Endogeneity of the elasticities and the real exchange rate in a balance of payments constrained growth model: cross-country empirical evidence

Frederico G. Jayme Jr (Cedeplar-UFMG, Brazil. Visiting Scholar, Downing College and Department of Land Economy, University of Cambridge)

Renato Campos (UFLA, Brazil)

Gustavo Britto (Cedeplar-UFMG, Brazil)

- ***Aims of the Paper:***

  - Assessing cross-country and time series empirical evidence the hypothesis that the elasticities of the balance of payments constrained growth model are endogenous;

  - Introducing the level of the real exchange rate as one of the elements that explain growth.

Canonical Model: Thirlwall's Law

- Thirlwall's (1979): country's maximum sustainable growth rate is given by the equation that defines the growth rate compatible with balance of payments equilibrium

$$y_{BP} = {}^{x}\!/_{\pi} = {}^{\varepsilon z}\!/_{\pi}$$

- x is the growth rate of exports;

- π is the income elasticity of the demand for imports;

- ε is the income elasticity of the demand for exports;

- z is the growth rate of world income.

- McCombie (2011) and the rationality behind this "law":

  No country can grow faster than the rate compatible with balance of payments equilibrium for long periods of time or its foreign debt would rise to such a level that would cause loss of international confidence, a decrease in the capacity of acquiring foreign credit, and a currency crisis.

Growth Models and Endogenous Elasticities

- Based on Thirlwall's original approach, some authors propose solutions for making the income elasticities endogenous under the Kaldorian framework.
  - McCombie and Roberts (2002); Missio and Jayme Jr. (2012)

- In the Thirwall's canonical model country's sustainable growth rate is given by the product of the ratio of its income elasticities and the growth rate of world income, **without the need of assuming that these elasticities are exogenous**.

- Income elasticities of demand of the countries would be largely determined by natural resource endowments and the characteristics of the goods they produce
  - Engel's Law (primary goods) and Thirlwall (industrial products)

Growth Models and Endogenous Elasticities

- Different way of making the elasticities endogenous, which furthermore allows for a structural analysis of their changes

  - Araújo and Lima (2007) - expanding Thirlwall's model to a multi-sectoral approach;

  - McCombie and Roberts (2002) - a balance of payments constraint model with hysteresis in the elasticities;

  - Missio and Jayme Jr. (2012) - the relationship between the exchange rate, structural heterogeneity and the income elasticities of the demand for exports and imports in developing economies.

Testing the hypothesis of endogenous elasticities and the role of the real exchange rate in a balance of payments contrained model

Estimation Strategies

1. Vector Auto Regression and Auto regressive distributive Lag to estimate the ratio of income elasticities of the demand for Exports and Imports for 38 countries;

2. Cross-country regression of the average relative growth rate of output against the previously estimated ratio to test the endogeneity;

3. Countries used in Blecker and Razmi (2008): 38 countries.

Estimation Strategies

✓ D u r b i n - W u - H a u s m a n (D W H) – endogeneity test with instrumental variable:

✓ share of technology-intensive sectors in a country's total exports

✓ the level of Real Exchange Rate

Estimation Strategies

- ✓ estimated using Lall (2001)'s methodology - output into primary products (PP), resource based manufactures (RB), low technology manufactures (LT), medium technology manufactures (MT) and high technology manufactures (HT);

- ✓ MT and HT manufactures into a high technology sector (HT) and RB and LT manufactures into a low technology one (LT), leaving primary products in a category of their own;

- ✓ grouping the medium and high technology manufactures into a single sector based on the average 2004-2010 value.

Aggregate estimations of the elasticities of foreign trade

- Considering Thirlwall's Law equilibrium equation we get the following testable model:

$$\left(\frac{y}{z}\right)_i = \beta\left(\frac{\varepsilon_i}{\pi_i}\right) + u_i$$

- $\frac{y_i}{z}$ is the ratio between national income and world income;

- $\frac{\varepsilon_i}{\pi_i}$ is the ratio of the income elasticities of the demand for exports and imports.

Aggregate estimations of the elasticities of foreign trade

$$\left(\frac{y}{z}\right)_i = \beta \left(\frac{\varepsilon_i}{\pi_i}\right) + u_i$$

- For the simplest version of Thilrwall's Law to be valid, β must equal 1 (VEC and ADL models);

- For the endogeneity hypothesis to be valid, $\frac{\varepsilon_i}{\pi_i}$

must be endogenous in this equation (Panel cross country)

Table 1: Estimation of the elasticities

Country	Time Period	Elasticities [t-statistic] (x) Exports	(m) Imports	(x/m) Ratio	(z) RWGDP	(x/m) × z BPCG	(y) GDP	(y/z) GDP/RWGDP
Argentina	1962-2011	2,2379 [16,8]	2,503 [11,1]	0,8941	3,4548	3,0889	2,842	0,8226
Australia	1960-2011	1,5701 [16,4]	2,0274 [10,4]	0,7744	3,471	2,6881	3,4938	1,0066
Belgium	1960-2010	1,4433 [10,4]	1,7918 [9,6]	0,8055	3,4869	2,8087	2,7296	0,7828
Brazil	1980-2011	2,2326 [43,2]	2,2853 [9,3]	0,9769	2,7929	2,7285	2,7291	0,9771
Cameroon	1968-2011	4,1951 [2,6]	3,8381 [3,3]	1,093	3,1754	3,4707	3,6356	1,1449
Canada	1960-2010	1,5221 [13,3]	1,8878 [9,97]	0,8063	3,4869	2,8114	3,2967	0,9454
Chile	1970-2011	2,4445 [9,8]	1,5368 [11,4]	1,5906	3,0402	4,8359	4,1227	1,356
China	1986-2011	6,0254 [27,4]	1,862 [9,2]	3,236	2,8325	9,1658	9,4374	3,3319
Colombia	1960-2010	1,5517 [8,2]	1,4992 [4,2]	1,035	3,4869	3,609	4,1264	1,1834
Ivory Coast	1960-2011	1,2367 [8,9]	1,3441 [5,7]	0,9201	3,471	3,1937	3,3494	0,965
Dominican Republic	1960-2011	1,5594 [8,4]	0,9055 [20,0]	1,7221	3,471	5,9776	5,162	1,4872
Ecuador	1960-2010	2,0555 [17,98]	1,4656 [10,8]	1,4025	3,4869	4,8904	3,8526	1,1049
France	1960-2010	2,07522 [6,3]	2,00728 [34,9]	1,0338	3,4869	3,6049	2,8863	0,8278
Germany	1970-2010	1,5809 [26,9]	1,9788 [23,3]	0,7989	3,0491	2,436	2	0,6559
Hong Kong	1981-2010	2,7504 [7,65]	1,98 [34,0]	1,3891	2,8288	3,9294	4,7643	1,6842

Table 1: Estimation of the elasticities

Country	Time Period	Elasticities [t-statistic] (ε) Exports	(π) Imports	(ε/π) Ratio	(z) RWGDP	(ε/π)×z BPCG	(y) GDP	(y/z) GDP/RWGDP
India	1960-2011	4,8035 * [6,3]	3,1494 * [3,4]	1,5252	3,471	5,294	5,004	1,4417
Indonesia	1967-2011	2,7768 * [7,4]	1,439 * [16,3]	1,9297	3,2039	6,1825	5,859	1,8287
Italy	1960-2010	1,7213 [14,3]	2,2386 * [3,7]	0,7689	3,4869	2,6812	2,7236	0,7811
Japan	1960-2010	1,1852 * [3,4]	1,1319 * [3,97]	1,0471	3,4869	3,6511	3,9156	1,1229
South Korea	1966-2010	3,3855 * [17,6]	1,3492 * [19,2]	2,5093	3,2755	8,2191	6,7434	2,0587
Malasia	1960-2010	3,4398 * [3,2]	1,4453 * [10,9]	2,38	3,4869	8,2988	6,2008	1,7783
Mauritius	1976-2011	1,353** [2,45]	0,8602 * [10,3]	1,5729	2,9655	4,6644	4,4118	1,4877
Mexico	1960-2011	2,9336 * [13,4]	2,3239 * [3,48]	1,2624	3,471	4,3817	3,984	1,1478
Netherlands	1960-2010	1,5549 * [12,2]	1,9507 * [15,8]	0,7971	3,4869	2,7794	3,0017	0,8608
Paquistan	1960-2011	4,5401 * [4,6]	3,3655 ** [2,5]	1,349	3,471	4,6824	5,1463	1,4827
Paraguay	1960-2011	2,0107 * [6,7]	1,6408 * [13,5]	1,2254	3,471	4,2535	4,2231	1,2167
Peru	1960-2011	0,8545 * [5,7]	0,7602 * [5,55]	1,124	3,471	3,9016	3,5285	1,0166
Philipines	1960-2011	2,18133 * [7,9]	2,06845 * [3,03]	1,0546	3,471	3,6604	3,9345	1,1335

Table 1: Estimation of the elasticities

Country	Time Period	Elasticities [t-statistic]		(σ/π)	(π)	(σ/π)×π	(γ)	(γ/π)
		(σ) Exports	(π) Imports	Ratio	RWGDP	BPCG	GDP	GDP/RWGDP
Singapore	1975-2011	3,4963 [47,7]	1,5583 [46,4]	2,2437	2,9128	6,5352	6,7224	2,3079
South Africa	1960-2010	1,21532 [2,8]	1,69164 [6,5]	0,7184	3,4869	2,5051	3,1743	0,9103
Sri Lanka	1984-2011	2,01865 [9,96]	1,40247 [18,8]	1,4394	2,9356	4,2253	4,854	1,6535
Switzerland	1980-2010	1,76278 [6,4]	3,2693 [2,2]	0,5392	2,7967	1,508	1,6357	0,5849
Syria	1975-2010	2,34852 [3,7]	1,36497 [2,6]	1,7206	2,9193	5,0229	4,703	1,611
Thailand	1960-2011	2,969 [6,7]	1,319 [13,4]	2,2509	3,471	7,813	6,0069	1,7306
Tunisia	1983-2011	1,55875 [3,9]	0,8341 [7,4]	1,8688	2,9295	5,4745	4,0638	1,3872
Uruguay	1960-2011	1,57996 [8,6]	2,28502 [22,8]	0,6914	3,471	2,4	2,1805	0,6282
Turkey	1987-2011	2,91603 [6,1]	2,08383 [2,44]	1,3994	2,8144	3,9384	4,0906	1,4534
United Kingdom	1988-2011	0,875711 [32,2]	0,934777 [13,2]	0,9368	2,7859	2,6098	2,2482	0,807

Notes: *Significant at 1%; **Significant at 5%; In bold: VEC; Standard deviation between brackets.

- The coefficients have the expected sign and are significant at 5%: First evidence in favour of Thirlwall's Law

Testing the Instrumental Variables

- Hypothesis: the ratio of elasticities is endogenous;

- Durbin-Wu-Hausman (DWH) test:

  - The Durbin-Wu-Hausman (DWH) test is a more robust version of the Hausman test, for it uses the device of augmented regressors (Davidson, 2000).

The Share of High Technology Manufactures in Foreign Trade

Industrialization deepens (and the share of technology-intensive sectors in the economy increases) → elasticities of exports and imports change → impacts the growth rate of output → productive structure dynamic → cumulativeness of short-term effects on the economy (can change long-term patterns).

The Share of High Technology Manufactures in Foreign Trade

- The greater the share of high technology manufactures in the economy, the greater will be the income elasticity of the demand for exports (which relaxes the balance of payments constraint, increasing the ratio of the elasticities).

The Level of the Real Exchange Rate

- Use of the level of the real exchange rate as an instrument for the ratio of the elasticities

  ➢ Balassa-Samuelson efect;

  ➢ Rodrik (2007) and Sampaio and Gala (2008) evidences;

  ➢ Ferrari *et al.* (2010), Silveira (2011); Missio and Jayme Jr. (2012) discussions regarding the endogeneity of the trade elasticities in a Balance-of-payments contrained growth framework

The Real Exchange Rate

- Affects the ratio of the elasticities → increasing the gains from the sale of tradable goods, profit margins and investment → diversification of the investments and products of sectors that operate in the world market;

- Spurs technological development → benefits to funding and credit → stimulating research and innovation;

The Real Exchange Rate

- Technological progress in developing countries depends on companies having available funds;

- The real exchange rate plays a subsidiary role in the long-term growth of the economies, particularly developing ones

  - Elasticities → relax the balance of payments constraint → spur economic growth
  - It is not a price competitiveness-induced improvement in trade

Estimations and the Endogeneity Test: an Overidentified Model

- The first stage presents the (DWH) test of the instruments against the "potentially" endogenous variable trade elasticities $\left(\frac{\varepsilon}{\pi}\right)$

- It is thus defined:

$$\left(\frac{\varepsilon}{\pi}\right)_i = \beta_{man.}M_i + \beta_{CR}CR_i + u_i$$

- ε/π is the ratio of the income elasticities;

- M is the share of high-technology manufactured goods in total exports;

- CR is the level of the real exchange rate.

Estimations and the Endogeneity Test: an Overidentified Model

- It defines an overidentified model with two instruments:
  1) the share of high-technology manufactured goods;
  2) the level of the real exchange rate.

- The advantage of an overidentified model is that it allows for testing overidentifying restrictions, whereby one can test the validity of overidentified instruments via a GMM estimation of the parameters.

- The endogeneity test for the ratio of the elasticities is made on the structural equation (already defined):

$$\left(\frac{y}{z}\right)_i = \beta \left(\frac{\varepsilon_i}{\pi_i}\right) + u_i$$

Estimations and the Endogeneity Test: an Overidentified Model

- We decided for a model without the constant term, for if we include the latter it would no longer be a test for Thirlwall's Law.

- Cameron and Trivedi (2009): when there are more instruments than regressors (an overidentified scenario) the most efficient estimators are the 2SLS and GMM.

  - However, in an overidentified model, 2SLS and GMM estimators can lead to different results.

  - The 2SLS estimator is more efficient if the errors u_i are independent and homoskedastic.

Estimations and the Endogeneity Test: an Overidentified Model

Table 2 – *First stage regression* (equation 11)

Estimator	Standard-errors adjustment	$(\beta_{man.})$ estimator: share of manufactured goods [t-statistic] {p-value}	(β_{CR}) estimator: real exchange rate [t-statistic] {p-value}
2SLS	VCE (Robust)	2,0082* [6,49] {0,00}	0,1749* [8,84] {0,00}
	No adjustments	2,0082* [7,14] {0,00}	0,1749* [5,68] {0,00}

* Significant at 1% ** Significant at 5%;

Estimations and the Endogeneity Test: an Overidentified Model

- The results for the first stage of the estimation (which only make sense for a model estimated by 2SLS):

  - the GMM estimator has the same result for the first stage;

  - indicates that the instruments are significant in determining the endogeneity of the tested variable;

  - both intrumental variables are significant at 1%.

Estimations and the Endogeneity Test: an Overidentified Model

Table 3 – *Overidentified* models: test of equation (10)

Estimator	Standard-errors adjustment	$(\beta_{\frac{\varepsilon}{\pi}})$ estimator: ratio of the elastic. [Z-statistic] {p-value}	Overidentifying restrictions test: Hansen-Sargan test		Wald test (restriction): $H0: \beta_{\frac{\varepsilon}{\pi}} = 1$ Chi2 statistic {p-value}
			Score Chi2 {p-value}	**Hansen's J Chi2** {p-value}	
2SLS	VCE (Robust)	0,9516* [35,47] {0,00}	0,03558 {0,8504}		3,25 {0,0712}
	No adjustments	0,9516* [39,37] {0,00}	0,0238 {0,8774}	0,02257 {0,8806}	4,01** {0,0452}
GMM	WMATRIX (Robust)	0,9528* [36,52] {0,00}		0,03558 {0,8504}	3,27 {0,0707}

* Significant at 1% ** Significant at 5%;
Source: the authors.

Estimations and the Endogeneity Test: an Overidentified Model

- The results:

  - the ratio of the elasticities is significant in determining the growth rate;

  - the Wald test on restrictions rejects the null hypothesis;

  - 10% significance level for the models with adjusted residuals and at 5% for the model with unadjusted residuals, against Thirlwall's (1979) simplest model;

  - there might be other determinants in the canonical model, such as the possibility of capital flows (Thirlwall and Hussein, 1982);

  - the overidentifying restrictions test do not reject the null hypothesis that all instruments are valid.

Estimations and the Endogeneity Test: an Overidentified Model

Table 4 – Endogeneity: robust Durbin-Wu-Hausman test

H₀ = the variables are exogenous	Standard-errors adjustment	Robust Score Chi2 {p-value}	Robust Regression F {p-value}	GMM C Statistic Chi2 {p-value}
2SLS	VCE (Robust)	1,32096 {0,2504}	1,4072 {0,2433}	
	No adjustments	1,4425 {0,2297}	1,4205 {0,2411}	
GMM	WMATRIX (Robust)			1,3054 {0,2532}

* Significant at 1% ** Significant at 5%;
Source: the authors.

Estimations and the Endogeneity Test: an Overidentified Model

- The test indicates that, for an overidentified model with two instruments (the share of high-technology manufactured goods and the real exchange rate):

  - the hypothesis that the ratio of the elasticities is an exogenous determinant of relative growth cannot be rejected.

  - This is another empirical evidence in favour of Thirlwall's Law.

Conclusions

- Although balance of payments constrained growth models in their simplest version is an important result, this work finds evidence that the level of the real exchange rate is a significant and can determine the income elasticities;

- The endogeneity tests support the simple version of Thirlwall's law.

Conclusions

- The endogeneity of the elasticities

  - do not reject the hypothesis that the ratio of the elasticities is exogenous;
  - support Thirwall's model;
  - the author's canonical model is not sufficient to explain the growth of the analysed countries – suggesting other variables, such as capital flows (Thirwall and Hussain,1982) and foreign debt (Moreno-Brid, 1998);

- The real exchange rate is one of the determinants of income elasticity.