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Relating Productivity and Trade 1980-2000: A Chicken and Egg Analysis

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Abstract

Given the nature and range of investigations of the trade/productivity relationship, we now know that possible reverse causation must be a consideration in empirical research. Indeed, some research finds that estimates of productivity gains attributed to trade capture instead the roles of institutions and geography. Here we estimate the relationship between productivity and trade for a panel of countries over the period 1980 to 2000 using instrumental-variables estimation of a productivity equation. The endogeneity of trade and institutional quality is accounted for by using instruments. We extend the specification used by Frankel and Romer (1999) using real openness as the measure of trade (following Alcala and Ciccone, 2004). The trade instrument is based on a gravity equation. The instruments for institutional quality come from Gwartney, Holcombe and Lawson (2004). This approach allows for identification of channels through which trade and production scale affect productivity.

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I Introduction

Interest in the relationship between trade (or openness) and growth is evident across an extensive range of economic research. Empirical evidence points to a relationship between trade and income growth via productivity. Just how to accurately construct and examine this causal relationship is problematic, however, as indicated by an array of theoretical investigation of this link. Developments in applied econometrics have allowed for various approaches to be used to investigate how trade and productivity are related but more recent research has focussed on whether estimated links between trade and productivity capture the roles of institutions and geography.

The measurement of trade in this literature includes explicit examination of exports only and their relationship with output and/or productivity. Some research includes openness as the measure of trade taking into account both exports and imports as separate but related channels that drive output or productivity growth. The standard measure of openness is a nominal measure of the sum of exports and imports expressed as a fraction of nominal GDP. However, this measure creates difficulties as outlined in Alcala and Ciccone (2004) due to the potential outcome of Balassa-Samuelson effects, which they presented for cross-country analysis using 1985 data.

Motivated by the substantial literature in this area, this paper investigates the effect of international trade on productivity across a sample of 73 countries over the period 1980 to 2000. Alternative measures of openness are used to compare the implications of using real or nominal openness. To take account of the potential endogeneity of trade and institutional quality we use instruments. The selected instrument for trade follows the standards of Frankel and Romer (1999), which argues that trade is determined partially by country factors unrelated to productivity. Following the work of Hall and Jones (1999) and Acemoglu, Johnson and Robinson (2001) the choice of instruments for institutional quality rest on the relationship between historical European influence and diffusion of the European institutional structure.

The paper is structured as follows. Section II provides the background literature on the trade-growth relationship and identifies the problems associated with measures of openness in empirical work. In Section III the selected productivity equation we estimate is presented and discussion of the instruments is provided in detail. Analysis and findings based on our estimated results is provided in Section IV while conclusions are offered in Section V.

II Trade, Productivity and Openness

Open economies can benefit from specialisation, which allows for the generation of higher levels of income from a comparative advantage perspective. This means that when more of a country's available resources are devoted to producing goods in which it has efficiencies (measured as lower opportunity costs of production) relative to other countries and it can import the goods in which it is less efficient, overall national output and consumption rise. Through creating international demand for domestic resources that might otherwise remain unused, a further (demand-side) basis for making more efficient use of resources exists in relation to trade. Static effects of specialisation change the economy's production (and labour) mix inline with comparative advantage and this in line with ability to trade at international prices leaves consumers better off. If dynamic benefits are also possible then as the market expands, the potential for greater division of labour arises, and the skills of labour may rise in response to greater division of labour. Hence, productivity improvements are observed in an outward expansion of the production possibilities frontier (Myint, 1958).

As countries open up to trade, international communication of ideas and technology also becomes increasingly possible and may have the effect of intensifying competition in both import and export markets, increasing the incentive for both imitation and innovation and accelerating the rate of technical progress that can lead to efficiency gains through more competitive cost structures and productivity improvement. Foreign exchange constraints may be eased also since increased exports provide a source of foreign exchange for countries that wish to purchase imports of final products or inputs that embody domestically unavailable technology.

In a scenario where increased exports lead to cost reductions and increased efficiency the underlying causal direction is from trade (particularly export growth) to output growth. Such cases describe export-led-growth, which is theoretically associated with the view of trade as an engine of growth. The extent to which positive externalities are generated from involvement in international markets, through resource allocation, economies of scale and pressure on new training for example, underpin how the hypothesis operates in practice (Medina-Smith, 2001).

An alternative causal explanation is manifest in Verdoorn's law which holds that output growth has a positive impact on productivity growth. Kaldor (1967) attributed this relationship to factors including economies of scale, learning curve effects, increased division of labour, and the creation of new processes and subsidiary industries. In this case productivity growth in the industrial sector, in particular, is considered as the principal determinant of output growth. Improved productivity and reductions in unit costs due to increasing returns simply make “it easier to sell abroad” (Kaldor, 1967: 42) implying a causal relationship from output growth, via productivity growth, to export growth.

Many studies confirm a statistical relationship between export growth and output growth (Michaely, 1977; Krueger, 1978; Balassa, 1978; and Feder, 1982). The potential benefits of export growth for economic development have been widely discussed (e.g. Keesing, 1967; Krueger, 1980; Bhagwati, 1988a; Greenaway and Sapsford, 1994) and empirically tested for many less developed countries, (Balassa, 1978; Feder, 1982; Bahmani-Oskooee and Alse, 1993). However, for more industrialized or developed economies the potential benefits of export growth may be less important because positive externalities enjoyed by LDCs are significantly higher than for developed countries, whose infrastructural development is more advanced (Afxentiou and Serletis, 1991). Benefits from increased competition are lessened since advanced countries are more competitive and new technology will have less impact because to retain competitiveness, continuous improvements in technology are required.

The export-growth correlation appeared to be particularly pronounced in the case of industrialized countries and Michaely (1977) and Tyler (1981) considered a minimum level of development was required for a significant relationship to be observed between output growth and export growth. However, the empirical approach based on cross-country correlations between exports and output (or productivity) yields no information for the causality question as they deal with statistical and not causal relationships. Many further studies have found a “moderate positive relationship” (Frankel and Romer, 1999: 379) between trade and income including Feder (1983), Kormendi and Maguire (1985), Fischer (1991, 1993), Dollar

(1992), Levine and Renelt (1992), Edwards (1993) and Harrison (1996). Unfortunately, as outlined further below, the potential endogeneity of the trade share has implications for the confidence that can be placed in the estimates.

Studies using Granger or Sims procedures to investigate causality do not provide conclusive support for the export-growth relationship (Chow, 1987; Jung and Marshall, 1985).[1] The existence of non-stationarity in the time series considered can lead to spurious regression results and invalidate the conclusions reached using Granger tests of causality, casting doubt on the results of the causality research carried out when the stationarity properties of the data were not identified. It is only possible to infer a causal long-run relationship between non-stationary time series when the variables concerned are cointegrated (Engle and Granger, 1987).[2] If cointegration analysis is omitted, causality tests present evidence of simultaneous correlations rather than causal relations between variables (Granger, 1988). As Ram (1985) points out

> it is … important to be able to make a reasonably satisfactory transition from statements about the correlation patterns to some judgements about the causal structure (p. 416).

Cointegration studies also yield differing results on the trade-growth relationship for cross-country analyses over differing time periods (Axfentiou and Serletis, 1991; Marin, 1992; Oxley, 1993; Bahmani-Oskooee and Alse, 1993). Omitted variables not controlled for will also have impacts on output and exports, and hence, measured causal impacts are inaccurate (Kwan and Kwok, 1995). Variables such as the terms of trade and capital stock have been included in export-growth analysis (Ghartey, 1993; Henriques and Sadorsky, 1996; Jin and Yu, 1996).

Advances in econometric techniques for causality analysis (Toda and Yamamoto, 1995; Zapata and Rambaldi, 1997) were based on the observation that the F-test procedure used for causality tests was not valid (i.e. it does not have a standard distribution) if time series are *I(1)* first difference stationary, a feature shared by a

[1] Chow (1987) examined manufacturing industries and found bi-directional causality for Hong Kong, Israel, Singapore, Taiwan and Brazil, uni-directional causality from export to output growth for Mexico and no causality for Argentina. Jung and Marshall (1985) used Granger causality tests and found support for the export-led growth hypothesis for just four out of thirty-seven developing countries. A statistically significant relationship from output growth to export growth was found for three countries. Six countries exhibited evidence of an export-reducing growth relationship, while a further three supported a growth-reducing exports relationship. Darrat (1986) and Hsiao (1987) find a similar lack of support for the export-led growth hypothesis.

[2] Granger tests of short-run causality can still be undertaken when series are not cointegrated.

large proportion of macroeconomic variables. Using augmented production function methodology in a VAR framework and taking this finding into account, Shan and Tian (1998) found that for Shanghai internal factors of foreign direct investment, labour, and investment contributed to rapid output growth and that output growth contributed to export growth over the period 1990 to 1996. In the case of China from 1987-1996, Shan and Sun (1998) found a feedback effect indicating bidirectional causality between exports and real industrial output (a proxy measure of output). Using a similar framework, Doyle (2001) found bi-directional causality for Ireland (1950-1997) and the terms of trade and foreign demand displayed statistical significance in explaining causality.

Bidirectional causality is a possibility when productivity increases that are made through the exploitation of scale economies lead to increased exports (Kunst and Marin, 1989). This occurs if the market structure changes (brought about by increased trade) result in fewer firms and if scale economies allow for increased competitiveness through further cost reductions. Hence a potential feedback effect exists between export growth and output (Sharma *et al*, 1991). Bhagwati (1988b) also considered the possibility for two-way causation between growth and exports (or trade in general) arguing that increased trade, regardless of its cause, stimulated increased output and in turn additional income facilitated more trade, generating a process of a virtuous circle of growth and trade.

In terms of new trade theory, Romer (1990), Grossman and Helpman (1991) and Rivera-Batiz and Romer (1991) developed models where an expansion of international trade increases growth by increasing the number of specialized production inputs. In models of imperfect competition and increasing returns to scale, however, this outcome is ambiguous (Helpman and Krugman, 1985) and Grossman and Helpman (1991) also pointed out that tariffs could be growth reducing. The impact of trade on growth appears to depend on market competition, market contestability and whether the market structure is stable with regard to trade disturbances or will be altered and lead to productivity improvements and technical efficiency. Marin (1992) included models of imperfect competition in his analysis of the exports-output relationship and posited that exports lead to output growth (through productivity enhancement) the smaller the country and the less entry that occurs. He based this view on the fact that minimum efficient scale of production is large relative to the home market so that the potential of exploitation of scale economies through export expansion was high. An export expansion is more likely to lead to productivity improvements if the entry of new firms instigates greater competition forcing inefficient firms to exit and increasing the incentive for incumbents to invest in R&D.

Recent examinations of trade and growth examine the extent to which productivity changes attributed to trade instead measure the effects of institutions and geography, rather than trade. The inclusion of variables to control for geography and institutional quality rendered trade insignificant in a number of studies (Rodrik, 2000; Rodriquez and Rodrik, 2001; Irwin and Tervio, 2002). Frankel and Romer (1999) outline the difficulty in trying to find if trade *causes* growth since if the trade share (or openness) is endogenous, countries with high incomes due to reasons other than trade, may trade more. Since geography is a strong determinant of trade – gravity models (Linneman, 1966; Frankel, 1997) are indicative - and geographical characteristics are not affected by income, it can be used as an instrument for trade.

In this context, Alcala and Ciccone (2004) identify potential deficiencies in using the standard measure of openness (nominal exports plus imports expressed relative to nominal GDP) for the trade share and estimate a measure of *real openness* used in a cross-country analysis of the trade-productivity relationship using 1985 data. Trade is found to be a significant and robust determinant of aggregate productivity. Our study follows the approach adopted but extends it in a time-series context from 1980 to 2000 across a sample of 73 countries.

3 Basis of Empirical Approach

The essence of Alcala and Ciccone (2004) is that the trade-related Balassa-Samuelson (Balassa 1964; Samuelson, 1964) hypothesis implies that using nominal openness as a measure of trade is problematic. If trade increases productivity, where gains are greater in manufacturing than in non-tradable services, a rise in the relative price of services might result in a decrease in openness. This is shown in a trade model with gains from specialisation, which is defined as the production of fewer varieties of tradable goods but in larger quantities. From the model, GDP in country c equals aggregate consumption (assuming balanced trade)

$$GDP_c = d_c y_c + a_c (1-t) x_c = t x_c + a_c (1-t) x_c$$

where

d_c measures the number of varieties of tradable goods produced in country c (as this measure of tradable goods produced domestically falls, the country becomes more specialized);
y_c denotes production of each tradable good
a_c reflects the equilibrium price of non-tradable goods in country c (reflecting factor efficiency in tradable goods sectors relative to non-tradable goods sectors). It is assumed that $a_c = g\ (d_{c,}\ L_c)$ where L denotes households' supply of labour. It is further assumed that households want to consume the same quantity of each tradable and non-tradable good irrespective of the price of non-tradables.
(1-t) denotes the fraction of commodities that are non-tradable
t denotes the fraction of tradable goods produced in country c
x_c denotes consumption of each good.

The production function in tradable goods is constant returns to scale where $y = A_c l$ where A_c is country-specific factor efficiency and l denotes labour. In turn, it is given by

$$\boldsymbol{A_c = B_c g\ (d_c,\ l_c)}$$

where B is an exogenous parameter, and l is aggregate employment. Gains from specialisation occur assuming $\delta g/\delta d_c < 0$. Increasing returns to aggregate employment occur assuming $\delta g/\delta l_c > 0$. Gains from specialisation are limited to this sector and no increasing returns are possible in non-tradable goods which are produced according to the production function $s = B_c l$.

Assuming balanced trade and labour market clearing, Alcala and Ciccone (2004) show that the share of labour allocated to non-tradable goods production is $(1\text{-}t)a_c\,/\,t + (1\text{-}t)a_c$. Given this and the production functions and the equation for ac, PPP GDP is shown to depend on specialisation.

$$\frac{PPP\,GDP_c}{L_c} = \frac{t + a(1-t)}{g(d_c, L_c)^{-1} t + (1-t)} B_c$$

where average labour productivity in PPP increases in the degree of specialisation and in aggregate employment.

In equilibrium nominal openness is

$$Open_c = 2\frac{Imports_c}{GDP_c} = 2\frac{t - d_c}{t + (1-t)a_c}$$

An increase in specialization can affect openness in two ways. A higher degree of specialisation, for a given price of non-tradable goods, raises openness as it implies a larger volume of imports. According to the equation deriving a_c, a higher degree of specialisation raises the price of non tradables, which lowers openness. Hence, higher openness is not necessarily associated with higher PPP labour productivity. Real openness is given by

$$ROpen_c = 2\frac{\boldsymbol{Im}\,ports_c}{PPP\,GDP_c} = \frac{t - d_c}{t + \boldsymbol{(}1 + t\boldsymbol{)}a}$$

which implies that as the price of non-tradables used to value production is the same across countries, real openness is a linear and increasing function of the degree of specialisation and average labour productivity in PPP can be written as an increasing function of real openness.[3]

3.1 Estimating Equation and Data

We extend Frankel and Romer's (1999) specification to consider the relationship between productivity and trade, following Alcala and Ciccone (2004).

$$\boldsymbol{log}\left(\frac{PPP\,GDP_c}{Workforce_c}\right) = x_0 + x_1 Trade_c + x_2\,\boldsymbol{log}\,DScale_c + x_3\,\boldsymbol{log}\,Area_c + x_4 IQual_c + a_c X_c + u_c$$

where $PPPGDP_c$ denotes Productivity Per Worker. Trade represents measures of openness (both nominal and real are considered here where real openness is national imports plus exports (in US $) divided by national GDP in PPP US$ (instrumenting is discussed below). DScale represents domestic scale of production. This is included since the size or scale of a country impacts not only its propensity to trade externally, but also internally, as explained by Frankel and Romer (1999: 380). Hence, a second geography-based test of trade's impact is considered by examining whether intra-country trade increases income focusing on whether larger countries, measured by population or workforce, have higher productivity.[4]

[3] Alcala and Ciccone (2004) pointed out that although all gains from specialization are supposed to occur in tradables, this assumption is not necessary for specialization to increase the price of non-tradables.
[4] Frankel and Romer (1999) focus on income per person. In line with Alcala and Ciccone (2004) our interest is in productivity.

Data for productivity, nominal imports and exports, GDP in PPP US$ used to measure openness, and population to measure scale are all taken from the Penn World Tables, 6.1 (Heston *et al*, 2002). For comparison purposes, labour productivity data were also taken from the Groningen Growth and Development Centre (GGDC) Total economy Database.[5] A 78-country sample is considered for which labour productivity data are available from both sources. Data limitations require that a smaller sample than in Alcala and Ciccone (2004) is employed. However, countries in our sample have more reliable data and are larger in size; hence their productivity is less likely determined by idiosyncratic factors (Frankel and Romer 1999:387).

Area represents the land area in square kilometres taken from the World Development Indicators (2005) of the World Bank.

IQual denotes institutional quality. Since we are conducting time-series analysis we require a measure for the period 1980-2000. The Economic Freedom of the World Index (Gwartney and Lawson, 2003: Gwartney, Holcombe and Lawson, 2004)[6] measures institutional quality across five areas: size of government, legal structure and security of property rights, access to sound money, exchange with foreigners and regulation of capital, labour and business. Data for 100 countries are available for the time period we consider. Should Iqual be endogenous, instruments are required. In instrumenting for institutional quality, Hall and Jones (1999) use the population share speaking English since birth, the population share speaking one of the five primary European languages, distance from the equator and Frankel and Romer's (1999) geography–based trade measure.[7]

X represents geography control variables including distance from the equator (measures used in Hall and Jones (1999) are used here)[8] and continent dummies for Europe, Africa, America, Asia and the omitted dummy is represented by the intercept.

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[5] The Conference Board and Groningen Growth and Development Centre, Total Economy Database, May 2006, http://www.ggdc.net.

[6] The authors are extremely grateful to Jim Gwartney and Bob Lawson for making the data available at http://www.freetheworld.com.

[7] Hall and Jones (1999) considered that the first three variables are correlated with historical influence of Europe and with providing a channel for the European institutional framework to have a growth impact. Alcala and Ciccone (2004) drop the fraction of English speaking population finding it does not support prediction of the endogenous variables in the specifications used. Acemoglu, Johnson and Robinson (2001) use European settler mortality during the 18th and 19th centuries as an instrument.

[8] The authors are extremely grateful to Robert Hall for making the data available at http://stanford.edu/~rehall/index_files/Page1379.htm.

If trade and institutional quality are endogenous, OLS cannot be used for the estimating equation. Two-stage least squares is appropriate. To develop the instrument for trade, Frankel and Romer's (1999) method is followed. A gravity equation is used to estimate bilateral trade shares using countries' geographic characteristics and size as explanatory variables. The data set used is a cross-section of bilateral trade flows across 178 countries between 1980 and 2000. The data are from Rose (2005)[9]; we provide limited details here since data sources and description can be found in the cited paper.

In the specification of the bilateral trade equation the dependent variable is total trade in real terms relative to PPP GDP. We include log population and log area as measures of size, log distance as measure of transport costs and a number of dummy variables that proxy for countries' geographic characteristics and integration agreements. In addition, following Anderson and van Wincoop (2003) we include exporter and importer country dummies as proxies for multilateral resistance terms. Anderson and van Wincoop (2003) demonstrated that these terms have to be included in order to have a "theoretically justified" gravity-model specification.

Thus, the equation we estimate is given by

$$\begin{aligned}
\ln(Trade_{ijt} / PPPGDP_{i}) &= \alpha_i + \chi_j + \varphi_t + \beta_1 \ln pop_{it} + \beta_2 \ln pop_{jt} + \beta_3 \ln(A_i A_j) \\
&+ \beta_4 \ln Dist_{ijt} + \beta_5 landl + \beta_6 lang_{ij} + \beta_7 Adj_{ij} + \beta_8 Island_{ij} + \beta_9 Comcol_{ij} \\
&+ \beta_{10} Currcol_{ij} + \beta_{11} CU_{ij} + \beta_{12} Colony_{ij} + \beta_{13} RTA_{ijt} + \beta_{14} gw1 + \beta_{15} gw2 \\
&+ \beta_{16} gsp + \mu_{ijt}
\end{aligned}$$

The bilateral trade shares predicted by the gravity equation are aggregated providing a geography-based instrument for trade for each of the 73 countries we include in the estimation of the productivity equation (see Figure A1 in the appendix for a plot of the predicted shares and real openness).

4 Descriptive Statistics and Estimation Results

Table 1 contains descriptive statistics and the correlation matrix for selected variables. Real openness displays a lower mean than openness. The correlation between openness and real openness is high at 0.86. Real openness is more highly

[9] The authors are extremely grateful to Andrew K. Rose for making the data available at http://stanford.edu/~rehall/index_files/Page1379.htm

correlated with log average labour productivity than openness (compare 0.27 and 0.45 for the GGDC productivity measure). The differences are emphasised further when the logged trade measures are used (compare 0.30 to 0.58). In line with Alcala and Ciccone (2004) the differences can be attributed to the Balassa-Samuelson effect (which is further tested below).

Table 1. Descriptive Statistics and Correlation Matrix

Variable	*Obs*	*Mean*	*Min*	*Max*	*Std. Dev.*
lproac	314	9.77	6.89	11.54	0.93
lpro	365	9.66	6.90	10.98	0.91
openc	323	72.68	11.51	439.03	59.20
lopenc	323	4.07	2.44	6.08	0.64
ropen	323	53.27	4.00	348.02	56.87
lropen	323	3.56	1.39	5.85	0.90
lpop	365	9.73	5.43	14.05	1.68
iqual	353	5.91	2.30	9.10	1.40

	lproac	*lpro*	*openc*	*lopenc*	*ropen*	*lropen*	*lpop*	*iqual*
lproac	1.00							
lpro	0.93	1.00						
openc	0.29	0.27	1.00					
lopenc	0.32	0.30	0.88	1.00				
ropen	0.48	0.45	0.86	0.74	1.00			
lropen	0.60	0.58	0.71	0.78	0.86	1.00		
lpop	-0.43	-0.44	-0.50	-0.60	-0.57	-0.67	1.00	
iqual	0.56	0.59	0.46	0.48	0.51	0.55	-0.31	1.00

	lpro	*lproac*	*iqual*	*englfrac*	*eurfrac*	*disteq*	*lropen*	*lopenc*	*lelrop2s*
lpro	1.00								
lproac	0.92	1.00							
iqual	0.57	0.54	1.00						
englfrac	0.30	0.29	0.34	1.00					
eurfrac	0.37	0.37	0.18	0.44	1.00				
disteq	0.57	0.64	0.21	0.16	0.01	1.00			
lropen	0.59	0.60	0.53	0.11	-0.02	0.35	1.00		
lopenc	0.28	0.29	0.45	-0.04	-0.21	0.06	0.76	1.00	
lelrop2s	0.53	0.54	0.37	0.04	0.06	0.54	0.68	0.51	1.00

Notes:
lproac and lpro are the log of labour productivity per worker from Penn World Tables and from the Groningen Growth and Development Centre respectively;
openc and ropen are openness and real openness, and lopenc and lropen are the same variables in logs;
lpop is the log of population and iqual is the institutional quality index.

4.1 Instruments Estimation

Table 2 contains the first-stage regression results for log real openness (lropen) and for our proxy of institutional quality (iqual).

Table 2: First stage regressions

Variables	***1980***		***1985***		***1990***		***1995***		***2000***	
lropen	***Coef.***	***t-ratio***	***Coef.***	***t-ratio***	***Coef.***	***t-ratio***	***Coef.***	***t-ratio***	***Coef.***	***t-ratio***
lelrop2s	0.17	1.69	0.19	1.80	0.20	1.76	0.28	3.06	0.24	2.99
lpop	-0.22	-3.34	-0.22	-3.03	-0.18	-2.15	-0.11	-1.44	-0.17	-2.21
lar	-0.11	-1.33	-0.09	-1.01	-0.14	-1.37	-0.13	-1.84	-0.13	-1.89
disteq	0.58	1.06	0.92	1.63	0.84	1.48	0.79	1.50	0.66	1.28
englfrac	0.56	3.08	0.57	2.54	0.29	0.95	0.35	1.43	0.34	1.55
dafrica	0.13	0.50	0.00	0.00	0.12	0.47	-0.18	-0.67	-0.24	-1.01
deurope	0.03	0.12	-0.13	-0.44	0.09	0.30	-0.10	-0.40	-0.02	-0.09
dasia	-0.27	-1.26	-0.18	-0.77	0.00	-0.01	-0.22	-1.08	-0.09	-0.32
deastasia	0.74	2.55	0.67	2.13	0.59	1.48	0.76	2.09	0.62	1.79
dsubsafrica	0.33	0.73	0.25	0.59	0.10	0.29	0.65	1.14	0.49	1.34
_cons	5.62	4.03	4.84	3.32	5.12	3.53	4.05	3.78	4.74	4.34
R-squared	0.72		0.70		0.62		0.67		0.74	
Nobs	58.00		58.00		58.00		61.00		59.00	
F(10,47)	14.56		11.51		13.55		14.94		23.10	

	1980		***1985***		***1990***		***1995***		***2000***	
iqual	***Coef.***	***t-ratio***	***Coef.***	***t-ratio***	***Coef.***	***t-ratio***	***Coef.***	***t-ratio***	***Coef.***	***t-ratio***
lelrop2s	0.31	1.52	0.13	0.54	0.13	0.55	0.28	1.39	0.15	0.92
lpop	-0.05	-0.39	-0.21	-1.36	-0.07	-0.49	-0.09	-0.65	-0.07	-0.57
lar	0.00	-0.02	-0.01	-0.07	-0.13	-0.73	-0.13	-0.89	-0.22	-1.47
disteq	-0.19	-1.02	0.17	0.78	0.25	1.16	0.22	1.11	0.38	2.12
englfrac	1.44	2.56	1.96	3.26	2.04	4.00	1.88	3.87	1.74	3.41
dafrica	-0.38	-0.66	-0.14	-0.25	-1.05	-1.98	-1.16	-1.79	-0.91	-1.43
deurope	-0.03	-0.06	-0.09	-0.16	-0.50	-0.84	-0.95	-1.80	-0.76	-1.71
dasia	-0.98	-2.38	-0.05	-0.10	-1.27	-2.75	-1.18	-2.64	-1.05	-2.58
deastasia	1.40	5.15	1.35	3.15	2.17	4.27	1.70	3.72	1.11	3.48
dsubsafrica	-1.61	-1.99	0.46	0.42	0.89	0.77	0.74	0.67	1.37	1.61
_cons	3.29	1.18	6.49	2.03	7.60	2.47	7.50	2.92	9.84	4.01
R-squared	0.51		0.30		0.40		0.42		0.49	
Nobs	64.00		68.00		68.00		65.00		58.00	
F(9,54)	7.26		3.63		8.31		8.35		8.12	

Our geography-based trade instrument is a statistically significant determinant of log real openness in the final two estimation periods of 1995 and 2000, when controlling for population, area, distance from equator, fraction of population speaking English and the continental dummies. The F-statistic of the hypothesis that our instrument can be excluded from the regression is statistically significant over all periods.

Results of the first-stage regression for our proxy of institutional quality indicate that the distance variable is statistically significant in 2000 only. Neither population nor area is significant. The fraction of population speaking English is statistically significant over all time periods. The fraction of population speaking one of the main five languages in Europe was also initially included, but it was always insignificant, therefore it is not included in the final regressions. Notably, the F-statistic is consistently lower in these results when compared to those for log real openness.

4.2 Trade and Productivity

We start by presenting cross-section results for five selected years in order to analyse the stability/evolution over time of the estimated coefficients and to compare our results with those obtained in previous research. Table 3 reports our results using two-stage least squares (2SLS) estimation when examining the effect of trade on productivity, where our dependent variable for labour productivity is taken from the Penn World Tables.

Our results show that in 1980, the variable area is significant at 5% level and only three of the continent dummies are statistically significant (1%) in explaining labour productivity when controlling for population, area, distance from the equator, institutional quality and continent dummies. Results for 1985 are somewhat similar with distance to the equator indicating significance also. In 1990 only distance and the Australasia dummy are significant at 1% level, whereas institutions quality is significant at 5% level, in explaining productivity. For 1995 and 2000, real openness and area display a statistically significant coefficient (at 1% level). The 2000 results indicate that our measure of institutional quality, together with real openness, area and three of the continent dummies are determinants of labour productivity. The results obtained in 2000 are more robust than those obtained in the previous years, the explanatory power is the highest and also the F-Statistic.

The continent dummies indicate that once we have controlled for the trade, institutions and scale effects, labour productivity is lower in the African continent and in Asia (excluding East Asia) than in North America (default dummy). The evolution over time shows that in Sub-Saharan Africa the situation has worsened whereas in Europe and East Asia the negative differential has somewhat decreased and the dummy is no longer significant in the 1990s.

Table 3. Instrumental Variables results (2SLS)[10]

Variables:	***1980***		***1985***		***1990***		***1995***		***2000***	
lpro	***Coef.***	***t***	***Coef.***	***T***	***Coef.***	***t***	***Coef.***	***t***	***Coef.***	***t***
lropen	1.01	1.54	0.14	0.28	0.26	0.49	0.75	2.12	0.66	2.04
iqual	0.01	0.03	0.33	1.65	0.26	1.75	0.20	1.48	0.32	2.41
lpop	0.04	0.23	-0.17	-1.29	-0.13	-1.13	0.01	0.17	0.05	0.76
lar	0.16	1.77	0.02	0.24	0.02	0.17	0.14	1.99	0.12	2.03
ldisteq	0.77	0.90	0.30	2.67	0.29	2.61	0.75	1.13	0.07	0.94
daustrasia	-0.64	-2.34	-0.66	-2.78	-0.62	-1.99	-0.43	-1.91	-0.39	-2.33
dafrica	-1.28	-3.32	-0.86	-2.64	-0.73	-1.66	-0.89	-2.83	-0.63	-2.93
deurope	-0.76	-2.27	-0.63	-2.00	-0.60	-1.35	-0.40	-1.24	-0.15	-0.64
deastasia	-0.59	-1.57	-0.32	-0.94	-0.14	-0.38	-0.32	-0.92	-0.21	-0.94
dsubsafrica	-1.18	-1.77	-0.21	-0.45	-0.13	-0.25	-1.32	-3.12	-1.52	-4.84
_cons	3.94	1.17	9.83	3.84	9.24	3.11	4.14	1.97	3.72	2.08
R-squared	0.78		0.85		0.75		0.70		0.87	
Nobs	56.00		58.00		58.00		66.00		59.00	
F(10,45)	18.68		3.68		10.51		16.09		36.65	
Wu-Hausman F test	0.85		0.98		0.20		1.44		0.84	
Durbin-Wu-Hausman Chi-sq test	2.13		0.97		0.51		3.44		2.09	
Sargan test (N*R-sq)	1.22		0.26		0.19		1.43		0.51	
Basmann test, Chi-sq(1)	0.98		0.21		0.15		1.17		0.41	

Notes: W-Hausman and Durbin-Wu-Hausman are tests of endogeneity of lropen and iqual (the results from the tests indicate acceptance of H0: Regressors are exogenous).
Sargan N*R-sq and Basmann are tests of over-identifying restrictions, a rejection of the null hypothesis indicates that the instrumental variables estimator should be employed (results indicate acceptance of H0).

As a next step, we present estimation results for the whole panel. Although we have seen in Table 3 that the absolute value and significance of the coefficients varies for different years, we expect to find an "average effect" by running a single regression with time dummies for the five years under analysis. We considered both openness and real openness in estimation and used both PWT and GGDC measures of productivity for comparison purposes. These results are shown in Table 4 for the complete panel.

[10] OLS results are provided (for both data sources of labour productivity) in the appendix, for information.

Table 4. Comparing Openness with Real Openness (2SLS panel)

Results with openness in nominal terms					Results with real openness			
lpro	**Coef**[1]	**t**	**Coef**[2]	**t**	**Coef**[1]	**t**	**Coef**[2]	**t**
Lopenc/lropen	0.74	1.46	0.10	0.20	0.55	2.33	0.32	1.43
iqual	0.33	4.35	0.40	5.44	0.23	2.69	0.32	3.96
lpop	-0.05	-0.70	-0.10	-1.45	-0.04	-0.92	-0.04	-0.72
lar	0.10	1.57	0.04	0.71	0.08	2.31	0.06	2.02
ldisteq	0.33	3.17	0.19	2.04	0.20	4.71	0.16	4.02
daustrasia	-0.67	-3.53	-0.46	-2.74	-0.54	-5.39	-0.47	-5.41
dafrica	-1.10	-3.29	-0.35	-1.23	-0.84	-5.81	-0.34	-2.82
deurope	-0.51	-2.09	-0.03	-0.15	-0.47	-3.09	-0.14	-1.03
deastasia	-0.42	-2.24	-0.22	-1.16	-0.29	-2.25	-0.26	-2.09
dsubsafrica	-0.25	-0.64	-1.29	-4.33	-0.73	-4.24	-1.46	-7.90
y85	0.04	0.38	-0.01	-0.13	0.25	1.85	0.13	1.02
y90	-0.12	-1.12	-0.10	-1.11	0.07	0.60	0.01	0.06
y95	-0.30	-2.56	-0.27	-2.60	-0.04	-0.26	-0.15	-1.22
y2000	-0.48	-2.88	-0.34	-2.19	-0.04	-0.23	-0.17	-1.19
_cons	5.12	1.81	8.13	3.06	6.50	5.25	7.08	6.02
Adj. R-squared	0.66		0.74		0.77		0.82	
Nobs	292		283		292		283	
Wu-Hausman F test	3.22		7.67		0.64		6.81	
Durbin-Wu-Hausman Chi-sq test	6.68		15.43		1.35		13.79	
Sargan test (N*R-sq)	1.50		5.56		0.44		5.81	
Basmann test, Chi-sq(1)	1.57		5.35		0.42		5.60	

Notes:
W-Hausman and Durbin-Wu-Hausman are tests of endogeneity of lropen (lopenc) and iqual (the results from the tests indicate acceptance of H0: Regressors are exogenous). Sargan N*R-sq and Basmann are tests of overidentifying restrictions, a rejection of the null hypothesis indicates that the instrumental variables estimator should be employed (results indicate acceptance of H0).
[1] The dependent variable is log of productivity measured as GDP per person employed in 1990 GK $ from the Groningen Centre.
[2]The dependent variable is log of productivity measured as GDP per person employed in 1990 GK $ from the PWT.

Institutional quality appears to explain productivity across when both openness and real openness are included in the specifications and when either productivity measure is employed. Distance from the equator is also statistically significant across specifications and productivity measures. Real openness appears to be statistically significant only when GGDC productivity data are used.

Population is statistically insignificant in all cases. Area is insignificant when using openness for both productivity measures but is significant when real openness is included in the specification.

For comparison purposes, we ran OLS regressions for each year and using the two alternative measures for the productivity variable. The results are shown in table A1 in the Appendix. The coefficients are generally more precisely estimated under OLS than under 2SLS, since the standard errors are almost always lower. We perform Wu-Hausman and Durbin-wu-Hausman tests of the hypothesis that trade and institutions quality are uncorrelated with the residuals, and thus OLS are unbiased. For most of the coefficients and years we cannot reject the hypothesis that the OLS and the 2SLS estimates are equal. The results from the tests are shown in the last rows of Tables 3 and 4.Both tests are, in the usual classical statistical sense, being conservative about concluding endogeneity. If theory or evidence from other studies or even common sense suggests endogeneity, this may suffice to proceed with the 2SLS regardless of the results of the test. In this case, it is convenient to report both the OLS and the IV estimates and the test results, and interpret the findings from the analysis accordingly. In particular, endogeneity is always rejected when productivity data from the Groningen centre are employed. Our results are in line with those found in Frankel and Romer (1999), since they show that the IV and OLS estimates of the trade impact on income never differ substantially. The authors find that moving from OLS to IV increase the estimated impact of trade and country size on income. On the contrary, we find that examining the link between trade and productivity using OLS overstates rather than understates the effect of trade. This is in accordance with the theory, since countries that are more open, are likely to adopt other policies that enhance productivity and are expected to have better infrastructures and transportation systems.

For thoroughness, we also used 3SLS estimation to examine the trade-productivity relationship across our sample of countries. This method provides a comprehensive and, arguably, more complete estimation method across the system of equations that characterise the relationships among our variables of interest. These results are presented in Table 5. By using 3SLS we also control for the existence of cross-correlation of the residuals in the three different equations. 3SLS combines the seemingly unrelated regression (SUR) technique with the 2SLS technique and it is therefore more accurate. We observe that some of the coefficients are higher in magnitude than those obtained with the 2SLS method (real openness and area) but the main results are unchanged: both real openness, institutions quality, area and distance and the continent dummies are statistically significant, whereas population is not.

Table 5. Panel results (Three-stage least-squares regression with time dummies)

variables	*Coef.*	*Std. Error*	*Z*	*variables*	*Coef.*	*Std. Error*	*z*
lpro				**lropen**			
lropen	0.65	0.24	2.71	lelrop2s	0.16	0.04	3.69
lpop	-0.01	0.04	-0.26	lpop	-0.18	0.03	-6.68
lar	0.11	0.04	2.62	disteq	0.95	0.29	3.33
iqual	0.20	0.09	2.35	lar	-0.14	0.03	-4.74
disteq	0.71	0.29	2.43	eurfrac	0.25	0.11	2.40
dafrica	-0.81	0.14	-5.84	englfrac	0.30	0.15	2.05
deurope	-0.48	0.14	-3.52	dafrica	0.14	0.14	1.00
daustrasia	-0.51	0.10	-5.21	deurope	0.09	0.13	0.66
deastasia	-0.42	0.13	-3.11	daustrasia	0.03	0.11	0.28
dsubsafrica	-1.00	0.17	-5.94	deastasia	0.68	0.12	5.81
y85	0.30	0.14	2.16	dsubsafrica	0.40	0.17	2.31
y90	0.11	0.12	0.89	y85	-0.35	0.09	-3.71
y95	0.00	0.14	0.03	y90	-0.14	0.09	-1.47
y2000	0.01	0.16	0.05	y95	-0.05	0.09	-0.53
_cons	5.18	1.26	4.10	y2000	-0.05	0.09	-0.61
				_cons	5.40	0.56	9.68
iqual							
lpop	-0.10	0.05	-1.95				
lar	-0.18	0.05	-3.71				
disteq	1.27	0.54	2.36				
eurfrac	0.37	0.20	1.84				
englfrac	2.04	0.28	7.18				
dafrica	-0.49	0.28	-1.78				
deurope	-0.20	0.24	-0.82				
daustrasia	-0.68	0.22	-3.11				
deastasia	1.73	0.22	7.68				
dsubsafrica	0.37	0.33	1.10				
y85	0.06	0.17	0.32				
y90	0.49	0.17	2.86				
y95	1.05	0.17	6.15				
y2000	1.45	0.17	8.40				
_cons	7.91	0.52	15.16				

Equation	*Obs*	*Parms*	*RMSE*	*R-sq*
lpro	292.00	14.00	0.45	0.77
lropen	292.00	15.00	0.48	0.69
iqual	292.00	14.00	0.92	0.54

One interesting aspect of our results is that in most of the regressions we find that population is insignificant and negatively signed. Alcala and Ciccone (2004) show in their regression results (Table 5:34) a positive and significant coefficient for population, however, Table I (Alcala and Ciccone, 2004: 30) shows a negative correlation between population and real openness. In this table they do not show the correlation coefficient between area and population, it could be that in their sample population and area are highly correlated and the population variable is showing the effect of the area variable (the area variable is insignificant in Alcala and Ciccone, 2004). In our results, the area variable is positively signed and significant. A greater area can have a positive impact on productivity via increased natural resources and a negative one via lower intra-country trade. Focusing on country size and holding population density constant (population/area) the effect of country size on productivity would be the sum of both the log of population and the log of area coefficients (Frankel and Romer 1999). Only with this hypothesis are we able to find a positive scale effect in our results.

We test for the Balassa-Samuelson Effect and results are provided in Table 6. We regress the price level on real openness and other variables included in the productivity equation. Both OLS and 2SLS estimations were conducted.

All geography controls and a constant were included. Results indicate that real openness has a highly significant positive effect on the price level, confirming the trade-related Balassa-Samuelson effect.

Table 6. Testing for the Balassa-Samuelson Effect (2SLS)

Without Iqual			***With Iqual***		
lprice	**Coef.**	**t**	**lprice**	**Coef.**	**t**
lropen	0.63	7.72	lropen	0.48	3.01
lpop	0.05	1.82	iqual	0.06	1.04
lar	0.07	4.17	lpop	0.03	0.94
ldisteq	0.18	6.34	lar	0.05	2.17
daustrasia	-0.24	-4.06	ldisteq	0.17	6.02
dafrica	-0.49	-6.16	daustrasia	-0.20	-2.95
deurope	-0.25	-3.22	dafrica	-0.43	-4.29
deastasia	-0.16	-1.85	deurope	-0.16	-1.55
dsubsafrica	0.65	5.64	deastasia	-0.18	-1.96
y85	-0.10	-1.53	dsubsafrica	0.65	5.46
y90	-0.10	-1.75	y85	-0.18	-1.98
y95	-0.18	-3.26	y90	-0.18	-2.11
y2000	-0.37	-6.72	y95	-0.27	-2.87
_cons	1.07	1.66	y2000	-0.48	-4.30
			_cons	1.68	1.98
Adj. R-squared		0.74	Adj. R-squared		0.72
Nobs		292	Nobs		292
Wu-Hausman F test		0.02	Wu-Hausman F test		0.46
Durbin-Wu-Hausman Chi-sq test		0.02	Durbin-Wu-Hausman Chi-sq test		0.97
Sargan test (N*R-sq)		3.71	Sargan test (N*R-sq)		3.53
Basmann test, Chi-sq(1)		3.55	Basmann test, Chi-sq(1)		3.34

Note: Lprice is the log of the price level from the PWT.

4.3 Robustness

We tested for the robustness of our results to inclusion of outliers. The results of our sensitivity analysis are provided in Table 7 (results for each year (1980, 1985, 1990, 1995 and 2000) are not provided here but were similar). Statistical significance of real openness (lropen) appears robust, however, but not for the non-OECD countries in our sample. Similar findings for institutional quality are evident. Population is insignificant and area remains statistically significant over the entire set of analyses. Distance from the equator is not statistically significant for the OECD sample of countries.

Table 7. Sensitivity analysis. Productivity equation for different sub-samples

Variables	*Bench-mark*		*Excluding HK, Lux., Sing.*		*OECD*		*NON-OECD*	
lpro	Coef.	t	Coef.	t	Coef.	t	Coef.	t
lropen	0.55	2.33	0.57	2.72	0.28	2.30	0.70	1.23
iqual	0.23	2.69	0.21	2.73	0.21	4.65	0.37	1.57
lpop	-0.04	-0.92	-0.04	-0.96	0.01	0.54	0.01	0.08
lar	0.08	2.31	0.10	3.09	0.06	3.20	0.13	2.82
ldisteq	0.20	4.71	0.22	4.66	-0.03	-0.29	0.16	2.59
daustrasia	-0.54	-5.39	-0.55	-5.52	-0.14	-1.82	-0.55	-1.56
dafrica	-0.84	-5.81	-0.87	-6.21	-		-0.41	-1.67
deurope	-0.47	-3.09	-0.48	-3.31	0.07	0.85	-0.08	-0.19
deastasia	-0.29	-2.25	-0.30	-2.32	-0.10	-0.90	-0.53	-1.73
dsubsafrica	-0.73	-4.24	-0.69	-3.77	-		-1.49	-6.44
y85	0.25	1.85	0.26	2.06	0.12	1.69	0.29	0.90
y90	0.07	0.60	0.09	0.76	0.04	0.56	0.10	0.36
y95	-0.04	-0.26	-0.02	-0.15	-0.07	-0.94	-0.15	-0.46
y2000	-0.04	-0.23	-0.02	-0.12	0.03	0.36	-0.26	-0.64
_cons	6.50	5.25	6.39	5.76	6.96	10.01	4.21	1.54
Adj. R-squared	0.77		0.77		0.71		0.68	
Nobs	292		286		115		163	
f(14,277)	61.34		60.64		17.38		27.51	
Wu-Hausman F test	0.53		0.64		0.87		5.52	
Durbin-Wu-Hausman Chi-sq test	0.51		1.35		1.96		11.46	
Sargan test (N*R-sq)	0.64		0.67		6.60		1.63	
Basmann test, Chi-sq(1)	1.35		0.63		6.15		1.48	

Notes:
W-Hausman and Durbin-Wu-Hausman are tests of endogeneity of lropen (lopenc) and iqual (the results from the tests indicate acceptance of H0: Regressors are exogenous).
Sargan N*R-sq and Basmann are tests of overidentifying restrictions, a rejection of the null hypothesis indicates that the instrumental variables estimator should be employed.

5 Conclusions

A considerable range of research examines the role of trade in growth and productivity. Some of this is discussed in Section 2 of our paper, in particular. Empirically, a range of results using different techniques across different country samples, yield alternative stories of how trade relates to productivity and growth. We add to this literature using the real openness measure as a determinant of labour productivity applied in a cross-country setting over the 1980-2000 period.

Using the measure of real openness, we find that it is a statistically significant explanatory variable for labour productivity across our sample of countries, when geography controls and institutional quality are included, for the data from 1995 and 2000. The effect is more modest than the previous literature suggested. The estimates suggest that a one-percentage-point increase in real openness raises productivity by only 0.55 per cent. Between 1980 and 1990, we find no statistically significant relationship between real openness and labour productivity. This differs to the findings of Alcala and Ciccone (2004) but different data sources and country sample were used and in particular we used an alternative measure of institutional quality. (Interestingly, while their data refer to 1985, their institutional quality data were from 1997/1998). Hence, while the rationale underlying the use of real openness was supported in our data with the finding of the Balassa-Samuelson effect, we cannot argue in favour of a robust relationship between real openness and labour productivity for our country sample for the period 1985-2000.

We only find partial support for the scale effect. Population is statistically significant in our first-stage regression for openness only. Using population alone has no impact on labour productivity. The theoretical rationale for inclusion of the variable in terms of the absorption effect finds no empirical support here. However, the area variable is significant and positive signed, thus considering the joint effect of area and population we are able to find a small positive effect of increasing size with population density held constant.

The use of different data sources for labour productivity reveals that this makes a substantial difference to the results of our analysis and the inferences we can make. More research is needed here to identify the sources of difference in the data that give rise to diverse results. This is where our further research is to be directed.

We also leave for further research the analysis of the channels through which openness affects growth and productivity in a dynamic setting.

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Table A1. OLS main results

Variables	1980 Coef.	t-ratio	1985 Coef.	t-ratio	1990 Coef.	t-ratio	1995 Coef.	t-ratio	2000 Coef.	t-ratio
lpro										
lropen	0.71	5.94	0.16	0.73	0.24	1.57	0.60	7.46	0.66	7.65
lpop	0.01	0.12	-0.15	-1.95	-0.10	-1.44	-0.05	-0.93	0.01	0.14
lar	0.10	2.33	0.03	0.59	0.02	0.33	0.12	3.26	0.13	4.01
iqual	0.06	1.00	0.34	3.29	0.33	3.61	0.13	2.83	0.24	4.97
ldisteq	0.15	3.03	0.28	3.07	0.28	3.45	0.17	2.24	0.11	1.46
daustrasia	-0.65	-3.49	-0.63	-3.01	-0.58	-3.33	-0.47	-2.70	-0.39	-2.33
dafrica	-1.09	-7.45	-0.84	-3.42	-0.65	-3.26	-0.89	-6.14	-0.71	-5.19
deurope	-0.48	-2.45	-0.61	-2.43	-0.59	-2.85	-0.32	-1.69	-0.21	-1.29
deastasia	-0.46	-2.60	-0.34	-1.58	-0.25	-1.24	-0.04	-0.18	-0.12	-0.54
dsubsafrica	-1.06	-4.71	-0.23	-0.42	-0.19	-0.36	-1.18	-4.60	-1.39	-6.14
Constant	6.23	6.71	9.33	6.49	8.59	7.50	6.46	7.97	4.72	5.01
R-Squared	0.88		0.76		0.76		0.88		0.90	
Nobs	59		61		61.00		65.00		62.00	
F(10,48)	48.68		18.88		24.60		42.48		59.06	

Note: Labour productivity data are from PWT

Variables	1980 Coef.	t-ratio	1985 Coef.	t-ratio	1990 Coef.	t-ratio	1995 Coef.	t-ratio	2000 Coef.	t-ratio
lproac										
lropen	0.66	4.66	0.61	5.69	0.47	5.03	0.48	6.38	0.57	7.91
lpop	-0.01	-0.07	-0.03	-0.40	-0.03	-0.56	-0.05	-0.93	0.00	0.05
lar	0.09	2.10	0.08	2.07	0.06	1.51	0.08	2.37	0.10	3.21
iqual	0.06	0.71	0.07	1.42	0.16	3.61	0.14	3.19	0.26	5.22
ldisteq	0.14	2.01	0.15	2.26	0.15	2.47	0.18	2.34	0.14	1.54
daustrasia	-0.67	-2.72	-0.62	-2.84	-0.64	-4.38	-0.45	-2.62	-0.35	-2.30
dafrica	-0.61	-2.59	-0.49	-1.64	-0.37	-1.77	-0.39	-2.27	-0.14	-0.92
deurope	-1.42	-3.80	-0.27	-1.30	-0.25	-1.72	-0.19	-1.10	-0.08	-0.50
deastasia	-0.33	-1.41	-0.20	-0.97	-0.07	-0.35	0.09	0.40	-0.01	-0.05
dsubsafrica	-0.37	-1.57	-1.34	-3.90	-1.58	-6.02	-1.65	-6.01	-1.99	-7.60
Constant	3.48	2.35	7.19	7.12	5.22	4.60	5.16	5.62	2.63	2.46
R-Squared	0.85		0.86		0.90		0.88		0.91	
Nobs	57		59.00		59.00		62.00		60.00	
F(10,48)	32.41		45.18		53.41		30.75		48.53	

Note: Labour productivity data are from the Groningen Centre.

Figure A1: Real Openness (in logs) Versus Constructed Trade Measure