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A further examination of the export-led growth hypothesis

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Abstract

This paper challenges the common view that exports generally contribute more to GDP growth than a mere change in export volume, as the export-led growth hypothesis predicts. Applying heterogeneous panel cointegration techniques to a production function model with non-export GDP as the dependent variable, we find for a sample of 45 developing countries that: (i) exports have a positive short-run effect on non-export GDP in developing countries, (ii) the long-run effect of exports on non-export output, however, is negative on average, and (iii) there are large differences in the long-run effect of exports on non-export GDP across countries. Evidence from a simple regression analysis suggests that these cross-country differences in the long-run effect of exports on non-export GDP are significantly negatively related to cross-country differences in primary export dependence, business regulation, and labour regulation, whereas there is no statistically significant association between the growth effect of exports and the capacity of a country to absorb knowledge.

JEL-Classification: F43; O11; C23

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1. Introduction

The question of whether exports are a key factor in promoting growth in developing countries, as the export-led growth hypothesis predicts, has been the subject of numerous studies over the past three decades. These studies can be roughly divided into four groups.[1] The first includes cross-country studies, such as Michaely (1977), Balassa (1978), Heller and Porter (1978), Tyler (1981), Feder (1983), Kavoussi (1984), Ram (1985), and McNab and Moore (1998). Collectively, this series of studies supports a positive association between export growth and output growth in developing countries. However, the studies assume, rather than demonstrate, that export growth has a positive causal effect on GDP (or GNP) growth, thus ignoring the fact that a significant positive correlation between these two variables can also be compatible with causality running from output growth to export growth. Furthermore, the estimates in these studies may be biased if causality runs in both directions. Finally, making matters worse, several country-specific factors may cause apparent differences in the effect of exports on growth across countries, but these factors cannot be fully controlled for in cross-country regressions (especially if effectively unobservable). This gives rise to the classical omitted-variables problem.

In response to these criticisms, the second group of studies investigates the causal relationship between exports and growth for individual countries using Granger's (1969) or Sims' (1972) causality test.[2] Among these studies are Jung and Marshall (1985), Chow (1987), Hsiao (1987), Bahmani-Oskooee et al. (1991), Dodaro (1993), Sharma and Dhakal (1994), Love (1994), and Riezman et al. (1996). Overall, these studies suggest that export growth has no causal effect on output growth in the majority of developing countries. However, they do not examine whether

[1] For comprehensive reviews of the literature, see Edwards (1993) and Giles and Williams (2000).

[2] For completeness, it should be noted that another group of studies uses simple OLS time-series regressions. This group includes, for example, Ram (1987), Salvatore and Hatcher (1991), Greenaway and Sapsford (1994). Like the cross-country studies in the first group, these studies do not test the direction of causality.

exports and GDP are cointegrated and thus whether there exists a long-run relationship between exports and output. Specifically, most of these studies test for causality by employing simple VAR models in growth rates or first differences. It is well known that the use of stationary first differences (or growth rates) avoids possible spurious correlations, but this approach precludes the possibility of a long-run or cointegrating relationship between the level of exports and the level of output a priori. Moreover, and perhaps more importantly, recent advances in time-series econometrics suggest that simply using first differences may lead to misspecification bias if a long-run or cointegrating relationship between the levels of the variables exists (see, e.g., Granger 1988). Indeed, there are some studies that estimate VAR models of the (log) level of exports and the (log) level of GDP. However, standard F-tests for Granger causality based on VAR models in levels are not valid if the underlying variables are nonstationary and not cointegrated (see, e.g., Toda and Phillips 1993).

In light of these limitations, the third group of studies uses cointegration techniques to examine the long-run relationship between exports and output for individual countries. This group includes, for example, Bahmani-Oskooee and Alse (1993), Van den Berg and Schmidt (1994), Ahmad and Harnhirun (1995), Al-Yousif (1997), Abu-Qarn and Abu-Bader (2004), Love and Chandra (2004), Bahmani-Oskooee and Oyolola (2007), and Bahmani-Oskooee and Economidou (2009). Taken as a whole, these studies suggest that in most developing countries there is a positive long-run relationship between exports and output, and that causality is running from exports to output or in both directions. A potential limitation of these studies, however, is the low power of the statistical tests due to the small sample size associated with the use of individual country time-series data.

Therefore, the fourth group of studies employs panel cointegration methods, which have higher power due to exploitation of both the time-series and cross-sectional dimensions of the data. Unfortunately, this group includes only four studies and the results of these studies are mixed. More precisely, Bahmani-Oskooee et al. (2005) and Reppas and Christopoulos (2005) conclude that long-run causality is unidirectional from GDP to exports, while the results of Parida and Sahoo (2007) suggest that increased exports are a cause of increased GDP, and Jun (2007) finds evidence of positive long-run effects running from exports to GDP and vice versa. However, these studies also have limitations. Reppas and Christopoulos (2005) and Parida and Sahoo (2007), for example, consider only a relatively small number of countries. More specifically, Reppas and Christopoulos analyse a sample of 22 African and Asian countries, while the sample of Parida and Sahoo includes only four South Asian countries. Thus, it is questionable whether the results of these two studies are representative for the group of developing countries as a whole. Another limitation is that Parida and Sahoo (2007) and Jun (2007) use within-dimension panel cointegration estimators, which, by their nature, are unable to capture the heterogeneity of the long-run coefficients across countries. Consequently, these studies do not allow conclusions regarding the long-run effects of exports (and thus the validity of the export-led growth hypothesis) for individual countries. In addition, and perhaps most importantly, Bahmani-Oskooee et al. (2005), Reppas and Christopoulos (2005), Jun (2007), and numerous other studies do not control for the simultaneity bias associated with the fact that exports, via the national income accounting identity, are themselves a component of GDP. Specifically, the problem is that a positive correlation may emerge simply because exports are part of GDP (rather than because of any extra contribution that exports make to GDP or, conversely, because of any extra contribution that GDP makes to exports), and that this simultaneity between exports and output may also lead to potentially misleading inferences on causality. Finally, a common feature of these studies is that they examine only the long-run relationship between exports and output and thus do not account for possible differences between the long-run and short-run effects of exports.

The purpose of this paper is to overcome these limitations by

1. employing heterogeneous panel cointegration techniques to investigate the export led-growth hypothesis for 45 developing countries, both for the sample as a whole and for each country individually,
2. using non-export GDP instead of export-inclusive GDP to separate the influence of exports on output from that incorporated in the 'growth-accounting' relationship, and
3. examining both the long-run and short-run effects of exports on non-export GDP to gain insights into the dynamics of exports over time.

To preview our main results, we find that: (i) exports have a positive short-run effect on non-export GDP in developing countries, (ii) the long-run effect of exports on non-export output, in contrast, is negative on average in developing countries, and (iii) there are large differences in the long-run effect of exports on non-export GDP across countries.

Given this latter finding, it is natural to ask how these differences can be explained. As a further contribution, we attempt to answer this question by examining whether the observed cross-country differences in the long-run effects of exports are linked to country-specific factors, such as the level of primary export dependence, business regulation, labour regulation, and the capacity to absorb foreign knowledge. Using simple graphical and regression analysis, we find that the cross-country differences in the long-run effects of exports on non-export GDP are significantly negatively related to cross-country differences in primary export dependence, business regulation, and labour regulation, whereas there is no statistically significant association between the growth effect of exports and absorptive capacity. Although caution is needed in drawing policy conclusions, we think that this is an important finding for countries which pursue export-oriented development strategies.

The rest of the paper is organised as follows. Section 2 discusses the export-led growth hypothesis in more detail. Section 3 presents the empirical model and the data. Section 4 contains the empirical analysis, and Section 5 concludes.

2. Theoretical discussion

It is conventional wisdom among policy makers, journalists, and academics that exports are a key factor in promoting economic growth in developing countries, and there are several theoretical arguments supporting this hypothesis. For example, from a demand-side perspective, it is argued that sustained demand growth cannot be maintained in domestic markets because of limited market size. Export markets, in contrast, are almost limitless and hence do not involve growth restrictions on the demand side, implying that exports can act as a catalyst for output growth through an expansion of aggregate demand (see, e.g., Siliverstovs and Herzer 2007). This is the direct and intuitively obvious growth effect of exports that, admittedly, does not need to be investigated further. Given the fact that the export-to-GDP ratio in developing countries increased from about 10 per cent in 1970 to about 35 per cent in 2006, it immediately becomes clear that exports have played a major role in the growth process of developing countries, as part of domestic production demanded by foreign buyers. In the empirical analysis, however, this direct effect must be controlled for. The reason is that the export-led growth hypothesis, in its original form, predicts that exports have an indirect growth effect that goes beyond the mere change in export volume — an effect on output through productivity.

In theory, there are several ways in which exports can affect productivity. First, exports can provide the foreign exchange to finance imports that incorporate knowledge of foreign technology and production know-how, thereby promoting cross-border knowledge spillovers (see, e.g., Grossman and Helpman 1991). Second, exports can increase productivity by concentrating investment in the most efficient sectors of an economy — those in which the economy has a comparative advantage (see, e.g., Kunst and Marin 1989). Third, since combining the international market with the domestic market facilitates larger-scale operations than does the domestic market alone, an expansion of exports allows countries to benefit from economies of scale (see, e.g., Helpman and Krugman 1985). Fourth, and perhaps most importantly, the export sector may generate positive externalities on the non-export sector (see, e.g., Feder 1983). The sources of these knowledge spillovers include, on the one hand, incentives for technological improvements, labour training, and more efficient management due to increased international competition and, on the other, direct access to foreign knowledge through relationships with foreign buyers (see, e.g., Chuang 1998).

Several arguments suggest, however, that these positive productivity effects predicted by the export-led growth hypothesis do not necessarily occur in developing countries. For example, one concern is that many developing countries are still heavily dependent on primary commodity exports. Such exports can lead economies to shift away from competitive manufacturing sectors in which many externalities necessary for growth are generated, while the primary export sector itself does not (by its nature) have many linkages with, and spillovers into, the economy (see, e.g., Sachs and Warner 1995, Herzer 2007). Moreover, primary exports tend to be subject to large price and volume fluctuations. Increased primary exports may therefore lead to increased GDP variability and macroeconomic uncertainty, which, in turn, may hamper efforts for economic planning and thereby reduce the quantity as well as the efficiency of domestic investment (see, e.g., Dawe 1996).

Another concern is that the ability of the non-export sector to absorb potential knowledge spillovers from the export sector depends on its absorptive capacity. In particular, domestically oriented firms using very backward production technology and low-skilled workers may be unable to make effective use of knowledge spillovers. Similarly, it can be argued that a certain level of technology and human capital in the export sector itself may be necessary to acquire foreign technology (see, e.g., Edwards 1993).

Finally, many developing countries are subject to excessive business and labour regulations (see, e.g., World Bank 2009) that limit both the mobility of factors between sectors and the flexibility of factor prices. In such a scenario of severe factor-market imperfections, an increase in exports may be associated with un- or underemployment and, as a consequence, with productivity losses (see, e.g., Edwards 1988).

From this it follows that the productivity effects of exports are ambiguous and depend upon several factors, such as the level of primary export dependence, the degree of absorptive capacity, and the degree of business and labour regulations. A simple but important implication of this is that the effects of exports on output through productivity may differ significantly from country to country. Another implication of the above discussion is that the productivity effects of exports may differ over time, as well. For example, in the short run, exports may increase productivity through specialisation according to comparative advantage. If, however, the increase in exports induces an expansion of sectors that do not exhibit positive externalities while other sectors with positive externalities shrink, the associated productivity loss will more than offset the traditional static specialisation gains in the long run. Accordingly, exports may have positive short-run, but negative long-run effects. Each of these issues is addressed in the empirical section.

3. Empirical model and data

In order to empirically capture the impact of exports on output through productivity, we start with an AK-type production function:

$$Y_{it} = B_{it} K_{it}^{b_1} , \tag{1}$$

where Y_{it} is the output of country *i* at time *t*, K_{it} is the capital of country *i* at time *t*, and B_{it} is a productivity parameter. Because we want to examine if and how exports affect economic growth via changes in productivity, we assume that the productivity parameter of country *i* at date *t* can be expressed as a function of exports, X_{it} :

$$B_{it} = f(X_{it}) = X_{it}^{b_2} . \tag{2}$$

Combining Equations (1) and (2) and taking natural logarithms yields:

$$\ln(Y_{it}) = b_1 \ln(K_{it}) + b_2 \ln(X_{it}), \quad (3)$$

where the coefficients b_1 and b_2 are the cross-country averages of the elasticities of output with respect to capital and exports, which are allowed to be country specific and thus to vary across countries.

Yet, the estimate of b_2 cannot be used to measure the average productivity effect of exports on output. Given the fact that exports — via the national accounting identity — are themselves a component of output, a positive and statistically significant relationship between exports and output will be almost inevitable, even if there are no productivity effects. To remedy this problem, we separate the influence of exports on output from that incorporated in the 'growth-accounting' relationship, by using output net of exports, $N_{it} = Y_{it} - X_{it}$ (see, e.g., Greenaway and Sapsford 1994, Siliverstovs and Herzer 2007). By replacing the logarithm of total output, $\ln(Y_{it})$, with the logarithm of non-export output, $\ln(N_{it})$, we obtain:

$$\ln(N_{it}) = c_1 \ln(K_{it}) + c_2 \ln(X_{it}). \quad (4)$$

The coefficient c_2 in this equation is 0, $c_2 = 0$, if the coefficient of the export variable in the augmented production function specification, indicated by Equation (3), just reflects the share of exports in output.[3] If, in contrast, the coefficient c_2 is greater than 0, $c_2 > 0$, the growth effect of exports goes beyond the mere increase in export volume, suggesting that exports increase output through increased productivity; whereas if $c_2 < 0$, exports contribute less to GDP growth than the increase in export volume, suggesting that exports are productivity-reducing (see, e.g., Siliverstovs and Herzer 2007).

[3] This can be seen by assuming a multiplicative relationship of the form: $Y = X^{a} N^{1-a}$, where a is the share of exports in GDP. Inserting this equation into Equation (3) yields after some manipulations Equation (4), where $c_1 = b_1 / (1 - a)$, $c_2 = (b_2 - a) / (1 - a)$. Thus, if $b_2 = a$, then $c_2 = 0$.

Finally, to control for any country-specific omitted factors that are relatively stable over time or evolve smoothly over time, we include country-specific fixed effects, c_{3i}, and country-specific deterministic time trends, $c_{4i}t$. Adding the usual error term, ε_{it}, yields the following regression model:

$$\ln(N_{it}) = c_{1i}\ln(K_{it}) + c_{2i}\ln(X_{it}) + c_{3i} + c_{4i}t + \varepsilon_{it}. \qquad (5)$$

Note that, unlike other studies, we do not include imports in the regression, because if we included imports, the estimate of the effect of exports on output through productivity would preclude any effect operating through its impact on this variable. Specifically, if export earnings are used to finance imports, then, by including imports in the regression, we would be omitting the productivity effect of exports that operates via imports. Also, we do not include labour since reliable employment data are not available for many developing countries over a long enough period of time. Furthermore, when the level of employment evolves relatively smoothly over the long run, it can be assumed that this feature will be absorbed into the country-specific deterministic trends. In fact, several studies for the US suggest that labour input (hours worked) is trend stationary (see, e.g., DeJong and Whiteman 1991; Leybourne 1995; Banerjee and Russel 2005). If this also applies to developing countries, labour input can be adequately captured by a deterministic trend.

In addition, as an indirect test for omitted variables, we can examine whether there is a (single) long-run or cointegrating relationship between $\ln(N_{it})$, $\ln(K_{it})$, and $\ln(X_{it})$, as represented by Equation (5). A regression containing all the variables of a cointegrating relationship will have a stationary error term; while any omitted nonstationary variable that is part of the cointegrating relationship will produce nonstationary residuals. Thus, an important implication of cointegration is that no relevant integrated variables in the cointegrating vector are omitted.

The data are from the World Development Indicators (2008). Exports (X_{it}) include both goods and services; gross capital formation is our proxy for capital (K_{it}); and the non-export output

(N_{it}) is measured by GDP minus exports of goods and services. All data are in constant 2000 dollars and our sample includes all countries for which continuous data are available from 1971 to 2005. Of these countries, four are in North Africa (Algeria, Egypt, Morocco, and Tunisia), nineteen are in sub-Saharan Africa (Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Gambia, Ghana, Guinea-Bissau, Kenya, Lesotho, Madagascar, Malawi, Mali, Rwanda, Senegal, South Africa, Sudan, Swaziland, Togo, and Zambia), nine are in South America (Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, and Uruguay), six are in Central America and the Caribbean (Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, and Mexico), three are in East Asia (Indonesia, Thailand, and South Korea), and four are in South Asia (Bangladesh, India, Iran, and Pakistan). Thus, our sample consists of 45 countries from all developing regions of the world.

4. Empirical analysis

This section is devoted to the empirical analysis of the export-led growth hypothesis. Specifically, we examine the following questions:

1. Is there a long-run relationship between non-export GDP, capital, and exports?
2. If yes, how do exports affect non-export GDP in the long run, and how is non-export GDP affected by exports in the short run?
3. Are there significant differences in the long-run effects of exports on non-export GDP across countries?
4. If yes, can these differences be explained by cross-country differences in primary export dependence, absorptive capacity, and business and labour regulations, as hypothesised in Section 2?

4.1. Cointegration tests

Given that Levin et al. (2002) and Im et al. (2003) panel unit root tests suggest that all our variables are integrated of order one (for brevity, the results are not reported here), the first step is to test for the existence of a long-run or cointegrating relationship between ln(N_{it}), ln(K_{it}), and ln(X_{it}). As discussed in Section 1, we use panel tests for this purpose, since panel-based tests have higher power than tests based on individual time-series. More specifically, we employ the panel cointegration approach of Pedroni (1999, 2004). This is a two-step procedure that allows for heterogeneous cointegrating vectors across countries by first estimating the hypothesised cointegrating regression (i.e., Equation (5)) separately for each country, and second, by testing the residuals from these regressions for stationarity using seven test statistics. Four of these seven pool the autoregressive coefficients across different countries during the unit-root test and thus restrict the first-order autoregressive coefficients to be the same for all countries. Pedroni refers to these within-dimension-based statistics as panel cointegration statistics. The other three test statistics are based on estimators that simply average the individually estimated autoregressive coefficients for each country, thus allowing the autoregressive coefficient to vary across countries. Pedroni refers to these between-dimension-based statistics as group mean panel cointegration statistics. The first of the panel cointegration statistics is a non-parametric variance ratio test. The second and the third are panel versions of the Phillips and Perron (PP) rho-statistic and *t*-statistic, respectively. The fourth statistic is a panel ADF *t*-test analogous to the Levin et al. (2002) panel unit root test. Similarly, the first of the group mean panel cointegration statistics is analogous to the PP rho-statistic, the second is a panel version of the PP *t*-statistic, and the third is a group mean ADF *t*-test analogous to the IPS (2003) panel unit root test.[4] Both the panel cointegration statistics and the group mean panel cointegration statistics test the null hypothesis H_0: "all of the individuals of the panel are not cointegrated." For the panel statistics, the alternative hypothesis is H_1: "all of the individuals of the

[4] See Pedroni (1999) for a detailed description of these test statistics.

panel are cointegrated," while for the group mean panel statistics, the alternative is H_1: "a significant portion of the panel members are cointegrated" (see, e.g., Pedroni 2004). The standardised distributions of the panel and group statistics are given by

$$\kappa = \frac{\varphi - \mu\sqrt{N}}{\sqrt{v}} \Rightarrow N(0, 1), \tag{6}$$

where φ is the respective panel or group statistic, and μ and v are the expected mean and variance of the corresponding statistic, tabulated by Pedroni (1999).

A potential problem with residual-based (panel) cointegration tests, such as the Pedroni (1999, 2004) procedure, is that the long-run elasticities are restricted to be equal to the short-run elasticites. If this common factor restriction is invalid, residual-based (panel) cointegration tests may suffer from low power, as shown, for example, by Westerlund (2007). In addition, residual-based cointegration tests are generally not invariant to the normalisation of the cointegrating regression, and, moreover, such tests are unable to identify more than one cointegrating relationship in systems with more than two variables.

Therefore, we also use the Larsson et al. (2001) procedure, which is based on Johansen's (1988) maximum likelihood approach. Like the Johansen time-series cointegration test, the Larsson et al. panel test treats all variables as potentially endogenous, thus avoiding the normalisation problems inherent to residual-based cointegration tests. Furthermore, the Larsson et al. procedure allows the long-run elasticities to differ from the short-run elasticities and hence does not impose a possibly invalid common factor restriction on the dynamics of the relationship between the variables involved. Finally, the Larsson et al. test also allows the determination of the number of cointegrating vectors.

The Larsson et al. panel cointegration test involves estimating the Johansen vector error-correction model for each country separately and then computing the individual trace statistics $LR_{iT}\{H(r)|H(p)\}$. The null hypothesis is that all of the N countries or cross-sections in the panel have a common cointegrating rank, i.e. at most r (possibly heterogeneous) cointegrating relationships among the p variables:

$$H_0 : rank(\Pi_i) = r_i \leq r \qquad \text{for all } i = 1, \ldots, N, \tag{7}$$

while the alternative hypothesis is that all the cross-sections have a higher rank:

$$H_1 : rank(\Pi_i) = p \qquad \text{for all } i = 1, \ldots, N, \tag{8}$$

where Π_i is the long-run matrix of order $p \times p$. To test H_0 against H_1, a panel cointegration rank trace test statistic is computed by calculating the average of the individual trace statistics:

$$\overline{LR}_{NT}\{H(r)|H(p)\} = \frac{1}{N}\sum_{i=1}^{N} LR_{iT}\{H(r)|H(p)\}, \tag{9}$$

and then standardising it as follows:

$$\Psi_{\overline{LR}}\{H(r)|H(p)\} = \frac{\sqrt{N}\left(\overline{LR}_{NT}\{H(r)|H(p)\} - E(Z_k)\right)}{\sqrt{Var(Z_k)}} \Rightarrow N(0,1), \tag{10}$$

where the mean $E(Z_k)$ and variance $Var(Z_k)$ of the asymptotic trace statistic are tabulated by Breitung (2005) for the model we use — the model with a constant and a deterministic trend in the cointegrating relationship.

However, it is well known that the Johansen trace statistics are biased toward rejecting the null hypothesis in small samples like ours. To avoid the Larsson et al. test, as a consequence of this bias, also overestimating the cointegrating rank, we compute the standardised panel trace statistics based on small-sample corrected country-specific trace statistics. Specifically, we use the small-sample correction factor suggested by Reinsel and Ahn (1992) to adjust the individual trace statistics as follows:

$$LR_{iT}\{H(r)|H(p)\} \times \left[\frac{T - k_i \times p}{T}\right], \tag{11}$$

where k_i is the lag length of the models used in the test.

Finally, we apply the above-described cointegration tests to both our raw data and to data that have been demeaned over the cross-sectional dimension; that is, in place of $\ln(N_{it})$, $\ln(K_{it})$, and $\ln(X_{it})$, we also use

$$\ln(N_{it})' = \ln(N_{it}) - \overline{\ln(N_{it})},$$

$$\ln(K_{it})' = \ln(K_{it}) - \overline{\ln(K_{it})}, \text{ and}$$

$$\ln(X_{it})' = \ln(X_{it}) - \overline{\ln(X_{it})}, \text{ where}$$

$$\overline{\ln(N_{it})} = N^{-1}\sum_{i=1}^{N}\ln(N_{it}),$$

$$\overline{\ln(K_{it})} = N^{-1}\sum_{i=1}^{N}\ln(K_{it}), \text{ and}$$

$$\overline{\ln(X_{it})} = N^{-1}\sum_{i=1}^{N}\ln(X_{it}), \tag{12}$$

to account for possible cross-sectional dependencies and the effects of common disturbances that impact all countries of the panel.

Table 1 reports the test results. As can be seen, five of the seven Pedroni statistics reject the null of no cointegration at least at the five per cent level both for the raw and the cross-sectionally demeaned data. Specifically, the ADF-type tests decisively reject the null hypothesis. Given that these tests have been shown to have the highest power for smaller sample sizes such as $T = 35$ (see, e.g., Pedroni 2004), the ADF test results, in particular, provide strong evidence of cointegration. This conclusion is supported by the panel trace statistics which, regardless of whether the unadjusted or demeaned data are used, show that $\ln(N_{it})$, $\ln(K_{it})$, and $\ln(X_{it})$ are cointegrated and exhibit a single cointegrating vector. In addition, the fact that three of the four panel cointegration statistics reject the null hypothesis in favour of the alternative hypothesis ('all of the individuals of the panel are cointegrated') suggests cointegration for the panel as a whole. The finding of cointegration also suggests that no relevant nonstationary variables are omitted, as discussed in Section 3.

Table 1

Panel cointegration tests

Pedroni (1999, 2004)	Panel cointegration statistics: Raw data	Panel cointegration statistics: Demeaned data	Group mean panel cointegration statistics: Raw data	Group mean panel cointegration statistics: Demeaned data
Variance ratio statistics	11.964**	0.095		
PP rho-statistics	-0.003	-2.265*	1.423	0.694
PP *t*-statistics	-2.998**	-5.498**	-3.754**	-4.277**
ADF *t*-statistics	-2.639**	-5.478**	-4.368**	-4.317**

	Cointegration rank					
	$r = 0$		$r = 1$		$r = 2$	
Larsson et al. (2001)	Raw data	Demeaned data	Raw data	Demeaned data	Raw data	Demeaned data
Panel trace statistics	8.052**	5.839**	0.446	-1.295	-2.135	-3.244

** (*) indicate a rejection of the null hypothesis of no cointegration at the 1% (5%) level. All test statistics are asymptotically normally distributed. Each test is one-sided. The number of lags was determined by the Schwarz criterion with a maximum number of four lags.

4.2. Long-run elasticities

Having found that there is a single long-run relationship between non-export GDP, capital, and exports, the next step is to estimate the long-run elasticities. To this end, we use the between-dimension group-mean panel DOLS estimator suggested by Pedroni (2001). Pedroni (2000, 2001) argues that such estimators have at least three advantages over the within-dimension approach. First, they allow for greater flexibility in the presence of heterogeneous cointegrating vectors, whereas under the within-dimension approach, the cointegrating vectors are constrained to be the same for each country. Second, the point estimates provide a more useful interpretation in the case of heterogeneous cointegrating vectors, since they can be interpreted as the mean value of the cointegrating vectors, which does not apply to the within estimators. And third, between-dimension estimators suffer from much lower small-sample size distortions than is the case with the within-dimension estimators.

The panel DOLS regression in our case is given by

$$\begin{aligned} \ln(N_{it}) &= c_{1i}\ln(K_{it}) + c_{2i}\ln(X_{it}) + c_{3i} + c_{4i}t \\ &+ \sum_{j=-k_i}^{k_i} \Phi_{1ij}\Delta\ln(K_{it-j}) + + \sum_{j=-k_i}^{k_i} \Phi_{2ij}\Delta\ln(X_{it-j}) + \varepsilon_{it}, \end{aligned} \tag{13}$$

where Φ_{1ij} and Φ_{2ij} are coefficients of lead and lag differences which account for possible serial correlation and endogeneity of the regressors. Thus, an important feature of the DOLS procedure is that it generates unbiased estimators for variables that cointegrate even with endogenous regressors. In addition, the group-mean panel DOLS estimator is superconsistent under cointegration, and is robust to the omission of variables that do not form part of the cointegrating relationship. It is calculated as

$$\hat{c}_m = N^{-1}\sum_{i=1}^{N}\hat{c}_{mi} , \tag{14}$$

where

$$t_{\hat{c}_m} = N^{-1/2}\sum_{i=1}^{N}t_{\hat{c}_{mi}} \tag{15}$$

is the corresponding *t*-statistic of $\hat{c}_m$ (m = 1, 2) and $\hat{c}_{mi}$ is the conventional time-series DOLS estimator applied to the *i*th country of the panel. As found by Stock and Watson (1993), this estimator performs well in small samples (like ours) compared with other cointegration estimators, such as the maximum likelihood estimator of Johansen (1988) or the fully modified ordinary least squares estimator of Phillips and Hansen (1990).

The DOLS group-mean estimates for the coefficients on capital and exports are reported in the upper part of Table 2. To account for the possible cross-sectional dependence through common time effects, we again present results for the raw data, as well as for the data that have been demeaned with respect to the cross-sectional dimension for each period. As can be seen, the unadjusted and demeaned data produce almost identical values, suggesting that the estimation results are not affected by the presence of possible cross-sectional dependencies. The results show that the coefficient on $\ln(K_{it})$ is highly significant and positive, as expected. The estimated coefficient of the export variable, in contrast, is highly significant and negative. More precisely, the coefficient on $\ln(X_{it})$ is estimated to be -0.15, implying that, in the long-run, a one per cent increase in exports leads to a 0.15 per cent decrease in non-export GDP on average for the countries in our sample.

Since this finding challenges the conventional view that exports generally contribute more to GDP growth than the mere change in export volume, we examine whether the negative long-run relationship between exports and non-export output is robust to different estimation techniques. Specifically, we use the within-dimension DOLS estimator suggested by Kao and Chiang (2000), which differs from the between-dimension group-mean DOLS estimator in that it assumes homogeneous long-run coefficients (c_1 and c_2) for all countries. The lower part of Table 2 shows that the results obtained by Kao and Chiang's panel DOLS estimator are consistent with the group-mean results: the coefficient on $\ln(X_{it})$ is negative and significant at the one per cent level. As expected, the within-dimension estimator tends to produce somewhat lower estimates (in absolute value) than the group-mean estimator, which is in line with the findings of Pedroni (2001).

Table 2

DOLS estimates

	$\ln(K_{it})$	$\ln(X_{it})$
Group-mean estimator (Pedroni, 2001)		
Raw data	0.279** (35.25)	-0.152** (-11.69)
Demeaned data	0.283** (33.44)	-0.153** (-8.97)
Within-dimension estimator (Kao and Chiang, 2000)		
Raw data	0.264** (19.99)	-0.167** (-9.85)
Demeaned data	0.253** (19.30)	-0.168** (-6.93)

The dependent variable is $\ln(N_{it})$. ** indicate significance at the 1% level. *t*-statistics in parentheses. The DOLS regression was estimated with one lead and one lag.

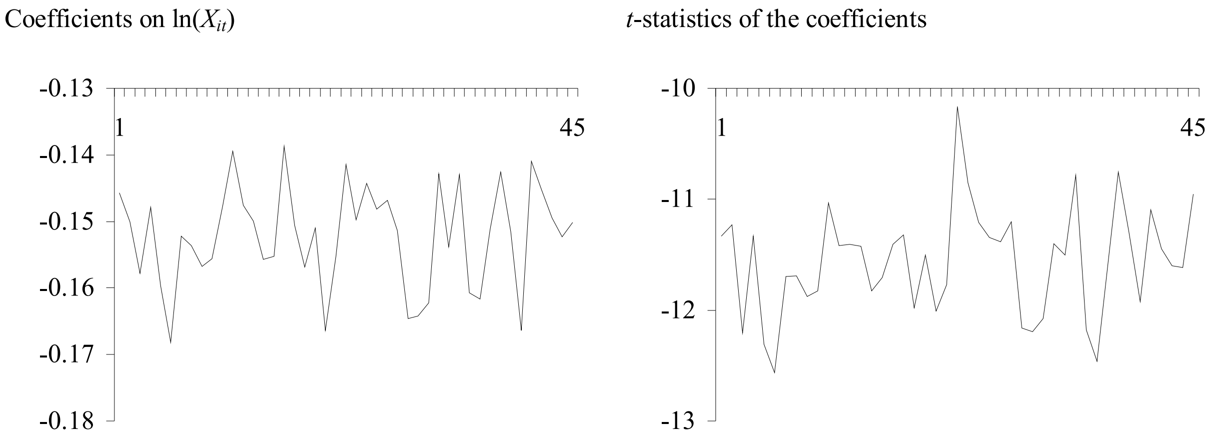
Next, we examine whether the negative effect of exports and non-export GDP is the result of outliers. To this end, we re-estimate the group-mean panel DOLS regression (with unadjusted data)[5]

[5] We continue to rely on the unadjusted DOLS estimates because the demeaning approach implicitly assumes that the form of cross-sectional dependency is such that it is driven by a single common source and that the response to the common factor is the same for all countries. Since these assumptions are likely to be violated, the results of the demeaning approach may be biased.

excluding one country at a time from the sample. The sequentially estimated export coefficients and their *t*-statistics are presented in Figure 1. Since the coefficients are fairly stable around -0.15 and always significant at one per cent level, we conclude that the results are not driven by outliers.

Figure 1

DOLS estimation with single country excluded from the sample (raw data)



We also examine whether the negative long-run relationship between exports and non-export output in developing countries is due to sample-selection bias. Specifically, a group of countries in a particular region could have a significant effect on the results. To investigate this issue, we re-estimate Equation (13), excluding countries from North Africa, sub-Saharan Africa, South America, Central America and the Caribbean, East Asia, and South Asia. The resulting group-mean values for c_2 are reported in Table 3. Regardless which of these regions is excluded from the sample, the long-run relationship between exports and non-export GDP remains negative and highly significant.

Table 3

DOLS estimation with regional country groups excluded from the sample

	$\ln(K_{it})$	$\ln(X_{it})$	Number of countries in the sample
Excluding North Africa	0.280** (31.81)	-0.136** (-11.09)	41
Excluding sub-Saharan Africa	0.337** (36.12)	-0.123** (-8.07)	26
Excluding South America	0.255** (29.96)	-0.185** (-12.44)	36
Excluding Central America and the Caribbean	0.296** (33.43)	-0.178** (-11.80)	39
Excluding East Asia	0.252** (29.25)	-0.125** (-9.17)	42
Excluding South Asia	0.273** (33.79)	-0.161** (11.26)	41

** indicate significance at the 1% level. *t*-statistics in parentheses. The countries included in each region are: North Africa: Algeria, Egypt, Morocco, Tunisia; sub-Saharan Africa: Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Gambia, Ghana, Guinea-Bissau, Kenya, Lesotho, Madagascar, Malawi, Mali, Rwanda, Senegal, South Africa, Sudan, Swaziland, Togo, Zambia; South America: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay; Central America and the Caribbean: Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, Mexico; East Asia: Indonesia, Thailand; South Korea; South Asia: Bangladesh, India, Iran, Pakistan.

Finally, we check whether the results are sensitive to the sample period. For this purpose, we re-estimate the DOLS regression for the (arbitrarily chosen) sub-periods from 1971 through 1990 and 1986 through 2005. The results are presented in Table 4. Once again, the coefficient on $\ln(X_{it})$ is always negative and statistically significant.

Table 4

DOLS estimation for different sub-periods

	$\ln(K_{it})$	$\ln(X_{it})$
1971-1990	-0.291** (33.25)	-0.162 (12.04)**
1986-2005	-0.267** (34.25)	-0.147 (11.43) **

** indicate significance at the 1% level. *t*-statistics in parentheses.

Thus, it can be concluded that the negative long-run effect of exports on non-export GDP in developing countries is robust to different estimation techniques, outliers, sample selection, and the sample period.

4.3. Short-run and long-run causality

The above interpretation of the estimation results is based on the assumption that long-run causality runs from $\ln(K_{it})$ and $\ln(X_{it})$ to $\ln(N_{it})$. In order to test this assumption, and to examine the short-run dynamics between the variables (in particular between exports and non-export GDP), we estimate a panel vector error-correction model given by

$$\begin{bmatrix} \Delta\ln(N_{it}) \\ \Delta\ln(K_{it}) \\ \Delta\ln(X_{it}) \end{bmatrix} = \begin{bmatrix} \mu_{1i} \\ \mu_{2i} \\ \mu_{3i} \end{bmatrix} + \sum_{j=1}^{p} \Gamma_j \begin{bmatrix} \Delta\ln(N_{it-j}) \\ \Delta\ln(K_{it-j}) \\ \Delta\ln(X_{it-j}) \end{bmatrix} + \begin{bmatrix} a_1 \\ a_2 \\ a_3 \end{bmatrix} ec_{it-1} + \begin{bmatrix} \varepsilon_{1it} \\ \varepsilon_{2it} \\ \varepsilon_{3it} \end{bmatrix}, \quad (16)$$

where μ_{1i}, μ_{2i}, and μ_{3i} are fixed effects, the lagged differenced variables capture the short-run dynamics, and the error correction term, ec_{it}, is the residual from the estimated DOLS long-run relationships of the individual countries:

$$ec_{it} = \ln(N)_{it} - \left[\hat{c}_{1i}\ln(K_{it}) + \hat{c}_{2i}\ln(X_{it}) + \hat{c}_{3i} + \hat{c}_{4i}t\right]. \quad (17)$$

A statistically significant coefficient on ec_{it-1} (a_1, a_2, a_3) implies that the null hypothesis of weak exogeneity can be rejected; a rejection of the null of weak exogeneity, in turn, implies long-run Granger causality from the regressors to the dependent variable(s) (see, e.g., Granger 1988).

Following Herzer (2008), we test for weak exogeneity by first eliminating the insignificant short-run dynamics in the model successively according to the lowest *t*-values and then deciding on the significance of the error-correction term. In doing so, we reduce the number of parameters and thereby increase the precision of the weak exogeneity tests on the α coefficients. Since all variables in Equation (16), including ec_{it-1}, are $I(0)$ variables, conventional *t*-tests can be used for this purpose.

Table 5 reports the results. According to the *t*-statistics of the error-correction terms, capital and exports can be regarded as weakly exogenous, whereas weak exogeneity of $\ln(N_{it})$ is decisively rejected. Consequently, non-export GDP is the only variable that is endogenous in the cointegrating relationship and hence Granger-caused by capital and exports in the long run. In other words, long-run causality is unidirectional from capital and exports to non-export GDP. From this it follows that the estimates in the previous section reflect a negative long-run impact of exports on non-export GDP, as expected.

Another important result is that the coefficient on $\Delta\ln(X_{it-1})$ is statistically significant and positive in the $\Delta\ln(N_{it})$ equation presented in Column 2, suggesting that exports have a *positive* causal effect on non-export GDP in the short run. Thus, the export-led growth hypothesis seems to be valid for developing countries, but only in the short run. As noted in Section 2, a possible explanation for the positive short-run effect of exports is static specialisation gains, whereas, in the long run, the negative dynamic effects of exports on non-export GDP, possibly associated with primary export dependence and/or excessive business and labour regulations, tend to offset the short-run gains.

Table 5

Vector error-correction model, long-run causality and short-run dynamics

Independent variables	Dependent variable $\Delta\ln(N_{it})$	Dependent variable $\Delta\ln(K_{it})$	Dependent variable $\Delta\ln(X_{it})$
ec_{it-1}	-0.402** (-16.09)	-0.088 (-1.34)	0.055 (1.33)
$\Delta\ln(N_{it-1})$	0.127** (4.96)	0.222** (3.10)	0.040* (2.28)
$\Delta\ln(N_{it-2})$	-0.099** (-4.10)	–	–
$\Delta\ln(K_{it-1})$	–	-0.075* (-2.45)	0.049** (2.61)
$\Delta\ln(K_{it-2})$	–	-0.104** (-3.91)	0.060** (3.31)
$\Delta\ln(X_{it-1})$	0.058** (3.66)	0.189** (4.71)	-0.068* (-2.61)
$\Delta\ln(X_{it-2})$	–	–	-0.078** (-3.00)

** (*) indicate significance at the 1% (5%) level. *t*-statistics in parentheses. Insignificant short-run dynamics were eliminated successively according to the lowest *t*-values and hence are not reported here.

Moreover, there is evidence of short-run causality from exports to capital and vice versa; the first difference of exports, lagged one period, is significant and positive in the capital equation in Column 3, while the coefficients on $\Delta\ln(K_{it-1})$ and $\Delta\ln(K_{it-2})$, in turn, are statistically significant and positive in the export equation in Column 4. From this it can be concluded that, in the short run, increased exports are both a cause and a consequence of increased investment.

Finally, there is also evidence that an increase in non-export GDP causes an increase in exports in the short run, as indicated by the significant positive coefficient on $\Delta \ln(N_{it-1})$ in Column 4. A possible explanation for this finding is that an increase in non-export GDP, and the associated increase in income, allows firms in the non-export sector to acquire the resources necessary to enter export markets. The increase in exports is, however, only short-term, if these firms are unable to compete in the world market in the long run.

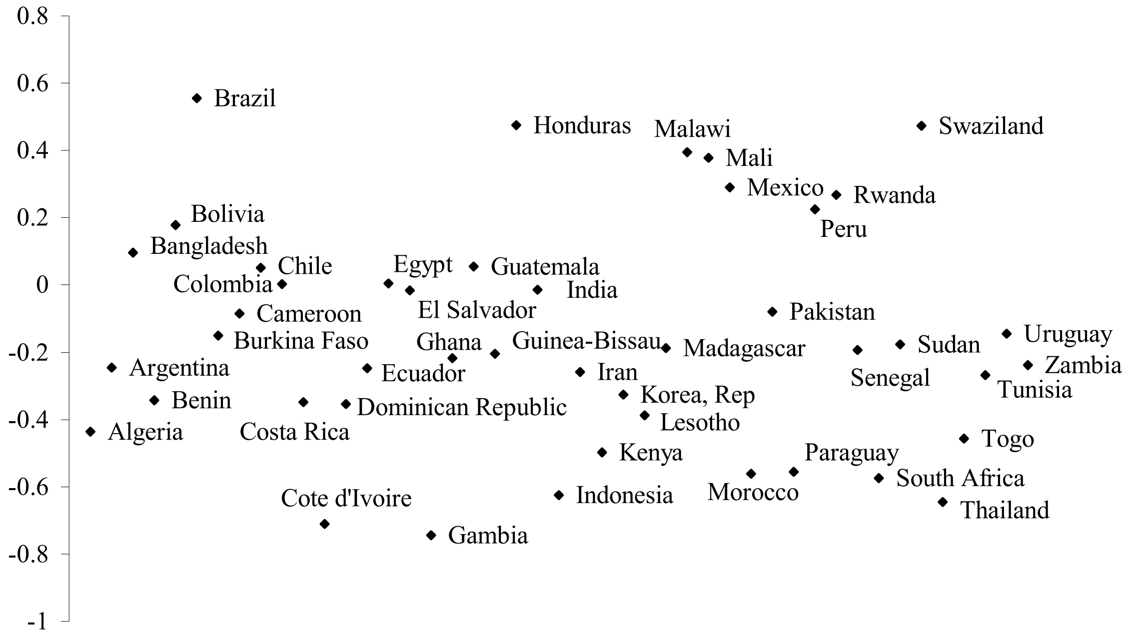
Summarising, we find that exports have a positive effect on non-export GDP in the short run, whereas the long-run effect of exports on non-export GDP is clearly negative. This result for the sample as a whole does, however, not imply that exports exert a negative long-run effect on non-export GDP in each individual country.

4.4. Individual country effects

Figure 2 plots the individual country DOLS estimates of the coefficients on $\ln(X_{it})$, $\hat{c}_{2i}$. The most striking feature of these estimates is the heterogeneity in the coefficients, ranging from -0.774 in Gambia to 0.555 in Brazil. Thus, although the long-run effect of exports on non-export GDP is negative in general or on average in developing countries, exports do not have a negative long-run effect on non-export GDP in all countries. More precisely, we find for 31 out of 44 countries (and thus in 69 per cent of cases) that an increase in exports is associated with a decrease in non-export GDP, while in 14 cases (and thus in 31 per cent of the countries) an increase in exports is associated with an increase in non-export GDP. But even within the country groups with negative and positive effects, the individual country estimates show considerable heterogeneity. For example, the point estimates suggest that Brazil, Honduras, Swaziland, and Malawi benefit markedly from exports. In contrast, in many countries, such as Columbia, Egypt, El Salvador, and India, both the positive and negative effects are marginal (close to 0), whereas in many other countries, such as Gambia, Cote d'Ivoire, Thailand, and Indonesia exports have a strong negative effect on non-export GDP.

Figure 2

Individual country DOLS estimates of the long-run impact of exports on non-export GDP



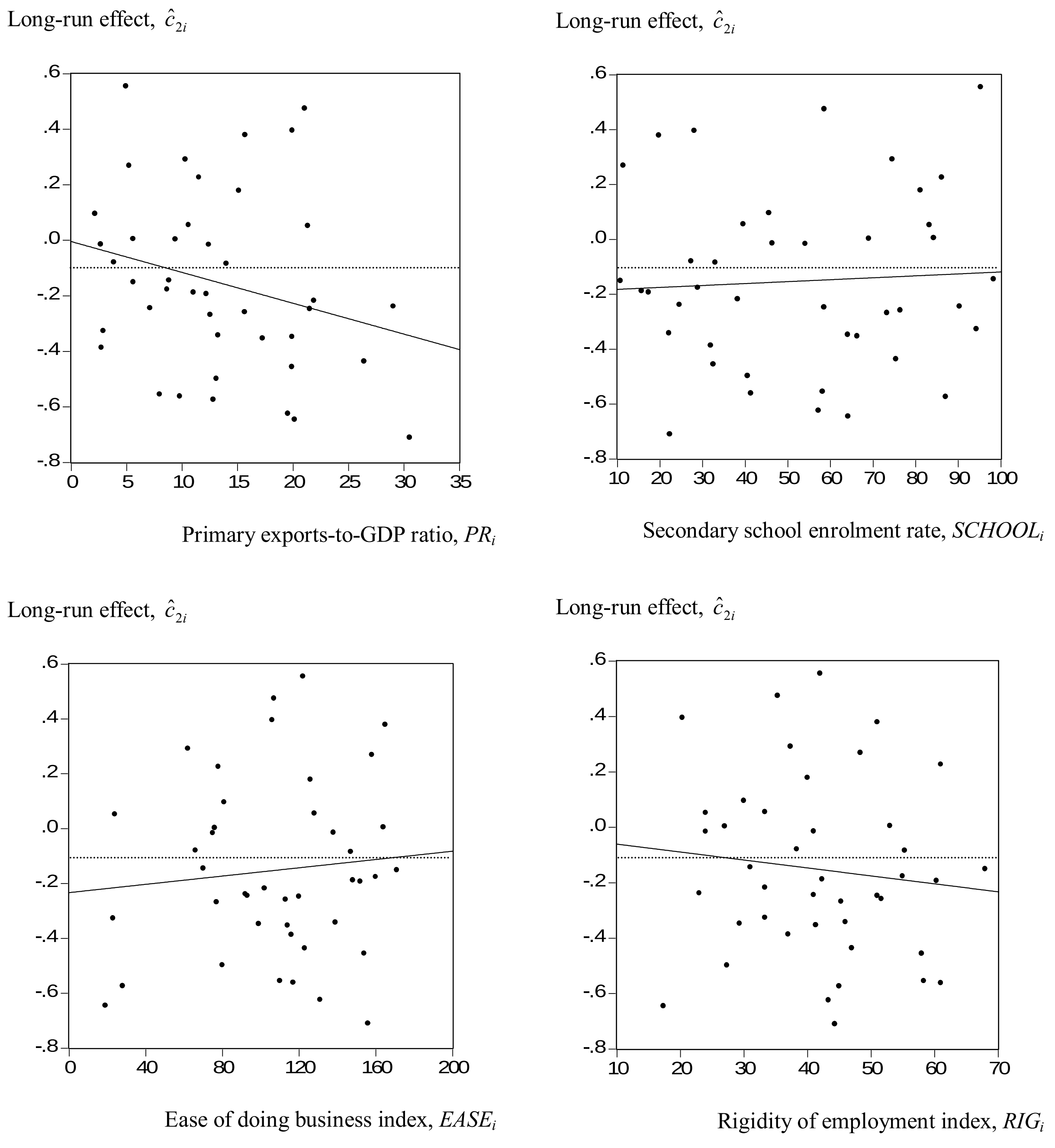
4.5. Searching for systematic variations in the long-run impact of exports on non-export

The cross-country differences in the long-run effect of exports on non-export GDP pose a new question: What factors can explain this heterogeneity or, in other words, what factors determine the long-run effect of exports on non-export GDP? Following the arguments of Section 2, a possible way to answer this question is to examine whether the observed pattern of the long-run effects of exports can be linked to cross-country differences in the level of primary export dependence, absorptive capacity, business regulation, and labour regulation.

We use the ratio of primary exports to GDP (PR_i) as measure of primary export dependence. The secondary school enrolment rate ($SCHOOL_i$) is our proxy for absorptive capacity, and business regulation is represented by the ease-of-doing-business index ($EASE_i$). Note that the higher this index, the more conducive the regulatory environment is to the operation of business. Finally, labour regulation is measured by the rigidity of employment index (RIG_i). A higher rigidity of employment index indicates more rigid labour regulations.

Figure 3

Cross-plots of the estimated long-run effects of exports on non-export GDP and indicators for primary export dependence, absorptive capacity, business regulation, and labour regulation



All data are from the World Development Indicators (2008) and are averaged over the period from 1971 to 2005. An exception is the ease-of-doing-business index for which data before 2005 are not available, so that we are constrained to use values for that single year. Moreover, we do not have complete data on all variables for all countries, forcing us to exclude Gambia, Guinea-Bissau, and Swaziland from the sample.

Figure 3 shows the scatter plots of the estimated long-run effects of exports on non-export GDP, $\hat{c}_{2i}$, against the above-described variables. In each plot, the dashed horizontal line is the mean impact (-0.15) while the second line is the regression line. As can be seen, the observed differences in the effects of exports across countries are negatively related to cross-country differences in primary export dependence and labour market regulation, and (mildly) positively related to cross-country differences in absorptive capacity (education) and freedom from business regulation.

Finally, to examine the relationship between the long-run impact of exports and the four variables more formally, we regress $\hat{c}_{2i}$ on PR_i, $SCHOOL_i$, $EASE_i$, and RIG_i (and an intercept). Since it is well known that an estimated dependent variable may introduce heteroskedasticity into the regressions (see, e.g., Saxonhouse 1976), we use White's heteroskedasticity-consistent standard errors to compute the *t*-statistics. The results of this regression are reported in Column 2 of Table 6.

Table 6

Regression of the estimated long-run effects of exports on indicators for primary export dependence, absorptive capacity, business regulation, and labour regulation

Independent variables	(2)	(3)
PR_i	-0.014* (-2.25)	-0.014* (-2.13)
$SCHOOL_i$	0.003 (1.49)	
$GDPPC_i$		0.00002 (1.10)
$EASE_i$	0.004* (2.16)	0.004* (2.05)
RIG_i	-0.011* (-2.02)	-0.012* (2.22)
Diagnostic tests		
Adj. R^2	0.11	0.10
RESET	0.023 (0.88)	0.637 (0.43)
JB	2.833 (0.24)	3.233 (0.20)
Included observations	42	42

* indicates significance at the 5% level. Reported *t*-statistics (in parentheses) are based on White's heteroskedasticity-consistent standard errors; the numbers in parentheses behind the diagnostic test statistics are the corresponding *p*-values: *RESET* is the usual test for general nonlinearity and misspecification and *JB* is the Jarque-Bera test for normality.

Since the diagnostic tests suggest that obvious nonlinearity and misspecification are absent, and that the residuals show no signs of nonnormality or heteroscedasticity, the following inferences can be drawn from the results: the long-run effect of exports on non-export GDP is significantly negatively associated with primary export dependence, business regulation, and labour regulation. (Note that the sign of the coefficient on $EASE_i$ is positive, since a higher value of the ease of doing business index indicates a lower level of business regulation). In contrast, there is no statistically significant association between the long-run effect of exports and absorptive capacity, measured by the secondary school enrolment rate. As can be seen from Column 3, this result does not change when alternative measures for absorptive capacity are used. This column shows the regression results when the secondary school enrolment rate is replaced by per capita PPP GDP. As in Column 2, primary export dependence, business regulation and labour regulation are statistically significant (with the correct signs), while the coefficient of absorptive capacity, measured by per capita PPP GDP, is not.

Without question, our sample of 42 countries is too small to draw definite conclusions about systematic variations in the long-run effect of exports across countries. In addition, the adjusted R^2s indicate that only about 10 per cent of the variation in the long-run effect of exports on non-export GDP is explained by the variables in the models, implying that the estimated regressions do not fit the data very well. Nevertheless, the results seem to suggest that cross-country differences in the long-run effect of exports on non-export GDP can be at least partly explained by cross-country differences in primary export dependence, business regulation, and labour regulation.

5. Conclusions

This paper challenges the conventional view that exports generally contribute more to GDP growth than the mere change in export volume, as the export-led growth hypothesis predicts. We first examined the nature of the growth effect of exports by applying panel cointegration methods to a production function model with non-export GDP as the dependent variable. Our results, based on data from 1972 to 2005 for 45 developing countries, show that the short-run effect of exports on non-export GDP is indeed positive, suggesting static gains from specialisation. In the long-run, however, an increase in exports leads to a reduction in non-export GDP in developing countries, on average. This effect is robust to different estimation techniques, outliers, sample selection, and different sub-periods. Nevertheless, there are large differences in the long-run effect of exports on non-export GDP across countries. More specifically, we found that an increase in exports is associated with a long-run decrease in non-export GDP in 69 per cent of the countries, while in 31 per cent of the cases, an increase in exports is associated with a long-run increase in non-export GDP.

Next, we examined whether the observed cross-country differences in the long-run effect of exports are linked to country-specific factors, such as the level of primary export dependence, business regulation, labour regulation, and the capacity of a country to absorb knowledge. Our results suggest that the long-run effect of exports on non-export GDP is significantly negatively associated with primary export dependence, business regulation, and labour regulation, whereas there is no statistically significant association between the growth effect of exports and absorptive capacity. All in all, it can be (cautiously) concluded that economic reforms aimed at

(i) removing primary export dependence by diversifying the economy,

(ii) minimising the regulatory burden on business, and

(iii) increasing labour market flexibility

can not only protect developing countries from the potential negative consequences of increased exports but also induce export-led growth in the long run.

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