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Tests of the Factor Price Equalization Theorem

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Abstract

Using annual data for 21 OECD countries over the period 1960 to 1993 this paper tests whether real wages have converged to a common mean alongside with increasing openness, as predicted by the factor price equalization theorem. The empirical estimates suggest that real wage convergence has taken place in most OECD countries. (JEL: F02, J3)

I. Introduction

The factor price equalization (FPE) theorem, advanced by Ohlin [1933] and further developed by Samuelson [1948], is an important component of every standard textbook of international economics. It states that factor prices tend to equalize across nations as international trade expands. It follows then, that real wages will tend to fall in nations with relatively high wages and increase in nations with relatively low wages as a result of increased openness.

As noted by Leamer [1995], only a few studies have tested whether the factor price equalization theorem holds. The empirical studies that have tested the FPE theorem include Mokhtari and Rassekh [1989], Gremmen [1985], Tovias [1982] and Burgman and Geppert [1993] ⟨see also the survey

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by Rassekh and Thompson [1993]〉. However, as pointed out by Burgman and Geppert [1993], some of the previous studies have erroneously drawn inferences from data that contain unit roots. Another problem with many of the previous studies is that some of the variables have not been measured correctly; probably because more accurate data are not readily available. This particularly applies to the wage data where wages have been measured either as direct labour costs in manufacturing or as total labour costs for the whole economy. Since indirect labour costs count for up to 50 per cent of total labour costs in manufacturing in the OECD, and their ratio to direct wages have changed substantially over the past four decades, they are too important to ignore. Nor are total labour costs for the whole economy useful, because the FPE theorem applies only to the import and export competing sectors of the economy.

This paper builds on the framework of Mokhtari and Rassekh [1989]. They estimate a wage equation augmented with trade openness using pooled cross-section and time-series data for the OECD countries. By casual inspection they find that openness tends to influence wages positively in low wage countries and negatively in high wage countries; a finding, which is consistent with the FPE theorem. This paper adapts a more formal procedure to test the FPE theorem. Relative manufacturing real total hourly labour costs, in common currency and purchasing power, are regressed on openness, incorporating asymmetrical adjustment, and other variables, which influence wage behaviour. This set-up enables one to test directly whether real wages converge as the economies open up.

Various estimation techniques are applied to investigate the degree to which the FPE occurs in the short and the long run. In the short run factor prices may be influenced by cyclical factors, which are difficult to control for in the regressions. Hence, the long-run estimates are likely to give a better indication of the validity of the FPE theorem. However, a higher degree of efficiency can be obtained in the short-run estimates, as discussed below. Furthermore, it is of interest to investigate to the extent to which short-run adjustment occurs. Thus, the short-run and the long-run estimates complement each other.

Section II presents the model used to test the FPE theorem and the long-run estimates of the model. Cointegration regressions and the Between estimator are employed to test whether FPE takes place in the long run. The short-run adjustment is estimated in section III using pooled cross-section and time-series analysis. Kmenta's [1986] cross-section heteroscedastic and Swamy's [1971] random coefficient models are used to estimate the short-run responses of relative real wages to openness. Annual data for 21 OECD countries over the period 1960 to 1993 are used in the estimates.

II. Long-run Estimates

The model that is used to test the FPE theorem is first established before the long-run estimates are performed. The model is derived from a wage equation, which is widely accepted in the literature. Letting lowercase letters be logs of capital letters the wage equation is given by:

$$(w-p)_t = \alpha_0 - \alpha_1 U_t + \alpha_2 (k-l)_t + \alpha_3 t_t^d + \alpha_4 w_t^i + \alpha_5 tot_t, \qquad (1)$$

where w is total hourly labour cost in manufacturing p is a value-added price-deflator for manufacturing production, U is the rate of unemployment, k is manufacturing capital stock, l is hours worked in manufacturing, t^d an average direct tax rate, w^i is indirect hourly labour costs in manufacturing and tot is combined indirect taxes and terms-of-trade. $k - l$ accounts for the marginal productivity of labour. Advances in the marginal productivity of labour increases labour demand, which in turn improves the bargaining position of workers, *vis-a-vis* the firms, and wages will consequently be pushed up. Higher direct taxes influence real wages as workers may seek compensation for the lower take home pay that results from these taxes. Indirect labour costs are composed of leave pay, insurance, sick leave, contributions to pension funds and other such costs. An increase in indirect labour costs tends to increase total labour costs as workers may not accept a reduction in direct wages which correspond to the increase in the indirect labour costs. The terms-of-trade variable is measured as consumer prices divided by the manufacturing value-added price-deflator. It reflects the fact that workers are concerned about consumer prices, whereas the relevant price deflator for firms is the value-added price-deflator. If, for instance, consumer prices increase and the value-added price-deflator remains constant, workers may seek compensation to maintain the purchasing power of their wage. Consequently, whereas wages deflated by consumer prices is unchanged, wages deflated by the value-added price-deflator have increased.

Equation (1) can be derived from bargaining models ⟨Nickell [1990], Manning [1993]⟩, efficiency wage models ⟨Shapiro and Stiglitz [1984]⟩ or the excess demand for labour framework ⟨Franz and Gordon [1993]⟩. Common to these models is that higher unemployment puts a downward pressure on wages as the relative bargaining power of workers weakens.[1] Furthermore, these models imply that higher taxes and import prices prompt workers to opt for higher real wages, at the costs of higher unemployment. Note that the bargaining models and the efficiency models do not necessarily include a productivity term. However, Manning [1993] give reasons as to why it is important to include a productivity term in a wage equation.

To make equation (1) suitable for testing the FPE theorem, it is rewritten as the deviation of country i's real wage from the OECD average. Furthermore, an openness variable is added to test whether it affects wage setting as predicted by the FPE theorem. This yields the equation:

$$\begin{aligned}
&[(w-p)_i-(w-p)_a]_t=\beta_0-\beta_1[U_i-U_a]_t+\beta_2[(k-l)_i-(k-l)_a]_t\\
&+\beta_3[t_i^d-t_a^d]_t+\beta_4[w_i^i-w_a^i]_t+\beta_5[tot_i-tot_a]_t+\beta_6 D\cdot op_{i,t}+\varepsilon_t,\\
&H_0\colon \beta_6=0,\ \ H_1\colon \beta_6<0. \qquad (2)
\end{aligned}$$

where the subscripts "i" and "a" refer to country i and an unweighted arithmetic average of the OECD countries, op is openness and ε is a zero-mean, finite-variance disturbance term. D is a dummy variable, which takes the value of 1 if the real wage is above the OECD average and −1 if the real wage is below the OECD average to allow for asymmetric wage responses, as discussed below. Openness is measured as the sum of real imports and exports of manufactures divided by real GDP for the whole economy. Manufacturing imports and exports are used to obtain correspondence to the other variables.

1. Though equation (1) resembles the Phillips curve there is one important difference. Unemployment puts continuous downward pressure on the wage growth in the Phillips curve framework, whereas unemployment affects the wage level in equation (1) and a change in unemployment has only a one-off effect on wage growth. Although this difference has important implications for the way the labour market adjusts to exogenous shocks ⟨see Bruno and Sachs [1985] and Blanchard and Summers [1986]⟩, the difference is not of major importance in the present context.

Since some variables in equation (2) are measured in relative price terms, they need to be converted into international prices. Real total hourly labour costs, direct tax rates, terms-of-trade and indirect labour costs are measured in US dollar purchasing power parity prices. U and $k - l$ and normalized to have the same mean across countries; otherwise countries with a high value of U and $k - l$ would weight more heavily in the OECD average.

The maintained hypothesis is that the openness of the economy does not influence wage behaviour. The alternative hypothesis is, according to the PFE theorem, that real wages tend to converge as the economies open up. Hence, if the real wage is above the OECD average, a relative real wage reduction will take place as the economy opens up and β_6 will consequently be negative. If the real wage, on the other hand, is below the OECD average a relative wage increase will take place as the economy opens up. Since op is multiplied by –1 in the latter case, β_6 will be negative.

A. Long-run Estimates Using Cointegration

This section presents the cointegration estimates of equation (2). All dependent variables are integrated of order 1 [I(1)], at the 1-percent level. All independent variables are I(1)'s except two, which are I(0).[2] Thus, equation (2) can be estimated as a cointegration regression with all variables measured in levels.

As the *t*-statistics from the cointegration estimates do not follow the standard t-distribution ⟨except in the special cases considered by Hamilton [1994]⟩, Saikkonen's [1991] estimator is used. Saikkonen's estimator enables one to obtain asymptotically consistent t-statistics, using the method outlined in Hamilton [1994, pp 608-611]. Thus, inferences on the FPE theorem can be made. Saikkonen's estimator estimates the cointegration regression with leads, contemporaneous values and lags of all regressors in first differences using OLS. Since there are only 34 observations available for each country, only contemporaneous values and one lag of the regressors in

2. Augmented Dickey-Fuller tests were used to test for order of integration with the dependent variable lagged one period. A time trend was not included following the rule of thumb of Hamilton [1994]. Hamilton suggests including a time trend only if the variable in question tends to trend upward infinitely such as income and prices.

Table 1
Cointegration Estimates of Equation (2)

	op	tot	$k-l$	U	t^{pr}	t^{d}	R^2	ADF
Can	−0.01(0.71)	0.36(1.96)	0.29(4.57)	0.17(12.8)	1.40(8.58)	−0.54(6.72)	1.00	4.16
USA	−0.00(0.28)	0.54(1.41)	0.99(1.77)	−0.13(1.52)	−1.33(2.05)	1.83(5.52)	0.98	3.00
Jap	−0.54(18.7)	−0.03(0.39)	0.14(6.63)	−0.03(1.60)	0.68(14.3)	0.33(6.55)	0.68	6.99
Aus	0.01(1.16)	2.05(3.29)	0.49(1.04)	0.18(2.53)	−0.25(0.84)	0.23(0.46)	0.99	3.51
NZ	0.01(2.84)	0.70(4.84)	−0.06(2.06)	0.02(2.04)	0.66(4.32)	0.31(3.72)	1.00	4.29
Aut	0.02(0.52)	0.94(4.37)	0.16(3.28)	0.03(1.64)	0.58(3.18)	−0.29(4.86)	1.00	4.07
Bel	−0.01(2.15)	0.93(4.49)	0.01(0.16)	0.27(5.64)	0.76(4.50)	−0.22(1.27)	1.00	4.89
Den	−0.02(0.33)	0.71(4.60)	0.57(9.57)	−0.01(0.66)	−0.12(1.26)	0.20(7.18)	0.97	4.79
Fin	−0.01(2.16)	0.66(11.5)	0.37(3.54)	−0.06(1.77)	0.34(1.36)	−0.16(1.11)	0.99	3.94
Fra	0.11(2.79)	0.56(4.53)	0.23(1.30)	0.01(0.35)	0.50(5.77)	−0.39(3.39)	0.94	3.78
Ger	−0.01(14.5)	0.63(16.2)	−0.03(2.40)	−0.03(12.3)	0.46(12.9)	−0.05(1.97)	1.00	6.76
Gre	−0.01(3.30)	−0.91(5.15)	0.37(1.12)	−0.17(4.20)	0.65(11.9)	1.06(6.28)	1.00	5.62
Ire	0.01(2.74)	1.31(16.3)	−0.08(1.18)	−0.38(1.68)	0.22(2.55)	0.35(2.49)	1.00	4.77
Itl	0.12(2.93)	0.06(0.19)	−0.22(1.56)	−0.03(0.89)	0.51(4.39)	0.58(3.08)	1.00	4.64
Net	0.00(0.15)	1.24(61.6)	0.49(11.6)	0.01(1.19)	−0.91(16.0)	0.63(9.54)	1.00	1.72
Nor	−0.01(3.20)	0.79(2.08)	−0.25(1.71)	0.05(1.07)	0.48(1.06)	−0.38(1.07)	0.94	3.46
Por	−0.02(5.23)	0.80(4.03)	−0.52(2.06)	−0.15(2.81)	−0.16(0.96)	−0.68(0.66)	1.00	5.27
Spa	−0.02(17.8)	0.53(14.9)	0.79(10.2)	−0.10(4.09)	−0.03(1.34)	0.18(2.05)	0.98	4.98
Swe	−0.14(2.44)	0.27(1.47)	0.50(3.66)	0.10(3.42)	0.57(5.10)	0.51(4.53)	1.00	5.62
Swz	−0.01(1.88)	0.42(4.18)	−0.19(2.69)	0.07(17.3)	0.85(10.8)	−0.42(3.51)	1.00	4.42
UK	−0.01(3.72)	1.15(19.1)	−0.78(9.39)	−0.10(6.18)	1.03(26.4)	−0.58(11.1)	1.00	5.24

Notes: Asymptotically consistent t-statistics in parentheses using the method of Hamilton [1994]. Aus = Australia, Aut = Austria. ADF = Augmented Dickey-Fuller test for cointegration, with the dependent variable lagged one period. R^2 = multiple correlation coefficient. Estimation period: 1960-93.

first differences are included in the estimates of equation (2).

The results of estimating equation (2), using Saikkonen's estimator, are presented in table 1 for the 21 OECD countries. The coefficient on the regressors in first differences are not shown in the table as they have no bearing on the results. The Augmented Dickey-Fuller tests suggest cointegration for about half of the countries, at the 10-percent level.[3] The R^2 are

3. One problem with the cointegration tests, as suggested to me by Adrean Pagan, is that they test for serial correlation of the residuals. However, a long-run relationship between the variables may exist in the sense that actual and predicted real wages do not drift apart over time despite the fact that the residuals may be serially correlated. Hence, the cointegration tests are supplemented with multiple correlation coefficients in table 1.

close or equal to one for most countries indicating a long-run relationship between the variables. Most of the coefficients have the expected sign and magnitude except the coefficients on direct taxes and unemployment. The few wrongly signed coefficients on direct taxes and unemployment suggest respectively that direct taxes do not influence wage setting much and that hysteresis in unemployment is present. If there is hysteresis in unemployment, the unemployed will not influence wage setting as they lose their insider status when they become unemployed ⟨Blanchard and Summers [1986]⟩.

The coefficients on openness are significant, at the 5-percent level, for 14 countries and 11 of them are negative. This result gives some support to the FPE theorem. Note that the coefficient on openness is markedly negative for Japan. Hence, the FPE theorem may explain some of the puzzle as to why workers in Japan, where real wages in 1960 were substantially below the OECD average, have experienced an increase in real wages well above the increase in the their marginal productivity ⟨Gordon [1987]⟩.

B. Long-run Estimates Using the Between Estimator

Another way to check the long-run response of real wages to openness is to use the Between estimator, which is based on the cross-sectoral component of the data. Baltagi and Griffin [1984] argue that long-lived lag effects coupled with the shortness of time-series is likely to result in dynamic underspecification in time-series estimates. However, if averages are taken over a period that is sufficiently long relative to the speed of adjustment, derivations around equilibrium values will be cancelled out in the averaging. Another advantage of the between estimator is that it is robust to dynamic misspecification of the underlying time-series model ⟨Pesaran and Smith [1995]⟩.

The Between estimator of equation (2) can be written in the following form:[4]

$$\begin{aligned}\Delta_{60\text{-}93}(w-p)_{d,i} = \gamma_0 - \gamma_1\Delta_{60\text{-}93}U_{d,i} + \gamma_2\Delta_{60\text{-}93}(k-l)_{d,i} + \gamma_3\Delta_{60\text{-}93}t^d_{d,i} \\ + \gamma_4\Delta_{60\text{-}93}w^i_{d,i} + \gamma_5\Delta_{60\text{-}93}tot_{d,i} + \beta_6 D\cdot\Delta_{60\text{-}93}op_i + \varepsilon_i,\end{aligned}$$

$$H_0\colon \beta_6 = 0, \quad H_1\colon \beta_6 < 0. \qquad (3)$$

4. Another possibility is to estimate equation (3) with each data point calculated as the average over the entire sample period for each country; for instance the average deviation of a country's real wage from the OECD average over the period from 1960

where $\Delta_{60\text{-}93}$ denotes the change from 1960 to 1993 and the subscript d signifies the deviation from the OECD mean. For instance, $\Delta_{60\text{-}93}(w-p)_{d,i} = [(w-p)_i - (w-p)_a]_{1993} - [(w-p)_i - (w-p)_a]_{1960}$. D takes the value 1 (–1) if the real wage of the country is initially above (below) the OECD average. The FPE theorem implies that, as trade opens, real wages decrease, relative to the OECD mean for countries with real wages that are initially above the OECD average.

Estimating equation (3) with data for the 21 OECD countries listed in table 1 gives the following result:

$$\Delta_{60\text{-}93}(w-p) = \underset{(1.05)}{-0.06} - \underset{(3.48)}{0.18}\Delta_{60\text{-}93}U + \underset{(0.55)}{0.06}\Delta_{60\text{-}93}(k-l) + \underset{(0.01)}{0.00}\Delta_{60\text{-}93}t^d$$

$$+ \underset{(0.55)}{0.08}\Delta_{60\text{-}93}w^i + \underset{(4.26)}{0.62}\Delta_{60\text{-}93}tot - \underset{(6.67)}{0.35}D.\Delta_{60\text{-}93}op_i,$$

$$R^2 = 0.93 \quad Het = 3.32, \tag{4}$$

where t-statistics are in parentheses and Het is Glejsler's test for heteroscedasticity, $\chi^2(5)$-distributed under the null hypothesis of homoscedasticity. The R^2 indicates that a high proportion of the variation of the dependent variable is explained. All coefficients have their expected sign. The coefficient on openness is highly significant, which gives support to the FPE theorem.

III. Short-run Estimates

In this section the FPE theorem is tested using short-run estimates.[5] The

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to 1993. However, there are three problems with this method. First, all variables need to be converted into purchasing power parities. However, data on purchasing power parity for manufacturing capital stock are not available. Second, the capital labour ratios are not comparable across nations as the level of capital stock cannot be compared across nations. Third, some countries have higher real wages than others because they have higher labour productivity, at a given capital-labour ratio.

5. Mokhtari and Rassekh [1989] formally test the validity of the FPE theorem using the following equation:

$$vw_t = k_0 + \kappa_1 vkl_t + \kappa_2 op_t + u_t,$$

where vw_t is the log of the variance of wages across countries, and vkl_t the log of the variance of the capital labour ratio across countries. This equation may not be suitable to test the FPE theorem, because the variances are sensitive to outliers. Fur data are pooled across countries to gain efficiency. All variables are measured in first differences to certify that they are stationary and that fixed effects are removed. The lagged residuals from the cointegration equations presented in table 1 are included in the estimates as an error-correction term. Equation (2) is first estimated using a generalized instrument estimator, which is very efficient; however, the hypothesis of coefficient homogeneity across countries is rejected, at the 1 percent level.[6] Hence, the estimates are supplemented with estimates using Swamy's [1971] random coefficient estimator, which is less efficient than the generalized instrument estimator but yields unbiased coefficient estimates.

The generalized instrument estimator assumes the following covariance structure ⟨Kmenta [1986]⟩:

$$E(\varepsilon_{it}^2) = \sigma_i^2, \qquad i = 1, 2, \ldots N,$$
$$E(\varepsilon_{it}\varepsilon_{jt}) = \sigma_{ij}, \qquad (5)$$

where N is the number of countries, ε_{it} is the disturbance term for country i

thermore, vw tends to be sensitive to cyclical influences; for instance, it showed an extraordinary cyclical downturn in the 1974/75 and 1981/82 recessions. Finally, this equation does not allow for the presence of unemployment (the FPE theorem is derived under the assumption of fully employed resources).

Estimating this equation with all variables measured in first differences (as the variables contain a unit root) and with vw_t measured as the variance of real wages in purchasing power prices yields:

$$\Delta vw_t = \underset{(3.23)}{-0.15} + \underset{(0.94)}{0.10}\Delta vkl_t + \underset{(3.68)}{3.96}\Delta op_t, \quad R^2 = 0.31 \quad DW = 1.82,$$

where t-statics are in parentheses and DW is the Durbin-Watson test for first order serial correlation. Note that only a small proportion of the variance of the dependent variable is explained. The estimate rejects the FPE theorem, at the 5 percent level.

6. The test suggested by McElroy [1977] was used instead of the Chow-test to test for coefficient homogeneity across countries, because the Chow-test tends to reject the null hypothesis too frequently ⟨Baltagi [1995]⟩ and does not take into account that the pooled estimates give more efficient parameter estimates than single country estimates. The unrestricted model was estimated using Zellener's SURE method since the restricted model is estimated under the assumption that the error terms are mutually correlated. The likelihood ratio test is 168.5, which is $x^2(21, \lambda)$ – distributed under the null hypothesis of coefficient constancy, where λ is a noncentrality parameter ⟨defined in Baltagi [1995]⟩. Note that $x^2(21, \lambda)$ does not follow the standard x^2-distribution. With a critical value of about 80, at the 1-percent level, the null hypothesis is rejected.

Table 2
Pooled Cross-section and Time-series Estimates of Equation (2) in First Differences

	Kmenta	Swamy
$\Delta(w-p)_{d,t-1}$	0.0301(2.06)	0.0535(1.54)
Δop_t	–0.0034(6.95)	–0.0097(0.33)
$\Delta tot_{d,t}$	0.4621(16.9)	–0.0850(0.59)
$\Delta(k-l)_{d,t}$	0.1927(9.53)	0.0632(0.72)
$\Delta(k-l)_{d,t-2}$	0.0953(4.73)	–0.0850(0.22)
$\Delta U_{d,t}$	–0.0194(2.85)	–0.0563(1.36)
$\Delta U_{d,t-1}$	–0.0181(5.56)	–0.0515(2.12)
$\Delta w^i_{d,t}$	0.8289(48.2)	0.7187(7.73)
ε_{t-1}	–0.5313(9.34)	–0.5432(5.12)
constant	–0.0015(8.75)	–0.0039(0.47)
R^2	0.87	0.55
DW	1.93	1.88
Het	0.07	0.00
RESET	2.93	0.88

Note: *t*-statistics in parentheses. ε_{t-1} = error correction term; ie the residuals from the cointegration estimates of equation (2). R^2 = Buse's R^2. *DW* = Durbin-Watson test for first order serial correlation. *Het* = Glejser's test for heteroscedasticity, $\chi^2(9)$-distributed under the null hypothesis of homoscedasticity. RESET = Ramsey's RESET test of power 3 for functional form, $\chi^2(2)$-distributed under the null hypothesis of correct functional form. Following instruments are used for ΔU_t: ΔU_{t-1}, $\Delta(w-p)_{d,t-1}$, Δtwy_t, Δtwy_{t-1}, $\Delta m1r_t$ and $\Delta m1r_{t-1}$, where *twy* is trade weighted income and *m*1*r* is *M*1 deflated by consumer prices. Following instruments are used for Δop_t: Δop_{t-1}, Δtwy_t, Δtwy_{t-1}, Δcx_{t-1}, Δpo_t and Δpo_{t-1}, where *cx* is export price competitiveness and *po* is oil prices measured in US dollars. Following instruments are used for $\Delta tot_{d,t}$: $\Delta tot_{d,t-1}$, Δpo_t, Δpo_{t-1}, Δcx_{t-1}, $\Delta m1r_t$ and $\Delta m1r_{t-1}$. Following instruments are used for $\Delta w^i_{d,t}$: $\Delta w^i_{d,t-1}$, $\Delta U_{d,t-1}$, Δpo_t, Δpo_{t-1}, $\Delta t^d_{d,t}$, $\Delta t^d_{d,t-1}$, Δgr_t and Δgr_{t-1}, where *gr* is real government consumption. Estimation period: 1965-1993.

at time *t*, σ_i^2 is its variance, σ_{ij} is the covariance of the disturbance terms across countries. The variance σ_i^2 is assumed to be constant over time for country *i*, but to vary across countries and the error terms are assumed to be mutually correlated across countries, σ_{ij}, as the countries have been exposed to shocks stemming from the same origin; for instance the oil price shocks, the labour movement mobilization that took place in most OECD countries in the late 1960's ⟨see Bruno and Sachs [1985]⟩ and the transition from fixed to floating exchange rates in the beginning of the 1970s. σ_i^2 and σ_{ij} are estimated using the feasible generalized least squares method described in Kmenta [1986]. All variables are lagged two periods to allow for sluggish adjustment. The general-to-specific model reduction procedure, with the 5 percent bench-mark significance level, is used to gain efficiency in the Kmenta estimates. Variables with wrongly signed coefficients are deleted, as they would otherwise introduce spuriousity into the regressions, except the coefficients on openness, because this is the coefficient of chief interest.[7] The following endogenous regressors are instrumented: $\Delta U_{d,t}$, Δop_t, $\Delta w^i_{d,t}$ and $\Delta tot_{d,t}$. The instruments are listed in table 2. The general-to-specific model reduction procedure is not used in estimate where the Swamy random coefficient estimator is used. Instead the reduced model from the Kmenta estimates is used.

Table 2 presents the results of estimating equation (2) in first differences. The diagnostic tests do not give evidence against the model specification. The Swamy model coefficient estimates, when they are significant, are of quite similar magnitude as the Kmenta model estimates. Thus, the estimating results, using the Kmenta estimator, are not likely to be too distorted by aggregation. I will therefore focus on the Kmenta estimates in the discussion in the next paragraph.

The coefficient estimates are compatible with most of the long-run estimates. The coefficient on openness is negative and significant, but lower than in the long-run estimates; however, the error-correction term certifies that the relative wages converge to the long-run equilibria dictated by the cointegration estimates. This result suggest that FPE takes place at a slow rate.

IV. Conclusions

This paper has examined the influence of openness on real wages in the OECD countries in the short and in the long run using a mix of time-series

7. The coefficients on openness are not sensitive to whether this rule is enforced or not.

and pooled cross-section and time-series analysis. The estimates indicate that real wages are converging across the OECD as a result of the increased openness as predicted by the PFE theorem. The convergence was found to occur at a slow pace over time.

Appendix
Data

Value-added price-deflator: Nominal GDP divided by real GDP: OECD, *National Accounts (NA)*. **Direct taxes:** General government direct taxes and other contribution receipts divided by nominal GDP for the whole economy *(NA)*. **Hours worked:** ILO, *Yearbook (YB)*. **Direct hourly wages:** *YB*. **Exchange rates:** IMF, *International Financial Statistics (IFS)*. **Employment:** *YB* and *NA*. **Total hourly labour costs:** Compensation to employees *(NA)* divided by hours worked and employment. **Indirect labour costs:** Total hourly labour costs minus direct hourly labour costs. **Consumer prices:** *IFS*. **Unemployment rates:** *YB* and OECD, *Labour Force Statistics (LFS)*. **Capital Stock:** Net capital stock OECD, *Flows and Stocks of Fixed Capital.* For the countries where the net capital stock for manufacturing is not available the inventory perpetual method is used. The capital output ratio is assumed to be 1 in 1950 and manufacturing investment data, with a 6-percent annual depreciation rate, are used. **Purchasing power parity prices:** OECD: *Purchasing Power Parities.* **Exports and imports in current prices:** OECD, *Foreign Trade by Commodities,* SITC sections 5 to 8. **Volume indices of manufacturing imports and exports:** OECD, *Historical Trade Statistics,* UN, *Statistical Yearbook,* World Bank, *World Tables,* OECD, *Trade Statistics* and national sources, which are available from author. **Trade weighted income:** Total real GDP **(NA)** in the OECD countries weighted by manufacturing export (OECD, *Trade in Commodities*) for each country in 1981. **Export price competitiveness:** Multilateral index for export price competitiveness deflated by manufacturing export prices (or export unit values): 1964-77; Durand [1986], 1978-93; OECD, *Economic Outlook;* 1960-63 plus Australia, Ireland and Spain for the whole period: relative wholesale prices with weights from the 1970 weighting matrix in Durand [1986]. **M1:** *IFS.* **US dollar oil prices:** IFS. **Real government consumption:** *NA*.

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