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Steve AMBLER,
Emanuela CARDIA and
Christian ZIMMERMANN

Université de Montréal

Centre de recherche et développement en économique

C.P. 6128, Succursale Centre-ville
Montréal (Québec) H3C 3J7

Téléphone : (514) 343-6557
Télécopieur : (514) 343-5831
Adresse électronique : crde@crde.umontreal.ca
Site Web : http://www.crde.umontreal.ca/

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Steve AMBLER[1], Emanuela CARDIA[2] and Christian ZIMMERMANN[1]

[1] Centre de recherche sur l'emploi et les fluctuations économiques (CREFÉ), Université du Québec à Montréal

[2] Centre de recherche et développement en économique (C.R.D.E.) and Département de sciences économiques, Université de Montréal

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RÉSUMÉ

La théorie moderne du cycle économique nécessite le développement de modèles qui expliquent les faits stylisés. Pour que cette stratégie réussisse, ces faits doivent être bien établis. Dans cet article, nous nous concentrons sur les faits stylisés des cycles économiques internationaux. Nous utilisons la méthode généralisée des moments et des données trimestrielles de dix-neuf pays industrialisés pour estimer les corrélations inter et intra-pays des agrégats macroéconomiques. Nous calculons les erreurs types des statistiques pour notre panel unique de données et testons des hypothèses concernant les tailles relatives de ces corrélations. Nous trouvons une moindre corrélation inter-pays de tous les agrégats, et particulièrement de la consommation, que dans les études précédentes. Les corrélations inter-pays de la consommation, de l'output et des résidus de Solow ne sont pas significativement différentes l'une de l'autre dans tout l'échantillon, mais il y a des différences significatives dans le sous-échantillon post-1973.

Mots clés : cycles économiques internationaux, faits stylisés, méthode généralisée des moments

ABSTRACT

Modern business cycle theory involves developing models that explain stylized facts. For this strategy to be successful, these facts should be well established. In this paper, we focus on the stylized facts of international business cycles. We use the generalized method of moments and quarterly data from nineteen industrialized countries to estimate pairwise cross-country and within-country correlations of macroeconomic aggregates. We calculate standard errors of the statistics for our unique panel of data and test hypotheses about the relative sizes of these correlations. We find a lower cross-country correlation of all aggregates and especially of consumption than in previous studies. The cross-country correlations of consumption, output and Solow residuals are not significantly different from one another over the whole sample, but there are significant differences in the post-1973 subsample.

Key words : international business cycles, stylized facts, generalized method of moments

1 Introduction

Dynamic general equilibrium (*DGE*) models have been quite successful in replicating a large number of the stylized facts of the business cycle. Progress in business cycle theory has often come from highlighting discrepancies between the predictions of the models and the accepted stylized facts. In a recent survey article, Backus, Kehoe and Kydland (1995, henceforth BKK) discuss two main puzzling features of the data on international business cycles that are hard for *DGE* models to capture.[1]

First, there is a *quantity anomaly*. In their data set, the cross-country correlation of output is generally higher than the cross-country correlation of aggregate productivity (as measured by Solow residuals). In standard models, the ordering of the output, Solow residual and consumption correlations is reversed. Risk sharing between agents in different countries leads to high cross-country correlations of aggregate consumption. Incentives to use inputs where they are most productive often lead to negative cross-country correlations of output. The same incentives lead to negative cross-country correlations of investment and employment in standard models; in the BKK data set, the cross-country correlations of these two variables are generally positive.

Second, there is a *price anomaly*. *DGE* models do not generate fluctuations in the terms of trade as large as those observed in the data. Models which restrict the elasticity of substitution between domestic and foreign goods can generate volatile terms of trade, but at the cost of a counterfactually low volatility of trade balances.

The goal of this paper is to submit the quantity anomaly to rigorous econometric estimation and testing. We have two main motivations for undertaking this task. First of all, the statistics reported by BKK are drawn from a limited set of countries.[2] They calculate cross correlations between U.S. aggregates and their counterparts in the other countries of their sample. The U.S.

[1] See also Baxter (1995) for a broad survey of international business cycle models.

[2] They use quarterly observations from Australia, Austria, Canada, France, Germany, Italy, Japan, Switzerland, the United Kingdom, the United States, and an aggregate of European countries.

economy is not representative among industrialized economies in terms of both its size and its openness. For comovements between other pairs of individual countries or groups of countries, the anomaly may be less striking. Second, BKK do not calculate confidence intervals for their statistics. Consequently, it is difficult to judge whether the quantity anomaly is a statistically significant regularity. It is also difficult to judge whether the moments generated by international business cycle models differ significantly from those in the data.

We use quarterly data from a unique data set with nineteen industrialized countries to estimate cross-country and within-country comovements using techniques based on the generalized method of moments (*GMM*).[3] We calculate standard errors for all of our statistics and perform hypothesis tests on the ordering of key cross-correlations.

The paper is structured as follows. In the following section, we summarize the evidence from BKK and survey some recent articles on international business cycles that take as given the *quantity anomaly* from the BKK data set. In the third section, we describe our econometric methodology in detail. In the fourth section, we describe our data sample and present our results, including the results of a series of hypothesis tests. The fifth section concludes.

2 The Quantity Anomaly in the Recent International Business Cycle Literature

The stylized facts of international business cycles are largely based on the seminal contributions of Backus, Kehoe and Kydland (1992). They build a two-country *DGE* model and compare the model's predictions concerning the cross-correlations of macroeconomic aggregates with the data. They summarize their results and survey open-economy *DGE* models in their 1995 paper.

Table 1 presents their empirical findings on cross-correlations. They calculate the cross-correlations between the same variable in different individual countries and the U.S., and between the same vari-

[3] Backus and Kehoe (1992) estimate the cross-correlations of output using *GMM* techniques applied to annual data on nine different countries. They report standard errors for individual country pairs but do not derive the implied standard errors for their entire panel of data.

able for an aggregate of European countries and the U.S. With two exceptions, the cross-correlations of output are higher than the cross-correlations of technology shocks as measured by Solow residuals. Without exception, the cross-correlations of output are higher than the cross-correlations of consumption. With only three exceptions, the cross-correlations of technology shocks are higher than the cross-correlations of consumption. Based on these results, BKK conclude that the following relative ordering constitutes a stylized fact of the international business cycle:

$$\text{cor}(y, y^*) > \text{cor}(z, z^*) > \text{cor}(c, c^*), \tag{1}$$

where y, z, and c are respectively output, the Solow residual and consumption, and asterisks denote foreign variables. The table also shows that the cross-correlations of investment and employment are generally positive. There is just one exception with investment and there are only two exceptions with employment. The last row of the table brings out the discrepancy between BKK's baseline model and their data. Their model predicts the opposite ordering of the cross-correlations of output, the Solow residual and consumption. The model also predicts strongly negative cross-correlations of investment and employment. Risk sharing is the explanation of the high cross-correlation of consumption. In the baseline model, there are strong incentives to use productive inputs more intensively in the country benefitting from a positive productivity differential. This leads to low cross-correlations of output, investment and employment (the impact of productivity on employment arises primarily because of an intertemporal substitution effect on labor supply).

Several recent studies attempt to build models compatible with these features of the data. Some proceed by modifying the constraints on trades among agents. Kollmann (1992), Baxter and Crucini (1995), and Heathcote and Perri (1999) build models with incomplete asset markets which reduce the incentive for risk sharing. These authors find that incomplete markets help reduce the cross-country correlation of consumption, but the cross-country correlations of output, investment and hours worked remain counterfactually negative. Kehoe and Perri (1996) build a model in which international loans are not perfectly enforceable, so that the degree of market incompleteness is endogenous. Their model generates positive cross-country comovements of output, investment and employment. Ricketts and McCurdy (1995) build a two-country model with money and differing rates of trend productivity growth across countries. In the version of their model in which there is no international trade in investment goods, so that investment goods in a given country must be produced in the same country, they obtain a relative ordering of the cross-country correlations that is compatible with the data used by BKK.

Other studies modify the specification of agents' preferences. Devereux, Gregory and Smith (1992) develop a model with a particular type of nonseparability between consumption and leisure. They succeed in lowering the cross-country correlation of consumption. Stockman and Tesar (1995) introduce nontraded goods sector in each country, and succeed in lowering the cross-country correlation of consumption while raising the cross-country correlation of output: they do not consider the cross-country correlations of investment or hours worked. They also introduce taste shocks that displace preferences between traded and nontraded goods in order to increase the predicted variability of both the terms of trade and the trade balance. The quantity anomaly remains for the traded goods sectors. Finally, Canova and Ubide (1998) develop a two-country model with home production. Their results indicate that their model can generate cross-country correlations of output similar to those of consumption, and that it can generate positive cross-country correlations of investment and employment.

Costello and Praschnick (1993) develop a two-country model which disaggregates each economy into one sector which produces an intermediate good and a single final goods sector. The final goods in the two countries are perfect substitutes. With complete markets and separability between leisure and consumption in the utility function, consumption is perfectly correlated across the two countries. Their model predicts a higher cross correlation of output than the BKK model. The paper does not examine the cross-country correlations of investment and employment, which are important aspects of the quantity anomaly documented in BKK. Head (1997) builds a two-country model with differentiated intermediate goods and monopolistic competition. He shows that increasing returns to the variety of intermediate goods can lead to a positive international transmission of the business cycle. Kouparitsas (1996) studies a two-country model with a primary goods sector (whose output is used as an intermediate input in manufacturing), a manufacturing sector whose output is traded, and a nontradable services sector to examine the implications of increasing North-South trade in financial assets. Park (1998) analyzes a model with tradable and nontradable investment and consumption goods. His model generates positive cross-country correlations of aggregate output and a cross-country correlation of consumption which is lower than that of output. Ambler, Cardia and Zimmermann (1998) build a two-country model with multiple tradable goods sectors. The model is relatively successful in matching the cross-country correlations of most aggregates, with the exception of consumption.

3 Methodology

We use *GMM* to estimate simple correlations and cross-country correlations. The point estimates for our entire panel of data are generated as follows. For a given statistic, we estimate its value for all of the countries in our sample (simple correlations) or for all of the possible unique country pairs in the sample (cross-correlations); for our nineteen-country sample, there are 171 such cross-correlations. In fact, we estimate the simple correlations and cross-correlations two at a time in order to obtain estimates of their variances and covariances using standard *GMM* techniques. We use quarterly data, with a base sample that runs from 1960:1 to 1991:2. Not all series are available for the entire sample. For a given statistic, we use the largest available subsample in our calculations.

We then derive a point estimate for our entire panel of countries by taking a weighted average of the individual correlation estimates according to a *weighting scheme*. We use six different weighting schemes. The *simple* weighting scheme gives the same weight to each correlation statistic. The *GDP* weighting scheme weights the individual statistics by countries' real 1985 GDPs from the Summers and Heston (1991) data set. The *trade* weighting scheme uses the size of countries' external sectors as measured by their real GDP multiplied by the share of imports in GDP. The three other weighting schemes correspond to the first three, but multiplied also by the number of observations used to calculate the correlation. For cross-correlations, the weights of the two relevant countries are multiplied with each other. For simple correlations, the estimate of the correlation statistic θ_i is calculated as folows:

$$\theta = \frac{1}{\left(\sum_{i=1}^{N} w_i\right)} \sum_{i=1}^{N} w_i \theta_i, \tag{2}$$

where θ_i is the correlation statistic for the i^{th} country, w_i is the weight applied to this correlation statistic, and N is the number of countries in the sample. For cross-correlations, the statistic ϕ is calculated as follows:

$$\phi = \frac{1}{\left(\sum_i \sum_{j>i} w_i w_j\right)} \sum_i \sum_{j>i} w_i w_j \phi_{ij}, \tag{3}$$

where ϕ_{ij} is the cross-correlation statistic between the i^{th} and j^{th} countries and where the summation is over all of the unique cross-correlations irrespective of ordering.

Given estimates of the variances of the individual simple correlations and cross-correlations, and estimates of all of the possible covariances among simple correlations and cross-correlations, the standard error for a given statistic is calculated as follows. For simple correlations, we have:

$$\mathrm{var}(\theta) = \mathrm{var}\left(\frac{1}{\left(\sum_{i=1}^{N} w_i\right)} \sum_i w_i \theta_i\right)$$

$$= \left(\frac{1}{\sum_{i=1}^{N} w_i}\right)^2 \left(\sum_i (w_i)^2 \,\mathrm{var}(\theta_i) + 2\sum_{ij} (w_i w_j)\,\mathrm{cov}(\theta_i, \theta_j)\right), \tag{4}$$

where $\sum_{ij}$ is the summation over all of the unique correlation pairs irrespective of ordering. For cross-correlations, we have:

$$\mathrm{var}(\phi) = \mathrm{var}\left(\frac{1}{\left(\sum_{ij} w_i w_j\right)} \sum_{ij} w_i w_j \phi_{ij}\right)$$

$$= \left(\frac{1}{\sum_{ij} w_i w_j}\right)^2$$

$$\left(\sum_{ij}(w_i w_j)^2\,\mathrm{var}(\phi_{ij}) + 2\sum_{ij,kl}(w_i w_j)(w_k w_l)\mathrm{cov}(\phi_{ij},\phi_{kl})\right), \tag{5}$$

where $\sum_{ij}$ is the summation over all of the unique cross-correlations for our sample, and $\sum_{ij,kl}$ is the summation over all of the unique *pairs* of cross-correlations irrespective of ordering for our sample.

We use a chi-squared test to determine the significance of a difference between two given cross-correlation statistics. The statistic can be calculated as:

$$\text{chistat} = \frac{(\mathrm{cor}(x,x^*) - \mathrm{cor}(y,y^*))^2}{\mathrm{var}(\mathrm{cor}(x,x^*)) + \mathrm{var}(\mathrm{cor}(y,y^*))}, \tag{6}$$

where $\mathrm{cor}(x,x^*)$ and $\mathrm{cor}(y,y^*)$ are two different cross-correlation statistics for the aggregates x and y.[4]

4 Results and Hypothesis Tests

4.1 Results

Table 2 shows the results of estimates of a number of within-country correlations. The table confirms the robustness of the stylized facts familiar from closed-economy business cycle models. The correlations between GDP and consumption and between GDP and investment all have very low standard errors. GDP and the trade balance are significantly negatively correlated. The estimates are close to those in BKK and confirm that this stylized fact is significant. The point estimate of the correlation between GDP and the terms of trade is negative for all of the weighting schemes, but the correlation is never significant at conventional levels.

The correlation between the terms of trade and the trade balance is negative, but its value is quite sensitive to the weighting scheme. For the GDP and GDP/observations weights, the correlation is insignificant. This result reflects the role of the U.S. as an outlier in our data set. The correlation between the terms of trade and the trade balance is positive in the U.S. and negative

[4] The denominator gives the variance of the random variable in the numerator. We ignore the covariance between the two cross-correlations, which would be extremely laborious to compute.

or close to zero for most other countries. When U.S. observations are given more weight because of the size of U.S. GDP, the correlation for the entire panel of countries becomes insignificant.

Table 3 shows the results of estimates of the J-curve with our pooled sample of observations. The results indicate that the J-curve is a fairly robust stylized fact.[5] The contemporaneous correlations between the terms of trade and the trade balance are significantly negative (except when observations are weighted by output). The correlation between the terms of trade and the trade balance two or more periods later is significantly positive at standard levels (except for the correlation with the trade balance at $t+2$ with the *simple* weighting scheme, which is significant at the 10% level).

Table 4 presents the core results of the paper, dealing with the cross-correlations of different macroeconomic aggregates. The first three columns of the table show cross-correlations for the entire sample with the first three weighting schemes. The results with the last three weighting schemes are very similar (where the number of observations is taken into account), so we do not report them.[6] The last three columns show cross-correlations when the sample is truncated to 1973:1-1991:2. The starting date of the subsample coincides with the first OPEC oil shock and the collapse of the Bretton Woods system. There is some evidence that the properties of the international business cycle changed in 1973 (this is confirmed by the results in Table 11.7 of BKK), so it is important that we investigate the sensitivity of our results to the sample period.

All the correlations in Table 4 are of a similar order of magnitude. The lowest correlation coefficient is equal to 0.14 (the cross-correlation of consumption with the simple weighting scheme). The highest is equal to 0.49 (the cross-correlation of output when observations are weighted by GDP). For the full sample, the cross-correlations of consumption, GDP and technology shocks are in most cases within two standard deviations of one another. This no longer holds for the post-1973 subsample. For the full sample, the highest cross-correlation of output (0.31 when observations are

[5] For a theoretical analysis, see Backus, Kehoe and Kydland (1994, 1995).

[6] They are available on request.

weighted by GDP) is lower than the smallest value reported by BKK, which is the correlation between Austrian and U.S. output. For the post-1973 subsample, the highest cross-correlation of output (0.49 when observations are weighted by GDP) is less than the median value of output cross-correlations in Table 1.

Table 5 organizes the results in a slightly different way. We start by ordering the pairwise cross-country correlation statistics. We report the value of the given correlation coefficient for the country pair at the 25% quantile level, the 50% quantile level, and the 75% quantile level. As for Table 3, we report results for the first three weighting schemes for both the full sample and the post-1973 subsample. This table brings out more clearly the variability of the correlation coefficients across the countries of the sample. It shows that for most of the correlation statistics, the differences are greater at the lower end of the distribution. This also shows that a non-negligible share of the cross-correlations is negative.

4.2 Test Results

Table 6 shows results for a battery of hypothesis tests. The tests are designed to reveal whether the *quantity anomaly* is statistically significant or not. The following null hypotheses are tested against two-sided alternatives:[7]

1. $H_0 : \text{cor}(y, y^*) = \text{cor}(c, c^*)$
2. $H_0 : \text{cor}(y, y^*) = \text{cor}(z, z^*)$
3. $H_0 : \text{cor}(z, z^*) = \text{cor}(c, c^*)$
4. $H_0 : \text{cor}(y, y^*) = \text{cor}(n, n^*)$
5. $H_0 : \text{cor}(y, y^*) = \text{cor}(i, i^*)$

We show results for the first three weighting schemes for the full sample and the post-1973 subsample.

[7] Since the test statistic is quadratic, we cannot perform a one-sided test against the most natural alternative.

The results show that the *quantity anomaly*, if it is interpreted to mean the relative ordering of the output, technology, and consumption correlations, is not statistically significant for the full sample. The only statistic that is significant at the five percent level is for the equality of the cross-correlations of output and consumption with the the simple weighting scheme.

The test results are quite different for the post-1973 subsample. For each of the three weighting schemes, we can reject the equality of the cross-correlations of output and consumption at the one percent level. Since the point estimates of the cross-correlation of output are higher than those of consumption, the evidence suggests that the cross-correlation of consumption is significantly lower than the cross-correlation of output. With the GDP weighting scheme, we can reject the equality of the consumption and Solow-residual correlations at one percent, and we can reject the same null hypothesis at five percent with the trade weighting scheme. We can reject equality between the cross-correlations of Solow residuals and output in one case only, with the simple weighting scheme. These results tend to support the hypothesis that the quantity anomaly is statistically significant.

Table 6 also gives an idea of how often the quantity-anomaly ordering of cross-correlations is respected in our data set. The last row of the table indicates that the ordering holds in at most 37 percent of the country pairs in our sample, or as few as 30 percent of the country pairs, depending on the weighting scheme, for the entire sample. The reverse ordering holds for only four percent of the country pairs in our sample for the entire sample. For the post-1973 subsample, the percentage of country pairs respecting the quantity anomaly ordering increases, while the percentage of country pairs respecting the reverse ordering decreases to one percent for the GDP and trade weighting schemes.

5 Conclusions

Our results show that the *quantity anomaly* should be reinterpreted. The quantitatively anomaly does seem to be significant in the data, but only for the period after 1973. This may be due to the change in exchange rate regime, to the greater importance of real shocks since the first oil price shock, or to increasing capital mobility after 1973. The cross-correlations we calculate are generally lower than in the BKK data set. For investment and employment, this decreases the discrepancy between the predictions of standard *DGE* models and the data. However, replicating the cross-country correlation of consumption will remain a significant challenge for *DGE* models as long as a high degree of risk sharing is possible in the models. Our results suggest that the divergence between the cross-country correlations of consumption predicted by standard models and in the data is actually larger than previously thought.

More generally, our results suggest that researchers should subject “stylized facts” to rigorous hypothesis testing. In addition, they should be test for the stability of relationships in the data across countries and across time. Stylized facts may not be as universally applicable as is often assumed. The facts highlighted by BKK may be appropriate for an international model calibrated to a relatively closed economy like the U.S. Studying other countries may require different models and a different set of stylized facts. Lucas' (1977) claim that all business cycles are alike may not be true in international economics.

Appendix: Data Sources

The data are the same as those in Zimmermann (1995). The data appendix to that paper contains further details.

The nineteen countries in tha sample are: Australia, Austria, Canada, Denmark, Finland, France, Germany, Greece, Italy, Japan, Netherlands, Norway, Portugal, South Africa, Spain, Sweden, Switzerland, United Kingdom, United States. With some exceptions, the data are quarterly from 1960:1 to 1991:2. The data are from the *OECD Main Economic Indicators* and the *OECD Quarterly National Accounts*, with the following exceptions.

- Australia: employment data are from the *Australian Bureau of Statistics.*
- Denmark: the data are from the *MONA* database of the *Danmarks Nationalbank.*
- Finland: the data are from *Suomen Pankki/Finlands Bank.*
- France: employment data are from the *Institut national de la statistique*, *Études économiques.*
- Greece: data are from the *Athens Institute of Economic Policy Studies.*
- Japan: data are from the *Bank of Japan.*
- Netherlands: data are from the *Central Planning Bureau.*
- Norway: data are from the *Statistisk Sentralbyrå.*
- South Africa: data are from the *South African Reserve Bank.*
- Spain: data are from the *Instituto nacional de estadistica.*
- Sweden: data are from the *Statistiska Centralbyrå.*
- Switzerland: data are from the *Office fédéral des questions conjoncturelles.*

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Table 1: BKK Data Set

	Correlation of Each Country's Variable with Same U.S. Variable					
Country	output	consumption	investment	government spending	employment	Solow residual
Australia	.51	-.19	.16	.23	-.18	.52
Austria	.38	.23	.46	.29	.47	.17
Canada	.76	.49	-.01	-.01	.53	.75
France	.41	.39	.22	-.20	.26	.39
Germany	.69	.49	.55	.28	.52	.65
Italy	.41	.02	.31	.09	-.01	.35
Japan	.60	.44	.56	.11	.32	.58
Switzerland	.42	.40	.38	.01	.36	.43
United Kingdom	.55	.42	.40	-.04	.69	.35
Europe	.66	.51	.53	.18	.33	.56
baseline model	-.21	.88	-.31	—	-.31	.25

See Backus, Kehoe and Kydland (1995, p.366).

Table 2: Simple correlations

Variable	Weighting scheme: simple	trade	output	observ.	obs. trade	obs. output
output, consumption	0.61	0.62	0.68	0.61	0.63	0.69
	(0.02)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
output, investment	0.67	0.74	0.79	0.68	0.75	0.80
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
output, exports	0.31	0.33	0.30	0.32	0.33	0.30
	(0.04)	(0.04)	(0.05)	(0.03)	(0.04)	(0.05)
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
output, imports	0.59	0.64	0.65	0.60	0.65	0.66
	(0.03)	(0.04)	(0.04)	(0.03)	(0.04)	(0.04)
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
output, terms of trade	-0.02	-0.01	-0.03	-0.03	-0.02	-0.04
	(0.04)	(0.06)	(0.08)	(0.04)	(0.06)	(0.08)
	0.63	*0.90*	*0.70*	*0.48*	*0.60*	*0.48*
output, trade balance	-0.29	-0.32	-0.33	-0.29	-0.32	-0.34
	(0.03)	(0.05)	(0.06)	(0.03)	(0.04)	(0.06)
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
terms of trade, trade balance	-0.32	-0.19	-0.09	-0.30	-0.16	-0.06
	(0.04)	(0.05)	(0.06)	(0.03)	(0.04)	(0.06)
	0.00	*0.00*	*0.13*	*0.00*	*0.00*	*0.30*
savings, investment	0.44	0.55	0.63	0.46	0.56	0.64
	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
savings/output, investment/output	0.15	0.33	0.44	0.17	0.35	0.47
	(0.04)	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*

First line is average correlation.
(Second line is standard deviation of average correlation.)
Third line is p-value of a χ^2 *test for* $H_0 = 0$.

Table 3: J-curve: correlations of terms of trade at t with trade balance at $t + x$

Weight scheme	x -5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
simple	-0.11	-0.16	-0.22	-0.25	-0.27	-0.32	-0.10	0.05	0.16	0.24	0.27
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.10*	*0.00*	*0.00*	*0.00*
trade	-0.08	-0.12	-0.17	-0.20	-0.22	-0.19	-0.04	0.12	0.25	0.33	0.32
	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)	(0.05)	(0.05)	(0.04)	(0.04)	(0.03)	(0.04)
	0.04	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.49*	*0.00*	*0.00*	*0.00*	*0.00*
output	-0.06	-0.07	-0.09	-0.10	-0.12	-0.09	0.05	0.20	0.32	0.39	0.36
	(0.05)	(0.05)	(0.05)	(0.04)	(0.04)	(0.06)	(0.07)	(0.05)	(0.04)	(0.04)	(0.04)
	0.29	*0.21*	*0.09*	*0.02*	*0.00*	*0.13*	*0.46*	*0.00*	*0.00*	*0.00*	*0.00*
simple obs.	-0.09	-0.15	-0.21	-0.23	-0.25	-0.30	-0.09	0.06	0.17	0.24	0.27
	(0.04)	(0.03)	(0.03)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.03*	*0.00*	*0.00*	*0.00*
trade obs.	-0.07	-0.11	-0.15	-0.17	-0.19	-0.16	-0.01	0.14	0.25	0.33	0.32
	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)	(0.04)	(0.05)	(0.04)	(0.03)	(0.03)	(0.03)
	0.05	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.84*	*0.00*	*0.00*	*0.00*	*0.00*
output obs.	-0.05	-0.05	-0.06	-0.08	-0.09	-0.06	0.08	0.22	0.33	0.40	0.36
	(0.06)	(0.05)	(0.05)	(0.04)	(0.04)	(0.06)	(0.07)	(0.05)	(0.04)	(0.04)	(0.04)
	0.39	*0.38*	*0.23*	*0.08*	*0.02*	*0.30*	*0.27*	*0.00*	*0.00*	*0.00*	*0.00*

First line is average correlation.
(Second line is standard deviation of average correlation.)
Third line is p-value of a χ^2 test for $H_0 = 0$.

Table 4: Cross-correlations

Variable	Full Sample simple	Full Sample trade	Full Sample output	Post-1973 simple	Post-1973 trade	Post-1973 output
	Weighting scheme			Weighting scheme		
output	0.23	0.30	0.31	0.30	0.45	0.49
	(0.03)	(0.06)	(0.07)	(0.03)	(0.04)	(0.05)
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Investment	0.16	0.21	0.23	0.21	0.29	0.33
	(0.03)	(0.05)	(0.06)	(0.03)	(0.05)	(0.06)
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Consumption	0.14	0.20	0.25	0.15	0.21	0.27
	(0.03)	(0.04)	(0.06)	(0.03)	(0.04)	(0.06)
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Employment	0.20	0.19	0.17	0.21	0.24	0.23
	(0.03)	(0.04)	(0.05)	(0.03)	(0.04)	(0.06)
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Total hours	0.23	0.30	0.33	0.23	0.30	0.33
	(0.03)	(0.06)	(0.07)	(0.03)	(0.06)	(0.07)
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Employment[1]	0.25	0.23	0.21	0.21	0.23	0.21
	(0.03)	(0.05)	(0.06)	(0.03)	(0.05)	(0.06)
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Productivity	0.16	0.28	0.28	0.20	0.38	0.44
(from y and n only)	(0.03)	(0.06)	(0.07)	(0.03)	(0.05)	(0.06)
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Productivity	0.07	0.20	0.22	0.09	0.27	0.35
(best available)[2]	(0.02)	(0.04)	(0.06)	(0.02)	(0.04)	(0.05)
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.02*

First line is average correlation.
(Second line is standard deviation of average correlation.)
Third line is p-value of a χ^2 *test for* $H_0 = 0$.
1: For those countries for which total hours are measured.
2: Uses capital stock when available, otherwise y and n only.

Table 5: Cross-correlations quantiles

	Full Sample			Post-1973		
	Weighting scheme			Weighting scheme		
Variable	simple	trade	output	simple	trade	output
25%						
output	0.10	0.21	0.25	0.15	0.34	0.40
Consumption	-0.02	0.01	0.07	-0.04	0.02	0.08
Investment	-0.02	0.09	0.14	0.03	0.19	0.22
Employment	0.02	0.00	-0.02	0.02	0.00	0.00
Productivity	0.05	0.15	0.15	0.06	0.23	0.35
Hours	0.09	0.18	0.23	0.07	0.20	0.24
50%						
output	0.26	0.31	0.31	0.34	0.48	0.52
Consumption	0.14	0.22	0.33	0.17	0.24	0.37
Investment	0.18	0.26	0.26	0.22	0.32	0.37
Employment	0.20	0.17	0.11	0.22	0.21	0.18
Productivity	0.18	0.29	0.31	0.20	0.42	0.47
Hours	0.24	0.28	0.29	0.26	0.40	0.49
75%						
output	0.37	0.42	0.40	0.46	0.61	0.61
Consumption	0.33	0.40	0.40	0.34	0.43	0.44
Investment	0.32	0.34	0.31	0.38	0.44	0.53
Employment	0.36	0.37	0.37	0.40	0.51	0.52
Productivity	0.29	0.37	0.36	0.37	0.51	0.60
Hours	0.35	0.40	0.40	0.41	0.54	0.54

Table 6: Cross-correlations, alternative tests

	Full Sample			Post-1973		
	Weighting scheme			Weighting scheme		
Test	simple	trade	output	simple	trade	output
P-values						
$H_0 : \text{cor}(y, y^*) = \text{cor}(c, c^*)$	0.03	0.15	0.50	0.00	0.00	0.00
$H_0 : \text{cor}(y, y^*) = \text{cor}(z, z^*)$	0.13	0.75	0.79	0.02	0.32	0.47
$H_0 : \text{cor}(z, z^*) = \text{cor}(c, c^*)$	0.60	0.28	0.70	0.21	0.01	0.04
$H_0 : \text{cor}(y, y^*) = \text{cor}(n, n^*)$	0.44	0.11	0.12	0.06	0.00	0.00
$H_0 : \text{cor}(y, y^*) = \text{cor}(i, i^*)$	0.12	0.22	0.41	0.04	0.01	0.04
% of occurrences						
$\text{cor}(y, y^*) > \text{cor}(c, c^*)$	0.70	0.69	0.60	0.75	0.87	0.90
$\text{cor}(y, y^*) > \text{cor}(z, z^*)$	0.74	0.71	0.72	0.78	0.69	0.58
$\text{cor}(z, z^*) > \text{cor}(c, c^*)$	0.58	0.62	0.54	0.58	0.74	0.79
$\text{cor}(y, y^*) > \text{cor}(n, n^*)$	0.57	0.70	0.73	0.57	0.69	0.75
$\text{cor}(y, y^*) > \text{cor}(i, i^*)$	0.64	0.65	0.58	0.68	0.77	0.82
$\text{cor}(c, c^*) > \text{cor}(z, z^*) > \text{cor}(y, y^*)$	0.04	0.04	0.04	0.04	0.01	0.01
$\text{cor}(y, y^*) > \text{cor}(z, z^*) > \text{cor}(c, c^*)$	0.37	0.36	0.30	0.30	0.45	0.39

y: output; c: consumption; n: employment;
z: total productivity (defined from y and n).