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Trade and economic growth: A re-examination of the empirical evidence

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Abstract

While trade integration is often regarded as a principal determinant of economic growth, the empirical evidence for a causal linkage between trade and growth is ambiguous. This paper argues that the effect of trade in dynamic panel estimations depends crucially on the specification of trade. Both from a theoretical as well as an empirical point of view one specification is preferred: the volume of exports and imports as a share of lagged total GDP. For this trade measure, a positive and highly significant impact on economic growth can be found.

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1. Introduction

The integration of countries into the world economy is often regarded as an important determinant of differences in income and growth across countries. Economic theory has identified the well-known channels through which trade can have an effect on growth. More specifically, trade is believed to promote the efficient allocation of resources, allow a country to realize economies of scale and scope, facilitate the diffusion of knowledge, foster technological progress, and encourage competition both in domestic and international markets that leads to an optimization of the production processes and to the development of new products.[1] In particular for less-developed countries, trade patterns and changes in those patterns over time are closely associated with the transfer of technology. Also, openness to trade introduces the possibility of an international product cycle, as the production of certain products previously produced by advanced economies migrates to less-developed countries. This process of "product migration" is accompanied by an increase in the trade volumes of less-developed countries and a diffusion of more advanced production technologies, which expands the technology available to less-advanced countries.[2]

The effect of trade policy on income and growth is more controversial.[3] On the one hand, lowering trade barriers is likely to foster international trade by reducing transaction costs, which in turn can enhance economic growth rates. Likewise, it can be argued that developing countries or emerging market economies that are more open to the rest of the world have a greater ability to absorb technologies developed in more advanced nations. On the other hand, it has been argued that some forms of protectionism, e.g., infant industry protection to develop certain industries or sectors or a strategic trade policy in key sectors, can be beneficial for economic development.

Not surprisingly, the empirical literature has analyzed both the impact of trade policies and trade volume on economic growth extensively. Rodríguez and Rodrik (2001) argue that both effects are related as a matter of course but pose conceptually distinct questions and have quantitatively (or even qualitatively) different outcomes. Trade policies can be seen as responses to market imperfections or as mechanisms of rent seeking. Trade restrictions induced by such policies have a different impact on trade volumes than other constraints due to transport costs or shifts in consumer preferences. The main challenge of empirically analyzing the effect of trade policy has been to find adequate measures of trade restrictions and trade policy. The employed measures range from (weighted) average tariff rates, the extent of non-tariff barriers or price-distortion indexes to more complex composed indicators that include a detailed classification of countries with respect to their degree of openness.[4]

Similar to the impact of trade policy on growth rates, the empirical evidence for the trade volume is ambiguous too, as the methodologies used as well as the robustness of the results have been challenged (Rodríguez and Rodrik 2001, Rodríguez 2007). As a measure of the trade volume, the overwhelming majority of papers use the trade ratio, that is, exports plus

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[1] See Krugman (1979), Grossman and Helpman (1991), Young (1991), Lee (1993), Rodríguez and Rodrik (2001), Bernard et al. (2003), Obstfeld and Taylor (2003) and Bernard and Jensen (2004).

[2] See Krugman (1979) drawing on the idea of Vernon (1966).

[3] See Grossman and Helpman (1991), Rivera-Batiz and Romer (1991), Barro and Sala-i-Martin (1997) and Edwards (1998).

[4] See Dollar (1992), Ben-David (1993), Sachs and Warner (1995), Edwards (1998), Warner (2003), Dollar and Kraay (2004), Sala-i-Martin et al. (2004), Wacziarg and Welch (2008), and Manole and Spatareanu (2010). Yanikkaya (2003) provides an extensive survey of the literature.

imports as a share of GDP. As the dependent variables, these studies use either economic growth rates or income levels.[5]

In this paper, we will re-examine the impact of the trade volume on economic growth. Our contribution to the literature is mainly methodological. Two main aspects are addressed. Firstly, we discuss (and test) various indicators for trade in empirical growth regressions. One particular indicator emerges as our preferred choice both from a theoretical as well as an empirical point of view: the volume of exports and imports as a share of lagged total GDP. This trade measure avoids a potential bias due to simultaneous changes of both the nominator, volume of exports and imports, and the denominator, total GDP. Secondly, we use an appropriate econometric method for estimating the impact of trade on economic growth, that is, the System GMM estimator. This estimator is highly suitable for dynamic panel models to address various econometric challenges, including endogeneity problems.

The remainder of the paper proceeds as follows: In the following section, we present the econometric model that builds on the augmented Solow growth model but allows technology to differ across countries with trade as the main determinant of that difference. In addition, Section 2 introduces the specific variables used in our empirical investigation, including various trade variables. Section 3 presents the empirical evidence and concludes with a summary of the main findings.

2. Econometric Model, Data and Variables

Starting point of our analysis is the augmented Solow growth model, which has been used in many previous empirical growth studies, e.g., by Mankiw et al. (1992). In that model, growth, measured as the difference between the logarithm of output per worker in periods t and t-1, is determined – above all – by the level of technology (A_t), the rate of technological progress (g), the initial output per worker (y_0), the saving rate (s_k), the depreciation rate (δ), the growth rate of the labor force (n) and investment in human capital (s_h). It is assumed the level of technology at any given point in time depends on every country's initial level of technology while the growth rate of technology is constant across all countries. There is, however, a country-specific technology component that differs across countries. Trade can then modelled as the main country-specific determinant of technological progress. As a consequence, this model allows for a combination of the properties of the augmented Solow model with more realistic assumptions about a country-specific development of the technology level. The econometric model reads as follows:

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\begin{aligned}
lny_{it} - lny_{it-1} = \; & \alpha + \beta_1 lny_{it-1} + \beta_2 lns_{k,it} + \beta_3 ln\, s_{h,it} + \beta_4\, ln(n_{it} + g + \delta) \\
& + \phi_j X_{j,it} + \tau_t + \eta_i + \nu_i
\end{aligned}
\qquad (1)
$$

Where lny_{it} stands for the log of GDP per capita in country i in period t and X_j represent the various trade variables of main interest. The model includes period-specific intercepts (τ_t), accounting for period-specific effects like changes in productivity affecting all countries, country-specific fixed-effects (η_i) and an independent and identically distributed error term (ν_i).

Estimating the above model, however, is plagued by some well-known difficulties. The explanatory variables are potentially endogenous and measured with error. Some

[5] See Romer and Frankel (1999) for a seminal contribution using measures of the geographic component of a country's trade as instruments to address the endogeneity problems involved. For more recent contributions, see Noguer and Siscart (2005), Feyrer (2009) and Squalli and Wilson (2011).

important variables, e.g., the initial level of technology and other country-specific effects, are not observable and omitted in the estimation. Estimating this dynamic panel data model by ordinary least squares (OLS) or within group estimations will potentially lead to biased results. To solve this problem, we use the System GMM estimator suggested by Arellano and Bover (1995) and Blundell and Bond (1998). The System GMM estimator does not require any external instruments but uses lagged levels and differences between two periods as instruments for current values of the endogenous explanatory variables. The procedure simultaneously estimates a system of equations that consists of both first-differences as well as levels of the estimation equation. Taking first differences eliminates country-specific fixed-effects and solves the problem of the potential omission of the initial level of technology and other time invariant country-specific factors influencing growth. This approach ensures that we can concentrate on the impact of the explanatory variables on income per capita growth and not vice versa.

The panel dataset consists of up to 108 countries covering the period 1971-2005 (1970-2005 for the GDP per capita variable).[6] Unfortunately, data is not available for all countries for the first periods resulting in a slightly unbalanced panel. To reduce the impact of business cycles we use a total of seven five-year averages for all variables, 1971-1975, 1976-1980 and so on, until 2005. As dependent variable, we use the growth rates of income calculated as the difference in the logarithm of GDP per capita (in constant 2000 US dollars) between the last year of the previous period and the last year of the period under consideration (the variable is labeled as Δ*GDPpc*).[7]

In our model, we include the control variables of the core Solow model following the specification of Mankiw et al. (1992). The saving rate (s_k) is approximated by the investment share of real GDP per capita in current prices (*InvestmentShare*). For the growth rate of the labor force (n), we use the average population growth rate which is the difference between the logarithm of total population at the beginning and the end of the period. As in Mankiw et al. (1992), the growth rate of the world technology frontier (g) and the depreciation rate (δ) are assumed to be constant across countries. The term $\ln(n + g + \delta)$ is calculated as the logarithm of the population growth rate and 0.05 p.a. ($g + \delta$) as a constant (*PopulationGrowth*). Investment in human capital (s_h) is approximated by educational attainment, more precisely the average years of secondary schooling in the total population over age 15 (*Education*). To control for economic convergence, we include the initial level of GDP per capita (*GDPpc (t-1)*). In an additional regression, which serves also as a robustness check, we add the inflation rate (*Inflation*) to control for macroeconomic distortions and a broader democracy indicator (*PoliticalRegime*) to account for the type of the political regime. The first variable is measured by changes in the consumer price index whereas the second one refers to the Polity IV combined indicator for democracy and autocracy, ranging from -10 (strongly autocratic) to +10 (strongly democratic).

There is no unique indication in which manner trade should enter growth estimations. A commonly used measure in the analyses of the relationship between trade and growth is total trade volume (of both goods and services) as a share of total GDP (*TradeShare*). The trade-to-GDP ratio is often referred to as the "trade openness ratio". The term does not

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[6] See Appendix A for data sources and Appendix C for a list of countries included. Descriptive statistics can be found in Appendix B.

[7] The results are not sensitive to alternatively using the difference between the first and the last year of the current period. The Solow model suggests using GDP per worker instead of GDP per capita which might be important if dependency ratios vary across countries. Mankiw et al. (1992) use per worker data while other authors, e.g., Caselli et al. (1996) and Islam (1995), use per capita data. Hoeffler (2002) has found that results are not sensitive to either choice.

necessarily imply low tariffs or low non-tariff barriers but simply measures how much of a country's GDP is traded. In a dynamic panel setting, we argue that the trade-to-GDP ratio is not suitable to measure correlation or causality between trade and growth. If trade in general has a positive impact on growth in the sense that increasing trade (volumes) does increase GDP through the channels described above, the "trade openness ratio" fails to adequately capture this effect over time. Depending on the elasticity of trade on GDP, increasing the trade volume might increase GDP in a proportionately larger, smaller or exactly equal way. Consequently, the "trade openness ratio" can either increase, decrease or stay the same due to an increase in trade and its corresponding changes in GDP. A positive impact of trade on GDP can lead to a decrease in the "trade openness ratio" as an increase of the numerator might be offset by a larger increase of the denominator.

We propose a solution to that problem by using lagged values of total GDP for the "trade openness ratio" instead of trade volume and GDP of the same period. Using lagged values has the same effect of normalizing trade volumes across countries but that ratio does not suffer from biases due to simultaneous changes in both variables. *TradeShare (GDP t-1)* is calculated as exports and imports of goods and services in current US$ divided by total GDP in current US$ lagged by one period.

Furthermore, we use the logarithm of total trade volume (*Trade*). This variable follows the assumption that, abstracting from the actual size of a country, trading more may be associated with having access to a larger pool of technology. Focusing on the growth rate of total trade volume (*TradeGrowth*) assumes that it is especially the expansion of trade and its associated access to supplementary technologies that boosts growth. Another approach for relating trade to the size of a country is to divide trade by total population yielding a measure of trade per capita (*TradePop*). The intuition of that variable is not apparent straight away. In contrast to physical capital and labor that enter the production function in per capita terms, advances in technology can be implemented simultaneously by several individuals. Overall, the choice of our trade indicators is motivated by the intention to replicate the results of previous studies using a different econometric technique (System GMM). At the same time, we intend to compare the results of our preferred trade variable *TradeShare (GDP t-1)* with other trade variables that have been used before.

In general, System GMM estimation results are quite sensitive with respect to the treatment of right hand side variables as predetermined, endogenous or strictly exogenous. In our model the only variables that are strictly exogenous are the year dummies. Theory serves as a guideline for classifying the remaining variables. The lagged GDP per capita and the education variable can be treated as predetermined.[8] Lagging these variables by at least one period yields valid instruments for the equation in differences and correspondingly their first differences valid instruments for the equation in levels. The investment rate as a share of GDP, the population growth rate and all different trade variables are treated as endogenous since contemporary shocks are likely to affect both GDP per capita growth rates as well as those explanatory variables. To obtain valid instruments for the endogenous explanatory variables, observations lagged by at least two periods are used.

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[8] Education data is collected every 5 years by Barro and Lee (2010). We include the educational attainment at the start of each period, e.g., the observation of 1970 for the period 1971-1975 in the estimation equation and subsequently treat that variable as predetermined. This has been done in a similar form by Hoeffler (2002). A different possibility would be to take the average of two consequent observations and treat the education variable as either predetermined or endogenous. Our results are not sensitive to either choice.

3. Empirical Results

Following the model specification and the introduction of the variables, we now turn to the empirical results. As a benchmark, we first focus on the augmented Solow model that explains differences in GDP per capita growth across countries and time with the initial level of GDP per capita, the investment rate, population growth and human capital. The first three columns of Table I present the estimation results of the augmented Solow model obtained by using different estimation techniques: OLS (column 1), fixed-effects estimation (column 2) and System GMM (columns 3 and 4). In dynamic panel data models, due to potentially endogenous estimators the results of the OLS estimation may be biased upwards while the results of the fixed-effects estimation may be biased downwards. The System GMM results should be somewhere in between both biased results. The OLS estimation (column 1) yields a relatively high coefficient of the initial level of GDP per capita while for the fixed-effects estimation (column 2) the coefficient has considerably decreased in magnitude. The coefficient of the initial level of GDP per capita obtained by the System GMM estimation (column 3) lies comfortably between both albeit closer to the OLS results. For the System GMM regression, all other variables of the augmented Solow model have the expected sign. The investment rate as a share of GDP (*InvestmentShare*) has a positive and highly significant coefficient. Increases in population growth (*PopulationGrowth*) have a significantly negative effect on GDP per capita growth rates and the influence of investment in human capital (*Education*) is positive and significant at the conventional 10 per cent level.

The Sargan/Hansen test of overidentifying restrictions confirms the joint validity of our instruments. The p-value of the Arellano-Bond test for second-order correlation in differences (Ar(2)-Test) rejects first-order serial correlation in levels.[9] In the System GMM regression of column 3, all realizations of the potentially endogenous explanatory variables lagged by two periods and more have been included as instruments. In the case of the education variable, the realization lagged by one period serves as an additional valid instrument. As we use lagged levels and lagged differences, the number of instruments can be quite large. Yet too many instruments can overfit the model and also weaken the power of the Sargan/Hansen test. Thus, we reduce the size of the instrument matrix by restricting the number of lags used.[10] In the next step, we therefore replicate the estimation reducing the number of instruments. In column 4 only the first available instrument has been employed. Changing the lag-structure does not fundamentally alter our results. Only the coefficient of the *Education* variable drops slightly below the 10 per cent level of confidence. All test statistics confirm the validity of instruments for the reduced lags. Both our System GMM regressions (column 3 and 4) are very much in line with other applications of that estimation technique to test the augmented Solow model.[11]

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[9] Another Arellano-Bond test confirms that we do have the required first-order serial correlation (not reported). We also test for unit roots using the Fisher test for unbalanced panels. The results indicate that we do not have unit roots (not reported).

[10] In column 3 the total number of instruments is below the number of countries. However, the extensive lag-structure limits the possibility of adding further endogenous explanatory variables that require additional instruments and easily increases their number to a critical amount. In additional regressions, we further reduce the number of instruments by using only one lag per endogenous variable as well the collapse option in Stata. But the results hardly change. All non-reported results can be obtained from the authors upon request.

[11] We are able to replicate the basic findings of previous works, e.g., Bond et al. (2001) and Hoeffler (2002).

Table I: Benchmark Regressions and Different Trade Variables

Independent Variables	(1) OLS	(2) FE	(3) Sys. GMM	(4) Sys. GMM	(5) Sys. GMM	(6) Sys. GMM	(7) Sys. GMM	(8) Sys. GMM	(9) Sys. GMM	(10) Sys. GMM
GDPpc (t-1)	-0.031*** (-3.711)	-0.211*** (-6.885)	-0.0597*** (-2.638)	-0.0484** (-2.320)	-0.0408** (-2.235)	-0.0675*** (-3.730)	-0.0453** (-2.211)	-0.0507*** (-3.110)	-0.140** (-2.202)	-0.0486** (-2.572)
InvestmentShare	0.0940*** (5.339)	0.103*** (4.495)	0.178*** (5.402)	0.183*** (5.946)	0.181*** (5.088)	0.0919** (2.199)	0.172*** (3.989)	0.157*** (3.781)	0.139*** (3.161)	0.0882** (2.299)
PopulationGrowth	-0.205*** (-3.677)	-0.147 (-1.407)	-0.333*** (-2.878)	-0.256** (-2.065)	-0.285** (-2.277)	-0.486*** (-3.220)	-0.401* (-1.956)	-0.381** (-2.408)	-0.456** (-2.019)	-0.648*** (-3.718)
Education	0.0189 (1.227)	-0.0524** (-2.310)	0.0668* (1.755)	0.0586 (1.438)	0.0367 (1.064)	0.0702* (1.930)	-0.00252 (-0.0678)	0.0369 (1.173)	0.00833 (0.234)	0.0435 (1.163)
TradeShare					-0.0123 (-0.220)					
TradeShare (GDP t-1)						0.0865** (2.575)				0.0687** (2.175)
Trade							0.00820 (0.421)			
TradeGrowth								1.159*** (3.863)		
TradePop									0.100* (1.821)	0.100* (1.821)
Inflation										-0.0041 (-0.288)
PoliticalRegime										-0.0046 (-1.525)
Observations	752	752	752	752	707	707	612	612	612	594
Number of Countries	108	108	108	108	107	107	94	94	94	99
Number of Instruments			90	40	49	49	49	49	49	67
Sargan/Hansen			0.353	0.210	0.405	0.292	0.314	0.314	0.188	0.435
Ar(2)-Test			0.592	0.620	0.766	0.781	0.777	0.777	0.724	0.747

Notes: * significant at 10% level; ** significant at 5% level; *** significant at 1% level; t-values reported in parentheses; constant term and time dummies always included; Ar(2)-Test refers to the Arellano-Bond test for second-order correlation in differences (p-values); Sargan/Hansen test of overidentifying restrictions (p-values).

Having established a valid benchmark, we subsequently include our main variable of interest: trade. The first candidate is the widely used *TradeShare* variable (column 5), which is the total trade volume divided by total GDP of the same period. Including that additional variable does not fundamentally alter the results of the benchmark regression but the coefficient of the trade variable is negative and not significant. As argued above, we do not believe that this *TradeShare* variable adequately captures the impact of trade on GDP per capita growth.

Including our preferred measure of that influence, *TradeShare (GDP t-1)*, fundamentally changes the regression results for the impact of trade on GDP per capita growth (column 6). *TradeShare (GDP t-1)* has a positive coefficient and is significant at the 5 per cent level of confidence. At the same time, the control variables of the augmented Solow model maintain their expected influence and all test statistics confirm the validity of our instruments. An increase in the volume of exports and imports divided by total GDP of the previous period, *TradeShare (GDP t-1)*, by one unit at the mean (106.0) is associated with an increase in GDP per capita growth of 0.08 percentage points over a period of five years. For an interpretation of the economic significance, it has to be taken into account that the *TradeShare (GDP t-1)* variable varies considerably across countries or over time. Using our alternative trade share variable in combination with the valid instrumentation of the System GMM estimator allows us to establish a causal relation between trade and differences in GDP per capita growth. Trade does have a positive impact on GDP per capita growth and our results show that it indeed matters in which way trade enters empirical growth regressions.

We then turn to the additional trade indicators. For the logarithm of total trade volume, *Trade*, no significant results can be found (column 7). The average growth rate of trade, *TradeGrowth*, has a positive and highly significant effect (column 8). An increase in *TradeGrowth* by one unit increases GDP per capita growth by 1.16 percentage points (over 5 years). Including trade divided by a country's total population, *TradePop* (column 9), yields a positive and significant effect as well. The marginal effect at the mean of a one unit increase of *TradePop* (4565.26 US$) is an increase in GDP per capita growth of 0.002 percentage points over a period of five years. Employing alternative trade measures confirms the significant influence of trade on GDP per capita growth. Finally, we control for two additional potential determinants of economic growth (*Inflation* and *PoliticalRegime*). To save space, we test the impact using *TradeShare (GDP t-1)* only. The results hardly change in case of these additional controls (column 10).

Next, we examine whether both channels of how trade influences GDP per capita growth – via the absolute volume of trade (or alternatively the volume divided by total GDP or population) and its growth rate – can be substantiated even if they occur simultaneously. Table II shows the regression results where we include both the *TradeGrowth* variable and one of our additional trade measures in the analysis. First of all, we focus on the conventional *TradeShare* variable (column 1). While the growth rate of trade, *TradeGrowth*, has a positive and highly significant effect, the additional *TradeShare* variable is not significant, reflecting our results from Table I. When we include our novel *TradeShare (GDP t-1)* variable, both *TradeGrowth* and *TradeShare (GDP t-1)* have a positive and highly significant effect (column 2). In column 3 *TradeGrowth* and *Trade* are included. The results confirm the importance of *TradeGrowth* while no evidence can be found for the logarithm of total trade volume. Finally, in column 4 both *TradeGrowth* and *TradePop* are included which yields significant results for both variables. The results of Table II once more confirm the adequateness and robustness of our *TradeShare (GDP t-1)* variable. In addition, we show that both channels, trade and the expansion of trade, have an independent impact on GDP per capita growth.

Table II: TradeGrowth and TradeShare

Independent Variables	(1)	(2)	(3)	(4)
	System GMM			
GDPpc (t-1)	-0.0425** (-2.503)	-0.0599*** (-3.199)	-0.0518*** (-3.070)	-0.121** (-2.576)
InvestmentShare	0.161*** (3.565)	0.0835* (1.804)	0.139*** (3.244)	0.118*** (2.992)
PopulationGrowth	-0.373** (-2.431)	-0.556*** (-3.310)	-0.386** (-2.249)	-0.421*** (-2.617)
Education	0.0135 (0.434)	0.0487 (1.351)	0.0311 (1.101)	0.0312 (1.062)
TradeGrowth	1.118*** (3.883)	1.087*** (3.382)	1.172*** (4.255)	1.047*** (3.858)
TradeShare	-0.00158 (-0.0303)			
TradeShare (t-1)		0.0614* (1.887)		
Trade			0.00565 (0.289)	
TradePop				0.0758* (1.771)
Observations	606	606	612	612
Number of Countries	94	94	94	94
Number of Instruments	58	58	58	58
Sargan/Hansen	0.366	0.634	0.192	0.141
Ar(2)-Test	0.342	0.216	0.321	0.293

Notes: * significant at 10% level; ** significant at 5% level; *** significant at 1% level; see Table I for further notes.

It is obvious to ask if our results for total trade hold true for imports and exports independently as well. Table III repeats the exercise we have done for total trade for its two components, showing a similar picture: *ExportShare* (column 1) with the current realization of total GDP as its denominator is not significant. Employing the 5 year lagged realization of total GDP, *ExportShare (GDP t-1)*, yields positive and significant results for the export measure (column 2). The coefficient of the logarithm of total export volume, *Exports* (column 3), is not significant while the average growth rate of exports, *ExportGrowth* (column 4) and *ExportPop* (column 5), are again positive and significant. The results for the import variables (columns 6-10) are qualitatively almost the same as for the export variables with the exception of *ImportPop* (column 10).[12]

[12] Both imports and exports are highly correlated (with a correlation coefficient of 0.85 for the observations included in our sample).

Table III: Exports and Imports

Independent Variables	(1)	(2)	(3)	(4)	(5)	Independent Variables	(6)	(7)	(8)	(9)	(10)
	System GMM						System GMM				
GDPpc (t-1)	-0.0414** (-2.160)	-0.066*** (-3.656)	-0.0390* (-1.882)	-0.0308* (-1.697)	-0.118** (-2.108)	GDPpc (t-1)	-0.0413** (-2.202)	-0.066*** (-3.545)	-0.0477** (-2.304)	-0.049*** (-2.830)	-0.107* (-1.734)
InvestmentShare	0.178*** (5.237)	0.109*** (2.826)	0.155*** (3.816)	0.133*** (3.279)	0.145*** (3.963)	InvestmentShare	0.175*** (4.781)	0.0846* (1.890)	0.181*** (4.077)	0.189*** (4.508)	0.160*** (3.366)
PopulationGrowth	-0.276** (-2.178)	-0.468*** (-3.179)	-0.345* (-1.804)	-0.339** (-2.192)	-0.447** (-2.164)	PopulationGrowth	-0.279** (-2.253)	-0.475*** (-3.096)	-0.407* (-1.912)	-0.347* (-1.839)	-0.426* (-1.763)
Education	0.0460 (1.294)	0.0573 (1.498)	-0.0130 (-0.368)	0.0130 (0.431)	-0.0109 (-0.309)	Education	0.0369 (1.036)	0.0782** (2.217)	0.00544 (0.143)	0.0304 (0.842)	0.0152 (0.426)
ExportShare	-0.00420 (-0.0893)					ImportShare	0.00397 (0.0688)				
ExportShare (GDP t-1)		0.0731** (2.437)				ImportShare (GDP t-1)		0.0891** (2.572)			
Exports			0.0171 (0.919)			Imports			0.00474 (0.230)		
ExportGrowth				1.205*** (4.124)		ImportGrowth				0.639** (2.484)	
ExportPop					0.0834* (1.764)	ImportPop					0.0626 (1.157)
Observations	707	707	612	612	612	Observations	707	707	612	612	612
Number of Countries	107	107	94	94	94	Number of Countries	107	107	94	94	94
Number of Instruments	49	49	49	49	49	Number of Instruments	49	49	49	49	49
Sargan/Hansen	0.508	0.318	0.314	0.215	0.147	Sargan/Hansen	0.290	0.271	0.271	0.469	0.167
Ar(2)-Test	0.774	0.7	0.783	0.35	0.751	Ar(2)-Test	0.780	0.845	0.774	0.695	0.729

Notes: * significant at 10% level; ** significant at 5% level; *** significant at 1% level; see Table I for further notes.

Table IV: Developing Countries Only

Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	FE	Sys. GMM	Sys. GMM	Sys. GMM	Sys. GMM	Sys. GMM	Sys. GMM
GDPpc (t-1)	-0.0293*** (-3.212)	-0.215*** (-6.556)	-0.0584** (-2.019)	-0.0404* (-1.666)	-0.0862*** (-3.081)	-0.0477* (-1.844)	-0.0545* (-1.784)	-0.111** (-2.005)
InvestmentShare	0.0951*** (5.252)	0.108*** (4.601)	0.196*** (5.645)	0.209*** (5.170)	0.0965** (2.139)	0.161*** (3.913)	0.171*** (4.153)	0.172*** (3.918)
PopulationGrowth	-0.218*** (-3.510)	-0.135 (-1.186)	-0.257* (-1.650)	-0.219 (-1.580)	-0.426** (-2.479)	-0.227 (-1.127)	-0.291 (-1.643)	-0.302 (-1.334)
Education	0.0215 (1.255)	-0.0468* (-1.725)	0.0853 (1.501)	0.0531 (1.128)	0.101* (1.909)	0.0178 (0.374)	0.0723 (1.390)	0.0278 (0.524)
TradeShare				-0.0448 (-0.824)				
TradeShare (GDP t-1)					0.0947*** (2.845)			
Trade						0.0247 (1.292)		
TradeGrowth							1.143*** (4.069)	
TradePop								0.0661 (1.220)
Observations	605	605	605	561	561	465	465	465
Number of Countries	87	87	87	86	86	73	73	73
Number of Instruments			40	49	49	49	49	49
Sargan/Hansen			0.185	0.575	0.399	0.304	0.764	0.432
Ar(2)-Test			0.504	0.668	0.727	0.934	0.487	0.894

Notes: * significant at 10% level; ** significant at 5% level; *** significant at 1% level; see Table I for further notes.

The evidence established so far has been for the total sample, including both developed and developing countries. The question arises if the positive influence of trade on income growth is robust for a sample of developing countries only. It might be argued that for the developing countries the preconditions for the realization of a positive trade-income-growth nexus are not in place yet. Table IV sheds some light on this issue by showing the results for a subsample of developing countries.[13] Columns 1-3 set up the benchmark repeating the exercise of comparing the regression results obtained by the System GMM estimator with those of the OLS and fixed-effects estimation. As expected, the System GMM coefficient (column 3) for the initial level of per capita GDP lies size wise between the OLS (column 1) and fixed-effects estimation results (column 2). The control variables have the expected influence and the test statistics confirm the validity of the instruments obtained by including the twice lagged observation for all endogenous explanatory variables and the once lagged observation for the Education variable.

Starting from a valid benchmark, we add the *TradeShare* variable (column 4) and again do not find significant results for that measure of trade. Including the measure *TradeShare (GDP t-1)* (column 5) confirms the positive and significant effect of trade on GDP per capita growth for developing countries. For *TradeGrowth* (column 7) the positive and significant impact is confirmed as well, whereas for *Trade* (column 6) and *TradePop* (column 8) the coefficients do not reach conventional significance level. The results show that the positive effect of both trade and the expansion of trade can be found for developing countries as well.

Summing up the evidence of our empirical investigation, we find that an increased integration of countries into the world economy through trade can be seen as a fundamental cause of differences in income and growth across countries. By using an appropriate empirical method to control for endogeneity, we are able to establish a causal linkage between trade and GDP per capita growth. We find evidence that the expansion of trade, e.g., through its associated access to additional technologies, has a significant impact on income growth. Above all, this holds for our preferred trade measure, that is, the volume of exports and imports as a share of lagged total GDP. In addition, it can be shown that both channels, trade and the expansion of trade, have an independent influence on GDP per capita growth. The same results hold true for both exports and imports separately as well for the sub-sample of developing countries.

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[13] All countries included are listed in Appendix C. In order to avoid a sample selection bias we focus on countries that have been considered developing countries in 1970. The World Bank classification of countries as low- or middle-income countries which are commonly considered as developing countries started in 1987 only. We include all of those countries that were classified as low- or middle-income countries in that year (World Bank 2010).

References

Arellano, M. and O. Bover (1995) “Another Look at the Instrumental Variable Estimation of Error-components Models” *Journal of Econometrics* **68**, 29-51.

Barro, R. and J.-W. Lee (2010) “A New Data Set of Educational Attainment in the World, 1950-2010” NBER working paper number 15902.

Barro, R. and X. Sala-i-Martin (1997) “Technological Diffusion, Convergence, and Growth” *Journal of Economic Growth* **2**, 1-26.

Ben-David, D. (1993) “Equalizing Exchange: Trade Liberalization and Income Convergence” *Quarterly Journal of Economics* **108**, 653-79.

Bernard, A.B. and J.B. Jensen (2004) “Why Some Firms Export” *Review of Economics and Statistics* **86**, 561-69.

Bernard, A.B., J. Eaton, J.B. Jensen and S. Kortum (2003) “Plants and Productivity in International Trade” *American Economic Review* **93**, 1268-90.

Blundell, R. and S. Bond (1998) “Initial Conditions and Moment Restrictions in Dynamic Panel Data Models” *Journal of Econometrics* **87**, 115-43.

Bond, S., A. Hoeffler and J. Temple (2001) “GMM Estimation of Empirical Growth Models” CEPR Discussion Papers 3048.

Caselli, F., G. Esquivel and F. Lefort (1996) ”Reopening the Convergence Debate: A New Look at Cross-Country Growth Empirics” *Journal of Economic Growth* **1**, 363-89.

Dollar, D. and A. Kraay (2004) “Trade, Growth, and Poverty” *Economic Journal* **114**: F22-F49.

Dollar, D. (1992) “Outward-Oriented Developing Economies Really Do Grow More Rapidly: Evidence from 95 LDCs, 1976-1985” *Economic Development and Cultural Change* **40**, 523-44.

Edwards, S. (1998) “Openness, Productivity and Growth: What Do We Really Know?” *Economic Journal* **108**, 383-98.

Feyrer J. (2009) “Trade and Income - Exploiting Time Series in Geography”, NBER working paper number 14910.

Frankel, J. and D. Romer (1999) “Does Trade Cause Growth?” *American Economic Review* **89**, 379-99.

Grossman, G. and E. Helpman (1991) *Innovation and Growth in the Global Economy*, MIT Press: Cambridge, MA.

Heston, A., R. Summers and B. Aten (2010) “Penn World Table” Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania.

Hoeffler, A. (2002) “The Augmented Solow Model and the African Growth Debate” *Oxford Bulletin of Economics and Statistics* **64**, 135-58.

Islam, N. (1995) “Growth Empirics: A Panel Data Approach” *Quarterly Journal of Economics* **110**, 1127-70.

Krugman, P. (1979) ”A Model of Innovation, Technology Transfer, and the World Distribution of Income” *Journal of Political Economy* **87**, 253-66.

Lee, J.-W. (1993) “International Trade, Distortions, and Long-Run Economic Growth” *IMF Staff Papers* **40**, 299-328.

Mankiw, N.G., D. Romer and D.N. Weil (1992) “A Contribution to the Empirics of Economic Growth” *Quarterly Journal of Economics* **107**, 407-37.

Manole, V. and M. Spatareanu (2010) “Trade Openness and Income – A Re-examination” *Economics Letters* **106**, 1-3.

Marshall, M., K. Jaggers and T.R. Gurr (2012) “Polity IV Project: Political Regime Characteristics and Transitions, 1800-2010”, Internet Posting: http://www.systemicpeace.org/polity/polity4.htm.

Noguer, M. and M. Siscart (2005) “Trade Raises Income, a Precise and Robust Result” *Journal of International Economics* **65**, 447-60.
Obstfeld, M. and A.M. Taylor (2003) “Globalization and Capital Markets” NBER Chapters: Globalization in Historical Perspective, 121-188.
Rivera-Batiz, L.A. and P.M. Romer (1991) ”Economic Integration and Endogenous Growth” *Quarterly Journal of Economics* **106**, 531-55.
Rodríguez, F.R. (2007) “Openness and Growth: What Have We Learned?” DESA Working Papers 51, United Nations, Department of Economics and Social Affairs.
Rodríguez, F.R. and D. Rodrik (2001) “Trade Policy and Economic Growth: A Skeptic's Guide to the Cross-National Evidence” *NBER Macroeconomics Annual* **15**, 261-338.
Sachs, J.D. and A. Warner (1995) “Economic Reform and the Process of Global Integration” *Brookings Papers on Economic Activity* **26**, 1-118.
Sala-i-Martin, X., G. Doppelhofer and R.I. Miller (2004) “Determinants of Long-term Growth: A Bayesian Averaging of Classical Estimates (BACE) Approach” *American Economic Review* **94**, 813-35.
Squalli, J. and K. Wilson (2011) “A New Measure of Trade Openness” *World Economy* **34**, 1745-70.
Vernon, R. (1966) “International Investment and International Trade in the Product Cycle” *Quarterly Journal of Economics* **80**, 190-207.
Wacziarg, R. and K.H. Welch (2008) “Trade Liberalization and Growth: New Evidence” *World Bank Economic Review* **22**, 187-231.
Warner, A. (2003) “Once More into the Breach: Economic Growth and Integration” Center for Global Development Working Papers Number 34.
World Bank (2010) “World Development Indicators”, Internet Posting: http://data.worldbank.org/data-catalog/world-development-indicators.
Yanikkaya, H. (2003) “Trade Openness and Economic Growth: A Cross-country Empirical Investigation” *Journal of Development Economics* **72**, 57-89.
Young, A. (1991) “Learning by Doing and the Dynamic Effects of International Trade” *Quarterly Journal of Economics* **106**, 369-405.

Appendix A: Definition of Variables and Data Sources		
Variable	Definition	Data source
GDPpc	Real Gross Domestic Product per capita (constant 2000 US$, in logs)	World Bank (2010)
InvestmentShare	Investment share of real GDP (in logs)	Heston et al. (2010)
PopulationGrowth	Growth rate of total Population	World Bank (2010)
Education	Average years of secondary schooling in the population of age 15 and over	Barro and Lee (2010)
Inflation	Change in the consumer price index in percent (in logs)	World Bank (2010)
PoliticalRegime	Indicator for democracy and autocracy, Polity IV dataset, ranging from -10 (strongly autocratic) to +10 (strongly democratic)	Marshall et al. (2012)
Exports	Exports of goods and services (constant 2000 US$, in logs)	World Bank (2010)
ExportGrowth	Growth rate of exports of goods and services	World Bank (2010)
ExportShare	Exports of goods and services (current US$) divided by total GDP (current US$)	World Bank (2010)
ExportPop	Exports of goods and services (current US$) divided by total population	World Bank (2010)
Imports	Imports of goods and services (constant 2000 US$, in logs)	World Bank (2010)
ImportGrowth	Growth rate of imports of goods and services	World Bank (2010)
ImportShare	Imports of goods and services (current US$) divided by total GDP (current US$)	World Bank (2010)
ImportPop	Imports of goods and services (current US$) divided by total population	World Bank (2010)
Trade	Sum of imports and exports of goods and services (constant 2000 US$, in logs)	World Bank (2010)
TradeGrowth	Growth rate of trade of goods and services	World Bank (2010)
TradeShare	Sum of imports and exports of goods and services (current US$) divided by total GDP (current US$)	World Bank (2010)
TradePop	Sum of imports and exports of goods and services (current US$) divided by total population	World Bank (2010)

Appendix B: Descriptive Statistics

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
GDPpc	852	7.64	1.63	4.44	11.15
Δ GDPpc	752	0.08	0.15	-0.55	0.69
InvestmentShare	752	2.67	0.60	0.16	4.09
PopulationGrowth	752	-1.00	0.18	-2.21	0.13
Education	752	0.16	0.95	-3.47	1.74
Inflation	632	2.11	0.82	-0.97	6.64
PoliticalRegime	733	1.63	4.01	-10.00	10.00
Trade	612	23.36	1.93	19.06	28.58
TradeGrowth	612	0.06	0.06	-0.23	0.26
TradePop	612	7.15	1.66	3.06	11.85
Exports	612	22.57	2.04	17.19	27.69
ExportGrowth	612	0.06	0.06	-0.21	0.32
ExportPop	612	6.36	1.78	2.19	11.23
Imports	612	22.72	1.87	18.89	28.06
ImportGrowth	612	0.06	0.07	-0.26	0.36
ImportPop	612	6.52	1.60	2.30	11.08
TradeShare	707	4.07	0.57	1.98	5.60
TradeShare (GDP t-1)	707	4.45	0.65	2.25	6.44
ExportShare	707	3.30	0.62	1.27	4.98
ExportShare (GDP t-1)	707	3.68	0.71	1.07	6.21
ImportShare	707	3.43	0.56	1.29	4.84
ImportShare (GDP t-1)	707	3.82	0.64	1.88	5.55

Appendix C: Country Sample

Algeria, Argentina, Australia, Austria, **Bahrain, Bangladesh, Barbados,** Belgium, **Benin, Bolivia, Botswana, Brazil, Bulgaria, Burundi, Cameroon,** Canada, **Central African Republic, Chile, China, Colombia, Democratic Republic of Congo, Republic of Congo, Costa Rica, Cote d'Ivoire, Cyprus,** Denmark, **Dominican Republic, Ecuador, Egypt, El Salvador, Fiji,** Finland, France, **Gabon, Gambia,** Germany, **Ghana, Greece, Guatemala, Guyana, Honduras, Hungary,** Iceland, **India, Indonesia, Iran,** Ireland, **Israel,** Italy, Japan, **Jordan, Kenya, Republic of Korea, Kuwait, Laos, Lesotho,** Luxembourg, **Malawi, Malaysia, Maldives, Mali, Mauritania, Mauritius, Mexico, Morocco, Mozambique, Namibia, Nepal,** Netherlands, New Zealand, **Nicaragua, Niger,** Norway, **Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Romania, Saudi Arabia, Senegal, Sierra Leone, Singapore, South Africa,** Spain, **Sri Lanka, Sudan, Swaziland,** Sweden, Switzerland, **Syrian Arab Republic, Tanzania, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, Uganda, United Arab Emirates,** United Kingdom, United States, **Uruguay, Venezuela, Zambia, Zimbabwe**

Note: Countries in **bold** are developing countries as of 1970.