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FURTHER EVIDENCE ON THE VALIDITYOF THIRLWALL'S LAW

Summary
A simple equation is considered whose empirical analysis could confirm – or reject – the validity of Thirlwall's Law. Autoregressive Distributed Lags (Bounds) approach is used to establish the empirical adequacy of the Law. The analysis, working with data for 58 countries and covering the years 1960-2012, suggests that the Law may not hold for the decisive majority of countries considered.

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Key words: *Thirlwall's Law, trade elasticities, balanced growth, co-integration, ARDL*

Introduction

Thirlwall's Law[1] is a conceptually simple approach to international macroeconomic analysis (see for example Thirlwall[2], and Soukiazis and Cerqueira[3], for relatively recent reviews of the Law's extensions and applications). Section 2 briefly restates the original Law. One of its underlying assumptions is that long-term growth in small open economies must respect the balance-of-payments constraint. The constraint, taking the form of an equation phrased in terms of conventional trade elasticities, is to reflect the existence of a balance-of-payments (or rather balance-of-trade) limit on the growth rate of output.

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[1] Thirlwall, A.P. 1979. The balance of payments constraint as an explanation of international growth rate differences. *Banca Nazionale del Lavoro Quarterly Review*, vol. 32, no. 128, 45-53

[2] Thirlwall, A. P. 2011. Balance of payments constrained growth models: history and overview. University of Kent, *School of Economics Discussion Papers*, KDPE 1111, May

[3] Soukiazis, E. and Cerqueira, P. A. (eds.) 2012. *Models of Balance of Payments Constrained Growth. History, Theory and Empirical Evidence*, Palgrave Macmillan

Podkaminer[4] noticed that Thirlwall's Law analytically rests on an equation that represented a necessary condition for externally balanced growth. A modification of the underlying equation was proposed. Section 3 briefly restates the case for the modification. The modified equation whose satisfaction is sufficient (as well as necessary) for growth to be externally balanced (and at the same time to be consistent with additional assumptions on the functional form of import and export functions) is restated in Section 4. In Podkaminer[5] an econometric co-integration analysis based on the modified equation, using the Dynamic Ordinary Least Squares (DOLS) method applied to data for 59 countries covering the years 1960-2012, suggested that Thirlwall's Law might not have held for the decisive majority of countries[6]. Section 5 reports the outcomes of the Autoregressive Distributed Lag (ARDL) 'Bounds' approach[7] being applied to the same set of data.[8] The findings are similarly negative regarding the empirical adequacy of Thirlwall's Law. Section 6 concludes.

1. The original Law

The assumptions behind the original Law are quite straightforward. In the spirit of the age-old traditions ('absorption and elasticity approaches') it is postulated that a small open economy's foreign trade can be properly described by two conventional 'demand equations', one for its exports (X), the other for its imports (M), both in real terms.

The equations are defined as follows

[4] Podkaminer, L. 2015. "Thirlwall's Law" Reconsidered. *Empirica* DOI.1007/s10663-015-9310-6

[5] Ibidem

[6] Aricioglu, Ucan and Sarac (2013) provide a review of recent studies concerned with econometric testing of the conventional versions of the model (i.e. the versions based on the necessary, but not sufficient, condition for externally balanced long-term growth). In the majority of multi-country studies listed therein the Law is found invalid in one third to one half of the cases.

[7] Pesaran, M. H., Shin, Y. and Smith, R.J. 2001. Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, vol. 16, no. 3, 289-326

[8] The ARDL approach has a number of advantages over the older approaches to co-integration. Its major disadvantage has been the necessity to conduct a very large amount of auxiliary calculations (for example in order to be able to select the optimal lags for the variables considered). The EViews 9 econometric package, currently available, allows fast (automated) conduct of the most labour-intensive auxiliary calculations.

$$X = Ax(P/EP^*)-\varepsilon x Y^*\eta x \quad (1)$$

$$M = Am(EP^*/P)-\varepsilon m Y\eta m \quad (2)$$

where P and Y are the 'home' country's price and real GDP levels; P* and Y* are price and real GDP levels of the 'foreign' country (it is assumed that the 'home' and 'foreign' countries trade exclusively with each other); E is the home country's exchange rate (its currency per unit of the foreign country's currency); A_x and A_m are non-negative constants and P/EP* is the real exchange rate. All constant elasticity parameters (ε and η) are assumed to be positive ($-\varepsilon_x$, $-\varepsilon_m$ are price elasticities of exports and imports respectively; η_x and η_m are income elasticities of exports and imports respectively). The Marshall-Lerner condition ($\varepsilon_x+\varepsilon_m \geq 1$) is (usually) assumed (or expected) to hold.

From the postulate that trade must be balanced 'in the long run' (i.e. the *value* of exports must be equal to the *value,* in foreign currency terms*,* of imports: PX=EP*M), it is then tacitly concluded that in the long run the rates of growth of values of exports and imports must be equal to each other.

This conclusion gives rise to the following equation

$$(\varepsilon x+\varepsilon m-1)(p-p^*-e) = \eta x y^*-\eta m y \quad (3)$$

where the lower-case symbols (p, p*, e, y, y*) represent growth rates of the variables P, P*, E, Y, Y* respectively.

Equation (3) is equivalent to the following one

$$y = [(1-\varepsilon x-\varepsilon m)(p-p^*-e)+\eta x y^*]/\eta m \quad (4)$$

Various conclusions are customarily drawn from (3) and/or (4). For example, suppose that there is one currency shared by both countries so that e=0 and, in addition, $p \approx p^*$ (there is no substantial inflation differential).

Then

$$\eta x y^* = \eta m y \quad (5)$$

or

$$y = (\eta x/\eta m)y^* \quad (6)$$

Equations (5) and (6) are valid also when $(\varepsilon_x+\varepsilon_m-1)=0$ or under 'elasticity pessimism' extensively discussed in the literature. Equation (6) is commonly referred to as Thirlwall's Law. It relates the rate of growth of a country's GDP to the rate of growth of GDP of its foreign partners combined (or of the rest of the world). According to (6), the lower the country's elasticity of demand for imports η_m and the higher the world's elasticity of demand for its exports η_x, the faster its (*externally balanced*) GDP growth. Observe that (5) implies the equality of the real *rates of growth* of exports and imports – but not the equality of (changing) volumes of exports and imports.

2. The satisfaction of the Law is *necessary* but *not sufficient* for growth to be externally balanced

Balanced trade, i.e. the satisfaction of

$$PX = EP^*M$$

implies the satisfaction of equation (3) – and of the equations eventually derived from (3). But the satisfaction of (3) does not *per se* imply the satisfaction of the equation PX=EP*M, i.e. of trade being balanced. Equation (3) is a reduced form derived from equations (1)-(2) under the *additional* assumption of trade being balanced. The condition that is *both* sufficient and necessary for growth to be balanced is, of course, PX=EP*M. By plugging (1) and (2) into it one obtains the following expression

$$PAx(P/EP^*)-\varepsilon x Y^*\eta x = EP^*Am(EP^*/P)-\varepsilon m Y\eta m \quad (7)$$

Taking logarithms of the expressions on both sides of (7) and rearranging the result, one obtains an equation relating log(Y) to log(Y*):

$$\log(Y)=(1/\eta m)\log(Ax/Am)–((\varepsilon x+\varepsilon m-1)/\eta m)\log(P/EP^*)+(\eta x/\eta m)\log Y^* \quad (8)$$

Assuming that equations (1)-(2) hold (for some concrete values of the parameters), equation (8) describes log(Y) as a function of log(Y*). Notice that unlike equation (3), equation (8) *guarantees* the satisfaction of the balanced-trade requirement, all along.

The assumption on trade being balanced is of course violated for practically all countries, and most of the time too. But common sense dictates that trade cannot go imbalanced (either way) *indefinitely*. From this fact it follows that (8) is interpreted as a kind of *locus of balanced positions*

for the variables (Y, Y* and P/EP*) in question. The observed values of the variables in question may lie off the curve given by (8), reflecting imbalanced trades. But there should be a *tendency* for such imbalances to diminish sooner or later. It is in this sense that one can talk of the *long-run tendency* to balanced trade - and of real output growth being consistent with such a trade. If the assumptions underlying equations (1) and (2) (plus the notion that there is a *tendency* for imbalances to correct themselves) are empirically correct then the logarithms of Y, Y* and (P/EP*) ought to stand in a long-run relationship, or to be *co-integrated*. The presence of co-integration of Y, Y* and (P/EP*) means that the parameters of (8) are such that the trade imbalances represented by

$$[\log(Y)-(1/\eta m)\log(Ax/Am)+((\varepsilon x+\varepsilon m-1)/\eta m)\log(P/EP^*)-(\eta x/\eta m)\log(Y^*)]$$

show the *tendency* to diminish following occasional 'disturbances'. The tendency of the above difference to diminish would then also lend credence to equation (3) – and to equations derived from it (such as (4) or (6)).

To avoid misunderstanding, the failure to confirm the existence of co-integration between log(Y) and log(Y*) does not necessarily mean that the actual output growth has *not* respected the external balance constraint. The 'normal' countries have to respect the external trade-balance constraint in the longer run – no matter how their export and import functions are functionally defined. The failure to confirm the existence of co-integration may mean that the basic forms of the demand equations (1) and (2) – from which (8) is derived – are incorrect.

3. Testing for co-integration

Assuming the presence of co-integration of the logarithms of Y, Y* and P/EP*, one is able to say something about the parameter estimates – without engaging into *separate* estimations of export and import functions which is usually based on the logarithmic) forms of (1)-(2).[9]

Observe that if co-integration of the logarithms of Y, Y* and P/EP* is confirmed (following the application of some specific econometric tests) and log(Y) is assumed to be determined by log(Y*) (and eventually in

[9] Equation (8) does not require information on (or estimates of) separate trade elasticities featuring in (1) and (2). This must be considered an important advantage. The calculation of trade volumes – needed for separate estimations of these elasticities – is a cumbersome business as it requires application of reliable price deflators for exports and imports.

addition also by log(P/EP*)), and not the other way round, then there are parameters (call them c_1, c_2, c_3) to estimate from the following regression:

$$\log(Y) = c1+c2\log(P/EP^*) + c3\log(Y^*) \quad (9)$$

It follows that if the equations (1)-(2) are the correct formulae for the export and import functions *and* trade has had the tendency to be balanced then the parameters in (9) may be given specific meanings. The c_1 parameter would then correspond to $(1/\eta_m)\log(A_x/A_m)$ in (8); c_2 to $(\varepsilon_x+\varepsilon_m-1)/\eta_m$; and c_3 to (η_x/η_m).

If co-integration is *not* confirmed, there is really no point in trying to estimate the specific elasticities and parameters in equation (8) (and in (9)), by *any* method. Absence of co-integration would mean that the basic model (1)-(2) is inappropriate – and/or that the assumption is not confirmed that there has been a *tendency* for imbalances to correct themselves, or both. Consequently, in such situations (3)-(6) are also irrelevant.

Of course even if co-integration between the logarithms of Y, Y* and (P/EP*) is not rejected, the empirical results will not always make sense. For example, the eventual parameters of the 'co-integration equation' (9) may have apparently 'wrong' signs (e.g. the estimated ratio of income elasticities (c_3) may turn out to be negative or the estimate of c_2 (equal $-(\varepsilon_x+\varepsilon_m-1)/\eta_m$) may turn out to be positive, contradicting the Marshall-Lerner condition).

4. Co-integration of the logarithms of Y, Y* and P/EP* seems to be quite rare

This Note reports the main findings of co-integration tests conducted, by means of the Autoregressive Distributed Lags 'Bounds' method, for a sample of countries for which reasonably long time series of data on Y, Y* and P/EP* are available. The sample of countries under examination consists of Argentina, Australia, Austria, Bangladesh, Belgium, Bolivia, Brazil, Canada, Chile, China P.R., Colombia, Cyprus, Denmark, Egypt, Ecuador, Finland, France, Greece, Germany, Iceland, India, Indonesia, Iran, Israel, Italy, Japan, Kenya, Korea, Madagascar, Malaysia, Mexico, Namibia, Netherlands, New Zealand, Nigeria, Norway, Pakistan, Panama, Paraguay, Peru, Philippines, Portugal, Senegal, South Africa, Spain, Sweden, Switzerland, Tanzania, Togo, Tunisia, Turkey, Uganda, UK, USA, Venezuela, Vietnam, Zambia and Zimbabwe: 58 countries in total. (Ireland, which was considered in Podkaminer, 2015 is excluded this time round because the time series for that country is too short for a meaningful

application of ARDL). The data, extending (for most countries) from 1960 through 2012, come from the World Development Indicators (WDI), which are accessible on the World Bank web page. A country's GDP (Y) is measured at constant 2005 USD. GDP of a country's 'rest of the world' (Y*) is measured as the difference between global GDP (again measured at constant 2005 USD) and Y. The Real Effective Exchange Rate Index (REER) series reported by WDI are substantially shorter than the Y and Y* series. They do not start before 1975, while for some countries they start later and for some other countries they are not reported at all. The P/EP* measure used instead of REER is calculated from the WDI series of real and nominal GDP (the former expressed at constant 2005 USD, the latter at current USD). This measure (called Π henceforth) is actually closer to the original P/EP* concept.[10]

It is assumed that log(Y) is the dependent variable, potentially determined by log(Y*) (and, additionally, possibly by log(Π)). This is justified by the fact that any country's GDP is a more or less small fraction of the GDP of the rest of the world. Testing for co-integration between log(Y) and log(Y*) and log(Π) reported below was conducted by means of the ARDL method. The ARDL approach requires that the variables considered are not I(2). That requirement is easily satisfied as evidence (following the application of ADF unit root tests) is strong that all log(Y) and log(Y*) series are I(1) while log(Π) series are either I(1) or possibly even I(0). The second essential requirement is that the residuals to the eventual ARDL models are free from autocorrelation. That requirement is safely satisfied for all countries - whether or not the analysis rejects the existence of co-integration[11].

ARDL was first applied to the equation abstracting from the exchange rate term (log(Π)):

$$\log(Y) = c1 + c3\log Y^*$$

The F-statistics alone, calculated as prescribed by Pesaran et al (2001), rejects (at the conventional significance levels) the null of 'no long-term relationship' for 27 countries. But for 6 of these countries the estimates for c_3 turn out to be negative – which does not seem to make sense. For some

[10] Let Y_{nom} and Y^*_{nom} be nominal GDP levels (at current USD) of a country and *its* 'rest of the world'. Π is then defined as $(Y_{nom}/Y)(Y^*_{nom}/Y^*)$. Observe that $\Pi_{2005}=100$ in each case. In most cases the Π and REER series turn out to be quite strongly correlated.

[11] Similarly, the customary stability tests (such as CUSUM) do not suggest instability of the estimated parameters.

other countries (including China, India, Italy, USA) the estimate for the so-called error-correction (EC) term turns out to be positive – thus indicating the non-existence of long-term co-integration. According to the t-statistics (which is the second 'bounds' testing statistics associated with ARDL) only 10 countries (out of the 27 passing the F-statistics test) qualify. Estimated c_3 for these countries are positive and significant at 0.01% level while the estimated error-correction terms are all negative (as should be expected) and also significant at 0.01% level (see Table 1).

Table 1. The 10 cases of non-rejected co-integration between log(Y) and log(Y*)

	Observations included	F-statistics	t-statistics	EC term	c_3
Argentina	45	4.83**	-3.000*	-0.3239	0.6299
Colombia	49	4.28*	-3.494**	-0.255	1.1986
Finland	51	5.94**	-2.950*	-0.2179	0.9513
Indonesia	51	10.5***	-3.470**	-0.1305	1.825
Israel	51	10.50***	-3.110*	-0.240	1.4486
Kenya	52	23.9***	-2.990**	-0.1655	1.283
Malaysia	51	4.3**	-3.190**	-0.1945	2.048
Tunisia	51	8.715***	-3.240**	-0.2596	1.406
Uganda	29	11.44***	-4.490***	-0.2245	2.423
Venezuela	51	6.36**	-3.075**	-0.241	0.6739

F-statistic values for testing Ho: 'no long-term relationship exists'. *** implies rejection of Ho at 1%significance; **: rejection at 5%; *: rejection at 10%. The critical bounds for the F-statistics aretaken from Narayan[12], Appendix Tables A1-A3. t-statistics values for testing the same hypothesis: *** implies rejection of Ho at 1% significance; ** at 5%, * at 10%. The critical bounds for t-statistics aretaken from Pesaran et al. [13], Table CII(iii)).

The tests (for the same set of countries and the same time periods) based on DOLS reported in Podkaminer (2015, Table 1) suggested the

[12] Narayan, P. K. 2004. Reformulating Critical Values for the Bounds F-statistics Approach to Cointegration: An Application to the Tourism Demand Model for Fiji. *Dept. of Economics Discussion Papers*, no. 02/04, Monash University.
[13] Pesaran, M. H., Shin, Y. and Smith, R.J. 2001. Bounds testing approaches… op. cit.

presence of co-integration between log(Y) and log(Y*) in 6 cases.[14] Interestingly, 4 of these cases also appear in Table 1 above. (These are Finland, Indonesia, Israel and Malaysia. Reassuringly, the DOLS estimates for c_1 and c_3 for these four countries are very close to their ARDL counterparts).

According to the ARDL analysis, allowing for log(Π) as an additional explanatory variable, the F-statistics rejects the null of non-existence of long-term relationship in 31 cases. However, most of these cases are highly problematic anyway. In two cases the estimated EC term is positive and in 12 cases it is negative but very close to zero. In 8 cases the estimated c_3 is negative (though generally insignificant). The estimated c_2 has a 'wrong' (i.e. positive) sign in 19 cases. Finally, only 4 countries pass the second 'bounds' testing statistics (see Table 2). The estimates for c_2 are all 'wrongly signed' (in violation of the Marshall-Lerner condition) but – in two cases – statistically insignificant (see the last column in Table 2). The estimated EC terms and c_3 parameters for these cases are correctly signed and significant at 0.01% level. (However, the estimated EC term for Namibia is greater than 1 in absolute terms. This suggests instability of the ARDL model for that country.)

Table 2. The 4 cases of non-rejected co-integration between log(Y), log(Y*) and log(Π)

	Observations included	F-statistics	t-statistics	EC term	C_3	C_2	Prob.
Ecuador	49	4.13*	-4.02***	-0.267	1.082	0.0855	0.247
Namibia	29	7.07***	-4.58***	-1.014	1.433	0.2976	0.000
Tunisia	51	7.73***	-3.27*	-0.282	1.55	0.3605	0.0501
Venezuela	51	5.25**	-3.22*	-0.285	0.670	0.0361	0.6115

F-statistic values for testing Ho: 'no long-term relationship exists'. *** implies rejection of Ho at 1%significance; **: rejection at 5%; *: rejection at 10%. The critical bounds for the F-statistics aretaken from Narayan[15], Appendix Tables A1-A3. t-statistics values for testing the same hypothesis: *** implies rejection of Ho at 1% significance; ** at

[14] DOLS did not reject integration in 7 further cases with linear (or quadratic) trends included as additional variables in the long-run relationship between log(Y) and log(Y*).

[15] Narayan, P. K. 2004. Reformulating Critical Values… op. cit.

5%, * at 10%. The critical bounds for t-statistics aretaken from Pesaran et al. [16], Table CII(iii)).

The tests based on DOLS reported in Podkaminer (2015, Table 2) suggested the presence of co-integration between log(Y) and log(Y*) and log(Π) in only 2 cases (Ireland and Japan). In both cases the estimates for c_2 were also positive (i.e. 'wrongly') signed.

The findings reported in Tables 1-2 provide some support to Thirlwall's original idea that corrections of trade imbalances primarily involve quantity (GDP) and not the relative price (i.e. exchange rate) adjustments. In the cases reported in Table 1 the cointegration obtains with the exchange rate variable being ignored. When that variable is taken into consideration (Table 2) it proves to be 'wrongly' signed. In any case the elimination of trade imbalances in the cases from Tables 1-2 cannot be expected to proceed through exchange rate adjustments. However, our estimates do not allow any judgement on the relative roles of the quantity and price adjustments for the remaining countries.

Concluding remarks

An earlier analysis applying the Dynamic Ordinary Least Squares approach to the model given by (9) suggested that Thirlwall's Law did not hold for a decisive majority of countries considered. The same conclusion follows the analysis using the ARDL Bounds approach. The latter approach appears slightly more 'liberal' than DOLS. This may have something to do with the fact that the critical values for the upper bounds of the t-statistics (taken from Pesaran et al., 2001) are asymptotic – while the series considered are not very long. The exact critical bounds values for the t-statistic for the time series considered may have been more restrictive.[17]

The unimportance of the real exchange rate as a factor co-determining long-term growth, revealed earlier, has now been confirmed. Evidence is strong that the Marshall-Lerner condition does not hold, at least in the longer-run perspective. Of course this is not quite a novel finding as many authors have also found violation of the Marshall-Lerner condition in studies

[16] Pesaran, M. H., Shin, Y. and Smith, R.J. 2001. Bounds testing approaches… op. cit.
[17] The critical values for the F-statistics bounds, taken from Narajan (2004), are 'exact' – they allow for time series of finite lengths (in the 30-80 range). For the time series' lengths considered here Narayan's upper bounds for the F-statistics are generally much higher (more restrictive) than the respective asymptotic values reported in Pesaran et al. (2001).

concerned with the estimation of trade elasticities (e.g. Imbs and Mejean, 2010; Crane et al., 2007; Wu, 2011). Imperfect data may have been one reason for the generally negative verdict on the empirical validity of the Law. The 'fault' may also lie with the functional form of the underlying equations (1)-(2). Some parsimonious modifications of the functional form of equations (1)-(2) may perhaps need to be developed. With such modifications the Law may 'fit the data' satisfactorily without losing the power to provide simple insights into the role external imbalances play in determining long-term growth of small open economies. In any case it is vital that the eventual testing applies to models that are capable of reflecting sufficient (and not merely necessary) conditions for long-term balanced growth[18].

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[18] Recent contributions (such as Tharnpanich and McCombie (2013), Ibara and Blecker (2016) and Razmi (2015) among others) introduce variously defined structural changes (and 'structural breaks') into the original Thirlwall's framework. One trouble with these innovations is that they introduce additions making the basic insight of Thirlwall's Law no more appealingly transparent. Besides, the innovations rendering the elasticity parameters dependent on exogenous developments (e.g. the supply-side ones, or relating to the advances in globalisation) implicitly reject the underlying model (1-2) which assumes *constant* parameters. Moreover, the recent contributions go on with the direct – necessarily problematic - estimation of the elasticity parameters for the export and import functions. Last, but not least, the estimates they provide are derived from the formulae reflecting necessary – but not necessarily sufficient conditions for long-term balanced growth.

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