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**Can the HOS model explain changes in  
labor shares? A tale of trade and  
wage rigidities**

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**January 2011**

**DT-GREQAM**

# Can the HOS model explain changes in labor shares? A tale of trade and wage rigidities\*

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**Abstract:** This paper questions the ability of the standard HOS model to explain changes in the labor shares (LS) of income in OECD countries. We use the Davis (1998) model where there is a wage rigidity in a sub-group of countries. We show that trade openness with developing countries reduces LS in rigid-wage countries, and does not affect LS in free-wage countries. This pattern is induced by factor reallocation towards capital-intensive sectors in rigid-wage countries. Using the KLEMS dataset for 8 OECD countries over the period 1970-2005, we show that the weight of capital-intensive sectors substantially increased in Continental European countries, while it did not change or even decreased in the US and the UK. Fixed effects regressions suggest that trade intensity with China explains between 30% (IV estimates) and 60% (OLS estimates) of the observed differential labor share change between Continental Europe and Anglo-Saxon countries.

**Keywords:** Davis model; factor reallocation; elasticity of substitution; unemployment

**JEL classification:** E25; F16

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# 1 Introduction

The ratio of wage bill to value-added is not constant over time and space. In continental European countries, the labor share (LS) increased in the 1970s, peaked in the early 1980s, and then dramatically fell in the 1980s-1990s. The decline reaches 10 points in France, which creates endless debates about workers' fair share of income. By contrast, the share is very stable in the UK, US, and Canada. Accordingly, political interests in the LS are nonexistent. These diverging patterns of the LS take place in a particular era characterized by product market globalization, and especially trade with developing countries. The research question we address in this paper is whether the HOS model, once completed by a wage rigidity in a sub-group of countries, can account for such changes in LS in OECD countries.

Changes in LS are not easy to reconcile with perfect competition and technological homogeneity. The classical view of the LS highlights the role of the elasticity of substitution between capital and labor. From this perspective, LS movements result from the impacts of capital deepness and technological change. Cobb-Douglas technologies feature a unitary elasticity of substitution. The LS is constant as a result (see e.g. Kaldor, 1955, Solow, 1958, and Kravis, 1959). Constant Elasticity of Substitution technologies can explain why the labor share varies with capital intensity. But the predicted relationship between the labor share and capital intensity is monotonic, which is not compatible with the set of facts reported above. Since Blanchard (1997), several papers considered the role of technological change (see e.g. Hornstein et al, 2002, Acemoglu, 2003, Bentolila and Saint-Paul, 2003, Guscina, 2006, and Ellis and Smith, 2007). Firms may have adopted labor-saving technologies as an answer to the supply shock of the 1970s. The elasticity of substitution between capital and labor would have increased as a result. The main shortcoming of this approach is that, according to Nordhaus (1997), it seems unrealistic that production techniques used in continental European countries remain unknown in the Anglo-Saxon world.

A number of contributions depart from the perfect competition paradigm. Checchi and Garcia-Peñalosa (2007) show that in a closed economy where wages are collectively bargained, unemployment benefits, minimum wage or union bargaining power increase the labor share. Blanchard (1997) and Blanchard and Giavazzi (2003) highlight the interaction between product and labor market imperfections. A decrease in European labor shares may be due to (i) an increase in the mark-up of price over marginal costs, or (ii) a decrease in workers' bargaining power due to labor market reforms. However, a mark-up increase is not really plausible given that the 1980s and the 1990s are characterized by European integration, globalization and product market deregulation. Meanwhile, reforms have been more timid and piecemeal on the labor market (Boeri et al, 2000). In France for instance, the early 1980s saw the introduction of stricter regulations rather than softer ones.

In this paper, we point out the role of trade and wage rigidities, or, more precisely, the fact that the trade impact on the labor share differs according to whether the country is characterized by wage rigidity or not. Section 2 describes the aggregate patterns of labor shares in OECD countries. It also discusses the microeconomic evidence, which suggests that aggregate changes are driven by factor reallocation across sectors with heterogeneous and stable labor shares. Then, we consider the Davis (1998) model. In standard HOS theory, markets are perfectly competitive and factor prices are determined by factor endowments at the world level. The relative scarcity of capital with respect to labor determines the

relative price of the capital-intensive good. In turn, such a relative price determines the relative factor price by Stolper-Samuelson theorem. In Davis, a subset of countries participating in international trade set a wage rigidity that is not compatible with full employment. The wage rigidity does not alter the Stolper-Samuelson relationship, and the relative price of the capital-intensive good goes up. This must be true at the world level, leading to factor price equalization throughout the world. The employment cost of the rigidity is magnified.

We use the Davis model to predict the impact of trade openness and wage rigidities on the labor shares of income. We model the wage rigidity in a convenient form: we assume that the relative price of labor with respect to capital is exogenously given. This allows us to write the model outputs as simple functions of the relative wage rigidity. Our arguments hinge on the following idea. In the country that implements the relative wage rigidity, globalization induces factor reallocation towards capital-intensive and low-labor share sectors. Globalization, therefore, increases the aggregate elasticity of substitution between capital and labor, or, equivalently, reduces the aggregate elasticity of labor demand with respect to relative factor cost. In the free-wage country, globalization does not alter factor allocation across sectors. Sector weights in aggregate value-added do not change, and the aggregate labor share stays constant. We focus on two implications.

First, increasing the rigid wage is more likely to decrease the labor share in a globalized world than in a closed economy. For instance, the labor share stays constant in a closed economy when sector-specific technologies are Cobb-Douglas and the utility function is log-linear. By contrast, and under the same technological assumptions, the labor share falls when the economy is open to international trade. A decline in European labor shares does not require any product market imperfections and involves more rigid wages rather than less rigid wages. It also means that European workers not only pay a huge price in terms of foregone jobs, but they also suffer from low relative earnings prospects.

Second, we follow Davis and consider the implications of free trade between three economic zones: Europe, the US and Newly Industrialized Countries. The European wage rigidity is set at the competitive level that prevails in autarky. Trade openness leads to a strong decrease in European LS, while keeping the US share constant. Meanwhile, such changes at the aggregate level are compatible with stable labor shares at the firm/sector level.

Then, we turn to empirical implications. Our purpose is not to provide an n-th test of HOS theory. Rather, we assume that HOS theory broadly works to describe the patterns of trade<sup>1</sup>, and we examine whether trade-induced factor reallocation can explain a substantial part of observed changes in labor shares across Continental Europe and the Anglo-Saxon countries. We use the KLEMS dataset, which provides sectorial data for 8 OECD countries over the period 1970-2005. To closely mimic the model, we build two super sectors. The capital-intensive sector is composed of sectors whose capital intensity is larger than the aggregate capital intensity in 1980. The labor-intensive sector is composed of the remaining sectors. The magnitude of trade with developing countries is captured by bilateral trade openness with China. The choice of this variable follows Michaels et al (2009) who argue that trade with China is a good proxy for the whole of trade with developing countries.

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<sup>1</sup>One of the most serious critiques of the HOS model is that firm-level data do not support endowment-driven specialization across products. However, Schott (2003) argues that such specialization occurs *within* products.

Trade with China grew in all countries. It starts from 0 in the early 1970s and reaches between 1.5% and 3.5% in the 2000s. Meanwhile, the share of the capital-intensive super-sector experienced a 6-point increase in Continental European countries, while it did not change or even declined by 6 points in the UK and the US. Trade and capital-intensive sector shares seem, therefore, positively correlated in rigid-wage countries, and negatively or uncorrelated in free-wage countries. These opposite phenomena are in line with the model discussed above.

We then regress the share of the capital-intensive super-sector on trade with China. Trade with China is also interacted with a dummy variable taking the value one if the country is from continental Europe, and 0 otherwise. All regressions feature country fixed effects, time effects, and the aggregate ratio of capital stock to GDP to account for Rybczynski effects. IV estimates imply that trade with China explains half the observed differential capital-intensive sector share change (against 100% for OLS estimates). The corresponding differential impact on the labor share is about 1 point (2 points), a third (two thirds) of the observed effect.

Recent literature deals with the impact of globalization on the LS. A first strand of literature considers the basic implications of the HOS model without wage rigidity. Following trade openness between labor- and capital-abundant countries, the wage share should go down in capital-abundant countries and up in labor-abundant countries. This theory fails to explain the variety of patterns that the different groups of OECD countries experience. A second strand of the literature was initiated by Rodrik (1997) who argues that openness hurts workers' bargaining power and makes wages decreasing at given output. Going from a decline in wage to a decline in LS is not so simple: as far as labor is paid its marginal product, changes in wages do not tell much about changes in the LS. Models typically assume that there are rents on the product market created by imperfect competition, and workers and firms' owners bargain over total surplus, including rents. Any increase in firms' statu-quo position reduces the share of rents accruing to labor, thereby deteriorating the LS. Harrison (2002), for financial openness, and Ortega and Rodriguez (2002), for international trade, develop models along these lines. Rodrik-type arguments imply that the labor share should decrease both at the aggregate level and within firms or sectors. The empirical evidence suggests that it may not be the case, at least in OECD countries. Furthermore, and as the first strand of literature, those theories cannot predict the observed heterogeneity at the country level in the patterns of aggregate labor shares. Decreuse and Maarek (2009) develop a model in which foreign direct investment has negative and then positive impacts on the LS in DCs. Their paper does not involve international trade, and only concerns DCs.

The rest of the paper is organized as follows. Section 2 details the main stylized facts, while Section 3 presents the theoretical results. Section 4 discusses how the theory can explain the facts and extends the basic model to capital-skill complementarity. Section 5 concludes.

## 2 Stylized facts

In this section, we present the set of facts that we want to explain. Such facts concern overall changes in the labor shares in developed countries, the negative correlation between the LS and the unemployment rate, and the small changes observed at disaggregate level.

We distinguish developed countries according to the degree of wage rigidity. However, measures of the degree of wage rigidity are endogenous and may respond to changes in the labor share. In addition, we need a broad measure that allows us to sort countries into two groups, rather than a continuous measure that makes a precise distinction between countries. Botero et al (2004) show that the degree of labor market regulation is strongly determined by the legal origins of the judicial system. They classify five different legal origins: English, French, German, Scandinavian, and Socialist. They argue that countries with common law legal systems (English law) regulate their labor market much less than countries with civil law legal systems (other laws). Legal origins are predetermined, which offers a simple way to deal with potential endogeneity problems.

We distinguish two sets of countries. Civil-law countries correspond to Finland, France, Germany, Italy, the Netherlands, and Spain, whereas common-law countries correspond to the US, Canada, and the UK. This distinction broadly maps the more usual distinction between continental European and Anglo-Saxon countries.

The labor share is computed as the ratio of total employee compensation over value added calculated at market price. Labor shares must be corrected to account for self-employment.<sup>2</sup> Individual labor shares are reported in the Appendix. We compute the aggregate labor share for both zones as a weighted average of country-specific labor shares (GDP shares are used as weights).

Figure 1 reports the patterns of the labor shares in Anglo-Saxon and continental European countries. The labor share amounts to 64.5% for Anglo-Saxon countries and 65% for European countries in 1970, which corresponds to the standard calibrated value. Continental European countries experience an increase in the labor share starting from the early 1970s, and then a sharp decrease starting from the early 1980s. The decrease overshoots the increase of the 1970s and the labor share is lower in 2000 than in 1970, 59.5% against 65%. The Anglo-Saxon labor share is more stable: it decreases from 64.5% to 62.5%.<sup>3</sup> The differential change, therefore, is -3.5 labor share points against Continental Europe.

Overall changes in European labor shares broadly mirror changes in unemployment rates. European unemployment massively increased during the 1980s, and stayed high afterwards. By contrast, Anglo-Saxon unemployment rates did not change much. To quote Blanchard and Giavazzi (2003), for the major Continental European countries, Germany, France, Italy and Spain, "*the major decline in the share in the 1980s coincided with a further increase in the unemployment rate during that decade*".

We regress the labor share on the unemployment rate. Table 1 reports the estimates for our sample of countries. The coefficient is negative and statistically significant in Continental European countries, while it is positive or negative in Anglo-Saxon countries.

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<sup>2</sup>The self-employed contribute to value-added but do not receive any wage. We use the standard assumption that the wage of self-employed workers corresponds to the mean wage of employees (see also Gollin, 2002).

<sup>3</sup>This trend disappears when we consider unadjusted labor shares.

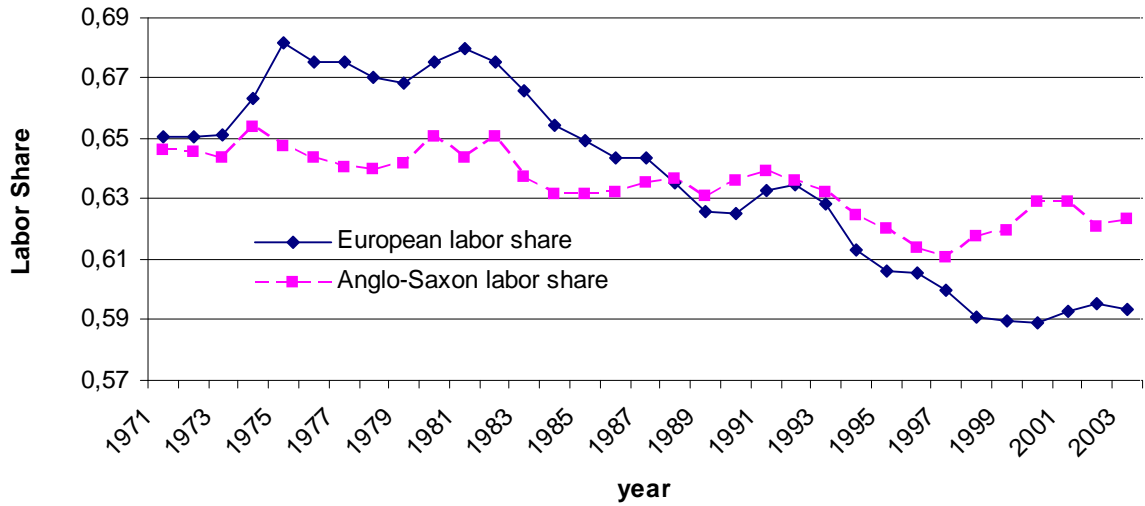


Figure 1: Labor shares in Anglo-Saxon and continental European countries, 1971-2004. Source: aggregate OECD data corrected for self-employment. Anglo-Saxon countries: Canada, UK, US. European countries: Finland, France, Germany, Italy, Spain. See the Appendix for details.

	Legal origin	Estimated coefficient
Canada	Common law	0.40*** (0.10)
Finland	Civil law (Nordic)	-0.72*** (0.15)
France	Civil law	-0.69*** (0.17)
Germany	Civil law (German)	-0.49*** (0.08)
Italy	Civil law	-1.01*** (0.19)
Netherlands	Civil law	-0.65** (0.27)
Spain	Civil law	-0.35+ (0.21)
UK	Common law	-0.29** (0.11)
US	Common law	0.29* (0.15)

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%. The Table reports the estimated coefficient of unemployment while regressing the labor share on unemployment and a constant. Squared errors between brackets.

Table 1: Unemployment and the labor share, 1970-2000



Table 2 emphasizes the divide between the two subsets of countries. We proceed to fixed-effects regressions. We estimate a single coefficient for the whole sample and for each subsample of countries. The results show that the coefficient is generally negative, and much larger for European countries than for Anglo-Saxon countries. The idea we put forward in this paper is that such a correlation between the labor share and the unemployment rate reflects the impact of an X factor that jointly determines the labor shares and corresponding unemployment rates. This X factor is trade globalization, and mostly trade with labor-abundant economies.

Legal origin	Estimated coefficient
Common law	-0.04 (0.09)
Civil law	-0.68*** (0.07)
Overall	-0.55*** (0.05)

\*\*\* significant at 1%. The Table reports the coefficient of unemployment from fixed effects regressions. Squared errors between brackets.

Table 2: Unemployment and the labor share, fixed-effects regressions

Several studies focus on labor shares at disaggregate level. They tend to show that the labor share is stable at micro level, which contrasts with the patterns of aggregate shares. Aggregate labor share can be written as

$$LS_t = \sum_{i=1}^n \phi_{it} LS_{it} \quad (1)$$

where  $i$  stands for sector, firms, or plant,  $t$  for the year and  $\phi_{it} = P_i Y_{it} / P_t Y_t$  for relative output in sector  $i$ . Labor share variation can be decomposed into two terms:

$$\Delta LS_t = \sum_{i=1}^n \Delta LS_{it} \phi_{it-1} + \sum_{i=1}^n \Delta \phi_{it} LS_{it} \quad (2)$$

Aggregate variation comes from within-sector (or firm) variation, and from between-sector factor reallocation. Kyyra and Maliranta (2008) show that all the decreases observed in Finland from 1970 to 2000 are due to factor reallocation between existing firms or plants. Böckerman and Maliranta (2009) show that trade is the main factor behind such factor reallocation. Bush et al (2008) focus on regional data for Italy (20 regions) and Germany (16 regions) and find only weak evidence in favor of a negative impact of trade on region-specific labor shares. The decrease in aggregate labor share must be due to factor reallocation across regions with different capital intensities and specialization patterns. De Serres et al (2002) decompose variations in the labor share at industry level between 7 industries. From 1970 to 2000, sector reallocation implies a 7-point decrease in aggregate labor share in Germany, 4 points in France, 3 points in Italy, and 4 points in the Netherlands.

In Section 4, we complete these findings. We examine sectorial data and show that capital-intensive sectors grew in Continental Europe, while they declined in the US and the UK. We also argue that the

differential pattern of factor reallocation between the two sets of countries is partly due to trade with developing countries. Before we present our methodology and results, we turn to theoretical developments.

### 3 HOS, labor shares, and wage rigidities

In this section, we confront the HOS model with wage rigidity to the set of facts reported in Section 2. We first derive well-known results concerning the impact of factor accumulation and changes in relative factor costs on the labor share. Second, we briefly recall Davis (1998) model with wage rigidity. Third, we discuss the effects of trade and wage rigidity on the labor shares. Fourth, we distinguish sector-specific effects from composition effects across sectors induced by factor reallocation. Finally, we examine how trade openness with labor-abundant countries can explain the patterns of labor shares in Continental Europe and in Anglo-Saxon countries.

#### 3.1 A reminder

Assume that there are two production factors,  $K$  and  $L$ , paid at marginal product and used in a constant returns to scale technology. The Euler theorem implies that output is totally dispatched between capital and labor returns so that the labor share is

$$\text{LS} = \frac{wL}{wL + rK} = \frac{\omega}{\omega + k}, \quad (3)$$

where  $w$  is the wage,  $r$  is the unit capital cost,  $\omega = w/r$  is the relative wage, and  $k = K/L$  is capital intensity. Changes in LS result from changes in  $k$  and  $\omega$ . However, these variables are generally linked to each other.

We start with the case where the dependence is nil, which we name the trade view of the labor share.

#### **Result 1** TRADE VIEW OF THE LABOR SHARE

*Let  $\omega$  be given. Then, the labor share strictly decreases with capital intensity, that is  $\partial \text{LS}_i / \partial k_i < 0$ .*

Capital deepness lowers the labor share. This property has two implications. Suppose first that  $\omega$  is the same across sectors. Then Result 1 means that capital-intensive sectors feature a lower labor share than labor-intensive sectors. Now, consider a set of countries forming a trade area. The Factor Price Equalization theorem states that  $\omega$  must be the same across countries. According to Result 1, country-specific labor share should decrease with capital intensity.

More generally, relative wage and capital intensity are positively related, which we summarize by the formal dependence  $\omega = \omega(k)$ . A change in relative wage has two opposite effects on the labor share:

$$\frac{\omega (\partial \text{LS} / \partial \omega)}{\text{LS}} = (1 - \text{LS}) \left[ 1 - \frac{\omega (dk/d\omega)}{k} \right]. \quad (4)$$

**Result 2** CLASSICAL VIEW OF THE LABOR SHARE

Let  $\varepsilon = \omega(\partial k/\partial\omega)/k$  be the elasticity of substitution between capital and labor. The labor share strictly decreases with relative wage if and only if the elasticity of substitution is larger than one, that is  $\partial\text{LS}/\partial\omega < 0$  is equivalent to  $\varepsilon > 1$ .

Firms substitute capital to labor when the relative wage increases. The magnitude of this substitution is captured by the elasticity of substitution between capital and labor. Following the classical view, the labor share should not depend on the relative factor cost when aggregate output is Cobb-Douglas.

**Result 3** LABOR MARKET VIEW OF THE LABOR SHARE

Let  $K$  be given and  $\eta = \omega(\partial L/\partial\omega)/L$  be the elasticity of the labor demand with respect to relative wage. The labor share strictly decreases with relative wage if and only if the elasticity of the labor demand is lower than  $-1$ , that is  $\partial\text{LS}/\partial\omega < 0$  is equivalent to  $\eta < -1$ .

When capital does not adjust, the relative factor cost alters capital intensity through its impact on employment:

$$\frac{dk}{d\omega} = -\frac{K}{L^2} \frac{dL}{d\omega}. \quad (5)$$

Hence, we can rewrite the elasticity of substitution

$$\frac{\omega dk/d\omega}{k} = -\frac{\omega dL/d\omega}{L}. \quad (6)$$

The labor market view states that the labor share decreases with relative wage when the labor demand is sufficiently responsive to changes in relative factor cost.

Globalization in the context of relative factor price rigidity affects capital intensity, the aggregate elasticity of substitution between capital and labor, and the elasticity of the labor demand with respect to relative factor price.

**3.2 HOS model with relative wage rigidity**

Davis (1998) examines the impacts of wage rigidities in the HOS framework. We now briefly recall the Davis model. The general assumptions of the model are very standard. There are two sets of countries denoted by  $i = 1, -1$ , and two final goods produced from capital  $K$  and labor  $L$ . Technologies have constant-returns to scale in each sector, and they are the same in both countries—up to Total Factor Productivity. The relative price of the capital-intensive good is  $p$ . Preferences over the two goods are the same across countries, while factor endowments differ between countries. Country 1 is endowed with  $(K_1, N_1)$ , while country -1 is endowed with  $(K_{-1}, N_{-1})$ . Capital is relatively more abundant in country 1 than in country -1, so that  $K_1/N_1 > K_{-1}/N_{-1}$ . The relative supply of capital at the world level is  $k^s = (K_1 + K_{-1}) / (N_1 + N_{-1})$ . There is perfect competition in the good market. The labor market is perfectly competitive in country -1, while factor prices are not flexible in country 1. Davis considers an absolute wage rigidity. We slightly alter his reasoning and focus on a relative wage rigidity. Hereafter, the relative wage  $\omega = w/r$  is fixed. This choice is made for exposition clarity.

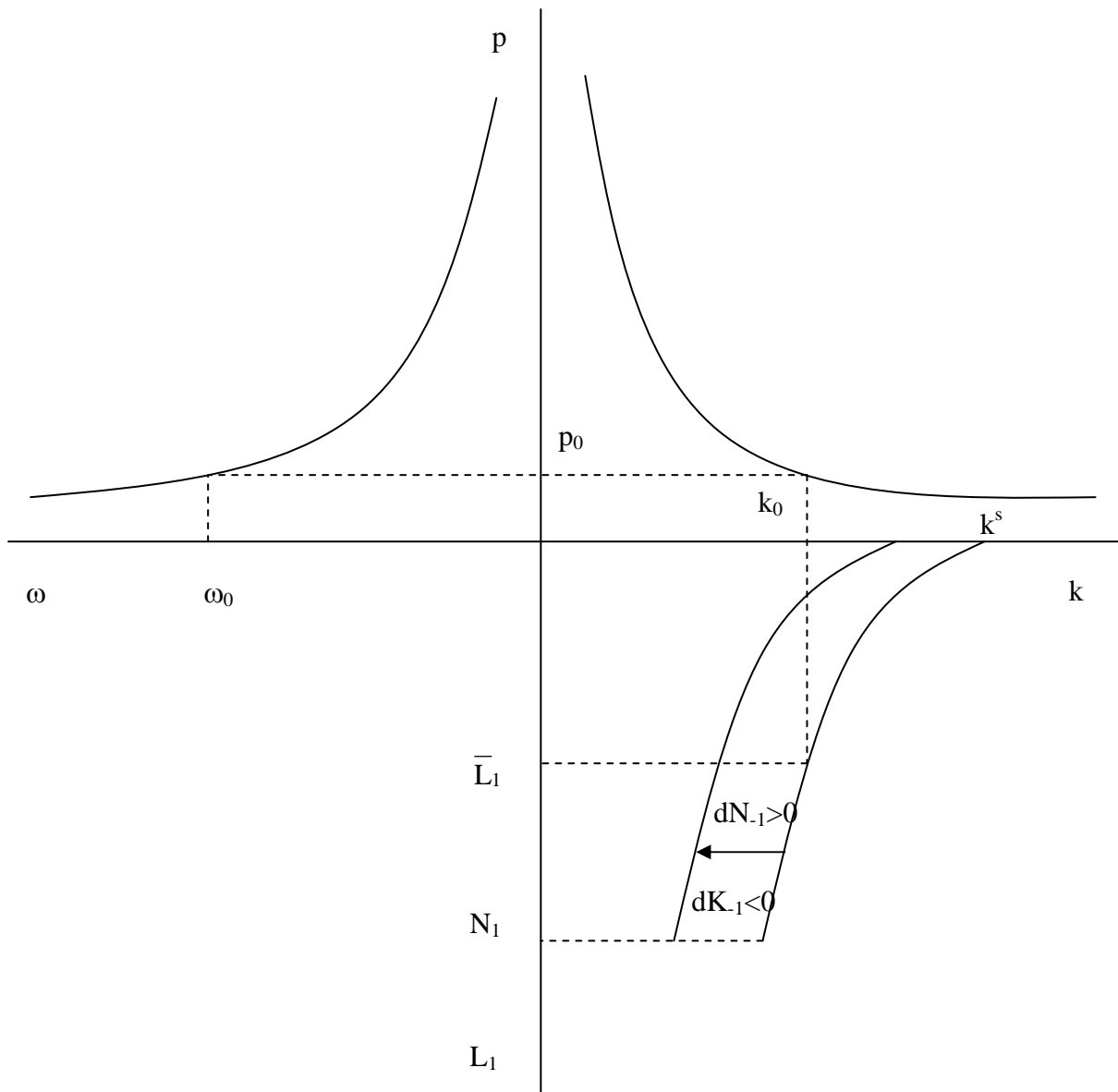


Fig.2: Davis (1998) model with wage rigidity. The model is composed of three relationships: the Stolper-Samuelson curve (SS), the Heckscher-Ohlin curve (HO), and the Brecher curve (BR).

The Davis model contains three endogenous variables: world relative price  $p$ , effective capital intensity  $k$ , and employment  $L_1$  in country 1. These three variables solve

$$p = p(k), \tag{HO}$$

$$\omega = \omega(p), \tag{SS}$$

$$L_1 = \frac{K}{k} - N_{-1}, \tag{BR}$$

with  $p'(\cdot) < 0$ ,  $\omega'(\cdot) < 0$ ,  $\omega \geq \omega(p(k^s))$ , and  $k = (K_1 + K_{-1})/(L_1 + N_{-1}) \geq k^s$ .

The first relationship is the Heckscher-Ohlin curve (HO). Following the Rybczinski theorem, an increase in capital intensity raises the relative supply of the capital-intensive good, thereby lowering the relative price of that good. Evidently, the relationship goes both ways, a feature that the model with wage rigidity extensively uses. The second relationship is the Stolper-Samuelson curve (SS). The relative price is the same in the whole integrated economy. When such a price increases, firms adjust the relative demand for capital as a result and the relative wage goes down. Owing to the Factor Price Equalization theorem, the adjustment is the same in both countries. Here again, the relationship goes both ways and an increase in relative wage translates into a decrease in the relative price of the capital-intensive good. The third curve is a variant of the Brecher (1974) curve. Following an increase in the relative demand for capital, employment must fall in the integrated economy. As wages are perfectly flexible in country  $-1$ , such a fall in employment can only take place in country 1.

Figure 2 depicts the working of the model.

The model with perfectly competitive factor markets starts from the right with the relative supply of capital, and ends up left with the relative wage. The model with wage rigidity works the other way around. Starting from country 1 relative wage  $\omega_0$ , the (SS) curve gives the relative price of the capital-intensive good as a result. This relative price must hold at the integrated level. Factor price equalization results and  $\omega_0$  prevails for the whole trade area. The corresponding relative price is not compatible with full employment. At such a price, the (HO) curve implies that the relative demand for the capital-intensive good is larger than the relative supply with full employment. Consequently, the relative demand for capital is larger than the relative supply  $k^s$ . Finally, the (BR) curve gives resulting employment in country 1.

What happens when the relative wage rigidity increases, or when globalization expands to less-developed trade partners? An increase in  $\omega$  lowers the relative price of the capital-intensive good, thereby further increasing the relative demand for capital. Employment in country 1 decreases as a result, leaving unchanged employment in country  $-1$ . Alternatively, opening to trade with less-advanced economies means that  $K_{-1}$  increases by less than  $N_{-1}$ . The relative supply of capital falls as a result. The (BR) curve moves rightward, which further deteriorates employment in country 1. Result 4 summarizes these predictions of the Davis model.

**Result 4** THE DAVIS (1998) PREDICTIONS

Let  $d\omega$  define a marginal increase in relative wage rigidity and let  $(dK_{-1}, dN_{-1}) > 0$  define a marginal increase in globalization. The following statements hold:

- (i) a marginal increase in relative wage rigidity raises the relative demand for capital and lowers employment in country 1—that is,  $dk/d\omega > 0$  and  $dL_1/d\omega < 0$ ;
- (ii) a marginal increase in globalization increases capital intensity and reduces employment in country 1 if and only if the relative supply of capital decreases at the world level—that is,  $dk_1 < 0$  and  $dN_{-1} < 0$  if and only if  $dK_{-1}/dN_{-1} < k$ .

We now turn to labor share predictions.

### 3.3 Labor share and globalization

Suppose that there is a marginal increase in globalization—that is,  $(dK_{-1}, dN_{-1}) > 0$ —in the particular context where  $\omega$  is fixed. Such a change in factor endowment alters the relative supply of capital at the world level, thereby changing the relative demand for capital and employment in country 1. The labor share in country 1 is  $LS_1 = \omega/(\omega + k_1)$ . It responds to the marginal change in globalization as follows:

$$dLS_1 = \frac{\partial LS_1}{\partial k_1} \left\{ \frac{\partial k_1}{\partial N_{-1}} dN_{-1} + \frac{\partial k_1}{\partial K_{-1}} dK_{-1} \right\}. \quad (7)$$

The marginal change in capital intensity is

$$\frac{\partial k_1}{\partial N_{-1}} = \frac{-K_1}{(L_1)^2} \frac{\partial L_1}{\partial N_{-1}}. \quad (8)$$

Using the Brecher relationship (BR), we obtain

$$\frac{\partial k_1}{\partial N_{-1}} = \frac{K_1}{(L_1)^2} > 0. \quad (9)$$

Similarly,  $\partial k_1/\partial K_{-1} = -K_1/(L_1^2)(1/k) < 0$ . Therefore, we have

$$dLS_1 = \frac{\partial LS_1}{\partial k_1} \frac{K_1}{(L_1)^2} \left( dN_{-1} - \frac{dK_{-1}}{k} \right). \quad (10)$$

**Proposition 1** LABOR SHARE AND TRADE GLOBALIZATION

At given  $\omega$  a marginal increase in globalization negatively affects the labor share in country 1 if and only if it increases the relative supply of capital—that is,  $dLS_1 < 0$  if and only if  $dK_{-1}/dN_{-1} < k$ .

Proposition 1 can be understood in light of Result 1. As labor-abundant economies enter the set of country  $-1$ , the relative supply of capital goes down, which further requires capital intensity to be increased in country 1. Accordingly, Result 1 implies that at given  $\omega$ , an increase in the relative demand for capital leads to a decrease in the labor share of income.

Proposition 1 also states that trade causes a negative correlation between unemployment and the labor share in countries that implement relative wage rigidities. By contrast, the correlation should not exist in countries where the labor market is perfectly competitive.

### 3.4 Labor share and relative wage rigidity

Changes in relative factor cost affect the labor share according to the values of the elasticity of substitution and elasticity of the labor demand. However, trade affects such elasticities, and, therefore, alters the effects of wage rigidities. The aggregate elasticity of the labor demand is

$$\frac{\omega \partial L_1 / \partial \omega}{L_1} = \frac{\omega}{L_1} \left( \frac{-K}{k^2} \frac{dk}{d\omega} \right). \quad (11)$$

Using the Brecher relationship (BR), we can decompose (11) in two terms

$$\frac{\omega \partial L_1 / \partial \omega}{L_1} = O(K, N_{-1}, k) \left( -\frac{\omega \partial k / \partial \omega}{k} \right), \quad (12)$$

where  $O(K, N_{-1}, k) = K / (K - N_{-1}k)$ . The aggregate elasticity of the labor demand is generally larger than the world aggregate elasticity of substitution. The factor proportion  $O$  depends on the extent of globalization. It is larger than one, except for the autarkic case where  $N_{-1} = 0$ . Globalization increases the elasticity of labor demand with respect to autarky.

**Proposition 2** LABOR SHARE AND RELATIVE WAGE RIGIDITY

*A marginal increase in relative wage rigidity implies a fall in the labor share if and only if the elasticity of substitution at the world level is lower than  $O(K, N_{-1}, k)^{-1}$ —that is,  $\partial LS_1 / d\omega < 0$  if and only if  $(\omega dk / d\omega) / k \leq 1 / O(K, N_{-1}, k) = (K - N_{-1}k) / K$ .*

In a globalized world, wage rigidities are more likely to reduce the labor share than in a closed economy. Globalization increases the elasticity of substitution between capital and labor at the country level. Indeed, a marginal increase in globalization modifies the openness term  $O$  in equation (12):

$$dO = (O - 1) (dN_{-1} / N_{-1} - dK_{-1}). \quad (13)$$

The change in openness  $dO$  has the sign of  $dN_{-1} / N_{-1} - dK_{-1}$ .

We solve the model with Cobb-Douglas technologies and a log-linear utility function. Per capita output in sector  $i = a, b$  is  $f(k_i) = A_i k_i^{\alpha_i}$ , with  $1 > \alpha_a > \alpha_b > 0$ . The utility function is  $U(c_1, c_2) = \beta \ln c_1 + \gamma \ln c_2$ . We can write the HO and SS relationships as follows:

$$p(k) = \frac{B_b}{B_a} \left[ \frac{\beta(1 - \alpha_a) + \gamma(1 - \alpha_b)}{\beta\alpha_a + \gamma\alpha_b} \right]^{\alpha_b - \alpha_a} k^{\alpha_b - \alpha_a}, \quad (14)$$

$$\omega(p) = \left( \frac{B_a}{B_b} p \right)^{1 / (\alpha_b - \alpha_a)}, \quad (15)$$

where  $B_i = (1 - \alpha_i)(\alpha_i / (1 - \alpha_i))^{\alpha_i} A_i$ . Hence, we have

$$\omega(k) = \frac{\beta(1 - \alpha_a) + \gamma(1 - \alpha_b)}{\beta\alpha_a + \gamma\alpha_b} k. \quad (16)$$

Consequently,  $k\omega'(k) / \omega = 1$ . Therefore,  $dLS / d\omega < 0$  whenever  $N_{-1} > 0$ . In autarky, factor accumulation and relative wage rigidity do no impact the aggregate labor share of income. Aggregate elasticity of substitution is equal to one. In the open-economy case, factor  $O$  becomes larger than one and the aggregate elasticity of substitution (of the labor demand) is larger than one (lower than minus one). The labor share, therefore, decreases with the relative wage rigidity.

### 3.5 Sector-specific vs aggregate labor share

Globalization and wage rigidities alter the aggregate labor share of income. Aggregate changes reflect changes within and between sectors. Formally, the aggregate labor share can be decomposed as follows:

$$LS_1 = \phi_a LS_a + (1 - \phi_a) LS_b, \quad (17)$$

with  $\phi_a = p_a Y_a / (p_a Y_a + p_b Y_b)$  the share of the capital intensive good in total value-added. As  $p = p_a / p_b$ , and denoting  $y = Y_a / Y_b$  relative output, we have  $\phi_a = py / (py + 1)$ .

Consider a marginal increase in relative wage  $\omega$ . We have

$$\frac{dLS_1}{d\omega} = \underbrace{\frac{d\phi_a}{d\omega} (LS_a - LS_b)}_{\text{sector reallocation}} + \underbrace{\phi_a \frac{dLS_a}{d\omega} + (1 - \phi_a) \frac{dLS_b}{d\omega}}_{\text{within-sector effects}}. \quad (18)$$

The global effect results from a composition effect and within-sector effects. We start with the composition effect. The relative wage rigidity increases the relative demand for capital  $k_1$ . The Rybczinski theorem implies factor reallocation towards the capital-intensive sector. It follows that  $dy/d\omega > 0$ . However, the increase in  $\omega$  also causes a price effect, namely a decline in the relative price  $p$  of the capital-intensive good. The relative strength of the two effects depends on preferences, technologies, and trade openness. In a globalized world, the Rybczinski effect is stronger than in autarky, and the share of the capital-intensive sector is more likely to increase.

Now consider sector-specific effects. Result 2 predicts the signs of such effects:

$$\frac{dLS_i}{d\omega} < 0 \text{ if and only if } \frac{\omega dk_i / d\omega}{k_i} > 1. \quad (19)$$

In the case of Cobb-Douglas technologies, the elasticity  $\omega (dk_i / d\omega) / k_i = 1$ . This implies  $dLS_i / d\omega = 0$ . Changes in aggregate labor share then reflect sector share changes. When preferences are log-linear, the Rybczinski effect exactly offsets the price effect in autarky, and overcrowds it when the country is open to trade. The labor share, therefore, stays constant under autarky and decreases otherwise.

Using the same rationale we can decompose the impact of globalization. Consider for instance a marginal increase in  $N_{-1}$ . We have

$$\frac{dLS_1}{dN_{-1}} = \underbrace{\frac{d\phi_a}{dN_{-1}} (LS_a - LS_b)}_{\text{sector reallocation } (<0)} + \underbrace{\phi_a \frac{dLS_a}{dN_{-1}} + (1 - \phi_a) \frac{dLS_b}{dN_{-1}}}_{\text{within-sector effects } (=0)}. \quad (20)$$

We know the overall impact, namely  $dLS_1 / dN_{-1} < 0$ . In addition, sector-specific labor shares must stay constant, that is  $dLS_i / dN_{-1} = 0$ ,  $i = a, b$ . Indeed,  $\omega$  and  $p$  stay constant. Sector-specific capital intensity does not change, which implies that  $LS_a$  and  $LS_b$  do not vary. The overall change in aggregate labor share is entirely driven by the pace of factor reallocation between sectors. Owing to the relative factor price rigidity, the relative price  $p$  of the capital-intensive good stays constant. The Rybczinski effect then implies that the capital-intensive sector share  $\phi_a$  increases.

### 3.6 Explaining LS changes

The model can predict the set of facts presented in Section 2, namely constant and uncorrelated with unemployment labor shares in Anglo-Saxon countries, decreasing and correlated with unemployment



shares in Continental Europe, broadly constant shares at sector/firm level.

Time  $t$  goes from 1970 to 2000. There are three sets of countries, two equally developed (Continental Europe  $E$ , and Anglo-Saxon countries  $US$ ) and one set of developing countries ( $D$ ). Europe is country 1, while Anglo-Saxon and developing countries belong to country  $-1$ . The set of factor endowments at date  $t$  is  $\{(K_{E,t}, N_{E,t}), (K_{US,t}, N_{US,t}), (K_{D,t}, N_{D,t})\}$ . The world relative supply of capital is  $k_t^s = \sum K_{i,t} / \sum N_{i,t}$ . The relative supply of capital is initially the same in Europe and in the US. It also stays fixed over time, so that  $K_{E,t} = k_E^s N_{E,t}$  and  $K_{US,t} = k_E^s N_{US,t}$  for all  $t$ . Developing countries gradually open to trade. Therefore  $K_{D,t}$  and  $N_{D,t}$  increase over time.

The relative wage rigidity  $\omega_t$  takes place in Europe. It stays fixed over time. As a benchmark, the initial value ensures that full employment holds in Europe in 1970, so that  $\omega_t = \omega(k_E^s)$ .

The model is

$$\omega_t = \omega(p(k_t)), \quad (21)$$

$$L_{E,t} = \frac{K_t}{k_t} - (N_{US,t} + N_{D,t}), \quad (22)$$

$$LS_{i,t} = \frac{\omega_t}{\omega_t + k_{i,t}}, \quad (23)$$

with  $k_{D,t} = K_{D,t}/N_{D,t}$ ,  $k_{US,t} = K_{US,t}/N_{US,t}$ , and  $k_{E,t} = K_{E,t}/L_{E,t}$ .

Figure 3 depicts the patterns of  $LS_{US}$ ,  $LS_E$ , and  $LS_D$ .

We start with the US labor share. As  $\omega_t$  remains fixed at the 1970 competitive level and the US relative supply of capital does not change over time, US employment adopts the pattern of the labor supply  $N_{US,t}$ . Meanwhile, the US labor share remains constant from 1970 to 2000. Employment and the labor share have independent patterns. Put differently, they should not be correlated.

In Continental European countries, employment and the labor share jointly move. The rigid relative factor price  $\omega_t$  does not correspond to the competitive one after the inclusion of new traders. That is  $\omega_t = \omega(k_t) \neq \omega(k_t^s)$ . The impacts on European employment and labor share are given by Result 4 and Proposition 1. They both decrease from one year to the other whenever  $\Delta K_{D,t}/\Delta N_{D,t} < k_t$ , stay constant when  $\Delta K_{D,t}/\Delta N_{D,t} = k_t$ , and increase when  $\Delta K_{D,t}/\Delta N_{D,t} > k_t$ . European employment and labor share should be positively correlated.

The fall in European share observed in the 1980s and 1990s can be predicted assuming that  $\Delta K_{D,t}/\Delta N_{D,t} < k$  for  $t = 1970, \dots, 2000$ . As new countries open to trade, the relative supply of capital decreases over a decade. The stagnation of the share observed in the mid-1990s means that the relative supply of capital stays constant from 1990 to 2000. This is possible if older entrants in world trade accumulate physical capital at a rate that compensates the entry of newer and more labor-abundant countries.

The fall in European aggregate labor shares is associated with factor reallocation towards capital-intensive sectors. By contrast, no factor reallocation takes place in Anglo-Saxon countries. The pattern of aggregate labor shares strongly contrast with micro (sector-specific) patterns. In so far as the relative factor cost stay fixed, sector-specific shares do not change at industry/firm level. This prediction distinguishes the HOS model with wage rigidity from the Rodrik-type models discussed in the introduction. In such models, the labor share goes down because globalization boosts the outside options of capital owners, pushing wages down at given output. This mechanism should take place at firm level, which

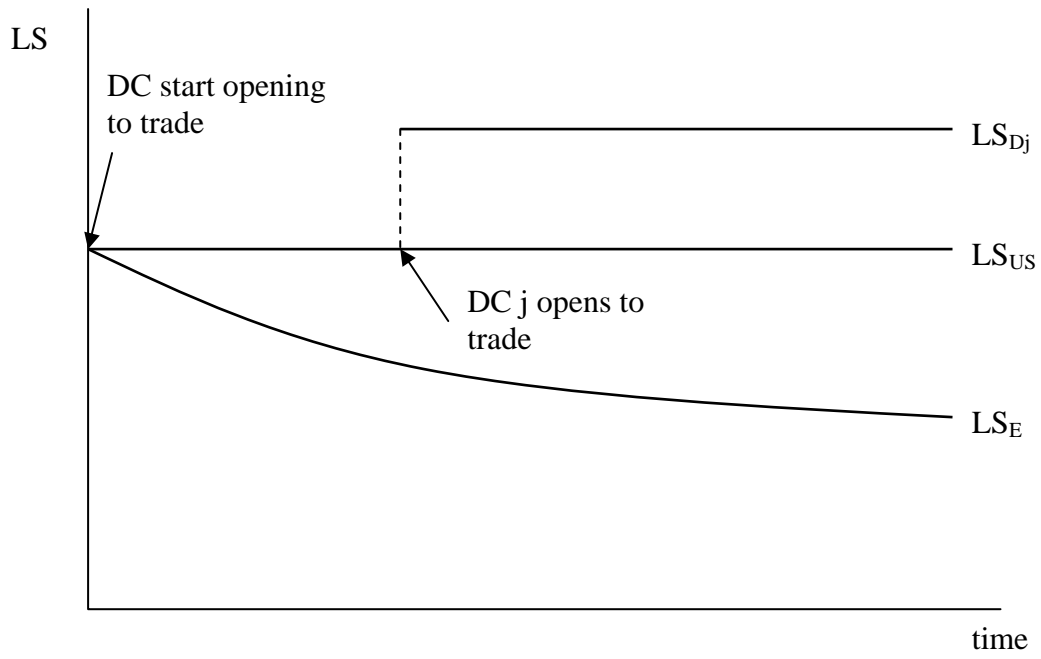


Fig.3 : Trade and aggregate labor shares. DC gradually open to trade and relative wage stays constant.

contradicts the micro evidence.

In developing countries, employment is determined by the labor supply  $N_{D,t}$ . Globalization affects the labor share through two distinct mechanisms, depending on whether we consider the country at world trade entry or after entry.

At entry, say in  $t$  (so the country is closed in  $t - 1$ ), the variation in the labor share is

$$\Delta LS_{D,t} = \frac{\omega}{\omega + k_{D,t}^s} - \frac{\omega(k_{D,t-1}^s)}{\omega(k_{D,t-1}^s) + k_{D,t-1}^s} > 0. \quad (24)$$

The labor share increases at world trade entry. It is consistent with labor share patterns observed in some Newly Industrialized Countries and East Asian countries.

After entry, the labor share is larger than in Europe and the US. The year-to-year change  $\Delta LS_{D,t}$  has the sign of  $-\Delta k_{D,t}^s$ . As long as those countries accumulate physical capital over time, the labor share must go down. This explanation to the decrease in the labor share of developing countries hinges on the fact that the corresponding countries belong to the diversification cone of the developed economies (see Schott, 2003).

The model can predict the set of facts we are interested in. However, it also predicts that the labor share should be larger in developing than in developed countries. This contradicts the empirical evidence according to which the labor share increases along with development.<sup>4</sup> This prediction is closely associated with the working of the HOS model. It follows Result 1, whereby the labor share decreases with capital intensity within a given trade area.

## 4 Empirical evidence

This section confronts the model predictions to sectorial data. We want to assess whether trade with developing countries specifically increased the pace of factor reallocation towards capital-intensive sectors in Continental Europe, and whether such an increase leads to significant changes in the labor share. We first present our dataset, and then turn to fixed effects regressions.

### 4.1 Dataset

The KLEMS dataset provides sectorial data for 8 OECD countries over the period 1970-2005. We use this dataset to compute labor shares and sector shares at sector level. The COMTRADE dataset provides country-specific data on trade intensity with China. We use this variable as a proxy for trade with developing countries.

The KLEMS dataset covers 28 sectors. In each sector, there are data on wages, employment, output, and capital stock. Sector-specific and aggregate labor shares are computed as the ratio of total wage bill to value-added. The ratio is corrected from self-employment. Namely, we attribute the mean wage of employees to self-employed workers.

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<sup>4</sup>Using UN aggregate data, Gollin (2001) argues that the labor share does not change with GDP per capita. However, he in no way claims that it decreases with development.

We build two super-sectors from the 28 sectors. A sector is capital-intensive if capital intensity is larger than the aggregate capital to labor ratio in 2000. For robustness purposes, we isolate tradable sectors and proceed similarly. The tradable sectors are "*Agriculture, Hunting, Forestry and Fishing*", "*Mining and Quarrying*", and "*Total manufacturing*".

We compute the share of the capital-intensive (super-)sector in total value-added. Let  $i \in \{1, \dots, 28\}$  denote the sector index,  $k \in \{1, \dots, 8\}$  be the country index, and  $t \in \{1970, \dots, 2005\}$  be the time index. Let also  $T = \{i \in \{1, \dots, 28\}, i \text{ is tradable}\}$  denote the subset of tradable sectors. For all  $t$ , we have

$$SS_{1t} = \sum_{i=1, \dots, 28} \mathbf{1}_{ik} P_{ikt} Y_{ikt} / P_{kt} Y_{kt} \text{ with } \mathbf{1}_{ik} = \begin{cases} 1 & \text{if } (K/L)_{ik1970} > (K/L)_{k1970} \\ 0 & \text{else} \end{cases}, \quad (25)$$

$$SS_{2t} = \sum_{i \in T} \mathbf{1}_{ik} P_{ikt} Y_{ikt} / P_{kt}^T Y_{kt}^T \text{ with } \mathbf{1}_{ik} = \begin{cases} 1 & \text{if } (K/L)_{ik1970} > (K/L)_{k1970}^T \\ 0 & \text{else} \end{cases}, \quad (26)$$

where  $P_{kt} Y_{kt} = \sum_i P_{ikt} Y_{ikt}$ ,  $(K/L)_{k1970} = (\sum_i K_{ik1970}) / \sum_i L_{ik1970}$ , and the superscript  $T$  denotes that the variable is computed within the set of tradable sectors.

	Mean value	Mean LS
SS <sub>1</sub>	34%	58
1-SS <sub>1</sub>	66	78
SS <sub>2</sub>	48	47
1-SS <sub>2</sub>	52	80

Table 3: Super-sector shares and labor shares

Table 3 presents the results. In line with Result 1, the labor share within the capital-intensive super-sector is 58%, against 78% for the labor-intensive super-sector. The difference is even stronger when we only focus on tradable sectors. In the Appendix, we show that this result holds at a more disaggregate level. If we restrict the analysis to tradable sectors only, the difference is even greater, as the labor share goes from 47% to 80%. Factor reallocation between sectors, therefore, can affect the aggregate labor share.

We need a trade variable that varies across countries, and that reflects trade with developing countries rather than trade in general. We follow Michaels et al (2009) and consider the ratio of Chinese exports plus imports to GDP. This variable must be viewed as a proxy for overall trade with developing countries.

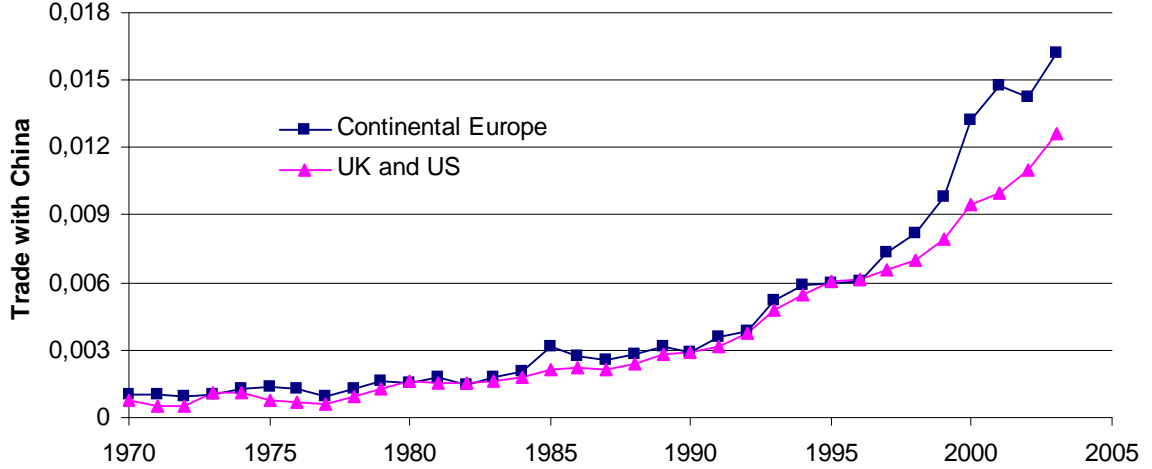


Fig.4: Trade with China in Continental Europe and in the US-UK, 1970-2005. Continental Europe: Finland, France, Germany, Netherlands, Spain.

Figure 4 shows that trade with China massively increased from 1970 to 2005, starting from 0 and reaching 1.5% on average for the two sets of countries by the end of the period. The rise in trade is a homogenous phenomenon in our sample of countries. Variance decomposition shows that most of trade volatility is actually driven by the time dimension rather than by cross-country heterogeneity. Indeed, the standard deviation is roughly equal to the trade mean, which approximately corresponds to the within deviation, and represents 3 times the between deviation.

Table 4 provides descriptive statistics for the variables we use in sub-section 4.2.

	Mean	Stand. dev.	min	max	obs
SS <sub>1</sub>	0.34	0.06	0.20	0.46	281
SS <sub>2</sub>	0.48	0.07	0.30	0.66	281
Trade	0.0043	0.0048	0	0.0331	271
K/Y	0.61	0.55	0.29	3.44	281
(K/Y) <sup>T</sup>	0.54	0.43	0.18	3.05	281

Table 4: Descriptive statistics

Theory predicts that labor shares decrease in rigid-wage countries where strong factor reallocation towards capital-intensive sectors take place. By contrast, factor reallocation should be much weaker in free-wage countries. The panel of Figures 5 reveals four facts. For each year, we compute the mean share of the capital-intensive sector in civil-law and common-law countries. We confront it to the mean value

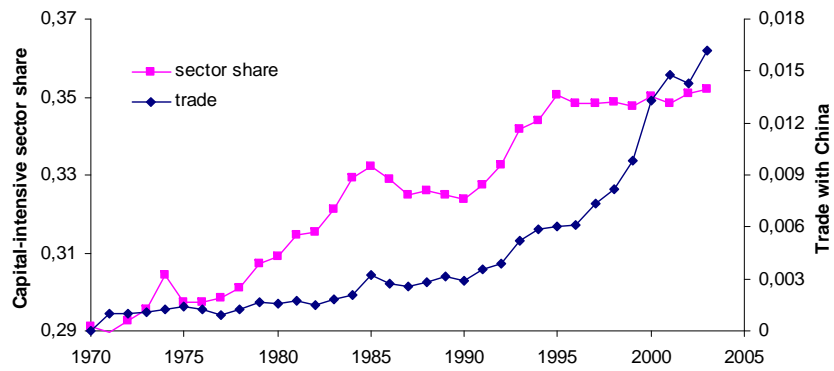


Fig. 5a: Share of the capital-intensive sector in aggregate output and trade openness with China in civil-law countries.

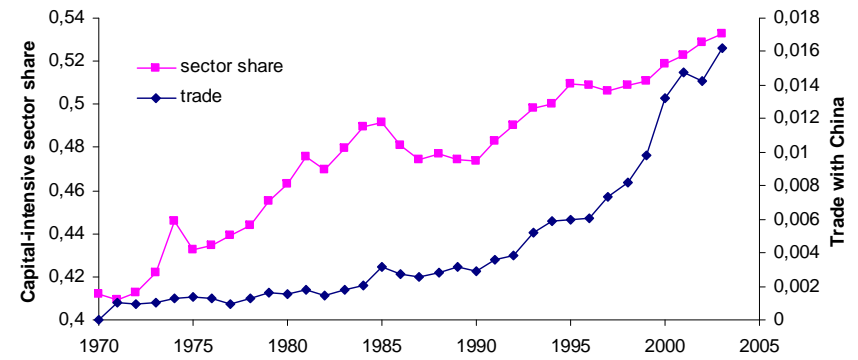


Fig. 5c: Share of the capital-intensive sector in tradable output and trade openness with China in civil-law countries

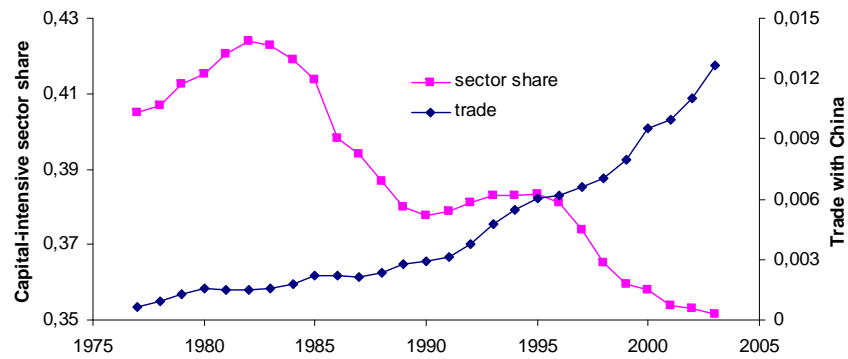


Fig. 5b: Share of the capital-intensive sector in aggregate output and trade openness with China in common-law countries

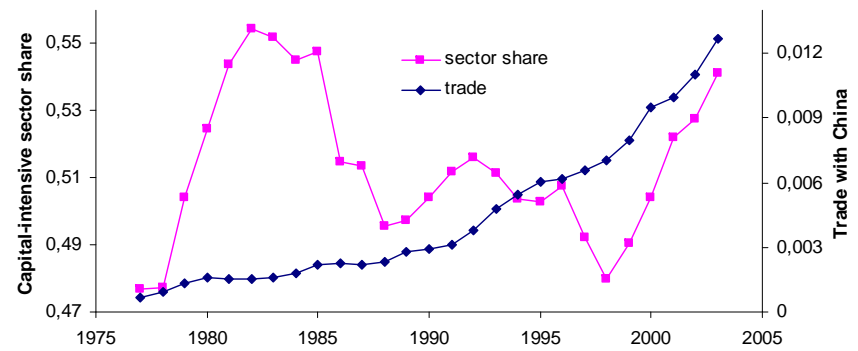


Fig. 5d: Share of the capital-intensive sector in tradable output and trade openness with China in common-law countries

of the trade ratio with China within each group of countries. The share of the capital-intensive sector substantially increased in civil-law countries. From 1970 to 2005, the share goes from 29% to 35%, a 6-point increase. If we restrict the analysis to tradable sectors only, the increase has a similar magnitude. The share of the capital-intensive super-sector decreased in common-law countries (if we focus on the whole economy), or did not show any trend (if we only focus on tradable sectors).

The magnitude of factor reallocation in civil-law countries is potentially promising to explain changes in aggregate labor share. For instance,  $SS_1$  experiences a 6-point increase in civil-law countries and a 5-point decrease in common-law countries. The differential change amounts to 11 points. The mean labor share is 58% in the capital-intensive sector, while it is 78% in the labor-intensive sector. Factor reallocation between sectors, therefore, can lead to a differential change in labor share that amounts to  $11 \times (0.78 - 0.58) = 2.2$  points. Section 2 shows that the observed differential change is about 3.5 points. Factor reallocation between sectors, therefore, can explain up to 60% of the observed differential change between the two sets of countries.

Of course, part of this change has nothing to do with trade. The purpose of the next sub-section is to measure the proportion of this change that can be directly attributed to trade with developing countries.

## 4.2 Fixed-effects regressions

We proceed to the following fixed effects regressions:

$$SS_{it} = \beta_1 Trade_{it} \times EU_i + \beta_2 Trade_{it} + \beta_3 (K/Y)_{it} + \alpha_i + \alpha_t + \epsilon_{it}, \quad (27)$$

where  $EU$  is a dummy variable that takes the value 1 if civil law is the legal origin of the country and 0 otherwise. We regress the share of the capital-intensive super-sector on trade and its interaction with the dummy  $EU$ . The statistical model allows us to test whether trade with China has a distinctive and significantly positive effect on the weight of the capital-intensive sector in civil-law countries. Theory, therefore, predicts that parameter  $\beta_1$  is positive.

In addition to Trade variables, we add a control for capital intensity at the aggregate level. At given relative factor price, the Rybczinski theorem predicts that capital intensity should increase the weight of the capital-intensive sector. We do not consider the ratio of capital to labor. The theoretically relevant ratio is actually the ratio of capital to efficient units of labor. Its computation requires labor-augmenting technological change to be correctly defined. We abstract from such a computation by considering the ratio of capital to output.

Finally, we add country fixed effects and time dummies. Country fixed effects control for time-invariant unobserved characteristics that are correlated with trade and the weight of the capital-intensive sector. Time dummies account for shocks that affect all countries simultaneously and may be correlated with trade as a result. For instance, changes in relative wage rigidities in Continental European countries increase the weight of capital-intensive sectors in all developed countries. Changes in factor endowments in developing countries have similar effects. Capital accumulation in China should reduce the share of capital-intensive sectors in developed countries.

Endogeneity bias must be taken into account. There are two sources of potential biases. On the one hand, the share of the capital-intensive sectors may cause trade with China. Capital-intensive industries

may require inputs especially produced in developing countries. On the other hand, there may be an omitted variable that causes both trade and the growth of capital-intensive industries. Both sources of bias are not very convincing as trade grew both in civil-law and common-law countries, while the capital-intensive super-sector increased in the former and decreased in the latter. Why would reverse causality bias only affect the US and the UK? Why would an X factor creating an artificial correlation between trade and sector share work differently for civil and common-law countries? However, we choose to address the problem by means of an explicit IV strategy.

We need an instrument that is highly correlated with the trade variables, but uncorrelated with sector shares in developed countries. The Fraser Institute provides various institutional variables for developing countries over a long time range. Institutions in developing countries are not necessarily correlated with sector shares in developed countries, and could well be correlated with trade development with China. All the variables take values between 0 (highly regulated) and 10 (no regulation). The list is the following: "*Economic Freedom*", "*Size of Government*", "*Legal Structure and Security of Property Rights*", "*Access to Sound Money*", "*Freedom to Trade Internationally*", and "*Regulation of Credit, Labor and Business*". These variables are defined over 5-year periods, from 1980 to 2005 for most, and for 1970-2005 for "*Access to Sound Money*" and "*Regulation of Credit, Labor and Business*". We complete the variables by linear interpolation.

A first regression, not reported here, shows that all these variables are strongly correlated with Trade and Trade\*EU, except for "*Legal Structure and Security of Property Rights*". However, only the variable "*Access to Sound Money*" (ASM) seems exogenous to the share of the capital-intensive super-sector.<sup>5</sup> The correlation of this variable with trade is due to the fact that people involved in international trade need to convert foreign money, and to have banking accounts in foreign countries to pay, to receive payments, and borrow money (see Berman and Héricourt, 2010). The variable is available since 1970.

The other instruments are more usual. We consider trade and trade\*EU lagged 10 years. Such trade flows are not related to the share of the capital-intensive sector ten years later. In addition, they have been available since 1960. However, reported trade flows were 0 during part of the 1960s when China was closed to international trade. We omit these observations – whether we exclude or include them marginally affects the results.

First-stage regressions are the following:

$$\begin{aligned} Trade_{it} &= \lambda_1 ASM_t + \lambda_2 ASM_t * EU_i \\ &+ \lambda_3 Trade_{it-10} + \lambda_4 Trade_{it-10} * EU_i + \lambda_5 [included] + \epsilon_{it}, \end{aligned} \quad (28)$$

$$\begin{aligned} Trade * EU_{it} &= \mu_1 ASM_t + \mu_2 ASM_t * EU_i \\ &+ \mu_3 Trade_{it-10} + \mu_4 Trade_{it-10} * EU_i + \mu_5 [included] + \epsilon_{it}, \end{aligned} \quad (29)$$

The excluded instruments are  $ASM_t$ ,  $ASM_t * EU_i$ ,  $Trade_{it-10}$ , and  $Trade_{it-10} * EU_i$ . The included instruments are all the regressors but trade variables: country fixed effects, time effects and aggregate

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<sup>5</sup>The index ranges from 0-10 where 0 corresponds to ‘high annual money growth’, ‘high variation in the annual rate of inflation’, ‘high inflation rate’, and ‘restricted foreign currency bank accounts’ and 10 corresponds to ‘low annual money growth’, ‘low or no variation in the annual rate of inflation’, ‘low inflation rate’, and ‘foreign currency bank accounts are permissible without restrictions’.



capital to output ratio.

Table 5 displays the results. We only report the coefficients associated with the excluded instruments.

	Trade	Trade*EU
Trade <sub>t-10</sub>	1.35*** 0.23	-0.49* 0.28
Trade <sub>t-10</sub> *EU	-0.24 0.51	1.99*** 0.53
ASM	.001* .000	.000 .000
ASM*EU	.002*** .000	.003*** .000
No obs	254	254

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

The Table only reports parameters associated with excluded instruments.

Table 5: First-stage regression results

Excluded instruments are strongly significant. The sign of the various parameters is economically relevant: lagged trade has a positive impact on current trade, and Access to sound money as well. Note, however, that overall trade seems better correlated with ASM than with ASM\*EU. In addition, Shea partial R<sup>2</sup> is 25% for the first regression, and 75% for the second one.

Table 6 reports the estimates. The first two columns report OLS estimates when the dependent variable is, respectively, SS<sub>1</sub> and SS<sub>2</sub>. The next two columns report 2SLS results. We do not present two-step GMM estimates, as they marginally differ from 2SLS results. Squared errors are corrected by the Eicker-White method.

	OLS SS <sub>1</sub>	OLS SS <sub>2</sub>	IV SS <sub>1</sub>	IV SS <sub>2</sub>
Trade*EU	7.44*** (1.41)	3.12*** (1.20)	4.22*** (1.36)	2.65** (1.31)
Trade	-6.18*** (1.83)	-.79 (1.71)	5.59 (3.91)	.31 (3.48)
K/Y	-.001 (.03)	.01 (.01)	-.03*** (.01)	.001 (.011)
No obs	264	264	243	243
Hansen over-identification test	.	.	0.77	0.24
within-R <sup>2</sup>	0.41	0.52	.	.
within-R <sup>2</sup> (/ time dummies)	0.35	0.39	.	.

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%. Robust standard errors between brackets. The dependent variable is the capital-intensive super-sector share. All regressions feature country and time dummies. The Hansen line reports the p-value of the Hansen test.

Table 6: Fixed effects regressions

The results for trade are in line with theory. Trade has no significant impact on sector share in common-law countries. By contrast, it has a strong positive effect in civil-law countries. The effect is typically lower when we focus on the tradable sector only. However, the labor share differential between the capital- and labor-intensive super-sectors is larger in this latter case.

Accounting for endogeneity bias substantially reduces the effects of trade. The parameter associated with trade\*EU is divided by two for the SS<sub>1</sub> variable, while the reduction is smaller for the SS<sub>2</sub> variable. As discussed below, this result was expected. The development of the capital-intensive sector requires inputs that are produced in China.

Factor endowments do not affect the share of capital-intensive sectors. The effect of K/Y is even negative when the dependent variable is SS<sub>1</sub>. This result is at odds with the Rybczinski theorem. A possible explanation relies on the fact that country-specific factor endowments must be compared to the factor endowments in the rest of the world, and especially in developing countries. As we do not measure such endowments, country-specific factor endowments alone do not necessarily alter sector shares.

### 4.3 Discussions

Using our estimates, we can quantify the impact of trade with China on the capital-intensive sector share, and then on aggregate labor share. The rise in trade is roughly similar across countries. It increases by about 1.5 percentage points. The first line of Table 6 allows us to quantify the differential impact on Continental European capital-intensive sector shares. According to the OLS estimate, this impact is about  $7.44 * 1.5 \approx 11$  percentage points. This broadly corresponds to the observed differential change in capital-intensive sector share between Continental Europe and Anglo-Saxon countries. The OLS estimate, therefore, attributes the whole differential change to trade with developing countries. According to the IV estimate, this impact is about  $4.22 * 1.5\% \approx 6.5$  percentage points. The predicted impact is reduced by 40%, which seems more reasonable given the fact that part of trade with China is actually caused by the capital-intensive sector share. Given the mean labor share differential between the capital-intensive and the labor-intensive super-sector, the OLS estimate predicts that Continental European shares are reduced by  $11 * (0.78 - 0.58) \approx 2.2$  points compared with Anglo-Saxon countries. The IV estimate predicts a more modest and more realistic decline by  $6.5 * (0.78 - 0.58) \approx 1.3$  points.

Overall, the predicted differential labor share change between Continental Europe and the US-UK is not far from the observed one. For instance, our preferred estimate, the IV estimate, predicts a 1.3-point difference, which is about 40% of the observed difference. We now comment this result.

On the one hand, our study provides a lower bound to the magnitude of trade effects on factor reallocation. Sectorial data do not allow us to capture the whole phenomenon of factor reallocation predicted by trade theories based on factor endowment heterogeneity. Schott (2003, 2004) for instance shows that factor intensities vary considerably within a sector. In addition, within-product specialization alters our ability to distinguish capital-intensive sectors from labor-intensive sectors. To quote Schott: "[The] evidence suggests that conventional tests of trade theory using industry level data are problematic because much of the endowment-driven specialization occurs at a level that was, until recently, hidden from the researcher."

In terms of the Davis model with wage rigidity, the question is whether factor reallocation towards

capital-intensive high-quality goods especially occurred in Continental Europe. This may explain why output per worker in the industrialized sector is so much higher in Continental Europe than in the UK. Böckerman and Maliranta (2009) provide evidence of this phenomenon for Finland. They work at plant level and show that most of the fall in labor share observed there corresponds to composition effects taking place at plant level.

On the other hand, our study cannot exclude that differential time-varying effects took place between Continental Europe and Anglo-Saxon countries. For instance, the effects of trade with China vanish when we introduce time dummies or trends that differ between civil and common-law countries. This result is not very surprising given the homogeneity of the trade pattern in our sample of countries. Nevertheless, we cannot reject the thesis whereby other factors, correlated with trade, take place and explain sector share changes in developed countries. From this perspective, our study provides an upper-bound to the magnitude of trade effects, because we attribute the whole effect of such trends to trade. However, the puzzle would remain: what could be such differential effects?

## 5 Conclusion

This paper questions the ability of the HOS model to reproduce the patterns of labor shares in two sets of countries. Namely, labor shares stay constant in Anglo-Saxon countries, and go down in continental European countries. In addition, the labor share does not change much at sector or firm level. We show that once completed with a relative wage rigidity in Europe, the model can predict such facts. The key mechanism at work relies on the fact that trade globalization with developing or newly industrialized countries increases European unemployment. Factors are reallocated towards low labor-share sectors in Europe, which decreases the aggregate labor share.

The model predictions are broadly confirmed by the empirical evidence at sector-level data. We use the KLEMS dataset for 8 OECD countries over the period 1970-2006. We build a super capital-intensive sector in each country. The share of this sector in overall GDP increased with trade with China in Continental European countries compared with Anglo-Saxon countries. Put otherwise, the fall in European labor shares is partly due to trade-induced factor reallocation towards capital-intensive industries. Fixed effects estimates imply that the pattern of trade with China between the 1970s and the 2000s predicts a differential labor share change between Continental Europe and Anglo-Saxon countries that is comprised between 1 point (OLS estimates) and 2 points (IV estimates).

Still, the model remains puzzling in one respect. It generically predicts that the labor share decreases with capital intensity within a trade area. It implies, therefore, that the labor share is larger in developing than in developed countries. This fact, together with the more usual Leontief critique, calls for refinement. In future work, we plan to revisit the model predictions when there are skilled and unskilled workers, and skilled workers are complementary to physical capital.

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## 6 Appendix

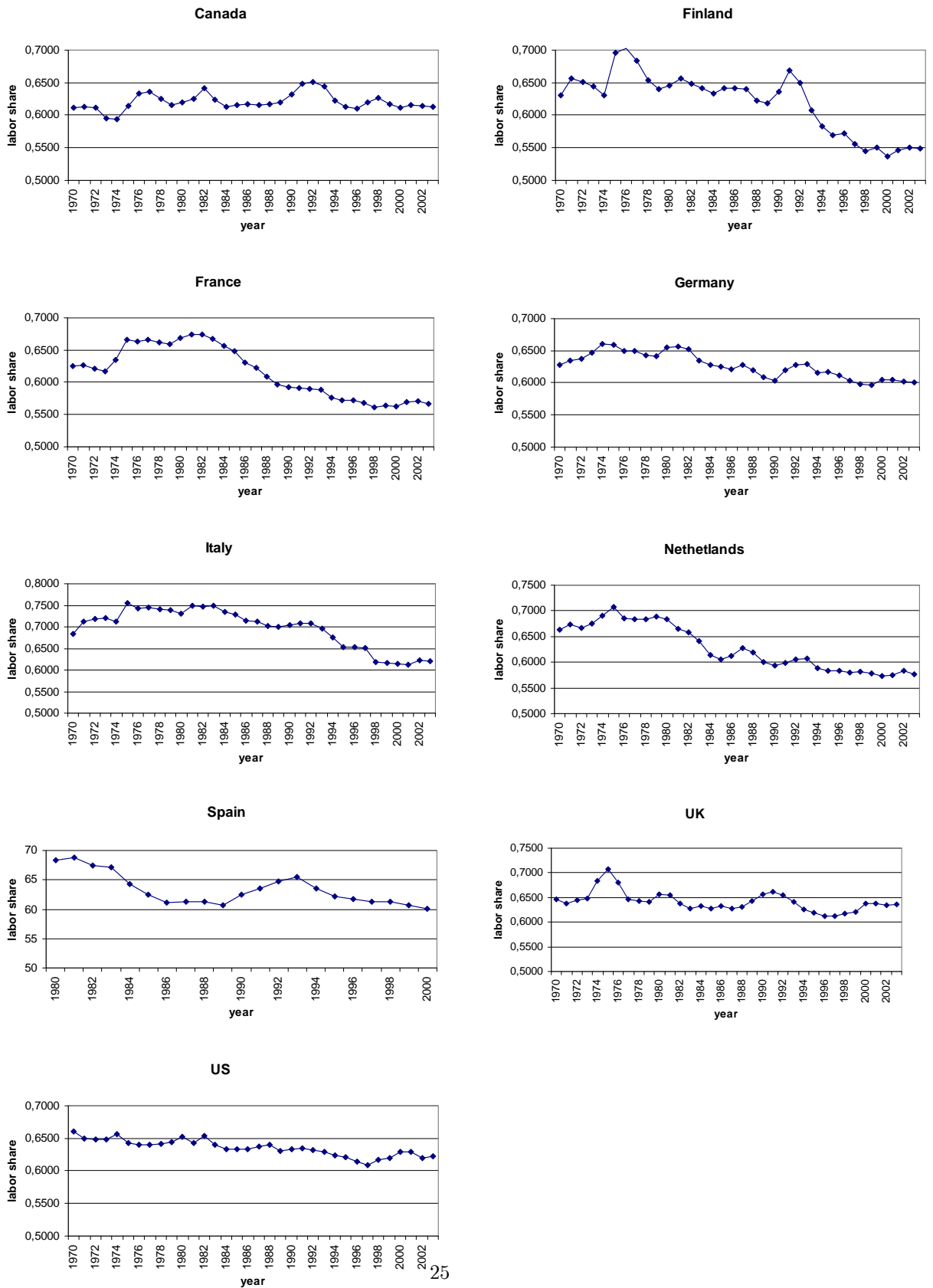


Fig. A1: Labor shares over time

- List of sectors: Agriculture, Hunting, Forestry and Fishing; Mining and Quarrying; Food products, Beverages and Tobacco; Textiles, Textile Products, Leather and Footwear; Wood and Products of Wood and Cork; Pulp, Paper, Paper products, Printing and Publishing; Coke, Refined Petroleum Products and Nuclear Fuel; Chemicals and Chemical Products; Rubber and plastics products; Other Non-Metallic mineral products; Basic Metals and Fabricated metal products; Machinery, nec; Electrical and Optical equipment; Transport equipment; Manufacturing nec, recycling; Electricity Gas and Water supply; Construction; Sale, maintenance and repair of motor vehicles and motorcycles, retail sale of; Wholesale trade and commission trade, except of motor vehicles and motorcycles; Retail trade, except of motor vehicles and motorcycles; repair of household goods; Hotel and Restaurants; Transport and Storage; Post and Telecommunications; Financial inter-mediation; Real estate activities; Renting of machinery and equipment and other business activities; Community social and personal services.
- List of tradable sectors: Agriculture, Hunting, Forestry and Fishing; Mining and Quarrying; Food products, Beverages and Tobacco; Textiles, Textile Products, Leather and Footwear; Wood and Products of Wood and Cork; Pulp, Paper, Paper products, Printing and Publishing; Coke, Refined Petroleum Products and Nuclear Fuel; Chemicals and Chemical Products; Rubber and plastics products; Other Non-Metallic mineral products; Basic Metals and Fabricated metal products; Machinery, nec; Electrical and Optical equipment; Transport equipment; Manufacturing nec, recycling

Figure A2 and the panel of Figures A3 show that the labor share decreases with capital intensity at sector level. All Figures use data from the 28 sectors of the dataset in 2000. Figure A2 pools the 8 countries, while the panel of Figure A3 separately considers each country.

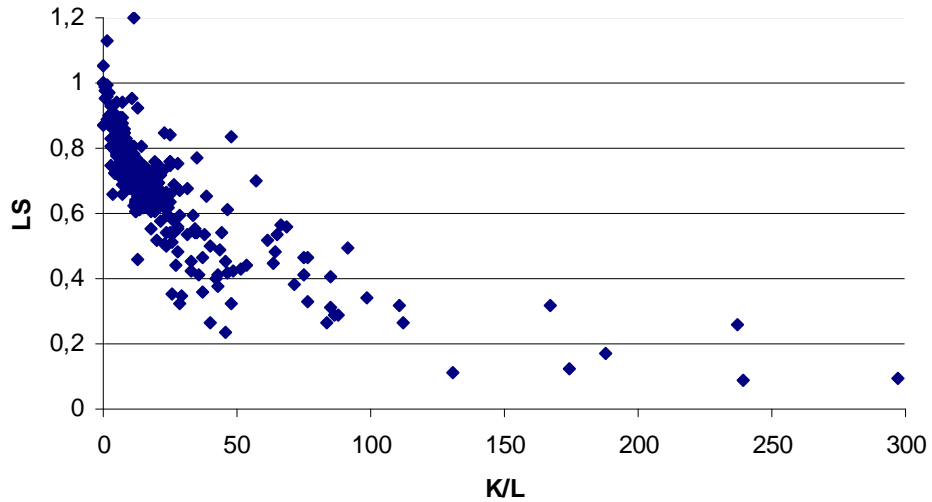
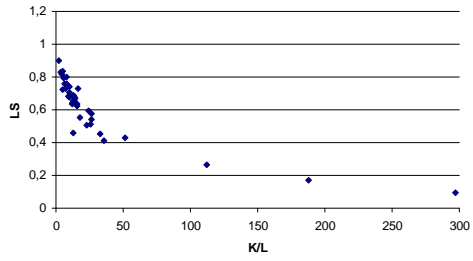
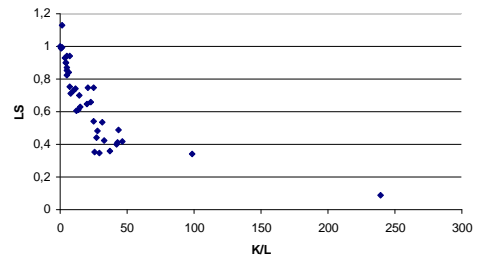


Fig.A2: Labor share and capital intensity at sector level in 2000.  $K/L$  is the capital labor ratio, while  $LS$  is the ratio of wage bill to value-added corrected for self-employment. There are 28 sectors and 8 countries. Source: KLEMS dataset and authors' computations.

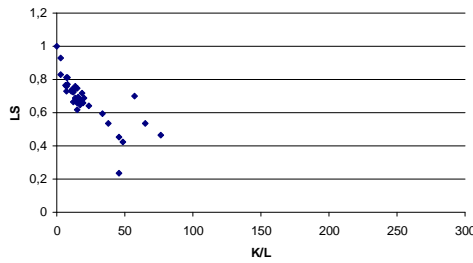




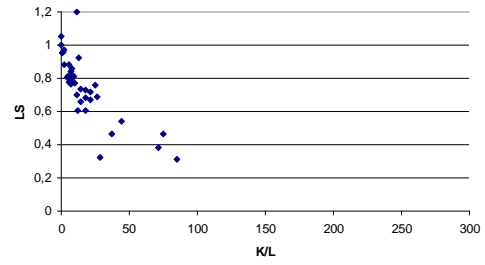
Spain



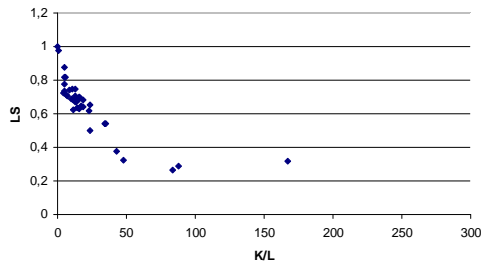
Finland



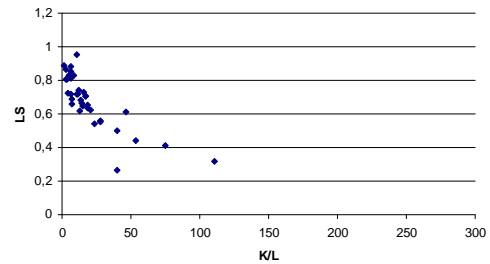
France



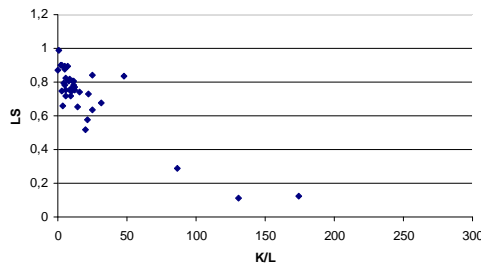
Germany



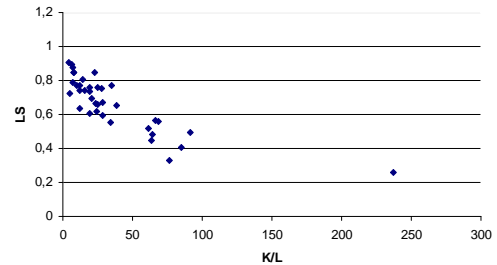
Italy



Netherlands



UK



US

Panel of Figures A3: Labor shares and capital intensity at sector level, country-specific patterns, 2000