Product Prices and the OECD Cycle

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Abstract: It is well known that business cycles in OECD countries exhibit a remarkable degree of synchronization. Much less known is that the peak of the OECD cycle is associated with high prices of labour-intensive products and low prices of capital-intensive ones. We document this cyclical behavior of product prices and argue that it offers an important clue as to why business cycles are so synchronized. Positive shocks in one or more countries raise the prices of labour-intensive products and, as a result, the demand for labour throughout the industrialized world. This generates increases in wages, employment and output in all industrial countries. Through this channel, shocks are positively transmitted across countries, creating a force towards the synchronization of business cycles.

It hardly seems necessary to document that business cycles are strongly synchronized among industrial countries. Table 1 reports the time-series correlations of annual real per capita GDP growth with OECD average growth excluding that country, over the period 1960-1996, for all OECD countries. These correlations are substantial, averaging 61% in the G7 and 47% in the full OECD sample. One might think that these correlations are high because the sample period includes the large increases in the price of oil in the 1970s which constituted a large adverse shock for most of the OECD economies. However, the second column of Table 1 shows that even if we exclude the 1973-1981 period from our sample, the cross-country growth correlations average 54% and 46% percent in the G7 and the full OECD samples, respectively. These figures justify the notion of an OECD cycle.

Since much of the fluctuations in output can be traced back to fluctuations in employment and hours worked, it is not surprising that labour market indicators also exhibit a strong correlation among industrial countries. Table 2 documents this for a sample of 12 countries for which internationally-comparable indicators are available. The correlations of annual growth rates of manufacturing hours, employment and real wages with OECD average per capita output growth excluding that country are quite high, averaging 41%, 43%, and 24%, respectively. A natural interpretation of this set of correlations is that shifts in the demand for labour tend to occur at the same time in all countries.

Why are shifts in the demand for labour highly correlated across countries? Part of the answer may be that shocks to labour productivity are positively correlated across countries. But this cannot be the whole story. Figure 1 shows that output growth correlations exceed those of productivity shocks in 22 out of 24 countries.[1] Either there are other shocks to labour demand that are highly correlated across countries, or there are channels of transmission of shocks that generate correlations in income growth in excess of those of the underlying shocks.

In this paper, we argue that the cyclical behavior of product prices offers an important clue to understanding how shocks are positively transmitted across countries. By the cyclical behaviour of product prices, we refer to the observation that OECD booms are associated with increases in the price of labour-intensive products and decreases in the price of capital-intensive products. This can be shown by estimating the following regression model:

$$\Delta \ln p_{ict} = (\beta_1 + \beta_2 \cdot S_{ic}) \cdot \Delta \ln Y_t + (\lambda_1 + \lambda_2 \cdot S_{ic}) \cdot \Delta \ln y_{ct} + f_{ic} + u_{ict}$$

where $\Delta \ln p_{ict}$ denotes the growth rate of the price index of output in industry i in country c in year t relative to the consumer price index in country c in year t; S_{ic} is the average over time of labour's share in value-added in industry i and country c; $\Delta \ln Y_t$ and $\Delta \ln y_{ct}$ and denote real per capita GDP growth rates in the OECD and in country c in year t, respectively; and f_{ic} and u_{ict} are a country- and industry-specific fixed effect and a well-behaved error, respectively. We estimate the model using data on 28 manufacturing sectors in a sample of 20 OECD economies over the period 1963-1995.

[1] This is by no means a new observation. See Backus, Kehoe and Kydland (1995) who argue that the finding that GDP growth rates are more correlated across countries than Solow residuals is one of the main puzzles that arise when one attempts to interpret the data from the perspective of the stochastic growth model. We follow the standard but admittedly controversial practice of interpreting Solow residuals as a measure of productivity shocks.

Table 1
The OECD Cycle: Output Fluctuations

Correlation of Real Per Capita GDP Growth With OECD Average Excluding that Country

	Full Sample (1960-96)		Non-Oil Shock Sample (1960-72, 1982-96)	
G7				
Canada	0.69	***	0.79	***
France	0.74	***	0.67	***
Germany	0.66	***	0.53	***
Italy	0.54	***	0.54	***
Japan	0.50	***	0.47	**
United Kingdom	0.61	***	0.39	**
United States	0.50	***	0.36	*
Rest of OECD				
Australia	0.52	***	0.56	***
Austria	0.53	***	0.54	***
Belgium	0.62	***	0.66	***
Denmark	0.58	***	0.42	**
Finland	0.41	**	0.55	***
Greece	0.58	***	0.57	***
Iceland	0.15		0.20	
Ireland	0.31	*	0.25	
Luxembourg	0.29	*	0.07	
Netherlands	0.67	***	0.66	***
New Zealand	0.29	*	0.27	
Norway	0.31	*	0.37	**
Portugal	0.39	**	0.18	
Spain	0.54	***	0.61	***
Sweden	0.50	***	0.73	***
Switzerland	0.54	***	0.66	***
Turkey	-0.06		0.02	
G7 Average	0.61		0.54	
Rest of OECD Average	0.42		0.41	
OECD Average	0.47		0.46	

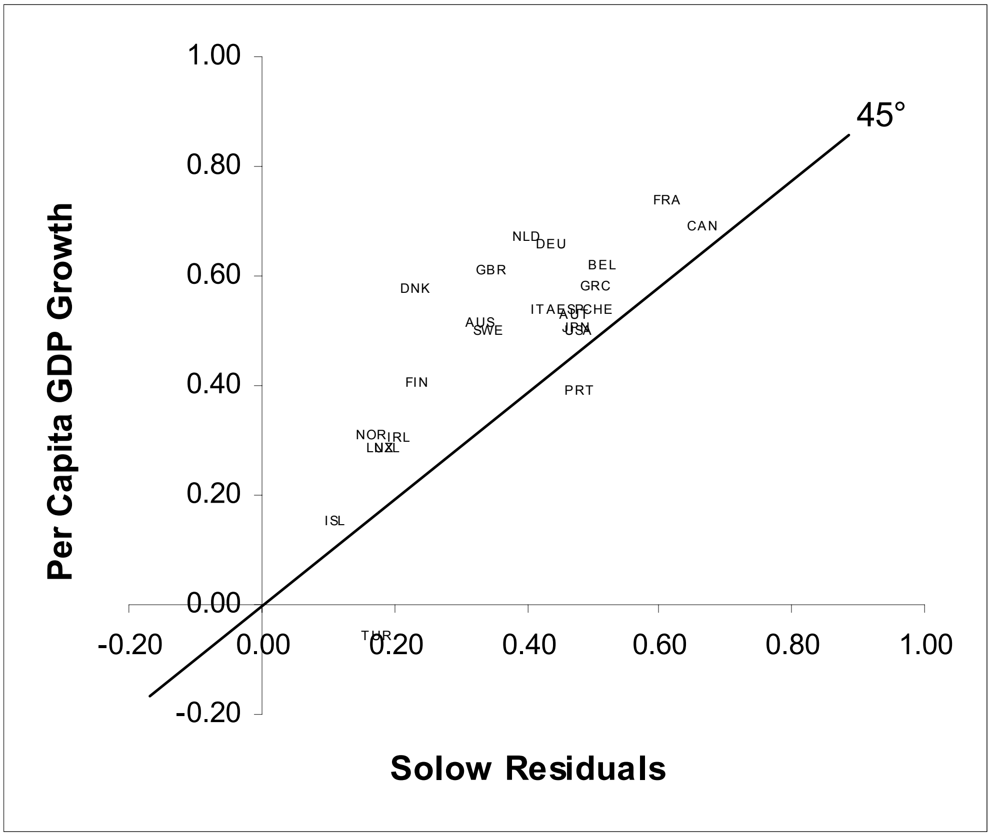
This table reports the correlation of annual real per capita GDP growth with OECD average real per capita GDP growth excluding that country, for the indicated periods. Annual data on real per capita GDP at PPP and population are taken from Penn World Table, Version 5.6 (codes RGDPCH and POP), and are extended through 1996 using World Bank data on real per capita GDP at PPP and population (codes NYGDPCAPPPKD87 and SPPOPTOTL). * (**) (***) indicate significance at the 10% (5%) (1%) level respectively.

Table 2
The OECD Cycle: Labour Market Fluctuations

	Correlations with OECD Average Real Per Capita GDP Growth of Growth in:		
	Manufacturing Employment	**Manufacturing Hours**	**Manufacturing Real Wages**
		Full Sample (1960-96)	
G7			
Canada	0.61 ***	0.61 ***	0.16
France	0.44 ***	0.52 ***	0.07
Germany	0.40 **	0.46 ***	0.41 **
Italy	0.31 *	0.40 **	0.14
Japan	0.39 **	0.53 ***	0.33 **
United Kingdom	0.58 ***	0.61 ***	-0.11
United States	0.49 ***	0.42 ***	0.31 *
Other			
Belgium	0.44 ***	0.49 ***	0.32 **
Denmark	0.57 ***	0.39 **	0.23
Netherlands	0.33 **	0.24	0.44 ***
Norway	0.17	0.04	0.27 *
Sweden	0.37 **	0.24	0.26
G7 Average	0.46	0.51	0.19
G12 Average	0.43	0.41	0.24
		Non-Oil Shock Sample (1960-1972, 1982-1996)	
G7			
Canada	0.71 ***	0.66 ***	0.38 **
France	0.44 **	0.49 ***	0.24
Germany	0.32 *	0.33 *	0.46 **
Italy	0.41 **	0.39 **	0.26
Japan	0.30 *	0.40 **	0.41 **
United Kingdom	0.63 ***	0.57 ***	0.09
United States	0.38 **	0.24	0.38 **
Other			
Belgium	0.49 ***	0.38 **	0.59 ***
Denmark	0.41 **	0.25	0.36 **
Netherlands	0.41 **	0.24	0.53 ***
Norway	0.26	0.16	0.45 **
Sweden	0.59 ***	0.37 **	0.61 ***
G7 Average	0.46	0.44	0.32
G12 Average	0.45	0.37	0.40

This table reports the correlation of annual growth rates in each variable with OECD average real per capita GDP growth, excluding that country. Annual indices of hours worked, employment and wages in manufacturing are from the United States Bureau of Labour Statistics, International Labour Statistics (codes 0003, 0006, 0022, and 0024, available at ftp://ftp.bls.gov/pub/time.series/in/) Real wage growth is obtained by deflating by the consumer price index as reported by the IMF International Financial Statistics (code 64...zf). * (**) (***) indicate significance at the 10% (5%) (1%) level respectively.

Figure 1
Cross-Country GDP Growth and
Solow Residual Correlations



This figure plots the correlation of annual real per capita GDP growth with OECD average growth excluding that country (on the vertical axis) against the correlation of annual Solow residuals with OECD average Solow residuals excluding that country (on the horizontal axis). Real per capita GDP growth correlations are drawn from Table 1. Solow residuals are constructed as the growth in total real GDP, less the economy-wide share of wages in GDP times growth in total civilian employment, less one minus the share of wages in GDP times growth in the total capital stock. The share of wages in GDP is constructed using current price local currency compensation of employees and GDP by expenditure components taken from the OECD National Accounts (codes M0COM and M0GDPE). Total civilian employment is drawn from the OECD Labour Force Statistics. The total capital stock is in 1987 constant local currency units and is drawn from Nehru and Dhareshwar (1993) and is updated to 1995 using World Bank data. The OECD average Solow residual is constructed as a population-weighted average of country Solow residuals. Due to missing data on employment, Solow residual correlations are computed over the period 1960-1995. 22 out of 24 countries lie above the 45-degree line, and the null hypothesis that the growth rate correlations are equal to the Solow residual correlations is easily rejected. The p-value associated with a simple sign test is less than 0.01.

The results reported in Table 3 point to three conclusions. First, across all specifications, the estimate of β_2 is positive and significantly different from zero, which we interpret as evidence that the sensitivity of product price changes to OECD growth is higher for labour-intensive products. For instance, if we take two products with labour shares of 10 and 70 percent (roughly corresponding to the bottom and top deciles in our sample), the first column of Table 3 suggests that a one percentage point increase in OECD growth leads to a change in their prices of –1.2 and 0.6 percent, respectively. Second, the cyclical pattern in product prices is driven primarily by OECD-wide shocks and not by domestic shocks. This may be seen in the second and fourth columns of Table 3, where we relax the restriction $\lambda_1=\lambda_2=0$ and find that these coefficients are not significantly different from zero. Third, the cyclical behavior of product prices is not driven by the oil shocks of the 1970s. The last two columns of Table 3 indicate that our results are qualitatively unaffected but slightly smaller in absolute value when we drop the oil-shock years from the sample.

When viewed as a whole, this evidence is consistent with the view that there is a channel of transmission of business cycles that works through changes in relative product prices. In particular, individual countries find that positive shocks abroad lead to increases in the prices of labour-intensive commodities, raising wages and stimulating employment and output at home. Through this channel, shocks are positively propagated across countries, contributing to the creation of the OECD cycle. International commodity trade plays a crucial role in our argument, since it creates a link between product prices in different countries.

In the remainder of this paper, we develop a stylized model that formalizes this channel of transmission through relative product prices, and examine some of its limitations. To highlight this channel, the model features a single source of interaction among countries: commodity trade based on differences in effective factor endowments. As a result, we abstract from other transmission channels that arise in models that feature other sorts of commodity trade, factor movements and/or financial linkages. For a discussion of these alternative transmission channels, we refer the reader to Mussa (1979) and Backus, Kehoe and Kydland (1995), who provide useful reviews of how shocks are transmitted across countries in the Mundell-Fleming and the stochastic growth models, respectively.

Table 3
Labour Intensity and Price Cyclicality

(Dependent Variable is Growth in Price Index of Industry i in Country c at Time t)

	Full Sample (1960-96)		**Non-Oil Shock Sample (1960-72, 1982-96)**	
OECD Growth	-1.462 (0.621)**	-2.009 (0.743)***	-0.752 (0.440)*	-1.363 (0.775)**
OECD Growth x Labour Intensity	2.965 (0.833)***	3.120 (0.937)***	1.916 (0.670)***	2.128 (1.003)**
Domestic Growth		0.478 (0.446)		0.501 (0.588)
Domestic Growth x Labour Intensity		0.207 (0.617)		0.143 (0.727)
Number of Observations	16418	16418	11494	11494

Standard errors are corrected for heteroskedasticity and serial and cross-sectional dependence using the procedure suggested by Driscoll and Kraay (1998). * (**) (***) indicates significance at the 10% (5%) (1%) level. Country-industry fixed effects are removed by taking deviations from country-industry means. The price and labour-intensity data cover 28 three-digit ISIC manufacturing sectors in 20 OECD countries for all available years over the period 1963-1995 (Iceland, Luxembourg, Switzerland and Turkey are excluded due to inadequate data coverage), and are drawn from the United Nations Industrial Development Yearbook. The dependent variable is the growth rate of the implicit gross output deflator (constructed as the growth in nominal local currency gross output less growth in the real industrial production index) relative to growth in the consumer price index. Labour intensity is measured as the share of employee compensation in value added. OECD and domestic growth are constructed as in Table 1.

1. A Stylized Model of Trade and Fluctuations

We consider a world (named the "OECD") consisting of a continuum of countries with mass one; many industries producing distinct perishable products indexed by j=1,..,J; and two factors of production, labour and capital. All countries have the same technology, preferences and factor endowments. The latter are given in fixed supply and cannot be transported across borders. Countries only differ in the state of their business cycle, as measured by an index of productivity, π. The state of the world is fully described by cross-country distribution of productivities. Let Π be the mean of this distribution, which we refer to as the OECD-wide index of productivity. Both π and Π fluctuate randomly over time. We allow countries to to trade in goods, but assume that there is no trade in financial assets. As a result of trade, product prices are equalized across countries, and we shall see later that they can be written as a function of the OECD-wide productivity index, i.e. $p_j(\Pi)$ for j=1,..J. Also, we shall see later that the wage rate and rental rate differ across countries and can be written as functions of the country's and the OECD-wide productivity, i.e. $w(\pi,\Pi)$ and $r(\pi,\Pi)$. For simplicity, we omit the productivity indices whenever this is not confusing.

Consumers

Each country is populated by a continuum of consumers of mass one. Consumers are endowed with a unit of capital, and decide how much to consume and whether or not to work. Consumers differ in their personal opportunity cost of work, or reservation wage, which can be thought of as the value of non-market activities. We index consumers by $z\in[1,\infty)$ and assume that this index is distributed according to this Pareto distribution: $F(z)=1-z^{1-\mu}$, with $\mu>1$. The parameter μ determines the dispersion of reservation wages across consumers. A consumer with index z maximizes the following expected utility:

$$(1) \qquad E\int_0^{\infty} U\left(\left(\sum_{j=1}^{J} c_j(z)^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}} - \frac{i(z)}{z}\right)\cdot e^{-\rho\cdot t}\cdot dt \qquad (\theta>0,\ \rho>0)$$

where U(.) is any well-behaved function; i(z) is an indicator function that takes value 1 if the consumer works and 0 otherwise; $c_j(z)$ is the consumption of good j of a consumer with index z. The consumer's budget constraint is $\sum_{j=1}^{J} p_j \cdot c_j(z) \le w\cdot i(z)+r$.

A consumer with index z works if and only if w>1/z, where w is the wage rate. Therefore, aggregate employment is $1-F(w^{-1})=w^{\mu-1}$. Note that the wage elasticity of the labour supply, μ-1, is a function of the dispersion of reservation wages.[2] Consumers allocate their expenditure such that the ratio of spending on any two goods

[2] When the wage reaches one, the entire population is working and the labour supply is vertical. We assume that all countries are always operating in the elastic section of their labour supply. This can be ensured through some alternative (and innocuous) parameter restrictions.

j and k is $\left(\frac{p_j}{p_k}\right)^{1-\theta}$. The elasticity of substitution θ determines how much prices need to change to convince consumers to vary their relative consumptions of any two products.

Firms and Technology

In each industry and country, there are many competitive firms which hire workers and rent capital to produce output. Within each industry, all firms face the following identical Leontief unit cost functions: $\alpha_j \cdot w \cdot e^{-\varepsilon \cdot \pi} + (1-\alpha_j) \cdot r \cdot e^{-\pi}$, for j=1,...,J. Note that industry j is more labour-intensive than industry k if $\alpha_j > \alpha_k$. Production costs differ across countries only to the extent that the productivity index π varies across countries. The parameter $\varepsilon > 0$ determines the factor bias associated with productivity fluctuations. If $\varepsilon < 1$, the productivity of labour relative to capital is low when π is high, and conversely it is high when π is low.

Business cycles arise as π fluctuates randomly. We refer to changes in π as productivity shocks. The index π is the sum of a global component, Π, and a country-specific component, π-Π. Each of these components is an independent Brownian motion reflected on the interval $[-\delta, \delta]$ with zero drift and instantaneous variances equal to σ and 1-σ respectively, with $\delta > 0$ and $0 < \sigma < 1$. Let the country-specific components be independent and uniformly distributed on $[-\delta, \delta]$. This means that the cross-sectional distribution of π-Π is time-invariant.[3] While π has been defined as an index of domestic productivity, Π serves as an index of OECD average productivity. It is straightforward to show that the instantaneous correlation between domestic shocks, $d\pi$, and OECD shocks, $d\Pi$, is $\sqrt{\sigma}$.[4] The parameter σ therefore regulates the extent to which the variation in domestic productivity is due to global or country-specific components, i.e. whether it comes from $d\Pi$ or $d(\pi-\Pi)$.

Equilibrium

A competitive equilibrium of the world economy consists of a sequence of prices and quantities such that consumers and firms maximize and markets clear. Our assumptions ensure that a competitive equilibrium exists and is unique. We prove this by constructing the set of equilibrium prices.

As in Trefler (1993), all countries have identical technology if factors are measured in productivity equivalents. Let $\hat{r} = r \cdot e^{-\pi}$ and $\hat{w} = w \cdot e^{-\varepsilon \cdot \pi}$ denote the rental and wage rates of factors measured in this way, i.e. productivity-adjusted factor prices. If cross-industry differences in capital-labour ratios are large relative to cross-country differences in productivity-adjusted capital-labour ratios, $\hat{r}$ and $\hat{w}$ will be equalized across countries. We assume this in what follows.[5]

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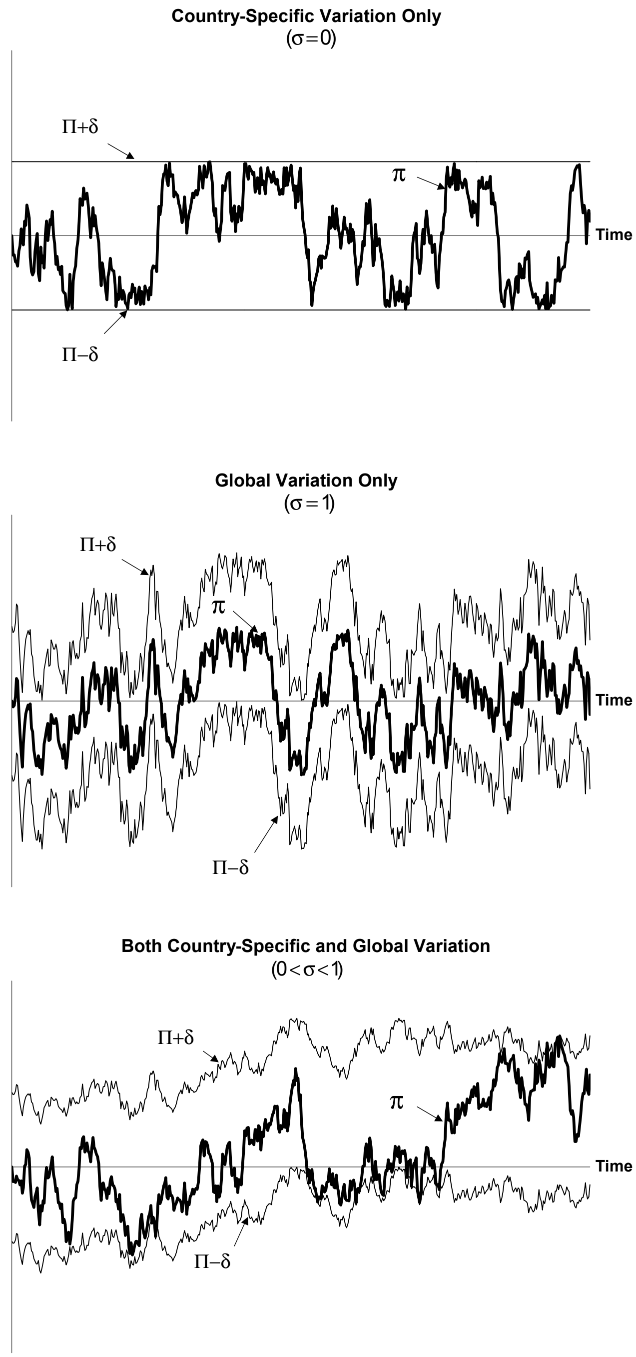
[3] See Harrison (1990), Chapter 5.

[4] This is true except when either π or Π are at their respective boundaries. These are rare events since the dates at which they occur constitute a set of measure zero in the time line.

[5] This is a standard condition in this class of trade models. See Helpman and Krugman (1985, ch.1) for details. In our application, this condition basically requires δ to be small and/or the α_js to be sufficiently extreme.

Figure 2
Sample Paths of the Productivity Index



We normalize prices such that the ideal consumer price index is equal to one, i.e. $\sum_{j=1}^{J} p_j^{1-\theta} = 1$. Since price equals cost in all industries, this normalization allows us to write the price of good j as follows:

$$(2) \qquad p_j = \frac{\alpha_j \cdot \omega + 1 - \alpha_j}{\left[\sum_{k=1}^{J} (\alpha_k \cdot \omega + 1 - \alpha_k)^{1-\theta}\right]^{\frac{1}{1-\theta}}}$$

where ω is the productivity-adjusted wage-rental, i.e. $\omega = \frac{\hat{w}}{\hat{r}}$. This relative price plays a key role in the analysis, and is implicitly defined by:[6]

$$(2) \qquad \frac{\sum_{j=1}^{J} (1-\alpha_j) \cdot (\alpha_j \cdot \omega + 1 - \alpha_j)^{-\theta}}{\sum_{j=1}^{J} \alpha_j \cdot (\alpha_j \cdot \omega + 1 - \alpha_j)^{-\theta}} = \Psi \cdot e^{(1-\varepsilon\cdot\mu)} \cdot \omega^{1-\mu} \cdot \left(\sum_{j=1}^{J} (\alpha_j \cdot \omega + 1 - \alpha_j)^{1-\theta}\right)^{\frac{\mu-1}{1-\theta}}$$

where $\Psi = \frac{\varepsilon \cdot \mu \cdot (e^{\delta} - e^{-\delta})}{e^{\delta\cdot\varepsilon\cdot\mu} - e^{-\delta\cdot\varepsilon\cdot\mu}}$ is a constant. It is immediate to check that there is only one positive value of ω that satisfies (2). The unique equilibrium set of commodity prices then follows from Equation (2), and the set of factor prices follows from the definitions in the text.

Applying Ito's lemma and using the implicit function theorem, we find the following dynamics for ω:[7]

$$(3) \qquad d\ln\omega - E[d\ln\omega] = \frac{(1-\varepsilon\cdot\mu)}{\tilde{\theta} + (\mu - 1)\cdot(1-S)} \cdot d\Pi$$

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[6] Since productivity-adjusted factor prices are equalized, we can solve for the equilibrium wage-rental by equating the OECD-wide demand for capital relative to labour. The former is equal to $\frac{\sum_{j=1}^{J}(1-\alpha_j)\cdot Q_j}{\sum_{j=1}^{J}\alpha_j \cdot Q_j}$ while the latter is equal to $e^{(1-\varepsilon\cdot\mu)\cdot\Pi} \cdot \frac{\int_{-\delta}^{\delta} e^{\pi-\Pi} \cdot \frac{d(\pi-\Pi)}{2\cdot\delta}}{\hat{w}^{\mu-1} \cdot \int_{-\delta}^{\delta} e^{\mu\cdot\varepsilon\cdot(\pi-\Pi)} \cdot \frac{d(\pi-\Pi)}{2\cdot\delta}}$, where Q_j is OECD total production of good j. Using the goods market clearing conditions, firms' pricing rules, and the numeraire rule provided in the text yields Equation (2) after a few manipulations.

[7] Ito's lemma states that if $X=F(Z_1,Z_2)$, where Z_1 and Z_2 are Wiener processes and F(.) is a continuous and twice-differentiable function, $dX - E[dX] = \frac{\partial F}{\partial Z_1} \cdot dZ_1 + \frac{\partial F}{\partial Z_2} \cdot dZ_2$ See Harrison (1990), Chapter 4

Equation (3) states that increases in average productivity lead to increases in the productivity-adjusted wage-rental if and only if $1>\varepsilon\cdot\mu$. Since capital is in fixed supply, increases in the effective supply of capital are proportional only to the productivity of capital; i.e. proportional to Π. Since labour is elastically supplied, increases in the effective supply of workers are proportional to increases in both the productivity of workers and their number; i.e. proportional to $\varepsilon\cdot\mu\cdot\Pi$. If $1>\varepsilon\cdot\mu$, increases in OECD average productivity raise the effective supply of capital relative to labour, and so the relative price of labour must increase to maintain market equilibrium. This condition will play an important role in what follows.

2. Transmission Through Relative Product Prices

We now explore the implications of this simple model for the transmission of business cycles among OECD economies. We first characterize fluctuations in prices and OECD average income. We then characterize fluctuations in income at the country level, and show how OECD-wide shocks are transmitted to the domestic economy. Finally we provide some calibrations which shed light on the empirical importance of this transmission mechanism.

The OECD cycle

Let y denote the income of a country, i.e. $y=\hat{w}^{\mu}\cdot e^{\mu\cdot\varepsilon\cdot\pi}+\hat{r}\cdot e^{\pi}$, and let Y be OECD average income, i.e. $Y=\int_{-\delta}^{\delta} y\cdot\frac{d(\pi-\Pi)}{2\cdot\delta}$. Applying Ito's lemma to the appropriate definitions and using Equation (3), we find that innovations or shocks to the growth rates of Y and p_j take this form:

$$(4)\qquad d\ln Y-E[d\ln Y]=\frac{\tilde{\theta}\cdot\varepsilon\cdot\mu\cdot S+(\tilde{\theta}+\mu-1)\cdot(1-S)}{\tilde{\theta}+(\mu-1)\cdot(1-S)}\cdot d\Pi$$

$$(5)\qquad d\ln p_j-E[d\ln p_j]=\frac{1-\varepsilon\cdot\mu}{\tilde{\theta}+(\mu-1)\cdot S}\cdot\left(S_j-S\right)\cdot d\Pi$$

where $\tilde{\theta}=\theta\cdot\frac{\sum_{j=1}^{J}\left(V_j\cdot(1-S_j)^2\right)-(1-S)^2}{S\cdot(1-S)}>0$; V_j is the share of spending on good j; $S_j=\frac{\alpha_j\cdot\hat{w}}{\alpha_j\cdot\hat{w}+(1-\alpha_j)\cdot\hat{r}}$ is the share of labour in industry j; and $S=\sum_{j=1}^{J}V_j\cdot S_j$ is the overall share of labour in income.

Equations (4) and (5) characterize the OECD cycle and the cyclical movement of product prices. They are the central elements of our story. Not surprisingly, Equation (4) shows that increases in average productivity lead to higher than average growth rates. Equation (5) states that, if $1>\varepsilon\cdot\mu$, prices of relatively-labour intensive goods, i.e. goods for which $S_j>S$, will increase with increases in OECD average productivity, while prices of relatively capital-intensive goods will fall. In light of the empirical evidence on the cyclical properties of product prices, we shall proceed under the empirically relevant assumption of $1>\varepsilon\cdot\mu$.

The Transmission of Shocks

Applying Ito's Lemma to the definition of income and using Equation (3), we find that innovations or shocks to the growth rate of income in each country take this form:

$$\text{(6)}\qquad d\ln y - E[d\ln y] = [1 - s\cdot(1-\varepsilon\cdot\mu)]\cdot d\pi + [s\cdot(\mu-1)\cdot(1-S) + s - S]\cdot \frac{1-\varepsilon\cdot\mu}{\tilde{\theta} + (\mu-1)\cdot(1-S)}\cdot d\Pi$$

where $s = \frac{\hat{w}^{\mu}\cdot e^{\mu\cdot\varepsilon\cdot\pi}}{\hat{w}^{\mu}\cdot e^{\mu\cdot\varepsilon\cdot\pi} + \hat{r}\cdot e^{\pi}}$ is the country's share of labour in income. Equation (6) shows how the growth rate reacts to shocks at home and abroad. For our purposes, the key result in Equation (6) is that, holding constant domestic growth, shocks abroad are positively transmitted to the domestic economy if and only if $s > \frac{S}{1+(\mu-1)\cdot(1-S)}$. This condition combines the effects of two channels of transmission of shocks. Both channels work through changes in relative prices. Since we have assumed that $1>\varepsilon\cdot\mu$, the productivity-adjusted wage rental, ω, and prices of labour-intensive goods, are procyclical. Consequently, positive shocks abroad stimulate employment and production at home. This wage effect is measured by $\frac{s\cdot(\mu-1)\cdot(1-S)\cdot(1-\varepsilon\cdot\mu)}{\tilde{\theta}+(\mu-1)\cdot(1-S)}\cdot d\Pi$. In addition, positive shocks abroad constitute favourable (unfavourable) movements in the terms of trade for countries that are exporters of labour-intensive (capital-intensive) products, i.e. countries for which s>S (s<S). This terms-of-trade effect is measured by $\frac{(s-S)\cdot(1-\varepsilon\cdot\mu)}{\tilde{\theta}+(\mu-1)\cdot(1-S)}\cdot d\Pi$.[8]

How much do these transmission channels contribute to the creation of the OECD business cycle? To answer this question, we perform a calibration exercise. Since the theory predicts that V_j, S_j, and S are the same in all countries, we can use disaggregated U.S. national accounts data to calibrate these shares. In particular, we measure V_j as value added in industry j as a share of total value added, and S_j as the share of compensation of employees in value added in industry j, for 66 industries covering the entire economy, averaging over the period 1987-1996.[9] In order to focus

[8] A shock at home has two effects. First, increased productivity raises production of both industries. This effect is measured by $(s\cdot\varepsilon+1)\cdot d\pi$ and, not surprisingly, coincides with the Solow residual, i.e. that fraction of the GDP growth rate that cannot be accounted for by changes in factor inputs. Second, increased productivity raises wages at home and, therefore, employment and production. This effect is measured by $s\cdot(\mu-1)\cdot\varepsilon\cdot d\pi$. Both effects are expansionary.

[9] We use data on GDP and its components by industry, available from the U.S. Bureau of Economic Analysis at www.bea.doc.gov/bea/dn2/gpo.htm.

on the predictions of the theory for a "typical" country, we abstract from terms of trade effects and set s=S. The data on spending shares suggests that these do not vary much over the cycle. We therefore choose θ=1.[10]

Finally, we need to choose three more parameters: σ, μ and ε. We do this so as to match the evidence presented in the introduction. First, we note that the theory predicts that the cross-country correlation of Solow residuals is $\sqrt{\sigma}$. Using the data underlying Figure 1, we find that this correlation is 0.32 and, as a result, we choose σ=0.1024. Second, we choose μ and ε so as to match the econometric evidence in Table 3 and the cross-country output correlations in Table 1, as explained in the note to Figure 3. This procedure delivers μ=1.5 and ε=0.01. This value of μ is quite reasonable, since it implies an elasticity of the labour supply of 0.5. This value lies within the (wide) range of existing empirical estimates.[11] Unfortunately, we are not aware of any existing empirical study that measures the factor bias in productivity oscillations over the cycle. As a result, it is hard to determine whether the value of ε we find is "reasonable" or not. In any case, we note that the model is able to account for both the cyclical behavior of product prices and the observed correlation of business cycles with a reasonable labour-supply elasticity and a strong factor bias in productivity shocks.

In Figure 3, we explore how sensitive the model's predictions are to the choice of μ and ε (which we initially chose to match the data). The left and right columns of Figure 3 plot the predicted (heavy line) and actual (light line) slope of a regression of relative prices on OECD output, and the correlation of dlny with dlnY, respectively. In each column, the two figures explore the sensitivity of the model's predictions to variations in each of the parameters, holding the other one constant at their benchmark values. It is clear from the figures that the model's ability to explain the fluctuations in goods prices and the correlation of business cycles depends on choosing values for μ and ε that do not depart too much from their benchmark values.

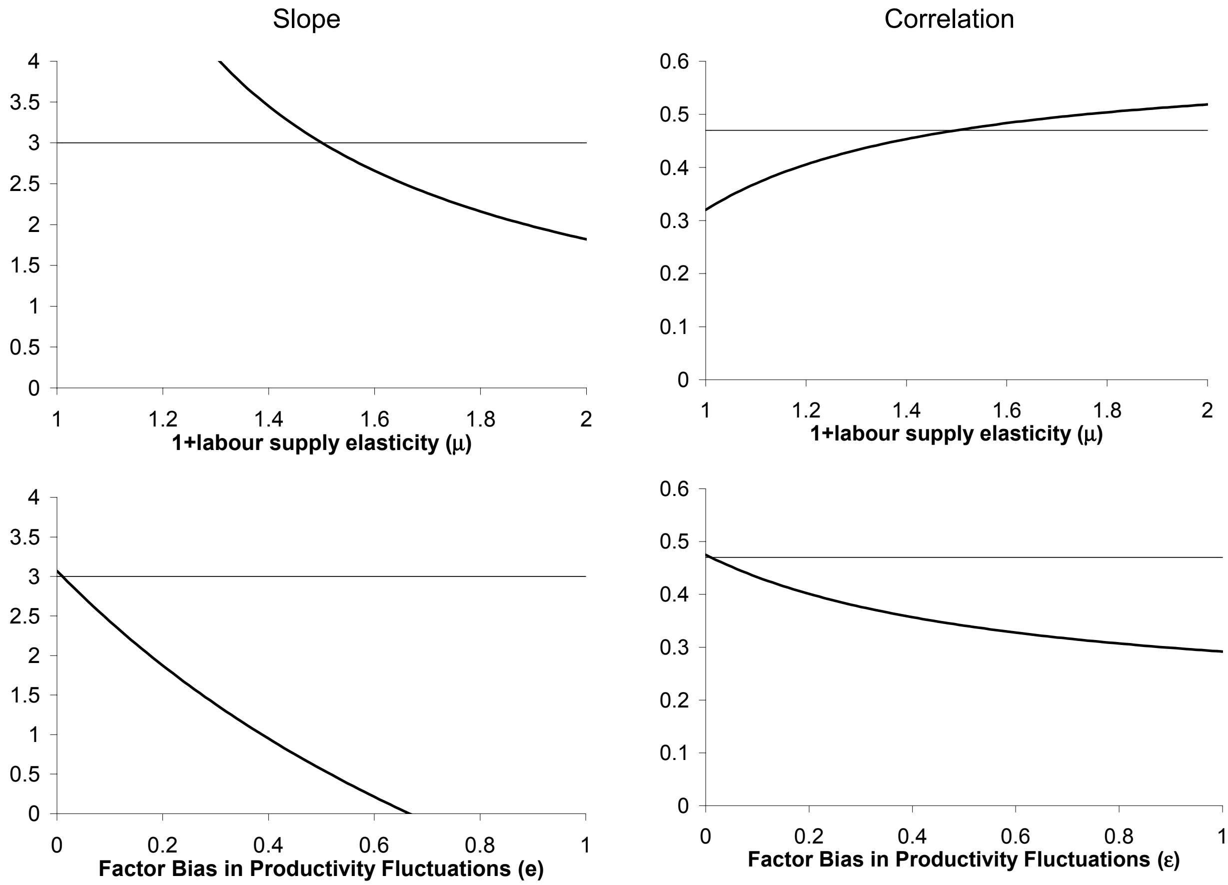
3. Conclusion

To sum up, our argument goes as follows: favourable shocks in one or more OECD countries lead to increases in the prices of labour-intensive products and, therefore, raise wages, employment and output in the rest of the OECD. First, we presented evidence showing that periods of high growth in the OECD are associated with increases in the prices of labour-intensive products in all countries. Second, we developed a stylized model that illustrates how this cyclical behavior of product prices creates a channel of positive transmission of shocks that might be one of the factors behind the OECD cycle. Going beyond the details of the model, it should be apparent that the key ingredients of our argument are: (1) during booms labour-intensive products become relatively scarce and therefore the demand for labour increases in all countries; (2) wages and employment respond positively to increases in the demand for labour. Any model that combines these two features would rationalize our claim that

[10] We re-did our calculations using values of θ that go from 0.5 to 1.5, and found that this has very small effects on the ability of the model to match the data.
[11] See for example a survey of the microeconomic evidence in Ashenfelter (1984).

the cyclical behavior of product prices provides an important clue on how shocks are transmitted across OECD countries.

Figure 3:
Sensitivity Analysis



Note: The theory predicts that in a regression of $d\ln p_j$ on $d\ln Y$ and $S_j \cdot d\ln Y$, the slope coefficient on the interaction term is $\frac{1-\varepsilon\cdot\mu}{\tilde{\theta}\cdot\varepsilon\cdot\mu\cdot S+(\tilde{\theta}+\mu-1)\cdot(1-S)}$, while the correlation coefficient of dlny and dlnY is

$$\frac{1}{\sqrt{1+\frac{1-\sigma}{\sigma}\cdot\left[\frac{1-s\cdot(1-\varepsilon\cdot\mu)}{1-s\cdot(1-\varepsilon\cdot\mu)+\left[s\cdot\left(S+\mu\cdot(1-S)\right)-S\right]\cdot\frac{1-\varepsilon\cdot\mu}{\tilde{\theta}+(\mu-1)\cdot(1-S)}}\right]^2}}.$$

We choose μ and ε to ensure that the slope coefficient is equal to 3 (see the estimates in the first column of Table 3), and the correlation coefficient is equal to 0.47 (using the OECD-average cross-country correlation of per capita GDP growth in the first column of Table 1), conditional on the data on spending shares, factor shares, and correlation of shocks discussed in the text and our assumption that $\theta=1$. This procedure delivers values of $\mu=1.5$ and $\varepsilon=0.01$. The top (bottom) two figures show how the slope and correlation vary with μ (ε) holding ε (μ) constant at its benchmark value.

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