Country size and the price of tradeables: is there any relationship beyond wishful thinking?

Andrea Mantovani[*] Gianpaolo Rossini[†] Paolo Zanghieri[‡]

September, 2002

Abstract

The existence of transport costs among countries makes prices of tradables diverge. When the market structure is a differentiated oligopoly the prices of tradables increase as a country get larger.and/or richer. In a framework of economies of scale-differentiation-monopolistic competition a less definite result can be found, since it all depends on the level of transport costs and the degree of openess.

First we go through some theoretical aspects of these different approaches. Then, we provide empirical tests that may be able to discriminate among the two competing approaches.

The results show that a relationship exists between size, percapita incomes and prices of tradables in countries separated by some transport cost. As a country is larger prices are lower, yet they become higher if percapita income is higher.

Keywords: Transport Costs, Oligopoly, Monopolistic Competition, Trade. JEL Classification F12, I00, R40

[*]Department of Economics, University of Bologna, Strada Maggiore, 45, I-40125 Bologna Italy, mantovan@spbo.unibo.it and CORE, Université Catholique de Louvain, 34, Voie du Roman Pays - 1348 Louvain-la-Neuve, Belgium, mantovani@core.ucl.ac.be

[†]Corresponding author, Department of Economics, University of Bologna, Strada Maggiore, 45, I-40125 Bologna, Italy, rossini@spbo.unibo.it

[‡]CEPII Centre d'Etudes Perspectives et d'Informations Internationales. 9 rue Georges Pitard 75015 Paris, zanghieri@cepii.fr

[§]Paper to be presented at the ETSG conference, Kiel 12-15 September 2002.We acknowledge the financial support of the University of Bologna and the Italian Ministry of Education within the 60% scheme for academic year 2002. We also thank Giordano Mion for useful suggestions and CEPII for kind provision of facilities and empirical support. The usual disclaimer applies.

1 Introduction

The existence of transport costs in international trade is one of the main sources of divergences in the prices of tradeable across countries. This issue has been analyzed since the very beginning of the modern trade literature (Samuelson, 1952), yet only marginally since most trade models work properly only if trade costs are null. Despite its frequent neglect, the question of transport costs has been at the heart of many questions, such as the actual patterns of specialization, income distribution and prices of tradeable across countries engaged in international exchange.

Transport costs usually put a wedge between the price paid by consumers and the revenue received by the producer of the good. This gap is one of the reasons why the Purchasing Power Parity tends to fail in empirical tests mainly in its strong version (absolute values) rather than in its weak form (variations) (Rogo¤, 1996). According to Obstfeld and Rogo¤ (2000) the inclusion of transport-transaction costs can explain several puzzles in international macroeconomics, included those related to home biases.

Nonetheless, the issue of transport costs has not received su¢cient attention in the literature, perhaps because of steadily declining communication and shipment costs. The persistence of many home biases con…rms that the question of transport costs is not a secondary one and needs further and deeper investigations.

If we go through the literature and con…ne our attention to recent contributions we may distinguish two main routes which have been followed since the 1980's as to trade modelization. The two approaches are based on imperfect markets and the main di¤erence between them hinges upon the assumptions made as to the market structure.

The …rst stream of models is based on the monopolistic competition-economies of scale model (Krugman, 1980, 1979, 1981; Fujita-Krugman-Venables, 1999; Neary, 2000) that is cast in a general equilibrium perspective. In this framework, transport costs have a relevant e¤ect on specialization. Their existence gives rise to many home market e¤ects. Among them, one is that consumers in larger countries have access to a broader variety of goods that translates into higher utility. As far as prices of tradeable are concerned, the e¤ect of size of a country is to make prices of domestically produced tradeable higher. However, the price index of a country includes also imported goods, whose price in the importing country depends on transport costs. Then we are not able to establish any relationship between the size of a country and the price index of tradeable in that country. A relationship may also be found between percapita income and the domestic prices of internally produced tradeable.. However, the relationship vanishes or becomes awkward to sustain when we consider price indices including imported goods.

The second stream of models is based on oligopoly and cast usually in a partial equilibrium framework. Here trade has a procompetitive e¤ect since it changes the basic market structure leading to less concentrated markets. This is an e¤ect that does not appear in the previous models since in monopolistic competition, with its long run zero pro…t equilibrium condition, the price level is not in‡uenced by the number of …rms. In the new oligopoly context transport costs produce fresh home distortions (Brander, 1981; Brander-Spencer, 1983). As to the price of tradeable, the result is unique: as a country gets larger the price of tradeable becomes higher (Lambertini-Mantovani-Rossini, 2001; Lambertini-Rossini, 2001) and consumers do not bene…t much from economies of scale unless there is a simultaneous increase in the competitiveness of the market, i.e.: new entries.

Our aim is to brie‡y compare theoretically these two approaches and subsequently test their prediction or non prediction as to the level of prices of tradeable whenever we consider countries of di¤erent size and percapita income in the presence of transport costs.

We then sketch the main theoretical background of the two approaches and their results as to the prices of tradeable.. An empirical test is then undertaken to see which one of the two approaches seems to be more capable of interpreting actual prices. The analysis we undertake may be considered as a complement of a large part of Purchasing Power Parity (PPP) literature (Rogo¤, 1996), since we are indirectly measuring how much transport costs drive countries away from PPP and how the deviation hinges upon their relative dimension.

Our result will shed some further empirical light on the relationship between size, per capita income and prices of tradeable among countries.

In the following section we go through the oligopoly model of trade with transport costs. In the third section we provide a sketch of the traditional monopolistic competition with economies of scale and trade In the fourth section we go through the empirical tests. In the …fth we draw some conclusions.

2 Prices in an international duopoly with transport costs

Here we adopt a partial equilibrium approach (Brander, 1981; Brander and Spencer, 1983) and consider a Cournot differentiated duopoly in a simple two countries framework. Each firm is based in one single country and sells in both of them a differentiated product using a technology with a fixed cost and a constant variable cost.

We then have two couples of inverse demand functions, two for each national market. The preferences embodied in those demand functions are of the kind utilized in Singh and Vives (1984) and Lambertini and Rossini (1998). We assume that countries are separated by natural geographical barriers giving rise to transport costs only when shipping abroad. To this purpose we adopt the traditional iceberg approach devised by Samuelson (1952) and extensively used in the literature.

The demand functions in the home market are:

$$p_{hh} = a - hh - \gamma t f \tag{1}$$

$$p_f = a - \gamma hh - t f \tag{2}$$

where hh indicates the quantity of the good produced and sold at home at price p_{hh}; f is the quantity produced abroad by the foreign firm and shipped to home market where it is sold at price p_f, $\gamma \in [0;1]$ measures product substitutability between domestic and foreign goods, a is the reservation price of the home market proxying either size or percapita income of a country; $t \in [0;1]$ is the fraction of the foreign good that reaches final destination, since $(1 - t)$ melts down during transportation.

Similarly, the demand functions in the foreign market are:

$$p_{ff} = e - ff - \gamma t h \tag{3}$$

$$p_h = e - \gamma ff - t h \tag{4}$$

where ff indicates the good produced and sold in the foreign market, h is the quantity produced at home by the domestic firm and sent abroad, while e is the reservation price of the foreign market.

Profit functions of home and foreign firms are respectively:

$$\pi_h = (p_{hh} - c)\, hh + (p_h t - c)\, h - k \tag{5}$$

$$\pi_f = (p_{ff} - c)\, ff + (p_f t - c)\, f - k \tag{6}$$

where k is a fixed cost and c the marginal cost.

Optimal quantities may be derived from four first order conditions[1] (FOCs):

$$ff^* = \frac{t(2c - 2e + \gamma e) - \gamma c}{(\gamma^2 - 4)t} \tag{7}$$

$$hh^* = \frac{t(2c - 2a + \gamma a) - \gamma c}{(\gamma^2 - 4)t} \tag{8}$$

$$h^* = \frac{t(\gamma e - 2e - \gamma c) + 2c}{(\gamma^2 - 4)t^2} \tag{9}$$

$$f^* = \frac{t(a\gamma - 2a - \gamma c) + 2c}{(\gamma^2 - 4)t^2} \tag{10}$$

Equilibrium prices are:

$$p^*_{ff} = \frac{\gamma^2 ct - 2(c + e)\, t + \gamma (et - c)}{(\gamma^2 - 4)\, t} \tag{11}$$

$$p^*_{hh} = \frac{\gamma^2 ct - 2(a + c)\, t + \gamma (at - c)}{(\gamma^2 - 4)\, t} \tag{12}$$

$$p^*_{h} = \frac{(\gamma - 2)\, et + c(\gamma^2 - \gamma t - 2)}{(\gamma^2 - 4)\, t} \tag{13}$$

$$p^*_{f} = \frac{a(\gamma - 2)\, t + c(\gamma^2 - \gamma t - 2)}{(\gamma^2 - 4)\, t} \tag{14}$$

We can now see the effect of the size of a country on prices, simply by evaluating the sign of partial derivatives of prices with respect to the dimension of the market:

[1] We should specify non negativity conditions on equilibrium quantities. In particular, $ff \geq 0$ for $t \geq \frac{\gamma + c}{e\gamma + 2c + 2e}$, $hh \geq 0$ for $t \geq \frac{\gamma + c}{a\gamma + 2c + 2a}$, $f \geq 0$ for $t \geq \frac{2c}{2a + \gamma c - a\gamma}$ and $h \geq 0$ for $t \geq \frac{2c}{2e + \gamma c - \gamma e}$.

$$\frac{\partial p_{hh}}{\partial a} = \frac{1}{2+\gamma} > 0 \tag{15}$$

$$\frac{\partial p_{h}}{\partial e} = \frac{1}{2+\gamma} > 0 \tag{16}$$

Similar results hold for $\partial p_{ff}/\partial e$ and $\partial p_f/\partial a$.

Therefore we can derive a simple

Remark 1 The prices of tradeable get higher as the size, and/or marginal willingness to pay, of the country increases.

The same result can be derived in a parallel Bertand environment with differentiated goods.

3 A monopolistic competition environment

In this section we go through a general equilibrium monopolistic competition model, closely following Krugman (Krugman, 1980, 1981), to see whether the size of a country affects the prices of tradable manufactured goods faced by consumers of that country.

We consider two countries, as in the previous case. However, there are n_h manufactured goods produced at home and n_f goods produced in the foreign country.

Preferences of consumers in both countries are alike, show a love for variety and are represented by:

$$U_{f;h} = \Sigma_i^{n_f} c_i^{\sigma} + \Sigma_j^{n_h} c_j^{\sigma} \quad \text{with } 0 \le \sigma \le 1 \tag{17}$$

where $i = 1...n_h$; number of goods produced at home; $j = 1...n_f$; number of goods produced abroad and $c_{i;j}$ is the consumption of good $i; j$.

Production takes place in firms that compete in a monopolistically competitive environment. Labour is the only factor of production. There are economies of scale that can be represented by the following cost function:

$$l_i = \alpha + \beta(h_i + hh_i) \quad \text{with } \alpha(\text{fixed cost}); \beta(\text{marginal cost}) \ge 0 \tag{18}$$

where l_i is the amount of labor used in the production of quantity $h_i + hh_i$ of good i. A similar cost function can be written for the foreign country.

Full employment is assumed. Therefore:

$$L_h = \Sigma_i^{n_h} l_i \tag{19}$$

where L_h stands for the total amount of labor available at home. A similar equation holds for the foreign country.

If there are transport costs, opening of trade puts a wedge between the price paid by consumers for the imported good and the unit revenue received by the foreign producer. Therefore, if we consider the price of the imported good in home market we have to take into account the effect of transport costs.

The net price paid by consumers at home for the imported good is then:

$$p_f^T = p_f / t; \tag{20}$$

Similarly, the net price paid by consumers in the foreign country for the imported good is:

$$p_h^T = p_h / t: \tag{21}$$

Profit of a representative firm belonging to home country and selling in both countries is then given by:

$$\pi_h = p_h hh + p_h^T \, t \, h - (\alpha + \beta(hh + h))w_h \tag{22}$$

The domestic labor wage is given by w_h: Analogous profit functions may be written for firms of the foreign country.

Long run equilibrium of the autarchic monopolistic markets is found by imposing the traditional tangency solution that implies zero profits. At home:

$$hh + h = \frac{\alpha}{\frac{p_h}{w_h} - \beta} = \frac{\alpha\sigma}{\beta(1 - \sigma)} \tag{23}$$

since the elasticity of individual demand is assumed constant and independent of the number of goods, i.e.: $1/(1 - \sigma)$:

Assuming symmetry across countries, $hh + h = ff + f$, because all parameters are the same in both countries.

However, the number of goods produced in each country is determined by the size of the country. From the full employment condition we get:

$$n_h = \frac{L_h}{\alpha + \beta(h + hh)}: \tag{24}$$

Opening of trade has the effect of increasing the number of goods available to consumers. To see the effect of the size of a country on the prices consumers face in that country we have to calculate an index that groups together the prices of home produced goods and imported goods.

Prices in the two countries of respectively home produced goods are:

$$p_h = \frac{\alpha w_h + (h + hh)\beta w_h}{h + hh} \tag{25}$$

$$p_f = \frac{\alpha w_f + (f + ff)\beta w_f}{f + ff} \tag{26}$$

To see the relationship between the prices of the two countries we have to go through the equilibrium conditions for the world economy.

Define as σ_h the ratio of demand by home residents for foreign products over the demand for home products, and σ_f the corresponding ratio for the foreign country.:

$$\sigma_h = \left(\frac{p_h}{p_f}\right)^{\frac{1}{1-\theta}} t^{\frac{\theta}{1-\theta}} \tag{27}$$

$$\sigma_f = \left(\frac{p_h}{p_f}\right)^{-\frac{1}{1-\theta}} t^{\frac{\theta}{1-\theta}}: \tag{28}$$

We now write the balance of trade as:

$$B = \frac{\sigma_f n_h}{\sigma_f n_h + n_f}\frac{w_h}{w_f} L_f - \frac{\sigma_h n_f}{\sigma_h n_f + n_h}\frac{w_h}{w_f} L_h \tag{29}$$

Equilibrium requires that $B = 0$: Then we must have:

$$\frac{\sigma_f}{\sigma_f L_h + L_f} = \frac{\sigma_h}{\sigma_h L_f + L_h}; \tag{30}$$

by substituting (27) and (29) we obtain:

$$\left(\frac{p_h}{p_f}\right)^{-\frac{1}{1-\theta}} \left[L_h + L_f \left(\frac{p_h}{p_f}\right)^{\frac{1}{1-\theta}} t^{\frac{\theta}{1-\theta}}\right] = \tag{31}$$

$$= \left(\frac{p_h}{p_f}\right)^{\frac{1}{1-\theta}} \left[L_f + L_h \left(\frac{p_h}{p_f}\right)^{-\frac{1}{1-\theta}} t^{\frac{\theta}{1-\theta}}\right]$$

The above equation can be solved for the relative price $\frac{p_h}{p_f}$ in terms of the parameters t, μ and the size indicators, L_h, L_f. Then, the solution is:

$$\frac{p_h}{p_f} = 2^{1-\mu}\left[\frac{t^{\frac{\mu}{1-\mu}}\left(L_h - L_f + \sqrt{(L_h - L_f)^2 + 4L_hL_f\, t^{\frac{2\mu}{\mu-1}}}\right)}{L_h}\right]^{\mu-1}. \qquad (32)$$

Within the feasible sets of parameters, i.e.: $\mu \in (0,1]$ and $t \in (0,1]$ the relative price is strictly larger than unity if $L_h > L_f$. This statement can be proved by observing that, for $\frac{p_h}{p_f} = 1$, the balance of trade as it is represented in (??) is positive for $L_h > L_f$ and negative otherwise. As a consequence, when $L_h > L_f$ we must have $\frac{p_h}{p_f} > 1$ to comply with balance of trade equilibrium.

However, to see the entire effect of transport costs on the prices of tradeable in each country we have to consider a suitable price index for traded goods. Considering the home country, this index is given by the weighted average of the prices of the imported goods and the domestically produced goods, using as weights the proportions of expenditure of domestic and foreign goods for consumers at home.

Therefore the index is:

$$I_h = p_h\left(\frac{n_h}{n_h + n_f}\right) + \frac{1}{t}p_f\left(\frac{n_f}{n_h + n_f}\right); \qquad (33)$$

where $\left(\frac{n_h}{n_h+n_f}\right)$ is the proportion of expenditure of consumers in home country for goods that are home produced and $\left(\frac{n_f}{n_h+n_f}\right)$ is the fraction of goods which are imported.

Whenever we take into account the effect of imported goods, on whose price transport costs have an influence, the general price index of tradeable may be larger or lower in a large country vis à vis a small country, according to the level of t that may even reverse the statement derived by simply looking at the relative prices (32).

As there is a direct relation between prices and wages it appears that in the country with the higher prices for the domestically produced tradeable also wages will be higher than abroad.

4 An empirical test

The test we perform may be thought as belonging to the bulk of PPP studies. We wish to see whether there is any dependence of the aggregate price of tradeable in a country upon its size and, secondarily, upon the per capita GDP.

As we have seen in both approaches above, the size of a country is always associated with a higher level of the prices of domestically produced tradeable, but not necessarily to the aggregate index if there is monopolistic competition. While in the oligopoly model this extends also to the aggregate index.

The econometric analysis we conduct is based on cross sections of a proxy (private consumption de‡ator[2]) of an aggregate price for each country on the country size (and secondarily on per-capita GDP).

The analysis is conducted on averages over time series of di¤erent extensions.

First we test the relationship on averages of variables over the period 1960-1992, then on sample of decreasing length, i.e.: ten years, …ve years, three years.

The …rst econometric speci…cation adopted is:

$$\ln I_i = a + b \ln GDP_i + u_i: \qquad (34)$$

A second speci…cation utilizes in addition per-capita GDP (gdp) as an explanatory variable:

$$\ln I_i = a + b \ln GDP_i + c \ln gdp_i + z_i: \qquad (35)$$

We …rst consider 28 countries[3] and provide results for the most extended average of variables, i.e. 1960-92, for speci…cation (34).

The results are reported in table 1:

---

[2] This is the only aggregate absolute price available for our analysis. Mind you that we cannot use price indeces.

[3] The countries considered are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany W., Greece, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Singapore, South Africa, Spain, Sweden, Switzerland, UK, Usa.

Table 1:(34)

Variable	Coe¢cient	Std. Error	t-Statistic	Prob
Constant	-.057	.050	-1.140	.265
Size (Ln GDP)	-.015	.012	-1.214	.236
		Mean dependent var (ln)	¡ :022	
R-squared	:056	S.D. dependent var	:216	
S.E. of regression	:214	Akaike info criterion	¡ :176	
Sum squared resid	1:143	Schwarz criterion	¡ :080	
Log likelihood	4:382	F-statistic	1:474	
		Prob (F-statistic)	:236	

Then we go through the results of the test that uses also per capita incomes as an explanatory variable. The results are reported in table 2 below.

Table 2:(35)

Constant	.276	.401	.687	.500
PercapitaGDP (Ln)	.487	.106	4.589	.000
Size (Ln GDP)	-.043	.021	-2.044	.055
		Mean dependent var (ln)	1:976	
R-squared	:532	S.D. dependent var	:085	
S.E. of regression	:061	Akaike info criterion	¡ 2:615	
Sum squared resid	0:072	Schwarz criterion	¡ 2:467	
Log likelihood	31:768	F-statistic	10:782	
		Prob (F-statistic)	:001	

As it can be seen there is evidence of a relationship between size of a country, percapita income and the level of the aggregate price of tradeable in that country.

In other words there seems to be a direct relationship between percapita incomes and prices. A richer country has higher tradeable prices. At the same time size makes a di¤erence since as a country gets larger it seems that prices become lower. All this is compatible with both models seen above, if we interpret the intercept of the demand curves in the oligopolist models as a marginal willingness to pay measure rather than as a market size indicator.

A further series of tests are conducted using di¤erent time span of average variable and are provided in Appendix. The through series of tests provided there lead to the same conclusions.

5 Conclusions

Despite the insu¢cient quality of prices used for our tests of whether large countries have lower or higher prices for tradeable, it appears that the theoretical results coming from both the monopolistic competition approach and the oligopoly model quite closely represent reality.

When we adopt as explanatory variables both size and percapita income we …nd a fairly robust relationship which says that the prices of a country are higher the higher is the average willingness to pay of its consumers and the smaller is the country. Large countries bene…t from their dimension in terms of lower prices but only if they are not richer.

This conclusion is fairly consistent with both models.

The Krugman's model of monopolistic competition and trade says that, if a country has higher wages it will have also higher prices while dimension tends to have a negative impact on prices once we keep transport costs constant.

The oligopoly model says that prices are higher as we interpret the height of demand as a marginal willingness to pay indicator rather than as a size measure.

References

[1] Brander, J. (1981), Intra-Industry Trade in Identical Commodities. Journal of International Economics, 11, 1-14.

[2] Brander, J. and Spencer, B. (1983), International R&D Rivalry and Industrial Strategy. Review of Economic Studies, 50, 707-22.

[3] Fujita, M., Krugman, P.A., Venables, A.J. (1999, The Spatial Economy. Cities, Regions, and International trade. MIT Press, Cambridge, MA.

[4] Krugman, P.A. (1979), Increasing Returns, Monopolistic Competition and International Trade. Journal of International Economics, 9 (4), 469-79.

[5] Krugman, P.A. (1980), Scale Economies, Product Di¤erentiation and The Pattern of Trade. American Economic Review, 70 (5), 950-9.

[6] Krugman, P.A. (1981), Intraindustry Specialization and the Gains from Trade. Journal of Political Economy, 89, 959-74.

[7] Lambertini, L., Mantovani, A., Rossini, G. (2001), R&D in Transport and Communication in a Cournot Duopoly. University of Bologna, Dipartimento di Scienze Economiche Working Paper n.401, http://www.dse.unibo.it/wp/index.htm.

[8] Lambertini, L. and Rossini, G. (1998), Product homogeneity as a prisoner's dilemma in a duopoly with R&D. Economics Letters, 58, 297-301.

[9] Lambertini,L. and Rossini, G. (2001), Investment in Transport and Communication Technology in a Cournot Duopoly with Trade. University of Bologna, Dipartimento di Scienze Economiche, Working Paper n.407, http://www.dse.unibo.it/wp/index.htm.

[10] Neary, P. J. (2000) Of Hype and Hyperbolas: Introducing the New Economic Geography. Mimeo, University College Dublin and CEPR

[11] Obstfeld, M. and Rogo¤, K. (2000), The Six major Puzzle in International Macroeconomics: Is There a Common Cause? NBER Working Paper No. 7777, http://www.nber.org/papers/w7777.

[12] Rogo¤, K. (1996), The Purchasing Power Parity Puzzle. Journal of Economic Literature, 34, 647-68.

[13] Samuelson, P.A. (1952), The transfer problem and transport costs: the terms of trade when impediments are absent. Economic Journal, 62, 278-304.

6 Appendix

Results of tests conducted on a sample of 24 countries[1],
over averages of 3, 5, 10 years, using specification (eco1).

3YEARS SAMPLE MEAN

1)
Dependent Variable: LCP3_1 (average over 3 years of ln deflator) (1960-62)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.948957	0.169987	11.46534	0.0000
LGDP3_1	-0.017910	0.033824	-0.529503	0.6023

R-squared	0.013825	Mean dependent var	1.859724
Adjusted R-squared	-0.035484	S.D. dependent var	0.102637
S.E. of regression	0.104442	Akaike info criterion	-1.593861
Sum squared resid	0.218163	Schwarz criterion	-1.494675
Log likelihood	19.53247	F-statistic	0.280373
		Prob(F-statistic)	0.602286

2)
Dependent Variable: LCP3_2 (average over 3 years of ln deflator) (1963-65)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.050655	0.164698	12.45099	0.0000
LGDP3_2	-0.032189	0.032320	-0.995942	0.3312

R-squared	0.047252	Mean dependent var	1.887990
Adjusted R-squared	-0.000386	S.D. dependent var	0.099451
S.E. of regression	0.099470	Akaike info criterion	-1.691406
Sum squared resid	0.197887	Schwarz criterion	-1.592220
Log likelihood	20.60546	F-statistic	0.991901
		Prob(F-statistic)	0.331176

[1] We exclude Luxembourg, Korea, Singapore, South Africa

3)
Dependent Variable: LCP3_3 (average over 3 years of ln deflator) (1966-68)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.915055	0.142286	13.45919	0.0000
LGDP3_3	-0.005260	0.027244	-0.193079	0.8488

R-squared	0.001861	Mean dependent var	1.887807
Adjusted R-squared	-0.048046	S.D. dependent var	0.083096
S.E. of regression	0.085069	Akaike info criterion	-2.004196
Sum squared resid	0.144735	Schwarz criterion	-1.905010
Log likelihood	24.04616	F-statistic	0.037280
		Prob(F-statistic)	0.848844

4)
Dependent Variable: LCP3_4 (average over 3 years of ln deflator) (1969-72)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.068213	0.140331	14.73810	0.0000
LGDP3_4	-0.017200	0.026558	-0.647659	0.5246

R-squared	0.020542	Mean dependent var	1.978036
Adjusted R-squared	-0.028431	S.D. dependent var	0.080925
S.E. of regression	0.082068	Akaike info criterion	-2.076035
Sum squared resid	0.134702	Schwarz criterion	-1.976850
Log likelihood	24.83639	F-statistic	0.419462
		Prob(F-statistic)	0.524571

5)
Dependent Variable: LCP3_5 (average over 3 years of ln deflator) (1973-75)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.131544	0.171426	12.43418	0.0000
LGDP3_5	-0.022576	0.032250	-0.700048	0.4920

R-squared	0.023917	Mean dependent var	2.012449
Adjusted R-squared	-0.024887	S.D. dependent var	0.097748
S.E. of regression	0.098956	Akaike info criterion	-1.701766
Sum squared resid	0.195848	Schwarz criterion	-1.602580
Log likelihood	20.71942	F-statistic	0.490068
		Prob(F-statistic)	0.491961

6)
Dependent Variable: LCP3_6 (average over 3 years of ln deflator) (1976-78)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.195619	0.178737	12.28411	0.0000
LGDP3_6	-0.025435	0.033370	-0.762216	0.4548

R-squared	0.028229	Mean dependent var	2.060396
Adjusted R-squared	-0.020360	S.D. dependent var	0.101036
S.E. of regression	0.102059	Akaike info criterion	-1.640026
Sum squared resid	0.208320	Schwarz criterion	-1.540840
Log likelihood	20.04028	F-statistic	0.580973
		Prob(F-statistic)	0.454827

7)
Dependent Variable: LCP3_7 (average over 3 years of ln deflator) (1979-82)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.027115	0.159947	12.67365	0.0000
LGDP3_7	-0.011858	0.029746	-0.398642	0.6944

R-squared	0.007883	Mean dependent var	1.963817
Adjusted R-squared	-0.041723	S.D. dependent var	0.088516
S.E. of regression	0.090344	Akaike info criterion	-1.883876
Sum squared resid	0.163241	Schwarz criterion	-1.784690
Log likelihood	22.72264	F-statistic	0.158916
		Prob(F-statistic)	0.694381

8)
Dependent Variable: LCP3_8 (average over 3 years of ln deflator) (1983-85)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.875465	0.184221	10.18050	0.0000
LGDP3_8	0.007534	0.034053	0.221241	0.8271

R-squared	0.002441	Mean dependent var	1.915927
Adjusted R-squared	-0.047437	S.D. dependent var	0.101515
S.E. of regression	0.103894	Akaike info criterion	-1.604375
Sum squared resid	0.215881	Schwarz criterion	-1.505189
Log likelihood	19.64813	F-statistic	0.048948
		Prob(F-statistic)	0.827148

9)
Dependent Variable: LCP3_9 (average over 3 years of ln deflator) (1986-88)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.099535	0.207608	10.11299	0.0000
LGDP3_9	-0.012323	0.038094	-0.323491	0.7497

R-squared	0.005205	Mean dependent var	2.032859
Adjusted R-squared	-0.044535	S.D. dependent var	0.114122
S.E. of regression	0.116635	Akaike info criterion	-1.373020
Sum squared resid	0.272076	Schwarz criterion	-1.273834
Log likelihood	17.10322	F-statistic	0.104647
		Prob(F-statistic)	0.749681

10)
Dependent Variable: LCP3_10 (average over 3 years of ln deflator) (1989-91)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.151297	0.204537	10.51786	0.0000
LGDP3_10	-0.014707	0.037354	-0.393706	0.6980

R-squared	0.007691	Mean dependent var	2.071350
Adjusted R-squared	-0.041925	S.D. dependent var	0.112710
S.E. of regression	0.115048	Akaike info criterion	-1.400428
Sum squared resid	0.264721	Schwarz criterion	-1.301242
Log likelihood	17.40471	F-statistic	0.155004
		Prob(F-statistic)	0.697964

5YEARS SAMPLE MEAN

1)
Dependent Variable: LCPI5_1 (average over 5 years of ln deflator) (1960-65)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.979005	0.167650	11.80440	0.0000
LGDP5_1	-0.022076	0.033198	-0.664970	0.5137

R-squared	0.021631	Mean dependent var	1.868472
Adjusted R-squared	-0.027287	S.D. dependent var	0.101028
S.E. of regression	0.102397	Akaike info criterion	-1.633403
Sum squared resid	0.209704	Schwarz criterion	-1.534218
Log likelihood	19.96744	F-statistic	0.442185
		Prob(F-statistic)	0.513665

2)
Dependent Variable: LCPI5_2 (average over 3 years of ln deflator) (1966-70)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.063954	0.154802	13.33285	0.0000
LGDP5_2	-0.032460	0.030005	-1.081817	0.2922

R-squared	0.055282	Mean dependent var	1.897869
Adjusted R-squared	0.008046	S.D. dependent var	0.093477
S.E. of regression	0.093100	Akaike info criterion	-1.823772
Sum squared resid	0.173353	Schwarz criterion	-1.724587
Log likelihood	22.06149	F-statistic	1.170328
		Prob(F-statistic)	0.292206

3)
Dependent Variable: LCPI5_3 (average over 5 years of ln deflator) (1971-75)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.012729	0.138251	14.55855	0.0000
LGDP5_3	-0.012813	0.026262	-0.487877	0.6309

R-squared	0.011761	Mean dependent var	1.945813
Adjusted R-squared	-0.037651	S.D. dependent var	0.079916
S.E. of regression	0.081406	Akaike info criterion	-2.092216
Sum squared resid	0.132540	Schwarz criterion	-1.993030
Log likelihood	25.01438	F-statistic	0.238024
		Prob(F-statistic)	0.630942

4)
Dependent Variable: LCPI5_4 (average over 5 years of ln deflator) (1976-80)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.147359	0.174253	12.32323	0.0000
LGDP5_4	-0.021965	0.032693	-0.671868	0.5094

R-squared	0.022072	Mean dependent var	2.031169
Adjusted R-squared	-0.026824	S.D. dependent var	0.098945
S.E. of regression	0.100264	Akaike info criterion	-1.675522
Sum squared resid	0.201055	Schwarz criterion	-1.576336
Log likelihood	20.43074	F-statistic	0.451407
		Prob(F-statistic)	0.509355

5)
Dependent Variable: LCPI5_5 (average over 5 years of ln deflator) (1981-85)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.039712	0.160350	12.72038	0.0000
LGDP5_5	-0.012194	0.029809	-0.409076	0.6868

R-squared	0.008298	Mean dependent var	1.974595
Adjusted R-squared	-0.041287	S.D. dependent var	0.088834
S.E. of regression	0.090649	Akaike info criterion	-1.877129
Sum squared resid	0.164346	Schwarz criterion	-1.777944
Log likelihood	22.64842	F-statistic	0.167343
		Prob(F-statistic)	0.686832

6)
Dependent Variable: LCPI5_6 (average over 5 years of ln deflator) (1986-90)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.026133	0.199058	10.17861	0.0000
LGDP5_6	-0.006010	0.036614	-0.164156	0.8713

R-squared	0.001346	Mean dependent var	1.993692
Adjusted R-squared	-0.048587	S.D. dependent var	0.109326
S.E. of regression	0.111951	Akaike info criterion	-1.455004
Sum squared resid	0.250660	Schwarz criterion	-1.355819
Log likelihood	18.00505	F-statistic	0.026947
		Prob(F-statistic)	0.871256

10YEARS SAMPLE MEAN

1)
Dependent Variable: LCP10_1 (average over 10 years of ln deflator) (1960-70)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.024240	0.159907	12.65883	0.0000
LGDP10_1	-0.027766	0.031304	-0.886990	0.3856

R-squared	0.037849	Mean dependent var	1.883592
Adjusted R-squared	-0.010259	S.D. dependent var	0.096374
S.E. of regression	0.096867	Akaike info criterion	-1.744454
Sum squared resid	0.187663	Schwarz criterion	-1.645268
Log likelihood	21.18899	F-statistic	0.786751
		Prob(F-statistic)	0.385626

2)
Dependent Variable: LCP10_2 (average over 10 years of ln deflator) (1970-80)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.081325	0.151520	13.73632	0.0000
LGDP10_2	-0.017108	0.028597	-0.598264	0.5564

R-squared	0.017581	Mean dependent var	1.991375
Adjusted R-squared	-0.031540	S.D. dependent var	0.086742
S.E. of regression	0.088099	Akaike info criterion	-1.934200
Sum squared resid	0.155229	Schwarz criterion	-1.835014
Log likelihood	23.27619	F-statistic	0.357920
		Prob(F-statistic)	0.556379

3)
Dependent Variable: LCP10_3 (average over 10 years of ln deflator) (1980-90)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.030987	0.177049	11.47133	0.0000
LGDP10_3	-0.008617	0.032732	-0.263245	0.7951

R-squared	0.003453	Mean dependent var	1.984718
Adjusted R-squared	-0.046374	S.D. dependent var	0.097586
S.E. of regression	0.099823	Akaike info criterion	-1.684322
Sum squared resid	0.199294	Schwarz criterion	-1.585137
Log likelihood	20.52755	F-statistic	0.069298
		Prob(F-statistic)	0.795055

WHOLE SAMPLE (1960-90)

Dependent Variable: LCPT
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.051181	0.150998	13.58413	0.0000
LGDPT	-0.014253	0.028365	-0.502481	0.6208

R-squared	0.012467	Mean dependent var	1.975881
Adjusted R-squared	-0.036910	S.D. dependent var	0.085395
S.E. of regression	0.086957	Akaike info criterion	-1.960305
Sum squared resid	0.151229	Schwarz criterion	-1.861120
Log likelihood	23.56336	F-statistic	0.252488
		Prob(F-statistic)	0.620817

RESULTS OF SPECIFICATION WITH PERCAPITA INCOME

WHOLE SAMPLE MEANS (1960-90)

Dependent Variable: LCPT (1960-90)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.275735	0.401344	0.687030	0.5004
LGDPT	-0.042899	0.020992	-2.043598	0.0551
LGDPPCT	0.486780	0.106078	4.588877	0.0002

R-squared	0.531599	Mean dependent var	1.975881
Adjusted R-squared	0.482293	S.D. dependent var	0.085395
S.E. of regression	0.061443	Akaike info criterion	-2.615281
Sum squared resid	0.071730	Schwarz criterion	-2.466502
Log likelihood	31.76809	F-statistic	10.78175
		Prob(F-statistic)	0.000743

TEN YEARS SAMPLE MEANS

1)
Dependent Variable: LCP10_1 (1960-70)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.996607	0.413581	2.409705	0.0263
LGDP10_1	-0.052883	0.029067	-1.819366	0.0847
LGDPPC1	0.303353	0.114847	2.641371	0.0161

R-squared	0.296263	Mean dependent var	1.883592
Adjusted R-squared	0.222185	S.D. dependent var	0.096374
S.E. of regression	0.084996	Akaike info criterion	-1.966311
Sum squared resid	0.137261	Schwarz criterion	-1.817533
Log likelihood	24.62942	F-statistic	3.999353
		Prob(F-statistic)	0.035514

2)

Dependent Variable: LCP10_2 (1970-1980)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.403240	0.470708	0.856667	0.4023
LGDP10_2	-0.046240	0.023762	-1.945955	0.0666
LGDPPC2	0.462045	0.125415	3.684144	0.0016

R-squared	0.426949	Mean dependent var	1.991375
Adjusted R-squared	0.366627	S.D. dependent var	0.086742
S.E. of regression	0.069033	Akaike info criterion	-2.382333
Sum squared resid	0.090546	Schwarz criterion	-2.233554
Log likelihood	29.20566	F-statistic	7.077921
		Prob(F-statistic)	0.005045

3)

Dependent Variable: LCP10_3 (1980-90)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.419989	0.473843	-0.886346	0.3865
LGDP10_3	-0.041053	0.022109	-1.856852	0.0789
LGDPPC3	0.647365	0.121414	5.331882	0.0000

R-squared	0.600784	Mean dependent var	1.984718
Adjusted R-squared	0.558761	S.D. dependent var	0.097586
S.E. of regression	0.064822	Akaike info criterion	-2.508207
Sum squared resid	0.079837	Schwarz criterion	-2.359429
Log likelihood	30.59028	F-statistic	14.29665
		Prob(F-statistic)	0.000163

NOTES

CP = deflator of private consumption computed in PPP from *Penn World Tables*.(2001)[2]

GDP =: GDP in dollars 1990 at PPP[3]. LGDP = Ln GDP

GDPPC = per capita GDP, LGDPPC = Ln GDPPC

[2] Alan Heston, Robert Summers and Bettina Aten, *Penn World Tables* Version 6.0, Center for International Comparisons at the University of Pennsylvania (CICUP), December 2001.
[3] Source Data bank CHELEM, property of CEPII.