over a decade and using a gravity model to overcome the problem of endogeneity. On average, 1% increase in openness leads to a fall in infant mortality rates by at least 0.2%, which at the sample mean means about 8 infant deaths per 1000 live births. Given that the mean infant mortality rates are 74.8 in Africa in the sample, that leads to a reduction of about 15 infant deaths (See Appendix Table A3 for regional variation in infant mortality rates). This is a sizeable impact, which is robust to country specific time invariant heterogeneity as well as outliers. The main channels of operation seem to be through increasing incomes, increasing health expenditures, and decreasing inequality. There is also evidence of wide heterogeneity among regions.

Since there are data limitations on cross-country indicators, measurement error could be a problem. This study tries to minimize it by using instrumental variables for the main variable of interest. However, measurement error may be biasing some other variables down. While the fixed effects specification does control for time invariant country heterogeneity, it may be increasing the problem of measurement error. With measurement error already in the data, it makes the estimates to be biased down. The IV estimates are most consistent asymptotically and are the preferred specification. Given the heterogeneity, further research may be useful in a country specific case study. Women's labor force participation is insignificantly affected by trade at the macro level in the analysis. However, household responses to a changing economy and shifts between different employment sectors may be masked when the analysis is performed at this level. A careful analysis of changing composition of industries at the country level may reveal the various pathways through which trade can affect child health and development.

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Appendix Table A1: List of 171 countries included in the analysis

Afghanistan	Ecuador	Macedonia, FYR	St. Lucia
Albania	Egypt, Arab Rep.	Madagascar	St. Vincent and the Grenadines
Algeria	El Salvador	Malawi	Sudan
Angola	Equatorial Guinea	Malaysia	Suriname
Argentina	Eritrea	Maldives	Swaziland/Eswatini
Armenia	Estonia	Mali	Sweden
Australia	Ethiopia	Malta	Switzerland
Austria	Fiji	Mauritania	Syrian Arab Republic
Azerbaijan	Finland	Mauritius	Tajikistan
Bahamas, The	France	Mexico	Tanzania
Bahrain	Gabon	Moldova	Thailand
Bangladesh	Gambia, The	Mongolia	Timor-Leste
Barbados	Georgia	Morocco	Togo
Belarus	Germany	Mozambique	Tonga
Belgium	Ghana	Namibia	Trinidad and Tobago
Belize	Greece	Nepal	Tunisia
Benin	Guatemala	Netherlands	Turkey
Bhutan	Guinea	New Zealand	Turkmenistan
Bolivia	Guinea-Bissau	Nicaragua	Uganda
Bosnia and Herzegovina	Guyana	Niger	Ukraine
Botswana	Haiti	Nigeria	United Arab Emirates
Brazil	Honduras	Norway	United Kingdom
Brunei Darussalam	Hungary	Oman	United States
Bulgaria	Iceland	Pakistan	Uruguay
Burkina Faso	India	Panama	Uzbekistan
Burundi	Indonesia	Papua New Guinea	Vanuatu
Cambodia	Iran, Islamic Rep.	Paraguay	Venezuela, RB
Cameroon	Iraq	Peru	Vietnam
Canada	Ireland	Philippines	Yemen, Rep.
Cape Verde	Israel	Poland	Zambia
Central African Republic	Italy	Portugal	
Chad	Jamaica	Qatar	
Chile	Japan	Romania	
China	Jordan	Russian Federation	
Colombia	Kazakhstan	Rwanda	
Comoros	Kenya	Samoa	
Congo, Dem. Rep.	Korea, Rep.	Sao Tome and Principe	
Congo, Rep.	Kuwait	Saudi Arabia	
Costa Rica	Kyrgyz Republic	Senegal	
Cote d'Ivoire	Lao PDR	Sierra Leone	
Croatia	Latvia	Singapore	
Cuba	Lebanon	Slovak Republic	
Cyprus	Lesotho	Slovenia	
Czech Republic	Liberia	Solomon Islands	
Denmark	Libya	South Africa	
Djibouti	Lithuania	Spain	
Dominican Republic	Luxembourg	Sri Lanka	

Appendix Table A2: Variables definitions

Variables	Definitions	Source
Ln IMR	Infant mortality rate is the number of infants dying before reaching one year of age, per 1,000 live births in a given year. Natural logarithmic transformation of IMR is used.	World Development Indicators, World Bank
Ln GDP (per capita)	Gross domestic product divided by midyear population. Natural logarithmic transformation of this indicator is used.	World Development Indicators, World Bank
LFPR – Female labor force participation rate as % of female pop age >15	Women's labor force participation rate - proportion of the women population ages 15 and older that is economically active	World Development Indicators, World Bank
Total health expenditure as % of GDP (log)	Total health expenditure is the sum of public and private health expenditure. It covers the provision of health services (preventive and curative), family planning activities, nutrition activities, and emergency aid designated for health but does not include provision of water and sanitation. Natural logarithmic transformation is used.	World Development Indicators, World Bank
Openness – Total trade as % of current GDP	Openness at current prices; defined as volume of exports and imports as a percentage of current GDP	Penn World Table (PWT 7.0)
Sanitation - %age of population with access to sanitation	Access to improved sanitation facilities refers to the percentage of the population with at least adequate access to excreta disposal facilities that can effectively prevent human, animal, and insect contact with excreta.	World Development Indicators, World Bank
Urban - %age of people living in urban areas	Urban population refers to people living in urban areas as defined by national statistical offices.	World Development Indicators, World Bank
Gini – Gini coefficient to measure inequality	Gini index measures the extent to which the distribution of income among individuals or households within an economy deviates from a perfectly equal distribution. Gini index of 0 represents perfect equality, while an index of 100 implies perfect inequality.	World Development Indicators, World Bank; CIA Factbook
Primary education completion rate, females	Percentage of female students completing the last year of primary school. It is taken as a measure/extent of education achieved by females/mothers in this model. For some countries for which education data points were not available, the region average (based on income and geography etc.) was used to impute the values.	World Development Indicators, World Bank
Muslim	Dummy variable taking the value 1 if a country is predominantly Muslim	List of predominantly Muslim countries, CIA Factbook

Appendix Table A3: Regional Heterogeneity

Region	**Mean (IMR)**
Africa (reg 1)	74.81
East Asia (reg 2)	5.26
East Europe (reg 3)	12.7
Latin America (reg 4)	25.41
Middle East (reg 5)	28.99
OECD (reg 6)	5.585
South Asia (reg 7)	40.74