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French and German Productivity Levels in Manufacturing: a Comparison Based on the Industry-of-Origin Method

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Abstract

The major problem with international comparisons of output and productivity levels is finding a suitable conversion factor to express output in a common monetary unit. Commonly used approaches applying purchasing power parities or market exchange rates have important methodological inconveniences. This study on France's and West Germany's manufacturing sector is based on the so-called 'industry-of-origin' method, where producer price ratios are used as conversion factors. These producer price ratios are based on ex-factory unit values for about 240 products corresponding to some 18% of total manufacturing.

The relative level of *producer prices* thus calculated suggests that, compared to Germany, France benefits from a competitive price advantage since about 1987. This price gap may be necessary to compensate the German non-price competitiveness which is often evoked in international trade comparisons. Despite this remaining price gap for total manufacturing, there is a remarkable convergence in relative price levels among major branches.

In terms of the volume of *output* and *factors of production*, the relative French-German levels show quite a contrasting pattern during the last two decades. Whereas the 1970s saw France catch up with Germany, the 1980s reversed most of these relative gains. In the beginning of the 1990s, the relative size of French manufacturing was again at almost the same level as 20 years before, at about half of German manufacturing.

During the whole time period, joint factor *productivity* was very close in both countries, whereas its two components show a clear divergence. At about the same level until the early 1980s, French labour productivity increased strongly and capital productivity declined substantially when compared to Germany's.

The symmetric evolution of relative labour and capital productivity is closely linked to the much stronger substitution of labour by capital in France than in Germany. French capital intensity in manufacturing rose increasingly above Germany's, despite lower labour costs and higher real interest rates. This paradox might be a major reason for the high French unemployment rate, despite relatively high growth rates in the late 1980s.

Résumé

Dans les comparaisons internationales des niveaux de production et de productivité le principal problème consiste à calculer un facteur de conversion adéquat pour exprimer la production de chacun des pays dans une unité monétaire commune. A ce titre, l'originalité de cette étude comparative France-Allemagne est d'appliquer la méthode dite *industry-of-origin* au lieu de recourir aux instruments usuels tels que le taux de change nominal ou les parités de pouvoir d'achat qui présentent d'importants inconvénients méthodologiques. Ici, les ratios de valeurs unitaires qui assurent les parités des prix de production servent de taux de conversion. Ils sont calculés à partir de valeurs unitaires sortie-usine pour environ 240 produits correspondant à 18 % du secteur manufacturier.

Le niveau relatif de *prix industriels* ainsi calculé révèle un léger avantage de compétitivité-prix en faveur de la France vis-à-vis de l'Allemagne depuis 1987. Un écart sans doute nécessaire pour résister à la compétitivité hors-prix allemande réputée dans le commerce internationale. Ce qui n'empêche pas les structures des prix relatifs des deux pays d'enregistrer une remarquable convergence au cours des deux dernières décennies.

Les niveaux relatifs France-Allemagne de la *production* et des *facteurs de production* suivent des évolutions contrastées dans les années soixante-dix et quatre-vingt. Tandis que la première décennie correspond à une période de rattrapage du niveau industriel allemand par la France, la seconde témoigne la perte complète de ces gains, et en début des années quatre-vingt-dix, l'industrie française retrouve la même taille relative qu'il y a vingt ans vis-à-vis de l'Allemagne.

Dans l'ensemble de la période, le niveau de la *productivité* globale des facteurs est resté similaire dans les deux pays, mais ses deux composants ont marqué des évolutions nettement divergentes depuis le début des années quatre-vingt : le niveau français de la productivité du travail par heure a largement dépassé le niveau allemand, mais en contrepartie, la productivité relative du capital français s'est sensiblement dégradée.

Les évolutions symétriques des productivités relatives des deux facteurs résultent d'une substitution plus forte du capital au travail en France qu'en Allemagne. A présent, l'intensité capitalistique relative française est devenue plus importante dans l'industrie, en dépit du coût de travail moins élevé et des taux d'intérêts réels plus importants qu'en Allemagne. Ce paradoxe français se trouve peut-être à l'origine du niveau élevé du chômage qui coexiste, dans les années quatre-vingt, avec une croissance relativement élevée.

French and German Productivity Levels in Manufacturing: A Comparison Based on the Industry-of-Origin Method

Michael Freudenberg and Deniz Ünal-Kesenci[1]

Introduction

This paper presents a comparison of levels of French and German manufacturing productivity based on the 'industry-of-origin' method. As I. Kravis states, 'productivity is the ratio of output to one input such as labour services or to inputs taken in their totality. Since economics is in its very essence concerned with the organisation of inputs (scarce means) to produce outputs (satisfy human wants), comparisons of productivity go to the heart of the assessment of economic performance.'[2]

Productivity comparisons between countries over *time* are quite straightforward since within each country we can assume consistency in definitions of inputs, outputs and industrial classifications. This will readily yield productivity *growth rates,* e.g. value added per employee. However, international comparisons in *space*, i.e. across countries, to estimate productivity *levels* are much more problematic.

In some enterprises, productivity levels among countries are compared using **physical quantities** (e.g. tonnes per employee). These comparisons can have a certain interest for some industries with standardised products (e.g. a certain type of steel). However, this approach cannot be used for total manufacturing as quantities are indicated in different units (tonnes, litres, meters, etc.) and it is impossible to weight products by their relative importance. Since the work of Rostas, many comparisons have been done using **gross value of output** (sold quantities valued at producer prices).[3] However, this creates certain difficulties, since gross output includes intermediate consumption. In order to exclude 'double counting', we have to move to a 'net' concept of output, for which **value added** is the most appropriate.

For the 'monetary' indicators (gross value of output as well as value added) where output is expressed in national prices, the major problem with cross-country comparisons is finding a suitable conversion factor to express output in a *common monetary unit*. For

[1] Economists at the CEPII. We are grateful to Bart van Ark of the International Comparisons of Output and Productivity (ICOP) Project at the University of Groningen, Netherlands, whom we thank for technical advice and fruitful discussions. Further thanks go to Michel Fouquin, Remco Kouwenhoven, Gérard Lafay, Jean Pisani-Ferry, the participants in the workshops 'International Productivity Differences and their Explanations' (Wissenschaftszentrum Berlin, 26-27 November 1993) and 'International Comparisons of Price and Productivity Levels' (CEPII, 25 February 1994) for comments and advice. Thanks to the Conseil national de l'information statistique, the SESSI kindly provided us with confidential information for some industries, which helped to increase the number of product matches.

[2] Kravis (1976, p. 1).

[3] For an overview of the most important studies, see van Ark (1993, pp. 13-18).

example, how is average value added per hour worked of FF 150 in a particular French industry to be compared with DM 50 in the same industry in Germany?

Basically, there are three main approaches. The most straight forward, using **market exchange rates**, can yield misleading results. As Maddison and van Ark point out, 'exchange rates do not indicate the average purchasing power of currencies over all goods and services, but mainly reflect their purchasing power over tradable goods and services. Furthermore, exchange rates are subject to fluctuation, and capital movements may play a major role in determining their level.'[4]

An alternative is to use **purchasing power parities** (PPPs) provided by the International Comparisons Program of the United Nations and by Eurostat. PPPs indicate the conversion rate which has to be applied to the value in one country's currency of a given basket of products to permit the purchase of the same quantity of products in the other country. For example, if a basket of goods in a particular industry costs FF 30,000 in France and DM 10,000 in Germany, then the PPP for this industry is 3.00 FF/DM. However, this method is inappropriate for productivity comparisons. Country comparisons using PPPs are useful to compare standards of living, but are less suited for analyses of industrial structures, as they do not reflect supply-side conditions. First, the basket used to estimate PPPs concern goods and services for final expenditure only, whereas we are interested in the production side, where intermediate goods are too important to be neglected. Second, PPPs are calculated for goods whether they are produced locally or imported, and exports are excluded. Third, PPPs are based on retail prices, which include indirect taxes and subsidies, transport costs and distribution margins, and are collected at a given moment in time in a limited number of places. Furthermore, for the French-German comparison, it is more appropriate to use these countries' price structure rather than PPPs based on a multilateral price system, which does not reflect 'country characteristicity'.

Our paper is based on a third approach, the so-called 'industry-of-origin' method, which allows most of these factors to be taken into account.[5] Here, **producer price ratios** are used as conversion factors. For each product, dividing ex-factory sales by corresponding quantities yields their unit value. For similar products in the two countries, so called 'unit value ratios' (UVRs) in FF/DM can be calculated, by dividing French by German unit values. UVRs for individual products are then aggregated to an industry level and applied to value added. The calculations are made for 1987, and the results extrapolated backwards to 1970 and forwards to 1992.

1. The Industry-of-Origin Method Step by Step

Production censuses provide information on ex-factory sales and their corresponding quantities for a great number of products. However, these figures are

[4] Maddison and van Ark (1989, p. 1).

[5] See Maddison and van Ark (1989) and van Ark (1993) for an overview of this approach.

insufficient to compare French and German output directly, as they are indicated in different currencies.

French production in FF:

$$\sum q^{F} p^{F(FF)} \tag{1.a}$$

German production in DM:

$$\sum q^{G} p^{G(DM)} \tag{1.b}$$

The basic procedure for international comparisons is to estimate -separately for each product- the sold quantities (q) of the two countries by a *common set of prices* (p), either French or German ones. These prices are unit values obtained by dividing sales values by quantities. In order to compare similar products, this part is done at the most detailed level possible, and only then aggregated to a higher level (industry, branch, major branch or manufacturing sector).

French production in DM:

$$\sum q^{F} p^{G(DM)} \tag{2.a}$$

German production in FF:

$$\sum q^{G} p^{F(FF)} \tag{2.b}$$

Once each country's production is estimated in both currencies, we can calculate French-German output as well as price ratios.

For a given industry, the average **quantity ratio** is obtained by weighting the quantities of the products by the corresponding unit values of one of the two countries.

(Paasche[6]) quantity ratio in French 'prices':

$$\frac{\sum p^{F(FF)} q^{F}}{\sum p^{F(FF)} q^{G}} \tag{3.a}$$

(Laspeyres[7]) quantity ratio in German 'prices':

$$\frac{\sum p^{G(DM)} q^{F}}{\sum p^{G(DM)} q^{G}} \tag{3.b}$$

6 Superscripts referring to the country form a 'P' like Paasche.

7 Superscripts form an 'L' like Laspeyres.

The average **price ratio** for a given industry is obtained by weighting the unit values of the matched products by the corresponding quantity weights of one of the two countries. In order to not confuse the price ratio for final expenditure used by the United Nations ('purchasing power parities'), we apply the term *unit value ratios (UVRs)* used by the industry-of-origin approach (ICOP, University of Groningen, Netherlands).

(Paasche) UVR weighted by French quantities:

$$UVR^{F} = \frac{\sum q^{F} p^{F(FF)}}{\sum q^{F} p^{G(DM)}} \qquad (4.a)$$

(Laspeyres) UVR weighted by German quantities:

$$UVR^{G} = \frac{\sum q^{G} p^{F(FF)}}{\sum q^{G} p^{G(DM)}} \qquad (4.b)$$

The industry-of-origin method generally uses two sources of data: one for products, another one for industries. For enterprises with 20 employees or more, information on ex-factory sales and corresponding quantities for **products** is obtained from national censuses of production.[8] This allows unit values to be calculated and, once products in the censuses are 'matched,' their unit value ratio. These UVRs are then applied to **industry** gross value added at factor cost, which we obtain, together with data on sales and employment, basically from the same organisations, but from different publications.[9]

Table 1 is a summary table of these concepts. While the figures are fictitious, in practice price as well as quantity ratios are different when weighted by one country's as compared to the other country's weights. This is because the internal structure of prices and quantities is in general different between two countries. Therefore, in the literature, the geometric average (Fisher index) is often used. It has no theoretical or economic meaning, but has the advantage of being transitive.[10]

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[8] German product information is from Statistisches Bundesamt, Produzierendes Gewerbe, Fachserie 4, Reihe 3.1, *Produktion im produzierenden Gewerbe des In- und Auslands, 1987.* For French product data, we used the *Enquêtes de branches 1987* of the Service des statistiques industrielles (SESSI), Ministère de l'industrie et de l'aménagement du territoire. Thanks to the Conseil national de l'information statistique, the SESSI kindly provided us with confidential information for some industries, which helped to increase the number of product matches. We used additional data on steel from the *Annual Bulletin of Steel Statistics for Europe,* Vol. XVI, United Nations (1988).

[9] Statistisches Bundesamt, Produzierendes Gewerbe, Fachserie 4, Reihe 4.3.1 - 4.3.3, *Kostenstruktur der Unternehmen.* Service des statistiques industrielles (SESSI), *Enquête annuelle d'entreprise 1987*; as well as the *Annuaire de statistique industrielle 1990-91.* Additional data on food processing from the Service central des enquêtes et des études statistiques (SCEES), *Enquête annuelle d'entreprise* 1987, Industries agricoles et alimentaires (IAA).

[10] See I. Kravis, A. Heston and R. Summers (1982, 71-74) for desired properties of an ideal PPP.

Table 1
Example of Price and Quantity Ratios Derived from Gross Value of Output

Prices in ...	Quantities of ...		Quantity Ratio
	France	Germany	(Germany =100)
FF	$\sum q^F p^F = 300$	$\sum q^G p^F = 500$	$\frac{\sum p^F q^F}{\sum p^F q^G} = 60$
DM	$\sum q^F p^G = 100$	$\sum q^G p^G = 150$	$\frac{\sum p^G q^F}{\sum p^G q^G} = 66$
Price Ratio (UVR) (FF/DM)	$\frac{\sum q^F p^F}{\sum q^F p^G} = 3.00$	$\frac{\sum q^G p^F}{\sum q^G p^G} = 3.33$	

In order to permit transparency of this method, the next section indicates step-by-step how we applied the industry-of-origin approach. A reader familiar with this approach might skip section 1.1 and turn directly to the results for manufacturing output (section 2).

1.1. The First Step: The Matching Procedure to Calculate 'Real' Production for Matched Products

This stage is ideally done at the most detailed possible level of the nomenclatures. Products in national production censuses can be 'matched' only if their technical descriptions are similar. For a given French product, we have to find the corresponding one in the German nomenclature. While this is a is very time-consuming task, it is the most important one, as final productivity comparisons depend heavily on the results obtained here.

The 'real' production of these matched products is calculated by multiplying the quantities of one country by the unit values of the other one. With subscript *mp* referring to matched products in a given industry, equations (2.a) and (2.b) become.

French matched production in DM:

$$\sum q^F_{mp} \, p^G_{mp} \tag{5.a}$$

German matched production in FF:

$$\sum q^G_{mp} \, p^F_{mp} \tag{5.b}$$

Table 2 gives an example of the matching procedure for 'men's outerwear' where four groups of products (suits, jackets, trousers and coats) are matched. For this industry, as well as for the others, the number of items actually taken into account is substantially higher than the indicated number of product matches. While it is desirable to match relatively homogeneous products, in practice, however, we often have to aggregate detailed product information in one country to make the nomenclatures comparable. For example, in contrast to the French census, the German one distinguishes suits according to the cloth used (cotton, wool or other material). In this case, despite individual product information for Germany, the three German items were grouped together before being compared to French suits, thus obtaining one single match for suits.

The UVR for 'men's outerwear' is 3.29 FF/DM at German and 3.11 FF/DM at French weights. French matched production represents some 63% of the German level when weighted by German quantities and 60% at French quantities. In our sample industry, as well as in the others, only a fraction of total output could be matched: the four product matches in this industry represent 44% of German and 35% of French sales. There are several reasons for this. Statistical sources do not always indicate the necessary information on production and quantities sold, partly for reasons of confidentiality; information on quantities may not be compatible (e.g. litres in one country and kilograms in the other); goods can be produced in one country but not in the other; relative unit values are so extremely low or high that we decided to exclude them, as this might possibly indicate either a mismatch between technically different products or a serious quality problem.[11] We also excluded certain products to minimise the compositional or 'product-mix' effect on UVRs.[12]

[11] For example, we decided to exclude the item 'aminoplastes'. While from the description it looked like an unambiguous match, its UVR was more than 10 FF/DM. For a discussion on quality problems, see van Ark (1990a, p. 81 and 1990c, p. 347) as well as Maddison et van Ark (1989, p. 35). For possible product-mix and quality adjustments, see van Ark (1990b, pp. 73).

[12] For example, German cars with a cylinder capacity of 3 litres or more were excluded since there are no or hardly any comparable French cars in that category.

Table 2
Product Matches in the Industry 'Men's Outerwear', France and Germany, 1987'

Product Item	Q	V	P	Product Item	Q	V	P	Real Output		UVR		Q-Ratio	
	Germany				France			Germany	France	Q(G)	Q(F)	P(G)	P(F)
		(DM)	(DM)			(FF)	(FF)	(FF)	(DM)	(FF/DM)		(%)	
Herrenanzüge	**3,817**	**791.1**	**207.3**	**Costumes complets et ensembles**	**1,428**	**977.3**	**684.4**	**2,612.3**	**296.0**	**3.30**	**3.30**	**37.4**	**37.4**
aus Baumwolle	186	38.6	207.4										
aus Wolle u. feinen Tierhaaren	2,753	579.7	210.6										
aus sonst. Material	878	172.8	196.8										
Herrensakkos u. -jacken	**4,816**	**603.5**	**125.3**	**Vestes seules et blasers**	**2,151**	**1,016.7**	**472.7**	**2,276.3**	**269.5**	**3.77**	**3.77**	**44.7**	**44.7**
aus Baumwolle	984	110.2	112.0										
aus Wolle u. feinen Tierhaaren	2,644	339.0	128.2										
aus sonst. Material	1,188	154.3	129.9										
Herrenhosen, lang	**31,710**	**1,449.6**	**45.7**	**Pantalons**	**28,189**	**3,712.8**	**131.7**	**4,176.6**	**1,288.6**	**2.88**	**2.88**	**88.9**	**88.9**
aus Baumwolle	8,020	317.7	39.6	Jeans en "denim"	12,981	-----							
aus Wolle u. feinen Tierhaaren	8,312	462.9	55.7	Pantalons de ville et loisir	15,208	-----							
aus sonst. Material	11,739	551.9	47.0										
Jeanshosen	3,639	117.0	32.1										
Herrenmäntel u. -umhänge	**705**	**132.6**	**188.1**	**Pardessus, manteaux et vêtements similaires**	**152**	**155.4**	**1,022.3**	**720.7**	**28.6**	**5.43**	**5.43**	**21.6**	**21.6**
aus Baumwolle	232	37.1	160.1										
aus Wolle u. feinen Tierhaaren	318	63.1	198.5										
aus sonst. Material	155	32.3	208.7										
Industry Matched Production		**2,976.8**				**5,862.2**		**9,786.0**	**1,882.7**	**3.29**	**3.11**	**63.2**	**59.9**
Industry Sales		**6,732.6**				**16,954.8**							
Coverage Ratio (%)		**44.2**				**34.6**							

Note: Quantities (Q) are in 1,000 pieces, values (V) in millions and unit values (P) in 1,000s.

Sources: For product information, SESSI, *Enquêtes de branches 1987* and Statistisches Bundesamt, *Produktion im produzierenden Gewerbe des In- und Auslands 1987*. Industry information is from SESSI, *Enquête annuelle d'entreprise 1987* and Statistisches Bundesamt, *Kostenstruktur der Unternehmen 1987*.

1.2. The Second Step: Treatment of Output Non-Covered by Matched Products

Given the importance of total output as compared to output covered by matched products, we have to make certain assumptions in order to estimate *total*, real production for each aggregate.

1.2.1. Two Alternative Methods to 'Blow-Up' Covered Output: Quantity Ratios and Price Ratios

There are two alternative methods to estimate total real production from real matched production. Either we assume that the quantity ratio of French and German matched production is representative for total output, or that the price ratio is representative.[13]

1.2.1.1. The Quantity Ratio Method

This method assumes that the French-German quantity ratio for matched products in a given industry is identical to the quantity ratio of the entire industry. Subscript *mp* referring to output covered by matched products, this relation is as follows:

Industry quantity ratio at French prices:

$$\frac{\sum p^F q^F}{\sum p^F q^G} = \frac{\sum p^F_{mp} q^F_{mp}}{\sum p^F_{mp} q^G_{mp}} \qquad (6.a)$$

Industry quantity ratio at German prices:

$$\frac{\sum p^G q^F}{\sum p^G q^G} = \frac{\sum p^G_{mp} q^F_{mp}}{\sum p^G_{mp} q^G_{mp}} \qquad (6.b)$$

Equations (6.a) and (6.b) can be rewritten to estimate total production in the other country's prices:

Total German 'real' output in FF:

$$\sum p^F q^G = \frac{\sum p^F_{mp} q^G_{mp}}{\underbrace{\left(\frac{\sum p^F_{mp} q^F_{mp}}{\sum p^F q^F}\right)}_{\text{French coverage ratio}}} \qquad (7.a)$$

13 Maddison and van Ark (1988, pp. 31-34).

Total French 'real' output in DM:

$$\sum p^{G} q^{F} = \frac{\sum p^{G}_{mp}\, q^{F}_{mp}}{\underbrace{\left(\dfrac{\sum p^{G}_{mp}\, q^{G}_{mp}}{\sum p^{G} q^{G}}\right)}_{\text{German coverage ratio}}} \qquad (7.b)$$

1.2.1.2. The Price (or Unit Value) Ratio Method

The second method to estimate total real output from covered output is to use price ratios. The assumption in this second method is that UVRs for matched products in a given industry are representative for the entire industry.

Price ratio at French weights:

$$\frac{\sum q^{F} p^{F}}{\sum q^{F} p^{G}} = \frac{\sum q^{F}_{mp}\, p^{F}_{mp}}{\sum q^{F}_{mp}\, p^{G}_{mp}} = UVR^{F}_{mp} \qquad (8.a)$$

Price ratio at German weights:

$$\frac{\sum q^{G} p^{F}}{\sum q^{G} p^{G}} = \frac{\sum q^{G}_{mp}\, p^{F}_{mp}}{\sum q^{G}_{mp}\, p^{G}_{mp}} = UVR^{G}_{mp} \qquad (8.b)$$

Equations (8.a) and (8.b) can be rewritten to estimate total real output:

French total real output in DM:

$$\sum q^{F} p^{G} = \frac{\sum q^{F}_{mp}\, p^{G}_{mp}}{\underbrace{\left(\dfrac{\sum q^{F}_{mp}\, p^{F}_{mp}}{\sum q^{F} p^{F}}\right)}_{\text{French coverage ratio}}} = \frac{\sum q^{F} p^{F}}{\underbrace{\left(\dfrac{\sum q^{F}_{mp}\, p^{F}_{mp}}{\sum q^{F}_{mp}\, p^{G}_{mp}}\right)}_{UVR^{F}_{mp}}} \qquad (9.a)$$

German total real output in FF:

$$\sum q^{G} p^{F} = \frac{\sum q^{G}_{mp}\, p^{F}_{mp}}{\underbrace{\left(\dfrac{\sum q^{G}_{mp}\, p^{G}_{mp}}{\sum q^{G} p^{G}}\right)}_{\text{German coverage ratio}}} = \sum q^{G} p^{G} \underbrace{\left(\frac{\sum q^{G}_{mp}\, p^{F}_{mp}}{\sum q^{G}_{mp}\, p^{G}_{mp}}\right)}_{UVR^{G}_{mp}} \qquad (9.b)$$

1.2.1.3. The Choice of the Unit Value Ratio Method to Estimate Total Real Production

The *quantity ratio* method estimates total real output by dividing a country's real matched production by the coverage ratio of the *other* country. In contrast, the *price ratio* method divides it by the coverage ratio of the *same* country. If the coverage ratios of the two countries are identical, total real production is the same in the two methods. Otherwise, we have to make a choice.

Table 3 compares the two methods for the industry 'men's outerwear'. The columns indicate each country's production in both currencies as well as quantity and price ratios. The first line indicates the data of the matched products in that industry (from Table 2). The bold figures in lines 2 and 4 indicate total sales value in that industry (DM 6,733 million for Germany and FF 16,955 million for France).

- The **quantity ratio method** (lines 2 and 3) estimates real output in that industry at FF 28,303 million for Germany and at DM 4,259 million for France (figures in the box). The resulting industry UVR becomes about 4.20 FF/DM at German and 3.98 FF/DM at French weights.

- The **price ratio method** (lines 4 and 5) yields total real output of FF 22,133 million for Germany and DM 5,445 million for France. In this case, the new quantity ratio for the industry is about 81% at German and 77% at French weights.

Table 3
Comparison of the Quantity and Price Ratio Methods for the Sample Industry 'Men's Outerwear', France and Germany, 1987

	Production				Quantity Ratio		Price Ratio	
	Germany		France		P(G)	P(F)	Q(G)	Q(F)
	(mio. DM)	(mio. FF)	(mio. DM)	(mio. FF)	(%)		(FF/DM)	
Matched Production	**2,977**	**9,786**	**1,883**	**5,862**	**63.2**	**59.9**	**3.29**	**3.11**
Total Using Quantity Ratio	**6,733**	28,303	4,258	**16,955**	63.2	59.9	4.20	3.98
Coverage Ratio (%)	44.2	34.6	44.2	34.6				
Total Using Price Ratio	**6,733**	22,133	5,445	**16,955**	80.9	76.6	3.29	3.11
Coverage Ratio (%)	44.2	44.2	34.6	34.6				

Sources: Figures in bold from Table 2.

Which of the two methods is preferable? This problem has generated many discussions since Mills raised the issue in 1932. Maddison and van Ark refer to authors like Burns (1934), Fabricant (1940) and Stone (1956), who all prefer the price ratio method:

> "Burns (1934, p.260-1) stressed that the prices of different commodities are likely to be under the general influence of 'common monetary factors', whereas there is no such 'single dominant force acting pervasively' on quantitative movements for different commodities. Fabricant (1940) also preferred price indicators because

> 'prices probably move together within closer limits than do quantities'. Richard Stone (1956) stated that completeness of coverage is of less importance with price indicators compared to quantity indicators, because 'prices charged for close substitutes by different firms or in different parts of a country are likely, in many cases, to show similar movements even if their absolute level is a little different'."[14]

Like the ICOP studies, we use the price ratio method to estimate total real production.

1.2.2. Assumptions for Unit Value Ratios (UVRs) for Categories with an Insufficient Coverage Ratio

Even if we decide to apply the UVRs of matched products to the entire industry, in some categories, matched products cover too low a percentage of total output to be considered 'representative'. Therefore, we have to introduce some assumptions regarding UVRs for 'non-representative' categories.

- For industries with a coverage ratio (matched in total production) of at least 25% (Fisher geometric average for the two countries), we assume that the UVR of their matched part is equal to the UVR of the non-covered part. In this case, the UVRs obtained from the product matches are **directly** used to estimate total real output.

  Our sample industry 'men's outerwear' is 'representative', since the average coverage ratio in the two countries is about 39% (see Table 4 which indicates the number of product matches in each category, the coverage ratio, 'initial' UVRs derived from the product matches as well as 'intermediate' UVRs used to convert output in the other country's currency).

In order to not overestimate the importance of matched products compared to non-matched products, UVRs from matched products are used only **indirectly** in the following cases:

- For *industries* with no product matches or an unacceptable matching percentage (less than 25%, marked with *), we used the average UVRs for all matched products in their corresponding branch, i.e. the next higher category.[15]

[14] Maddison and van Ark (1988, p. 34). F.C. Mills, *Economic Tendencies in the United States: Aspects of Pre-War and Post-War Changes,* NBER, New York (1932). A.F. Burns, *Production Trends in the United States Since 1870,* NBER, New York (1943). S. Fabricant, *The Output of Manufacturing Industries,* 1899-1937, NBER, New York (1940). R. Stone, *Quantity and Price Indices in National Accounts,* OEEC, Paris (1956).

[15] For example, the 4 matched products in the industry 'other stone and glass products*' represent less than 8% of German and only 3% of French sales. Therefore, we did not use the UVRs from the product matches in that industry (3.57 FF/DM at German and 4.09 FF/DM at French weights). Instead, we used the UVR for the branch 'stone, glass and non-metallic mineral products' (3.70 and 3.51 FF/DM, respectively). So, the original UVRs for the product matches are only partly taken into account.

Table 4
Initial UVRs and Choice of Intermediate UVRs, France and Germany, 1987

Major branches / Branches / *Industries*	Matches Number	Coverage Ratio (%) Germany	France	Fisher	Initial UVRs (FRF/DEM) Q(G)	Q(F)	Intermediate UVRs (FRF/DEM) Q(G)	Q(F)
Food and beverages* **	**0**	**0.0**	**0.0**	**0.0**	**na**	**na**	**3.07**	**3.01**
Wearing apparel, textiles and leather products	**30**	**22.3**	**19.8**	**21.0**	**3.42**	**2.98**		
Wearing apparel	18	42.2	41.9	42.0	3.73	3.57		
Men's outerwear	*4*	*44.2*	*34.6*	*39.1*	*3.29*	*3.11*	*3.29*	*3.11*
Women's and children's outerwear	*6*	*52.3*	*44.9*	*48.5*	*3.94*	*3.62*	*3.94*	*3.62*
Shirts and underwear	*1*	*23.5*	*31.7*	*27.3*	*3.24*	*3.24*	*3.24*	*3.24*
Brassieres and girdles	*2*	*24.1*	*68.7*	*40.7*	*4.28*	*4.44*	*4.28*	*4.44*
Other wearing apparel	*5*	*16.0*	*53.9*	*29.4*	*4.14*	*4.66*	*4.14*	*4.66*
Textiles**	7	4.7	2.6	3.5	3.38	2.93	3.42	2.98
Footwear and leather products	5	44.5	38.8	41.5	2.62	2.29		
Wood, paper and other industries	**25**	**27.4**	**25.3**	**26.4**	**3.17**	**3.12**		
Chemicals, rubber and plastic products	**68**	**20.3**	**25.5**	**22.8**	**3.24**	**3.14**		
Stone, glass and non-metallic mineral products	16	23.8	38.7	30.4	3.70	3.51		
Glass	*8*	*41.1*	*63.1*	*50.9*	*3.78*	*3.35*	*3.78*	*3.35*
Cement	*2*	*83.8*	*84.1*	*83.9*	*4.16*	*4.16*	*4.16*	*4.16*
Ceramics	*2*	*40.6*	*38.1*	*39.3*	*2.58*	*2.69*	*2.58*	*2.69*
*Other stone and glass products**	*4*	*2.9*	*7.7*	*4.7*	*3.57*	*4.09*	*3.70*	*3.51*
Rubber and plastic products	22	39.5	49.4	44.2	3.03	2.96		
Chemicals	30	13.1	15.1	14.1	3.26	3.10		
Basic metals and metal products	**38**	**26.0**	**24.2**	**25.1**	**3.18**	**3.08**		
Machinery	**42**	**6.6**	**9.1**	**7.7**	**3.06**	**2.80**		
Transport equipment	**8**	**37.1**	**34.3**	**35.7**	**2.80**	**2.86**		
Electric and electronic products	**26**	**7.0**	**4.5**	**5.6**	**3.04**	**3.06**		
Manufacturing	**237**	**18.2**	**18.0**	**18.1**	**3.07**	**3.01**		

Note: The detail by industries is given only for the branches 'wearing apparel' and 'stone, glass and non-metallic mineral products'.

Sources: For product information, SESSI, Enquêtes de branches 1987, Statistisches Bundesamt, Produktion im produzierenden Gewerbe des In- und Auslands 1987 and United Nations (1988), Annual Bulletin of Steel Statistics for Europe. Industry information is from SESSI, Enquête annuelle d'entreprise 1987, SCEES, Enquête annuelle d'entreprise 1987 and Statistisches Bundesamt, Kostenstruktur der Unternehmen 1987.

- For one *branch* ('textiles', marked with **) with no product matches we applied the UVR for all matched products in their corresponding 'major branch'.[16]
- For one *major branch* ('food and beverages***') where no matches could be made, we applied the UVR for all matched products in manufacturing (3.01 and 3.07 FF/DM, respectively). Another possibility would have been to assume that the quantity (not the

[16] The 7 matched products in the branch 'textiles**' represent less than 5% of German and 3% of French sales. Instead of using the UVRs from the product matches in this branch (3.38 FF/DM at German and 2.93 FF/DM at French weights), we applied the UVR for the major branch 'wearing apparel, textiles and leather products' (2.98 and 3.42 FF/DM, respectively).

price) ratio of the covered output is representative, or proxy-PPPs could have been used.[17] However, in this study, we decided to apply the same method for all categories.

These 'intermediate' UVRs are obtained either directly from product matches or indirectly from all product matches in the next higher category. The UVRs obtained in this second stage allow total real production to be estimated.

1.2.3. Changing the Output Concept: From Gross Value of Output to Value Added

The output concept used for product matches and UVRs is the gross value of output (sold quantities valued at producer prices). However, this implies important difficulties for international comparisons of output and productivity, since gross output includes *intermediate* consumption. "In two countries producing a similar value added, the one with the most specialised plants will have a higher gross output because there will be more interplant shipments for intermediate processing."[18] In order to exclude 'double counting', we have to move to a 'net' concept of output, for which value added is the most appropriate.

But how is value added to be estimated in the other country's currency? Since value added is the difference between output and intermediate consumption, there are two methods. The 'double deflation' method applies *separate* UVRs to gross output and intermediate inputs and then calculates the difference, while the 'single indicator' method applies the *same* UVRs directly to value added.

1.2.3.1. The Double Deflation Method

The double deflation method deducts intermediate goods and services from gross output by applying separate UVRs. With subscripts *GO* referring to gross output and *I* to intermediate consumption, 'real' value added for a given industry is therefore:

French value added in DM:

$$\frac{q_{GO}^{F}\ p_{GO}^{F}}{UVR_{GO}^{F}} - \sum \frac{q_{I}^{F}\ p_{I}^{F}}{UVR_{I}^{F}} \tag{10.a}$$

German value added in FF:

$$q_{GO}^{G}\ p_{GO}^{G}\ \ UVR_{GO}^{G} - \sum q_{I}^{G}\ p_{I}^{G}\ \ UVR_{I}^{G} \tag{10.b}$$

Smith, Hitchens and Davies mention the interest of this method especially for comparisons between countries where relative prices for inputs differ strongly.

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17 For 'food and beverages', the former method was used by van Ark and Kouwenhoven in their USA-France comparison (1994).

18 Maddison and van Ark (1988, p. 11).

"Double deflation is a technical aspect of a phenomenon that excites considerable interest in the context of international competitiveness, especially between Europe and the United States; the allegation is that because of America's greater degree of self-sufficiency in raw materials etc., and because of Federal government action to hold down the price of oil and gas -and thus fuel costs and inputs in the chemical and textile industries- industrial activities in the US have enjoyed a head start in competitiveness. The corollary of this in the present context is that low relative prices for US inputs may encourage a comparatively large usage of them per unit of output, in effect substituting for manpower and boosting labour productivity. In principle, allowance would be made for this in our measure by double deflation (...)."[19]

On a conceptual level, double deflation is the best method to estimate real value added. In practice, however, estimating two separate UVRs is often not possible. Attempts for double deflation have been made, but the results are often unreliable, yielding, in some cases, *negative* value added.[20]

1.2.3.2. The Single Indicator Method

In the present study, we applied the so-called single indicator method. For each industry, the 'intermediate' UVRs for gross output (directly or indirectly derived from matched products, see Step 2) are applied to value added. Implicitly, we assume that relative prices for input and output are identical. With *intermed* referring to 'intermediate' UVRs, real value added for a given industry is therefore:

French value added in DM:

$$VA^{F(DEM)} = \frac{VA^{F(FRF)}}{UVR^{F}_{intermed}} \tag{11.a}$$

German value added in FF:

$$VA^{G(FRF)} = VA^{G(DEM)}\, UVR^{G}_{intermed} \tag{11.b}$$

1.3. The Final Step: Aggregation of Output and Reestimation of UVRs

Real value added can now be aggregated to the branch, major branch, and total manufacturing level. We can now estimate quantity as well as price ratios for value added.

[19] Smith, Hitchens and Davies (1982, p. 23).

[20] See for example Szirmai and Pilat (1990, pp. 74-82) for a rough approximation for 15 industries. In this case, UVRs for input were not calculated separately, but depend directly on output UVRs, which are weighted by industry input shares from input-output tables. The authors admit that, 'though the average effects of double deflation do not seem totally unacceptable, the results at branch level are still very implausible'.

Relative level of value added in FF:

$$\frac{VA^{F(FRF)}}{VA^{G(FRF)}} = \frac{\sum VA^{F(FRF)}}{\sum VA^{G(DEM)}\, UVR^{G}_{intermed}} \tag{12.a}$$

Relative level of value added in DM:

$$\frac{VA^{F(DEM)}}{VA^{G(DEM)}} = \frac{\sum \frac{VA^{F(FRF)}}{UVR^{F}_{intermed}}}{\sum VA^{G(DEM)}} \tag{12.b}$$

With *ind* and *agr* referring to industry and aggregate levels, *intermed* to 'intermediate' UVRs (Step 2) and *final* to final UVRs (Step 3), the final, value added weighted UVRs at an aggregate level are:

Final UVRs at German weights:

$$UVR^{G}_{final,agr} = \frac{\sum VA^{G(DEM)}_{ind}\, UVR^{G}_{intermed,ind}}{\sum VA^{G(DEM)}_{ind}} \tag{13.a}$$

Final UVRs at French weights:

$$UVR^{F}_{final,agr} = \frac{\sum VA^{F(FRF)}_{ind}}{\sum \frac{VA^{F(FRF)}_{ind}}{UVR^{F}_{intermed,ind}}} \tag{13.b}$$

Table 5 indicates for the major branch 'chemicals, rubber and plastic products' the three UVRs corresponding to the three different stages: initial UVRs which are obtained from product matches (Step 1), intermediate UVRs which are applied to value added (Step 2) and final, value added weighted UVRs (Step 3).

Of course, initial and final UVRs are identical for representative industries, but change at a more aggregated level if there is at least one non-representative industry. For example, due to the assumption concerning the industry 'other stone and glass products', final UVRs for the branch 'stone, glass and non-metallic mineral products' are 3.62 FF/DM at German and 3.40 FF/DM at French weights (as compared to initial UVRs of 3.70 and 3.51, respectively). In general, the difference between the two is rather small (see also the appendix for a complete breakdown of the manufacturing sector).

Table 5
Initial, Intermediate and Final UVRs in the Major Branch 'Chemicals, Rubber and Plastic Products', France and Germany, 1987'

	Initial UVRs		Intermediate UVRs		Value Added at Factor Cost				Final UVRs	
Branches	Q(G)	Q(F)	Q(G)	Q(F)	Germany	France	Germany	France	Q(G)	Q(F)
Industries	(FF/DM)		(FF/DM)		(Mio. DM)	(Mio. FF)	(Mio. FF)	(Mio. DM)	(FF/DM)	
Stone, glass and non-metallic mineral products	$\boxed{3.70}$	$\boxed{3.51}$			15,943	37,737	57,791	11,092	3.62	3.40
Glass	*3.78*	*3.35*	*3.78*	*3.35*	*4,562*	*12,616*	*17,260*	*3,770*	*3.78*	*3.35*
Cement	*4.16*	*4.16*	*4.16*	*4.16*	*1,355*	*5,824*	*5,640*	*1,400*	*4.16*	*4.16*
Ceramics	*2.58*	*2.69*	*2.58*	*2.69*	*1,951*	*4,859*	*5,041*	*1,803*	*2.58*	*2.69*
*Other stone and glass products**	*3.57*	*4.09*	$\boxed{3.70}$	$\boxed{3.51}$	*8,074*	*14,438*	*29,849*	*4,118*	*3.70*	*3.51*
Rubber and plastic products	3.03	2.96			21,911	37,591	65,107	12,906	2.97	2.91
Rubber products	*2.66*	*2.69*	*2.66*	*2.69*	*7,313*	*16,772*	*19,474*	*6,234*	*2.66*	*2.69*
Plastic products	*3.13*	*3.12*	*3.13*	*3.12*	*14,597*	*20,820*	*45,633*	*6,673*	*3.13*	*3.12*
Chemicals	$\boxed{3.26}$	$\boxed{3.10}$			58,657	101,391	191,424	32,743	3.26	3.10
Chemicals prim. for use in ind. and agr.	*3.19*	*2.86*	*3.19*	*2.86*	*7,315*	*19,486*	*23,303*	*6,801*	*3.19*	*2.86*
Soap, detergents and perfumes	*3.41*	*3.42*	*3.41*	*3.42*	*4,851*	*14,661*	*16,553*	*4,284*	*3.41*	*3.42*
*Other chemical products**	*3.26*	*3.34*	$\boxed{3.26}$	$\boxed{3.10}$	*46,491*	*67,244*	*151,568*	*21,658*	*3.26*	*3.10*
Total Major Branch	**3.24**	**3.14**			**96,511**	**176,719**	**314,321**	**56,741**	**3.26**	**3.11**

Sources: For product information, SESSI, *Enquêtes de branches 1987* and Statistisches Bundesamt, *Produktion im produzierenden Gewerbe des In- und Auslands 1987*. Industry information is from SESSI, *Enquête annuelle d'entreprise 1987* and Statistisches Bundesamt, *Kostenstruktur der Unternehmen 1987*.

Table 6 summarises the three stages of the basic procedures, where subscripts *mp* refer to matched products, *ind* to industries and *agr* to a higher level of aggregation. In the first step, we weight product UVRs by physical quantities to obtain 'initial' industry UVRs. In the second step, depending on the coverage ratio, we decide which industry UVRs are applied directly or indirectly to value added ('intermediate' UVRs). In the third step, 'final' UVRs are calculated by weighting 'intermediate' industry UVRs by value added. This step-wise aggregation is done in order to not overestimate the importance of matched products compared to non-matched products.

Table 6
Stage-wise Aggregation Procedure of UVRs

Stage 1: Initial UVRs	**Stage 2: Intermediate UVRs**	**Stage 3: Final UVRs**
Quantity weighted UVRs from product matches	Treatment of non-representative categories	Value added weighted UVRs
$UVR^{F}_{ind} = \frac{\sum q^{F}_{mp} p^{F(FF)}_{mp}}{\sum q^{F}_{mp} p^{G(DEM)}_{mp}}$	**Coverage ratio>25%:** Initial UVRs are used *directly*	$UVR^{F}_{agr} = \frac{\sum VA^{F(FF)}_{ind}}{\sum \frac{VA^{F(FF)}_{ind}}{UVR^{F}_{intermed,ind}}}$
$UVR^{G}_{ind} = \frac{\sum q^{G}_{p} p^{F(FF)}_{p}}{\sum q^{G}_{p} p^{G(DM)}_{p}}$	**Coverage ratio<25%:** Initial UVRs are used *indirectly*: Average UVR of all matched products in the next higher category	$UVR^{G}_{agr} = \frac{\sum VA^{G(DM)}_{ind} UVR^{G}_{intermed,ind}}{\sum VA^{G(DM)}_{ind}}$

2. Results of the French-German Comparison for Manufacturing in 1987

In this section, we present relative French-German levels of producer prices (UVRs), input, output and productivity, both for major branches and the manufacturing total.

2.1. Producer Prices

Table 7 shows the number of product matches, the coverage ratio as well as initial UVRs from product matches and final, value added weighted UVRs IN 1987. In total, 237 products could be matched, and were attributed to 35 industries, 14 branches, and 8 major branches.[21] The results here are presented only for major branches (see appendix for a complete breakdown). Most matches were made in the major branches of 'chemicals, rubber and plastic products' (68), 'machinery' (42), and 'basic metals and metal products' (38). On the other hand, not a single match could be made for 'food and beverages', as there are two different and incompatible French censuses for data on quantities and values. The matched products represent some 18% of total manufacturing sales in both countries. Major branches with a relatively high matching percentage are 'transport equipment', 'chemicals, rubber and plastic products' as well as 'wood, paper and other industries'. The coverage ratio is rather low in 'machinery' and especially in 'electric and electronic products'.

Table 7
Results of Product Matches by Major Branches, France and Germany, 1987

Major branches	Matches	Coverage Ratio		Initial UVRs	Final UVRs	Price Level
		Germany	France	Fisher		
	Number	(%)		(FRF/DEM)		(Germany=100)
Food and beverages***	0	0.0	0.0	na	3.04	91.1
Wearing apparel, textiles and leather	30	22.3	19.8	3.19	3.18	95.3
Wood, paper and other industries	25	27.4	25.3	3.15	3.11	93.0
Chemicals, rubber and plastic products	68	20.3	25.5	3.19	3.18	95.4
Basic metals and metal products	38	26.0	24.2	3.13	3.19	95.9
Machinery	42	6.6	9.1	2.93	2.94	88.1
Transport equipment	8	37.1	34.3	2.83	2.84	84.9
Electric and electronic products	26	7.0	4.5	3.05	3.05	91.5
Manufacturing	237	18.2	18.0	3.04	3.06	91.7
Exchange rate					3.35	

[21] See appendix for tables of correspondence. Note that 'oil refining' and 'tobacco' are excluded from the comparison.

Sources: For product information, SESSI, Enquêtes de branches 1987, Statistisches Bundesamt, Produktion im produzierenden Gewerbe des In- und Auslands 1987 and United Nations (1988), Annual Bulletin of Steel Statistics for Europe. Industry information is from SESSI, Enquête annuelle d'entreprise 1987, SCEES, Enquête annuelle d'entreprise 1987 and Statistisches Bundesamt, Kostenstruktur der Unternehmen 1987. The exchange rate is from CEPII, database 'CHELEM'.

The Fisher geometric average for final, value added weighted UVRs for total manufacturing is 3.06 FF/DM, and very close to the initial UVR derived from product matches (3.04 FF/DM). Among major branches, UVRs are highest in 'basic metals and metal products', 'chemicals, rubber and plastic products' and 'wearing apparel, textiles and leather' (3.18 to 3.20 FF/DM), indicating relatively high French unit values, and lowest in 'transport equipment' and 'machinery' (2.84 and 2.94 FF/DM respectively), indicating relatively high unit values in Germany.[22]

The last column indicates the relative French-German price level, which divides UVRs by the average exchange rate of 3.35 FF/DM in 1987. For the total manufacturing sector, the relative price level is 92%. Therefore, if we interpret the overall UVR as a converter for average manufacturing production costs in the other country's prices, relatively low UVR as compared to the exchange rate indicate more price-competitive French manufacturing products. This advantage persists in all major branches, since relative price levels are all below 100.

2.2. Value Added

Table 8 presents three indicators concerning value added at factor cost in 1987: for each country, the ratio of value added in sales and the distribution of value added among major branches, as well as the French-German ratio.

[22] See the discussion on the quality problem in section 2.5.

Table 8
Gross Value Added at Factor Cost in Manufacturing, France and Germany, 1987

	Value Added / Sales		Distribution of Value Added		Ratio of Value Added
	Germany	France	Germany	France	Fisher
	(%)		(DM)	(FF)	(Germany=100)
Food and beverages***	20.0	19.5	6.4	11.1	101.2
Wearing apparel, textiles and leather	33.4	34.5	4.6	7.6	92.5
Wood, paper and other industries	37.7	35.1	7.9	9.9	71.5
Chemicals, rubber and plastic products	36.1	32.4	20.2	20.8	57.5
Basic metals and metal products	37.6	32.8	12.7	11.4	49.5
Machinery	42.3	36.0	15.8	8.9	34.1
Transport equipment	34.1	29.2	15.1	14.9	61.6
Electric and electronic products	42.7	40.2	17.2	15.5	52.4
Manufacturing	35.9	31.2	100.0	100.0	58.0

Sources: For UVRs used to convert value added, see Table 7. Industry information is from SESSI, *Enquête annuelle d'entreprise 1987*, SCEES, *Enquête annuelle d'entreprise 1987* and Statistisches Bundesamt, *Kostenstruktur der Unternehmen 1987*.

In total manufacturing, as for most major branches, the share of value added in sales is higher in Germany than in France. For example, in 'machinery', the ratio is 42% for Germany and 36% for France. This suggests a slightly stronger German vertical integration (or, in other words, a higher degree of specialisation for France). However, from these figures, it is not clear at which level the vertical integration is higher in Germany. It could be (1) at the *enterprise* level, where German firms produce more of their own intermediate consumption; or (2) at the *major branch* level, where 'outsourcing' in Germany is done to a larger extent within a major branch, i.e. compared to France, a higher share of intermediate inputs is produced by other firms in the same major branch. But there are two more possible levels: (3) manufacturing inputs in Germany might be produced to a higher extent by other German enterprises in the *manufacturing sector*, whereas 'outsourcing' in France might concern relatively more enterprises in services; and (4) France 'outsources' *abroad* and imports relatively more intermediate products than Germany.

The distribution of value added by major branch (for each country in its own prices) shows that among the most important major branches, three have a similar relative weight in both countries: 'chemicals, rubber and plastic products' with about 20%, followed by 'electric and electronic products' and 'transport equipment'. 'Machinery' is much more important in Germany (16% as compared to only 9% in France), whereas the weight of 'food and beverages' in France is almost twice than in Germany (11% compared to 6%).

The geometric average of the French-German ratio shows that French manufacturing value added represents about 58% of the German level.[23] While for 'food and beverages', France produces more value added even in absolute terms than Germany, its output in 'machinery' represents only a third of the German level.

2.3. Productivity

Since value added for both countries is expressed in FF as well as in DM, it can now be compared to different inputs (employees, hours worked, capital stock) to estimate French-German productivity levels.

2.3.1. Labour Productivity

Calculating French and German value added *per employee* is the most straight forward way to compare levels of labour productivity, as figures for both value added and employees are from the same sources. In our study, self-employed persons are excluded.[24] With *VA* referring to value added at factor cost and *L* to employees, relative levels of value added per employee at a given level of aggregation are:

in FF:

$$\frac{\dfrac{\sum VA^{F(FRF)}}{\sum L^{F}}}{\dfrac{\sum VA^{G(FRF)}}{\sum L^{G}}} \tag{14.a}$$

in DM:

$$\frac{\dfrac{\sum VA^{F(DEM)}}{\sum L^{F}}}{\dfrac{\sum VA^{G(DEM)}}{\sum L^{G}}} \tag{14.b}$$

The figures for labour input in 1987 are indicated in Table 9. French employment of 3.6 million employees in manufacturing represents 54% of the German level (6.7 million). These census employment figures (in enterprises with 20 persons or more) represent about

23 The relative importance of German value added in manufacturing is not only due to the larger size of its economy, but also to its sectoral composition, since the share of manufacturing in German GDP is more important than in France.

24 The concept of employees refers to 'effectif employé' in France (*Enquête annuelle d'entreprise*, Table I) and to 'beschäftigte Arbeitnehmer' in Germany (*Kostenstruktur der Unternehmen*, Table 7).

81% in both countries when compared to national accounts. Compared to the manufacturing average, French employment is higher in 'wearing apparel, textiles and leather products' (93%) and 'food and beverages' (82%), and rather low in 'machinery' (31%) and 'electric and electronic products' (45%).

In manufacturing, France produces about 58% of German value added with relatively less employees (54%). The relative French level of value added per employee is therefore 108.4%. The higher French labour productivity for the manufacturing level has already been shown by other studies.[25] French productivity is remarkably high in 'food and beverages' (123%), but persists in almost all major branches.[26] Even in 'machinery' and 'transport equipment', where Germany is one of the world's leading exporters, the gap in labour productivity is in favour of France.

Table 9
Labour Input and Productivity in Manufacturing, France and Germany, 1987

	Employees		Hours worked		Ratio of Employees	Ratio Total Hours	Productivity / Employee	Productivity / Hour
	Germany	France	Germany	France			Fisher	Fisher
	(1,000s)					(Germany=100)		
Food and beverages***	451.2	370.8	1,814	1,609	82.2	72.9	123.2	138.9
Wearing apparel, textiles and leather	446.6	417.6	1,571	1,607	93.5	95.7	99.0	96.7
Wood, paper and other industries	562.2	385.1	1,671	1,623	68.5	66.5	104.3	107.4
Chemicals, rubber and plastic products	1,146.0	609.4	1,665	1,602	53.2	51.2	108.1	112.3
Basic metals and metal products	934.4	441.9	1,630	1,624	47.3	47.1	104.7	105.1
Machinery	1,124.4	352.5	1,632	1,644	31.3	31.6	108.8	108.0
Transport equipment	895.9	498.8	1,557	1,608	55.7	57.5	110.7	107.2
Electric and electronic products	1,111.3	496.5	1,561	1,599	44.7	45.8	117.2	114.4
Census Manufacturing	6,671.9	3,572.5	1,627	1,614	53.5	53.1	108.4	109.3
National Accounts Manufacturing	8,203.0	4,377.6						
Census / National Accounts (%)	81.3	81.6						

Sources: Information on employees is from SESSI, *Enquête annuelle d'entreprise 1987*, SCEES, *Enquête annuelle d'entreprise 1987* and Statistisches Bundesamt, *Kostenstruktur der Unternehmen 1987*, as well as INSEE, database 'NOUBA' and Statistisches Bundesamt, *Volkswirtschaftliche Gesamtrechnungen, Revidierte Ergebnisse, 1950 bis 1990*, with updates to 1992 kindly provided by Dr. Räth. Hours worked are from INSEE, database 'NOUBA' and H. Kohler and L. Reyher, *Arbeitszeit und Arbeitvolumen in der Bundesrepublik Deutschland : 1960-1990*, Institut für Arbeitsmarkt und Berufsforschung (IAB). Updates to 1992 kindly provided by H. Kohler. For UVRs used to convert value added, see Table 7.

[25] See van Ark and Kouwenhoven (1994) whose implicit French-Germany level via their own France-USA and Germany-USA comparisons is very close to our result. Different studies of the OECD are based on PPPs and data from national accounts, but yield similar results for total manufacturing. See also Guinchard (1984), who suggested that France overtook Germany at the end of the 1970s.

[26] As already noted, the estimate for the UVR in 'food and beverages' is rather crude. However, even if we had excluded this major branch from the comparison, French manufacturing productivity would still be about 7% higher.

In order to take into account differences in working time, we calculated relative levels of value added *per hour worked*. For this, however, we have to rely on different sources.[27] Annual hours effectively worked take into account differences in holidays, working days lost due to sickness or strikes, as well as differences in part time workers.[28] In 1987, average annual hours worked in the French manufacturing sector are slightly lower than in Germany (1614 as compared to 1627). Therefore, relative French productivity per hour worked in manufacturing is even higher, with an advantage of about 9%. Again, France has a higher productivity in virtually all major branches, especially in 'food and beverages,' with the exception of 'wearing apparel, textiles and leather.'[29]

2.3.2. Capital Productivity

Comparisons of capital productivity are much more problematic than those for labour productivity. As with labour input, capital as a production factor must be considered in terms of stock.[30] However, production censuses do not provide information on capital stock. Nevertheless, data on gross value added, employment as well as on capital stock can be found in national accounts. Therefore, one possibility to estimate a capital stock comparable to census employment figures is to assume that capital intensity according to national accounts is identical to the one in production censuses.

In many countries, capital stock is estimated by the so-called 'perpetual inventory method' (PIM). Annual investment is cumulated, and asset scrapping and depreciation are deducted.[31]. However, assumptions regarding the average life time and the mortality function of capital can differ between two countries.[32] Van Ark applied the perpetual inventory method with the same assumptions and finds that German manufacturing capital stock is underestimated when compared to France, but, compared to other countries, the

[27] For French hours worked, we used the on-line database NOUBA from INSEE, and German figures are from H. Kohler and L. Reyher, Institut für Arbeitsmarkt und Berufsforschung (IAB). French figures on hours are available only at a more aggregated level (see appendix for the correspondence between census' and national accounts' nomenclatures).

[28] For a more detailed discussion, see for example Fleurbaey and Joly (1990).

[29] In the latter major branch, Germany seems to have a minor disadvantage rather than an advantage, given the relatively poor performance compared to its national average (see graph 1).

[30] In contrast to value added which is a flow.

[31] See for example Kessler (1979) and O'Mahony (1993) for an overview of the different methods.

[32] While differences in *mortality functions* have only a small effect on the outcome of capital stock estimates, differences in the *average life time* can substantially alter the results, see Maddison (1993) and O'Mahony (1993).

The average life in the 1980s for equipment was 17 years in France and 15 in Germany, and 37 and 41 years, respectively, for buildings and structures (O'Mahony, 1993, pp. 7-8). In contrast to France where the life time is considered constant, German national accountants assume that service lives have been declining over time.

difference is rather small.[33] We would have ourselves preferred to apply the perpetual inventory method at a major branch level, but were unable to do so as data on investment at such a detailed level do not stretch back far enough.[34] Therefore, and despite these shortcomings, we used official national accounts estimates and assumed an identical capital intensity in national accounts and production censuses to estimate 'census capital stock'.[35]

As we estimated UVRs to convert value added in the other country's currency, we had to find a suitable conversion factor to compare French and German capital stock. We used purchasing power parities (PPPs) for gross fixed capital formation (3.23 FF/DM at German and 3.26 FF/DM at French weights in 1985 prices).[36] Not disposing of more detailed information, we used it both for total manufacturing as well as for each individual major branch.

The relative level of capital productivity is then

in DM:

$$\frac{\dfrac{VA^{F(FRF)} / UVR^{F}}{K^{F(FRF)} / PPP^{F}}}{\dfrac{VA^{G(DEM)}}{K^{G(DEM)}}} \tag{15.a}$$

in FF:

$$\frac{\dfrac{VA^{F(FRF)}}{K^{F(FRF)}}}{\dfrac{VA^{G(DEM)}\ UVR^{G}}{K^{G(DEM)}\ PPP^{G}}} \tag{15.b}$$

Capital stock in French manufacturing represents 65% of the German level in 1987 (Table 10). In comparison, the relative level of employment was 53% at that time (Table 9).

[33] Van Ark (1993) applied the average life time in OECD countries. While French official figures for manufacturing capital stock in 1987 are only 4% lower when compared to his standardised method, the difference for Germany is about 15%.

[34] For series on capital stock starting in 1970, we would have gone back as far as the 1920s.

[35] Gross fixed capital stock is in 1980 prices for France but in 1985 prices for Germany. The French series was adjusted to '1985' prices on the basis of current prices. Since French current prices in 1980 and constant 1980 prices are not identical, we had to make an additional adjustment.

[36] PPPs for gross fixed capital formation are for industrial buildings and some producer durables (machinery & non-electrical equipment and electrical machinery & appliances), World Bank (1993). The PPPs in OECD dollars (Table 23) are weighted by per capita GDP expenditure in national currencies (Table 24).

Therefore, capital intensity (ratio capital and employees or capital and total hours worked) is higher in France (about 21% higher for the manufacturing sector). The capital intensity is higher for almost all major branches, and particularly high in 'basic metals and metal products' (187%).[37] The high capital intensity in French manufacturing seems to be compatible with studies which have pointed out the strong substitution of labour for capital in France and the decline in capital productivity.[38]

The configuration is quite different from that of labour productivity. Given the relative abundance of French capital stock, French manufacturing capital in 1987 is about 10% less productive than German capital. As for capital intensity, 'basic metals and metal products' are a clear outlier, since French productivity is just half of the German level. Could we have underestimated French capital productivity as compared to Germany? A rough cross-check is to calculate capital productivity in *national* prices, where UVRs and PPPs do not intervene.[39] For manufacturing, relative capital productivity based on national prices is even lower (85%) than the one based on international prices (90%), and the two are virtually identical in 'basic metals and metal products'. In this major branch, French capital intensity is extremely high, both when compared to Germany as well as to the French manufacturing average.

[37] In both countries, the nomenclature in national accounts is more aggregated than in the census and, therefore, not exactly compatible (see appendix for the table of correspondence). The major problem arises in 'basic metals and metal products', which includes certain extraction industries in France but not in Germany. In this major branch, French capital intensity is extremely high, both when compared to Germany as well as to the French manufacturing average.

[38] See for example Fleurbaey and Joly (1990).

[39] Since both value added and capital stock are in FF for France and in DM for Germany, the ratio VA/K eliminates the monetary unit for each country. The relative level of capital productivity becomes

in FF and in DM: $$\frac{\dfrac{VA^{F(FF)}}{K^{F(FF)}}}{\dfrac{VA^{G(DM)}}{K^{G(DM)}}}$$

While this method easily permits calculation of relative levels of capital productivity, it does not take into account differences in relative prices for value added and capital. Neither can the level of capital stock and capital intensity be compared between two countries.

Table 10
Relative Levels of Capital Stock, Capital Intensity and Capital Productivity in Manufacturing, France and Germany, 1987

	Capital Stock	Capital Intensity		Capital Productivity		Capital Intensity (K/LH)	
	Fisher	K/L	K/LH	Fisher	Nat. Prices	Germany	France
		(Germany=100)				(Manuf. =100)	
Food and beverages***	99.6	121.1	136.6	101.7	95.3	115.7	130.4
Wearing apparel, textiles and leather products	85.8	91.8	89.7	107.8	105.7	84.9	62.9
Wood, paper and other industries	65.5	95.6	98.5	109.1	104.4	92.2	74.9
Chemicals, rubber and plastic products	54.5	102.4	106.4	105.6	103.6	140.8	123.7
Basic metals and metal products	88.1	186.4	187.0	56.2	55.5	109.1	168.5
Machinery	37.4	119.3	118.4	91.2	82.7	66.0	64.5
Transport equipment	58.5	105.1	101.7	105.3	92.1	109.4	91.8
Electric and electronic products	50.7	113.6	110.9	103.2	97.2	78.4	71.7
Manufacturing	64.4	120.2	121.2	90.2	85.2	100.0	100.0

Sources: Information on employment and capital stock in national accounts is from INSEE, database 'NOUBA' and Statistisches Bundesamt, *Volkswirtschaftliche Gesamtrechnungen, Revidierte Ergebnisse, 1950 bis 1990,* with updates to 1992 kindly provided by Dr. Räth. The resulting capital intensity is applied to census employment figures from SESSI, *Enquête annuelle d'entreprise 1987*, SCEES, *Enquête annuelle d'entreprise 1987* and Statistisches Bundesamt, *Kostenstruktur der Unternehmen 1987*. Hours worked are from INSEE, database 'NOUBA' and H. Kohler and L. Reyher, *Arbeitszeit und Arbeitvolumen in der Bundesrepublik Deutschland : 1960-1990*, Institut für Arbeitsmarkt und Berufsforschung (IAB), with updates to 1992 kindly provided by H. Kohler. For UVRs used to convert value added, see Table 7. PPPs for gross fixed capital formation are for industrial buildings and some producer durables (machinery & non-electrical equipment and electrical machinery & appliances), World Bank (1993). The PPPs in OECD dollars (Table 23) are weighted by per capita GDP expenditure in national currencies (Table 24).

2.3.3. Joint Factor Productivity

Calculating labour or capital productivity separately leads to attributing all value added to a single production factor. To estimate the combined effect of labour and capital on output, we have to assume a relationship between these factors. In the literature, joint factor productivity is often estimated via a Cobb-Douglas production function, where α and β correspond to partial elasticity of output with respect to labour and capital.

$$Y = AL^{\alpha}K^{(1-\alpha)} \tag{16}$$

The factor share of labour (α) is the geometric average of the share of labour compensation in gross domestic product.[40] We interpret the term 'A' as the joint factor

[40] The share of labour compensation is from OECD (1984b, 1988, 1992). For each country, the share of labour compensation in gross domestic product in manufacturing minus indirect taxes plus subsidies was calculated for the years for which there are data available. Alpha is the geometric average for the two

productivity. Equation (16) can be rewritten to calculate relative levels of total factor productivity.

$$\ln\left(\frac{A^F}{A^G}\right) = \ln\left(\frac{Y^F/L^F}{Y^G/L^G}\right) - (1-\alpha)\ln\left(\frac{K^F/L^F}{K^G/L^G}\right) \tag{17}$$

Of course, such a simplified production function puts certain restrictions on the interpretation of the results. Overall joint factor productivity (both in terms of employ in 1987 (see Table 11). France has the strongest advantages in 'food and beverages' (17% on the basis of employees only, and 27% when adjusted for differences in hours worked), 'electric and electronic products' and 'chemicals, rubber and plastic products', whereas Germany has a relative advantage only for 'basic metals and metal products'. The difference between relative labour and capital productivity is substantial for some major branches, especially in 'basic metals and metal products' where the gap is 50 percentage points.

In 1987, while there are differences among major branches, relative joint factor productivity for manufacturing is very close in France and Germany. However, this similarity breaks down once we analyse the two components separately: France has a substantial advantage in labour productivity, while Germany has a better performance in capital productivity.

2.4. Explaining Labour Productivity Differences

The labour productivity gap between France and Germany in 1987 found in the previous section may have several causes. In this study, we have analysed three explanatory factors: the effect of the employment structure, firm size and capital intensity.

countries. The OECD data cover the years 1970 to 1990 for Germany, but only 1977 to 1988 for France. The average share of labour compensation in GDP in both countries was 71.8%. See also Fleurbaey and Joly (1990, p. 37).

Table 11
Relative Labour, Capital and Joint Factor Productivity in Manufacturing, France and Germany, 1987

	Productivity Employee	Productivity / Hour	Capital Productivity		JFP (L)	JFP (LH)
	Fisher	Fisher	Fisher (Germany=100)	Nat. Currency	Factor shares	
Food and beverages***	123.2	138.9	101.7	95.3	116.7	127.2
Wearing apparel, textiles and leather products	99.0	96.7	107.8	105.7	101.4	99.7
Wood, paper and other industries	104.3	107.4	109.1	104.4	105.7	107.9
Chemicals, rubber and plastic products	108.1	112.3	105.6	103.6	107.4	110.4
Basic metals and metal products	104.7	105.1	56.2	55.5	87.8	88.1
Machinery	108.8	108.0	91.2	82.7	103.5	102.9
Transport equipment	110.7	107.2	105.3	92.1	109.2	106.7
Electric and electronic products	117.2	114.4	103.2	97.2	113.1	111.1
Manufacturing	**108.4**	**109.3**	**90.2**	**85.2**	**102.9**	**103.5**

Sources: See Table 10. The average share of labour compensation in gross domestic product in manufacturing minus indirect taxes plus subsidies is from OECD (1984b, 1988, 1992).

The basic procedure to estimate the effect of each of these factors is to calculate a 'corrected' labour productivity by assuming the same conditions in the two countries. For example, to check if the high overall French labour productivity is due to a concentration of labour input in more performing branches, one country's employment structure is used to reestimate labour productivity in both countries. The difference between the 'initial' and the 'corrected' relative productivity is then interpreted as being due to this factor.

2.4.1. Structure of Employment

The first explanatory factor is the effect of employment structure. The *upper* part of Graph 1 presents two indicators. The histogram, referring to the left y-axis, shows the share of the volume of hours worked by major branch for the two countries (for each country, the sum over all major branches is 100). The points referring to the right y-axis indicate labour productivity by major branch compared to each country's manufacturing average (calculated in national currencies, national manufacturing average=100). The productivity performance for each major branch is rather close in the two countries, except for 'food and beverages', which is more productive than the manufacturing average in France and less in Germany. In both countries, three of the most productive major branches are also those where the input share is among the highest ('chemicals, rubber and plastic products', 'electric and electronic products' and 'transport equipment'). In contrast, labour input in 'wearing apparel, textiles and leather products' is relatively small and less productive.

The histogram in the *lower* part of Graph 1 represents the relative French-German hourly labour productivity level (Fisher geometric average, Germany = 100). The dotted line indicates the relative labour productivity for total manufacturing (109.3, see also Table 9), thus separating major branches which are relatively more productive than the French-

German average from the less productive ones. 'Food and beverages' yield the highest French advantage. In contrast, the relatively higher German productivity in 'wearing apparel, textiles and leather products' has to be interpreted as a minor disadvantage, given its weak performance compared to the national average.

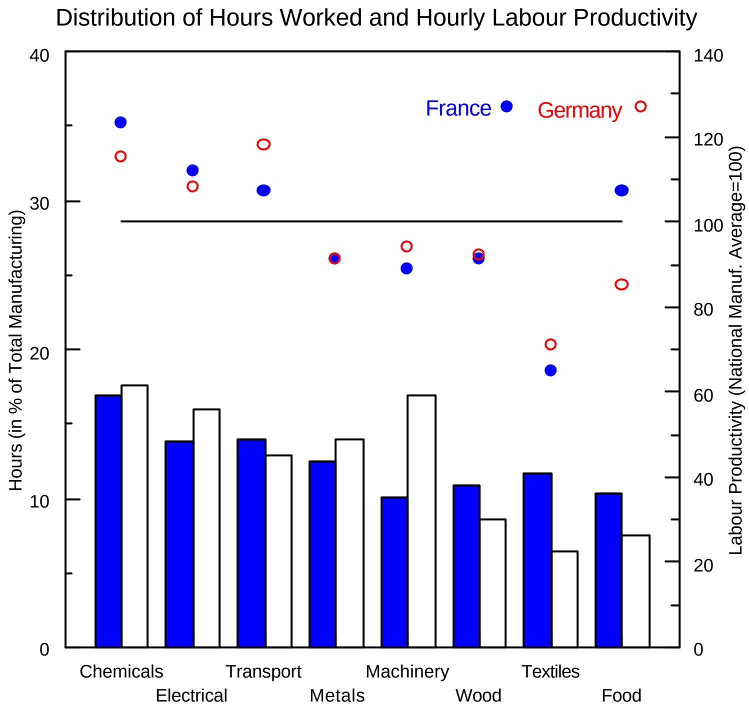
To take into account the effect of structural differences, we weight each country's major branch value added per hour (either in DM or by FF) by the same weights of labour inputs (either by French or German weights). The following equation indicates 'adjusted' manufacturing labour productivity in DM and at German weights (with subscripts referring to branch k and the manufacturing sector m).

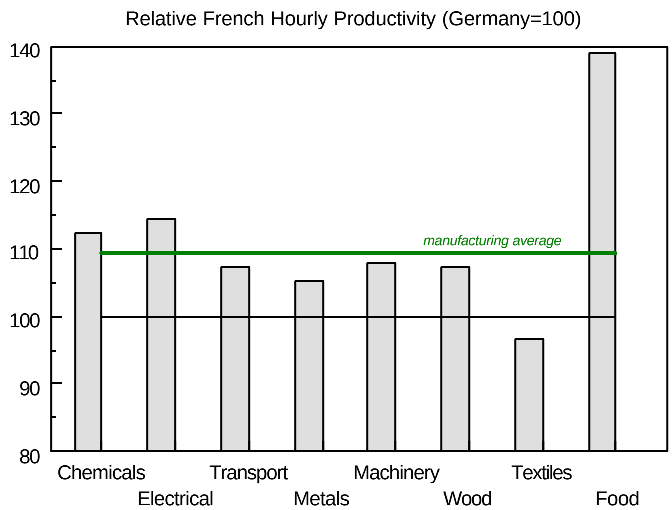
$$\frac{Prod_m^{F(DM)\,L(G)}}{Prod_m^{G(DM)\,L(G)}} = \frac{\sum \frac{VA_k^{F(FF)} / UVR_k^F}{LH_k^F} \left(\frac{LH_k^G}{LH_m^G} \right)}{\sum \frac{VA_k^{G(DM)}}{LH_k^G} \left(\frac{LH_k^G}{LH_m^G} \right)} \qquad (18)$$

There are three more combinations possible. The overall result is the Fisher geometric average of the four combinations.

The structural effect is rather small but positive. French-German relative hourly labour productivity adjusted for structural differences is 111%, i.e. about one and a half points higher than the original one. The effect of structural differences does not explain the productivity gap. On the contrary, the adjustment suggests an even higher relative French performance if the industrial composition were the same in the two countries.

Graph 1
Distribution of Hours Worked and Hourly Labour Productivity in Manufacturing by Major Branch, France and Germany, 1987





Sources: See Table 9.

2.4.2. Firm Size

We used five size categories to estimate the effect of firm size on relative productivity performance: 20-49, 50-99, 100-199, 200-499 and 500 or more employees. On average, German firms are larger than French companies, both in total manufacturing and in each major branch.[41]

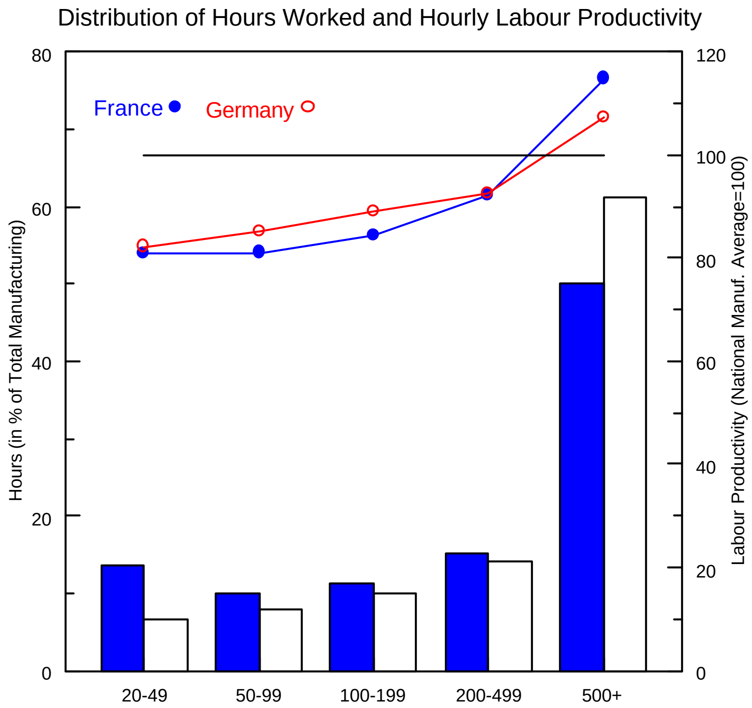
The effect of firm size on relative labour productivity performance between France and Germany is calculated in a similar way as the effect of structure. While Graph 2 presents the figures for manufacturing, the calculations are done separately for each major branch: the productivity of each country's size category is weighted by the same labour inputs, and aggregated to total manufacturing.

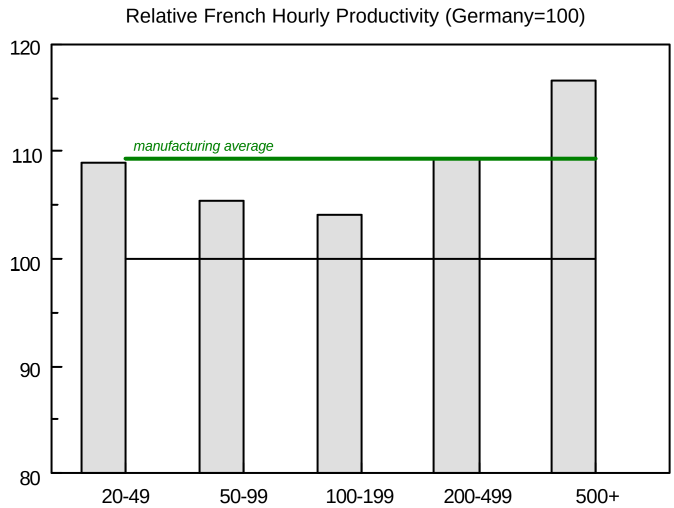
Graph 2 is presented in a similar way as Graph 1. The left y-axis of the *upper* part refers to the share of the volume of hours worked by size category in the two countries. In France, half of all employees work in enterprises with 500 or more employees, whereas this share is more than 60% in Germany. In contrast, employment in small and medium-size firms are relatively more important in France. The right y-axis indicates labour productivity by size category compared to each country's manufacturing average (national manufacturing average=100). In both countries, relative productivity increases with firm size, suggesting economies of scale, which are even more pronounced in France. However, a more detailed analysis shows that this phenomenon does not exist for all major branches (see appendix).

The *lower* part of Graph 2 shows the histogram representing the relative French-German labour productivity (Germany = 100). In total manufacturing, France has a productivity advantage over German firms in all size categories, which is highest in the category of 500 or more employees. In contrast, the relatively high French productivity in the category between 20 and 49 employees has to be interpreted as a minor disadvantage, given its weak performance compared to the national average.

41 According to our calculations from census data excluding firms with less than 20 employees, the German average firm size in 1987 in total manufacturing was 211 employees, as compared to 141 for France, while the median size was, respectively, 782 and 501 employees.

Graph 2
Distribution of Hours Worked and Hourly Labour Productivity in Manufacturing by Firm Size, France and Germany, 1987





Sources: See Table 9. Figures on firm size from SESSI, *Enquête annuelle d'entreprise 1987*, SCEES, *Enquête annuelle d'entreprise 1987* and Statistisches Bundesamt, *Kostenstruktur der Unternehmen 1987*.

The overall effect of firm size is positive. French-German relative manufacturing hourly labour productivity of 109.3 raises to 113% when adjusted for firm size differences. As with structural differences, firm size differences do not only not explain the productivity gap; but on the contrary, increase by more than three points the relative French performance.

2.4.3. Capital Intensity

As we already noted, calculating labour or capital productivity separately means attributing all value added to a single production factor. Since value added is the combined effect of labour and capital, high French labour productivity might be due to relative abundance of capital compared to labour. To take into account the effect of capital intensity, we assume the same capital intensity in the two countries. Equation (17) can be used to reestimate labour productivity:

$$ln \frac{\left(\frac{{}^{F}}{L^{F}}\right)}{\left(\frac{{}^{G}}{L^{G}}\right)} = ln \frac{A^{F}}{A^{G}} + (1-a)\underbrace{ln \underbrace{\left(\frac{\frac{K^{F}}{L^{F}}}{\frac{K^{G}}{L^{G}}}\right)}_{=1}}_{=0} = ln \frac{A^{F}}{A^{G}} \qquad (19)$$

Relative capital intensity being equal to one, the logarithmic index becomes zero. Relative labour productivity adjusted for capital intensity thus equals the relative joint factor productivity, i.e. 102.9% in terms of employees and 103.5% in terms of hours worked. This is a drop of some 6 points compared to the initial relative labour productivity, and partly explains the productivity difference between France and Germany.

2.4.4. Combined Effect of the Three Explanatory Factors and Remaining Residuals

The results concerning relative labour productivity, and the effect of structure, firm size and capital intensity are shown in Table 12 (in terms on employees) and Table 13 (in terms of hours). The productivity gap in favour of France in 1987 remains largely unexplained by these factors, as the 'adjusted' labour productivity still remains 8 to 9% higher in France than in Germany, in 1987. In this study, we have not yet examined the role of another important explanatory factor, the quality of labour force. Other studies have shown that the share of employees with intermediate or higher vocational qualifications is more important in Germany than in France. Therefore, if we had included this factor, the productivity gap would have increased even more.

Table 12
Explaining Labour Productivity Differences in Manufacturing between France and Germany, 1987

	Labour	Effect of ...			Adjusted Labour
	Productivity	Structure	Firm size	Capital intensity	Productivity
			(Germany = 100)		
Food and beverages***	123.2		126.3	116.7	119.6
Wearing apparel, textiles and leather products	99.0		99.3	101.4	101.7
Wood, paper and other industries	104.3		105.6	105.7	106.9
Chemicals, rubber and plastic products	108.1		110.4	107.4	109.6
Basic metals and metal products	104.7		107.2	87.8	89.6
Machinery	108.8		112.6	103.5	107.1
Transport equipment	110.7		112.1	109.2	110.6
Electric and electronic products	117.2		119.5	113.1	115.3
Manufacturing	**108.4**	**109.9**	**111.9**	**102.9**	**107.8**
Additive effect		+1.4	+3.5	-5.6	-0.6

Sources: See Tables 9 and 11.

Table 13
Explaining Hourly Labour Productivity Differences in Manufacturing between France and Germany, 1987

	Labour	Effect of ...			Adjusted Labour
	Productivity	Structure	Firm size	Capital intensity	Productivity
			Germany = 100		
Food and beverages***	138.9		142.4	127.2	130.3
Wearing apparel, textiles and leather products	96.7		97.1	99.7	100.1
Wood, paper and other industries	107.4		108.7	107.9	109.2
Chemicals, rubber and plastic products	112.3		114.8	110.4	112.6
Basic metals and metal products	105.1		107.6	88.1	89.8
Machinery	108.0		111.7	102.9	106.5
Transport equipment	107.2		108.5	106.7	108.0
Electric and electronic products	114.4		116.7	111.1	113.3
Manufacturing	**109.3**	**111.0**	**113.0**	**103.5**	**108.8**
Additive effect		+1.6	+3.6	-5.8	-0.5

Source: See Tables 9 and 11.

2.5. The Product Quality Problem

The results so far indicate a rather low French price level and labour productivity advantage compared to Germany. This is true not only for the manufacturing total, but for virtually all major branches. At the same time, the non-explained productivity difference is rather important. How much confidence can we have in our results, especially at a more detailed level? Could differences in product quality influence these results?

In each of the different stages of the industry-of-origin approach, we had to introduce assumptions which were sometimes rather strong. The product matching procedure seems to be the most important stage, since all other stages are based on the obtained unit value ratios. There is a link between the first stage, unit value ratios, and the last one, relative labour productivity.

Relatively high German unit values (in DM) translate in relatively low unit value ratios (in FF/DM). These UVRs are used to estimate value added in the other country's currency. The lower the UVR, the lower is German value added in FF (or the higher is French value added in DM, see equations 11.a and 11.b), and, hence, the lower German labour productivity compared to France. *Ceteris paribus*, there is an inverse relation between German unit values and relative labour productivity levels. For example, in 'transport equipment', German unit values are on average rather high: the value added weighted UVR is 2.84 FF/DM and the relative value added per hour 107%. In contrast, for 'wearing apparel, textiles and leather products', it is France that has relatively high unit values: the final UVR is 3.18 FF/DM, which translates into a relatively low labour productivity of 99%.

There are two main sources of differences in UVRs which can, but do not necessarily have to be closely intertwined: production costs and product quality. In the industry-of-origin approach, though we are aware of the problem of product quality, we assume that there is no quality difference when we make a product match, and we attribute differences in UVRs to differences in production costs. However, relatively low UVRs do not tell us if production costs or product quality (or both) are higher in Germany than in France. In the first case, the industry-of-origin approach might correctly indicate lower German productivity, whereas in the second case this result is misleading.

If there were no systematic quality differences between countries, errors due to mismatches might cancel out on the total manufacturing sector. However, they might persist at a more detailed level and therefore impede a meaningful sectoral analysis. Germany's productivity estimates might be biased downwards for some branches because of relatively high prices due to high quality, a phenomenon which may not be picked up by the product matches. In general, researchers who themselves do the product matches using production censuses have little information to verify the validity of their results.

In a study on German and French trade specialisation, M. Freudenberg and F. Müller (1992) put forward exactly the opposite hypothesis to the industry-of-origin approach: differences in unit values were interpreted as reflecting differences in quality, and not in production costs (neither in mark-up).[42] The analysis was made at a very detailed level (looking at exports and imports for some 9,500 products with 20 geographic regions, yielding some 400,000 basic observations for each country). Unit values of each elementary trade flow were compared to a European norm, to establish **product price/quality ranges**: *up-market* products (with unit values exceeding the European norm by at least 15 %), *down-market* products (more than 15 % below the norm), as well as *middle-market* products. As exports and imports were analysed separately, flows for the same product, with a given trade partner, can exist in different quality ranges.

[42] This was an extension of an approach initially proposed by K. Abd-El-Rahman (1986a, 1986b).

While the two countries have a similar import structure, Germany exports more up-market products than France. In 1989, 52% of German exports concern up-market products, compared to 40% for France (Table 14).[43] Table 14 also shows an indicator of 'revealed comparative advantage'.[44] Both countries have an advantage in up-market products, and comparative disadvantages in the other two ranges, but this phenomenon is much more pronounced for Germany.

Table 14
Product Quality Ranges in German and French Foreign Trade, 1989

Product Quality Ranges	Exports		Imports		Export-Import Ratio		Comparative Advantage	
	Germany	France	Germany	France	Germany	France	Germany	France
	(%)		(%)		(%)			
Up-market	51.6	40.2	32.1	30.8	201.7	120.0	48.2	19.4
Middle-market	37.3	40.7	44.5	45.6	105.4	82.0	-17.7	-10.2
Down-market	10.6	18.1	22.0	22.7	60.6	73.5	-28.2	-9.4
Residue	0.5	1.0	1.4	0.9	43.8	104.0	-2.3	0.2
Total	100.0	100.0	100.0	100.0	125.6	92.0	0.0	0.0

Source : Freudenberg and Müller (1992).

[43] A breakdown by branches shows that the case of vehicles is even more striking: whereas 60% of German exports are in the upper price range and 30% in the medium one, the French shares are just the opposite.

[44] This indicator was developed by G. Lafay (1987, 1990). If there were no comparative advantage or disadvantage for any industry k (in a given country), then total trade surplus or deficit should be distributed across all industries according to their share in total trade. The 'contribution to the trade balance' is the difference between the actual and the theoretical balance. Expressed in thousandths of GDP, that is:

$$\frac{1000}{Y}\left[\left(X_k - M_k\right) - \left(X - M\right)\frac{X_k + M_k}{X + M}\right]$$

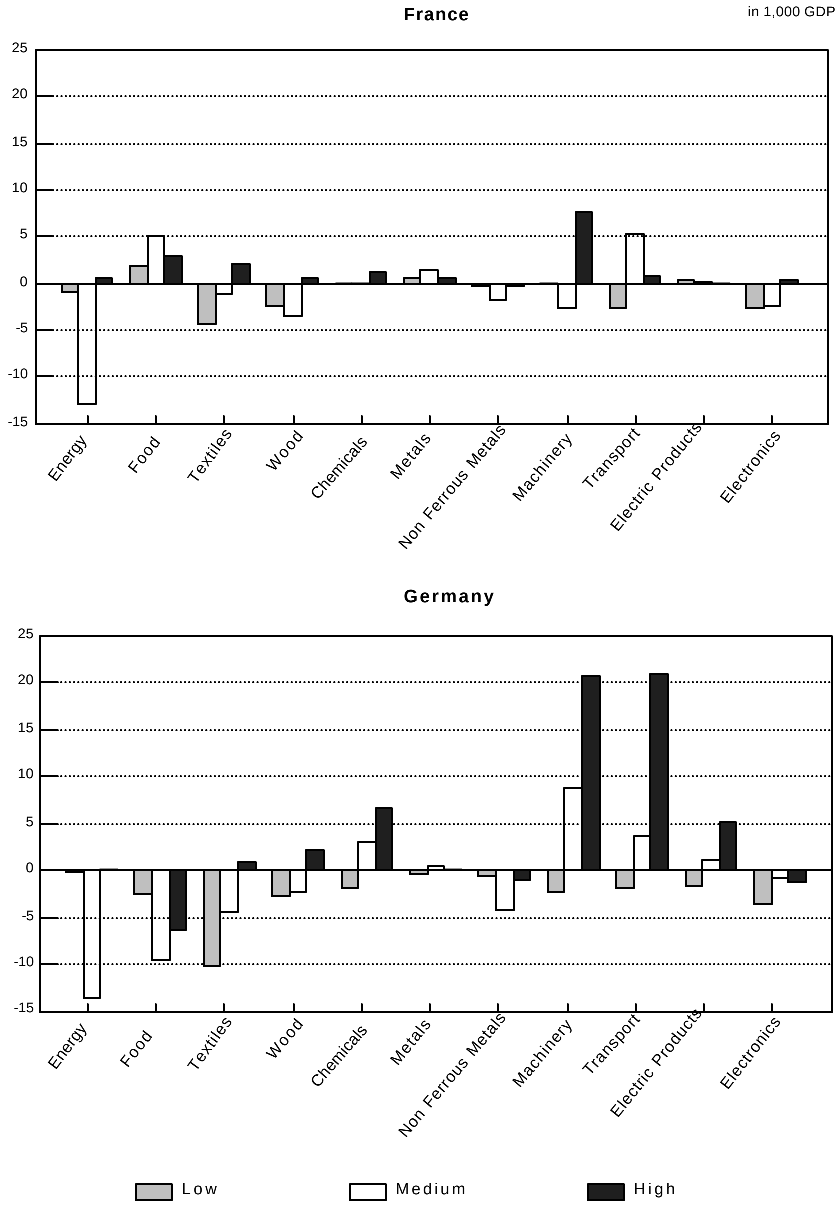
By definition, the sum over all industries is zero. This indicator can be transformed. With TT representing total trade, TT_k trade in industry k and Y gross domestic product, the contribution of the trade balance is:

$$4000\,\frac{TT}{2Y}\,\frac{TT_k}{TT}\left[\frac{\dfrac{X_k}{M_k} - \dfrac{X}{M}}{\left(\dfrac{X_k}{M_k} + 1\right)\left(\dfrac{X}{M} + 1\right)}\right]$$

It depends on (1) the degree of openness of the country, (2) the industry's share in total trade, and (3) an element indicating the industry's relative performance. It is this last element which determines whether the industry has a comparative advantage or disadvantage, since it depends on the difference between the industry's and total export-import ratio, and this independent of the country's total trade surplus or deficit.

Graph 3 shows comparative advantages for price/quality ranges by branches. A comparative German disadvantage for down-market products is more than offset by advantages for up-market products, especially in Germany's key industries.

Graph 3
Revealed Comparative Advantage by Branch and Price/Quality Range, Germany and France, 1989



Source: Freudenberg and Müller (1992).

The second dimension of the analysis on French-German trade performance is the definition of **trade categories**.[45] One of the most striking results of that study is that it suggests a strong non-price competitiveness for Germany, especially in Germany's leading export sectors (vehicles and machinery). In these industries the indicator of 'revealed comparative advantage' is highest for Germany's up-market products in one-way trade (i.e. where exports are much higher than imports). Stated otherwise, the export-import ratio is higher (and the competition seems lower) for more expensive, German goods! And there must be a lot of them, since the indicator is also sensitive to their share in total trade.

Of course, these results from international trade cannot be simply compared to the present study. Neither the base year, nor the industry classification was the same. But they show that Germany exports relatively *more* high quality products than France. However, this volume indication does not tell us if German export unit values are on the average *higher* than French ones.

2.5.1. Production versus Export Unit Values

A possibility is to compare UVRs with export unit values. A potential problem is that the price levels of goods produced locally and exported are not necessarily the same, as market deficiencies, differences in consumer tastes and income levels etc. can be exploited by exporting firms.

We analysed French and German unit values for manufacturing exports (fob) to the rest of the world on the most detailed level of the Harmonised System (about 7,300 products, see appendix for the Table of correspondence).[46] Relative French-German producer price and export price levels are strikingly similar, at a level of about 92%. Also for most major branches, the two relative price levels are quite close. There are two major exceptions. In 'wearing apparel, textiles and leather products', French relative export prices are notably higher than relative producer prices (23%). Here, French export prices are also higher than Germany's (about 17%). For 'transport equipment', the situation is symmetrical. In this case, Germany's relative export prices are higher than its relative producer prices (93%), and its export prices are also higher than France's (79%).

[45] For a given product, the analysis of unit values permits to distinguish if a country trades 'similar' or 'vertically differentiated' products with its different partners, depending on the difference of their unit values (less than 15 % or not). Furthermore, trade is classified as being 'two-way' if the minority flow (e.g. imports) represents at least 10 % of the majority flow (e.g. exports), otherwise as 'one-way'. To simplify, these two criteria yield three trade categories: *two-way trade in similar products* (which is bilateral if export and import partners are the same, and triangular if they are different), *two-way trade in vertically differentiated products*, and *one-way trade*.

[46] Relative export price levels are calculated in a similar way as producer price levels. The only difference is that export prices are already indicated in ECU. Equations (4.a) and (4.b) therefore yield directly relative price levels.

Table 15
Relative French-German Producer and Export Price Levels in Manufacturing, 1987

	Relative Price Levels		
	Producer Prices	Export Prices	Export / Producer Prices
	(Germany=100)		
Food and beverages***	91.1	93.2	102.4
Wearing apparel, textiles and leather products	95.3	117.2	123.0
Wood, paper and other industries	93.0	99.3	106.8
Chemicals, rubber and plastic products	95.4	101.8	106.8
Basic metals and metal products	95.9	92.6	96.5
Machinery	88.1	87.6	99.4
Transport equipment	84.9	79.1	93.1
Electric and electronic products	91.5	89.7	98.1
Manufacturing	91.7	92.0	100.3

Sources: For producer price ratios, see Table 7. Export unit values from Eurostat, database 'Comext'. We thank G. Gaulier for research assistance.

One interpretation of the lower French export prices is that the French price-advantage in manufacturing costs translates into a competitive advantage in export prices. Unfortunately, we were not able to test if differences in export prices are indeed due to quality differences or to market power. To discriminate between the two, we would have had to test if price differences are correlated to differences in market power.

2.5.2. Observed versus 'Theoretical' UVRs

Recently, the McKinsey Global Institute (1993) compared manufacturing productivity in the United States, Germany and Japan with the assistance of members of the ICOP (University of Groningen). The study does not cover the whole manufacturing sector, but provides some case studies. While based to a large extent on the industry-of-origin approach, sectoral experts were able to carry out a more in-depth analysis. In contrast to our study, some matched products were adjusted for quality differences.

> "*We compare like products to like products*. (...) We decided to assume quality was the same across countries unless there are differences that meet the following two-part test. The differences in quality are: 1) recognized by consumers and such are they willing to pay a price premium; and 2) are a results of differences in the production process, and not of advertising, tradition, nationalism, differences in information, etc. We adjust our comparable products for quality only if the product differences meet these two conditions..."[47]

The McKinsey study basically uses the same hypotheses as we do to estimate total output from the covered part of matched products.

[47] McKinsey (1993, box after page 8 on 'productivity and the measurement of quality').

> "The second step in accounting for quality differences across countries arises with products that are not comparable. We argue that, provided the PPP has been correctly estimated for the standard products in that industry, there is no further adjustment necessary to take account of specialty products that are either higher or lower in quality than standard products. The basis for this is that *specialty products will command a higher or lower price in the market than the standard industry products and will consequently add more or less to value added per unit than the standard industry products. The price system in market economies automatically provides a quality adjustment* because it reflects value as perceived by customers."[48]

It is assumed that, compared to standard products, unit values and value added move in the same direction. We have just mentioned that German relative productivity might be 'penalised' by the industry-of-origin approach because of relatively high prices due partly to high quality, a phenomenon which may not be picked up by the product matches. If the assumption mentioned above is correct, and our product matches are 'representative', relatively high German unit values should go along with high value added figures. Let us therefore also consider the relationship between value added per employee and UVRs.

The observed relative French-German productivity level in FF is:

$$\frac{\dfrac{VA^{F(FRF)}}{L^F}}{\dfrac{VA^{G(DEM)}\,UVR^G_{observed}}{L^G}} \tag{20}$$

These UVRs are derived from the product matches. Let us therefore call them *observed* UVRs. Yet, from the industry information we have, we can calculate a *theoretical* UVR for each industry, which assures the same productivity in the two countries.

Theoretical relative productivity in FF:

$$\frac{\dfrac{VA^{F(FEF)}}{L^F}}{\dfrac{VA^{G(DEM)}\,UVR^G_{theoretical}}{L^G}} = 100\% \tag{21}$$

This gives the relationship between relative French-German labour productivity and observed and theoretical UVRs:

[48] McKinsey (1993, box after page 8 on 'productivity and the measurement of quality'). Emphasis added.

Observed relative productivity:

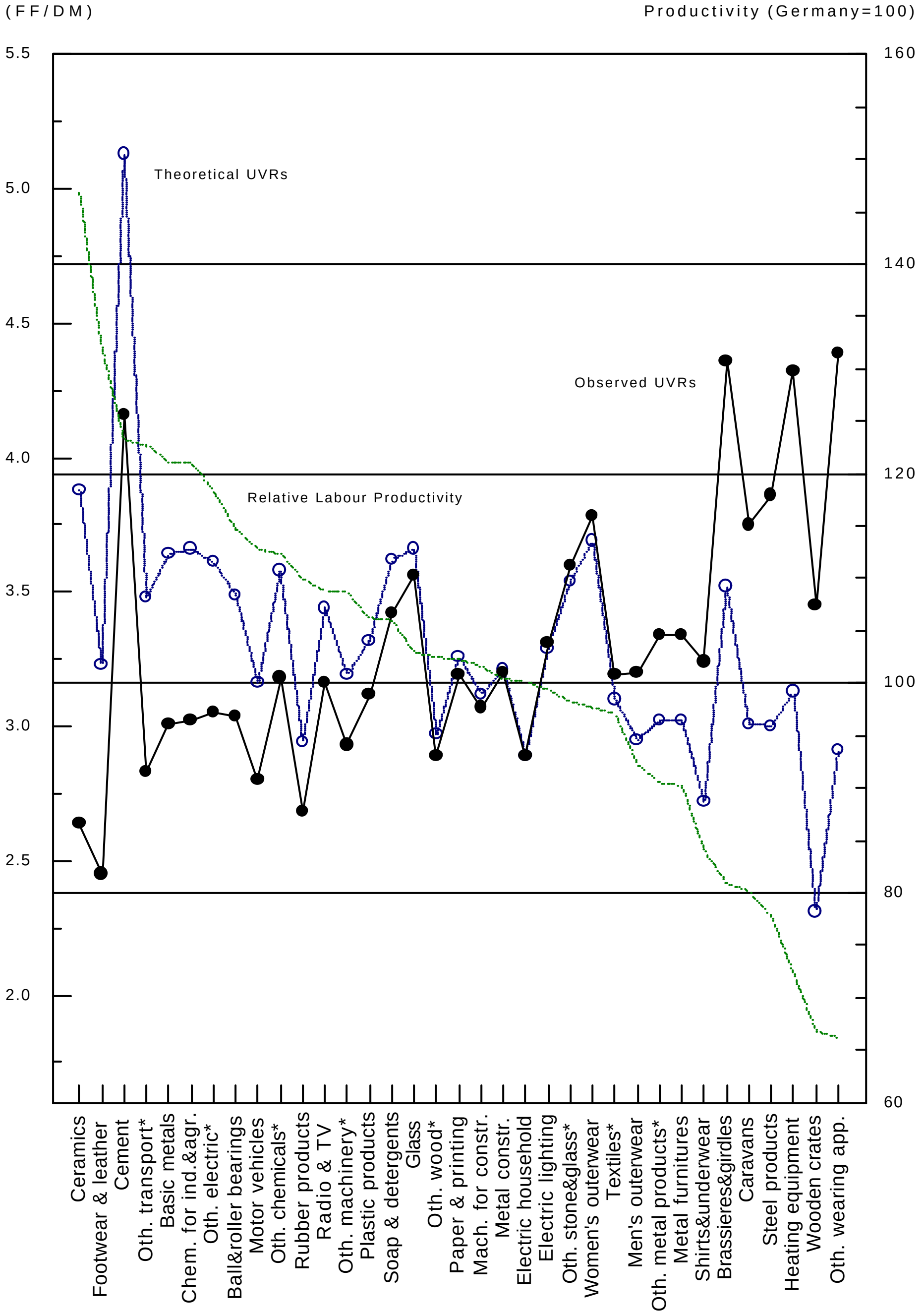
$$\frac{UVR_{\ theoretical}}{UVR_{\ observed}} \tag{22}$$

If the observed UVR is lower than the theoretical one (we multiply German value added by less than we would if its productivity were the same as in France), then German labour productivity is lower than French productivity. There is an inverse relation *ceteris paribus* between observed unit value ratios and relative labour productivity levels (taking into account theoretical UVRs). Graph 4 shows both theoretical and observed UVRs for all industries (sorted in descending order of relative labour productivity) as well as for total manufacturing. For total manufacturing, the theoretical UVR (3.32 FF/DM) is almost identical to the exchange rate of 3.35 FF/DM in 1987 (represented by the vertical line), but 8.4% higher than the observed value of 3.06 FF/DM. These 8.4% correspond to the French advantage in labour productivity.

Despite the differences between theoretical and observed UVRs among industries - due either to productivity differences or measurement errors- the two often move in the same direction.[49] For example, the 'motor vehicles' industry shows low observed UVRs (due to relatively high German prices) and rather low theoretical UVRs (due to relatively high German value added). The two UVRs move roughly in the same direction, but nevertheless the theoretical value is higher than the observed UVR, yielding a French labour productivity advantage. For 'brassieres and girdles', the situation is symmetrical. We feel that our results are not too far off from the 'real' relative productivity.

[49] This is not necessarily so, but outliers of *theoretical* UVRs might indicate an incorrect industry correspondence, while outliers of *observed* UVRs might indicate a product mismatch.

Graph 4
Observed Versus 'Theoretical' UVRs, France and Germany, 1987



Sources: See Table 9.

3. Extrapolating the 1987 Benchmark Results (1970-1992)

The results so far refer to the year 1987. Using time series from national accounts on value added and capital in constant prices, as well as on employment and hours worked, UVRs and relative productivity levels were extrapolated backwards to 1970 and forwards to 1992.[50] We then present the evolution for total manufacturing and for major branches. Even after the German unification, the data used refer only to former West Germany.

3.1. Evolution of UVRs

The 1987 value added weighted UVR (here at French weights) is extrapolated to year t by applying the ratio of French and German price indices for value added in national currencies.

$$UVR_t^F = UVR_{87}^F \frac{\left(\dfrac{P_t^{F(FRF)}}{P_{87}^{F(FRF)}} \right)}{\left(\dfrac{P_t^{G(DEM)}}{P_{87}^{G(DEM)}} \right)} \qquad (23)$$

3.1.1. Total Manufacturing

Graph 5 shows the evolution of (value added weighted) UVRs for total manufacturing, market exchange rates, as well as purchasing power parities for Gross Domestic Product.[51] During the time period considered, the French franc has regularly depreciated compared to the German mark, from about 1.50 FF/DM in 1970 to 3.35 FF/DM in 1987, entering a period of stability thereafter (until the speculations against the franc in September 1992 and summer 1993). While nominal exchange rates can be erratic in the short-run and influenced by trade balance or capital movements for example, this depreciation of the French franc in the long-run seems justified by the evolution of manufacturing UVRs, as well as purchasing power parities.

Until the mid-1980s, the nominal exchange rate systematically aligned on these two indicators, which themselves are strikingly similar and -by nature- more inert than market exchange rates. After 1987, the pivoting rates for exchange rates were frozen within the European Monetary System.[52] UVRs as well as PPPs also levelled off, but at different

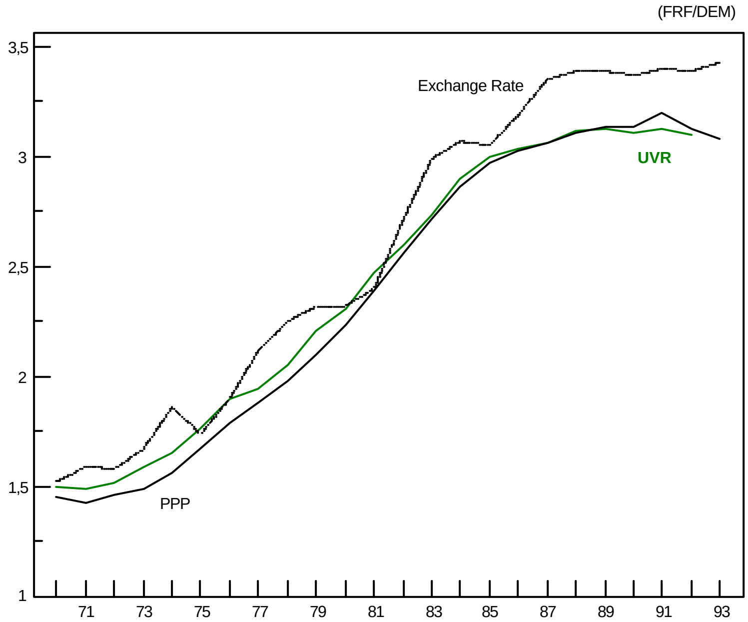
[50] See van Ark (1993, pp. 68-69) for the procedure. For time series we used gross value added figures from national accounts, whereas productivity calculations are based on gross value added at factor cost from production censuses.

[51] PPPs are from the database 'CHELEM' of the CEPII (base year 1990). In 1987, our manufacturing UVRs and PPPs for gross domestic product in 1990 prices are identical (3.06 FF/DM).

[52] The history of the EMS can roughly be divided in four periods, see G. Lafay and D. Ünal-Kesenci (1993).
The first period (March 1979 to February 1983 was a phase of orientation, with no common strategy concerning economic policies. Member states reacted in different ways to exogenous shocks, making

levels, creating a stable but significant gap between exchange rates and these two indicators. So, while the EMS created a monetary environment impeding further adjustments of nominal FF/DM exchange rates, the resulting gap suggests that the French franc is slightly undervalued when compared to the German mark, and that France benefits from a competitive price-advantage over Germany.

Graph 5
Evolution of Manufacturing UVR, PPP for GDP and the Exchange Rate, France-Germany



Sources: For the UVR in 1987, see Table 7. Extrapolations are based on series from INSEE, database 'NOUBA' and Statistisches Bundesamt, *Volkswirtschaftliche Gesamtrechnungen, Revidierte Ergebnisse, 1950 bis 1990*, with updates to 1992 kindly provided by Dr. Räth. Exchange rates and PPPs are from CEPII, database 'CHELEM'.

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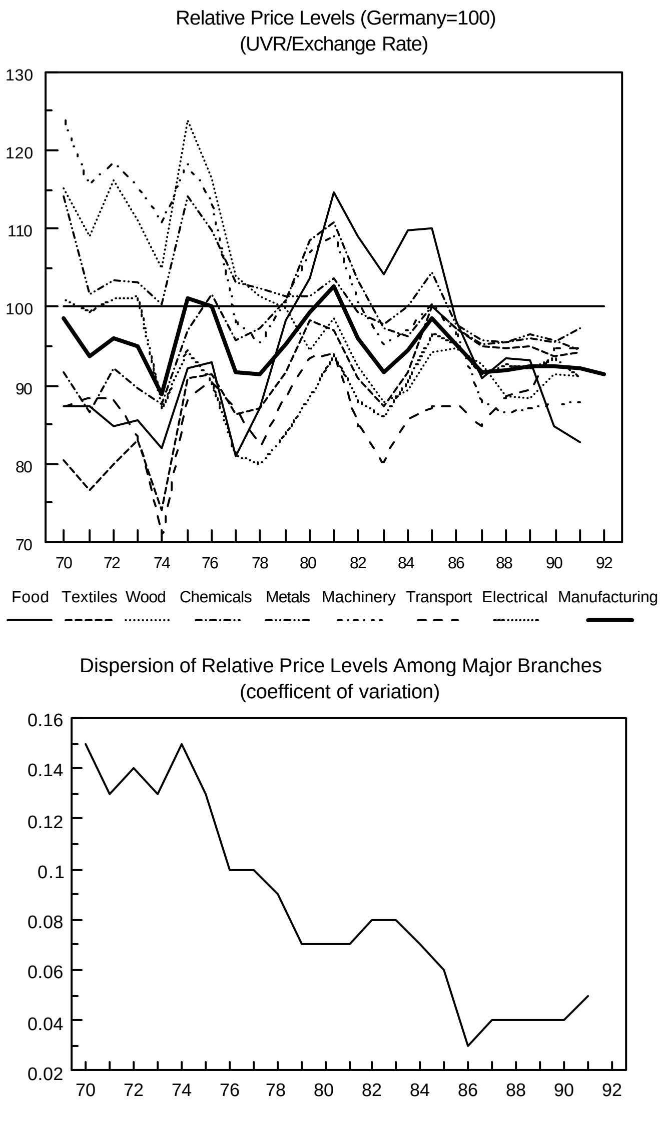
several adjustments necessary.
The second period (March 1983 to August 1987) was a consolidation phase. Economic policies were oriented towards internal monetary stability, and realignments served not only to compensate previous cost and price gaps, but also to minimise future gaps and to favour budgetary discipline. Economic policies converged increasingly during this period.
The third period (September 1987 to August 1992) saw a reinforcement of the EMS. The Basle/Nyborg Agreement set the bases for central banks to have access to very short-term and unlimited credits within the EMS. This (technical) aspect allowed central banks to intervene immediately and with unlimited amounts to defend their currencies and maintain exchange rates more effectively within the fixed (politically desired) margins.
After five years of fixed exchange rates, a first crisis broke out during summer 1992 and then in summer 1993. An insufficient convergence of inflation rates, budgetary problems of some member states and effects of the German unification, coupled with enormous capital movements due to deregulation, brought on speculation against, and subsequent devaluation of, several European currencies.

3.1.2. Major Branches

The upper part of Graph 6 shows the relative French-German price level in major branches, which is obtained by dividing UVRs by the exchange rate. Values above unity indicate relatively high French prices, values below suggesting stronger French price-competitiveness.

Graph 6
Relative French Price Levels in Major Branches (Germany=100)



Sources: See Graph 5.

While the exchange rate and the manufacturing UVR move closely together (see also Graph 5), the relative French price level for manufacturing is slightly below the German level in most years. At the beginning of the time period, the dispersion among major branches was high and more or less evenly distributed above and below the level of 100. After the mid-1980s, the relative price level of all major branches converged strongly, but to a level of about 90%. So, despite the remaining (absolute) price gap for total manufacturing, there is a clear (relative) convergence in relative producer prices among major branches. The coefficient of variation (lower part of Graph 6) among the eight major branches dropped substantially, especially after the first oil shock, increased slightly after the second oil shock, and fell again from 1983 to 1986. Since this date, the dispersion of relative prices among major branches has slightly increased. This increase is mainly due to the relative price level of 'food and beverages', which continues to decline.

3.2. Evolution of Input, Output and Productivity in Manufacturing

As for equation (23), input and output indices from national accounts are applied to 1987 levels of census data. For example, the extrapolation of relative hourly labour productivity from the base year 1987 to a given year t is presented in equation (24). There, the 1987 (census) value added figure is expressed in prices of one of the countries (here in DM), whereas the index for constant (national accounts') value added is expressed in each country's prices.

$$\frac{\dfrac{VA_t^{F(DM)}}{LH_t^F}}{\dfrac{VA_t^{G(DM)}}{LH_t^G}} = \frac{\dfrac{VA_{87}^{F(DM)}\left(\dfrac{VA_t^{F(FF)}}{VA_{87}^{F(FF)}}\right)}{LH_{87}^F\left(\dfrac{LH_t^F}{LH_{87}^F}\right)}}{\dfrac{VA_{87}^{G(DM)}\left(\dfrac{VA_t^{G(DM)}}{VA_{87}^{G(DM)}}\right)}{LH_{87}^G\left(\dfrac{LH_t^G}{LH_{87}^G}\right)}} \qquad (24)$$

3.2.1. Total Manufacturing

In order better to apprehend the evolution of relative French-German levels of manufacturing input, output and productivity (Graph 8), Graph 7 presents indices from national accounts for total manufacturing (the base year is 1970, except for indicators involving capital stock, where it is 1971).[53]

[53] We used data from 1970 onwards, but while German national accounts indicate figures for the *beginning* of the year, French national accounts provide *end-of-the-year* figures. We adjusted both series to obtain mid-year figures.

Graph 7 shows that during the 1970s -with the exception of the period after the first oil shock- both countries saw sustained growth in manufacturing value added (1970=100), with France by far outpacing Germany. In contrast, the volume of hours worked fell in both countries. While before 1974, labour input rose in France but declined in Germany, the first oil shock immediately reversed this situation in France, and accelerated sharply the fall in labour input in Germany. During the decade, labour productivity growth was similar in the two countries, as higher French growth in value added was counterbalanced by a stronger reduction in inputs in Germany. Capital stock (index 1971=100) rose faster than output in both countries: in contrast to labour productivity, capital productivity actually declined.

Graph 8 shows relative French-German levels of manufacturing inputs, outputs and productivity (Germany=100). The upper part of Graph 8 shows that at the beginning of the decade, French value added, hours worked and capital stock represented about 54% of the German level, and productivity was almost identical in the two countries (lower part of Graph 8). During the 1970s, as growth in value added and capital stock was higher and the decline in labour input less pronounced than in Germany (Graph 7), France caught up with Germany, both in terms of output as of production factors (to a level of 61-62%), while productivity in the two countries remained very close, despite minor fluctuations.

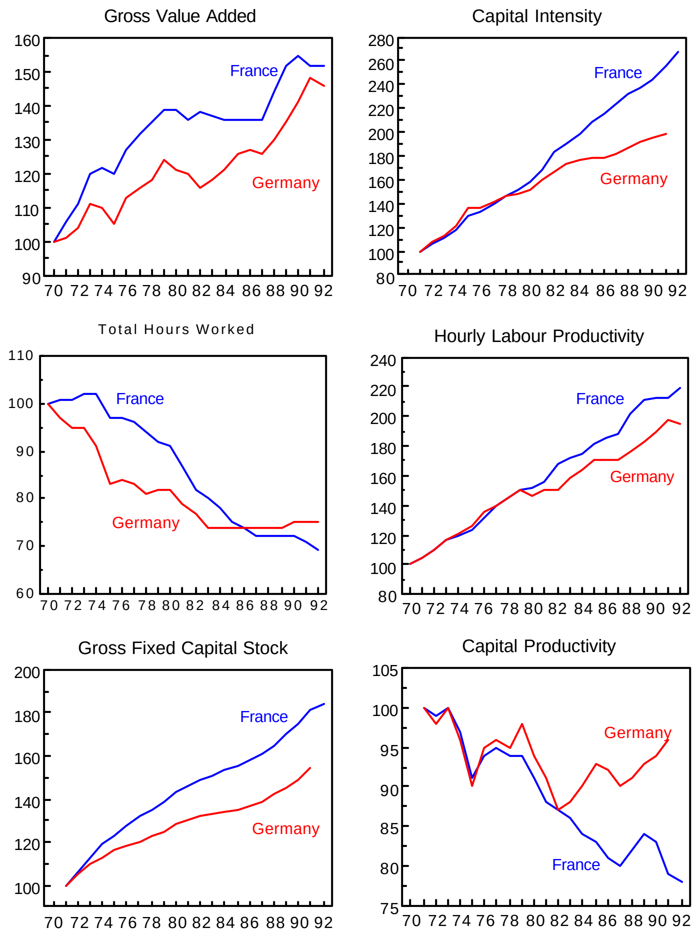
The second oil shock and the recession of the early 1980s had stronger negative effects on economic growth and labour input in France than the first oil shock (Graph 7). However, from the mid-1980s onwards, the oil counter-shock as well as the preparation for the Single Market and German unification were positive factors for economic growth.[54] Nevertheless, while the 1970s were a decade of catching-up for France with Germany, the 1980s reversed most of these relative gains. In the beginning of the 1990s, the relative size of French manufacturing (as indicated by value added) was again at almost the same percentage as 20 years before (about 55% of German manufacturing, Graph 8), whereas French labour input dropped to an even lower level than in 1970. If measured in terms of employees only, the relative French decline is even more pronounced. Only relative French capital stock continued to increase (to some 65%). Therefore, while joint factor productivity remained very close in the two countries until the end of the period, its components show a radically different evolution. Relative French labour productivity improved considerably (from about 97% of the German level in 1976 to 110% in 1992), whereas relative French capital productivity fell from about the same level as Germany, to about 85%.[55] These two phenomena are closely related to relative capital intensity (lower part of Graph 8), which increases from less than 100% to more than 125%. Gains in labour productivity and losses

[54] More precisely, the German unification had two opposing effects for France and most European countries. At first, 1990 and 1991, German demand and constraints on its own production capacities had favourable effects on exports and the economic growth of European countries. But then, especially after 1992, high German short-term interest rates to curb inflation conflicted with the need of lower rates in other countries to stimulate home demand. Tensions within the EMS are one of the reasons for insufficient growth in Europe.

[55] By construction of the Cobb-Douglas production function, joint factor productivity is more sensitive to labour than to capital productivity, since the share of labour compensation in GDP (alpha) is about 71%.

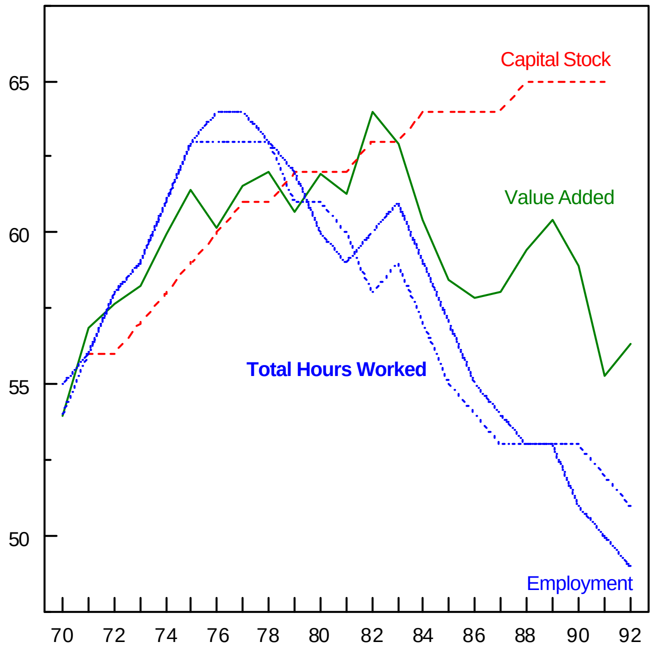
in capital productivity in France are basically due to the substitution of labour by capital, which was much stronger than in Germany. Nevertheless, since the early 1980s, this link has almost disappeared, and the stronger substitution in France does not translate any more in relative French labour productivity gains.

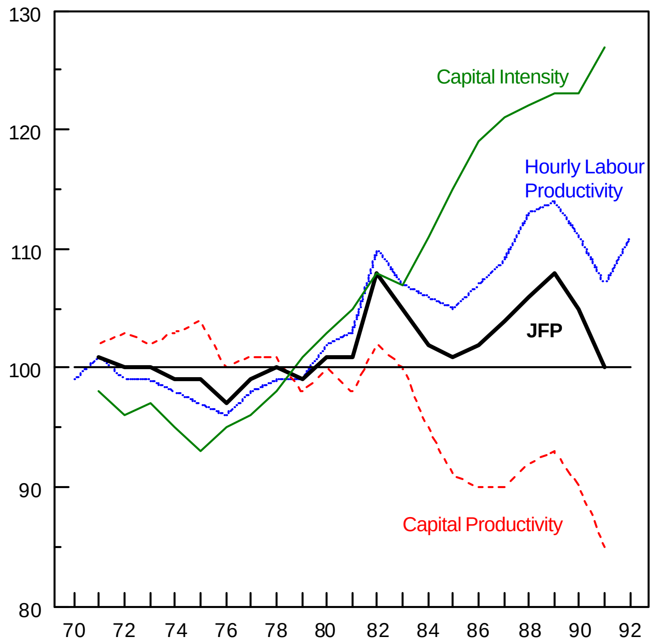
Graph 7
Indices on Data from National Accounts for Manufacturing, France and Germany



Sources: Extrapolations are based on series from INSEE, database 'NOUBA' and Statistisches Bundesamt, *Volkswirtschaftliche Gesamtrechnungen, Revidierte Ergebnisse, 1950 bis 1990*, with updates to 1992 kindly provided by Dr. Räth. Hours worked for Germany are from H. Kohler and L. Reyher, *Arbeitszeit und Arbeitvolumen in der Bundesrepublik Deutschland : 1960-1990*, Institut für Arbeitsmarkt und Berufsforschung (IAB), with updates to 1992 kindly provided by H. Kohler.

Graph 8
Relative French Levels of Inputs, Outputs and Productivity in Manufacturing, (Germany=100)

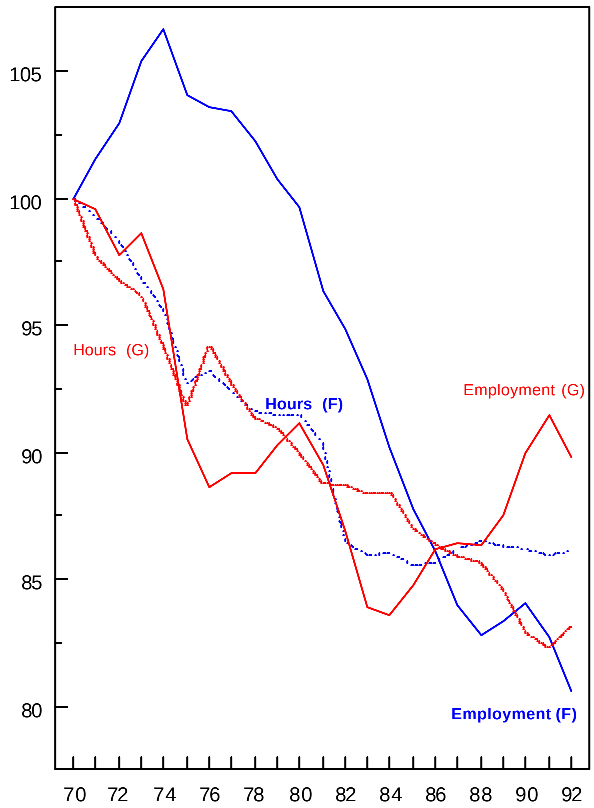




Sources: See Tables 7, 8, 9 and 10 as well as Graph 7.

In Graph 9, labour input is decomposed into employment and annual hours worked per employee (1970=100). Between 1970 and 1986, the number of employees as well as annual hours worked per employee dropped by almost 15% in both countries. Until the early 1980s, the evolution of hours worked per employee in the two countries was similar: therefore, the relative evolution of the volume of hours worked (Graph 7) is mostly determined by the evolution of the number of employees in both countries. The evolution of employees in Germany is very sensitive to business cycles, while French employment falls regularly even in periods of growth. After about 1984, we find an interesting phenomenon: in Germany, decreasing annual hours per employee go along with a rise in the number of employees, whereas in France, annual hours were almost constant while employment further adjusted downwards. Given the much higher unemployment rate in France, this phenomenon is no without interest for the debate on a reduction of working hours in France...

Graph 9
Decomposition of Total Hours Worked, France and Germany



Sources: See Graph 7.

3.2.2. Major Branches

For the eight major branches in manufacturing, indices from national accounts on input, output and productivity can be found in the appendix. We will only present the major results for relative French-German levels of inputs, outputs and productivity (Graphs 10 to 13).

- **'Chemicals, rubber and plastic products'** and **'electric and electronic products'** had the highest growth rates in gross value added between 1970 and 1991, and became two of the most important major branches in both countries (see appendix). As already shown in Graph 1 for 1987, they are also the major branches in which value added per hour worked compared to the national manufacturing average is highest. In 'chemicals rubber and plastic products', French value added fluctuated around 60% of the German level during the whole period, whereas the evolution in 'electric and electronic products' is clearly divided in two phases: a substantial French catch-up during the mid- and late 1970s is followed by an almost as dramatic decline in the 1980s. In both major branches, France caught-up and then overtook Germany in terms of capital intensity (from 80% to 110%) due to higher investment. France had an advantage in joint factor productivity during most of the period. Relative French labour and capital productivity evolve like a pair of scissors: relative labour productivity is lower in the beginning and higher at the end of the period than relative capital productivity. Relative labour productivity is highly correlated with capital intensity in 'chemicals rubber and plastic products', but not in 'electric and electronic products'.

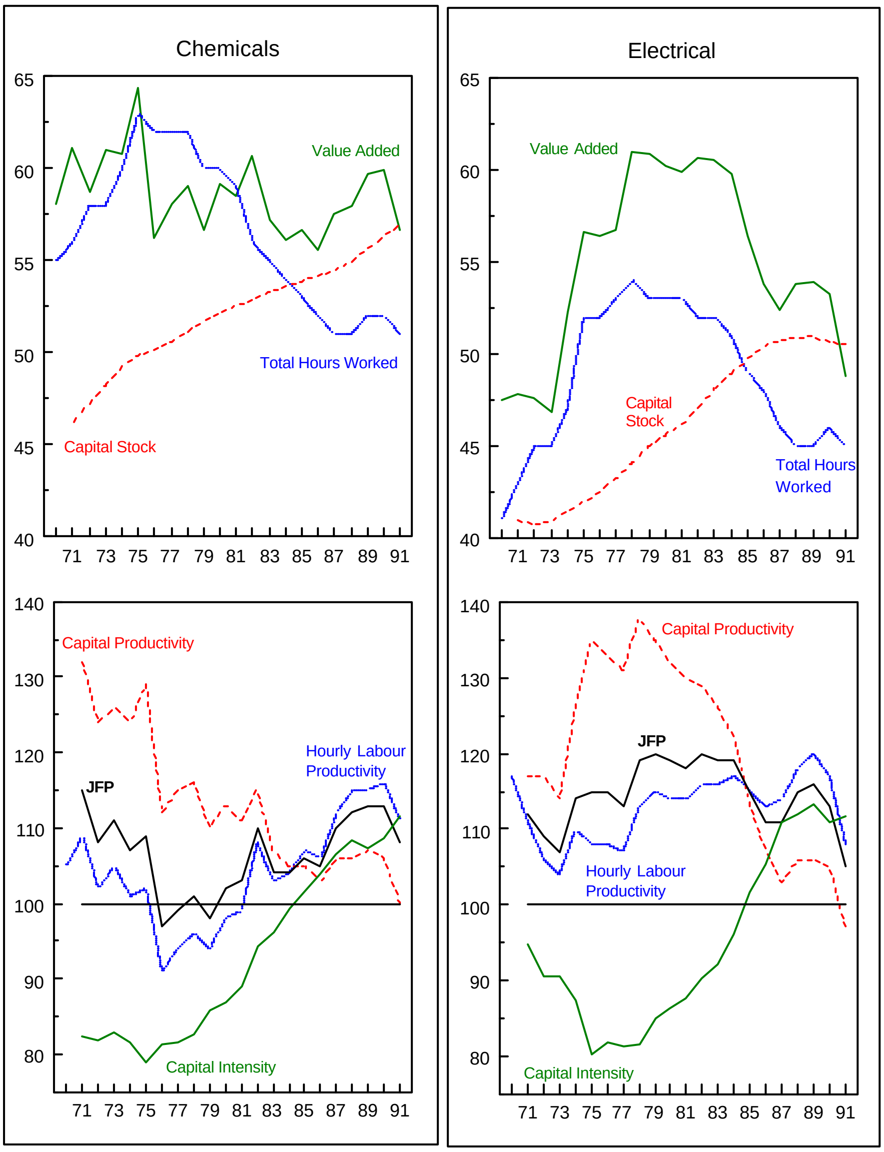
- **'Transport equipment'** and **'machinery'** are two other major branches were France caught-up with and overtook Germany in terms of capital intensity. In 'transport equipment', growth in value added was substantially higher in Germany than in France (see appendix), translating in an extreme drop in relative French value added from about 90% in 1974 to only 55% in 1991. Relative French labour input shows a similar evolution, since the volume of hours worked declined regularly in France but rose slightly in Germany after 1974. 'Transport equipment' is the only major branch in which Germany could actually raise the number of employees compared to 1970 (see appendix). In contrast to other major branches, the much stronger substitution of labour by capital in France did not go along with higher relative labour productivity. Compared to 'transport equipment' (in the early 1970s), 'machinery' is of much less importance in France than in Germany: the relative level of value added represents some 30% during the whole period. Relative French labour input dropped strongly after the first oil shock, and France almost doubled its relative capital intensity (from 65% to about 115%). As in chemicals and electric products, relative labour and capital productivity evolve like scissors in both major branches: relative French labour productivity is lower in the beginning and higher at the end of the period, than relative capital productivity. While this phenomenon is largely correlated with the strong increase in French capital intensity in 'machinery', there is virtually no such a link in 'transport equipment'.

- For **'food and beverages'** and **'basic metals and metal products'**, we find the most extreme figures. Concerning joint factor productivity 'food and beverages' remained the most performant major branch in France during the last two decades, with an advantage of about 30% over Germany. In contrast, 'basic metals and metal products' was the least performant one, with a level of between 80 and 90%. In both major branches, relative labour productivity is considerably higher than capital productivity: during the whole period, relative French labour productivity was very high in 'food and beverages' and relative capital productivity extremely low in 'basic metals and metal products'. But, as already indicated, we might have somewhat overestimated French capital stock in 'basic metals and metal products'.

- The French performance is relatively weak in **'wearing apparel, textiles and leather products'**, but German productivity gains, especially during the 1980s, cannot be seen as a veritable advantage, as both countries are disengaging themselves from this major branch. The decline is manifested both in terms of value added (it is the only major branch where value added actually decreased in both countries between 1970 and 1991) and especially in terms of labour input, where both countries have reduced labour input by some 60% (see appendix). For **'wood, paper and other products'**, we find a substantial increase in relative French value added (from 50% in the beginning to about 75% in the end of the period), but this major branch is of minor importance in both countries.

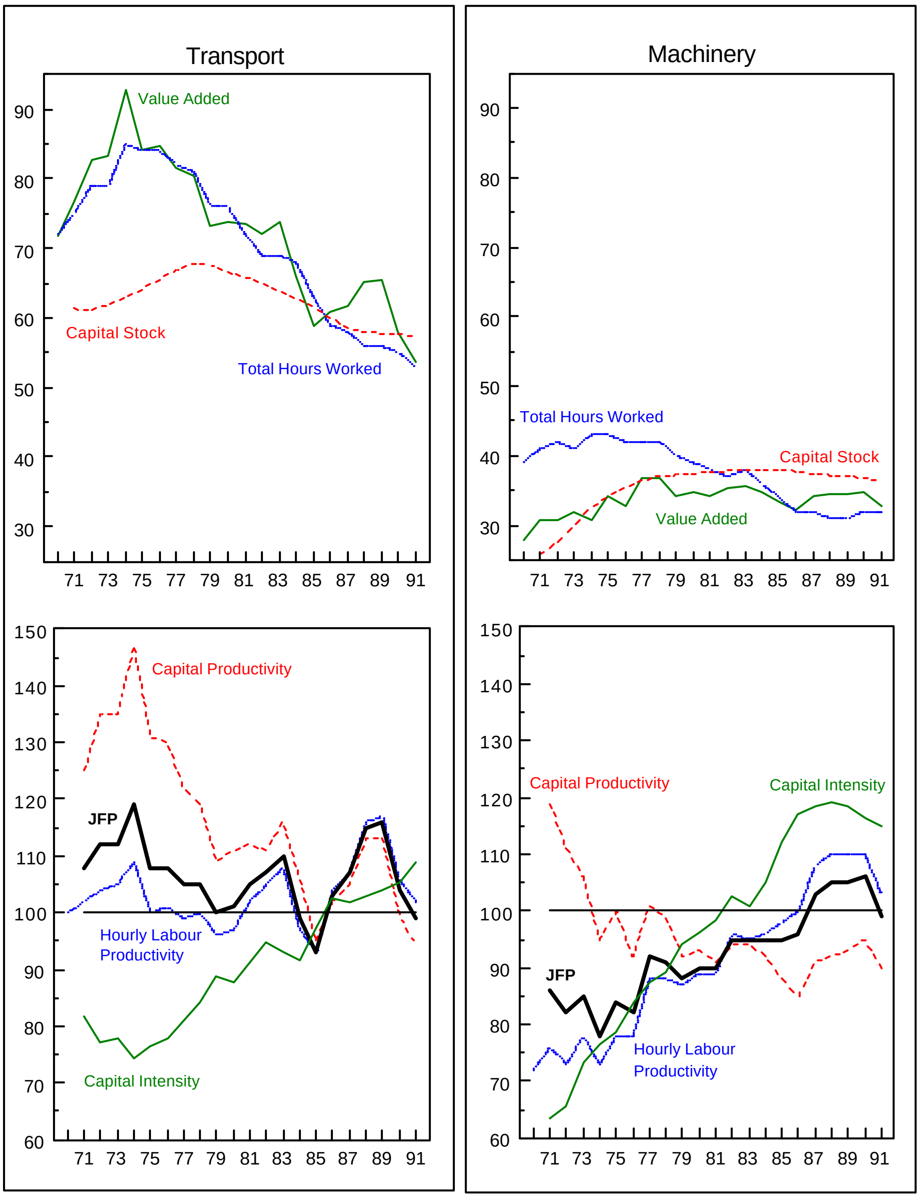
With the exception of 'transport equipment' and 'chemicals, rubber and plastic products', there is a remarkable correlation between relative French-German joint factor productivity and relative value added.

Graph 10
Relative French Levels of Inputs, Outputs and Productivity for 'Chemicals' and 'Electric and Electronic Products' (Germany=100)



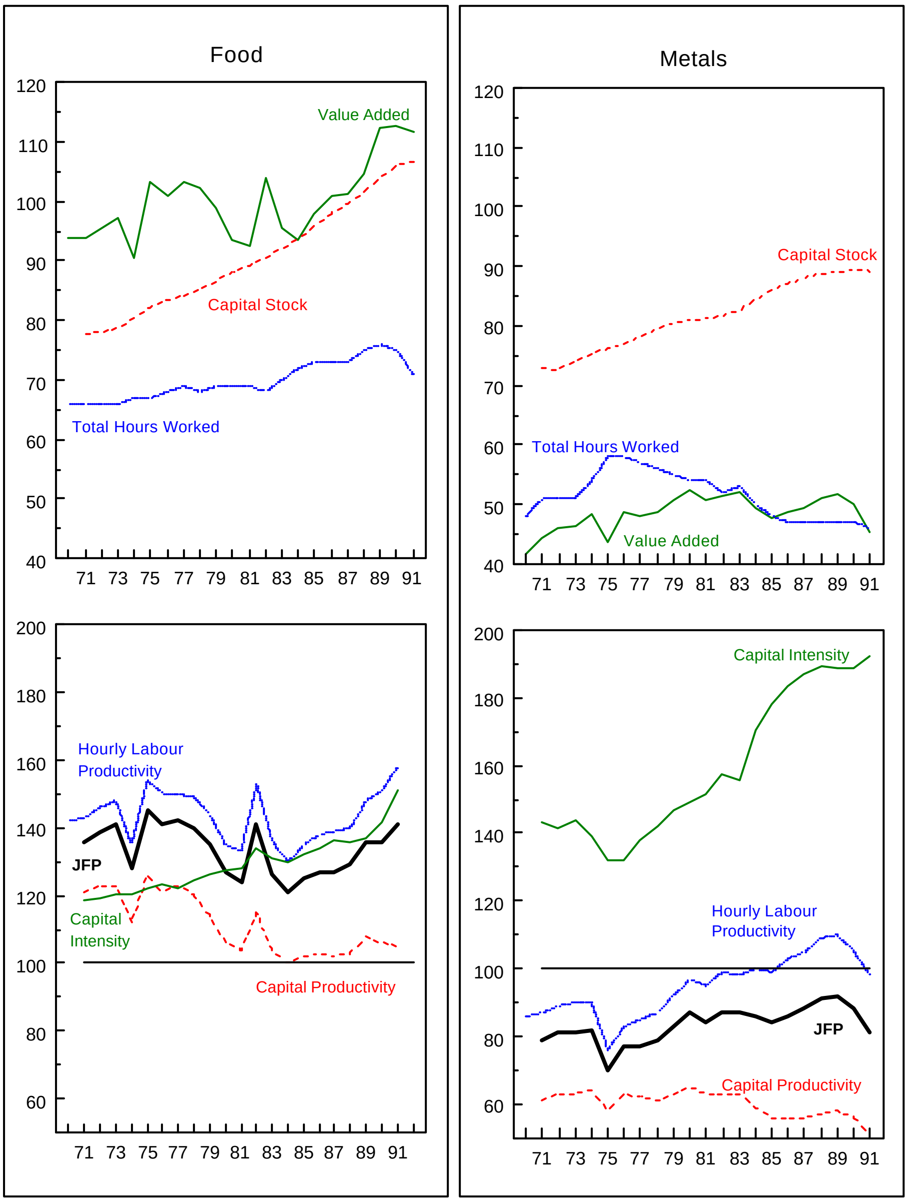
Sources: See Tables 7, 8, 9 and 10 as well as Graph 7.

Graph 11
Relative French-German Levels of Inputs, Outputs and Productivity for 'Transport' and 'Machinery' (Germany=100)



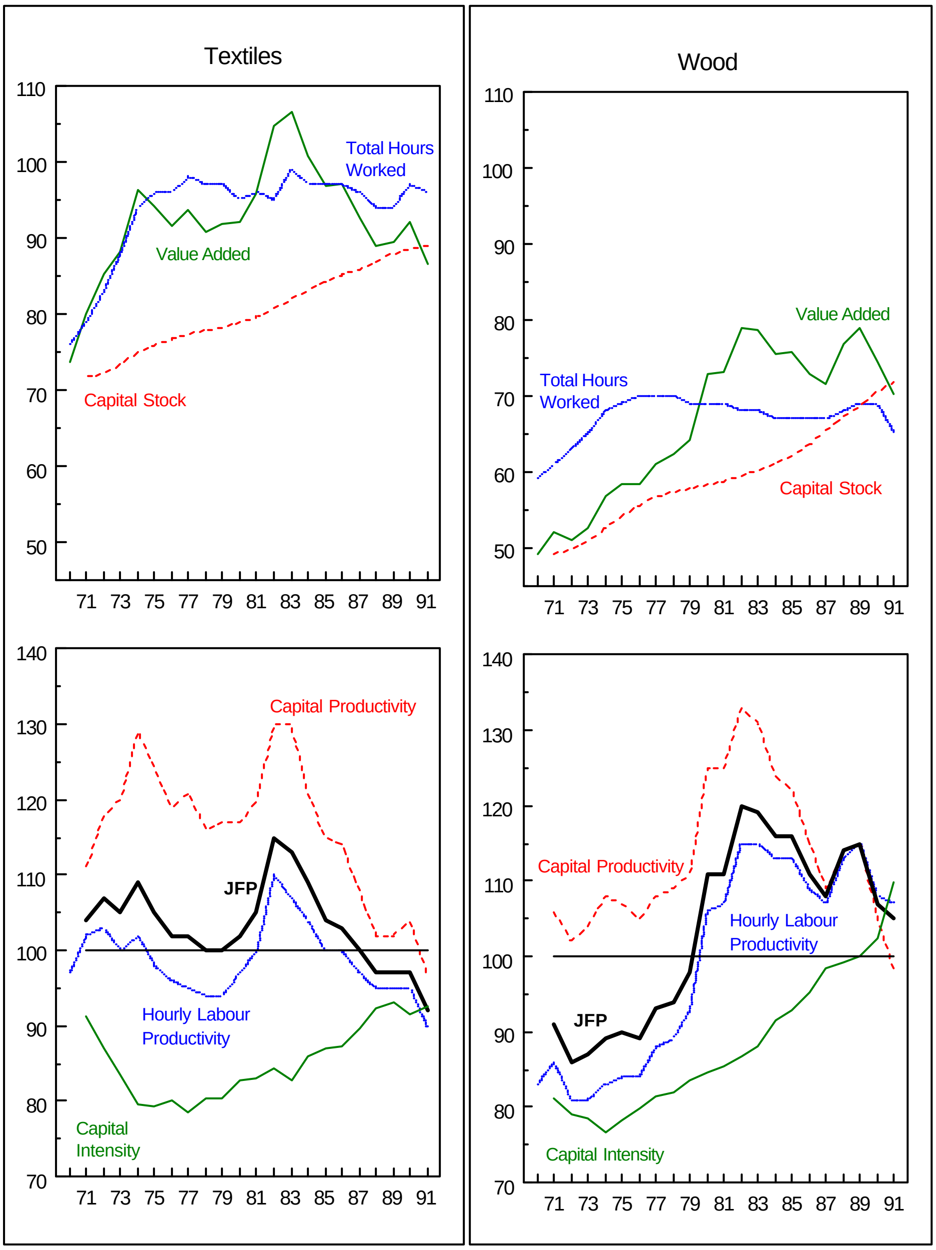
Sources: See Tables 7, 8, 9 and 10 as well as Graph 7.

Graph 12
Relative French-German Levels of Inputs, Outputs and Productivity for 'Food and Beverages' and 'Metals' (Germany=100)



Sources: See Tables 7, 8, 9 and 10 as well as Graph 7.

Graph 13
Relative French-German Levels of Inputs, Outputs and Productivity for 'Textiles' and 'Wood (Germany=100)

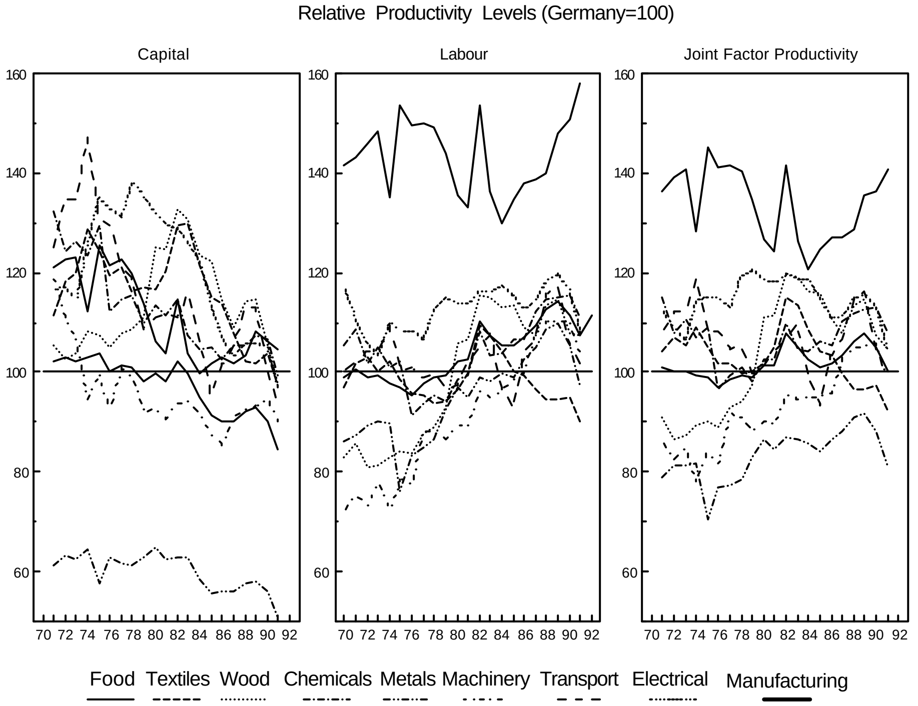


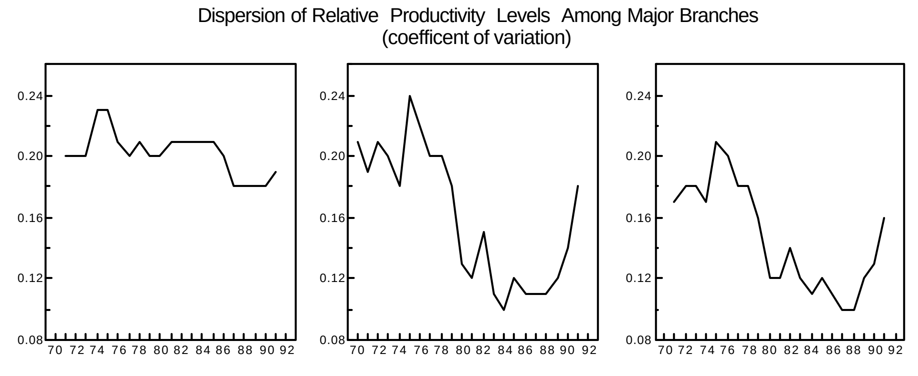
Sorces: See Tables 7, 8, 9 and 10 as well as Graph 7.

3.2.3. Convergence in Relative Levels of Productivity

Is there, as we have seen for price levels, a convergence in relative levels of labour, capital and joint factor productivity among the eight major branches? Graph 14 shows relative French-German productivity levels in major branches and the coefficient of variation.

Graph 14
Levels and Dispersion of Relative French-German Productivity in Major Branches





Sources: See Graph 13.

At the beginning of the time period, relative French-German labour productivity levels among major branches were more or less evenly distributed, above and below the level of 100. While relative French labour productivity increased in general, it was mainly France's least productive branches which improved most during the mid-1970s and mid-1980s. The resulting convergence can be seen by the coefficient of variation which dropped strongly during this period. Thereafter, the dispersion increased again, and is mostly due to 'food and beverages' -which became even more productive in France- and 'textiles' which continued to decline in relative terms. Despite the remaining (absolute) labour productivity gap for total manufacturing, there is a convergence in relative productivities for most major branches.

The coefficient of variation for capital productivity remains very stable. This is mostly due to 'basic metals and metal products' which stayed at an exceptionally low level, while the other major branches converged in relative terms.

Joint factor productivity also shows a clear convergence among major branches. Due to the high share of labour compensation in GDP, the evolution of the coefficient of variation is quite close to the one of labour productivity. The outliers are again 'food and beverages' and 'basic metals and metal products'.

Concluding Remarks

Applying the industry-of-origin approach to France and West Germany, we calculated unit value ratios (UVRs) for about 240 products which correspond to some 18% of total manufacturing (in enterprises with 20 employees or more). These UVRs are used to convert value added in national prices into the currency of the other country. This allows estimation of relative price, output and productivity levels of the two countries. The calculations are made for 1987, and the results extrapolated backwards to 1970 and forwards to 1992 based on indices from national accounts.

Since about 1987, French price levels in manufacturing have been about 10% lower than West Germany's. One possible interpretation of the price gap is that French enterprises benefit from a certain price advantage which can partly compensate the supposedly stronger German non-price competitiveness. However, the problem of product quality differences translating into price differences could not be completely set aside. Despite the remaining absolute price gap for total manufacturing, there is a remarkable convergence in relative price levels among major branches. This is most probably due to the increasing openness of the economies and the resulting stronger competition among enterprises.

In terms of output and factors of production, the 1970s were a decade where France caught-up with Germany, whereas the 1980s reversed most of these relative gains. In the beginning of the 1990s, the relative size of French manufacturing (as indicated by value added) was again at almost the same percentage as 20 years earlier (about 55% of German manufacturing), whereas the volume of hours worked and especially the number of employees, dropped even more in France than in Germany.

French and German labour, capital and joint factor productivities were very close during most of the 1970s. However, the picture changed radically since the end of the 1970s. Whereas joint factor productivity in the two countries remained rather close (but nevertheless with a slight French advantage in the 1980s), its two components showed a clear divergence: relative French labour productivity improved considerably while its relative capital productivity declined substantially. The French labour productivity advantage would have been even higher if we had included former East Germany after 1990.[56]

The factors examined in this paper explain only partly the French advantage in labour productivity over Germany. Structural differences like employment concentration and firm size do not explain the differences; on the contrary, they suggest an even higher French labour productivity. However, capital intensity explains some of the productivity gap. French capital intensity in manufacturing has become increasingly higher than Germany's. Despite lower labour costs and higher real interest rates than in Germany, the substitution of labour by capital was much stronger in France during the 1980s. This substitution might be a major reason for the rise in the French unemployment rate despite relatively high growth rates in the late 1980s.

[56] N. Beintema and B. van Ark (1993) estimate the of value added per hour worked in manufacturing in East Germany to about 28% of the West German level.

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Appendices

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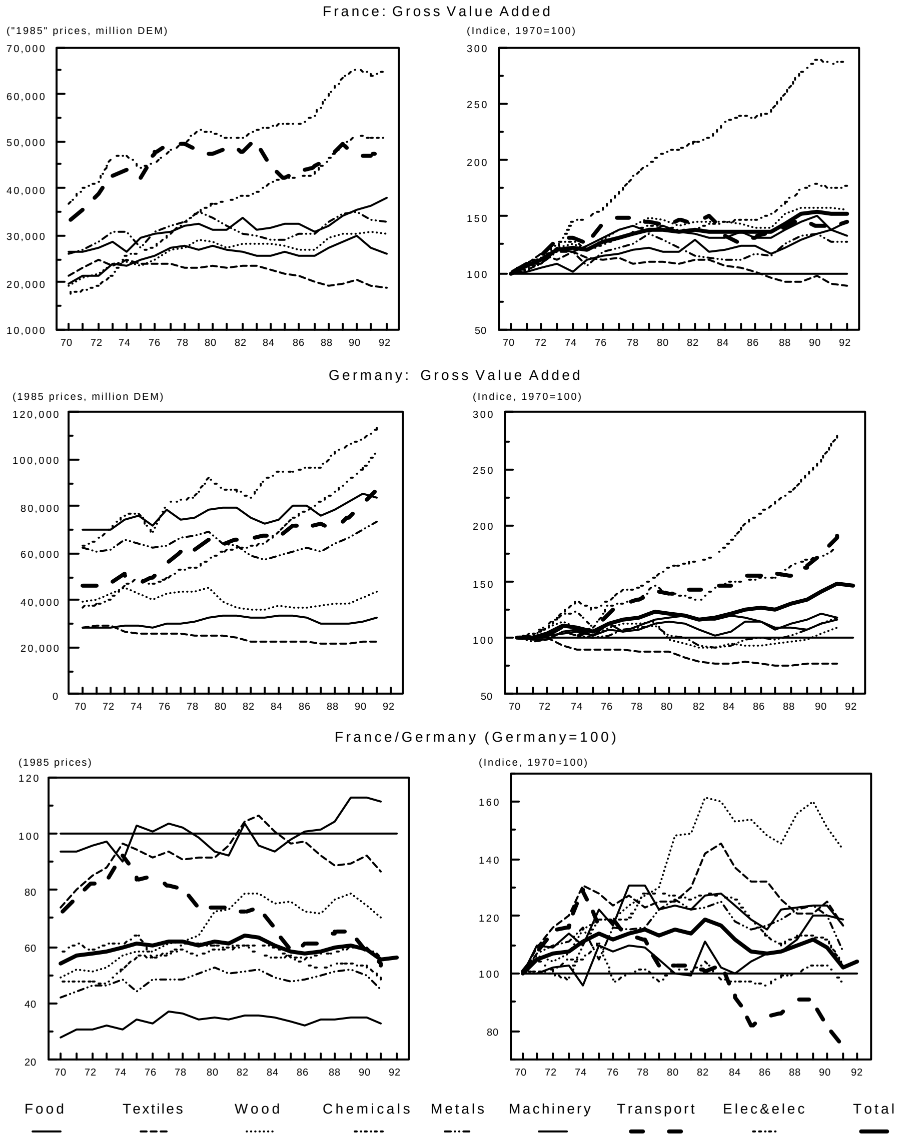
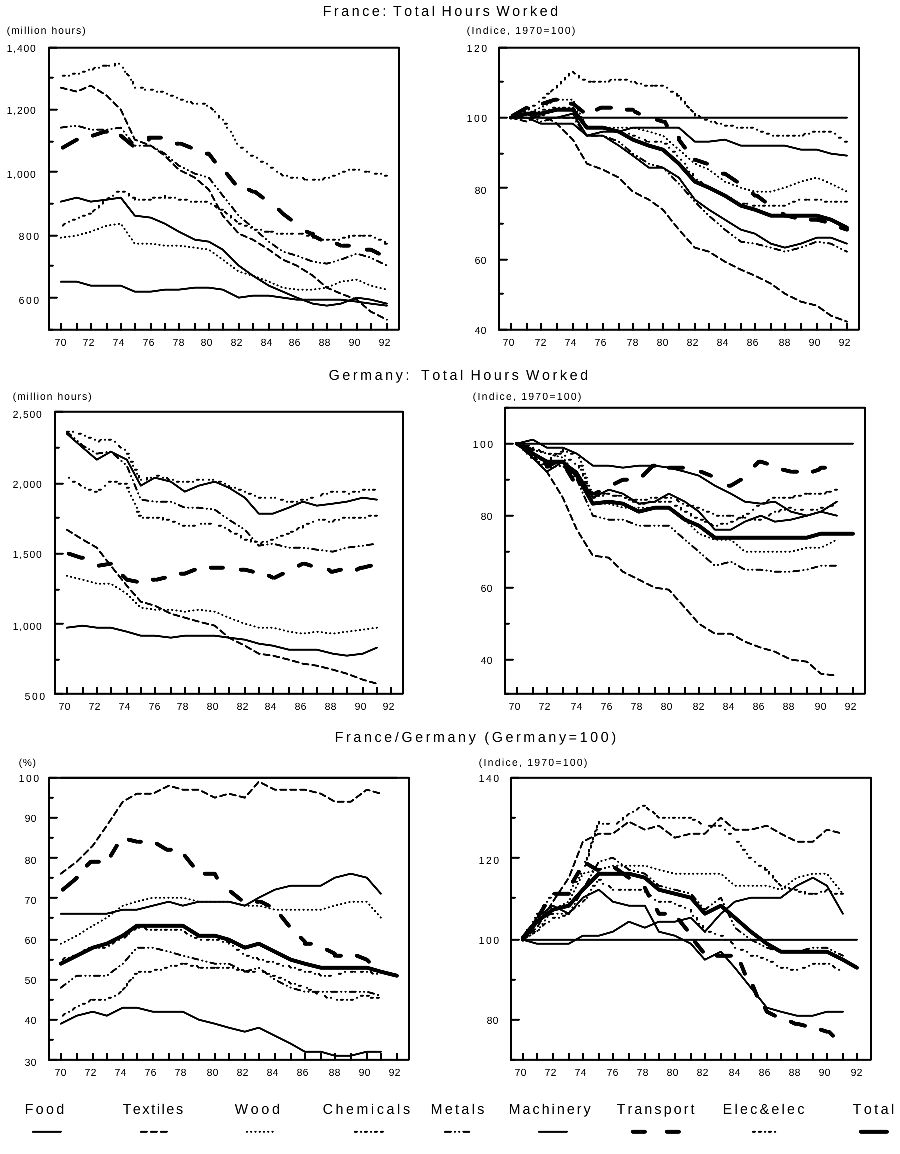
Appendix 1
Evolution of Manufacturing Gross Value Added, France and Germany



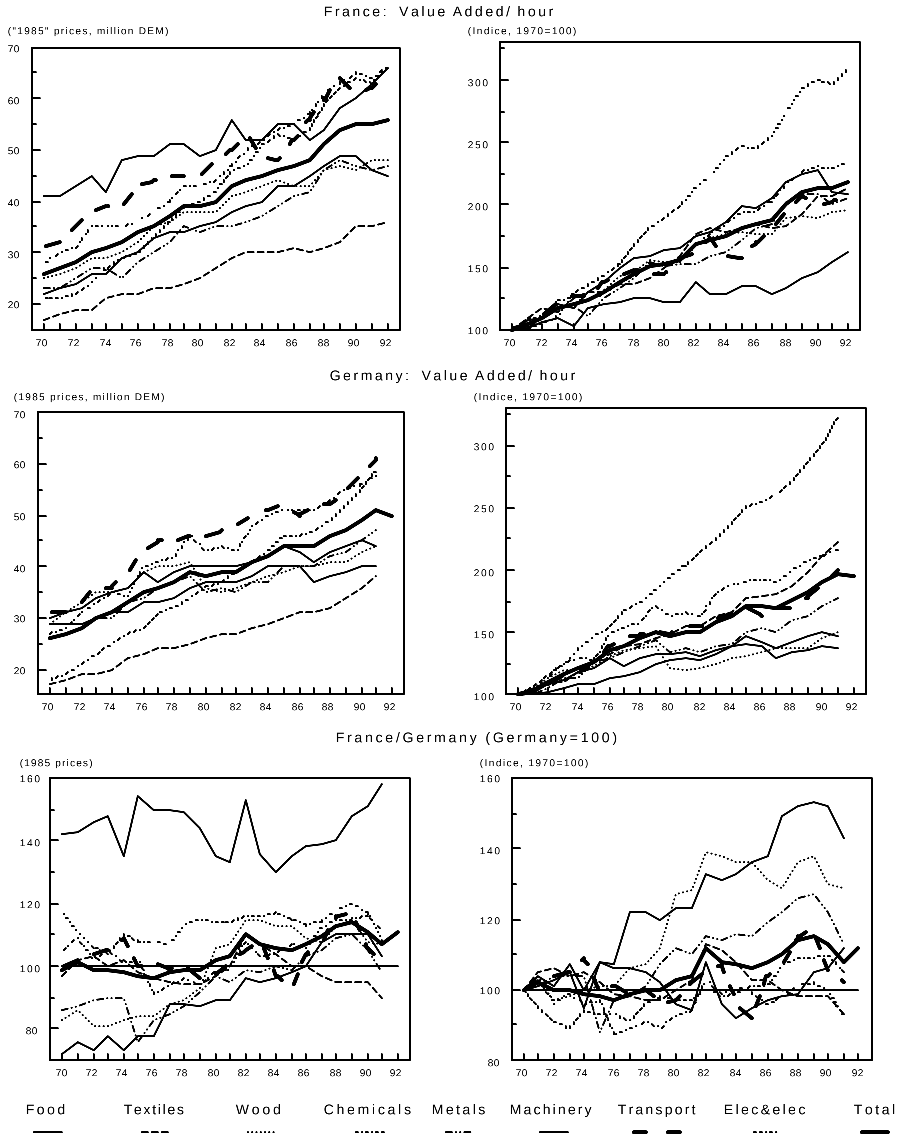
Sources: For UVRs used to convert value added, see Table 7. Industry information is from SESSI, *Enquête annuelle d'entreprise 1987*, SCEES, *Enquête annuelle d'entreprise 1987* and Statistisches Bundesamt, *Kostenstruktur der Unternehmen 1987*. Extrapolations are based on series from INSEE, database 'NOUBA' and Statistisches Bundesamt, *Volkswirtschaftliche Gesamtrechnungen, Revidierte Ergebnisse, 1950 bis 1990*, with updates to 1992 kindly provided by Dr. Räth.

Appendix 2
Evolution of Hours Worked in Manufacturing, France and Germany



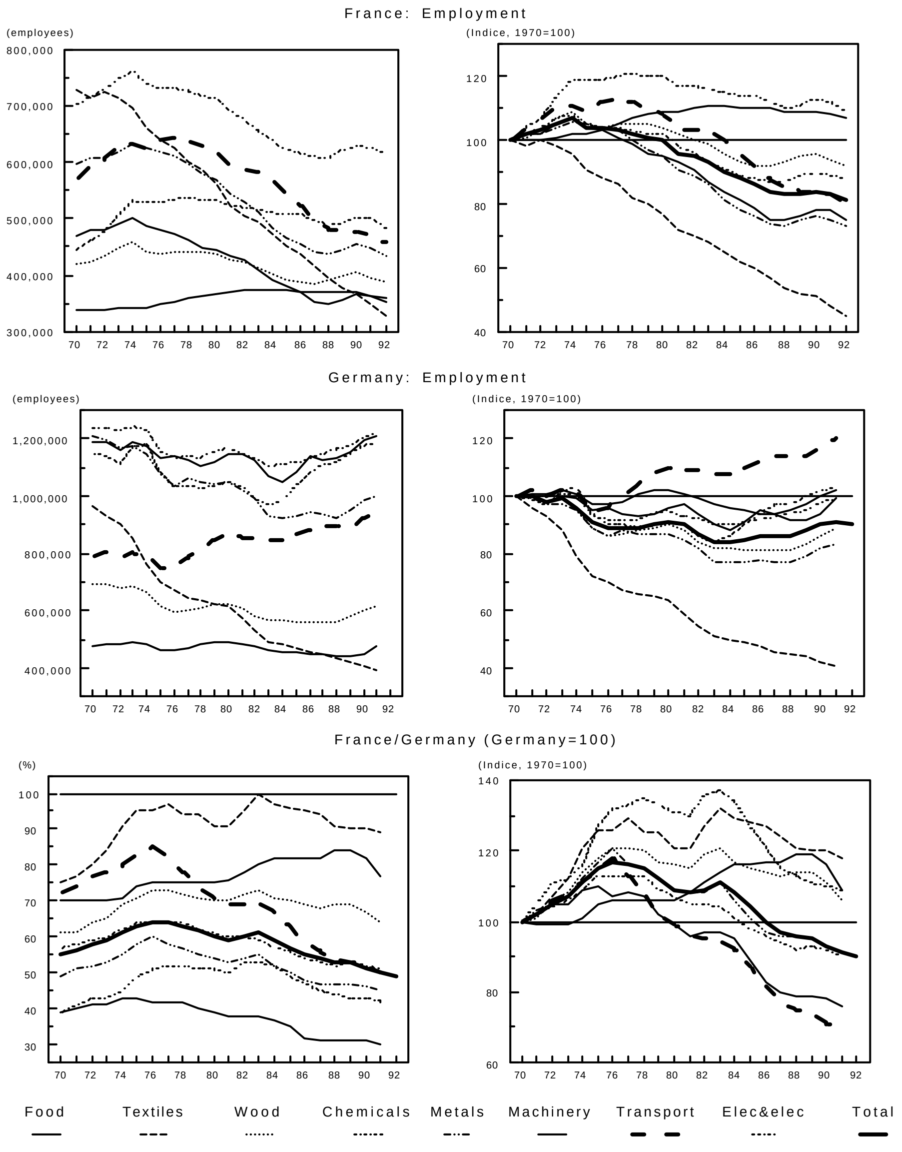
Sources: Information on employees is from SESSI, *Enquête annuelle d'entreprise 1987*, SCEES, *Enquête annuelle d'entreprise 1987* and Statistisches Bundesamt, *Kostenstruktur der Unternehmen 1987*, as well as INSEE, database 'NOUBA' and Statistisches Bundesamt, *Volkswirtschaftliche Gesamtrechnungen, Revidierte Ergebnisse, 1950 bis 1990*, with updates to 1992 kindly provided by Dr. Räth. Hours worked are from INSEE, database 'NOUBA' and H. Kohler and L. Reyher, *Arbeitszeit und Arbeitvolumen in der Bundesrepublik Deutschland : 1960-1990*, Institut für Arbeitsmarkt und Berufsforschung (IAB). Updates to 1992 kindly provided by H. Kohler.

Appendix 3
Evolution of Hourly Labour Productivity in Manufacturing, France and Germany



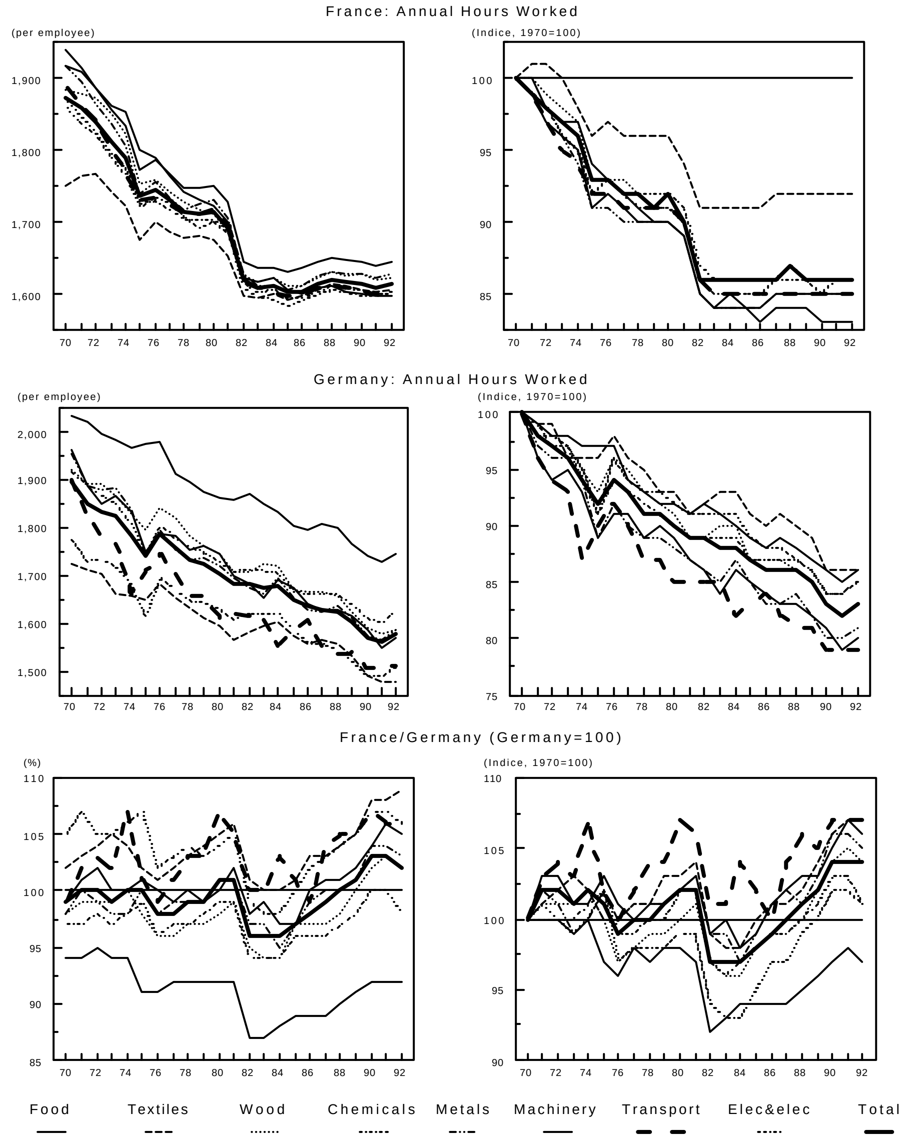
Sources: See Graphs A-1 and A-2.

Appendix 4
Evolution of Manufacturing Employment, France and Germany



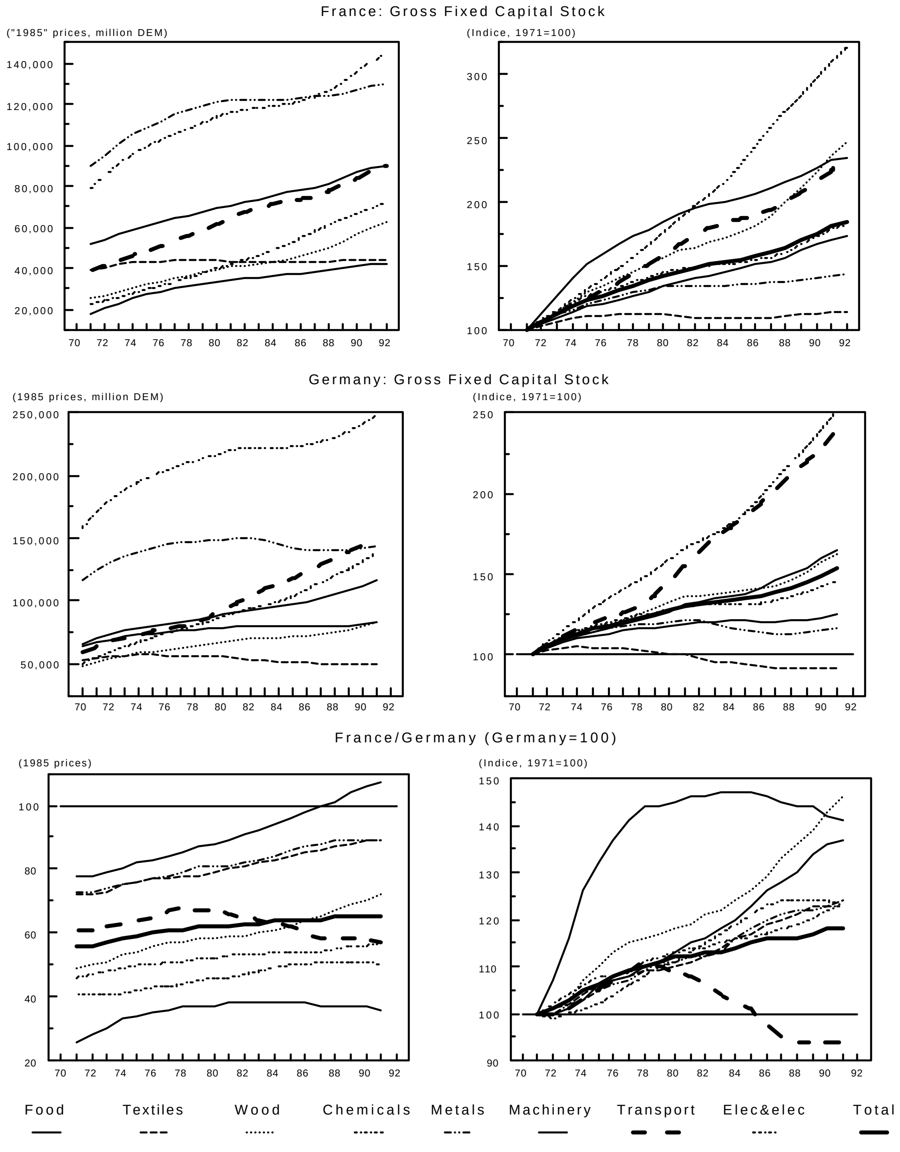
Sources: See Graph A-2.

Appendix 5
Evolution of Annual Hours Worked in Manufacturing, France and Germany



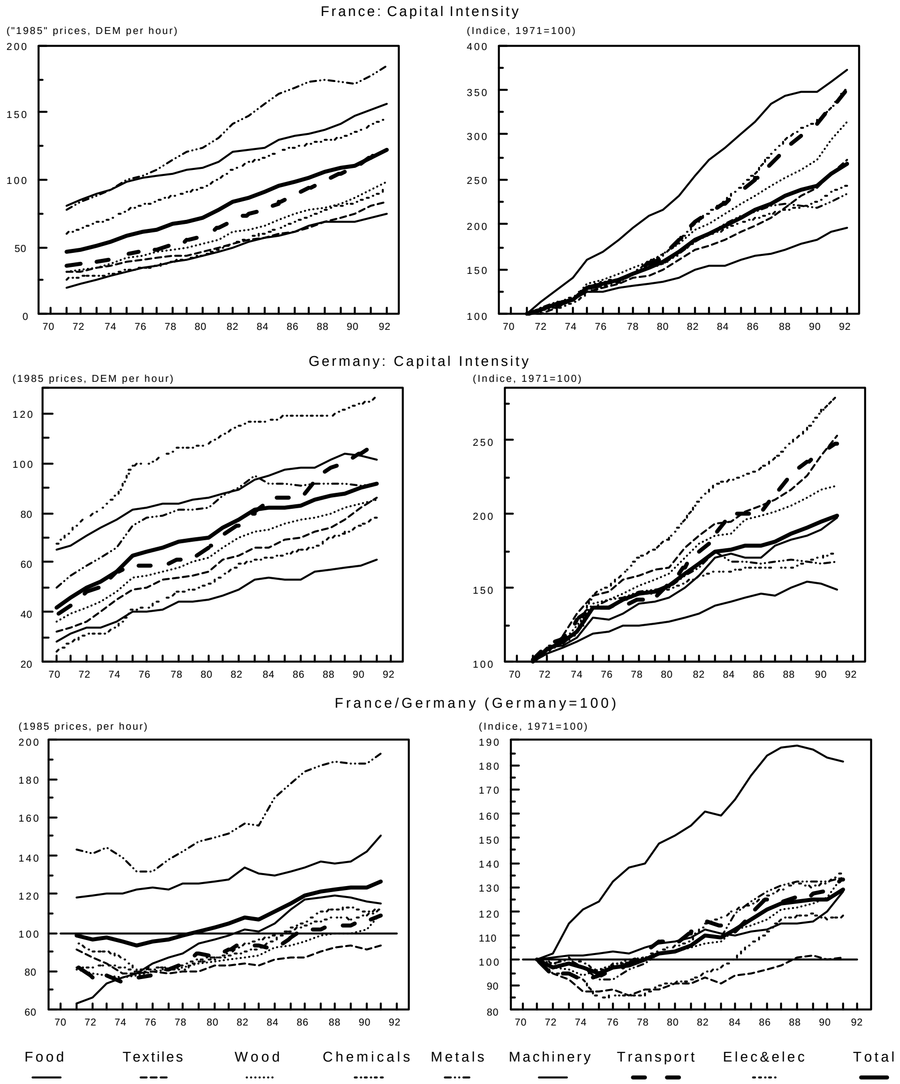
Sources: See Graph A-2.

Appendix 6
Evolution of Gross Fixed Capital Stock in Manufacturing, France and Germany



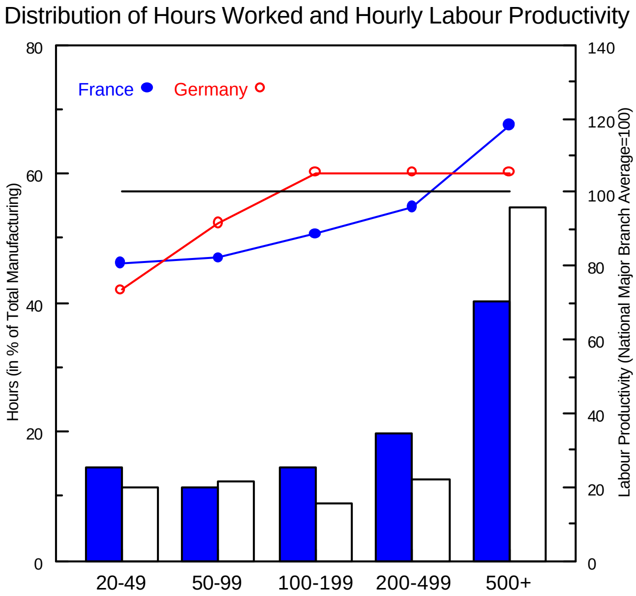
Sources: Information on employment and capital stock in national accounts is from INSEE, database 'NOUBA' and Statistisches Bundesamt, *Volkswirtschaftliche Gesamtrechnungen, Revidierte Ergebnisse, 1950 bis 1990*, with updates to 1992 kindly provided by Dr. Räth. The resulting capital intensity is applied to census employment figures from SESSI, *Enquête annuelle d'entreprise 1987*, SCEES, *Enquête annuelle d'entreprise 1987* and Statistisches Bundesamt, *Kostenstruktur der Unternehmen 1987*. PPPs for gross fixed capital formation from World Bank (1993).

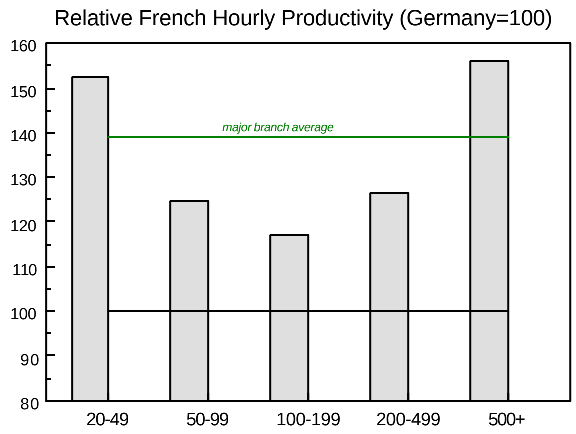
Appendix 7
Evolution of Capital Intensity in Manufacturing, France and Germany



Sources: Information on employment and capital stock in national accounts is from INSEE, database 'NOUBA' and Statistisches Bundesamt, *Volkswirtschaftliche Gesamtrechnungen, Revidierte Ergebnisse, 1950 bis 1990*, with updates to 1992 kindly provided by Dr. Räth. The resulting capital intensity is applied to census employment figures from SESSI, *Enquête annuelle d'entreprise 1987*, SCEES, *Enquête annuelle d'entreprise 1987* and Statistisches Bundesamt, *Kostenstruktur der Unternehmen 1987*. PPPs for gross fixed capital formation from World Bank (1993).

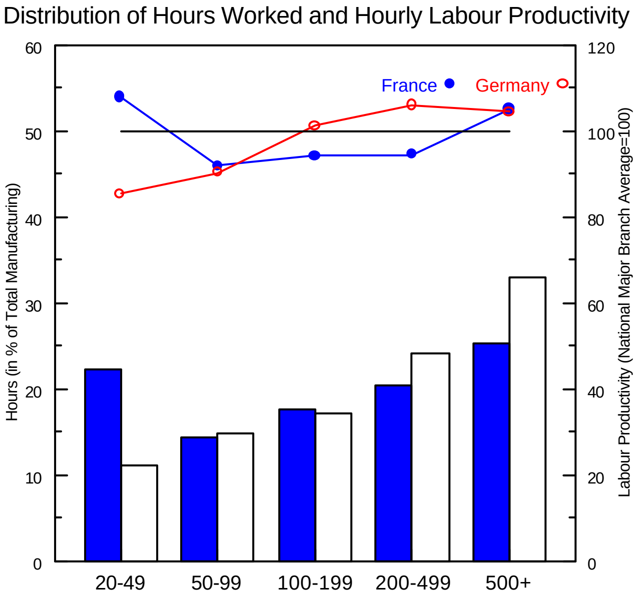
Appendix 8
Hourly Labour Productivity and Hours Worked by Firm Size for 'Food and Beverages', France and Germany, 1987

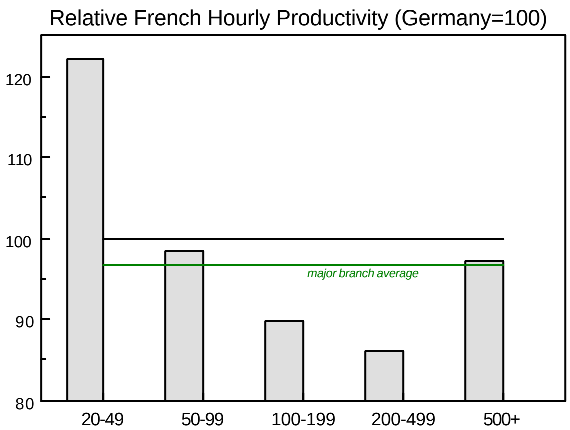




Sources: Information on employees is from SESSI, *Enquête annuelle d'entreprise 1987*, SCEES, *Enquête annuelle d'entreprise 1987* and Statistisches Bundesamt, *Kostenstruktur der Unternehmen 1987*, as well as INSEE, database 'NOUBA' and Statistisches Bundesamt, *Volkswirtschaftliche Gesamtrechnungen, Revidierte Ergebnisse, 1950 bis 1990*, with updates to 1992 kindly provided by Dr. Räth. Hours worked are from INSEE, database 'NOUBA' and H. Kohler and L. Reyher, *Arbeitszeit und Arbeitvolumen in der Bundesrepublik Deutschland : 1960-1990*, Institut für Arbeitsmarkt und Berufsforschung (IAB). Updates to 1992 kindly provided by H. Kohler. For UVRs used to convert value added, see Table 7.

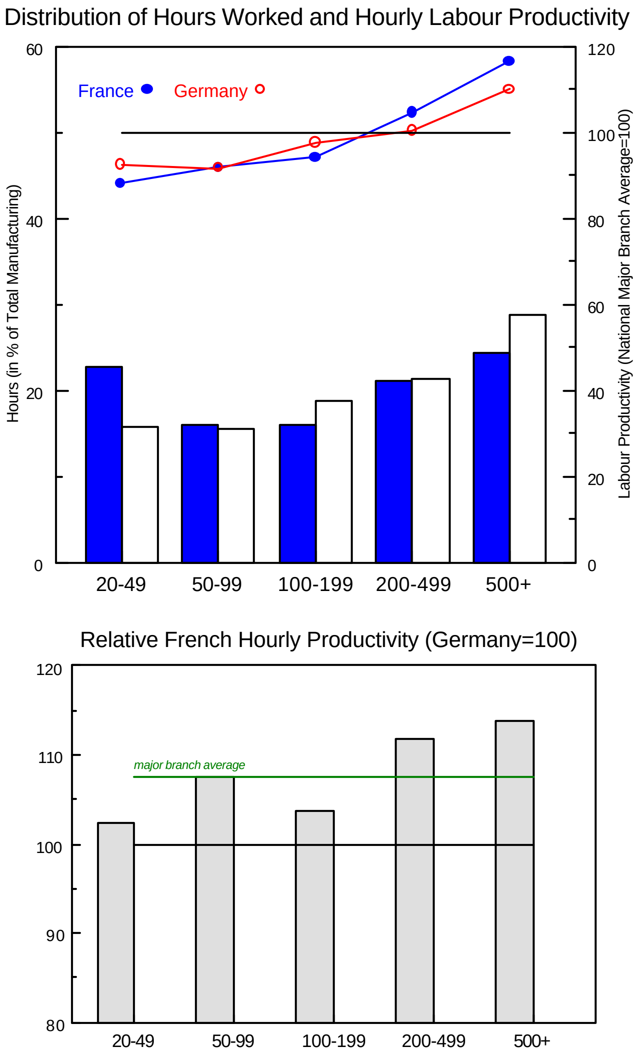
Appendix 9
Hourly Labour Productivity and Hours Worked by Firm Size for 'Textiles', France and Germany, 1987





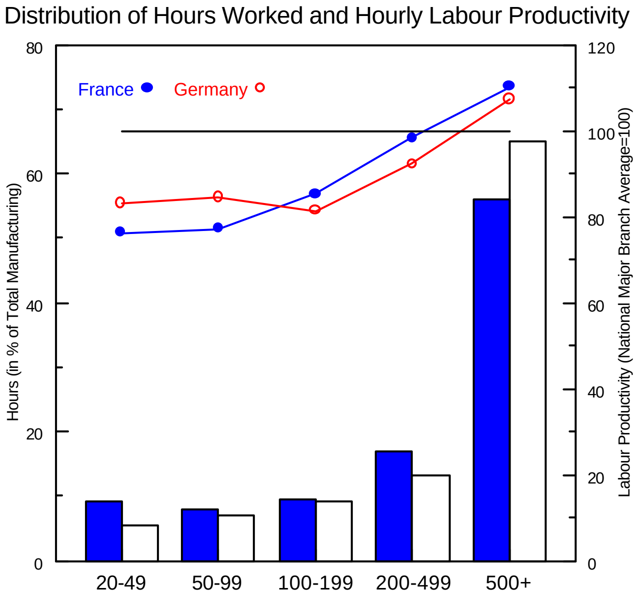
Sources: See Graph A-8.

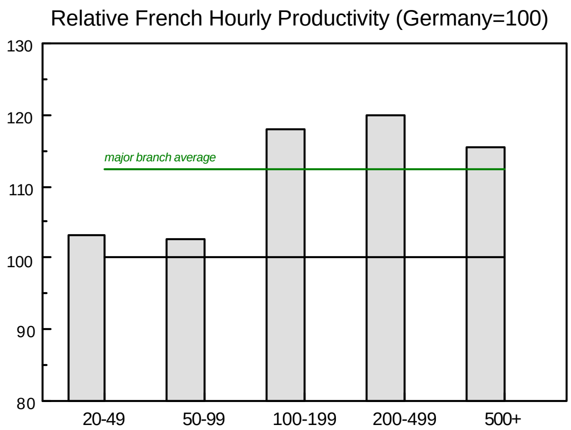
Appendix 10
Hourly Labour Productivity and Hours Worked by Firm Size for 'Wood', France and Germany, 1987



Sources: See Graph A-8.

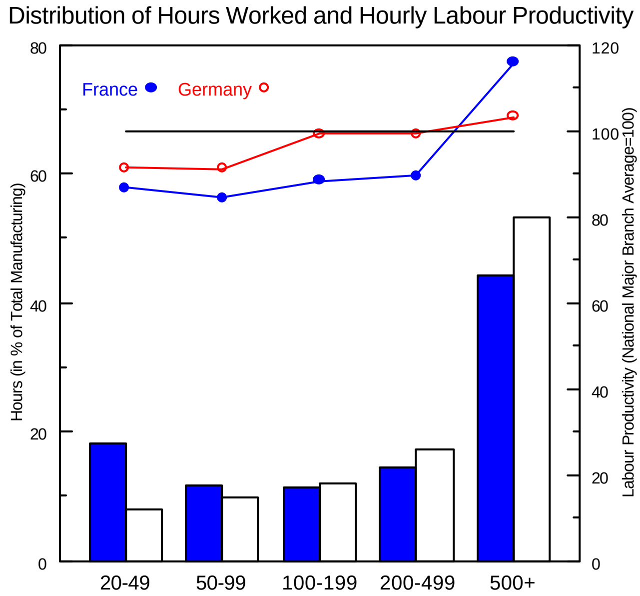
Appendix 11
Hourly Labour Productivity and Hours Worked by Firm Size for 'Chemicals', France and Germany, 1987

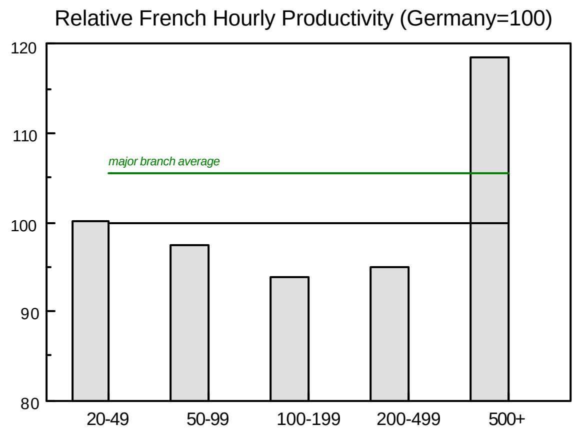




Sources: See Graph A-8.

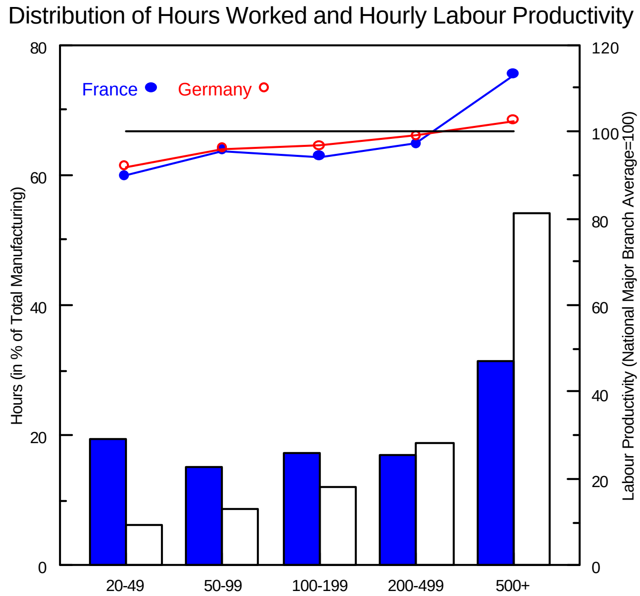
Appendix 12
Hourly Labour Productivity and Hours Worked by Firm Size for 'Metals', France and Germany, 1987

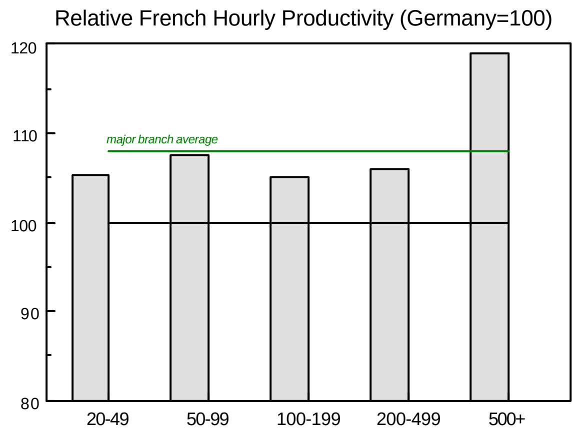




Sources: See Graph A-8.

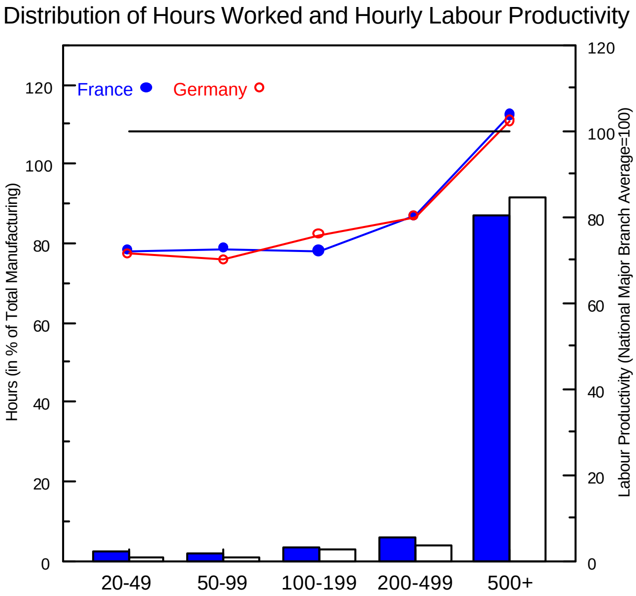
Appendix 13
Hourly Labour Productivity and Hours Worked by Firm Size for 'Machinery', France and Germany, 1987

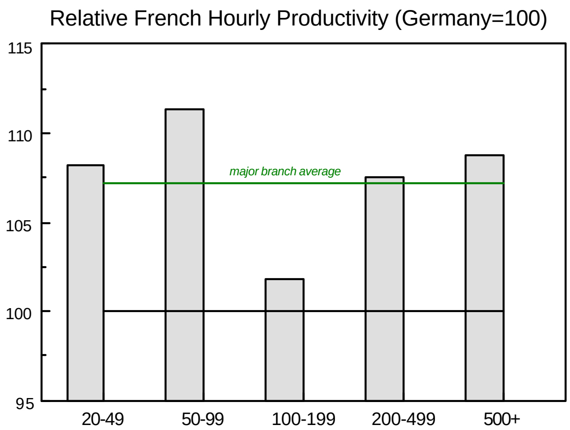




Sources: See Graph A-8.

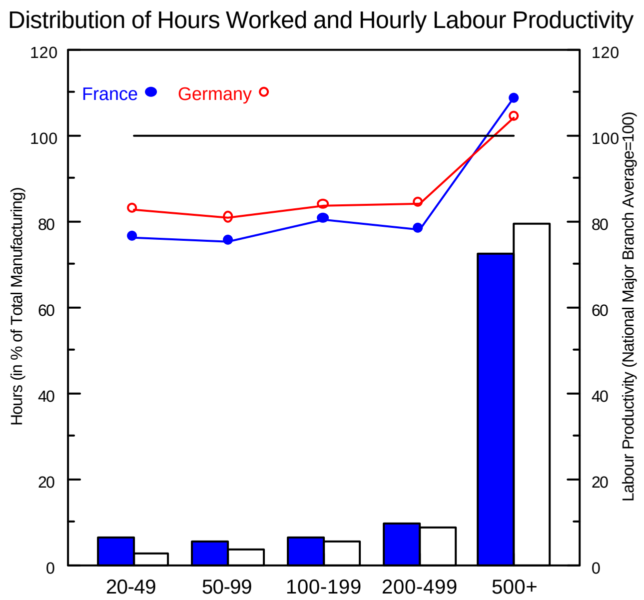
Appendix 14
Hourly Labour Productivity and Hours Worked by Firm Size for 'Transport', France and Germany, 1987

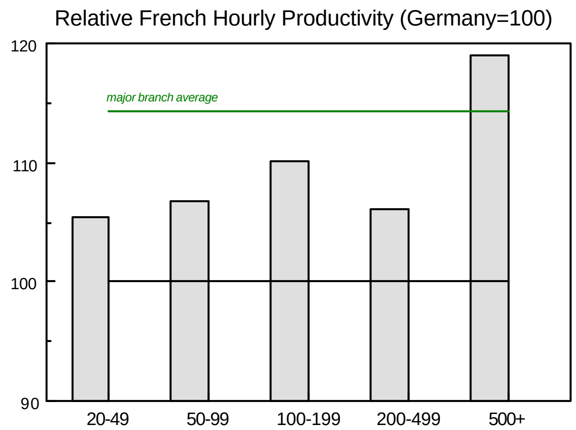




Sources: See Graph A-8.

Appendix 15
Labour Productivity and Hours Worked by Firm Size for 'Electrical', France and Germany, 1987





Sources: See Graph A-8.

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