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**Working Paper**

## Wages, prices, and international trade: Trends across industries for an "export champion"

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Diskussionsbeiträge



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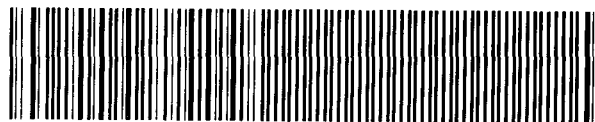
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Bernd Fitzenberger

**Wages, Prices, and International Trade**

Trends across Industries  
for an "Export Champion"

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# **Wages, Prices, and International Trade**

**Trends across Industries for an "Export Champion"**

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Serie II - Nr. 323

Oktober 1996

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# Wages, Prices, and International Trade

## Trends across Industries for an "Export Champion"

### Abstract

The recent economic policy debate in Germany emphasizes the impact of globalization of the world economy on the German labor market. This paper provides an empirical analysis of the relationship between trade and the labor market in West Germany for the period from 1970 until German reunification in 1990. Building on the emphasis of trade theory on relative output prices as the major transmission channel of trade effects on the labor market, the empirical analysis first develops a series of empirical regularities characterizing trends in trade, total factor productivity growth, and labor markets. Then building on Leamer (1996), a more structural analysis identifies empirically the qualitative effects of trade and total factor productivity growth.

The analysis allows for three skill types of labor. The major empirical findings are that, relative to skilled labor, wages were increasing disproportionately both for low- and high-skilled labor whereas employment trends were favoring higher skill levels monotonically. Import competition as well as total factor productivity were increasing disproportionately in those industries using low- or high-skilled labor-intensively. These results are consistent with trade effects dominating for low-skilled labor and technology effects for high-skilled labor. At the same time, the wage bargaining institutions were holding up relative wages of low-skilled labor which accounts for the disproportionate increase of unemployment for this group. The empirical analysis merges national account data for 49 industries with the "IAB-Beschäftigtenstichprobe", a 1% random sample from German social security accounts, which has become available only recently.

Keywords : International trade, industry data, wage structure, price structure,  
West Germany, total factor productivity

JEL-Classification : F1, J21, J31

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# 1 Introduction

*“Two important mistakes that we make when we analyze data are: (1) taking the theory too seriously, and (2) not taking the theory seriously enough.”*

Quoted from: Leamer (1996, p.8)

West Germany experienced a considerable trade surplus until 1990 and was viewed as an “export champion” by many commentators. Even though the trade surplus of unified Germany plummeted after 1990, it has been improving continuously since 1991. Nevertheless, the economic policy debate today views global competition as one of the great economic challenges for Germany.<sup>1</sup> Correspondingly, it is discussed intensively whether the high level of unemployment is due to the general wage level being too high and due to a lack of flexibility in the German wage structure caused by the prevailing wage bargaining system. In fact, many commentators consider the problem being aggravated by international competition from low-wage countries resulting in a loss of competitiveness of the German economy. Yet, until quite recently, there has been surprisingly little empirical evidence in Germany on wage trends, the actual flexibility of the wage structure, and the relation to trade while taking account of compositional effects.<sup>2</sup>

At an international level, a considerable increase in earnings inequality since the early 1980's has been observed for various industrial countries, the most prominent being the United States and the United Kingdom, see OECD (1993). Compared to developments in other countries, the latter study (based on a fairly small set of descriptive statistics) shows that West Germany exhibits an exceptionally stable wage structure since the mid 1980's. This perception motivated some of the recent empirical studies on the wage structure in West Germany and its flexibility. This paper is concerned with the effects of international trade on wage and employment trends across skill groups and industries for West Germany during the time period from 1970 until German reunification in 1990. West Germany provides a polar case to the developments in the United States (and various other industrialized countries) in at least two aspects. First, wage trends and wage bargaining institutions have been very different, and second, West Germany has been a trade surplus country.

As the conceptual basis for the empirical analysis, this paper takes the view of a classic Heckscher-Ohlin-Samuelson (HOS) model. In the HOS view, changes in product prices form the fundamental link between trade and labor markets, and it is mainly this link the empirical analysis in this paper is exploring. Of course, the HOS model requires a bulk of highly unrealistic assumptions, but the result that it is changes in prices of traded goods that matter for trade having an impact on factor prices proves quite robust in trade theory, cf. the discussion in Lawrence and Slaughter (1993, pp. 188–189), Richardson (1995), and Leamer (1996, section 1). It is this focus on relative prices as transmission channel from

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<sup>1</sup>The title of the last annual report of the German Council of Economic Experts was “Facing global competition”, cf. SVR (1995).

<sup>2</sup>Exceptions are Abraham and Houseman (1994) and OECD (1993) concerned with trends in wages across skill groups; Bellmann and Möller (1993) and DeNew and Schmidt (1994) concerned with trends in wages across industries; Möller and Bellmann (1995), and Möller (1996) concerned with trends in wages both across skill groups and across industries. Siebert (1995) forcefully demands more empirical research for Germany on wage structure issues and on the link between international competition and wages.

trade to factor markets that characterizes the approach favored by the majority of trade theorists and that differentiates this approach from quantity based approaches favored by some trade and labor economists.

Most quantity based approaches, so-called factor content studies, amount to analyze the labor market effects of trade by estimating the labor content of imports and adding this to the domestic labor supply. The impact on factor prices is then determined as a standard reaction to factor supply increases in (partial) labor market equilibrium, cf. Wood (1995) and Freeman (1995). Trade theorists have been very eager to criticize quantity based approaches on theoretical grounds, cf. Lawrence and Slaughter (1993) and Richardson (1995) among others. For instance, in the case of a small open economy, relative product prices are given by the world market and, given production technology, relative factor prices are only determined by relative product prices, irrespective of the volume of imports. Without going further into the controversies around factor content studies, I decided to use a HOS based approach since my goal was to obtain a general appraisal of trade effects on labor markets in West Germany without having to specify the “rest of the world”. Also, as a start, the HOS view seems to allow for a closer link between theoretical concepts and empirical work, cf. the quote from Leamer (1996) at the beginning of the introduction.

For the purpose of this paper, the classic HOS view has to be modified to gain empirical relevance regarding the following three issues. First, when there is (incomplete) specialization of countries to the production of different goods or when there are industry specific input factors, cf. among others Dixit and Norman (1980), Jones (1995), and Leamer (1996, section 1), some of the conclusions of HOS theory change. For instance, in a multi-commodity setting with different rankings of factor intensities across countries, one factor could actually gain in equilibrium even though the supply of this factor increases abroad. This example should be taken as a cautionary note against the simple argument that in the North-South context, the abundance of low-skilled labor in the South should necessarily lead to a deterioration of the relative wages of low-skilled labor in the North. It is still the case that in equilibrium an increase in import competition for an industry should result in a fall of its relative output price. With integrated factor markets, that should result into a decline of the relative factor price for the factor used intensively in that industry.

Second, when relative factor prices are rigid, i.e. not sufficiently responsive to the effects of output price changes on factor demand, the HOS view can be modified such that factor price rigidities result in unemployment of the factor which is used intensively in the industry whose relative product price declines. This is taken as a working assumption in this paper which appears to be quite common in the economic policy debate on trade effects in Europe. Factor price rigidities in trade models have been considered in the literature, cf. among others Dixit and Norman (1980, chapter 8.1) and Krugman (1995). Krugman’s treatment under the heading of a “European” model involves relative factor price rigidities.<sup>3</sup> As such, his approach appears broadly consistent with my working assumption. However, I see a fundamental problem in the feature of his model that rigid relative factor prices automatically translate into fixed relative output prices. I would argue that in a model with industry specific rents relative output price can change without relative factor prices changing, cf. Borjas and Ramey (1995), i.e. with increasing import competition in one industry the relative output price for this industry should decline implying decreasing industry specific rents. A rigorous

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<sup>3</sup>Building on Krugman (1995), Landmann and Pflüger (1996) provide a theoretical and empirical appraisal both of trade and technology effects on labor markets in OECD countries.



general (dis)equilibrium formulation of such a model is lacking which should take account of the stylized features of the West German wage bargaining system, cf. Franz (1994, chapters 7 and 8). Wage bargaining in Germany typically occurs at an industry level, with wage bargaining institutions (unions and employers' associations) organized along industry lines. Although only wage floors are set at the industry level, it is a common perception, that (effective) wage growth is fairly uniform across industries ("pattern bargaining").

Third, standard HOS theory assumes factor prices to be equal across industries. Empirically, wages differ systematically within and across industries among workers with exactly the same observable characteristics. Nevertheless, with a fixed relative inter-industry factor price structure in the long run,<sup>4</sup> trade effects are still likely to operate via relative output prices in an analogous way as in the standard model provided one appropriately takes account of between-industry employment shifts. An analogous defence holds with respect to the unobserved within industry distribution being fairly stable. However, the empirical analysis in this paper could be severely affected by unobservable shifts in the composition of the factor inputs across industries over time or by changes in industry specific rents, cf. Borjas and Ramey (1995). Such changes could very well be due to trade effects.

Analogous to the impact of trade, a controversial discussion has evolved around the effects of technology on the wage structure. The labor economics camp has been emphasizing the importance of skill biased technological change saving low-skilled labor, cf. among others Bound and Johnson (1992), Berman, Bound and Griliches (1994), and Möller (1996). Trade economists, cf. among others Richardson (1995, p. 41), are inclined to argue that only an industry bias in technological change has an impact on the wage structure in a HOS view, which is, however, only a first order result in general equilibrium, cf. Leamer (1996, section 3). To illustrate this point, it is helpful to analyze an example in the context of the classic Rybczynski effect. Assume in a HOS model that, given industry output prices (small country), the supply of one factor, say skilled labor, doubles. Then, in general equilibrium, the relative wage rates do not change. Now, instead of doubling the supply of one factor, the same effect can be obtained by doubling the efficiency unit of skilled labor (factor augmenting technical progress) but leaving the number of skilled workers unchanged. Now, in general equilibrium, the relative wage rates in efficiency units remain unchanged but the relative wage of a skilled worker (per capita) doubles. As a final note on this, industry bias and factor bias of technological change are basically observationally equivalent in the empirical approach taken by Leamer (1996, section 3) and latter in this paper, where technology trends are identified by total factor productivity growth based on a log-linear specification (Cobb-Douglas) of the production technology (Solow-residual).

The goal of this paper is to identify and disentangle trade and technology effects on relative wages for West Germany in the light of HOS theory. The fundamental working hypothesis is that changes in relative industry output prices encompass the effects of globalization, and therefore, the price effects should result into the respective Stolper-Samuelson (1941) effects on factor prices - or, alternatively, into unemployment of the factor whose relative factor price is prevented from falling. Concretely, the empirical analysis in this paper addresses the following sets of questions:

- How do relative factor intensities across industries relate to export and import performance and to changes in relative output prices?

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<sup>4</sup>There is some empirical evidence for this, cf. the seminal paper by Krueger and Summers (1988)

- Can relative factor price trends be related to relative factor intensities across industries and respective changes in relative output prices?
- Are there differential between- and within-industries shifts in factor intensities as a result of Stolper–Samuelson effects on factor prices?
- In case of relative factor price trends not being in accordance with Stolper–Samuelson effects, do factor employment trends correspond to the rigidity-in-relative-factor-prices story?
- Can biases in technological trends explain differential factor price and employment trends across input factors?
- Are industries which are not exposed to international trade shielded from trade effects?

To address these questions, this paper uses a dataset which combines national accounts data for industries with a micro dataset providing wage and employment information for different skill groups of labor across industries. The first part of the analysis consist of descriptive evidence on each of the aforementioned questions. The second part uses a more structural approach suggested by Leamer (1996, section 3) to disentangle trade and technology effects.

The major empirical findings are that, relative to skilled labor, wages were increasing disproportionately both for low- and high-skilled labor whereas employment trends were favoring higher skill levels monotonically. This is in contrast to the aforementioned results in OECD (1993), however, the estimated changes are small in international comparison. Import competition as well as total factor productivity were increasing disproportionately in those industries using low- or high-skilled labor-intensively. These results are consistent with trade effects dominating for low-skilled labor and technology effects for high-skilled labor. At the same time, the wage bargaining institutions were holding up relative wages of low-skilled labor which accounts for the disproportionate increase of unemployment for this group.

In the past, there has been some empirical research on labor market effects of trade in Germany, cf. among others Haisken–DeNew and Zimmermann (1995)<sup>5</sup> and Landmann and Pflüger (1996), but there is only little evidence explicitly based on the HOS view. For example, Lawrence (1994, pp. 18–19) contains a short cross-country comparison where he investigates the correlation between wholesale and import price changes and the ratio between manual (“Arbeiter”) and nonmanual (“Angestellte”) workers for Germany. He finds a positive relation between price changes and the manual–nonmanual ratio (significantly so only for wholesale prices) and no decline in the relative price of manual–worker-intensive products. But, without an analysis of wage and employment trends, this finding is not conclusive on whether trade effects were operating on the German labor market.

The remainder of this paper is organized as follows. Section 2 describes the data used in this paper. Building on a “light touch” of theory, section 3 develops a series of empirical regularities on the relationship between wages, prices, total factor productivity growth, and trade. Section 4 builds on a slightly more structural approach in order to estimate the

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<sup>5</sup>In their study for West Germany, Haisken–DeNew and Zimmermann find a negative impact of industry trade deficits (relative to industry value added) on wages. This analysis falls into the class of approaches criticized heavily by most trade economist who emphasize that relative output prices not quantities are the appropriate indicator of trade effects.

impact of trade and technology trends on factor remuneration rates. Section 5 concludes. The final appendix provides further information on the data set used, tables containing empirical results, and graphical illustrations.

## 2 Description of the Data

To study the relationship between wages, prices, and international trade, it is natural to use detailed industry data comprising wage and employment figures for different skill levels of labor. For the United States such data are available and widely used, cf. among others Berman, Bound, and Griliches (1994), Lawrence and Slaughter (1993), or Leamer (1996). For West Germany, I had to construct such a dataset building on national account data and on the IAB–BST dataset (“IAB–Beschäftigtenstichprobe”), a 1% random sample from German Social Security Accounts. Additional information was merged with these two main data sources. The analysis in this paper is restricted to the pre-unification situation for West Germany up to 1990. This section describes the most important features of the data used. Further details can be found in the appendix.

The national accounts provide data from 1970 to 1990 for former West Germany at the 2- and 3-digit industry level (58 industries in total). These data comprise information on value added, production (shipment) value, net capital stock, total employment, wage bill, exports, imports, and the respective price deflators. After 1990 export and import data are only available for unified Germany. I decided to work with the 49 industries given by the industry classification in the appendix and I consider 36 industries to produce tradable goods, i.e. industries whose final products are tradable. The table comprising the industry classification provides also information on which industries are traded-goods industries and which industries are subject to strong government market regulations (“regulated industries”). For my definition of a “regulated industry”, I only consider types of government regulations, where market access is strictly controlled or where subsidies are crucial for the industry to survive. The traded-goods industries mainly consist of the manufacturing industries (“Verarbeitendes Gewerbe”). Their share in total employment decreased from 48.7% in 1970, to 41.8% in 1980, and to 38.8% in 1990 corresponding to the well known trends for manufacturing.

Trade flow data in the national accounts are based on production (shipment) values of goods and services, i.e. export and import figures comprise value added as well as material inputs (“Vorleistungen”) of the respective industry. Therefore, the trade data do not correspond directly to production (value added) of the industry and the impact of trade is not restricted to industries classified as traded-goods industries.<sup>6</sup> The focus here is on the primary effects within the industry adding the final value to a product. However, for consistency, I define measures of trade exposure relative to production value of the respective industries, e.g. the export share of industry  $i$  is defined as  $EXP_{i,t}/PV_{i,t}$ .

The second data set, the IAB–BST, is merged with the industry data from the national

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<sup>6</sup>For a complete analysis of the impact of trade, an input–output approach is warranted. This is, however, beyond the scope of this paper. A more comprehensive analysis would be plagued by various data problems. First, input–output tables are not available for every year. And second, at the disaggregation level used in this paper, the Federal Statistical Office publishes only nominal material inputs and production values, but no price indices.

accounts since the latter only provide limited information on different skill types of labor.<sup>7</sup> The IAB–BST data set is based on the reporting system of the German social security system. It is a 1% random sample of all individual social security accounts during the years 1975 to 1990. The earnings data and other relevant information of each person paying contributions to the social security system are recorded over the entire life-cycle in order to calculate the individual pensions. The social security contributions are mandatory for employees who earn more than a minimum threshold and who are working regularly. The main exemption are civil servants who do not pay social security taxes at all. Further exclusions from the mandatory contributions are students who work less than 20 hours a week on a regular basis or less than 6 weeks full-time. About 80 percent of the German employees are covered by this mandatory pension system.

Based on the IAB–BST data, I define the following three skill groups of workers

- (A) without a vocational training degree (low-skilled)
- (B) with a vocational training degree (skilled)
- (C) with a technical college (“Fachhochschule”) or university degree (high-skilled)

and for these, I calculate median wages and employment shares in each industry and year. In 1975, the estimated employment shares (see appendix for details) were 32.2% for (A), 64.2% for (B), and 3.7% for (C). For 1990, these shares changed to 15.7% for (A), 76.6% for (B), and 7.7% for (C).

A major limitation of the IAB–BST dataset is the fact that over time until 1984 the income components being subject to the social security tax were extended, cf. Bender et al. (1996, p. 15). In particular, in 1984, one-time payments to the employee were made taxable whereas before there had existed some discretion on this.<sup>8</sup> As a quick-and-dirty solution, I corrected the wage observations after 1983 by dividing through by a factor for each industry and skill group such that 1984 wage growth for each skill group corresponds to the average industry wage growth obtained from the national accounts, thus, for the year 1984 wage structure trends across skill groups are effectively taken out of the data.

### 3 Descriptive Evidence on Wages, Prices, Total Factor Productivity, and International Trade

This section provides some descriptive evidence on wages, prices, total factor productivity, and international trade. As the basic conception to analyze the data, I take a classic Heckscher–Ohlin–Samuelson (HOS) approach as described in Lawrence and Slaughter (1993,

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<sup>7</sup>Mainly for manufacturing industries, separate data for manual (blue collar, “Arbeiter”) and nonmanual (white collar, “Angestellte”) employees is available after 1977. I decided to use the IAB–BST instead, since it allows for a clearer definition of skill types by formal education and offers the potential for a more detailed analysis in further research. Even though “Angestellte” generally exhibit a higher skill level compared to “Arbeiter”, this distinction is problematic when the analysis is not restricted to manufacturing. In particular, in some service-industries many jobs requiring only low skills are performed by “Angestellte” who most likely would be “Arbeiter” if they were (still) working in manufacturing.

<sup>8</sup>Only after the first version of this paper had been written, this problem was pointed out by Viktor Steiner.

pp. 188–189) or Leamer (1996, section 1). However, this view has to be complemented by the existence of (involuntary) unemployment, cf. Krugman (1995) and Landmann and Pflüger (1996). The working hypothesis used here is that, when a shock (trade, technology) would cause relative wages to decline in equilibrium, keeping up the relative wage of one type of labor at a higher level would result in unemployment of this type of labor.

The focus of this paper is to identify links between trade and labor market trends in West Germany as opposed to other driving forces of labor market developments, such as technical progress. As the first part of the empirical analysis in this paper, this section identifies a series of empirical regularities concerning comovements between different variables which would be considered as endogenous within a complete structural model. As described in section 1, a HOS view has certain implications on comovements between endogenous variables in the face of certain shocks. Without estimating a complete structural model, the empirical analysis in section 4 builds on a tighter link between theoretical arguments and empirical specifications.

To get the general picture, section 3.1 presents economy-wide trends, whereas section 3.2 contains the main part of the analysis which is concerned with trends across industries. A first summary and interpretation of the descriptive evidence in this section is given in section 3.3. The results discussed in this section refer to the tables and figures presented in the appendix.

### 3.1 Aggregate Trends

#### Trade Exposure and Prices

Figure 1 depicts trends in trade exposure for West Germany from 1970 to 1990. Aggregate trade exposure (exports plus imports relative to aggregate value added) increases steadily from 39% in 1970 to 60% in 1985 and then swings back to 55% in 1990. West Germany always experienced a trade surplus which, however, exhibits a considerable cyclical behavior. From about 2.5% of aggregate value added in 1970 the trade surplus increases to about 6% in 1974, then decreases to 1% in 1980, and then increases again to about 6% in 1986. Afterwards, the trade surplus remains at this level until 1990.

Figure 2 exhibits export and import deflators relative to the aggregate producer price index (PPI – Deflator of aggregate Value Added) as well as trends in the terms of trade based on the ratio of the export and import deflators. Import Prices exhibit an upward trend relative to export prices and the PPI until about 1985. After 1985 export and import prices decrease relative to the aggregate PPI.<sup>9</sup> Terms of trade deteriorate until 1981, remain constant until 1985, and then improve again afterwards. Despite the considerable trade surplus, the considerable decline of import prices in the late 1980's and early 1990's corresponds to the common perception of greater import competition. Export prices appear to follow import prices suggesting that West German products are sold abroad for cheaper than in Germany. The changes in the trend behavior of the trade surplus in 1980 and 1986 is conspicuously associated with opposite changes in the terms of trade and might be related to the US-dollar cycle. This is not true for the change around 1975.

**Empirical Regularity 1:** *West Germany experiences a considerable trade surplus until 1990. Its peak is at about 6% of aggregate value added in 1975 and during the period from*

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<sup>9</sup>It could be suspected that import price trends are mainly driven by the prices for raw materials. However, it will be seen later that on average these findings hold up for the traded-goods industries.

1985 until 1990. It shows a trough in 1980 at about 1% and the trend changes around 1980 and 1985, respectively, are associated with a considerable drop and increase in the terms of trade, respectively. Import prices and export prices relative to the aggregate PPI decrease considerably after 1985, with export prices apparently following import prices.

### Wages and Employment Across Skill Groups

Figure 4 depicts (corrected)<sup>10</sup> aggregate real wages for all employees from 1970 to 1990 and for the three skill groups from 1975 to 1990. Employees in Germany experienced considerable wage growth from 1970 until 1980 and then from 1985 onwards. During the period from 1980 to 1985 real wages appear to be stagnating. After 1985 consumer wages were increasing at a higher rate than aggregate product wages, corresponding to the considerable fall in import prices. Wage trends across skill groups exhibit a U-shaped behavior. Wages for both low-skilled (A) and high-skilled labor (C) improved relative to skilled labor (B). Figures 5 and 6 show the (un)employment side of the labor market trends. Aggregate unemployment was increasing around 1975 and from 1980 to 1983, and did not decrease considerably after these recessions (persistence) even though aggregate employment was increasing steadily.

The aggregate trends hide considerable differences across skill groups. Relative unemployment rates of (A) was increasing considerably after 1975 until 1984, whereas unemployment of (B) and (C) remains lower than the aggregate figure with the relative unemployment experience of (C) improving slightly during the course of the 1980's. Employment trends differ even more. Employment of (C) almost doubled from 1975 to 1990 whereas employment of (A) decreased by almost 50%. Again trends for (B) are in between.

These labor market trends are consistent with a skill bias in labor demand in addition to wages bargaining between unions and employers' associations providing mostly binding floors for wages for (A). These wage floors were preventing (A)'s relative wage to fall, thus resulting in the severe increase of unemployment and reduction of employment in this group in the face of a considerable reduction of the labor supply of (A), cf. also Möller (1996) on this interpretation. Conventional accounts of wage trends across skill types in West Germany, cf. Abraham and Houseman (1994) and OECD (1993), do not find the trends reported here. Relative unemployment trends in Germany are often associated to the rigid wage structure translating the skill bias in labor demand into high unemployment of low-skilled labor instead of a decline in relative wages, as it is the stylized picture for the United States, cf. Freeman (1995), Krugman (1995), and Landmann and Pflüger (1996).

The two popular candidates in the U.S. literature explaining the skill bias in labor demand trends are (skill) biased trends in technical progress, cf. Bound and Johnson (1993) for the U.S. and Möller (1996) for Germany, and effects from international trade (globalization). However, based on aggregate numbers for West Germany from 1975 to 1990, for an argument emphasizing the impact of trade to be convincing, this would have to be reconciled with the observations that, in general, West Germany experienced a considerable trade surplus and that, in particular, labor market prospects for low-skilled workers deteriorated most during the period from 1975 to 1985 i.e. both at a time when the trade surplus was deteriorating and at a time when it was improving.

**Empirical Regularity 2:** *Real Wages in West Germany rise steadily from 1970 to 1980 and from 1985 onwards. They are stagnate from 1980 to 1985. Relative wage trends across skill*

<sup>10</sup>Cf. section 2 and appendix A.1 for the correction on skill specific wage trends in 1984.

types exhibit a U-shape behavior. Both wages of low-skilled and high-skilled labor increase relative to skilled labor. Relative employment trends are positively and relative unemployment trends negatively related to the skill level.

### 3.2 Trends across Industries

#### Relative Factor Usage and International Trade

In order to address the question, whether trade has an impact on labor market trends in West Germany, it is important to know whether exports and imports across industries differ by their relative use of different factors. A simple measure for qualitative differences in relative factor usage can be obtained by calculating weighted averages of (trends in) export shares, import shares, trade exposure, and trade surplus across traded-goods industries using the different factor inputs as weights. Such a weighted average is higher if and only if the respective trade measure on average exhibits higher values in industries using the respective factor intensively.<sup>11</sup>

Table 1 in the appendix provides weighted statistics for the two years 1970 and 1990. For instance, in 1970 the weighted average of export shares was 0.146 based on capital input as weights and 0.220 based on employment of high-skilled labor (C) as weights. Thus, capital-intensive industries exhibit lower export shares compared to (C)-intensive industries. Table 1 shows that both for 1970 and 1990 trade exposure is similar for capital and total labor but that labor-intensive industries exhibit a trade surplus in contrast to capital-intensive industries. Among the three skill types of labor, the trade exposure exhibits a U-shaped pattern whereas the trade surplus increases monotonically with the skill level. Trade exposure and the differences in trade surplus across skill groups of labor increase over time.

**Empirical Regularity 3:** *West Germany's exports exhibit a higher ratio of labor to capital than its imports and trade exposure increases more strongly for labor-intensive industries. Among the different skill groups trade exposure exhibits a U-shaped behavior being higher both for low-skilled and high-skilled labor. However, the higher the skill level of labor used intensively, the higher is the trade surplus. The latter effect becomes more pronounced over time.*

These findings indicate that West Germany enjoys a comparative advantage in human-capital-intensive production and a comparative disadvantage in capital-intensive production. Despite a significant increase in trade exposure, this comparative advantage has not changed from 1970 to 1990, except for a slight but noticeable deterioration of the relative trade surplus and an increase in the relative trade exposure of (A)-intensive industries. This evidence is consistent with an disproportionate increase in import competition for (A)-intensive industries.

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<sup>11</sup>To give a simple example, take an economy with two industries and let  $g_{i,j}$  be the share of factor  $j \in \{L, K\}$  (capital and labor) employed in industry  $i = 1, 2$  with  $g_{1,j} + g_{2,j} = 1$ . If  $x_i$  is the industry characteristic of interest, then  $g_{1,L} \cdot x_1 + g_{2,L} \cdot x_2 > g_{1,K} \cdot x_1 + g_{2,K} \cdot x_2$  implies that  $x_i$  is larger in the labor-intensive industry.

## Product, Export, and Import Prices across Traded-Goods-Industries

In the HOS view, relative product price changes are the central channel through which trade can exert an influence on domestic labor markets. Therefore, to evaluate the importance of trade effects, it is necessary to analyze how price trends are related to factor inputs. Since industry exports and imports are not measured in value added terms and since exports and imports are not the same kind of goods (intra-industry trade), table 2 in the appendix presents separate output, export and import price trends for the traded-goods industries. Between 1970 and 1980, and after 1985, all three price indices were decreasing relative to the aggregate. Export prices were following output prices fairly closely until 1985 and were declining relative to output prices after 1985. Import prices were decreasing relative to output prices until 1975 but almost caught up again until 1985. After 1985, export and import prices were strongly decreasing relative to industry output prices with the relative decline being about twice as large for import prices compared to export prices. The relative price declines apparently occurred almost entirely within industries, with some indication that between industries the employment share was increasing for those industries who were experiencing a comparatively large price decline.<sup>12</sup> These results are confirmed by a formal between-within decomposition of the overall price declines (not reported here).

Table 3 provides weighted means and standard deviations of output, export, and import price changes relative to the aggregate PPI between 1970 or 1975 and 1990, respectively. The changes are weighted by industry capital or labor input. Output prices decreased on average less than export or import prices irrespective of which input factor is used intensively. At the same time the standard deviation of output price changes is uniformly higher than for export and import prices. Overall the standard deviations are of the same order of magnitude as the relative changes in the price ratios indicating a considerable variability of price changes across industries. Relating price changes to factor input intensities across industries, it is evident that price changes were relatively unfavorable for capital-intensive industries. Among the different skill types of labor, one again finds a U-shaped behavior. Both (A)- and (C)-intensive industries experienced stronger relative price declines than (B)-intensive industries.<sup>13</sup> Contrasting export and import price changes, both capital-intensive and labor-intensive industries experienced a stronger relative import price decline from 1970 to 1990, the difference being greater for labor-intensive industries. However, from 1975 to 1990 the change was of similar magnitude for industries using some type of labor intensively and for capital-intensive industries relative export prices declined stronger from 1975 to 1990.

**Empirical Regularity 4:** *Output, export, and import prices in the traded-goods industries are on average declining relative to the deflator of aggregate value added. The decline is strongest for import prices, followed by export prices, and then followed by industry output prices. Average price changes are only to a very small extent associated with employment changes across industries. However, price changes differ considerably across industries, and in particular, price declines are stronger in capital-intensive industries. Among the three*

<sup>12</sup>Here and in the following, such a statement is based on the estimated trends not being very sensitive to whether industry dummies are included.

<sup>13</sup>This result provides a new interpretation of the results in Lawrence (1994) for Germany who finds that wholesale and import price changes were positively related to the ratio between manual ("Arbeiter") and nonmanual ("Angestellte") workers. Since typically manual workers are either of skill type (A) or (B) and nonmanual worker are either of skill type (B) or (C), the dominance of the (C) effect appears to drive Lawrence's result.



*skill groups, one finds a U-shaped profile of price declines being stronger both for industries using low- or high-skilled labor intensively.*

### Wages across Traded-Goods Industries

Average wage trends across industries are presented in table 4 in the appendix. Average wages relative to the deflator of aggregate value added (PPI) grew considerably from 1970 to 1990. Real wage growth was higher in the 1970's than in the 1980's and accelerated slightly in the second half of the 1980's. With respect to the three skill types, the U-shaped behavior found above is even more noticeable here. Wage increases were highest for high-skilled workers (C), followed by low-skilled workers (A), and with skilled workers (B) experiencing the smallest wage increases. The growth of product wages (relative to the deflator of industry value added) was higher than with respect to the deflator of the aggregate value added. Contrasting average wage growth to within industry changes indicates that high-wage industries for (A) and (B) were slightly increasing their employment share. From 1975 to 1990, the growth of wages averaged across skill groups was considerably higher than wage growth within all skill groups, reflecting the shift towards higher skill levels in employment. Thus, aggregate wage growth appears to be quite a misleading measure of compensation per efficiency unit of labor.

Table 5 provides weighted averages and standard deviations of wage changes over time across industries. In relation to average wage growth, the standard deviation across industries is fairly low. Thus, in comparison to relative price changes, wage trends are more uniform across industries since the absolute level of the standard deviation of relative wage changes is about half the size for the price changes. Table 5 further shows that wage growth was lower in capital-intensive industries, and with respect to the three skill groups, one finds the, by now, familiar U-shaped behavior across skill groups both in the wage and the employment dimension (except for  $W(B)_{it}$  across employment of different skill groups). Considering wage growth within the three skill groups, an interesting pattern emerges. Wage growth for all three skill groups is a positive function of the skill level the industry is using intensively (except for the small opposite effect for  $W(A)_{it}$  contrasting weighting by  $L(A)_{it}$  and  $L(B)_{it}$ ), i.e. wage growth for all workers (!) seems to be positively related to a larger share of workers with higher skills. This is consistent with a higher skill level generating more industry specific rents that are shared by all factor inputs. Also, the standard deviations of wage growth increase considerably with the skill level. For (C) the standard deviations are between three and four times higher than for (A) and about two times higher than for (B). The latter is consistent with a view that wage bargaining pushes up wages at the bottom of the distribution fairly uniformly across industries whereas wage trends in the upper part of the distribution depend to a large extent on the specific industry (rent sharing?).

**Empirical Regularity 5:** *Within the traded-goods industries, real wages are increasing steadily for all skill groups following the same U-shaped pattern in skills as for the aggregate figures. The growth of wages relative to industry output prices is higher than relative to the deflator of aggregate value added. Between industry changes in employment are slightly in favor of high wage industries. Wage growth is generally higher in labor-intensive industries and, particularly, almost uniformly higher across skill types the higher the relative usage of (high-) skilled labor.*

## Factor Input Ratios across Traded-Goods-Industries

Trends in relative factor input are presented in table 6. In my interpretation, I assume that the utilization rate of capital and of employed labor is constant over time. The capital-labor ratio is found to increase over time which appears to occur entirely within industries. The results on aggregate trends for the ratios between the three skill groups reported above are confirmed here for the traded-goods industries. The ratio of low-skilled workers (A) decreases relative to skilled workers (B) and the ratio of high-skilled workers (C) increases relative to (B). Again most of the changes occur within industries. Trends in capital intensities across skill groups differ considerably. Whereas the ratio between capital and (A) increases, the ratio stagnates for (B), and actually declines for (C).

The results discussed so far on between and within industry effects are confirmed by formal decompositions of the changes in factor input ratios in between and within effects (not reported here). In the HOS view, as pointed out by Lawrence and Slaughter (1993) and Lawrence (1994), product price changes resulting into changes in relative factor remuneration rates lead to differential between and within industry changes of factor employment. If product price changes are favorable for industries using one factor, let us say (C), intensively, then these industries will increase their overall employment share and at the same time, substitution of (C) by other factors would occur within these industries due to its relatively higher wage rate. Apparently, this did not happen (C).

**Empirical Regularity 6:** *Industry employment of low-skilled labor relative to skilled labor decreases and employment of high-skilled labor increases relative to skilled labor. The capital labor ratio exhibits an upward trend which is related to the relative decline in employment of low-skilled labor. Capital input relative to skilled labor remains fairly constant and decreases considerably relative to high-skilled labor. Almost all of the changes are within industry, but between industries, there is a tendency for declining employment shares of those industries exhibiting a large ratio of capital relative to high-skilled labor.*

## Factor Shares Across Traded-Goods Industries

Table 4 provides trends in factor shares across industries. As long as the elasticity of substitution between factors is above one, changes in the factor shares provide a better measure of a potential bias in factor demand trends compared to raw factor input measures, cf. Berman et al. (1994, p. 371). The elasticity of substitution between different types of skilled labor is likely to be above one, cf. Hamermesh (1993) and Möller (1996). Also based on the IAB-BST data, Möller estimates substitution elasticities between the skill groups (A), (B), and (C) to lie above one. On the other end, the elasticity of substitution between capital and total labor input is likely to be below one, cf. Hamermesh (1993) and Deutsche Bundesbank (1995).<sup>14</sup>

The results in table 4 show that labor's share was increasing until 1980 and then declining during the 1980's. In 1990, labor's share was still on average around 6% percentage points higher than in 1970. Among the three skill types of labor, low-skilled labor (A) lost considerably, whereas both skilled (B) and high-skilled (C) labor experienced an increase in

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<sup>14</sup>Deutsche Bundesbank (1995) estimates an aggregate CES production function for Germany using capital and total hours as inputs for which the estimated elasticity of substitution between capital and labor amounts to 0.8.

their share. Since employment of (C) is considerably smaller than that of (B), the relative change for (C) is much larger than for (B). Contrasting overall changes to within industry changes, there is some evidence of between industry effects confirmed by a formal decomposition which is omitted here. Industries with a high total labor share experienced a decline of their employment share. The same is true for industries where (A) has a particularly high share in the total wage bill, whereas employment shares were increasing slightly for industries where the shares of skilled or high-skilled labor were particularly large. Overall, these results suggest a strong skill bias in labor demand trends towards labor with higher skills since, in particular, (A) was experiencing a decrease in its share in the total wage bill despite an increase in its relative wage. Assuming an elasticity of substitution between capital and total labor below one, the findings for capital's share remain ambiguous with respect to the direction of shocks to labor demand.

**Empirical Regularity 7:** *Relative to capital, total labor experiences an increase in its factor share during the 1970's and a decrease over the 1980's. Among the three skill types, the share of low-skilled labor in the industry wage bill decreases considerably, whereas both skilled and high-skilled labor experience an increase. Compared to total labor on average, industries with relatively high capital shares, and with relatively high shares in skilled or high-skilled labor are increasing their employment shares.*

### Total Factor Productivity Growth Across Traded-Goods Industries

In addition to trade effects, biased technological change is a prominent factor for explaining the labor market outcome during the 1970's and 1980's for various industrial countries. An intensive debate has evolved about discriminating between trade versus technology effects on labor market. Many trade economists emphasize industry bias of technological progress as the main requirement for technological change to exhibit an impact on factor price ratios in long run equilibrium situations. Labor economists have often emphasized skill bias in technological change (in the form of augmenting the efficiency units of one input factor) as a major driving force for changes in factor prices. As argued in section 1, I find this difference to be of limited help, one reason being that skill biased technological progress automatically translates into a industry bias since different industries generally exhibit different factor intensities.

Following e.g. Leamer (1996, p. 23), I use a standard approach to obtain total factor productivity trends for each industry as the so-called Solow-residual. Whether differences in these trends reflect industry or factor biases remains unidentifiable without a tight structural approach to the estimation of the production technology. Total factor productivity (TFP) growth (logarithmic change)<sup>15</sup> is calculated as

$$\Delta t f p_i = \Delta y_i - \theta_K \Delta k_i - \theta_L \Delta l_i$$

when I refer to total labor and as

$$\Delta t f p_i = \Delta y_i - \theta_K \Delta k_i - \theta_A \Delta l(a)_i - \theta_B \Delta l(b)_i - \theta_C \Delta l(c)_i$$

<sup>15</sup> Alternatively, one could use more direct measures on technology trends such as R&D expenditures, patents or computer usage, cf. Machin et al. (1996).

when labor is disaggregated into three skill groups. Total factor productivity growth is assumed to be restricted to value added in the industry, cf. Leamer (1996) for a discussion involving material inputs. The  $\theta$ 's represent the factor remuneration shares in value added.

Table 7 and 8 in the appendix present some basic facts on total productivity growth. TFP grows steadily from 1970/1975 to 1990. Basically all estimated growth occurs within industries in the sense that trends in total employment shares were not systematically related to TFP growth. However, using beginning versus end of period factor shares and basing TFP on total labor solely versus on basing it on the three skill groups changes the numbers considerably. TFP growth appears higher with 1990 shares compared to 1970 shares when the measure refers to total labor whereas growth is considerably lower with 1990 shares compared to 1975 shares when three skill groups are used. These differences are somewhat disconcerting since it is not a priori clear which weights should be used to obtain the most reliable TFP measure. Table 8 provides means and standard deviations of TFP growth over the entire period weighted by various factor inputs. Irrespective of the period for which factor shares are taken, TFP growth on average was consistently higher in capital-intensive industries compared to industries using total labor-intensively. Among the three skill types, one finds again a U-shaped pattern. Both (A)- and (C)-intensive industries were experiencing a consistently higher TFP growth compared to (B)-intensive industries, with overall TFP growth being highest in (C)-intensive industries. The standard deviation of changes across industries was fairly similar for different factor intensities (slightly above 6% for the period 1970 to 1990 and around 4.5% for the period 1975 to 1990) except for (C)-industries industries for which the standard deviation was consistently higher (for the period 1975 to 1990).

**Empirical Regularity 8:** *The traded-goods industries experience steady total factor productivity (TFP) growth for the period 1970 to 1990. TFP growth is not consistently related to changes in employment shares across industries. There are considerable differences across factor input types. TFP growth is higher in capital-intensive industries as compared to industries using total labor input rather intensively. Differentiating between the three skill types of labor, a U-shaped pattern emerges with TFP growth being higher both for low- and high-skilled-labor-intensive industries, with overall TFP growth being highest in industries using high-skilled labor intensively.*

### Non-Traded-Goods Industries and Industries Subject to Governmental Regulations

Non-traded-goods industries are not directly (or to a lesser extent) exposed to foreign competition compared to traded-goods industries, cf. Freeman (1995). The validity of this claim depends upon to what extent non-traded goods are used as inputs for the production of traded goods, factor markets for traded and non-traded goods are integrated, and income effects of trade result in demand shifts. It is therefore of interest whether workers in non-traded-goods industries are shielded from trade effects, or whether trade effects also operate in the non-traded-goods industries. It is difficult to evaluate employment trends by themselves. The employment share of non-traded goods industries was increasing over time which could imply that the non-traded industries absorbed workers from traded-goods industries. This could be due to higher import competition but it could also be due to a shift in preferences shielding the economy more from trade. Considering wage bargaining,

it appears likely that wage-setters in non-traded-goods industries face less of a restraint in setting higher wages (shielding hypothesis). But, at the same time, union density (bargaining power?) is generally lower in non-traded-goods industries. Finally, also price setter should feel less of a restraint to increase prices in the non-traded-goods industries.

Contrasting the wage effects in table 9 with trends for traded-goods industries in table 4 reveals that until 1975 wage growth was similar on average, but after 1975 wage growth was actually considerably smaller in the non-traded goods industries for all skill groups. Regarding product wages the differences are even larger since output prices in non-traded goods industries grew considerably relative to traded-goods industries. Thus, prices rather than wages appear consistent with the aforementioned shielding hypothesis. However, for the government sector, price measures cannot be interpreted in the same way as for the private sector, and it does not seem advisable to calculate total factor productivities since value added is defined as the sum of factor remunerations.

It might not seem advisable to evaluate the economic outcome of purely private industries and industries subject to governmental regulations in the same way, and it could be argued, even more so than for the non-traded-goods industries, that competitive pressures on wages due to global competition are severely reduced due to government activities (shielding hypothesis). Table 10 in the appendix provides the estimated time trends in wages for regulated industries. Again, wage growth is about the same until 1975 but it is on average even lower after 1975 compared to the set of non-traded-goods industries.

Similar to traded-goods industries, one finds the U-shape pattern in wage trends across skill groups with (B) experiencing the lowest wage increases, both for the non-traded-goods and the regulated industries. But in contrast to the traded-goods industries, there is a slight between-industry-shift away from industries with high wages, in particular for (A) and (B). Finally, the trends in factor input ratios for the three skill types are similar to the traded-goods industries with within-industry employment trends being positively related to the skill level. These results are omitted here but available upon request.

**Empirical Regularity 9:** *The non-traded-goods industries experience lower wage growth and higher growth in output prices compared to the traded-goods industries. Relative employment trends within non-traded-goods industries are positively related to the skill level. Also, wage growth is uniformly lower in regulated industries compared both to non-traded-goods industries as well as to traded-goods industries.*

### 3.3 Summary and Interpretation

Can the puzzle of empirical regularities 1 to 9 be put together to yield a consistent stylized economic interpretation? Trade exposure was increasing steadily and trade exposure was higher for industries using low- or high-skilled labor intensively whereas the difference in trade exposure between capital and total labor was fairly small. The trade surplus, however, is positively related to the skill level of labor whereas capital-intensive industries were experiencing a trade deficit (a smaller trade surplus). Import competition (decline of import prices) was increasing – especially after 1985 – and export prices and output prices in the traded-goods industries were apparently following with a time lag but did not decrease by the same amount. Also, the trade surplus was not hurt, which could be consistent with

product upgrading (quality competition)<sup>16</sup>, with increases in productive efficiency spurred by import competition, or with price discrimination between domestic and export markets (charging lower prices on export markets in order to maintain market shares). However, these arguments require further investigation to gain credibility.

Real wages were rising steadily in West Germany, however, with a U-shaped trend in skills. Rising wages are consistent with price declines being comparatively larger for capital-intensive industries<sup>17</sup> resulting in overall capital intensity to increase over time. The U-shaped trend in skills is inconsistent with price declines being larger for industries using low- or high-skilled labor intensively. However, it is not too far fetched to assume that wages are not determined according to the long run HOS view and institutional aspects like wage bargaining play an important role. Then one might ask whether employment trends are consistent with trade effects operating via relative price changes. It can be argued that, relative to skilled labor, trends for low-skilled labor are consistent with trade effects operating but that this is not the case for high-skilled labor. Industries using low-skilled labor intensively were experiencing disproportionate price declines and wage increases, thus, the employment share of these industries as well as the within industry usage of low-skilled labor was decreasing. In addition, the relative trade surplus was declining in these industries. Overall, this is consistent with trade inducing a negative bias in labor demand against low-skilled labor, resulting into higher unemployment of this group rather than lower relative wages due to the wage bargaining system. A trade-based interpretation would just be opposite for skilled labor, but by itself it is not convincing because of the unfavorable wage trends (especially relative to high-skilled labor). Even to a lesser extent could trade explain trends for high-skilled labor, since even when assuming that relative wages of high-skilled labor were rising due to factors unrelated to trade, then a substitution away from high-skilled labor within industries as well as a decrease in the employment shares of high-skilled-labor-intensive industries should have occurred and one would have expected the relative trade surplus of high-skilled labor-intensive industries to decline, none of which happened. Compared to traded-goods industries, wages were growing to a lesser extent in non-traded-goods industries and in regulated industries, which is not in accordance with these industries being shielded from intensified import competition, i.e. it is an open question how the wage bargaining system could have increased relative wages in the traded-goods industries in a time when import competition presumably was increasing.

Most of the above findings suggest the “residual” technology explanation which is fairly common in the literature, cf. Lawrence and Slaughter (1993), Lawrence (1994), and Möller (1996): changes in the structure of wages must be induced by biased trends in technological progress. This interpretation is based on technological trends exhibiting a skill bias favoring in particular high-skilled labor such that technical progress is complementary to human capital. From an empirical view, this is observationally equivalent to total factor productivity growth being larger for industries using high-skilled labor intensively. The results on total factor productivity growth are somewhat supportive for this view. Industries using high-

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<sup>16</sup>Cf. Leamer (1996) and FitzRoy and Funke (1996). The latter authors argue that West Germany has so far been able to sustain export performance despite decreasing competitiveness through unfavorable exchange rate and relative wage trends. The authors then turn to the product quality of German exports and to increases in productive efficiency generated by growing competitive pressures as possible explanations.

<sup>17</sup>Capital user costs are notoriously difficult to measure, thus, the argument relies on the trend of the deflator of aggregate value added being a proxy for the trend in user costs of capital. This view is not rejected by the trends for the factor income share for capital.

skilled labor intensively were experiencing the highest total factor productivity growth. The ranking with respect to technical progress puts capital after high-skilled labor as second, low-skilled labor third and skilled labor last. Technical progress induced a U-shaped bias in labor demand across skills and was favorable to capital relative to total labor. Therefore, the technological trends are consistent with relative wage and employment trends between skilled and high-skilled labor (assuming an elasticity of substitution above one). Such a technology effect could only apply to low-skilled labor relative to the other two skill groups and to capital relative to total labor, if the respective elasticity of substitution is below one. This is likely to be the case for capital relative to total labor but not for low-skilled labor relative to other skill types. Thus, technology trends are consistent with a decrease in the capital factor income share, which is the long-term development in the traded-goods industries.

## 4 Somewhat More Structural Evidence

This section turns to a somewhat more structural estimation approach trying to disentangle the effects of relative output price changes from the effects of technical progress. As emphasized by Leamer (1996), there exists a trade off between a tight structural specification of the relationship between prices, wages, and trade and a data analysis with a “light” touch of HOS theory. A tight specification allows for the precise investigation of the relevance of some hypothesis. However, the chosen model could be incorrectly specified and it might not capture the various facets of the problem. This section attempts a slightly more structural analysis compared to the descriptive evidence presented in section 3.

### Structural Estimation Approach

Here, I follow Leamer’s (1996, section 3) approach in estimating “mandated” factor price changes resulting from technical change and from changes in relative industry output prices. Leamer’s analysis is based on a long run HOS view, where a set of zero profit conditions,  $p = A'w$ , describes the relationship between output prices and factor remuneration rates and where  $p$  is the vector of product prices,  $w$  the vector of factor remuneration rates and  $A$  the matrix of factor input intensities. With more industries than input factors, this set of equations  $p = A'w$  can be used within a regression framework to estimate what Leamer calls “mandated” changes in factor remuneration rates by regressing output price changes across industries  $i$  on the respective factor shares, i.e.

$$\Delta py_i = \theta_{K,i} \widehat{\Delta r_k} - \theta_{L,i} \widehat{\Delta w}$$

when considering only capital and labor and

$$\Delta py_i = \theta_{K,i} \widehat{\Delta r_k} - \theta_{A,i} \widehat{\Delta w(a)} - \theta_{B,i} \widehat{\Delta w(b)} - \theta_{C,i} \widehat{\Delta w(c)}$$

when considering capital and three skill types of labor. The estimated coefficients ( $\widehat{\Delta r_k}$ ,  $\widehat{\Delta w(.)}$ ) on each factor share  $\theta_{.,i}$  represent the estimated change in the factor remuneration rate resulting from a change in output prices which are warranted in light of long run zero profit conditions. This is the Stolper–Samuelson (1941) transmission channel. However, one has to take account of the fact that output prices do not only change for trade related reasons.

Leamer's analysis attempts to identify trade ("globalization") versus technology effects on remuneration ratios. He emphasizes, however, that such a decomposition is plagued by a fundamental identification problem relating to the "pass-through" of TFP growth. On one hand, TFP growth within industry could result in decreasing relative output prices ("complete pass-through"), on the other hand it could increase factor remuneration rate without changing output prices ("no pass-through"). In his analysis, Leamer assumes a constant "pass-through" rate across industries and studies the sensitivity of "mandated" factor remuneration changes with respect to this rate.<sup>18</sup> The component of TFP growth across industries which is not absorbed by output price changes together with the zero profit conditions define the factor remuneration rate changes "mandated" by technology. With a constant "pass-through" rate across industries, the sign of the changes of remuneration rates is independent of the "pass-through" rate and can be estimated by regressing TFP growth rates across industries  $i$  on the respective factor shares as follows

$$\Delta t f p_i = \theta_{K,i} \widehat{\Delta r_k} - \theta_{L,i} \widehat{\Delta w}$$

when considering only capital and labor and

$$\Delta t f p_i = \theta_{K,i} \widehat{\Delta r_k} - \theta_{A,i} \widehat{\Delta w(a)} - \theta_{B,i} \widehat{\Delta w(b)} - \theta_{C,i} \widehat{\Delta w(c)}$$

when considering capital and the three skill types of labor. The estimated coefficients ( $\widehat{\Delta r_k}$ ,  $\widehat{\Delta w(.)}$ ) on each factor share  $\theta_{.,i}$  represent the estimated change in the factor remuneration rate resulting from technological progress assuming "no pass-through". Thus, assuming zero profit conditions across industries the differential qualitative impacts of technology and trade can to some extent be evaluated by regressing price changes, TFP changes, and the sum of both on the respective factor shares.

One may wonder whether this analysis is still meaningful in the presence of unemployment. I would argue that it is because "mandated" factor price changes define an equilibrium-benchmark. If wages of some type of labor increase by more than this benchmark, this is consistent with increasing unemployment of this factor.

## Estimation Results

Table 11 in the appendix provides the regression results both for total labor and capital referring to the changes from 1970 to 1990 and for the three skill types of labor and capital referring to the changes from 1975 to 1990. The estimation results were obtained for output price changes relative to the deflator of aggregate value added, thus the estimated factor remuneration changes are also relative to this aggregate deflator. TFP growth by itself from 1970 to 1990 "mandates" remuneration increases both for capital and labor whereby the effect for capital is slightly larger. Overall effects as well as the difference between capital and labor are larger when 1990 shares are used compared to 1970 shares. Differentiating between three skill types of labor, TFP growth by itself from 1975 to 1990 "mandates" remuneration increases for capital, low-skilled, and high-skilled labor but for skilled labor

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<sup>18</sup>Lawrence and Slaughter (1993, p.203) calculate effective output prices as the sum of actual output price changes and TFP growth. Their discussion implicitly assumes a zero "pass-through" such that the effective price changes drive factor remuneration. Their analysis is consistent with assuming that output prices are given by the world market and therefore the impact of technological changes is fully absorbed by factor remuneration rates.



actually a decline in wages is “mandated”. The exact size of the effects differ depending on the year for which shares are used but the qualitative results are the same. However, the estimated coefficients for high-skilled labor are obviously too large in absolute values (log differences!), hence, I only rely on the qualitative results.

Price changes are effected by TFP growth as well as by trade. Assuming a constant “pass-through” of TFP growth across industries, the trade induced changes are a linear combination of the estimates referring to the sum of TFP growth and price changes and the estimates referring to price changes alone. Thus, in most cases, the qualitative nature of trade effects can be determined. This is due to the fact that most estimated coefficients in the TFP and price regressions are found to be of opposite sign. Thus, the results in table 11 can be interpreted in the following way. Industry output price changes were favoring total labor relative to capital. When differentiating between three different skill types of labor, trade effects were unfavorable for capital. Trade effects on real earnings from 1975 to 1990 were positive for skilled labor (B) and negative for high-skilled labor (C). Only for low-skilled labor (A), the sign of the trade effects is unclear since the coefficient estimates are of opposite sign in the two cases. Also the ranking between (A) and (B) changes since the sum of TFP growth and price changes favors (A) relative to (B) whereas price changes by themselves strongly favor (B).

### Summary

The results in this section can be summarized as follows. Technological change was favorable to capital relative to total labor and both to low and high-skilled labor relative to skilled labor. Technological change actually appears to “mandate” lower real wages of skilled labor. On the other hand, trade effects (identified by changes in industry output prices) were favorable for skilled labor and unfavorable both for high-skilled labor and capital. The effect is ambiguous for low-skilled workers. Overall, one might conclude that this is bad news for a mere trade based explanation of relative wage changes across skill groups. However, it could, in fact, mean that trade effects were mitigating changes in the wage structure, in particular, such that skilled labor did not lose relative to high-skilled labor to the same order of magnitude as, for instance, in the United States. Also, according to these calculations technological change did not “mandate” wage declines for low-skilled labor relative to skilled labor or capital but only relative to high-skilled labor. This is somewhat a puzzle for a technology explanation of wage and employment trends for low-skilled labor, thus, this analysis could only explain the fact that employment of (A) was declining so strongly by referring to increased import competition in (A)-intensive industries. As a cautionary note, the absolute size of some coefficient estimates in this section, in particular for (C), prohibits anything more than a qualitative interpretation.

## 5 Conclusions

For the time period from 1970 to 1990, this paper investigates links between trends in industry output prices, wages, and trade in West Germany by establishing a series of empirical regularities and then by using a slightly more structural approach to discriminate between trade and technology effects on wages. The main findings are that despite a considerable trade surplus, overall, import competition for the traded-goods industries was increasing

and disproportionately so after 1985. The relative wages of both low and high-skilled labor were increasing (the changes being small in international comparison) but at the same time import competition was increasing disproportionately for the industries using these factors intensively. Employment of high-skilled labor was increasing whereas employment and the factor income share of low-skilled labor was decreasing. This suggests a skill bias in labor demand trends favoring more skilled labor. Thus, together with the wage bargaining system setting "too high wages" and the disproportionate increase in unemployment for low-skilled labor the results suggest that trade might have partly explained labor market trends for low-skilled labor, namely, a negative trend in demand for low-skilled labor resulting in higher unemployment of this group since its relative wage did not fall. Total factor productivity growth was favoring both low- and high-skilled labor. Thus, technological change augmenting high-skilled labor is consistent with labor market trends for this group. Skilled labor appears to have experienced unfavorable total factor productivity changes but favorable trade effects. Overall, employment in skilled labor was increasing but wages were growing slower compared to low-skilled and high-skilled labor. High wage growth for low-skilled labor is most likely due to the wage bargaining system where downward pressure on wages of low-skilled labor was low in trade surplus industries (complementarity to capital and high-skilled labor) and these wages were copied in the remaining traded-goods industries ("pattern bargaining"). Somewhat surprisingly, wage growth was uniformly higher in the traded-goods industries compared to the non-traded-goods industries and compared to the industries which are subject to government regulation, even though the latter industries presumably are shielded from increasing import competition.

This paper can only be seen as a start towards a better understanding of trade and technology effects on the West German labor market. For instance, the following issues require further research: (i) How could the wage bargaining system effectively increase relative wages of low-skilled workers in the face of increasing import competition implying a strong negative labor demand shock? In the face of strong export performance, were there rents to be distributed in the traded-goods industries? (ii) Can a HOS long run general equilibrium model be augmented with an explicit wage setting model taking account of the West German wage bargaining system and with the existence of unemployment (in the short run)? (iii) It might prove fruitful to estimate models explicitly taking account of short-run adjustments of prices and wages towards long run equilibrium situations. As further research, I plan to extend the approach taken in section 4 to allow for long-run effects to work over time, i.e. to model the dynamics of adjustment within a short run wage and price setting framework. (iv) What will be the feedback on German labor markets with the enhanced possibilities of outsourcing and foreign direct investment, cf. Baldwin (1995). (v) How do the questions addressed in this paper relate to the possibility of migration of workers?

# A Appendix

## A.1 Data Reference

### Variable Definitions

Abbreviation	Definition
$V.A./V.A._i$	Gross value added obtained from the national accounts, current prices
$PY/PY_i$	Deflator of gross value added obtained from the national accounts
PC	Consumer price index (deflator of aggregate private consumption)
$Y/Y_i$	Gross value added obtained from the national accounts, in constant prices
$PV/PV_i$	Gross production (shipment) value obtained from the national accounts, current prices
EXP	Aggregate exports in current prices
IMP	Aggregate imports in current prices
$EXP_i$	Exports of goods produced in industry $i$ in current prices
$IMP_i$	Imports of the type of goods produced in current prices
Educ (A)	Skill group of workers without vocational training degree and without post secondary degree ("ohne abgeschlossene Berufsausbildung und ohne FH/Universitätsabschluß")
Educ (B)	Skill group of workers with vocational training degree and without post secondary degree ("mit abgeschlossener Berufsausbildung und ohne FH/Universitätsabschluß")
Educ (C)	Skill group of workers with post secondary degree ("FH/Universitätsabschluß")
$W/W_i$	Average annual earnings per worker obtained by dividing total labor costs by the number of employees from the national accounts, in current prices
$W(J)/W(J)_i$	Median of annual average daily earnings for skill group $J$ ( $J=A,B,C$ ) obtained from social security accounts ("IAB-BST"), not including employers' contribution to social insurances, in current prices
$L/L_i$	Employees obtained from the national accounts
$L(J)/L(J)_i$	Employees of skill group $J$ ( $J=A,B,C$ ) obtained from social security accounts ("IAB-BST")
$K/K_i$	Net capital stock (equipment and plants) obtained from the national accounts, in constant prices

- A variable with index  $i$  refers to industry  $i$ . The same variable without index refers to the aggregate economy
- All variables are for West Germany only ("Bundesrepublik Deutschland" before October 3, 1990).
- Lowercase letters indicate logarithms

## Data Sources

The analysis in this paper is based on two main data sources for West Germany which had to be combined:

1. National Account Data from the Federal Statistical Office disaggregated into 2- and 3-digit industries
2. The "IAB-Beschäftigtenstichprobe", a 1% random sample from German Social Security Accounts

Additional data sources were merged with these two datasets. The variable definitions can be found in the previous table.

1. Annual National Account data are taken from the "Volkswirtschaftliche Gesamtrechnungen" Fachserie 18, Reihe 1.3 (1970 to 1990) from the Federal Statistical Office (Statistisches Bundesamt). The data source contains a complete accounting system for 58 industries comprising the entire economy. In order to be able to merge the data and to reduce the information on small highly regulated or non-traded-goods industries, I aggregate these into 49 industries which are described in the next table. I omit the industry Housing (No. 62) since it does not comprise any employees.

The National Account data provide Import and Export series, both in current and constant prices, for groups of goods and services which can be merged with the 36 traded-goods industries in a fairly straight forward manner such that trade is attributed to the industry providing the final value added. Imports and Exports for West Germany are only available until 1990.

2. "IAB-Beschäftigtenstichprobe" (IAB-BST): a 1% random sample from German Social Security Accounts during the period from 1975 to 1990 which has only recently been made available by the research institute of the Federal Employment Service ("Institut für Arbeitsmarkt- und Berufsforschung") in Nürnberg. The main features of the data set and a users' guide can be found in Bender et al. (1996) and Rohwer (1995). Social security contributions are mandatory for employees who earn more than a minimum threshold and who are working regularly. The main exemption are civil servants who do not pay social security contributions at all. Further exclusions from the mandatory contributions are students who work less than 20 hours a week on a regular basis or less than 6 weeks full-time. About 80 percent of the German employees are covered by this mandatory pension system.

The industry classification of the IAB-BST differs slightly from the one used in the national account data. The IAB-BST industry classification comprises 95 industries which, in most cases, is finer than the national account data used here. However, in three cases, namely the industries 35/36 (Wood), 37/38 (Paper), and 60/61 (Banking, Insurances), only information for the union of the two respective industries is available in the IAB-BST. For these three cases, I divided the employment and wage information in IAB-BST using the employment weight of each industry in the national accounts.

From the IAB-BST dataset, I take wage and employment information by skill groups. The analysis differentiates between workers of the following three skill types:

(A) without a vocational training degree

(low-skilled)

- (B) with a vocational training degree (skilled)
- (C) with a technical college ("Fachhochschule") or university degree (high-skilled)

The basic information in the IAB-BST dataset consists of social security insurance spells comprising the starting and the end point of an employment spell and the average daily gross wage (excluding employers' contributions). The daily gross wage is censored from above and truncated from below. If the wage is above the upper social security threshold ("Beitragsbemessungsgrenze"), the daily social security threshold is reported instead. If the wage is below the lower social security threshold, the employee does not have to pay social security contribution and therefore, does not appear in the dataset. For these reasons, I use median daily gross wages. An annual wage observation is calculated as the weighted average of the wage observation of the individual for all spells within one year where the spell length is used as the weight. For the subsequent calculations, the annual wage observation is weighted by the total employment spell length within the year relative to the length of the year. These weights are used to calculate median wages and raw employment weights for all individuals in one skill group and industry. Total employment in one industry from the national account data is then divided up across skill groups using these weights. With multiple spells (jobs) at the same time, cf. Rohwer (1995, p.18), I take the sum of the daily wages across spells as the wage observation. In case of spells originating from different industries, this sum is assigned to each industry as the wage observation together with an employment weight that is the product of the ratio between the respective daily wage and the sum of daily wages times the spell length in years. The latter procedure is based on the assumption that the respective wage share is a good estimate of the relative time spent in the different jobs and that the hourly wage is the same across jobs.

Over time, the income components being subject to the social security tax were extended, cf. Bender et al. (1996, p. 15). In particular, starting in 1984 one-time payments to the employee had to be taxed. As a quick-and-dirty solution, I corrected the wage observations after 1983 by dividing through a factor for each industry such that 1984 wage growth for each skill group corresponds to the average industry wage growth obtained from the national accounts. To illustrate the difference, figures 3 and 4 later in the appendix contrast aggregate wage growth without and with this correction, respectively. Without the correction, skill group (C) in figure 3 exhibits an incredible jump in 1984 which could obscure trends in the wage structure across skill groups.

3. Skill specific unemployment rates: Information from the German microcensus on skill specific employment and unemployment are taken from "Bevölkerung und Erwerbstätigkeit" Fachserie 1, Reihe 4.1.2 from the Federal Statistical Office (Statistisches Bundesamt). These data are available for the years 1976, 1978, 1980, 1982, 1985, 1988, and 1990. When calculating skill specific unemployment rates for the missing years, I interpolate the data using a regression approach where the aggregate unemployment rate is used to predict the period specific movement.

Industry Classification used in this paper building on the classification of the National Accounts of the German Statistical Office ("Statistisches Bundesamt", FS 18, R 1.3). The numbers refer to the classification numbers used by the Statistical Office.

No.	Industry German	English	Trad- able	Regu- lated
01	LAND-U.FORSTWIRTSCHAFT, FISCHEREI	AGRICULTURE, FORESTRY AND FISHERIES	*	*
06	ELEKTR.-,GAS-,FERNWÄRME WASSERVERSORG.	ELECTRICITY, GAS, HEAT AND WATER		*
10	BERGBAU	MINING	*	*
14	CHEM.IND.,H.U.VERARB.V. SPALT-U.BRUTSTOFFEN	CHEMICAL PRODUCTS	*	
15	MINERALÖLVERARBEITUNG	PETROLIUM PROCESSING	*	
16	H.V.KUNSTSTOFFWAREN	SYNTHETIC MATERIAL	*	
17	GUMMIVERARBEITUNG	RUBBER PRODUCTS	*	
18	GEW.U.VERARB.V.STEINEN U.ERDEN	STONE AND EARTH PRODUCTS	*	
19	FEINKERAMIK	FINE CERAMICS	*	
20	H.U.VERARB.V.GLAS	GLASS AND PRODUCTS	*	
21	EISENSCHAFFENDE INDUSTRIE	IRON	*	
22	NE-METALLERZEUGUNG, NE-METALLHALBZEUGWERKE	NON-FERROUS METALS	*	
23	GIESSEREI	FOUNDRY	*	
24	ZIEHEREIEN,KALTWALZW., STAHLVERFORMUNG USW.	FABRICATED METAL PRODUCTS	*	
25	STAHL-U.LEICHTMETALL-, SCHIENENFAHRZEUGBAU	STEEL, LIGHT METAL AND TRACKED VEHICLES	*	
26	MASCHINENBAU	MACHINERY	*	
27	H.V.BÜROMASCHINEN, ADV-GERÄTEN U.-EINR.	OFFICE AND DATA PROCESSING MACHINES	*	
28	STRASSENFAHRZEUGBAU, REP.V.KFZ.USW.	VEHICLES AND REPAIRS	*	
29	SCHIFFBAU	SHIPBUILDING	*	
30	LUFT-U.RAUMFAHRZEUGBAU	AIR AND SPACE	*	
31	ELEKTROTECHNIK, REP.V.HAUSHALTSGERÄTEN	ELECTRIC APPLIANCES AND REPAIRS	*	
32	FEINMECHANIK,OPTIK, H.V.UHREN	PRECISION AND OPTICAL INSTRUMENTS	*	
33	H.V.EISEN-,BLECH- U.METALLWAREN	IRON, SHEET METAL AND METAL PRODUCTS	*	
34	H.V.MUSIKINSTR.,SPIELW., FÜLLHALTERN USW.	MUSICAL INSTRUMENTS, TOYS, FOUNTAIN PENS	*	
35	HOLZBEARBEITUNG	WOODWORK	*	
36	HOLZVERARBEITUNG	WOOD PROCESSING	*	

No.	Industry < continued > German	English	Trad- able	Regu- lated
37	ZELLSTOFF-,HOLZSCHL., PAPIER-U.PAPPEERZ.	PULP, PAPER AND BOARD	*	
38	PAPIER-U.PAPPEVERARBEITUNG	PAPER AND PRODUCTS	*	
39	DRUCKEREI,VERVIELFÄLTIGUNG	PRINTING AND PUBLISHING	*	
40	LEDERGEWERBE	LEATHER	*	
41	TEXTILGEWERBE	TEXTILES	*	
42	BEKLEIDUNGSGEWERBE	APPAREL	*	
43	ERNÄHRUNGSGEWERBE (OH.GETRÄNKEHERST.)	FOOD	*	
44	GETRÄNKEHERSTELLUNG	BEVERAGES	*	
45	TABAKVERARBEITUNG	TOBACCO	*	
46	BAUGEWERBE	CONSTRUCTION		
50	HANDEL	TRADE		
54	EISENBAHNEN	RAILWAYS		*
55	SCHIFFAHRT,WASSERSTRASSEN, HÄFEN	SHIP TRAFFIC, WATERWAYS, AND HARBOURS		*
56	DEUTSCHE BUNDESPOST	GERMAN POSTAL SERVICES		*
57	ÜBRIGER VERKEHR	OTHER TRANSPORTATION		*
60	KREDITINSTITUTE	CREDIT INSITITUTIONS	*	*
61	VERSICHERUNGSUNTERNEHMEN	INSURANCE COMPANIES	*	*
64	GASTGEWERBE,HEIME	CATERING AND HOTLES		
65	BILDUNG,WISSENSCH.,KULTUR USW., VERLAGSGEW.	EDUCATIONS,RESEARCH, AND CULTURE		
66	GESUNDHEITS-U. VETERINÄRWESEN	HEALTH AND VETERINARY		*
67	ÜBRIGE DIENST- LEISTUNGSUNTERNEHMEN	OTHER SERVICES		
70	STAAT	GOVERNMENT		*
73	PRIV.HAUSHALTE,PRIV.ORG.OH.E.	PRIVATE HOUSEHOLDS AND PRIVATE NON PROFIT ORGANIZATIONS		
76	ALLE WIRTSCHAFTSBEREICHE	TOTAL		

Industries characterized as "regulated" comprise the government sector itself and those industries with considerable government control of market access or subsidization of the domestic production.

## A.2 Tables of Results

Table 1: Weighted<sup>a</sup> Averages of Exports, Imports, Trade Exposure, and Trade Surplus Across Traded-Goods Industries Relative to Industry Production Values

	Variables			
	$EXP_{i,t}/PV_{i,t}$	$IMP_{i,t}/PV_{i,t}$	$(EXP_{i,t} + IMP_{i,t})/PV_{i,t}$	$(EXP_{i,t} - IMP_{i,t})/PV_{i,t}$
Weights	Year = 1970			
$K_{i,t}$	0.146	0.160	0.306	-0.0134
$L_{i,t}$	0.182	0.118	0.299	0.0641
$L(A)_{i,t}$	0.177	0.127	0.304	0.0498
$L(B)_{i,t}$	0.181	0.112	0.293	0.0687
$L(C)_{i,t}$	0.220	0.133	0.352	0.0868
Weights	Year = 1990			
$K_{i,t}$	0.241	0.249	0.490	-0.0080
$L_{i,t}$	0.290	0.225	0.515	0.0651
$L(A)_{i,t}$	0.298	0.257	0.555	0.0407
$L(B)_{i,t}$	0.284	0.210	0.494	0.0743
$L(C)_{i,t}$	0.323	0.231	0.554	0.0917

a: Industry weights are the average factor inputs in 1975 and 1990 for each industry

Table 2: Time Trends in Product, Export, and Import Prices Across Traded-Goods Industries Estimated as Logarithmic Changes<sup>a</sup>

Price Index	Relative to Deflator of Aggregate Value Added							
	Without Industry Dummies				With Industry Dummies			
	1975	1980	1985	1990	1975	1980	1985	1990
$py_{i,t} - py_t$ <sup>b</sup>	-0.057	-0.094	-0.093	-0.111	-0.055	-0.088	-0.087	-0.104
$px_{i,t} - py_t$ <sup>b</sup>	-0.041	-0.089	-0.084	-0.173	-0.040	-0.086	-0.082	-0.167
$pm_{i,t} - py_t$ <sup>b</sup>	-0.115	-0.159	-0.119	-0.242	-0.113	-0.155	-0.115	-0.235
Price Index	Relative to Deflator of Industry Value Added							
	1975	1980	1985	1990	1975	1980	1985	1990
$px_{i,t} - py_{i,t}$ <sup>b</sup>	0.015	0.005	0.008	-0.062	0.014	0.003	0.005	-0.062
$pm_{i,t} - py_{i,t}$ <sup>b</sup>	-0.058	-0.064	-0.026	-0.130	-0.058	-0.067	-0.027	-0.130

a: The numbers reported here refer to the traded-goods industries. They are coefficient estimates from a regression in each industry on a set of year dummies, where the dummy variable for the first year (1970 or 1975) is omitted. Without industry dummies the estimated coefficients on the year dummies capture the overall trends, whereas with industry dummies included they comprise the average within industry trend. All estimations are weighted least squares regressions where each industry observation is weighted by total employment in that industry.

b: Change relative to 1970

c: Change relative to 1975



Table 3: Weighted<sup>a</sup> Averages and Standard Deviations of Output, Export, and Import Price Changes Across Traded-Goods Industries Relative to Aggregate Deflator of Value Added (PPI)

	Price Index					
	$PY_{i,t}$		$PX_{i,t}$		$PM_{i,t}$	
	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.
Weights	Ratio 1990 to 1970					
$K_{i,t}$	0.863	0.062	0.807	0.052	0.789	0.051
$L_{i,t}$	0.937	0.053	0.866	0.045	0.809	0.043
$L(A)_{i,t}$	0.909	0.052	0.849	0.042	0.792	0.039
$L(B)_{i,t}$	0.952	0.053	0.875	0.046	0.818	0.043
$L(C)_{i,t}$	0.900	0.064	0.842	0.050	0.773	0.048
Weights	Ratio 1990 to 1975					
$K_{i,t}$	0.892	0.046	0.828	0.039	0.861	0.033
$L_{i,t}$	0.969	0.041	0.894	0.036	0.894	0.030
$L(A)_{i,t}$	0.960	0.039	0.882	0.035	0.880	0.029
$L(B)_{i,t}$	0.977	0.041	0.900	0.037	0.901	0.030
$L(C)_{i,t}$	0.927	0.048	0.873	0.037	0.871	0.032

a: Industry weights are the average factor inputs in 1975 and 1990 for each industry

Table 4: Time Trends in Wages and Factor Shares Across Traded-Goods Industries<sup>a</sup>

	Without Industry Dummies				With Industry Dummies			
	1975	1980	1985	1990	1975	1980	1985	1990
Wage Index	Relative to Deflator of Aggregate Value Added							
$w_{i,t} - py_t$ <sup>b</sup>	0.160	0.334	0.401	0.486	0.148	0.324	0.382	0.463
$w(a)_{i,t} - py_t$ <sup>c</sup>	–	0.133	0.188	0.256	–	0.130	0.181	0.246
$w(b)_{i,t} - py_t$ <sup>c</sup>	–	0.105	0.138	0.196	–	0.105	0.132	0.184
$w(c)_{i,t} - py_t$ <sup>c</sup>	–	0.209	0.259	0.297	–	0.210	0.258	0.296
Wage Index	Relative to Deflator of Industry Value Added							
$w_{i,t} - py_{i,t}$ <sup>b</sup>	0.217	0.429	0.494	0.598	0.204	0.412	0.470	0.568
$w(a)_{i,t} - py_{i,t}$ <sup>c</sup>	–	0.170	0.224	0.310	–	0.164	0.214	0.296
$w(b)_{i,t} - py_{i,t}$ <sup>c</sup>	–	0.143	0.174	0.250	–	0.139	0.165	0.234
$w(c)_{i,t} - py_{i,t}$ <sup>c</sup>	–	0.247	0.295	0.351	–	0.244	0.292	0.346
	Without Industry Dummies				With Industry Dummies			
	1975	1980	1985	1990	1975	1980	1985	1990
Factor	Ratio Wage Bill to Industry Value Added							
$L_{i,t}$ <sup>b</sup>	0.037	0.087	0.050	0.059	0.039	0.092	0.058	0.066
Factor	Ratio Wage Bill to Total Industry Wage Bill							
$L(A)_{i,t}$ <sup>c</sup>	–	-0.067	-0.124	-0.160	–	-0.064	-0.116	-0.150
$L(B)_{i,t}$ <sup>c</sup>	–	0.050	0.089	0.109	–	0.047	0.083	0.102
$L(C)_{i,t}$ <sup>c</sup>	–	0.016	0.034	0.051	–	0.017	0.033	0.049

a: Wage changes are estimated as logarithmic changes. The factor shares of total labor is the ratio between total wage bill and total value added. The shares of the three skill types are relative to the total industry wage bill. The capital share is omitted, since I assume it amounts to one minus total labor's share. The numbers reported in this table are coefficient estimates from a regression in each industry on a set of year dummies, where the dummy variable for the first year (1970 or 1975) is omitted. Without industry dummies the estimated coefficients on the year dummies capture the overall trends, whereas with industry dummies included they comprise the average within industry trend. All estimations are weighted least squares regressions where each industry observation is weighted by total employment in that industry.

b: Change relative to 1970

c: Change relative to 1975

Table 5: Weighted<sup>a</sup> Averages and Standard Deviations of Wage Changes Across Traded-Goods Industries Relative to Aggregate Deflator of Value Added (PPI)

Wage Index: $W_{i,t}$					
Mean Std.Dev.		Mean Std.Dev.		Mean Std.Dev.	
Ratio 1990 to 1970 weighted by					
$K_{i,t}$		$L_{i,t}$			
1.541	0.044	1.598	0.035	–	–
Ratio 1990 to 1970 weighted by					
$L(A)_{i,t}$		$L(B)_{i,t}$		$L(C)_{i,t}$	
1.598	0.035	1.592	0.035	1.671	0.035

	Ratio 1990 to 1975 of Wage Index							
	$W_{i,t}$		$W(A)_{i,t}$		$W(B)_{i,t}$		$W(C)_{i,t}$	
Weights	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.
$K_{i,t}$	1.332	0.030	1.265	0.014	1.188	0.024	1.287	0.052
$L_{i,t}$	1.374	0.024	1.281	0.011	1.206	0.018	1.350	0.036
$L(A)_{i,t}$	1.380	0.024	1.282	0.011	1.195	0.017	1.343	0.038
$L(B)_{i,t}$	1.369	0.024	1.280	0.011	1.209	0.019	1.351	0.035
$L(C)_{i,t}$	1.404	0.022	1.287	0.010	1.225	0.015	1.388	0.030

a: Industry weights are the average factor inputs in 1975 and 1990 for each industry

Table 6: Time Trends in Factor Input Ratios Across Traded-Goods Industries Estimated as Absolute Changes of the Ratios<sup>a</sup>

Factor Ratio	Without Industry Dummies				With Industry Dummies			
	1975	1980	1985	1990	1975	1980	1985	1990
$K_{i,t}/L_{i,t}$ <sup>b</sup>	0.022	0.025	0.034	0.035	0.022	0.026	0.035	0.039
$L(B)_{i,t}/L(A)_{i,t}$ <sup>c</sup>	–	0.778	1.780	2.888	–	0.728	1.668	2.744
$L(C)_{i,t}/L(B)_{i,t}$ <sup>c</sup>	–	0.006	0.019	0.034	–	0.007	0.018	0.032
$K_{i,t}/L(A)_{i,t}$ <sup>c</sup>	–	0.105	0.273	0.432	–	0.103	0.261	0.431
$K_{i,t}/L(B)_{i,t}$ <sup>c</sup>	–	-0.015	-0.014	-0.019	–	-0.013	-0.012	-0.012
$K_{i,t}/L(C)_{i,t}$ <sup>c</sup>	–	-1.903	-2.746	-3.388	–	-1.856	-2.589	-3.047

a: The numbers reported here refer to the traded-goods industries. They are coefficient estimates from a regression in each industry on a set of year dummies, where the dummy variable for the first year (1970 or 1975) is omitted. Without industry dummies the estimated coefficients on the year dummies capture the overall trends, whereas with industry dummies included they comprise the average within industry trend. All estimations are weighted least squares regressions where each industry observation is weighted by total employment in that industry.

b: Change relative to 1970

c: Change relative to 1975

Table 7: Time Trends in Total Factor Productivity Across Traded-Goods Industries<sup>a</sup>

Factor Shares	Total Factor Productivity Referring to Capital and Total Labor <sup>b</sup>							
	Without Industry Dummies				With Industry Dummies			
	1975	1980	1985	1990	1975	1980	1985	1990
1970	0.044	0.161	0.236	0.316	0.044	0.165	0.237	0.315
1990	0.061	0.180	0.260	0.342	0.061	0.184	0.262	0.342
Factor Shares	Total Factor Productivity Referring to Capital and three Skill types of Labor <sup>c</sup>							
	1975	1980	1985	1990	1975	1980	1985	1990
1975	–	0.118	0.207	0.306	–	0.120	0.206	0.301
1990	–	0.077	0.130	0.197	–	0.079	0.129	0.194

a: Changes in total factor productivity are estimated as logarithmic changes. The numbers reported in this table are coefficient estimates from a regression of total factor productivity in each industry on a set of year dummies, where the dummy variable for the first year (1970 or 1975) is omitted. Without industry dummies the estimated coefficients on the year dummies capture the overall trends, whereas with industry dummies included they comprise the average within industry trend. All estimations are weighted least squares regressions where each industry observation is weighted by total employment in that industry.

b: Change relative to 1970

c: Change relative to 1975

Table 8: Weighted<sup>a</sup> Averages and Standard Deviations of Logarithmic Changes in Total Factor Productivity Across Traded-Goods Industries

Factor Shares	Total Factor Productivity Referring to Capital and Total Labor				Total Factor Productivity Referring to Capital and Three Skill Types of Labor			
	Change from 1970 to 1990				Change from 1975 to 1990			
	1970		1990		1975		1990	
Weights <sup>a</sup>	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.
$K_{i,t}$	0.349	0.0637	0.370	0.0596	0.319	0.0471	0.231	0.0416
$L_{i,t}$	0.318	0.0627	0.344	0.0611	0.305	0.0472	0.198	0.0433
$L(A)_{i,t}$	0.335	0.0621	0.365	0.0603	0.322	0.0465	0.212	0.0423
$L(B)_{i,t}$	0.304	0.0610	0.328	0.0592	0.294	0.0460	0.188	0.0424
$L(C)_{i,t}$	0.335	0.0621	0.365	0.0603	0.357	0.0633	0.246	0.0572

a: Industry weights are the average factor inputs in 1975 and 1990 for each industry

b: Factor shares used to calculate total factor productivity

Table 9: Time Trends in Wages Across Non-Traded-Goods Industries<sup>a</sup>

	Without Industry Dummies				With Industry Dummies			
	1975	1980	1985	1990	1975	1980	1985	1990
Wage Index	Relative to Deflator of Aggregate Value Added							
$w_{i,t} - py_t$ <sup>b</sup>	0.165	0.262	0.264	0.305	0.166	0.271	0.277	0.330
$w(a)_{i,t} - py_t$ <sup>c</sup>	–	0.075	0.074	0.112	–	0.083	0.091	0.139
$w(b)_{i,t} - py_t$ <sup>c</sup>	–	0.079	0.083	0.119	–	0.081	0.088	0.127
$w(c)_{i,t} - py_t$ <sup>c</sup>	–	0.104	0.145	0.161	–	0.105	0.150	0.164
Wage Index	Relative to Deflator of Industry Value Added							
$w_{i,t} - py_{i,t}$ <sup>b</sup>	0.133	0.196	0.228	0.248	0.134	0.201	0.235	0.265
$w(a)_{i,t} - py_{i,t}$ <sup>c</sup>	–	0.041	0.070	0.088	–	0.046	0.083	0.108
$w(b)_{i,t} - py_{i,t}$ <sup>c</sup>	–	0.045	0.079	0.095	–	0.044	0.080	0.096
$w(c)_{i,t} - py_{i,t}$ <sup>c</sup>	–	0.070	0.141	0.136	–	0.068	0.142	0.134

Table 10: Time Trends in Wages Across Regulated Industries<sup>a</sup>

	Without Industry Dummies				With Industry Dummies			
	1975	1980	1985	1990	1975	1980	1985	1990
Wage Index	Relative to Deflator of Aggregate Value Added							
$w_{i,t} - py_t$ <sup>b</sup>	0.168	0.237	0.232	0.270	0.173	0.249	0.248	0.291
$w(a)_{i,t} - py_t$ <sup>c</sup>	–	0.075	0.060	0.082	–	0.080	0.068	0.090
$w(b)_{i,t} - py_t$ <sup>c</sup>	–	0.064	0.063	0.098	–	0.068	0.069	0.104
$w(c)_{i,t} - py_t$ <sup>c</sup>	–	0.109	0.141	0.140	–	0.112	0.145	0.145
Wage Index	Relative to Deflator of Industry Value Added							
$w_{i,t} - py_{i,t}$ <sup>b</sup>	0.071	0.164	0.174	0.254	0.070	0.165	0.177	0.260
$w(a)_{i,t} - py_{i,t}$ <sup>c</sup>	–	0.097	0.099	0.162	–	0.098	0.100	0.162
$w(b)_{i,t} - py_{i,t}$ <sup>c</sup>	–	0.087	0.102	0.179	–	0.086	0.101	0.176
$w(c)_{i,t} - py_{i,t}$ <sup>c</sup>	–	0.132	0.180	0.221	–	0.131	0.177	0.217

a: Wage changes are estimated as logarithmic changes. The factor shares of total labor is the ratio between total wage bill and total value added. The shares of the three skill types are relative to the total industry wage bill. The capital share is omitted, since I assume it amounts to one minus total labor's share. The numbers reported in this table are coefficient estimates from a regression in each industry on a set of year dummies, where the dummy variable for the first year (1970 or 1975) is omitted. Without industry dummies the estimated coefficients on the year dummies capture the overall trends, whereas with industry dummies included they comprise the average within industry trend. All estimations are weighted least squares regressions where each industry observation is weighted by total employment in that industry.

b: Change relative to 1970

c: Change relative to 1975

Table 11: Weighted Regression Results of Relative Output Price Changes<sup>d</sup>, Total Factor Productivity Growth, and the Sum of Both on Factor Income Shares<sup>a</sup>

	TFP-Growth		TFP-Growth plus Output Price Change <sup>d</sup>		Output Price Change <sup>a</sup>	
Factor	Total Factor Productivity Referring to Capital and Total Labor using 1970 Factor Shares <sup>b</sup>					
	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat
<i>K</i>	0.328	1.5	-0.450	2.0	-0.778	2.1
<i>L</i>	0.316	2.3	0.491	3.7	0.175	0.8
Factor	Total Factor Productivity Referring to Capital and Total Labor using 1990 Factor Shares <sup>b</sup>					
<i>K</i>	0.367	1.7	-0.171	0.8	-0.538	1.4
<i>L</i>	0.332	1.0	0.341	1.0	0.010	1.0
Factor	Total Factor Productivity Referring to Capital and Three Skill Types of Labor using 1975 Factor Shares <sup>c</sup>					
	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat
<i>K</i>	0.437	2.8	-0.211	1.6	-0.648	3.1
<i>L(A)</i>	0.919	2.9	0.711	2.7	-0.208	0.5
<i>L(B)</i>	-0.357	1.7	0.514	2.9	0.871	3.1
<i>L(C)</i>	3.488	2.7	-2.544	2.4	-6.032	3.6
Factor	Total Factor Productivity Referring to Capital and Three Skill Types of Labor using 1990 Factor Shares <sup>c</sup>					
<i>K</i>	0.489	4.1	-0.110	0.8	-0.599	3.0
<i>L(A)</i>	1.171	2.9	0.339	0.7	-0.832	1.2
<i>L(B)</i>	-0.520	3.5	0.387	2.3	0.907	3.6
<i>L(C)</i>	2.525	4.9	-1.202	2.0	-3.727	4.2

a: The left hand side variables in the regressions are logarithmic changes. Industry weights are the employment shares of the year for which factor shares are used to calculate TFP growth

b: Change relative to 1970

c: Change relative to 1975

d: Output price changes are relative to deflator of aggregate value added

### A.3 Figures

Figure 1: Aggregate Trade Exposure (Relative to Total Value Added)

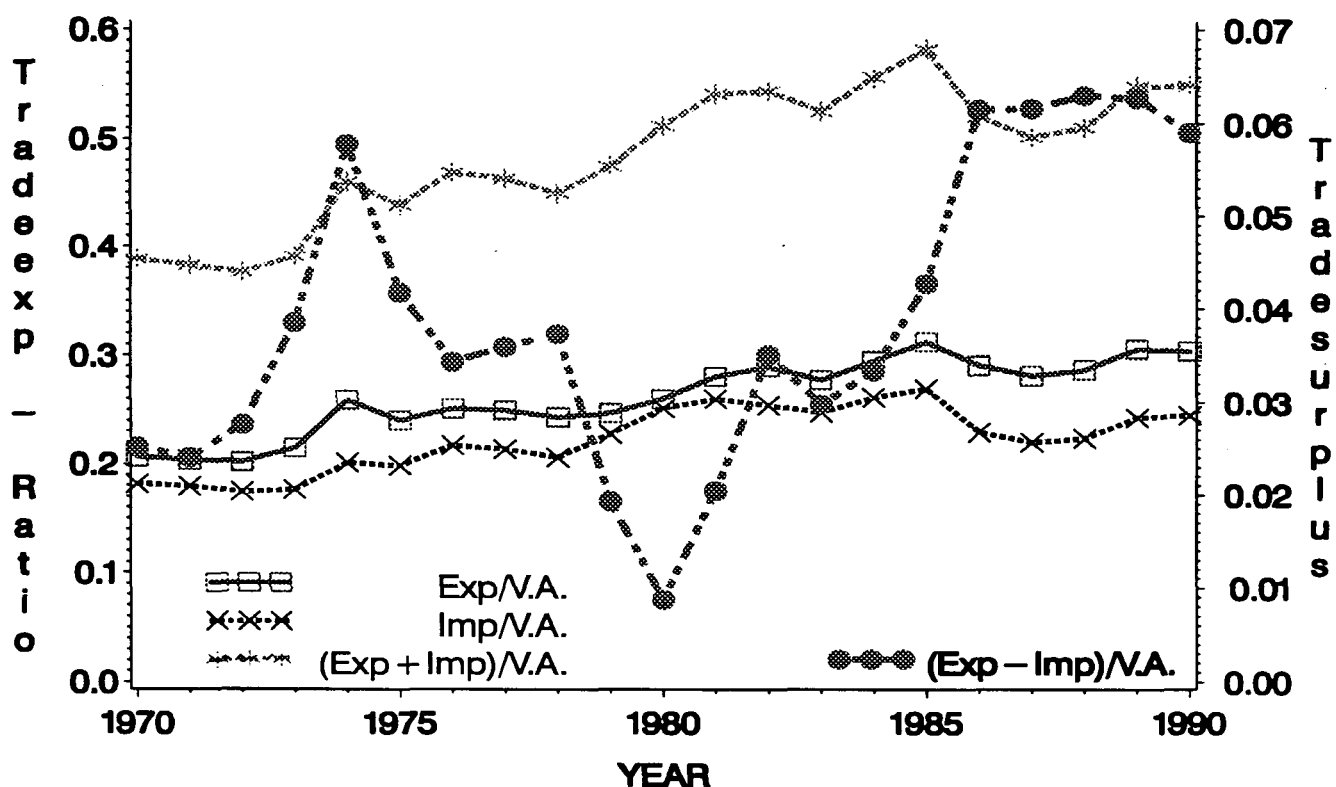


Figure 2: Export and Import Prices relative to Aggregate PPI

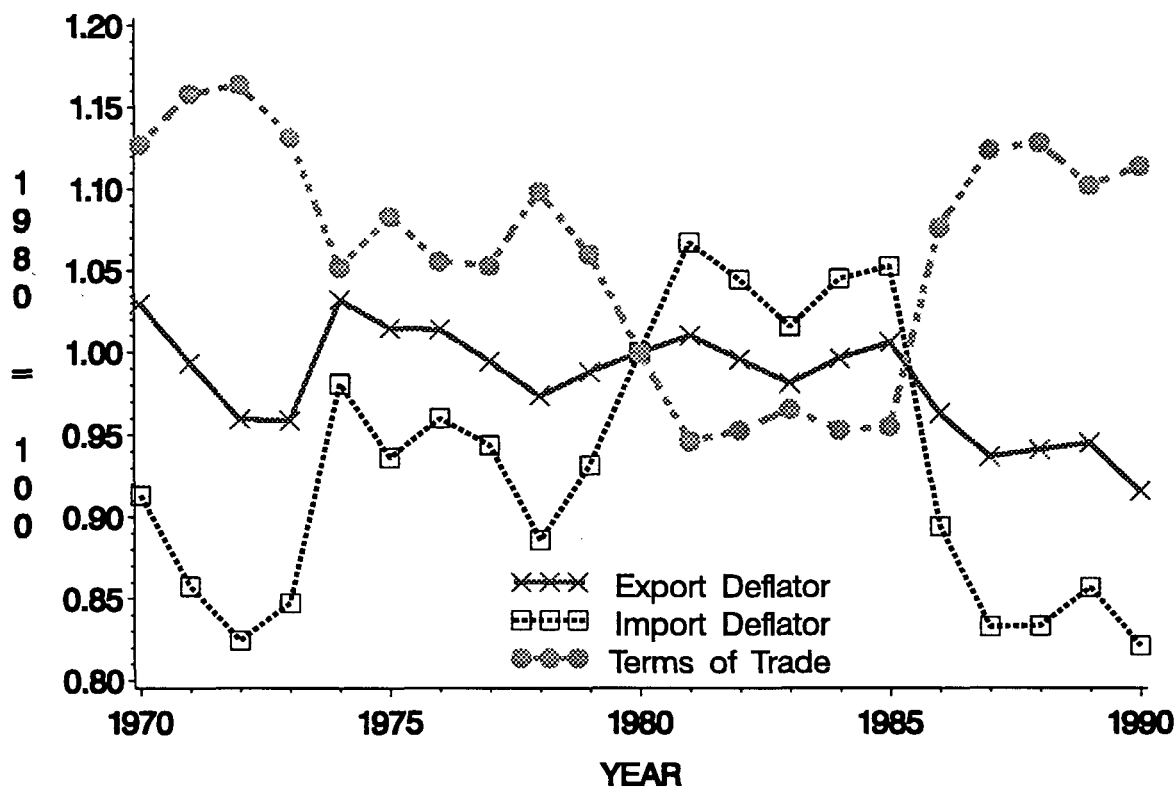


Figure 3: Aggregate Real Wages 1980=100 (Uncorrected)

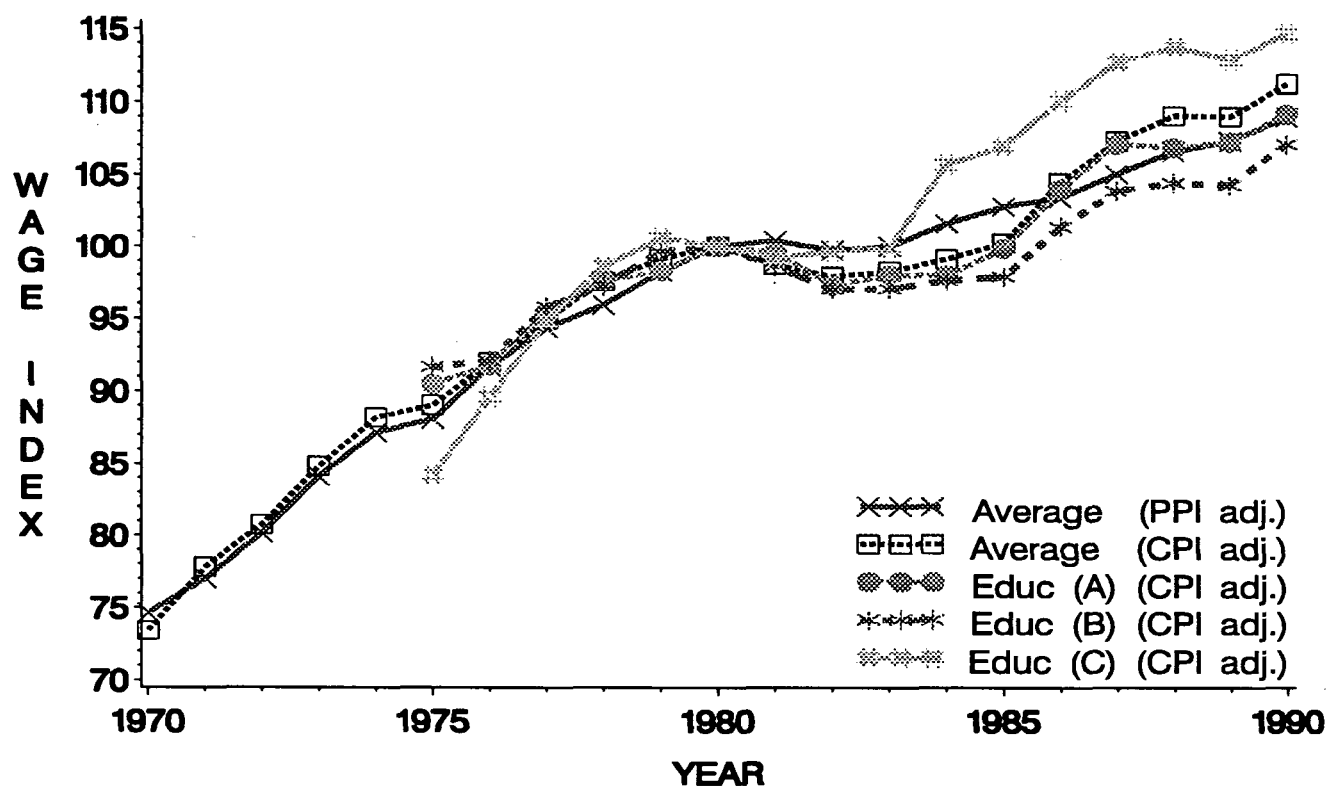


Figure 4: Aggregate Real Wages 1980=100 Medians (CPI adj.)  
(Growth in 1984 Corresponds to Average Growth)

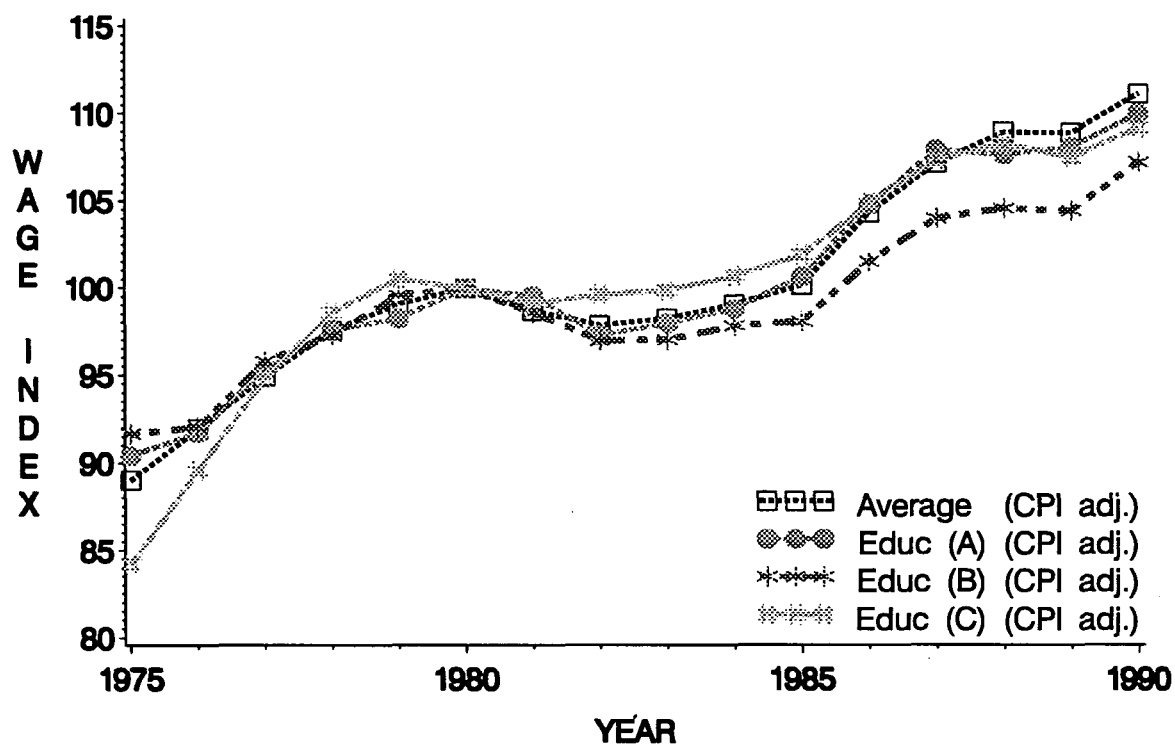




Figure 5: Aggregate and Skill Specific Unemployment Rates

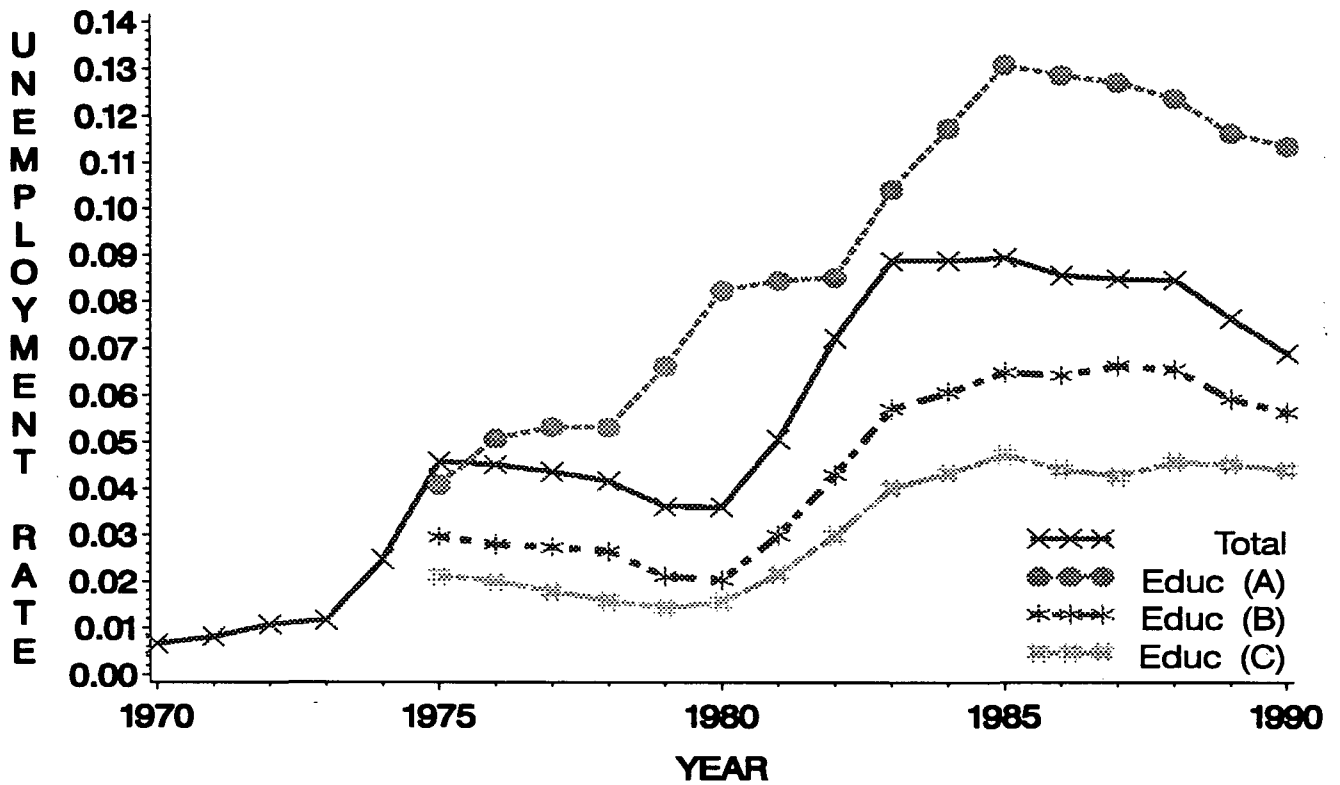
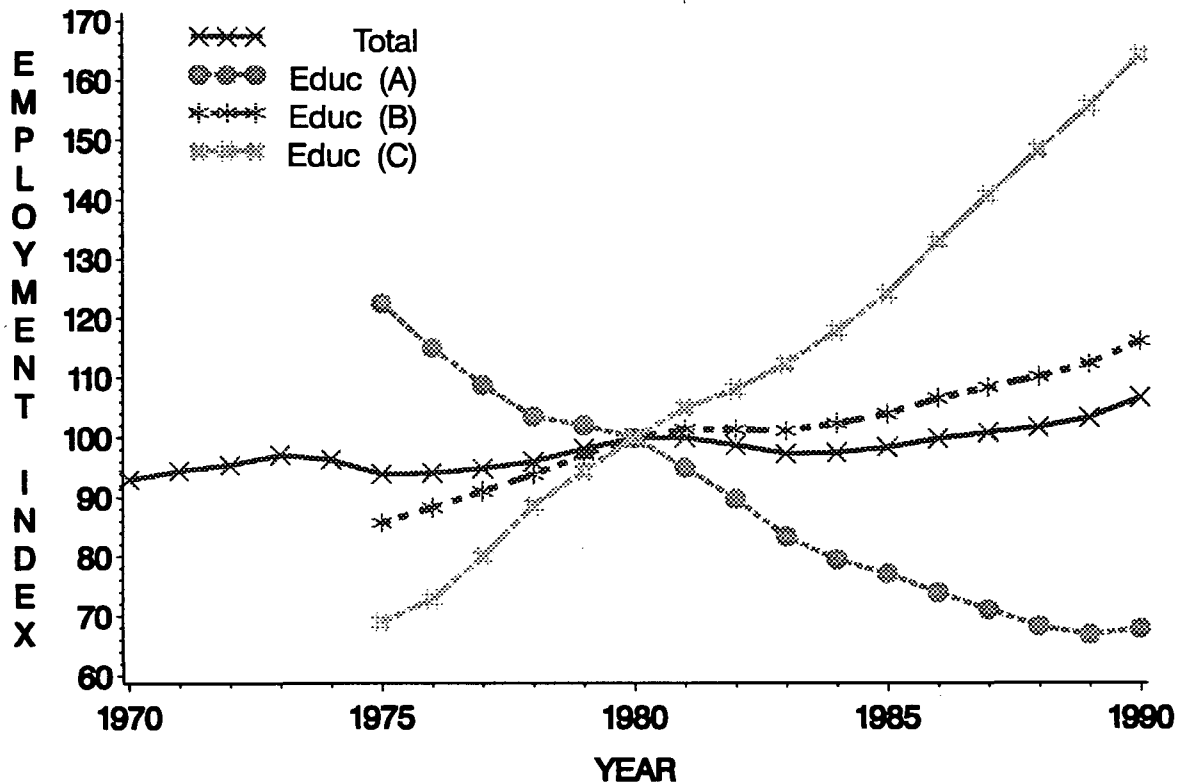


Figure 6: Aggregate and Skill Specific Employment Trends 1980=100



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