TESTING THE FACTOR PRICE EQUALIZATION
THEOREM IN THE SIXTEEN EUROPEAN COUNTRIES

Halit YANIKKAYA[*]

Abstract

The factor price equalization theorem states that trade in commodities through their indirect effects on factor prices tends to equalize factor rewards internationally although it is most unlikely to happen in the real world. Thus, this paper estimates factor price convergence rather than factor-price equalization in the sixteen European countries. First, graphical presentation of the data shows the convergence of factor prices during the sample period. Then, the statistically significant and negative coefficient for trade openness provides considerable evidence for the empirical relevance of the factor price convergence theorem, at least in the Europe-16. Conditional on the FPE theorem holds, we also distinguish between "high wage" countries and "low wage" countries.

1. Introduction

Ohlin (1952) argued that international trade that directly affects commodity prices and indirectly affects production factor prices tends to equalize factor prices internationally (originally stated in 1933). Later, Samuelson (1948 and 1949) showed in subsequent two papers that, under certain specified conditions, complete trade liberalization will inevitably lead to complete factor price equalization. Therefore, the factor price equalization (FPE) theorem implies that free trade in goods and services equalizes the returns earned by the same factor internationally under certain assumptions: identical technologies, identical product mixes, and no factor intensity reveals, which are the assumptions underlying Hecksher-Ohlin model of the international trade. Since Ohlin (1952), the FPE theorem has attracted much attention in the theoretical literature. Bhagwati (1964) surveyed mucf of the literature on the FPE theorem.

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[*] Dr., C.B.Ü., İktisadi ve İdari Bilimler Fakültesi, İktisat Bölümü.

In real world, we, however, expect only partial factor-price convergence rather than complete factor price equalization, which basically is impossible for a number of reasons. For example, when the number of factors exceeds the number of goods, no complete factor-price equalization can be expected from trade alone (see, Samuelson, 1948 and 1949). Also, in real life, taste differences must be expected to complicate the analysis (see, Samuelson, 1971). Moreover, Caves and Jones (1985) argued that without the assumption of identical technologies across countries, no presumption of trade equalizing factor returns remains. Other assumptions also disrupt the FPE theorem; transportation costs, scale economies, or tariffs may interfere with the factor-price equalization between countries.

Numerious studies (such as, Ethier, 1995, and Samuelson, 1948 and 1949), stated that if countries specialize completely, it will be highly unlikely for the FPE theorem to hold even with zero tariffs and transportation costs. Since factor prices need not be completely equalized because costs need not equal international prices and, therefore, each other. The FPE theorem depends on the proposition that free trade has been a complete substitute for international factor mobility. If specialization, however, prevents complete factor-price equalization, trade in goods is only a partial substitute for factor mobility. Trefler (1993) has made a lot of mileage out of the assumption of identical technologies across countries that there are technological differences across countries. Factor augmenting international technology differences imply that endowments must be adjusted to reflect international productivity differences. He showed that these international productivity differences are consistent with observed international price differences. He, then, concluded that the FPE hypothesis is widely at odds with the large variation in factor prices across countries.

However unlikely for the FPE theorem holds, it is most likely to occur in the European countries than anywhere in the world. Accordingly, this paper estimates the hypothesis of factor price convergence that higher trade volumes lead to convergence in factor prices, rather than factor-price equalization in the sixteen European countries. OLS estimation results presented in the paper show the process of relative factor price convergence in the Europe-16 during the sample period considered. Finally, conditional on the FPE theorem holds, the paper distinguishes between "high wage" and "low wage" European countries.

Section 2 reviews some of the previous empirical literature. Section 3 investigates the behavior of trade openness, factor endowments, and wage movements in sample countries. Section 4 provides an estimation of the FPE theorem. Section 5 concludes the paper.

2. Literature Review

Given the discussion above, it is no wonder that the FPE theorem has attracted little empirical attention from the economics profession. Moreover, Leamer and Levinshon (1995) argued that empirical studies should not try to test whether the FPE theorem is true or not. Rather they should try to find what causes the violations that we observe since FPE is a corollary requiring the additional and unlikely assumptions. Leamer (1993) investigated the behavior of the wages and found that there are vast differences around the world in the rates of labor compensation. Particularly, he found some wage differences among European Community Countries (ECC) in 1978 but concluded a considerable amount of wage equalization between 1978 and 1989. Tovias (1982) chose the ECC as an ideal environment to estimate the theorem. He investigated the wage movements in the member countries of the ECC before and after the formation of the ECC. He found the evidence for wage convergence between 1955 and 1970, but after the 1970's, the divergence started to occur in the original four members of the ECC. However, these result are contrasted with the fact that full regional trade liberalization in the Six was actually reached by 1968, a time, as we saw, when wages began to diverge again.

Gremmen (1985) enhanced Tovias' work by using regression analysis. He showed that where trade is intense, trade openness has a significant effect on wage movements while relative factor endowments do not, and where trade is not intense, both variables have significant effects on wage movements. He found exact same results for ECC countries where trade is intense, and for OECD countries where trade is not. Therefore, he concluded that the more free trade, the less the differences in good prices, and the greater the convergence in factor prices. Mokhtari and Rassekh (1989) investigated manufacturing wage movements, trade expansion, and factor endowments among sixteen OECD countries for the period 1961-1984. They found a strong evidence for factor price convergence and trade openness was the most crucial factor influencing wage variations across countries. They suggested a procedure in which we can distinguish countries as " high wage " and "low wage" countries, conditional on the validity of the FPE theorem.

3. Measurements and the Graphical Analyses of Data

This section presents a detailed description of the three variables that are used in the empirical part of the paper.

a. Trade Openness

Trade openness of countries is usually measured by using their trade volumes. The most basic and widely used measure of trade openness is the ratio of exports plus imports to GDP. Thus, higher ratios mean more open economies. Let X_{it}, M_{it}, and Y_{it} be real exports, real imports, and real GDP, respectively, for country i at time t, where i=1,...,n and t = 1971 to 1994. Thus, the degree of trade openness for each country can be measured by $OP_{it} = (X_{it} + M_{it}) / Y_{it}$. This ratio, which usually called the basic trade intensity ratio, demonstrates an upward trend over time for all of the sample countries even though the overall ratio fluctuates heavily over time. To measure the overall openness (TOP_t) in the Europe-16 (EC and EFTA countries omission of Luxembourg), we simply add up individual openness ratios over time. The graph of TOP_t for the period 1971-1994 appears in Figure 1. The Europe-16's overall trade relative to its output expanded slightly from 0.44 to 0.51 during the sample period. Aberrations to this trend occurred in early 1970's and 1985 probably due to global recessions.
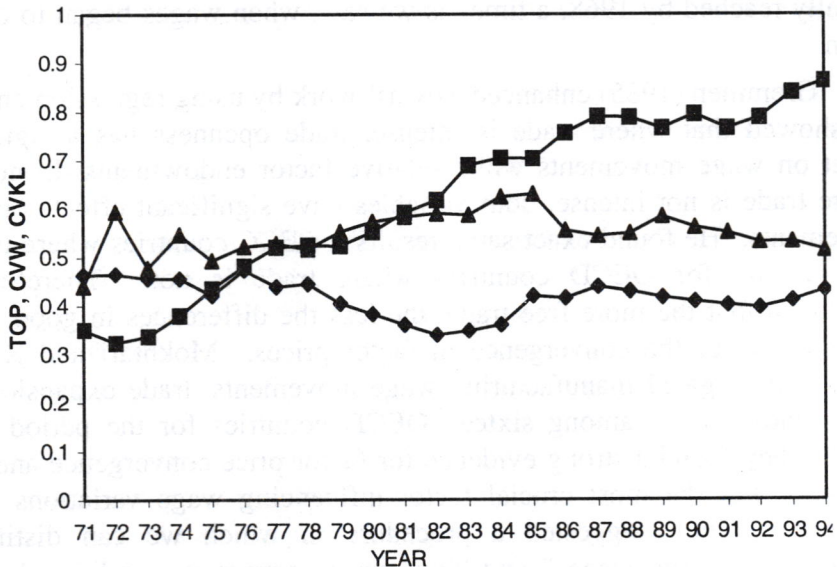
▲ TOP: Trade openness
♦ CVW: Coefficients of variation of real wages
■ CVKL: Coefficients of variation of capital-labor ratios
Sources cited in references.

Figure 1: Time Path of Trade Openness, Coefficients of Variation of Wages, and of Capital-Labor Ratios for 16 European Countries

b. *Factor Endowments*

The FPE theorem requires that the trading partners must have the same technology and their relative factor endowments should not be too disparate. Therefore, we calculated capital-labor ratios as $KL_{it} = K_{it} / L_{it}$, where K and L denote real capital stock, and employment, respectively. We generated time series of coefficients of variations of KL_{it} ($CVKL_t$), by computing the mean and standard deviation across countries for each year. Figure 1 shows a remarkable divergence of CVKL in the Europe-16 over the sample period.

The divergence of CVKL suggests that the methods of technology are diverging, which may cause factor price divergence. It may also suggest that the disparity in relative factor endowments is increasing.

c. *Wage Movements*

The FPE theorem also states that factor prices are equal by type, while manufacturing wages are average wages (Mokhtari and Rassekh, 1989). Consequently, to estimate the FPE theorem by using average wages is not implausible. Next, we generated the coefficients of variation of wages (CVW) by applying same technique, as used for capital-labor ratios. Real wages are used to compute CVW. Figure 1 presents the graph of this variable as well, which does not provide a strong evidence for convergence of manufacturing wages in the Europe-16 over time. However, convergence of wages took place from 1971 through 1982. It diverged heavily between 1982 and 1985, then it has almost remained at the same level after 1985. However, observe that the CVW in 1994 is still lower than that of in 1971, which indicates relative convergence of wages. A comparison between TOP and CVW reveals that from 1978 to 1982, increase in trade openness is associated with wage convergence. A sharp decline in trade openness that started in 1985 causes the more wage divergence in Europe-16. The association between CVW and TOP is predicted by the FPE hypothesis; an expansion in trade due to liberalization of trade flows results in good price convergence, which leads to narrowing international differences in factor rewards.

4. Empirical Results

This section provides an estimation of how manufacturing wages were affected by factor endowments, trade openness, and employment rates in the sixteen European countries. The reason why employment rates are included in the OLS regressions is that the FPE theorem assumes full employment.

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We employ the following equation by utilizing the coefficients of variation of wages as the dependent variable;

$$\ln CVW_t = a_o + a_1 \ln (CVKL_t) + a_2 \ln (TOP_t)$$

$$+ a_3 \ln (E_t) + u_t, \tag{1}$$

where, u_t is the white noise residual term, CVKL is the coefficients of variations of capital-labor ratios, TOP is the trade openness, and E is the cross country employment rate that is computed for each year. As the FPE theorem implies, we, a priori, expect the following: coefficients of capital-labor ratio and employment are positive and that of trade openness is negative. The CVW and E are positively correlated since with the labor force across countries assumed to be not homogeneous, a larger variation in wages should accompany a higher employment rate. We report OLS estimates of (1) below;

$$\ln CVW_t = -1.07 - 0.10 \ln (CVKL_t) -0.47 \ln (TOP_t) + 0.02 \ln(E_t)$$

$$(-6.59) \quad (-2.01) \qquad\qquad (-2.03) \qquad\qquad (2.14)$$

$$S.E = 0.070 \qquad R2 = 0.49 \qquad D.W = 1.69 \tag{2}$$

The values in the parentheses are t-statistics. Regression results show that CVKL has a statistically significant coefficient but not correct sign. As expected, trade openness and employment are the important factors affecting wages variation across countries and they have the correct signs. Since the R-coefficient is low, it is clear that, however, other factors will still have to be found to explain the wage differences in the Europe-16 countries. These results are not inconsistent with the findings of Gremmen (1985) and Mokhtari and Rassekh (1989).

Next, conditional on the FPE theorem holds, we attempted to find "high wage" countries and "low wage" countries. Therefore, we run the following regression for each individual country;

$$\ln W_{it} = b_o + b_1 \ln KL_{it} + b_2 \ln e_{it-1}$$

$$+ b_3 \ln w_{it-1} + b_4 \ln OP_{it} + u_{it}, \tag{3}$$

where u_{it} is white noise error term, KL_{it} denotes capital-labor ratio, $\ln e_{it-1}$ denotes lagged employment rate, w_{it-1} denotes lagged real wages, and OP_{it} denotes trade openness. The inclusion of the trade openness measure basically distinguishes between "high wage" countries and "low wage" countries. As trade expands, either wages of "high wage" countries should fall while those of "low wage" countries rise, or wages in the former should increase at a slower rate than the wages in the latter.

Equation (3) is estimated by pooling data for sixteen European countries over the period 1971-1994. Table 1 reports the estimation results for the coefficients of trade openness variables (b_4) for individual countries. As can be seen from the table, OLS estimates show negative coefficients for b_4 for all countries except Denmark and Italy. Although negative values classify these countries as "high wage" countries, trade openness has a significant coefficient for only six countries. The following countries, with coefficients below the median, can be classified as "high wage" countries; Belgium, Austria, Germany, Netherlands, Switzerland, Finland, and France. The coefficient of Portugal is -0.43, which is the median. Sweden, Greece, Norway, Italy, United Kingdom, Ireland, Denmark, and Spain can be classified as "low wage" countries.

Our results are mostly consistent with the results of Leamer (1993). He found a considerable amount of wage equalization between 1978 and 1989 among EC countries. Real wages in the "high wage" countries fell, and real wages of the "low wage" countries generally rose. He concluded that although there was a substantial wage differences between UK and the other member of the EEC in 1960, in 1978, the ECC seemed to divide into two groups: high wages in Denmark, Germany, France, Italy, and UK; and low wages in Ireland, Spain, Greece, and Portugal. Thus, while our classification of "low wage countries" is

Table 1: OLS Estimates: Dependent Variable: Real Wages

High Wage Countries		Low Wage Countries	
Belgium	-1.39	Sweden	-0.38
	(-3.53)		(-0.75)
Austria	-1.13	Greece	-0.34
	(-2.05)		(-1.01)
Germany	-1.05	Norway	-0.23
	(-2.61)		(-0.35)
Netherlands	-0.89	Italy	-0.19
	(-1.89)		(-0.34)
Switzerland	-0.83	U.K.	-0.1
	(-1.59)		(-0.28)
Finland	-0.53	Ireland	-0.07
	(-1.73)		(-0.05)
France	-0.49	Denmark	0.13
	(-1.53)		(0.19)
Portugal	-0.43	Spain	0.21
	(-1.88)		(0.38)

t-statistics are in parentheses.

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surprisingly similar to that of Leamer, there are some disagreements about the categorization of "high wage countries" probably due to the different time spans considered in each study.

5. Conclusions

Although the assumptions that the FPE theorem requires are unlikely to present, they are most likely to be present in sixteen Europe countries than anywhere in the world. Thus, this paper estimates factor price convergence that as trade barriers decrease, factor prices converge, rather than factor-price equalization in the sixteen European countries. Our results demonstrate the process of relative factor price convergence during the sample period. First, examination of the data reveals that capital-labor ratios diverged across the sample countries. Then, regression analysis employed to determine the degree to which wage convergence was influenced by capital-labor ratios, trade openness, and the employment rates. Our results fail to provide evidence to doubt the empirical relevance of the factor price convergence theorem, at least in the Europe-16. Finally, conditional on the FPE theorem holds, the paper distinguishes between "high wage" countries and "low wage" countries.

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