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Does trade drive global output growth?

Leon Podkaminer*

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Abstract

Conventional econometric analysis suggests that there has been a longer-term relationship between nominal world output and nominal world exports. The analysis says something about the rules governing adjustments in world output and exports. It appears that GDP plays the first fiddle. Rising world output seems to have pushed up world exports. But rising world exports do not seem to have resulted in positive changes in global GDP. The global growth slowdown, observed since the early 1970s, may have been linked to the steady expansion of global trade.

Keywords: world income, world trade, world output growth, globalisation, VEC

JEL: F43, F15, O41, O49

* The Vienna Institute for International Economic Studies; Wyższa Szkoła Administracji in Bielsko-Biała; e-mail: podkaminer@wiiw.ac.at.

1. Introduction

For many decades now international trade has been gaining in importance. The share of global exports of goods and non-factor services in global GDP, which stood at less than 12% in the early 1960s, climbed to over 32% in 2008 before falling – during the 2009 global crisis – slightly below the 30% mark.[1] Many explanations have been put forward to account for the tendency for the trade share to rise (see e.g. Krugman 1995; Frankel, Romer 1999; Baier, Bergstrand 2001). The phenomenon of world trade growing faster than world GDP can be seen as reflecting progressing liberalisation of international trade (and of international flows of capital and ideas generally) as well as continuing advances in transport and communication technologies. In particular, technological progress combined with the tendencies to liberalise internationally (as well as internally, in major trading nations) are certainly jointly responsible for the development of new internationalised forms of production organisation, as signified by the rising importance of offshoring, fragmentation of production, and outsourcing of the manufacture of intermediate inputs to low-wage emerging markets (Feenstra 1998; Helpman 2004). The ongoing internationalisation of production naturally inflates the values of international trade relative to final output. On the other hand, trade seems to have risen much faster relative to GDP also before the present era of intensified liberalisation and before the major technology breakthroughs. This is evidenced by early studies such as by Houthakker and Magee (1969) who sought to estimate the income elasticities of demand for exports and imports of developed nations. Their estimates (with averages ranging between 1.6 and 1.7) indicated that trade had been growing much faster than GDP also over the relatively illiberal 15-year period they studied (1951–1966).

Under the standard assumptions of the neoclassical trade theory, liberalisation of trade and reduced trade costs should be conducive not only to "more trade", but in the first place to more gains from trade – additional net output accruing (even if not necessarily equitably) to all countries participating in trade (and thus to greater global output).

The "new" theories of international trade and the new "new" trade theories generally support the view that more trade should generate more output to all participating parties. However, opinions openly doubting the benefits to individual nations of freer trade (often hinting at the advantages of some levels of protectionism) are not quite rare, especially among students of the developing countries (starting from Bhagwati 1958 to Stiglitz 2001 or Thirlwall, Pacheco-Lopez 2008 more recently). Interestingly, the "Pope" of neoclassical trade theory himself expressed some heretical doubts about the doctrine he had long preached (Samuelson 2004). On the other hand there has been no shortage of academic contributions defending the view that "trade drives growth" (for example Frankel 2008).

The reservations about the possibly undesirable consequences (including higher income inequality and depressed wages/employment in developed industrial countries) of growing trade notwithstanding, it is only fair to say that the hypothesis stipulating that "trade growth drives GDP growth" has assumed the status of a dogma – if not quite uniformly among the academic economists, then at least within truly influential institutions. Without the dogma status of that hypothesis it would be rather hard to account for the persistent efforts at global (and internal) liberalisation (GATT/WTO, IMF). Also, such integrative efforts as those on which the European Union (or NAFTA) is founded would lack economic rationale should the hypothesis be questioned. Last, but not least the case for a "trans-Atlantic" free trade area proposed recently would be rather weak should this hypothesis be disproved.

[1] All numbers quoted come from the World Bank's World Development Indicators, February 2014.

However, is there compelling empirical evidence supporting that hypothesis when applied to the aggregate global economy? Quite surprisingly, research does not seem to have addressed itself to testing that hypothesis. Naturally, there are numerous studies concerned with the evaluation of the role of trade for individual countries, or "panels" of countries. However, the rich empirical literature on growth accounting is not unanimously supportive of the hypothesis endowing rising foreign trade with growth enhancing abilities at the national level. A comprehensive survey by Lewer, Van der Berg (2003) of over 100 studies concerned with the growth-trade connection did not come to a definitive conclusion. A later study by the same authors (Lewer, Van der Berg 2007) is also inconclusive. As recently documented by Hillebrand, Lewer, Zagardo (2010), *"*... there is a troubling disconnect between the economic growth literature and the trade literature ...". Classical studies such as Denison (1985) dismiss trade as the source of the US longer-term economic growth, or fail to mention it altogether (see also Jorgenson 2005). Econometric studies, of which there is no shortage, attempting to quantify the impacts of various factors on GDP growth rates (or on total factor productivity growth) across larger samples of countries, typically do not produce generally accepted conclusions. For example, Rodrik, Subramanian, Trebbi (2004) state that "... once institutions are controlled for, trade is almost always insignificant, and often enters the income equations with the "wrong" (i.e. negative) sign ...".

Concluding, the general case for the "trade drives growth" thesis is rather weak at the national level. Perhaps this is not a coincidence. Growth in some countries may indeed have been driven by their rising trade. But at the same time that same trade may have impeded growth in other (e.g. net importing) countries. Given the conflicting evidence on the trade – output links at the national level it may be impossible to draw, from that evidence, any definitive conclusions concerning the aggregate output – aggregate trade link. To be able to assess the global consequences of continuing trade expansion it may be necessary to study the global aggregates: global trade and global output.[2]

This paper sets out to analyse econometrically the dynamic relationships between world GDP and world trade. Ultimately, the paper's goal is to substantiate (or otherwise) the conventional view on the desirability – from the viewpoint of the aggregate global economy – of an international economic order stipulating progressing trade liberalisation.

Section 2 briefly discusses the data used in the analysis. Section 3 reports the outcomes of Vector Error Correction (VEC) modelling of global trade and GDP. It suggests that upward movements in GDP tend to be followed by rising exports while upward movements in exports are likely to depress GDP growth. In this sense global trade growth does not drive global output growth – while global output growth does drive global trade growth. Section 4 offers some economic explanations of the regularity revealed. Section 5 discusses the limitations of the present study and its possible future extensions.

2. The data

The following analysis works with two time series taken from the World Bank's World Development Indicators (WDI) data set: world GDP and world exports of goods and non-factor services. Both items are expressed in current US dollars. Of course it would be desirable to work with volumes of GDP and

[2] Under the advancing internationalisation of production, trade and finance, the national income (and output) aggregates are increasingly interconnected (see e.g. OECD 2013). The developing global value chains allow systematic "transfers" of income, or output, across national borders. This may additionally distort the national income, or output, statistics. But such transfers should leave the global aggregates unchanged (at least in theory).

exports. However, as will be discussed in Section 5, the calculation of both items would require deep studies on meaningful price deflators, especially for world trade. This is still a task for the future.

The nominal world trade and GDP series currently available from WDI extend from 1960 through 2012. Figure 1 shows the development of the exports/GDP ratio over the whole period. As can be seen, the ratio followed a quite smoothly accelerating growth trajectory until 1973. A period of instability ensued. By 1987 the ratio seemed to have entered a new "regular" trajectory which then was abruptly perturbed by the 2009 events.

The "kinks" in the trajectory in Figure 1 coincide with the major changes in international economic arrangements. The economic stability period ended in 1973 as the Bretton Woods system with fixed exchange rates and managed private capital flows finally collapsed. During the ensuing instability period (1973–1987) two major oil price shocks hit the world economy with fits of very high inflation following in their wakes, additionally inflating the values of trade relative to the values of (the then depressed) GDP. Moreover, 1973–1987 was a period of great instability in exchange rates. Wild fluctuations in the US dollar exchange rates vs. the remaining major world currencies during that period may have disturbed the underlying relationship between changing trade and changing GDP. Throughout the period the creeping liberalisation of capital flows was followed by a series of severe sovereign debt crises (for instance in Latin America) with consequences for both global growth and trade. The Plaza Accord (1985) and especially the Louvre Accord (1987) effectively ended the global exchange rate disorder. These accords, coupled with the stabilisation (starting in 1987) of the Latin American foreign debt crisis, paved the way for a new phase in global trade and output developments. Whether that phase, disturbed by the events of 2009, has come to an end remains an open question now.

The natural logarithms of world output and world exports are denoted as y and x respectively. The conventional unit root tests do not reject nonstationarity of the x and y series for the whole 1960–2012 period, but the differenced series d(x) and d(y) appear to be stationary (Figure 2). While the Johansen cointegration tests suggest that x and y may be cointegrated over the whole 1960–2012 period, the resultant Vector Error Correction models (with or without the time dummy for 2009) estimated for the whole 1960–2012 period turn out to be unstable (inverse roots of their AR characteristic polynomials lie outside the unit circle). Moreover, these models tend to fail the residual tests (on the absence of serial correlation and/or normality). These outcomes may be due to the presence of structural breaks. In fact the Zivot and Andrews (1992) unit root test, allowing for a single endogenous structural break in the trends/intercepts of the two series under consideration, decisively ($p < 0.01$) rejects the null of unit roots. The Zivot and Andrews procedure selects the years 1973 and 1972 as the structural break dates for the x and y series respectively. Given the results of the Zivot and Andrews test it is not surprising that the VECs for the whole 1960–2012 period behave rather poorly.

According to the conventional (ADF and PP) tests the x and y series have unit roots also for the periods 1973–2008, 1987–2008 and 1987–2013[3]. This is consistent with the results of KPSS tests which suggest rejection of null of stationarity of x and y (Table 1 reports the ADF test results.) The differenced series d(x) and d(y) are stationary and the Johansen cointegration tests suggest that x

[3] The 1973–2012 series are too short for a meaningful implementation of the Zivot and Andrews procedure. However, as discussed above, it is quite obvious that the economic instability period which started with the collapse of the Bretton Woods system (in 1973) and the oil price shocks of the 1970s came to an end by 1986–1987 (see also Figures 1 and 2). 1986–1987 is consistent with the formal results of the Quandt and Andrews (unknown structural breakpoint) test for OLS regression involving the x and y series over the entire 1960–2012 period. The Quandt and Andrews test decisively ($p < 0.00005$) rejects the null of no breakpoint within 15% trimmed data, selecting 1986 as the break date.

and *y* are cointegrated over the 1973–2008, 1987–2008 and 1987–2011 periods. However, the VEC models estimated for the 1973–2008 period by and large fail to pass the residual tests (on normality and/or absence of serial autocorrelation).

However, data for the 1987–2008 and 1987–2012 periods (which, admittedly, are quite short[4]) allow estimation of fairly robust and meaningful VEC models.

3. Empirical results for 1987–2008 and 1987–2012

The Johansen tests suggest the existence of cointegration of *x* and *y* for 1987–2008 and 1987–2012. There are many specific cointegrating relationships for either period, depending on the assumed maximum lag for d(*x*) and d(*y*) and the specifics concerning intercepts/trends. The statistical qualities of the resultant alternative systems of VEC equations do differ, though not essentially. Alternative VEC systems share some basic properties: the impulse responses generated by different VEC systems have similar shapes, and the crucial regression coefficients (for the error-correction term) are highly significant. Table 2 shows the VEC system for 1987–2008 selected on the basis of the usual information criteria. The system from Table 2 passes the customary diagnostic (residual and lag-structure) tests with flying colours.

As can be seen, the regression coefficients for the error-correction terms (i.e. for the cointegrating equations in the upper panel of Table 2) in the equations for d(*x*) and d(*y*), which equal -0.86956 and -0.588332 respectively, are highly significant. Moreover, the regression coefficients for the lagged d(*x*) terms in the equation for d(*y*) are jointly significant (the null that they are all jointly equal zero is rejected at $p < 0.00005$). The same is true for the equation for d(*x*). The regression coefficients for the lagged d(*y*) terms are jointly highly significant (the null that they are all jointly equal zero is rejected at $p < 0.00005$). Apparently there is a bi-directional long- as well as short-term Granger causality between the levels of logarithms of trade and output.[5] Of course, there is also a bi-directional Granger causality between d(*x*) and d(*y*).

It must be observed (see Table 2) that all lagged d(*x*) variables enter the equation for d(*y*) with negative parameter estimates. But all lagged d(*y*) variables enter equations for both d(*x*) and d(*y*) with positive parameter estimates. This fact (by and large shared by other acceptable VEC models for the years 1987–2008) has important implications. Figuratively speaking, all else being equal, a positive rise in world exports would likely be followed by a fall in GDP (and also in exports) later on. But, all else being equal, a positive rise in world GDP is likely to be followed by a strong positive response of both exports and GDP. This intuitive interpretation is formally supported by the generalised[6] impulse responses derived from the VECM from Table 2 (see Figure 3).

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[4] Table 4 reports a VEC model for 1973–2008 (36 observations). This model was selected on the basis of the usual information criteria. It passes all the customary tests – excepting the Jargue and Bera test of (multivariate) normality of residuals. The null of normality is rejected at $p = 0.002$. The impulse response functions for this model (Figure 6) indicate that a positive innovation to exports tends to be associated with a weak and relatively short-lived response of output while a positive innovation to output is associated with a strong and long-lived response of exports.

[5] This conclusion is confirmed by the results of Toda and Yamamoto (1995) tests which reject the null of absence of Granger causality running from *y* to *x* and from *x* to *y* (each at $p < 0.00005$) for both the 1987–2008 and 1897–2012 periods.

[6] Figures 3, 4 and 6 show generalised (as defined by Pesaran and Shin 1998) impulse responses for VEC equations. The impulse responses in Figures 3, 4 and 6 allow for the correlations between shocks (including contemporaneous shocks), as implied by the data. Impulse responses derived here are independent of the ordering of variables.

Of particular interest are the responses of x to y (the upper right-hand panel) and the responses of y to x (the bottom left-hand panel). The former panel shows that a momentary (one-off) "positive shock" (or innovation) to y is followed by a positive, and persistent, response of x. In contrast, the effects on y of a momentary (one-off) positive shock to x are negative. In addition these negative effects strengthen over a longer time horizon.

The global output recession of 2009 brought an even steeper decline in global trade. It is rather clear that the data for 2009 are "outliers". On the assumption that the events of 2009 represented "an accident" the VEC estimation is applied to the whole period 1987–2012 – with an exogenous time dummy variable (u equal 1 for 2009) being added. The resulting VEC (as before chosen on the basis of the usual information criteria and satisfying the customary diagnostic tests) is found in Table 3. As for the 1987–2008 data, the null of absence of long- and short-term bi-directional Granger causality between the logarithms of x and y is decisively rejected.

The u variable in Table 3, representing the dummy for 2009, turns out to be highly significant. Otherwise, the parameter estimates of the cointergrating equation (the upper part of Table 3) are similar to those in Table 2. Moreover, 3 out of 4 lagged d(x) variables enter the equations for d(x) and d(y) with a negative sign while 3 out of 4 lagged d(y) variables enter these equations with a positive sign. Under such a configuration of parameters, the generalised responses to innovations in x and y (Figure 4) are not much different from those derived from the VEC system for the years 1987–2008.

As can be seen, exports respond positively to a positive "innovation" in output. Exports' response to one-off "output innovation" grows for three initial years before stabilising (until the 6th year) and gradually waning later on. In contrast, the effects on output of a one-off positive "innovation" in exports are negative. These negative effects worsen until the 7th year: only thereafter their negative impact gradually weakens.

4. Economic interpretations

The VEC analyses suggest that there has been a longer-term ("equilibrium") relationship between the logarithms of the levels of nominal world output and nominal world exports. That relationship is given by the cointegrating equations (appearing in the upper panels of Tables 2 and 3). There is a bi--directional Granger causality (long- as well as short-term) between world output and world exports (or, literally, between their logarithms). However, it turns out that while rising output may have contributed to rising exports indeed, the rise in exports may have actually depressed the rise in output. In this sense the analysis questions the popular belief that "exports cause growth".

It should be observed that the phenomenal expansion of world trade (relative to output, Figure 1)[7] has been actually associated with a secular slowdown of real global growth going on since the early 1970s (Figure 5).

Of course, the global growth slowdown could be attributed to some unfavourable "exogenous" developments other than the expansion of trade itself. However, it seems rather implausible that the global growth slowdown should reflect technological stagnation of some sort. If anything, the last

[7] Figure 1 features the ratio of nominal world exports and output. There are some reasons to presume that the ratio of real world exports and output would actually have risen even more steeply (meaning that real growth of trade has been even faster, relative to real growth in output). This presumption may be consistent with the fact that output growth is universally combined with prices of services (non-tradables) rising relative to the prices of tradables (Podkaminer 2011).

40–50 years have witnessed an unprecedented wave of applied technological innovation which has been coupled with an equally impressive upgrading of "human capital" (as documented by e.g. UNESCO's statistics on trends in educational attainment across the world). Due to the technological and human--capital developments the total factor productivity calculated for the global economy must have increased immensely over a couple of recent decades. Also, the growth slowdown cannot be attributed to e.g. intensified shortages of exhaustible resources (such as energy carriers), or of the labour force. In actual fact, since the early 1980s unemployment has become high and persistent – at least in the OECD countries (see e.g. Nickell, Nunziata, Ochel 2005) while the continuing secular decline in commodities' terms of trade indicate that resources are becoming less scarce, not more (see e.g. Mollick et al. 2008).

The last 50 years have not only produced a series of revolutionary technological changes which should have accelerated global growth. These decades have also witnessed a truly revolutionary systemic change (gradual at first, accelerating later on) on the global level. The change started with stepwise internal liberalisations and deregulations in major industrialised countries. The developed countries' socio-economic models, which had sought to balance the interests of labour and business while relying on fiscal and incomes policies, were gradually replaced by neoliberal and monetarists ones. The internal systemic changes have been synchronised with the consecutive waves of liberalisation of international economic relations. Trade liberalisations (cuts in tariff levels, progressive removal of many non-tariff barriers to trade) were followed by the wholesale liberalisation of capital flows, to a large degree completing the process of globalisation. The phenomenal rise in international trade has been the most obvious effect of globalisation. But, as Figure 5 indicates, globalisation – and the globalisation-driven expansion of international trade – appears to be associated with a slowdown of global real growth.

This observation seems to be consistent with the conclusions derived from the econometric analyses in Section 3. Indeed, it looks as if the expanding international trade has actually contributed to the secular slowdown of real global growth going on since the early 1970s.

Now, according to the classical, neoclassical and contemporary theories of international trade, "more trade" (and especially more free trade) should bring output gains. Why are such positive effects not revealed by our analysis? There may be two major reasons.

Firstly, it may be argued that rising world trade could have been productive on the global scale if GDP growth in individual countries had been at least approximately balanced most of the time – and not only sporadically, in response to the severe payments or exchange rate crises. The negative output effects of rising trade may have emerged under the huge and persistent trade imbalances that have developed under progressing globalisation. Such imbalances may have acted as brakes on sustained output growth in both the persistent deficit and the persistent surplus countries. Under a different international economic order, somehow enforcing more balanced trade among nations – with major nations not allowed to compensate deficient domestic demand with huge trade surpluses that destabilise their partners – global trade may assume the positive role assigned to it by the trade theory. The classical Bretton Woods system (terminated in 1973) was an example of such international arrangements limiting persistent and large trade imbalances.

Secondly, the expanding internationalisation of production[8] (which has been made possible by the liberalisation of trade and capital flows) seems to be generating, or at least supporting, the tendency for the global wage shares to decline – and thus for the global profit shares to rise (Podkaminer 2013b). This development may be closely related to the development of inequality on the global level (see e.g.

[8] Feenstra (1998) characterises the process as "integration of trade and disintegration of production in the global economy".

Freeman 2009). While the impact of globalisation on global inequality remains a controversial issue (see e.g. UNCTAD 2012 for a recent survey of views), there is also a possibility of a reverse impact: from higher inequality to slower growth. The global shift in income distribution from wages to profits can account for the weakening of global growth because such a shift raises the overall saving propensity – without necessarily raising the propensity to invest (Podkaminer 2013b). The tendency for the slowdown of growth of global output could then be an end effect of both developments: rising global profit share/profitability and falling propensity to invest.[9]

Concluding, it remains true that output of some individual countries may heavily rely on the expansion of their exports. Moreover, productivity growth (and growth of potential output) in many cases may critically depend on rising imports of capital goods and intermediate inputs. It is equally true that rising net exports may contribute substantially to overall GDP growth in some nations. But rising net exports may well be achieved at the cost of overall GDP growth stagnation. This is the case in Germany where high trade surpluses (achieved through the sustained repression of wages and domestic demand) have been associated with secularly anaemic GDP growth (Laski, Podkaminer 2012). Moreover, it must be remembered that for each country relying for GDP growth on the improvement of net exports there must be some other countries whose net exports necessarily contract – thus depressing their GDP growth. The existence of a club of countries following the "export-led" growth paths implies the existence of a club of "import-fed" countries whose GDP growth must sooner or later be held back by falling net exports. The global economy – being an autarchic system – cannot follow the export-led growth path.

The final "policy conclusion" could be that the basic paradigms of the international economic order need to be changed. The reformed international order should be capable of enforcing more balanced trade among nations. The major trading nations must not be allowed to compensate deficient domestic demand (and wages) with huge trade surpluses that destabilise their partners. Under the reformed world economic order the expansion of global trade could then be expected to support global growth. Of course, the basic paradigms of domestic macroeconomic policy-making in major countries would have to be overhauled too if these countries were to follow the externally balanced growth paths (Laski, Podkaminer 2012).

5. Caveats and further research

The conclusions from Section 3 and interpretations from Section 4 need to be properly qualified.

Firstly, it must be remembered that the world output and trade used in the analysis are both expressed in current US dollars. The world-level totals y and x represent the logarithms of the sums of national outputs (and trades) converted into US dollars at the available official (or somehow assessed by the World Bank staff, when necessary) current exchange rates. Thus the conclusions suggested by the analysis are in fact about the developments in log values of output and exports, not in their (log) volumes. Analyses conducted with the time series of real world output and real exports may have possibly produced different conclusions. However, the calculation of both items would require deep studies on meaningful price deflators – especially for world trade, still a task for the future. Feenstra (1994) illustrates some of the difficulties involved in the measurement of price indices for US trade.

[9] In terms of the Bhaduri and Marglin (1990) classification, global growth would then be characterised as "wage-led" rather than "profit-led".

Calculating meaningful price deflators for world trade must be incomparably more difficult. It is the opinion of the present author that the WDI price deflators (which are based on constant US dollars) for world output (and even more so for world trade) may not be entirely reliable yet.

The second, and related, problem is about the usage of the (current) exchange rates for the assessment of outputs of individual countries in any given year. It is quite obvious that this cannot adequately reflect the relative levels of real incomes of countries at vastly different levels of development (which is the case here). As is well known there are persistent gaps between purchasing power parities and exchange rates – and thus between income levels measured at exchange rates and at purchasing power parities. Even complete international economic integration (e.g. through intensified international trade) does not necessarily reduce the gaps in question (Podkaminer 2013a). Thus, the application of (current) purchasing power parities may have produced an alternative – and arguably a better – measure of nominal world output, at least theoretically.[10] However, in this case it would be quite logical to expect that the trade data be measured at purchasing power parities as well. But the purchasing power parities for international trade have not been available so far.[11]

Further research on the global trade-global output nexus, using alternative (possibly more relevant) measures of trade and output, should certainly be encouraged.

The economic interpretations suggested in Section 4 also deserve further research. The VEC models may get extended to allow for the dynamics of global inequality, global wage shares and/or global trade imbalances. Naturally, the possibly complex interactions between trade, growth, distributional and other relevant global[12] variables might also be studied by methods other than VEC, e.g. by means of ARDL proposed by Pesaran, Shin and Smith (2001). The major difficulty in extending the analysis is practical. The indicators measuring global inequality, distribution or trade imbalances would have to be defined and measured with reasonable precision.

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[10] Available sets of purchasing power parities differ on very many counts. The concepts underlying the calculation of purchasing power parities supplied by different institutions (e.g. by the World Bank, or Eurostat) are largely a matter of conventions, not necessarily shared universally. There is no single "objective" prescription for the calculation of the parities. Of course, also the practices of dealing with various specific issues (such as the assessment of relative prices of various non-market services) do differ.

[11] The international comparison projects which supply the overall (GDP) purchasing power parities for individual counties assume that the partial purchasing power parities for the "net exports aggregate" of GDP are equal to the respective exchange rates.

[12] There are very many studies reporting attempts at a dynamic modelling of links between trade, output and external debt (which can approximate accumulated trade imbalances) at the national levels (see e.g. the recent study by Dritsaki 2013).

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Appendix

Table 1
ADF tests for the order of integration of log(exports) and log(GDP).

Series	Lag length[1]	ADF test statistics	Probability[2]	Conclusion
		1987–2008		
x	0	0.2900	0.9721	Non stationary
y	1	0.2990	0.9724	Non stationary
d(*x*)	0	-3.4100	0.0217	Stationary
d(*y*)	0	-3.0529	0.0454	Stationary
		1987–2012		
x	0	-0.7552	0.8151	Non stationary
y	0	-0.8082	0.8001	Non stationary
d(*x*)	0	-5.1440	0.0003	Stationary
d(*y*)	0	-4.0330	0.0047	Stationary

Note: the ADF testing equations assumed an intercept. Non-stationarity of *x* and *y* is not rejected also assuming intercepts and linear trends.
[1] Selected automatically based on the Schwartz Information Criterion (max lag = 5).
[2] MacKinnon (1996) one-sided *p*-values.

Table 2
VEC estimates for 1987–2008

Variable	Estimates	
X(-1)	1.000000	
Y(-1)	-0.757307	
	(0.08729)	
	[-8.67603]	
@TREND(60)	-0.047986	
	(0.00407)	
	[-11.7820]	
C	-4.222963	
Error correction	**D(X)**	**D(Y)**
CointEq1	-0.869560	-0.588332
	(0.12981)	(0.05994)
	[-6.69874]	[-9.81609]
D(X(-1))	-0.695613	-0.458377
	(0.20959)	(0.09677)
	[-3.31893]	[-4.73670]

D(X(-2))	-0.864971	-0.773462
	(0.23746)	(0.10964)
	[-3.64254]	[-7.05446]
D(X(-3))	0.036786	-0.047101
	(0.23831)	(0.11003)
	[0.15436]	[-0.42806]
D(X(-4))	-0.498027	-0.251880
	(0.23402)	(0.10805)
	[-2.12816]	[-2.33114]
D(Y(-1))	1.462345	0.954057
	(0.25404)	(0.11730)
	[5.75628]	[8.13370]
D(Y(-2))	1.611656	1.220187
	(0.37117)	(0.17138)
	[4.34205]	[7.11986]
D(Y(-3))	0.099470	0.307317
	(0.37939)	(0.17517)
	[0.26218]	[1.75437]
D(Y(-4))	1.382440	0.942643
	(0.38798)	(0.17914)
	[3.56321]	[5.26217]
C	-0.028816	-0.024623
	(0.01801)	(0.00831)
	[-1.60034]	[-2.96172]
R-squared	0.905253	0.954093
Adj. R-squared	0.834192	0.919663
Sum of squared residuals	0.008664	0.001847
Standard error equation	0.026870	0.012406
F-statistic	12.73916	27.71107
Log likelihood	55.01943	72.02102
Akaike AIC	-4.092676	-5.638274
Schwarz SC	-3.596747	-5.142346
Mean dependent	0.092679	0.064661
Standard deviation dependent	0.065987	0.043771
Determinant of the covariance matrix of residuals (adjusted degrees of freedom)		1.07e-7
Determinant of the covariance matrix of residuals		3.18e-8
Log likelihood		127.4538
Akaike information criterion		-9.495796
Schwarz criterion		-8.355161

Notes:
Included observations: 22
Standard errors in ( ); t-statistics in [ ].

Table 3
VEC estimates for 1987–2012

Variable	Estimates	
X(-1)	1.000000	
Y(-1)	-0.718493	
	(0.07026)	
	[-10.2265]	
@TREND(60)	-0.041518	
	(0.00382)	
	[-10.8635]	
C	-5.666110	
Error correction	**D(X)**	**D(Y)**
CointEq1	-1.371769	-0.789706
	(0.20083)	(0.12114)
	[-6.83049]	[-6.51870]
D(X(-1))	-0.047724	-0.029568
	(0.16063)	(0.09689)
	[-0.29711]	[-0.30516]
D(X(-2))	-0.083912	-0.071138
	(0.15793)	(0.09527)
	[-0.53133]	[-0.74673]
D(X(-3))	0.827168	0.507278
	(0.16737)	(0.10096)
	[4.94226]	[5.02461]
D(X(-4))	-0.088371	-0.069186
	(0.18646)	(0.11248)
	[-0.47394]	[-0.61511]
D(Y(-1))	1.102351	0.752594
	(0.24511)	(0.14785)
	[4.49740]	[5.09010]
D(Y(-2))	0.889043	0.536708
	(0.28279)	(0.17058)
	[3.14388]	[3.14634]
D(Y(-3))	-0.787419	-0.487804
	(0.28792)	(0.17368)
	[-2.73483]	[-2.80862]

D(Y(-4))	0.799898	0.599107
	(0.28768)	(0.17353)
	[2.78051]	[3.45238]
C	-0.084519	-0.053133
	(0.02472)	(0.01491)
	[-3.41922]	[-3.56333]
U	-0.283045	-0.112318
	(0.03499)	(0.02111)
	[-8.08945]	[-5.32155]
R-squared	0.936177	0.920489
Adj. R-squared	0.893628	0.867482
Sum of squared residuals	0.012653	0.004604
Standard error equation	0.029044	0.017520
F-statistic	22.00245	17.36533
Log likelihood	62.27086	75.41317
Akaike AIC	-3.943912	-4.954859
Schwarz SC	-3.411640	-4.422587
Mean dependent	0.083572	0.060728
Standard deviation dependent	0.089051	0.048127
Determinant of the covariance matrix of residuals (adjusted degrees of freedom)		2.15e-7
Determinant of the covariance matrix of residuals		7.17e-8
Log likelihood		140.0778
Akaike information criterion		-8.852140
Schwarz criterion		-7.642431

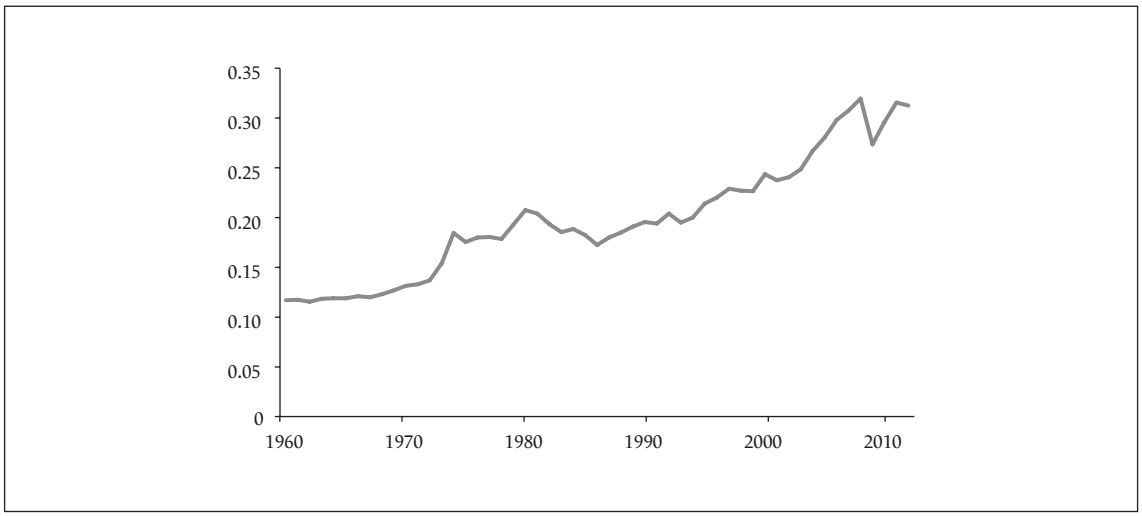
Notes:
Included observations: 26
Standard errors in ( ); t-statistics in [ ].

Table 4
VEC estimates for 1973–2008

Variable	Estimates	
X(-1)	1.000000	
Y(-1)	-0.165510	
	(0.19775)	
	[-0.83698]	
@TREND(60)	-0.074230	
	(0.01367)	
	[-5.43184]	
C	-21.61170	
Error correction	**D(X)**	**D(Y)**
CointEq1	-0.312999	-0.147974
	(0.06176)	(0.04455)
	[-5.06786]	[-3.32178]
D(X(-1))	-0.334702	-0.263629
	(0.18860)	(0.13603)
	[-1.77463]	[-1.93796]
D(Y(-1))	1.532188	0.986152
	(0.30574)	(0.22052)
	[5.01137]	[4.47191]
C	0.014303	0.026748
	(0.01488)	(0.01073)
	[0.96126]	[2.49234]
R-squared	0.707308	0.590879
Adj. R-squared	0.679868	0.552524
Sum of squared residuals	0.080866	0.042068
Standard error equation	0.050270	0.036258
F-statistic	25.77664	15.40548
Log likelihood	58.69090	70.45379
Akaike AIC	-3.038383	-3.691877
Schwarz SC	-2.862437	-3.515931
Mean dependent	0.101380	0.077848
Standard deviation dependent	0.088847	0.054202
Determinant of the covariance matrix of residuals (adjusted degrees of freedom)		1.97e-6
Determinant of the covariance matrix of residuals		1.56e-6
Log likelihood		138.5289
Akaike information criterion		-7.084938
Schwarz criterion		-6.601085

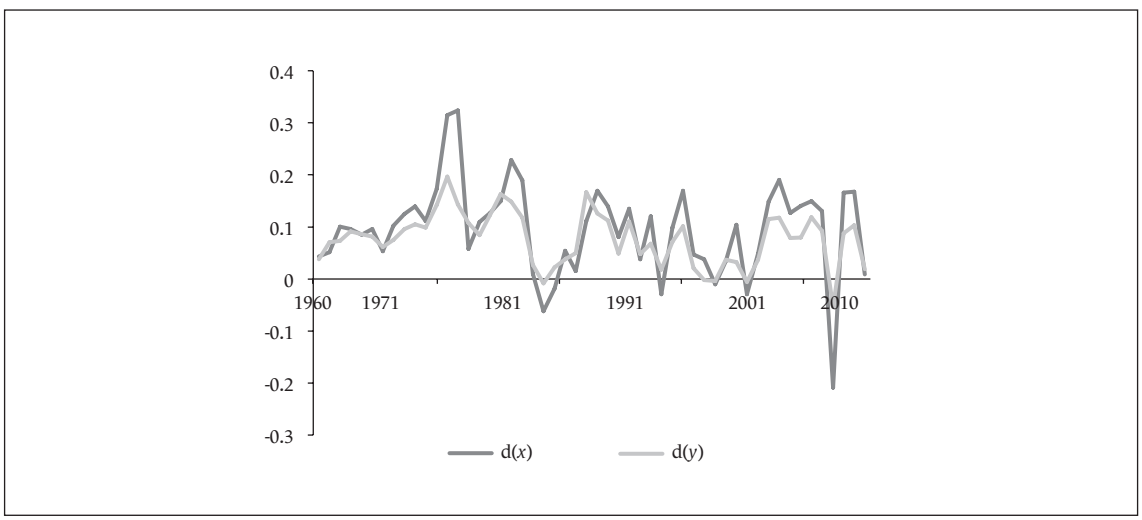
Notes:
Included observations: 36.
Standard errors in ( ); t-statistics in [ ].

Figure 1
Global exports/GDP ratio, 1960–2010



Source: calculations based on WDI (2014).

Figure 2
The first differences of the natural logarithm of world output, d(*x*), and world exports, d(*y*), covering the period 1960–2010



Source: calculations based on WDI (2014).

Figure 3
Responses to generalised one standard deviation innovations to *y* and *x* VEC system from Table 2

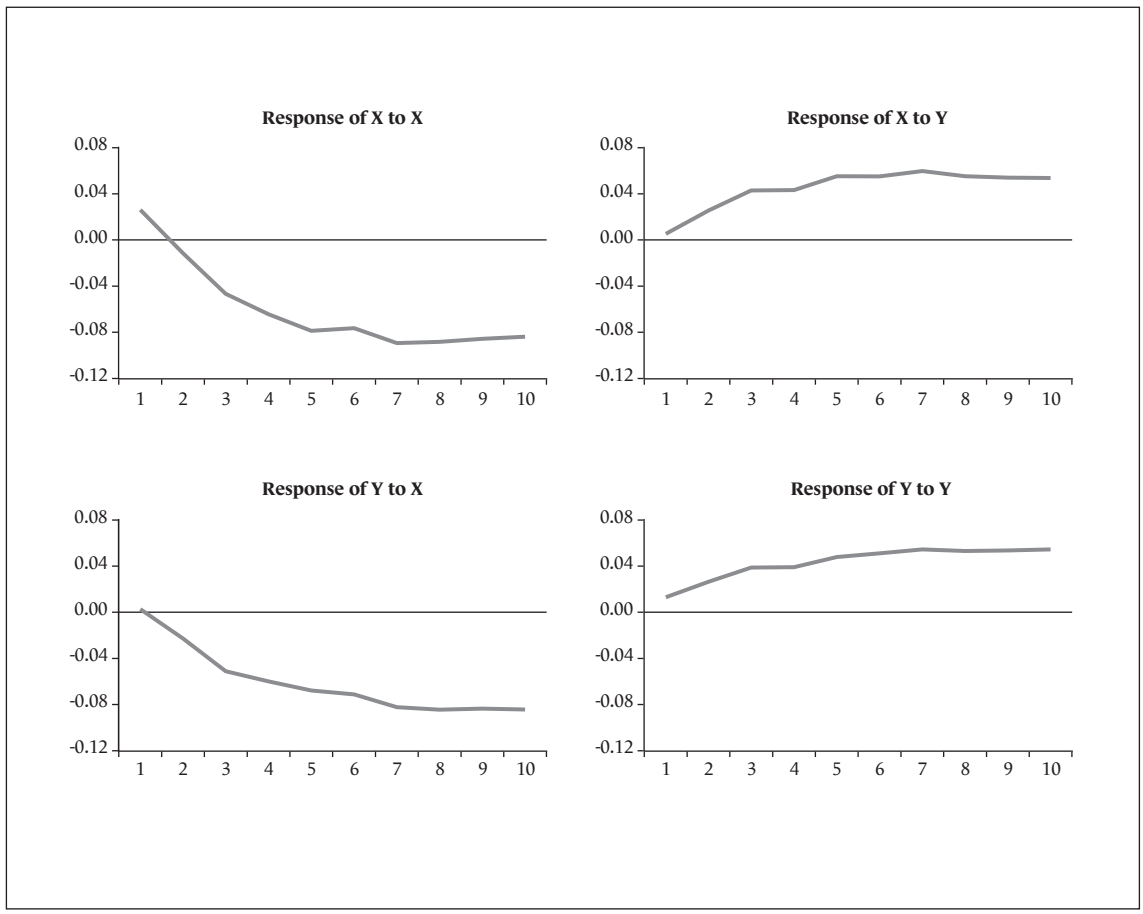


Figure 4
Responses to generalised one standard deviation innovations to y and x VEC system from Table 3

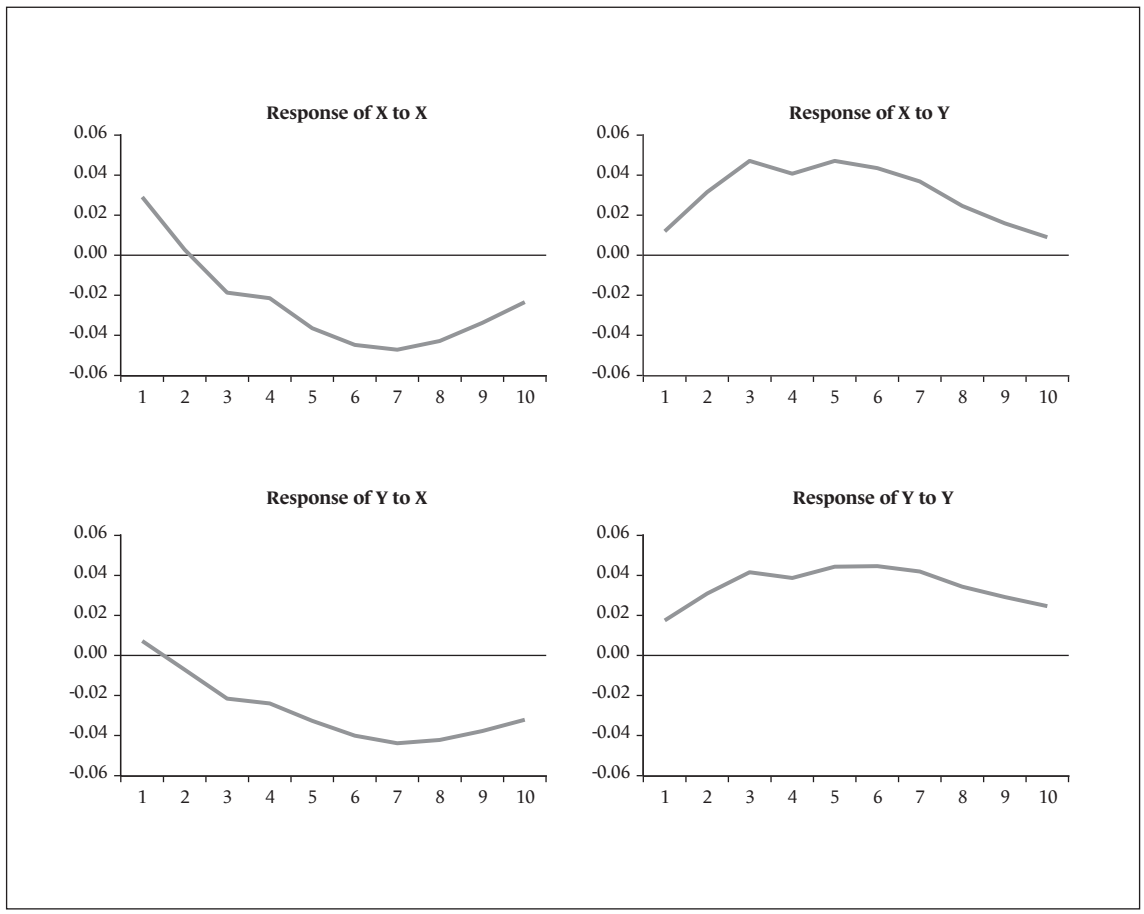
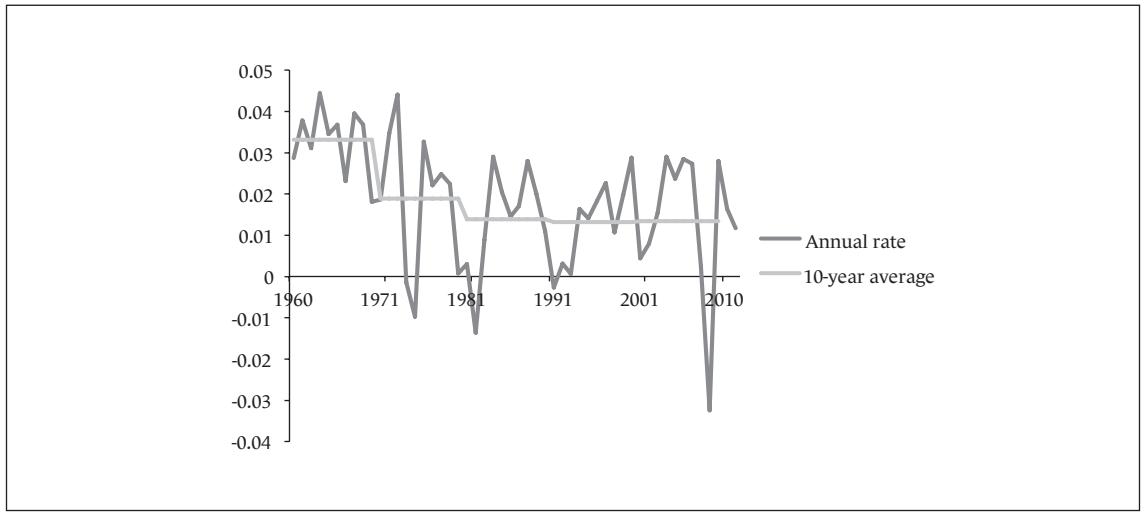


Figure 5
Growth rate of per capita real gross global product, 1960–2010



Source: calculations based on WDI (2014).

Figure 6
Responses to generalised innovations VECM from Table 4