Sectoral Transformation, Turbulence, and Labor Market Dynamics in Germany

Ronald Bachmann
Bergische Universität Wuppertal

Michael C. Burda *†
Humboldt-Universität zu Berlin, IZA and CEPR

February 21, 2007

Abstract

The secular rise of European unemployment since the 1960s is hard to explain without reference to structural change. This is especially true in Germany, where industrial employment has declined by more than 30% and service sector employment has more than doubled over the past three decades. Using individual transition data on *West* German workers, we document a marked increase in structural change and turbulence, in particular since 1990. Net employment changes resulted partly from an increase in gross flows, but also from an increase in the net transition "yield" at any given gross worker turnover. In growing sectors, net structural change was driven by accessions from nonparticipation rather than unemployment; contracting sectors reduced their net employment primarily via lower accessions from nonparticipation. While gross turnover is cyclically sensitive and strongly procyclical, net reallocation is countercyclical, meaning that recessions are associated with increased intensity of sectoral reallocation. Beyond this cyclical component, German reunification and Eastern enlargement appear to have contributed significantly to this accelerated pace of structural change.

Key words: Gross worker flows; sectoral and occupational mobility; turbulence.

JEL classification: J63; J64; J62

1 Introduction

Modern market economies are constantly subject to structural change. Some sectors shrink, while others grow. Some of these changes are of short duration, reflecting fads, terms of trade, or temporary shifts of technology, while others appear more or less permanent. The most important common long-run trend for developed economies has been a marked shift of employment away from production towards service activities, as predicted by the "three-sector hypothesis".[1] Indeed, with the exceptions of Finland, Ireland, and Sweden, the share of manufacturing in total GDP has declined throughout the European Union over the past quarter century.

It is natural to associate structural change with pervasive gross and net movements of workers between the different sectors of the economy. This expectation is borne out in economic research on labor market

*Addresses for correspondence: Ronald Bachmann, Bergische Universität Wuppertal, Institute for Economics, esp. Economic Policy, Gaußstraße 20, 42117 Wuppertal. Michael C. Burda, Institute for Economic Theory II, Humboldt-Universität zu Berlin, School of Business and Economics, Spandauer Straße 1, 10099 Berlin. Email addresses: bachmann@wiwi.uni-wuppertal.de, burda@wiwi.hu-berlin.de.

†We thank participants at the Berlin Network of Labour Market Research (BeNA), a seminar at Bergische Universität Wuppertal, and at the 2nd Data User Conference of the IAB in Nürnberg for helpful comments. We also gratefully acknowledge the support of the German Science Foundation (DFG) and of the Collaborative Research Centre SFB 649.

[1]For the classic references see Fisher (1935), Clark (1940), and Fourastié (1949).

flows, and is especially relevant for Germany, in which the share of manufacturing in total GDP declined from 28% in 1980 to 21% in 2005.[2] This development has not been an even one. From 1970 to 1990, manufacturing employment declined from 10.1m to 9.1m, i.e. by 1m or 10%. From 1990 to 2005, it fell further to 6.8m, which corresponds to a drop of 2.3m, or 25%. The growth of service sector employment, by contrast, was much more steady, rising from 6.1m in 1970, to 10.6m in 1990, to 14.5m in 2005. At the same time, unemployment rose from below 2% to over 10%. The German case is important not only because of Germany's size in the European Union and Euro area, but also because of its highly industrialized initial conditions and the marked delay of its transformation when compared with other EU economies.

While earlier influential analyzes of the European unemployment problem stressed the impact of systemic supply shocks of the 1970s (Bruno and Sachs, 1985) or inappropriate constellations of labor market institutions (Layard, Nickell, and Jackman, 2005), most research has dismissed the role of structural change for the secular rise of European unemployment since the 1970s (for recent summaries, see Nickell, Nunziata, and Ochel, 2005 and Blanchard, 2006). Only recently have structural shifts received more attention (cf. Ljungqvist and Sargent, 1998, 2003, 2004, Marimon and Zilibotti, 1998, and Kambourov and Manovskii, 2004). These studies have raised the question whether rising medium- to long-run unemployment could be attributable to diverging sectoral developments, combined with impediments to mobility and the risk of human capital loss during long spells of joblessness. By all accounts, workers are not as easily redeployed across sectors, occupations and locations as commonly-used models would assert.

Research on the roles of gross and net flows in structural change has been limited by the availability of detailed data on individual workers' employment histories. In this paper, we are able to assess both the extent and the dynamics of structural change by using data on individual worker transitions in West Germany during the time period 1975-2001. We do this by computing gross and net worker flows from a large panel data set which covers 2% of the German social security workforce, and by evaluating the extent of occupational and sectoral mobility over this period. We are thus able to identify precisely where structural change is most prevalent in the economy, which workers are most affected, which worker flows contribute most to it, *and how they do so*. Furthermore, we also emphasize the role the business cycle plays for sectoral and occupational worker reallocation.

Our most important and surprising finding is that the *West* German economy has exhibited a marked acceleration in the pace of structural change since 1990. This increase in deindustrialization is evident not only from analyzing the evolution of employment shares derived directly from our data - we use Chow-type tests to show that there is strong evidence of structural instability in the early 1990s - but also from measures of structural change associated with Lilien (1982). To our knowledge, this increase in the massive reallocation of workers has gone unnoticed in the previous literature. At the same time, we find little aggregate shift in the rate of gross worker turnover in the economy, nor do we uncover any significant increase in entropy measures based on sectoral gross turnover rates, until the mid-1990s, which means that the *net* yield from gross turnover increased during this time period. That these structural shifts begin in 1990 strongly suggest that German unification and eastern enlargement affected not only the new German states, but also had significant, persistent implications for the West Germany economy.

We then proceed to examine in more detail the source of this increase in net flows given gross flows. We begin by computing raw sectoral and occupational mobility rates as reported for the United States by Kambourov and Manovskii (2004). The German case offers an interesting contrast to the US, because occupational training in Germany is delivered by a pervasive apprenticeship system. While overall sectoral and occupational mobility in Germany did not increase significantly until the mid-1990s, important differences exist in these rates across age groups. Moreover, mobility patterns differ significantly between sectors which are expanding (such as services) and those which are contracting (such as manufacturing): net growth in employment in expanding sectors tends to represent workers originating from outside the labor force, while declining sectors tend to release workers into unemployment. Furthermore, growing sectors increase their employment share via higher inflow rates, not via lower outflow rates. Conversely,

[2]The data in this section are from the OECD STAN Database and Statistische Ämter der Länder (2006).

shrinking sectors reduce employment via lower inflow rates, not by higher outflows out of employment. We also report on the cyclical variation of these types of mobility. The results suggest that the business cycle plays an important role for the extent of sectoral reallocation in the economy. In particular, gross flows tend to decline in recessions, while net flows tend to rise.

The paper is organized as follows. Section 2 summarizes the theoretical and empirical literature on the linkages between structural change and gross worker flows, in the short and the long run, and presents some summary evidence on Germany and Europe in this context. Section 3 gives a detailed description of the data set and the calculations used to generate gross and net employment flows. In Section 4, we present new evidence on the evolution of the sectoral employment structure of the West German economy. The fifth section analyzes the dynamics of structural change by examining gross and net worker flows across sectors. We find that the gross flows results are consistent with the findings of Section 4: since 1990, Germany has experienced accelerated structural change, measured on the basis of a number of indicators. The final section summarizes these results and discusses their implications for theory and policy.

2 Theoretical and Empirical Perspectives on Structural Change

2.1 Long-run Trends and Structural Change

The long-run evolution of economies from agricultural, then to industrial, and finally to service-based structure is the key prediction of the "three-sector-hypothesis" associated with Fisher, Clark, and Fourastié. Central to most theoretical explanations is an exogenous, persistent divergence in labor productivity growth rates in manufacturing and services, as well as a relatively inelastic demand for services.[3] At the sectoral level, it is natural to think of an economy buffeted by idiosyncratic disturbances which reflect changes in tastes, terms of trade, technologies, or institutional interventions, and empirical evidence tends to support the view that these factors are responsible for long-term movements in unemployment.[4] One of the first models to consider this in general equilibrium was Lucas and Prescott (1974). Rogerson (1987, 2005) extended this analysis to include multi-sectoral models. In the former, a two-period, two-sector model with permanent sectoral shocks is analyzed. Rogerson (2005) proposes a variant of the Lucas-Prescott model which allows for finitely lived agents and sector-specific human capital. In contrast to Lucas and Prescott (1974), where workers always move from declining to expanding sectors, workers from a declining sector might well end up non-employed. This analysis thus allows for a richer set of worker histories. More recently, Lee and Wolpin (2006) investigate the importance of the costs workers face when switching their sector of employment, as well as the role of labor supply and demand factors in the growth of the service sector. In order to do so, they estimate a two-sector growth model with aggregate and idiosyncratic shocks for the US economy. They find that these mobility costs are large, and that demand side factors, namely technical change and movements in product and capital prices, were responsible for the growth of the service sector.

[3] See Baumol (1967) for theoretical linkages of labor productivity growth differences to the secular development of the size of the service sector. Balassa (1964) discussed these developments in terms of nontraded output. Fuchs (1980) linked these developments to increasing female labor force participation. More recently, Ngai and Pissarides (2005) have studied a multi-sector model of growth with differences in TFP growth rates between sectors to derive conditions for balanced growth. For empirical assessments see Layard, Nickell, and Jackman (2005), and the recent report by the European Central Bank (van Riet, Ernst, Madaschi, Orlandi, Rivera, and Benoît, 2004).

[4] Marimon and Zilibotti (1998) decompose employment and labor cost in 11 European countries into country, industry, and temporal influences, and attribute 80% of the long-run differentials across countries and industries in employment growth to sectoral effects. They argue that Spain's very high unemployment in the 1990s was mainly due to the difficulties this economy had with reallocating workers from agriculture to industry. van Riet, Ernst, Madaschi, Orlandi, Rivera, and Benoît (2004) review the main stylized facts concerning sectoral specialization in the European Union, as well as the changes that have taken place over time. One of their findings is that some countries (notably Finland, Germany, and Sweden) experienced above-average rates of sectoral reallocation in the early 1990s. In their analysis of the service sector employment in the EU-15, D'Agostino, Serafini, and Ward-Warmedinger (2006) conclude that an efficient sectoral reallocation of labor has been hindered by the inflexibility of the labor market and by the mismatch between workers' skills and job vacancies.

2.2 The Business Cycle and Structural Change

Another, somewhat unsuccessful strand of the macroeconomic literature has linked structural change to business cycle fluctuations. In his seminal contribution, Lilien (1982) associated downturns with periods of high sectoral desynchronization, arguing that sectoral shocks require the reallocation of workers between sectors. Because of the time-consuming nature of the labor reallocation process, frictional unemployment arises, which raises the overall unemployment rate. This hypothesis did not hold up to subsequent analyzes. Abraham and Katz (1986) and Blanchard and Diamond (1989) show that the evolution of vacancies is not consistent with the sectoral-shocks explanation. In particular, vacancy data do not show large differences in labor demand between sectors. Without very strong complementarities across sectors, such sectoral shocks cannot be seen as a cause of higher unemployment; rather, sectors merely differ in their sensitivity to aggregate shocks. According to Groshen and Potter (2003), the cyclical sensitivity of different sectors in the US economy has changed over time. They attribute the "jobless recovery" of the years 2001-2003 to the fact that more job losses during the preceding recession were permanent than had usually been the case in previous recessions. This means that structural transformation seems to have impeded certain industries from re-employing workers they had previously shed. Despite a lack of empirical support, the "Lilien Hypothesis" gave rise to further attempts to study sectoral complementarities and their role in the cycle. In a related vein, Caballero and Hammour (1994) endogenized the restructuring decision to allow for endogenous scrapping of capital, implying that recessions are better times for firms to "clean house" and shed unproductive capacity.

While this paper is mainly concerned with sectoral flows, it is related to a more general literature on mobility in the labor market, looking especially at the consequences of worker mobility for individual workers and for the economy as a whole.[5] Voluntary job mobility by individual workers has been extensively analyzed in the job search literature (for an overview of job search, see Rogerson, Shimer, and Wright, 2005). One of the conclusions related to our investigation is that young workers follow a two-stage search strategy: they first try to find a job in a preferred occupation, and only afterwards decide on which sector they want to work in (See, for example, Neal, 1999). Involuntary job mobility, on the other hand, has been studied extensively in the displaced workers literature (see Hamermesh, 1989, Burda and Mertens, 2001, Kuhn, 2002, and Bender and von Wachter, 2006). Displacement has implications both for future wages and for the subsequent labor market history of workers. These consequences are likely to be more negative when a worker has to change sector or occupation, as this implies the loss of sector- or occupation- specific human capital. Worker mobility thus plays a role for the evolution of the wage structure. As Kambourov and Manovskii (2004) point out, the increase of occupational mobility in the United States coincides with a spreading out of the wage distribution, since occupational change implies a loss of human capital, and hence a wage loss.[6] Finally, worker mobility is also important for the allocation of workers to their most productive use in the economy.

2.3 Turbulence and Labor Market Dynamics

Structural change and worker mobility is related to the recent discussion of *turbulence* in the labor market. It must be stressed that there exist a number of different notions of turbulence.[7] First, following Lilien (1982), turbulence could be defined as the increased *net* reallocation of workers between sectors during a period. Second, turbulence may be defined as an increasing instability of employment relationships, i.e. an increase in *gross* worker flows (cf. Farber, 1999). Third, one can define turbulence as an increase in mismatch on the labor market. Layard, Nickell, and Jackman (2005) look at the mismatch between labor

[5] Jovanovic and Moffitt (1990) estimate a structural model with both idiosyncratic and sectoral productivity shocks. They find that, for the US between 1966-1980, while having a lower impact than idiosyncratic factors, sectoral shocks play an important role for gross worker mobility.

[6] Note, however, that most of the increase in occupational mobility found by Kambourov and Manovskii (2004) occurs in the early 1970s. This result is thus consistent with Vella and Moscarini (2004), who do not find an increase in occupational mobility, because their analysis only starts in 1976.

[7] Note that there is also evidence on turbulence from outside the labor market. Comin and Phillipon (2005), for example, document that the sales volatility of firms has been steadily increasing since the 1960s.

demand and labor supply across economic sectors. This can be measured by examining either sectoral market tightness or sectoral unemployment rates. Similarly, Marimon and Zilibotti (1999) construct a theoretical model where workers have specific skills and firms have specific skill requirements. An increase in the mismatch between skills and skill requirements can be seen as an increase in turbulence. In a related vein, Ljungqvist and Sargent (2004) equate turbulence to the increased loss of human capital while workers are unemployed, which reduces the incentive to take up a new job. This is especially the case when unemployment benefits are high. Note that this definition only posits a reduced outflow rate from unemployment, but remains silent about all other worker flows.

While there is thus a large literature on the causes and the effects of sectoral change, there seems to be a lack of analyzes which specifically look at the dynamics of this change. The paper closest to our approach is Greenaway, Upward, and Wright (2000) who examine the behavior of net and gross worker flows in the UK over the time period 1950-2000. Their key findings are, first, that gross worker flows do not display a secular trend, and second, that net worker flows, i.e. sectoral reallocation, was higher in the 1970s and 1980s than in any other post-war decade. They also argue that gross worker flows are not indicative of the amount of sectoral reallocation occurring. Instead, they are best seen as an indication of the cost of sectoral reallocation.

There exists some work on occupational and sectoral mobility in Germany. The dynamics of the German labor market were analyzed by Bachmann (2005) using the IAB Regional File 1975-2001. This data set consists of registry data provided by the Institute for Employment Research (IAB) of the German Federal Employment Agency. He finds that worker flows do not display a marked trend over the time period considered, although there is some acceleration in gross flows in the second half of the 1990s. This is consistent with the evidence presented by Winkelmann and Zimmermann (1998), who find no evidence of increased job instability in Germany for the time period 1974-94. Similar findings are reported by Farber (1999) for the US. As for the cyclical features of worker flows, Bachmann (2005) shows that while separations are relatively flat over the business cycle, accessions are strongly procyclical. This points to the fact that hirings play a key role for the dynamics of the labor market. In the US context, this point has been stressed by Hall (2005) and Shimer (2005).

Velling and Bender (1994) analyze the cross-sectional properties of occupational mobility for employment covered by social security legislation for the year 1989. They also use registry data provided by the IAB. Their main findings are as follows: occupational mobility depends strongly on worker characteristics such as age, education, and sex. Furthermore, the labor market history of a worker, in terms of both wages and previous transitions, has an important impact on the probability of a change of occupation. Bender, Haas, and Klose (1999b) provide descriptive evidence on both types of mobility for the time period 1985-1995 using the same data set. From this, they conclude that the influence of the business cycle on both series is strong. Furthermore, unemployed workers are found to have become more mobile over the time period considered. Gathmann and Schoenberg (2006) analyze the transferability of specific skills across occupations using the IAB employment sample (IABS) 1975-2001. They find that movers can transfer between 20 and 33% of the value of occupational tenure across occupations. Isaoglu (2006) explicitly analyzes occupational mobility of male employed workers in Germany for the time period 1985-2003 using the German Socioeconomic Panel (SOEP). She estimates probit transition models and concludes that occupational mobility is strongly procyclical and strongly dependent upon individual characteristics.

2.4 This Study

Our study is explorative in nature and meant to aid the inductive search process from a wide class of existing models. The empirical approach differs from the work described above in a number of ways. First, we use information on individual transitions in the IAB employment sample (IABS) for the time period 1975-2001 to study aggregate gross and net sectoral worker flows over the period 1975-2001.[8] The main advantages of the IAB data set, which is described in detail below, are that the information is relatively accurate, that the sample size is very large, and that the same workers are followed over a

[8] Unfortunately, the data for the time period after 2001 has not yet been made available for public research.

long period of time.[9] Second, we consider occupational and sectoral mobility for workers experiencing different labor market transitions, namely those who switch to a new job without intervening spell of non-employment, those who were previously unemployed, and those who were not covered by the system of social security beforehand. Third, we consider men and women separately. Finally, this study considers data from Germany, the third largest economy in the world, the largest in the European Union as well as one long beset by chronic unemployment.

3 Data and Measurement Issues

3.1 The IAB Regional File

The data set used is the IAB Regional File 1975-2001 (IABS-R01), which is generated by the Institute for Employment Research (IAB) of the German Federal Employment Agency. The data base covers 2% of all the persons who worked in an employment covered by social security between the 1st January 1975 (for western German employees) or the 1st January 1992 (for eastern German employees) and the 31st December 2001. The data source consists of notifications made by employers to the social security agencies, which include health insurances, statutory pension schemes, and unemployment insurance.[10] These notifications are made on the behalf of workers, employees and trainees who pay contributions to the social insurance system. This means that, for example, civil servants and self-employed are not included. Overall, the subsample includes roughly 1.3 million people, of which 1.1 million are from western Germany. For 1995, the employment statistics, from which the IAB Regional File is drawn, cover roughly 80% of the employed persons in western Germany, and 86% of all employed persons in eastern Germany. Of the unemployed, only those entitled to unemployment benefits are covered. This means that the unemployment stock is about one third lower than that reported in official labor statistics.[11] Data observations are generated by notifications which are made at the beginning and at the end of an employment or unemployment spell. Furthermore, there is an annual report which updates some of the information. The information provided is the following: sex, year of birth, and degree of education/training. Also, information on the occupation and the gross earnings of workers, an establishment number, and the economic sector is available on a daily basis. Our notion of a job is based on establishments, not firms, which means that a change of establishment within the same firm will also be recorded as a job change. Employers do not have to notify the social security agency if *only* the sector or the occupation of an employee changes. However, this information must be reported in every mandatory notification, i.e. at the beginning of an employment spell, and at the beginning of every calendar year. As a change of sector always involves a new employment relationship, and thus a new notification, every such change is recorded. This is not true for changes of occupation, as this might well change for an employee while he remains in the same establishment. Therefore, a change of occupation on the same job will only be recorded at the end of the year. This means that some occupational mobility is not recorded, for example when an employee changes his occupation and the match is destroyed before the next annual notification. Thus, we have exact information on sectoral mobility, and a lower bound on occupational mobility. The empirical analysis considers 16 broad economic sectors; 128 different occupations are recorded.

Two states of the labor market can be directly derived from the data set: employment covered by social security, and unemployment, if the worker is receiving some form of unemployment compensation. The third state that we consider, "non-participation", is not directly recorded but is defined as those individuals of working age who do not pay social security contributions while employed, and do not receive unemployment benefits. This means that non-participation includes the state "out-of-the-labor-force", but also self-employment, civil service employment, retirement, or marginal employment. "Non-participation" thus provides an upper bound for "out-of-the-labor force".[12]

[9] This is not the case for the CPS, where workers are only followed for four consecutive quarters.
[10] For a complete description of the data set, see Bender, Haas, and Klose (2000).
[11] See Bender, Haas, and Klose (1999a).
[12] Cf. Fitzenberger and Wilke (2004) for an in-depth analysis of this issue.

This data set has a number of unique advantages. First, it does not suffer from the problems inherent in most panel data sets, e.g. there is no sample attrition, and it follows workers over a long period of time as opposed to rotation-based samples such as the CPS.[13] Given the length of our times series, the evidence here is likely to be more conclusive than the US studies cited above, which observe only one episode of labor market tightening (1994-2000) and slowdown (2000-2003). Our data set covers two decades and two full business cycle swings. Second, it offers observations at a very high frequency, which means that every actual transition is observed. This is a distinct advantage over survey data like the CPS or the SOEP, which does not record multiple transitions that take place between two interview dates and, in the case of the SOEP, uses retrospective data. Two limitations of the data are noteworthy. First, it is representative for the working population covered by social security legislation, and not the entire working population. Second, it only covers unemployed who receive unemployment benefits. Therefore, this special structure of the data set should be taken into account when interpreting the different flows, especially the ones going to and from non-participation.

3.2 Construction of Worker Flows

Given the data on the employment state of workers, there are two possible ways to calculate worker flows. First, one can use point-in-time comparisons. This implies checking the labor force state of each individual at two given dates (e.g. at the beginning of two consecutive months), and inferring the ensuing flow from this comparison. Second, one can calculate flows cumulatively, i.e. taking into account every change of state that takes place, even if there are several changes of state within a given time period (e.g. a month). As our data record every single move with daily accuracy, we opt for the latter approach. Thus, we take into account short spells as well, which are generally not recorded in other data sets.[14] As it is possible to track the employment and unemployment history of every person in the data set, we can compute the flows to new job matches from different origins. We do so for employer-to-employer (EE) transitions, unemployment to employment (UE) transitions, and transitions from non-participation to a new employment (NE).

We need to address the possibility of measurement errors in the data. In particular, workers' notifications of leaving the state of unemployment might not always correspond exactly to the actual change of labor market state. We correct for this latter potential measurement error in the following way: If the time interval between an unemployment and an employment record is smaller than 30 days, we count it as a direct transition between the two states recorded.[15] If the gap between two notifications is larger than 30 days, we count this as an intervening spell of non-participation. As for job-to-job flows, records that are from the same person and the same establishment are counted as one single spell as long as the time between two consecutive employment notifications does not exceed 7 days.

As we are interested in consistent time series that go back as far as possible, the empirical analysis is restricted to workers from western Germany. As there is no information on the place of residence in the data set, we discard observations on employees that at some point have worked in eastern Germany. We also drop some observations, such as artists, who feature an implausibly high number of spells. As these observations are due to administrative rules, they are not interesting from an economic point of view. We therefore eliminate all observations for any person who features more than 200 employment spells over the time period considered. We also exclude apprentices. The number of people receiving unemployment benefits is measured with significant error before 1980; consequently, the stock of those workers, as well as the flows from that state, are not used. As employment is correctly measured, we obtain reliable estimates for direct job-to-job transitions for the entire time period 1975 to 2001.

[13] Technically attrition is possible in the sense of non-benefit recipients and labor force activity in the underground economy.

[14] Note, however, the qualification mentioned above with respect to occupational mobility.

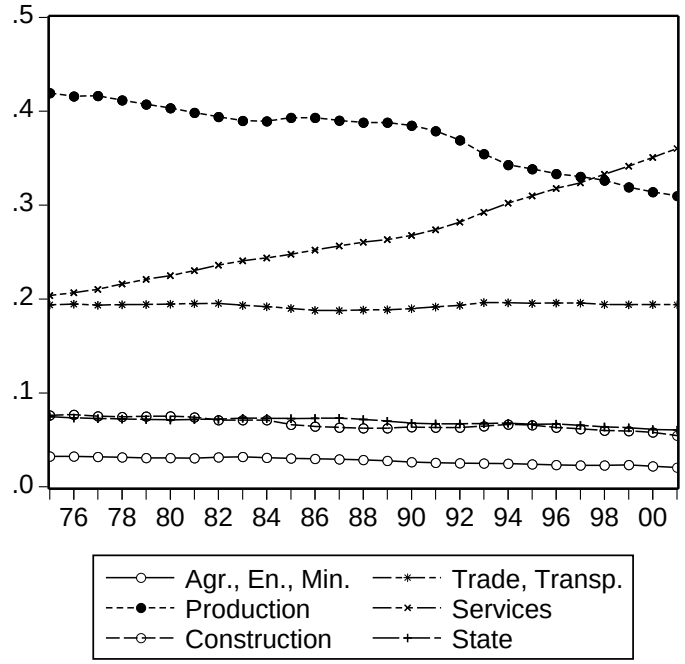
[15] Recalculation of spells for shorter intervals does not change the results significantly.

4 Findings: Sectoral Employment and Structural Change

4.1 The Sectoral Structure of the German Economy

We begin by examining trends in the allocation of dependent status, socially-insured, employment across six main sectors of the economy: agriculture, production, energy and mining, trade and transport, services and government. Dependent-status employment is defined for each year in our sample (1975-2001) as the average of the employment levels on the 15th of every month of that year.[16] The results are displayed in Figure 1, which conveys the quantitative importance of the different sectors. For the time period considered, most workers were employed in production, in the service sector, and in trade and transport; construction, agriculture, energy, and mining, and the public sector are quantitatively much less important. The three latter sectors, as well as trade and transport, are relatively stable over time and show little if any pronounced trend. The most striking evolution in the graph is the reduction of the employment share in the production sector, and a concomitant, sharp increase in the size of the service sector. The employment share of services rises by more than 10 percentage points, matched by an equal decline in the production sector's share.

Figure 1: Sectoral employment shares.



Source: IABS-R01 and authors' calculations.

Sectoral shares of full-time and part-time employment for a finer breakdown of 16 sectors are presented in Table A.1 in the appendix. Over the time period 1975-2001, household-related services remained relatively stable; the employment share of social services, however, increased by over 80%, and the share of business related services more than doubled. As for shrinking sectors, the decline in the employment share is strongest for primary and intermediate goods production (-40%), consumption goods (-41%), and construction (-45%). The main message of this analysis is that over the last decades, an ongoing process of structural change in the German economy has reallocated workers from the production sector to the service sector. Within the service sector, business-related services have increased most, while the

[16] Ideally, one would use beginning or end of year figures. However, due to the particular way in which data is collected in the IAB-data set, we are unable to do so.

share of household-related services has remained relatively constant. Moreover, this process seems to have accelerated since 1990. A natural question to address is whether the reallocation of workers from shrinking to expanding sectors has been smooth, or whether the pace of structural change has accelerated over time. This is the topic of the next section. Another question is: did those workers who have left declining sectors find work in the growing sectors? If so, are they working in the same occupation as before?

4.2 Net Structural Change and Turbulence

In general it is difficult to identify or much less measure causal factors behind turbulence. In the first instance, technical change is unobservable; the emergence of technical innovations does not necessarily imply that producers make immediate use of them, or they may do so with a delay. For that reason, economists are forced to study the variance or entropy of observable economic outcomes, for example changes in net employment, unemployment or sectoral value added. Lilien (1982) was among the first to look at the variance of the dispersion of employment growth rates as an indicator of turbulence. He argued that a large fraction of variance of the unemployment rate could be traced to this measure of turbulence. Following Layard, Nickell, and Jackman (2005) we calculate a turbulence index due to Lilien (1982). The index used takes the form[17]

$$\lambda_{d,t} = \frac{1}{2} \sum_{j=1}^{J} \left| \Delta_d \frac{E_{j,t}}{E_t} \right|. \tag{1}$$

Here, J denotes the number of economic sectors considered, $E_{j,t}$ is employment in sector j in period t, E_t is total employment in period t, Δ is the difference operator, and d indicates the number of years over which the difference is taken. Thus, for example, $\lambda_{1,t}$ measures the turbulence at time t as half the sum of changes in sectoral shares from year t to year $t-1$. The division by two is performed in order to avoid double counting. The evolution of the turbulence index is depicted in Figure 2 for six main economic sectors and three differences, namely 1-, 5-, and 8-year differences. As one can see, the indices rise with the amount of difference considered, i.e. the λ_5-index is larger than the λ_1-index, and the λ_8-index is larger than the λ_5-index. This could have been expected as the λ_1-index captures short-run changes (from one year to the next), while the other indices capture more long-run trends. What is striking however, is that all three measures indicate a marked increase in turbulence in the 1990s. Especially the early 1990s seem to have been a particularly turbulent period. This is in all likelihood due to the impact that German reunification had on the labor market of the entire country. But even in the second half of the 1990s, the indices do not return to the previous, lower levels of the 1980s. Neglecting the jump in the early 1990s and comparing the time periods 1985-89 and 1995-99, the means of the three indices increase by at least 85%. This means that this type of turbulence did not abate even more than five years after German reunification.

Table 1: Lilien index for sectors and occupations, different time periods

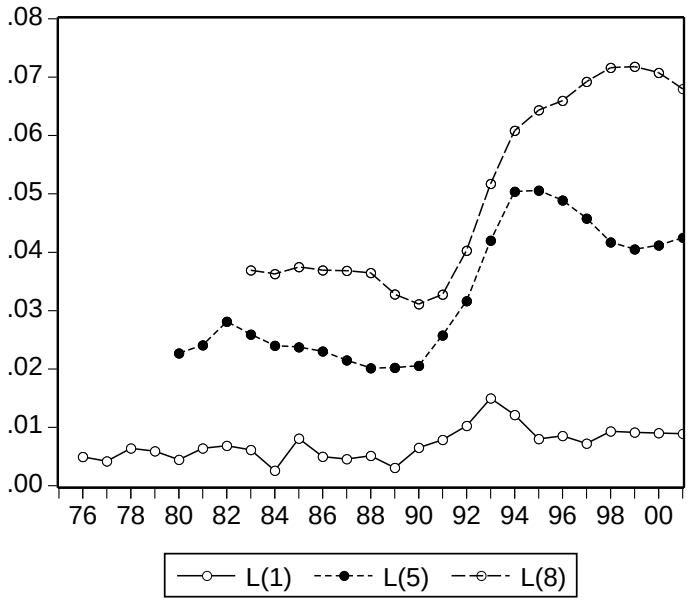
	1976-2000	76-80	81-85	85-90	91-95	96-00
Occupational turbulence, J=10	0.55	0.49	0.56	0.44	0.74	0.57
Sectoral turbulence, J=6	0.71	0.52	0.60	0.49	1.07	0.87
Sectoral turbulence, J=16	0.81	0.62	0.72	0.65	1.11	0.94

Source: IABS-R01 and authors' calculations.
Note: The Lilien index is defined in equation 1. Results are for $d = 1$.

Our findings for sectoral turbulence for a more detailed sectoral division are in Table 1 and in Figure 3. As one can see, the results are robust to considering a larger number of sectors: the Lilien indices

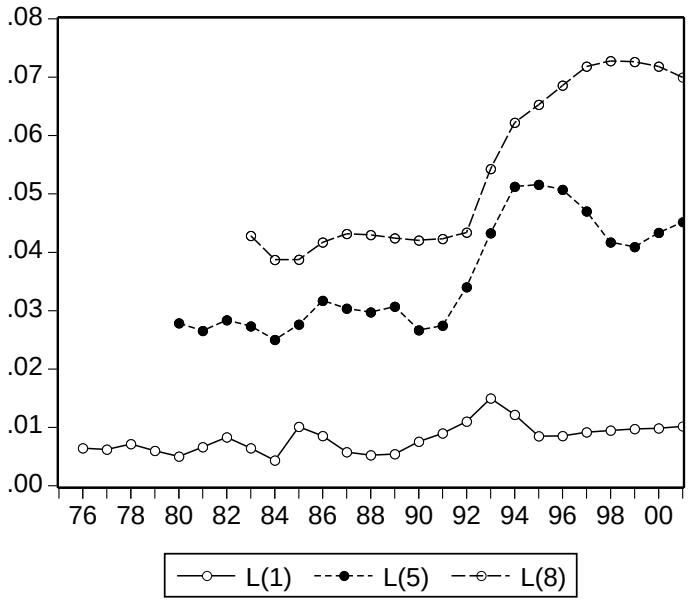
[17] The original Lilien (1982) index is defined as $\sigma = \left[\sum_{j=1}^{J} (\frac{E_{jt}}{E_t})(\Delta \log E_{jt} - \Delta \log E_t)\right]^{1/2}$. The reason for calculating a modified index is that it provides a more natural point of comparison for the flow analysis we are conducting. The two indices yield very similar results. For more discussion and use of this index, see Layard, Nickell, and Jackman (2005).

Figure 2: Turbulence index for different time lags, J=6



Source: IABS-R01 and authors' calculations.
Note: The Lilien index is defined in equation 1.

Figure 3: Turbulence index for different time lags, J=16



Source: IABS-R01 and authors' calculations.
Note: The Lilien index is defined in equation 1.

computed for 16 economic sectors also strongly rise in the early 1990s, and go back in the second half of the 1990s. However, in the latter period they still remain above the levels of the 1980s. The results

for turbulence with respect to occupations are in the same table. Similarly to the results for sectors, the Lilien index rises sharply in the early 1990s. Thereafter, however, it returns to levels which are similar to those in the 1980s.

To investigate why the sectoral Lilien indices increased in the early 1990s, and why they have remained high thereafter, we rewrite the modified Lilien index in the following way:

$$\lambda_t = \frac{1}{2}\sum_{j=1}^{J}\left|\Delta\frac{E_{j,t}}{E_t}\right| \approx \frac{1}{2}\sum_{j=1}^{J}\left|\frac{E_{j,t}-E_{j,t-1}}{E_t}\right| = \frac{1}{2}\sum_{j=1}^{J}\left|\frac{i_{j,t}-x_{j,t}}{E_t}\right|$$

where $i_{j,t}$ are inflows into and $x_{j,t}$ are outflows from sector j during time period $[t-1,t]$. The approximation holds if the changes in the employment stocks are not too large from one year to the next. Then, it is easy to see that the Lilien index will increase if inflows and outflows diverge. This can happen for two reasons: first, if the short-run variations of inflows and/or outflows increase, and, second, if long-run trends accelerate. In order to examine the second possibility, we run regressions of the form

$$y_t = c + at + by_{t-1} + \epsilon_t,$$

where $y_t \equiv \frac{E_{j,t}}{E_t}$ is the employment share of sector j at time t, c is a constant, t a time trend, and ϵ_t an error term.[18] We analyzed these series for structural breaks using the Chow forecast, the Chow sample split, and the Chow breakpoint tests. Using these tests, we analyzed the stability of the above regression for every year from 1980. As the tests are known to have substantially distorted size if the number of observations is small, we use bootstrap versions of the tests in order to size-adjust them (cf. Candelon and Lütkepohl, 2001). The p-values of the three tests for the employment share of the productive sector are in Figure A.1. Given that low p-values indicate instability, there is weak evidence for instability in the mid-1980s, and strong evidence for a structural break in the early 1990s, especially for the years 1991 and 1992. The results for the service sector (not reported here) are very similar, with signs of instability already occurring in the late 1980s. We conclude that the year 1990 marks a watershed for the West German labor market: After reunification, the structural change in the economy, i.e. the sectoral reallocation of workers, accelerated significantly.

5 More Detail: A Dissection of Mobility and Structural Change

The last section documented significant sectoral shifts in the structure of German dependent-status employment since 1990, but was silent about how structural change actually occurred. For example, from 1990 to 2000, the number of dependent-status workers in the West German manufacturing sector declined from 8.5m to 6.5m.[19] How was this reduction achieved? To answer this question, we need to compute from our data set individual gross worker flows with longitudinal information on the workers in question.

A gross flow can occur for several reasons. A change in labor demand of one economic sector relative to the others gives rise to flows from one sector to another, i.e. net sectoral reallocation. Changes in idiosyncratic productivity of a match can also result in worker flows which at some later data lead to matches in a different economic sector. It is possible to imagine workers "trading places" between sectors - for example if the relative demand for labor at the sectoral level remains unchanged but reallocation of workers turns out to be a Pareto improvement for everyone. Here, a worker flow in one direction implies another in the reverse direction. These two worker movements thus lead to gross reallocation of labor while leaving net reallocation and the distribution of workers across sectors unchanged.

Our analysis proceeds in several steps. First, we examine cross-sectional and long-run trends in gross worker flows in Section 5.1. A detailed analysis of net worker flows can be found in Section 5.2, where

[18] The great majority of employment share series proved to be trend-stationary at least at the 5% level of significance. Because of this, and because of the low power of unit root tests, we treated all time series as trend-stationary.

[19] Cf. Statistische Ämter der Länder (2006).

we investigate the evolution of the components of net flows, as well as the contribution of sectoral inflow and outflow rates to structural change. Finally, in Section 5.3, we examine the role of the business cycle for the dynamics of structural change.

5.1 Gross Sectoral and Occupational Mobility

First, we examine the cross-sectional properties of the worker flows in the labor market which are associated with a change of sector, occupation, or both. The aim of this exercise is to deliver a general picture of the magnitude of those flows, as well as of the differences between worker groups. Second, we examine the long-run trends of gross worker flows. This will give an indication of whether labor market dynamics have changed over time.

Consider first employment inflows: newly formed employment relationships (accessions) involving a change of sector, or occupation, or both, and distinguish between three different states of origin: employment, unemployment, and non-participation. Effectively, we are looking at flows entailing a change of sector/occupation with workers moving from one employer to another (EE flow) and from unemployment to employment (UE flow). Furthermore, transitions from the state of nonparticipation (technically, non-registration) to employment (NE flow) are analyzed.[20] The analysis is conducted separately for men and women, and for three different age groups, 16-29, 30-49 and 50-65.

The central statistic for our analysis is the rate of incidence of a transition conditional on being in the three states at the outset (employment, unemployment and nonparticipation), measured over a fixed period of time. In doing so we follow, but also extend Kambourov and Manovskii (2004). While these rates are computed on a cumulative monthly basis (i.e. all transitions are recorded on a daily basis), they will be generally presented as annual averages or averaged over several years. This rate captures the overall level of sectoral or occupational mobility, respectively. As both types of mobility are likely to be related to the type of transition a worker experiences at the same time, we also study the conditional probability of having made a sectoral or occupational transition, given that one particular employment transition has occurred. The rates generated in this way are meant to capture sectoral and occupational mobility *over and above* the movements in worker flows. They can therefore be interpreted as behavioral changes given a certain labor market transition.

5.1.1 Cross-Sectional Results

Table 2 provides an overview of different labor force transition probabilities on an annual basis for the time periods 1981-1990 and 1991-2000. Note that the transition probabilities to a new employer or to a new sector are calculated in the cumulative way described above. This means that all transitions are taken into account, also when a worker has multiple transitions within one year. The "no transition" category is calculated as one minus the sum of all transition probabilities. The results show that transitions from employment are most likely to lead to non-participation or to unemployment. The annual probability of a worker experiencing a direct job-to-job transitions is lower, and these transitions more often take place within the same sector rather than involving a change of sector. Workers leaving unemployment are most likely to transit to the state of non-participation. Furthermore, when a worker leaves unemployment, he is more likely to find a job in the sector where he has worked previously rather than in a different sector. Exits from non-participation usually lead to employment, and not to unemployment. Finally, note that these transition probabilities have changed over time, as a comparison between the two time periods considered shows. This issue will be considered in the next section.

Next, we analyze differences between age cohorts, and men and women. Table 3 shows the unconditional incidence, for dependent status employees, of moving into employment and changing sector at the same time, as well as the probability of changing sector conditional on making a certain type of transition. The corresponding results for occupational changes are presented in Table 4.

[20] Note that the data set does not contain any information on workers when they are neither in dependent-status employment nor receive unemployment compensation. We are therefore not able to report changes of sector or occupation for EN and NE transitions.

Table 2: Labor force transition probabilities

		Destination				
		No Transition	Employment, Same Sector	Employment, Different Sector	U	N
Origin	E	74.6 *72.9*	4.1 *5.2*	3.4 *4.0*	7.3 *6.5*	10.6 *11.4*
	U	- -	46.1 *30.3*	34.3 *28.2*	- -	56.9 *54.8*
	N	92.9 *92.6*	- -	5.5 *5.8*	1.6 *1.6*	- -

Sources: Statistisches Bundesamt, IABS-R01 and authors' calculations.
Notes: Figures report transition probabilities for the time period 1981-1990 (first figure for each transition) and for 1991-2000 (second figure for each transition, in italics) in % per annum. E, U, and N stand for the labor market states of dependent-status employment, unemployment, and non-participation.

Table 3: Sectoral transition probabilities and fraction of transitions involving a change of sector by age and sex

	Men			Women		
	EE	UE	NE	EE	UE	NE
Age 16-29	6.8 *35.3*	57.0 *50.2*	11.0 -	5.8 *31.5*	41.9 *51.0*	9.8 -
Age 30-49	3.8 *31.6*	40.0 *44.7*	4.2 -	3.0 *30.6*	31.9 *47.1*	5.1 -
Age 50-64	1.5 *34.5*	11.6 *29.7*	2.1 -	1.4 *26.1*	9.8 *33.7*	1.5 -

Sources: Statistisches Bundesamt, IABS-R01 and authors' calculations.
Notes: EE, UE, and NE are transitions from employment, unemployment, and non-participation, respectively, to employment. For EE and UE transitions, the first figure for a cohort reports the average transition probability associated with a change of sector; the second figure (in italics) reports which fraction of a given transition is associated with a change of sector. For NE transitions, information on sectoral mobility is not available; the average transition probability is reported. All figures in % per annum, averages for 1980-2000.

Table 4: Occupational transition probabilities and fraction of transitions involving a change of occupation by age and sex

	Men			Women		
	EE	UE	NE	EE	UE	NE
Age 16-29	6.2 *31.9*	58.6 *51.7*	11.0 -	4.9 *26.5*	41.2 *50.1*	9.8 -
Age 30-49	3.1 *25.8*	41.9 *46.1*	4.2 -	2.3 *23.1*	30.9 *45.6*	5.1 -
Age 50-64	0.9 *20.4*	12.5 *31.9*	2.1 -	0.8 *14.6*	9.7 *33.6*	1.5 -

Sources: Statistisches Bundesamt, IABS-R01 and authors' calculations.
Notes: EE, UE, and NE are transitions from employment, unemployment, and non-participation, respectively, to employment. For EE and UE transitions, the first figure for a cohort reports the average transition probability associated with a change of occupation; the second figure (in italics) reports which fraction of a given transition is associated with a change of sector. For NE transitions, information on occupational mobility is not available; the average transition probability is reported. All figures in % per annum, averages for 1980-2000.

The rates of incidence are very similar with respect to sectors and occupations. Looking at the

differences between age cohorts, one can see that the incidence probabilities are all strongly falling with age. This finding can be rationalized by the fact that young workers, who have only relatively recently entered the labor market, are engaging in job shopping in order to look for the sector and the occupation that suits them best (cf. Neal, 1999). For older workers, this effect is of less importance. Also, older workers have accumulated more sector/occupation-specific human capital. Changing sector or occupation therefore entails a larger loss of human capital for older workers than for younger workers. Hence, the propensity to change sector and occupation is falling with age.[21]

In general, women exhibit lower rates of sectoral and occupational change. This finding is in line with the evidence presented in Fitzenberger and Kunze (2005), who argue that female workers are often locked in low wage careers, characterized by low mobility and for which job changes only lead to small wage gains. The probability of changing sector and occupation is higher when a worker has been unemployed previously than when he experiences a direct job-to-job transition. This implies that direct job-to-job transitions generally take place between jobs involving the same sector and occupation. These results are quite similar for women, with one exception: for women at a young age, direct job-to-job transitions are much less likely to involve a change of occupation than for men.

5.1.2 Long-Run Trends

Let subscript j and t denote an economic sector and time period $[t, t+1]$, respectively. Then, we can compute a measure of gross worker flows normalized by the labor force as follows:

$$gross_t/L_t = \left[\sum_{j=1}^{J} 0.5 \cdot (EEI_{j,t} + EEX_{j,t}) + UE_{j,t} + EU_{j,t} + EN_{j,t} + NE_{j,t} \right] \cdot \frac{1}{L_t}$$

where $EEI_{j,t}$ are inflows into and $EEX_{j,t}$ outflows out of a sector j in period $[t, t+1]$ associated with a direct job-to-job transition; UE, EU, EN, and NE are the transitions between the states of employment E, unemployment U, and non-registration N. The "dependent-status (and socially insured) labor force" is defined as $L_t \equiv E_t + U_t$. This measure of gross flows gives an impression of the overall amount of sectoral worker reallocation in the economy. The resulting time series is in Figure 4, and averages for different time periods are in Table 6 in the appendix. Apart from business cycle fluctuations, the series is quite stable until the mid-1990s, after which it rises sharply.

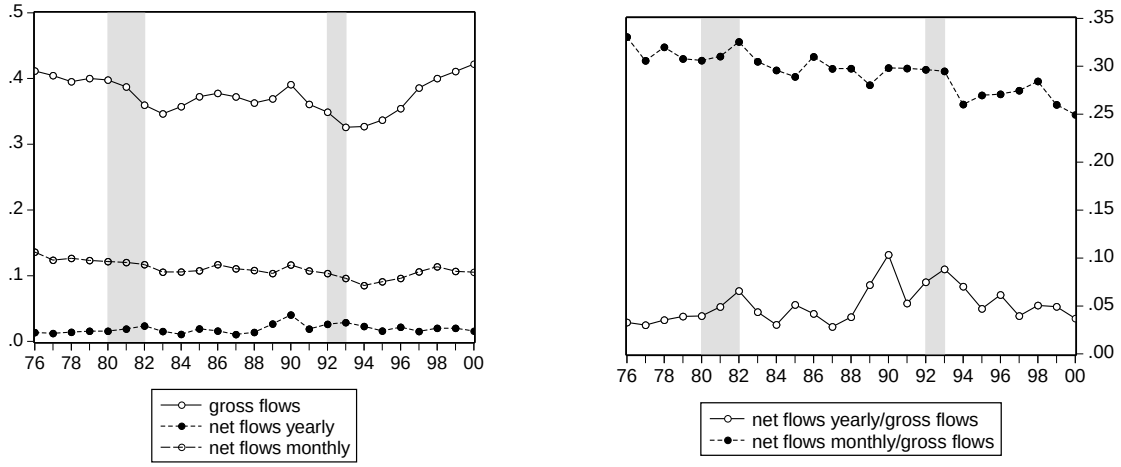
Next, we analyze the evolution of transition probabilities introduced in the previous section over time. In particular, we are interested in whether a certain type of transition displays a clear trend. This will cast further light on the questions of whether one can see more turbulence in the labor market as well as inform with respect to the source of turbulence. The analysis is now more detailed and can reveal whether employment relationships have become less stable, whether the unemployed have become more or less mobile over time (which might be an indication of Ljunqqvist-Sargent type turbulence), or whether there have been more or less direct job-to-job transitions involving a change of sector and/or occupation.

Table 2 in the previous section shows that there are clear differences between the transition probabilities in the 1980s and the 1990s. First, employment became slightly less stable, with the annual probability of remaining in the same job falling from 74.5% to 72.9%. Second, the probability of leaving unemployment to employment fell strongly. In particular, the probability of an unemployed worker to find a job in his previous sector of employment dropped dramatically from 46.1% to 30.3%. The probability of an unemployed worker to find a job in another sector also fell, but by less (from 34.4% to 28.2%). Finally, the exits from non-participation did not change significantly between the two decades.

We now look at the different time series in detail. The evolution of the joint probability of experiencing a sectoral change together with a job-to-job transition is in Figure A.2 in the appendix. The left panel displays these probabilities for different age groups of male workers, while the right panel shows the same for female workers. While there is no long-term trend in the data, the series are strongly procyclical.

[21] Because sectors are more broadly defined than occupations, the probability of sectoral change is generally lower than that for occupational change.

Figure 4: Gross and net flows across sectors



Source: IABS-R01 and authors' calculations.
Notes: Net flows on a monthly and a yearly basis normalized by the labor force (left panel), and the ratio of net to gross flows (right panel).

Furthermore, the cylicality is falling with age. In order to keep the analysis tractable, in the remainder of this section, we only discuss the results for men aged between 25 and 55.[22]

Figure A.3 depicts different measures of flows between sectors, while Figure A.4 does the same for occupations (both figures are in the appendix). The left panel shows the fraction of new employment relationships which involve a worker who has changed sector, and who has made either a direct job-to-job transition, or who has been previously unemployed, or not in the data set. The right panel displays the fraction of new employment relationships which involve a worker who has changed occupation *conditional on* a certain labor market transition. The latter transition thus abstracts from movements in the number of labor market transitions, and focuses on the fraction of labor market transitions which lead to a change of sector in the total number of a certain labor market transition. As for trend behavior, none of the series features a strong long-run trend, with one exception: The conditional probabilities of changing sector and of changing occupation after an unemployment spell has been strongly rising since the early 1980s. Thus, the unemployed seem to have become occupationally more mobile during the last two decades. This might be an indication for Ljungqvist-Sargent type turbulence: If the skills of the unemployed started depreciating more quickly from the early 1980s, then it is likely that the unemployed will have a lower propensity to return to their sector and/or occupation in later periods.

5.1.3 Gross Sectoral Flows and Outsourcing

Structural change does not only occur because workers are moving from one economic sector to another. Organizational changes within firms can also play an important role. In particular, firms might split up along their business divisions. As an example, a car manufacturer might create a subsidiary firm dealing uniquely with the logistics of the manufacturer. In the extreme case, the subsidiary firm will employ exactly those workers that were previously employed by the manufacturer, and perform exactly the same tasks. This case of "outsourcing" would show up as a sectoral employment shift, although the tasks performed in the economy have not changed. In order to test whether outsourcing is driving our results, we employ the following strategy:[23] Outsourcing as in the case described above would involve a

[22]The results for all age groups, and men and women, are similar with respect to long-run trends and cyclicality. They are available from the authors upon request.

[23]If there was firm information in the data set we use, we could analyze this issue in greater detail. However, this is unfortunately not the case, i.e. we only dispose of information on individual workers.

sectoral transition of an individual worker, but not a change of occupation. We therefore analyze which percentage of sectoral transitions involve a change of occupation as well. As direct job-to-job transitions are likely to play the most important role in this respect, we concentrate on these flows. The result is in Table 5.

Table 5: Percentage of sectoral EE flows involving a change of occupation for different time periods

1976-2000	1976-80	1981-85	1985-90	1991-95	1996-2000
58.3	62.3	55.9	61.8	57.4	54.0

Source: IABS-R01 and authors' calculations.

It becomes apparent that in all time periods considered, the majority of direct job-to-job transitions across sectors go together with a change of occupation. Furthermore, the percentage of sectoral EE flows involving a change of occupation has not fallen dramatically, as would have been the case if outsourcing had been a major driving force behind structural change. We see these results as evidence that outsourcing could have played some role, but certainly not an overwhelming one.

5.2 Net Flows

Having examined gross flows and sectoral inflows and outflows, we now turn to the analysis of net sectoral flows, i.e. changes in sectoral employment stocks. We calculate two different measures of net reallocation: the first measure has a net effect on sectoral employment stocks on a monthly basis, the second has a net effect on a yearly basis. Note that these two measures can move independently from each other, depending on which proportion of short-run turbulence is canceled out over the year.

Both time series are in Table 6 and in the left panel of Figure 4. The results show a marked difference between the two time series computed. Net flows on an monthly basis display a relatively small, but clear downward trend. This implies that the short-run variation in net changes has declined over time. Calculating net flows from seasonally adjusted worker flows reveals that this decline is entirely due to seasonal factors. Net flows on a yearly basis, on the other hand, increased over the same time period, and especially in the early 1990s. Given the results obtained for the modified Lilien index in Section 4.2, the latter result is not surprising. However, the fact that at the same time seasonally-induced short-run variations declined is somewhat of a puzzle.

5.2.1 Accounting for Changes in Employment Stocks: The Role of Different Labor Market Transitions

Having found that the evolution of employment stocks changed significantly from the beginning of the 1990s, we now want to analyze in more detail where these changes come from. In order to do so, we calculate the flow components of changes in stocks. Note that sectoral reallocation can be expressed in terms of flows:

$$net_t/L_t = \left[\sum_{j=1}^{J} |EEI_{j,t} - EEX_{j,t} + UE_{j,t} - EU_{j,t} + NE_{j,t} - EN_{j,t}| \right] \cdot \frac{1}{L_t}$$

We calculate both the differences $EEI - EEX$, $NE - EN$, $UE - EU$, and the individual flows. We do this for the economy as a whole, and for two sectors, the one with the highest growth in employment share (business-related services), and the one with the strongest decline in its employment share (consumer goods).

Net Flows: Aggregate Results

The results for the economy as a whole are in Table 6. Several features are noteworthy. First, direct job-to-job transitions only play a minor role for structural adjustment. Not only is their level low

relative to the other flows, but their net impact, measured by the difference between EEI and EEX, is low as well. Furthermore, their net effect over the time period considered is relatively stable. Second, both according to their level and their net effect, the flows between employment and unemployment are much more important. The level of these flows is relatively stable until the mid-1990s and increases thereafter. Finally third, the flows between employment and non-registration play the most important role. This is both true for the level of the gross flows, and for the net effect, which peaked in the second half of the 1990s.

Table 6: Yearly net and gross flows across sectors as share of the social security workforce, and ratio of net to gross flows

	1981-2000	81-85	85-90	91-95	96-00
Gross flows	36.8	36.5	37.4	34.0	39.5
0.5*(EEI+EEX)	3.6	2.8	4.0	3.8	4.0
UE+EU	11.7	13.3	12.0	10.3	11.4
NE+EN	21.5	20.3	21.5	19.9	24.1
Net flows, yearly basis	2.0	1.8	2.1	2.3	1.9
$\|EEI - EEX\|$	0.4	0.4	0.5	0.5	0.4
$\|UE - EU\|$	1.3	1.7	0.8	1.3	1.3
$\|NE - EN\|$	1.8	1.4	2.3	1.4	1.9
Net flows, yearly basis, to gross flows	5.5	4.8	5.7	6.7	4.8
Net flows, monthly basis	10.6	11.1	11.1	9.7	10.6

Source: IABS-R01 and authors' calculations.
Notes: EEI and EEX are direct job-to-job transitions associated with a sectoral inflow and outflow, respectively. UE and NE are sectoral employment inflows from unemployment and non-participation, respectively. EU and EN are sectoral employment outflows to unemployment and non-participation, respectively. All figures in per cent.

The analysis in this section up to now was for the economy as a whole. However, given the divergence in the evolution of employment between sectors, one would presume that there are also important differences in the way these net changes come about. In order to investigate this matter further, we again look at the differences between flows analyzed above, as well as at individual flows. This time, however, we do so for two sectors: first, the consumption goods sector, which lost 35% of its employment share between 1975 and 2001, and second, the business-related service sector, whose employment share grew by 75% during the same period.

Net Flows: Growing vs. Shrinking Sectors

The results for the consumption goods sector are in Table A.3, and those for the business-related service sector are in Table A.4 in the appendix. Direct job-to-job transitions are higher in the growing sector. The net contribution of these transitions to employment change ($|EEI - EEX|$) is very small in both sectors though.

Two noteworthy aspects differentiate the two sectors. First, the outflow rates are not appreciably different, and the one for the growing sector is even higher (22.9% for the service sector and 20.7% for the consumption goods sector). Higher growth of the service sector can be attributed to its higher inflow rate (25.7%, vs. 18.7% in the consumption goods sector). Second, there is a large difference in the net contribution of the flows between employment and unemployment. For the shrinking sector, these flows are relatively high (53% of sectoral inflows), and they play by far the most important role for net sectoral employment changes. This is not the case for the business-related service sector: here, unemployment flows only play a minor role (19% of sectoral inflows). By contrast, the transitions between non-registration and employment are relatively low for the declining sector (29% of sectoral inflows), and are not important for its net employment changes. For the growing sector, the opposite is true: these

transitions are high (62% of sectoral inflows), and they are by far the most important contributor to changes in the employment share. We conclude that direct job-to-job transitions only play a minor role for net worker reallocation in both sectors, flows between unemployment and employment are most important for this purpose in the shrinking sector, which is the case for transitions between non-registration and employment in the growing sector. The results featured by the consumption goods sector and the business-related services sector can be found for the other sectors of the economy as well, depending on their respective growth performance. In other words, the features of the consumption goods sector are shared by the other shrinking sectors in the economy, and those of the business-related services sector are shared by the other growing sectors.

5.2.2 Accounting for Changes in Net Flows: Sectoral Inflow and Outflow Rates

In the previous section, we analyzed which labor market transitions are most important for net changes in sectoral employment. Now, we want to examine which sectors were mainly responsible for the rise in the Lilien index documented above. In order to do so, we calculate inflow and outflow rates for the economy at the six- and sixteen-sector level. Inflow rates for sector j, I_j/E_j, are calculated as the number of workers employed in a sector who were not employed in the same sector one year before - i.e. they can have been employed in a different sector, unemployed, or not in the sample - divided by the employment stock of that sector. Conversely, outflow rates for sector j, X_j/E_j, are the number of workers leaving a sector, to employment in a different sector, to unemployment, or to out of the sample, divided by the employment stock. The results for six sectors are in Table A.5; Tables A.6 and A.7 contain the inflow and outflow rates for 16 sectors. The inflow rates into the different sectors behave very similarly: there is no discernible long-run trend, and the rates are procyclical. The same is true for the outflow rates, although the volatility of the outflows rates is generally lower, with the construction sector being an obvious exception.

In order to determine which sectors played the most important role for the increase in worker reallocation recorded above, we calculate the difference between worker inflows and outflows. This yields the change in the employment stock of a sector, which in turn can be used to calculate the change in sectoral employment shares. The results are in Table A.8. The second column shows that the construction sector, as well as services in general, have experienced the most important employment changes during the time period 1975-2001. In order to find out what caused the increase in the Lilien index in the 1990s, one has to look at the evolution over time of the net employment changes. It becomes apparent that not a single sector, or a single group of sectors, is to blame. In the first half of the 1990s, the production sectors, and the consumption goods sector, were subject to an important increase in turbulence, while the service sectors experienced a volatility of net employment changes which was below average (business- and household-related services) or at least not significantly above average (social services). In the second half of the 1990s, the situation was completely different; the production and consumption sectors displayed relatively stable net employment changes, while turbulence in the transport and communication sector, and in business-related and household-related services increased sharply. Thus, the increase in turbulence over the 1990s was not due to a single source over the whole decade. Rather, the impact of the production sector was felt more strongly during the first half, while the same was true for the service sector during the second half of the 1990s.

5.2.3 Accounting for Changes in Net Flows: The Persistence of Sectoral Flows and Sectoral Recalls

As shown above, net sectoral worker flows have increased mainly in the early 1990s, while gross sectoral worker flows only started to increase from the mid-1990s. This points to the issues of the *persistence* of sectoral flows, as well as of sectoral recalls. In this section, we try to measure the persistence of both. First, as a measure of the persistence of sectoral worker flows, we calculate which percentage of those workers who start employment in a new sector at a given point in time are still employed in this sector in the next year. Second, in order to analyze which role temporary movements play, we also calculate sectoral recalls. In particular, we quantify the percentage of workers who start employment in a new sector and who take

up an employment again in the sector they were previously employed in one year later. We calculate these two time series both for workers who were employed, and for workers who were unemployed, before their sectoral switch. The results are summarized in Table 7. Neither the persistence of sectoral flows coming from employment, nor the persistence of sectoral flows coming from unemployment, has increased significantly since the early 1980s. However, the inclination of workers to return to their previous sector has clearly declined. This is true both for workers coming from employment and from unemployment. The latter fact speaks in favor of sectoral shocks having become more permanent.

Table 7: The persistence of sectoral flows

	1975/1980-1999	1975-79	1980-84	1985-89	1990-94	1995-99
Mover-stayers, prev. employed	73.0	72.0	71.7	73.7	73.9	73.8
Mover-returners, prev. employed	7.5	8.4	7.9	7.8	6.5	7.1
Mover-stayers, prev. unemployed	75.5	–	75.9	75.0	77.0	74.1
Mover-returners, prev. unemployed	4.5	–	4.8	4.6	4.1	4.5

Source: IABS-R01 and authors' calculations.
Notes: Percentage of sectoral changers who are still in the new sector one year after the switch ("Mover-stayers"), and percentage of sectoral changers who return to their previous sector within one year ("Mover-returners"). "Employed" and "unemployed" refers to the state before the move.

We conclude that direct job-to-job transitions play only a minor role for new worker reallocation in both sectors. In shrinking sectors, it appears that worker flows between unemployment and employment are most important for this purpose, while in growing sectors, this is true for transitions between non-registration and employment. This means that, in reality, we observe elements of the Lucas and Prescott (1974) vision of the world, namely employment-unemployment transitions; the pervasiveness of worker flows to and from non-participation, however, point to features stressed by Rogerson (2005). The relative importance of transitions for worker reallocation appears to depend on the growth rate of a given sector.

5.3 Worker Reallocation Over the Business Cycle

The effect of the business cycle on the economy as a whole and on the labor market in particular has been a contentious issue at least since the times of Schumpeter (1942). On the one hand, recessions can be seen as being "cleansing", because they are times when outdated techniques and products are squeezed out of the market (Caballero and Hammour, 1994). On the other hand, recessions coincide with sharp declines in job-to-job transitions, which generally improve the quality of worker-firm matches (Barlevy, 2002, Krause and Lubik, 2006). Recessions can thus lead to a reduction in the average quality of newly created matches, i.e. they can have a "sullying" impact.

We add a new dimension to this debate by looking at the cyclicality of sectoral and occupational changes. The cylicality of gross flows and sectoral mobility and occupation mobility can be seen in Figures A.3 and A.4 respectively, which examine both transitions going together with a change of sector or occupation (left panel in the figures), and changes of sector or occupation conditional on a certain transition (right panel in the figures). The state of origin clearly matters. In a recession, fewer workers enter a new employment involving a different occupation directly from another job or from non-participation. Furthermore, given a transition from those two states of origin, the probability of changing sector or occupation goes down in a recession as well. Workers take advantage of favorable business cycle conditions in order to engage in on-the-job search, which then often results in a change of sector or occupation. On the contrary, in a recession, workers search less on-the-job, and even if they are successful in finding a new job, this transition is less likely to involve an occupational change than in a cyclical upswing.[24]

The picture looks different for workers coming from unemployment. In a downturn, the number of workers making a transition from unemployment to employment and switching occupation *increases*.

[24]The pro-cylicality of on-the-job search has been established by a number of researchers, including Burgess (1993) for the UK, and Fallick and Fleischman (2004) and Nagypál (2004) for the United States.

However, the probability of changing occupation conditional on having made a transition from unemployment to employment is falling. In other words, flows from unemployment to employment are generally going up in a recession.[25] This also raises the number of UE transitions which go together with a new occupation, but the share of UE transitions involving an occupational switch is falling. Therefore, in a recession, the probability of an unemployed worker finding a new job in the sector he was previously working in is going up. This is in all likelihood due to the fact that, in a recession, the proportion of workers who have only very recently joined the pool of the unemployed, is rising. These workers usually command more than average sector- or occupation-specific human capital and will be rehired quickly in their sector (occupation) of origin.

It is also instructive to analyze the behavior of net and gross sectoral mobility, depicted in Figure 4. In a recession, gross employment flows fall, which is mainly due to a reduction in the number of job-to-job transitions (cf. Bachmann, 2005). This is the "sullying" aspect of recessions. On the other hand, net flows go *up* in a downturn. This means that sectoral reallocation increases in bad times, i.e. recessions are then indeed times of economic restructuring, which could play a cleansing role. In an upswing, the labor market is relatively tight, leading workers to engage in on-the-job search. Direct job-to-job transitions are a consequence. However, workers are reluctant to change sector or occupation as this involves the loss of at least some sector- or occupation-specific human capital. Therefore, net employment changes are relatively low. In a downturn, the reverse is true: firms' hiring activity is low, and more workers have to change sector in order to find a job at all, even if this involves the loss of some specific human capital. In recessions, gross worker flows decline, even while net worker flows are increasing.

6 Conclusion

Like all industrial countries, Germany has experienced at least two decades of considerable structural change.[26] This paper set out to document the extent to which the labor market developments have mirrored the structural change in output composition. In particular, are gross and net labor market flows into and out of employment informative about the way structural change occurred? Was the decrease in employment in shrinking sectors a result of an increase in separations or a decrease in accessions? Was the increase in employment in growing sectors a result of an increase in accessions or a decrease in separations? Did the newly hired in growing sectors originate from outside the labor force, or were they unemployed, or even already employed? Have workers become more prone to switch occupational and industrial attachment? Are these processes sensitive to the business cycle? Has there been a recognizable change in recall behavior of firms, that is, to reemploy those with previous experience in the sector? In order to analyze the dynamics of structural change in more detail, we constructed worker flows from a panel data set covering 2% of the German social security workforce for the time period 1975-2001.

At the outset, we documented an important fact which, to our knowledge, has gone unnoticed in the literature: the pace of structural change in socially insured employment in the *west* German economy accelerated sharply after 1990, i.e. the manufacturing sector began shrinking more quickly, and the growth rate of the service sector increased significantly. While the employment share of the service sector rose by six percentage points in the period 1976-1990, that pace of change quickened to ten percentage points over the period 1991-2000. This development was accompanied by a significant increase in "turbulence" or variance of net employment changes, as measured by the dispersion or variance of k-period growth rates.

A quarter century ago, Lilien (1982) argued that recessions were periods of accelerated structural change, and that the increase in unemployment theoretically could be the result of sharply diverging sectoral evolutions. Subsequent work by Abraham and Katz (1986) and others showed that this was not the case: sectoral movements in vacancies and unemployment tend to be highly correlated across

[25] The finding of procyclical exits from unemployment to employment is consistent with Burda and Wyplosz (1994).

[26] For an international perspective, see van Riet, Ernst, Madaschi, Orlandi, Rivera, and Benoît (2004), D'Agostino, Serafini, and Ward-Warmedinger (2006), and Marimon and Zilibotti (1998).

sectors over the business cycle. In contrast to phenomena stressed by Lilien (1982), the changes we find in Germany appear to be of longer term nature.[27] Cyclical movements appear to mask low-frequency structural change which is more evident when differencing is performed on longer intervals. Interestingly, we found that gross worker (employment) flows and net worker flows - flows having a net impact on sectoral employment stocks - have not always moved together. In particular, net worker flows increased dramatically in the early 1990s, while gross worker flows only started to increase in a significant way after 1995. Put differently, the net sectoral "yield" from gross worker flows increased sharply since 1990.

We then investigated net worker flows in more detail. We found that job-to-job flows play only a minor role for net changes in sectoral employment, followed by transitions between employment and unemployment. Most important are flows between employment and non-participation (defined as being outside the group of employed or unemployed dependent-status employment). At the same time, net flows can vary significantly between sectors, as seen by a comparison of a sharply contracting sector (e.g. consumer goods) with a strongly growing sectors (e.g. business-related services). We showed that the employment share of the consumer goods sector fell mainly because of a low inflow rate, and not because of a high outflow rate. These results resemble the findings by Shimer (2005) using aggregate time series data. The opposite is true for the business-related services sector, however; its share in total employment increased due to a high inflow rate; the outflow rate out of employment was actually higher than in the consumer goods sector. We documented furthermore that, for the shrinking sector, both inflows and outflows were dominated by flows to and from the state of unemployment. By contrast, hirings from, and separations to non-participation were most important in the business services sector.

Finally, while the data are available for a limited time period only, we investigated the behavior of net and gross flows over the business cycle. Net reallocation was found to be counter-cyclical, and gross reallocation to be pro-cyclical. We interpret this as an indication of both clogging and cleansing effects of recessions: job-to-job transitions involving a change of sector decline sharply in economic downturns; workers are forced to change sectors, which leads to rising net reallocations. The mechanisms by which structural change occurs shed light on the effects of active and passive labor market policies. In general, economies can achieve structural change either by forcing costly mid-career industrial and occupational changes, or by "attrition", i.e. parking displaced workers in long-term unemployment, early retirement or disability pension, using retirements and voluntary separations where possible to reduce workforces, while relying on labor force entrants as a source of new workers. Thus while we have refrained in this paper from modeling structural change explicitly, our findings have implications for the relevant class of models which can help understand structural change in Germany. Consistent with the recent contribution by Rogerson (2005), we find that German workers - especially older ones - who lose their jobs in shrinking sectors tend to leave the labor force after extended spells in unemployment. Growing sectors tend to recruit new employees from outside the socially insured labor force. We do not find a significant component of net employment growth originating in transitions through unemployment, as in Lucas and Prescott (1974).

The weight of the evidence presented in this paper supports the proposition that structural change accelerated in Germany around 1990. Our analysis is silent on causes, however. The structural break could be related to the significant appreciation of an undervalued real exchange rate, which resulted from higher inflation and the collapse of the European Monetary System in the early 1990s. At the same time, German unification unlocked new sources of production factors as well as new market opportunities, and will continue to spur both structural change as well as institutional reform. Eastern enlargement of the European Union represents much the same process, with much larger long-term impact, yet at a much lower pace. To understand better the root causes of the shifts we have identified, research will need to focus on more detailed data, i.e. geographically-based, matched firm-employee datasets.

[27] It should be pointed out that, while we have also analyzed occupational changes, we have focused our attention on sectoral change because it is likely that the German system of apprenticeships and training introduces a considerable element of sector-specific human capital, and therefore immobility.

References

Abraham, K. G., and L. F. Katz (1986): "Cyclical unemployment: Sectoral shifts or aggregate disturbances?," *Journal of Political Economy*, 94(3), 507–22.

Bachmann, R. (2005): "Labour market dynamics in Germany: Hirings, separations, and job-to-job transitions over the business cycle," Collaborative Research Center 649 Discussion Paper 2005-45, Humboldt-Universität zu Berlin.

Balassa, B. (1964): "The purchasing power parity doctrine: A reappraisal," *Journal of Political Economy*, 72, 584–596.

Barlevy, G. (2002): "The sullying effect of recessions," *Review of Economic Studies*, 69(1), 65–96.

Baumol, W. (1967): "Macroeconomics of unbalanced growth: The anatomy of urban crisis," *American Economic Review*, 57, 415–26.

Bender, S., A. Haas, and C. Klose (1999a): "Die IAB-Beschäftigtenstichprobe 1975-1995," *ZA-Information*, 45, 104–115.

——— (1999b): "Mobilität allein kann Arbeitsmarktprobleme nicht lösen," *IAB kurzbericht*, 2.

——— (2000): "IAB employment subsample 1975-1995. Opportunities for analysis provided by the anonymised subsample," IZA Discussion Papers 117, Institute for the Study of Labor (IZA).

Bender, S., and T. von Wachter (2006): "In the right place at the wrong time - The role of firms and luck in young workers' careers," *American Economic Review*, 96(5), 1679–1705.

Blanchard, O. (2006): "European unemployment: The evolution of facts and ideas," *Economic Policy*, 1, 1–54.

Blanchard, O., and P. Diamond (1989): "The Beveridge Curve," *Brookings Papers on Economic Activity*, 1, 1–76.

Bruno, M., and J. Sachs (1985): *Economics of worldwide stagflation*. Cambridge, Massachusetts: Harvard University Press.

Burda, M. C., and A. Mertens (2001): "Estimating wage losses of displaced workers in Germany," *Labour Economics*, 8(1), 15–41.

Burda, M. C., and C. Wyplosz (1994): "Gross worker and job flows in Europe," *European Economic Review*, 38(6), 1287–1315.

Burgess, S. M. (1993): "A model of competition between unemployed and employed job searchers: An application to the unemployment outflow rate in Britain," *Economic Journal*, 103(420), 1190–204.

Caballero, R. J., and M. L. Hammour (1994): "The cleansing effect of recessions," *American Econonomic Review*, 84(5), 1350–1368.

Candelon, B., and H. Lütkepohl (2001): "On the reliability of Chow-type tests for parameter constancy in multivariate dynamic models," *Economics Letters*, 73(2), 155–160.

Clark, C. (1940): *The conditions of economic progress*. London: Macmillan.

Comin, D., and T. Phillipon (2005): "The rise in firm-level volatility: Causes and consquences," in *NBER Macroeconomics Annual*, ed. by M. Gertler, and K. Rogoff, vol. 20, pp. 167–202. MIT Press.

D'Agostino, A., R. Serafini, and M. Ward-Warmedinger (2006): "Sectoral explanations of employment in Europe - the role of services," ECB Working Paper Series 625, European Central Bank.

Fallick, B., and C. A. Fleischman (2004): "Employer-to-employer flows in the U.S. labor market: the complete picture of gross worker flows," Finance and Economics Discussion Series 2004-34, Board of Governors of the Federal Reserve System (U.S.).

Farber, H. S. (1999): "Mobility and stability: The dynamics of job change in labor markets," in *Handbook of Labor Economics*, ed. by O. Ashenfelter, and D. Card, vol. 3, pp. 2439–2483. Elsevier.

Fisher, A. G. (1935): *The clash of progress and security*. London: Macmillan.

Fitzenberger, B., and A. Kunze (2005): "Vocational training and gender: Wages and occupational mobility among young workers," *Oxford Review of Economic Policy*, 21(3), 392–415.

Fitzenberger, B., and R. Wilke (2004): "Unemployment durations in West-Germany before and after the reform of the unemployment compensation system during the 1980s," ZEW Discussion Papers 04-24, Zentrum fr Europische Wirtschaftsforschung.

Fourastié, J. (1949): *Le grand espoir du XXe siècle; progrès technique, progrès économique, progrès social*. Paris: Presses universitaires de France.

Fuchs, V. R. (1980): "Economic growth and the rise of service employment," NBER Working Paper 486, National Bureau of Economic Research.

Gathmann, C., and U. Schoenberg (2006): "How general is specific human capital? Using mobility patterns to analyse skill transferability in the labour market," IZA Discussion Paper 2485, Institute for the Study of Labor (IZA).

Greenaway, D., R. Upward, and P. Wright (2000): "Sectoral transformation and labour-market flows," *Oxford Review of Economic Policy*, 16(3), 57–75.

Groshen, E. L., and S. Potter (2003): "Has structural change contributed to a jobless recovery?," Current Issues in Economics and Finance 8, Federal Reserve Bank of New York.

Hall, R. E. (2005): "Job loss, job finding, and unemployment in the U.S. economy over the past fifty years," in *NBER Macroeconomics Annual*, ed. by M. Gertler, and K. Rogoff. The MIT Press.

Hamermesh, D. S. (1989): "What do we know about worker displacement in the United States?," *Industrial Relations*, 28(1), 51–9.

Isaoglu, A. (2006): "Occupational mobility in Germany," mimeo, European University Institute.

Jovanovic, B., and R. Moffitt (1990): "An estimate of a sectoral model of labor mobility," *Journal of Political Economy*, 98(4), 827–52.

Kambourov, G., and I. Manovskii (2004): "Occupational mobility and wage inequality," IZA Discussion Papers 1189, Institute for the Study of Labor (IZA).

Krause, M., and T. Lubik (2006): "The cyclical upgrading of labor and on-the-job search," *Labour Economics*, 13, 459–477.

Kuhn, P. J. (ed.) (2002): *Losing work, moving on: International perspectives on worker displacement*. W. E. Upjohn Institute, Kalamazoo, Michigan.

Layard, R., S. Nickell, and R. Jackman (2005): *Unemployment. Macroeconomic performance and the labour market*. Oxford, UK: Oxford University Press, Second edition.

Lee, D., and K. I. Wolpin (2006): "Intersectoral labor mobility and the growth of the service sector," *Econometrica*, 74(1), 1–46.

Lilien, D. (1982): "Sectoral shifts and sectoral unemployment," *Journal of Political Economy*, 90(4), 777–93.

Ljungqvist, L., and T. J. Sargent (1998): "The European unemployment dilemma," *Journal of Political Economy*, 106, 514–550.

——— (2003): "European unemployment: From a worker's perspective," in *Knowledge, Information, and Expectations, in Modern Macroeconomics in Honor of Edmund S. Phelps*, ed. by P. Aghion, R. Frydman, J. Stiglitz, and M. Woodford. Princeton: Princeton University Press.

——— (2004): "European unemployment and turbulence revisited in a matching model," *Journal of the European Economic Association*, 2, 456–468.

Lucas, R., and E. Prescott (1974): "Equilibrium search and unemployment," *Journal of Economic Theory*, 7, 188–209.

Lütkepohl, H., and M. Krätzig (eds.) (2004): *Applied Time Series Econometrics*. Cambridge University Press, Cambridge.

Marimon, R., and F. Zilibotti (1998): "'Actual' versus 'virtual' employment in Europe. Is Spain different?," *European Economic Review*, 42, 123–153.

——— (1999): "Unemployment vs. mismatch of talents: Reconsidering unemployment benefits," *Economic Journal*, 109(455), 266–291.

Nagypál, E. (2004): "Worker reallocation over the business cycle: The importance of job-to-job transitions," mimeo, Northwestern University.

Neal, D. (1999): "The complexity of job mobility among young men," *Journal of Labor Economics*, 17(2), 237–61.

Ngai, L. R., and C. A. Pissarides (2005): "Structural change in a multi-sector model of growth," IZA Discussion Papers 1800, Institute for the Study of Labor (IZA).

Nickell, S., L. Nunziata, and W. Ochel (2005): "Unemployment in the OECD since the 1960s. What do we know?," *The Economic Journal*, 115, 1–27.

Rogerson, R. (1987): "An equilibrium model of sectoral reallocation," *Journal of Political Economy*, 95(4), 824–34.

——— (2005): "Sectoral shocks, specific human capital and displaced workers," *Review of Economic Dynamics*, 8(1), 89–105.

Rogerson, R., R. Shimer, and R. Wright (2005): "Search-theoretic models of the labor market: A survey," *Journal of Economic Literature*, 43(4), 959–988.

Schumpeter, J. (1942): *Capitalism, socialism and democracy*. New York: Harper & Row.

Shimer, R. (2005): "The cyclical behavior of equilibrium unemployment and vacancies," *American Economic Review*, 95(1), 25–49.

Statistische Ämter der Länder (2006): *Volkswirtschaftliche Gesamtrechnungen der Länder: Bruttoinlandsprodukt, Bruttowertschöpfung in den Ländern und Ost-West-Großraumregionen Deutschlands 1991 bis 2005*. Stuttgart: Statistisches Landesamt Baden-Württemberg.

van Riet, A., E. Ernst, C. Madaschi, F. Orlandi, A. S. Rivera, and R. Benoît (2004): "Sectoral specialisation in the EU a macroeconomic perspective," Occasional Paper Series 19, European Central Bank.

Vella, F., and G. Moscarini (2004): "Aggregate Worker Reallocation and Occupational Mobility in the United States: 1976-2000," 2004 Meeting Papers 183, Society for Economic Dynamics.

Velling, J., and S. Bender (1994): "Berufliche Mobilität zur Anpassung struktureller Diskrepanzen am Arbeitsmarkt," *Mitteilungen aus der Arbeitsmarkt- und Berufsforschung*, 3.

Winkelmann, R., and K. F. Zimmermann (1998): "Is job stability declining in Germany? Evidence from count data models," *Applied Economics*, 30(11), 1413–20.

Appendix A Results

Table A.1: Employment shares for 16 sectors for different time periods

	1976-2000	76-80	81-85	85-90	91-95	96-00
Agr., En., Min.	2.7	3.1	3.1	2.9	2.5	2.3
Primary, intermediate good production	7.8	9.1	8.5	7.9	7.1	6.2
Production: investment goods 1	10.1	10.3	10.3	10.7	10.0	9.4
Production: investment goods 2	9.3	9.6	9.4	9.9	9.0	8.4
Consumption goods	7.4	8.9	8.1	7.5	6.8	5.8
Food, beverages, tobacco	3.2	3.5	3.4	3.3	3.2	2.9
Main construction trade	4.2	5.2	4.7	3.9	3.8	3.4
Construction (upgrading)	2.5	2.4	2.5	2.4	2.7	2.7
Distr. services 1, e.g. wholesale trade	6.1	6.1	6.0	6.0	6.2	6.3
Distr. services 2, e.g. retail trade	8.7	8.7	8.8	8.5	8.8	8.9
Transport and communication	4.5	4.6	4.5	4.3	4.4	4.5
Services, business-related	10.3	7.9	8.8	9.8	11.4	13.5
Services, household-related	3.7	3.5	3.7	3.8	3.7	3.9
Services: social 1, e.g. hospitals	8.3	6.8	7.5	8.1	9.1	10.1
Services: social 2, e.g. organisations	4.1	3.0	3.5	4.0	4.6	5.5
Government services, social insurance	6.9	7.1	7.2	7.1	6.7	6.4

Source: IABS-R01 and authors' calculations.
Note: Figures in per cent.

Table A.2: Flows as share of the social security labor force

	1981-2000	1981-85	1985-90	1991-95	1996-2000
Sectoral inflows	20.3	19.1	21.6	18.5	21.9
0.5*(EEI+EEX)	3.6	2.8	4.0	3.8	4.0
UE	5.3	5.8	5.8	4.6	5.1
NE	11.3	10.4	11.8	10.2	12.8
Sectoral outflows	20.2	20.1	19.8	19.2	21.6
EU	6.4	7.4	6.1	5.7	6.3
EN	10.2	9.9	9.7	9.7	11.3

Source: IABS-R01 and authors' calculations.
Notes: EEI and EEX are direct job-to-job transitions associated with a sectoral inflow and outflow, respectively. UE and NE are sectoral employment inflows from unemployment and non-participation, respectively. EU and EN are sectoral employment outflows to unemployment and non-participation, respectively. Annual figures in per cent.

Table A.3: The consumption goods sector: Different flow measures as share of employment

	1981-2000	1981-85	1985-90	1991-95	1996-2000
Sectoral inflows	18.7	17.3	21.0	16.9	19.4
EEI	3.4	2.3	3.9	3.5	3.8
UE	5.4	5.5	6.0	5.0	5.1
NE	9.9	9.5	11.1	8.5	10.5
Sectoral outflows	20.7	20.4	20.4	20.8	21.4
EEX	3.7	2.7	4.1	4.0	3.8
EU	7.6	8.5	6.9	7.5	7.5
EN	9.5	9.2	9.4	9.3	10.1
Gross flows	39.4	37.7	41.4	37.7	40.8
0.5*(EEI+EEX)	3.5	2.5	4.1	3.8	3.8
UE+EU	13.0	14.1	12.9	12.5	12.5
NE+EN	19.4	18.6	20.4	17.8	20.6
Net flows, yearly basis	2.5	3.1	1.3	3.8	1.9
$\|EEI - EEX\|$	0.3	0.4	0.2	0.5	0.2
$\|UE - EU\|$	2.3	3.0	1.1	2.6	2.4
$\|NE - EN\|$	1.1	0.7	1.7	1.0	0.8

Source: IABS-R01 and authors' calculations.
Notes: EEI and EEX are direct job-to-job transitions associated with a sectoral inflow and outflow, respectively. UE and NE are sectoral employment inflows from unemployment and non-participation, respectively. EU and EN are sectoral employment outflows to unemployment and non-participation, respectively. Annual figures in per cent.

Table A.4: The business-related service sector: Different flow measures as share of employment

	1981-2000	1981-85	1985-90	1991-95	1996-2000
Sectoral inflows	25.7	21.3	26.9	24.3	31.4
EEI	4.8	3.7	4.9	5.1	5.4
UE	5.0	4.4	5.1	4.5	6.0
NE	15.9	13.2	15.9	14.7	20.0
Sectoral outflows	22.9	20.6	21.7	21.8	27.4
EEX	4.7	3.4	5.1	4.8	5.6
EU	5.1	5.5	4.6	4.6	5.7
EN	13.1	11.8	12.0	12.4	16.0
Gross flows	43.8	38.4	42.6	41.1	53.3
0.5*(EEI+EEX)	4.7	3.5	5.0	5.0	5.5
UE+EU	10.1	9.9	9.7	9.1	11.8
NE+EN	29.0	25.0	27.9	27.1	36.0
Net flows	2.9	0.7	4.2	2.5	4.0
$\|EEI - EEX\|$	0.3	0.3	0.2	0.4	0.3
$\|UE - EU\|$	0.7	1.0	0.7	0.4	0.7
$\|NE - EN\|$	2.9	1.5	3.9	2.2	4.0

Source: IABS-R01 and authors' calculations.
Notes: EEI and EEX are direct job-to-job transitions associated with a sectoral inflow and outflow, respectively. UE and NE are sectoral employment inflows from unemployment and non-participation, respectively. EU and EN are sectoral employment outflows to unemployment and non-participation, respectively. Annual figures in per cent.

Table A.5: Sectoral inflow and outflow rates for different time periods

	1976-2000	1976-80	1981-85	1985-90	1991-95	1996-2000
Inflow rate						
Agr., En., Min.	9.93	10.45	9.74	9.62	8.56	11.24
Production	9.69	10.59	9.06	10.69	8.41	9.66
Construction	14.28	15.05	12.92	14.70	13.57	14.59
Trade, Transp.	15.37	17.15	13.68	15.11	14.83	15.63
Services	16.49	17.57	15.01	16.13	15.74	17.76
State	10.97	11.97	10.62	11.59	10.07	10.41
Outflow rate						
Agr., En., Min.	13.53	12.84	13.02	12.63	12.74	16.46
Production	11.13	11.18	11.05	10.30	11.82	11.35
Construction	21.14	19.17	25.07	21.72	18.05	22.68
Trade, Transp.	15.94	17.18	15.79	15.06	15.50	16.27
Services	15.50	15.91	15.14	14.90	14.75	16.79
State	11.99	12.56	11.54	11.86	11.60	12.41

Source: IABS-R01 and authors' calculations.
Notes: The inflow and outflow rate are calculated as sectoral employment inflows and outflows divided by the employment stock, respectively. Annual averages calculated from yearly panel. Figures in per cent.

Table A.6: Sectoral inflow rates for different time periods

	1976-2000	76-80	81-85	85-90	91-95	96-00
Agr., En., Min.	9.9	10.5	9.7	9.6	8.6	11.2
Primary, intermediate good production	9.2	9.7	8.2	10.3	8.4	9.6
Production: investment goods 1	9.8	11.2	9.2	10.9	8.0	9.5
Production: investment goods 2	11.3	11.9	10.6	12.8	9.7	11.6
Consumption goods	12.4	14.0	11.3	13.2	11.3	12.2
Food, beverages, tobacco	22.7	29.0	21.5	23.9	19.1	20.0
Main construction trade	13.4	13.9	11.7	14.0	12.9	14.4
Construction (upgrading)	17.1	19.3	16.6	18.5	15.5	15.9
Distr. services 1, e.g. wholesale trade	17.0	19.3	15.0	17.0	16.9	16.8
Distr. services 2, e.g. retail trade	18.1	21.0	16.5	18.2	17.1	17.6
Transport and communication	14.3	14.4	12.0	14.6	14.2	16.5
Services, business-related	16.2	15.8	13.9	16.1	16.3	19.1
Services, household-related	22.5	24.5	22.4	23.5	19.9	22.2
Services: social 1, e.g. hospitals	16.1	18.4	14.8	15.6	15.3	16.5
Services: social 2, e.g. organizations	18.5	19.8	16.4	17.9	18.5	19.5
Government services, social insurance	10.5	11.5	10.1	11.2	9.7	10.1

Source: IABS-R01 and authors' calculations.
Notes: Sectoral inflow rates are sectoral inflows divided by the respective employment stock. Annual averages calculated from yearly panel. Figures in per cent.

Table A.7: Sectoral outflow rates for different time periods

	1976-2000	76-80	81-85	85-90	91-95	96-00
Agr., En., Min.	11.8	10.9	10.9	10.9	11.2	14.9
Primary, intermediate good production	10.8	10.6	10.2	10.1	11.3	11.9
Production: investment goods 1	10.0	10.4	9.7	9.1	11.0	9.9
Production: investment goods 2	11.7	11.7	11.2	11.1	12.7	12.1
Consumption goods	14.0	14.4	13.7	13.1	14.4	14.2
Food, beverages, tobacco	15.6	17.0	14.3	15.7	15.0	16.0
Main construction trade	15.2	13.9	16.3	14.1	13.9	17.8
Construction (upgrading)	16.7	18.0	17.9	16.0	14.6	16.8
Distr. services 1, e.g. wholesale trade	16.5	18.3	15.8	15.6	16.2	16.8
Distr. services 2, e.g. retail trade	18.3	20.2	18.1	17.3	17.4	18.5
Transport and communication	14.5	14.8	13.5	13.7	14.9	15.6
Services, business-related	14.1	13.8	13.1	13.3	14.2	16.2
Services, household-related	22.1	23.4	22.6	22.4	20.2	21.8
Services: social 1, e.g. hospitals	14.9	15.8	14.3	13.8	14.0	16.4
Services: social 2, e.g. organizations	16.5	16.9	14.7	16.3	16.2	18.5
Government services, social insurance	11.5	11.9	11.0	11.3	11.2	12.1

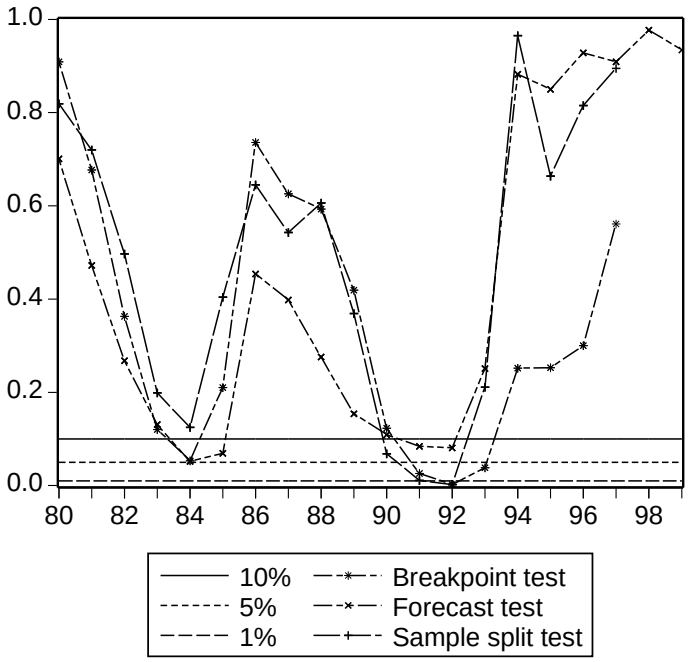
Source: IABS-R01 and authors' calculations.
Notes: Sectoral outflow rates are sectoral outflows divided by the respective employment stock. Annual averages calculated from yearly panel. Figures in per cent.

Table A.8: Changes in sectoral employment shares

	1976-2000	76-80	81-85	85-90	91-95	96-00
Agr., En., Min.	1.5	1.3	1.5	0.8	2.4	1.7
Primary, intermediate good production	1.9	0.8	1.9	1.6	2.9	2.3
Production: investment goods 1	1.9	0.7	1.7	2.5	3.2	1.6
Production: investment goods 2	2.4	0.8	2.8	2.5	3.3	2.4
Consumption goods	1.9	0.7	2.8	1.4	3.3	1.6
Food, beverages, tobacco	1.5	0.7	1.1	2.0	1.4	2.3
Main construction trade	3.0	2.8	5.1	2.7	1.2	2.9
Construction (upgrading)	2.3	1.5	2.3	4.0	2.3	1.5
Distr. services 1, e.g. wholesale trade	1.9	1.3	1.1	2.9	1.4	2.7
Distr. services 2, e.g. retail trade	2.0	1.7	1.1	2.9	1.3	3.1
Transport and communication	2.3	1.6	1.7	2.5	1.8	4.0
Services, business-related	3.8	2.8	1.1	4.8	3.4	7.1
Services, household-related	2.9	1.7	0.9	4.0	1.2	6.6
Services: social 1, e.g. hospitals	3.2	3.7	1.3	3.6	3.3	4.3
Services: social 2, e.g. organizations	4.1	4.1	2.9	3.9	4.4	4.1
Government services, social insurance	1.0	0.9	0.6	1.1	1.0	1.5

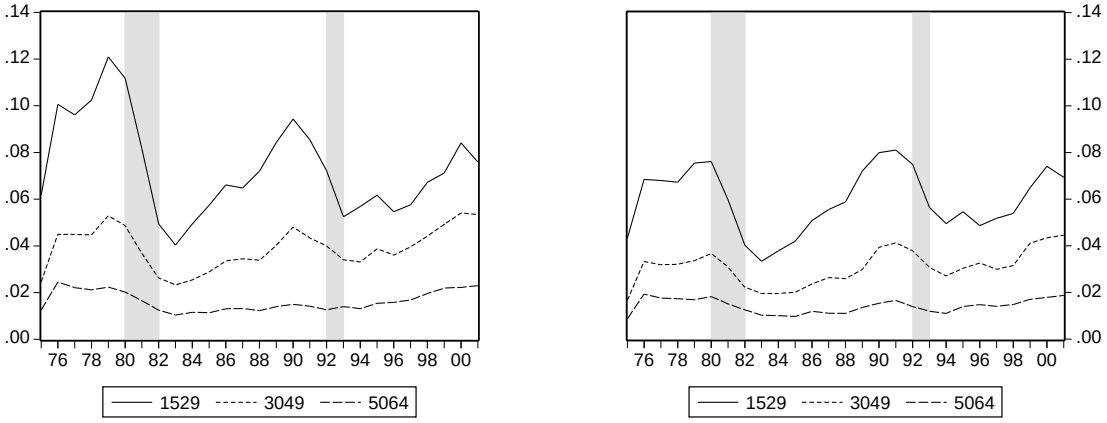
Source: IABS-R01 and authors' calculations.
Notes: Annual averages in per cent.

Figure A.1: p-values of Chow-type stability tests for the productive sector



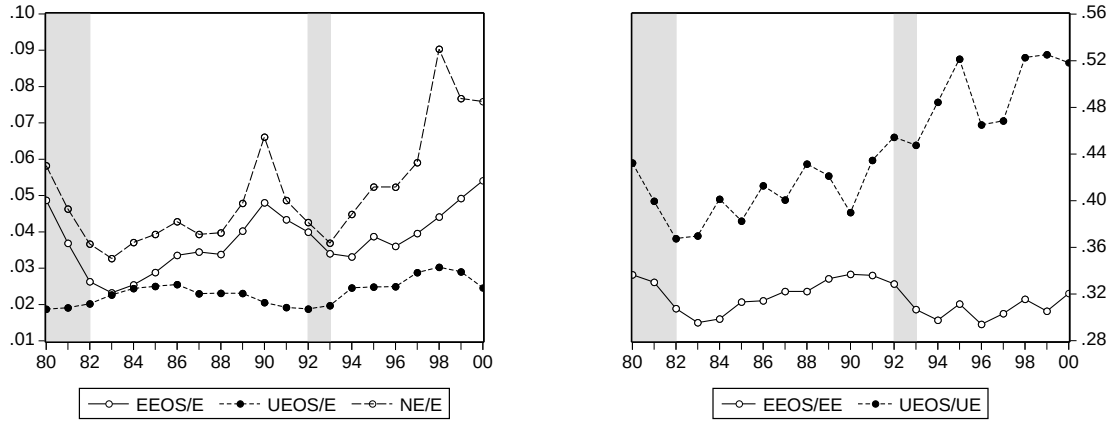
Source: IABS-R01 and authors' calculations.
Notes: p-values are bootstrapped and computed with JMulTi 4.15 (cf. Lütkepohl and Krätzig, 2004) using 1000 replications.

Figure A.2: Probability of experiencing a job-to-job transition together with a change of sector for different age groups and men (left panel) and women (right panel)



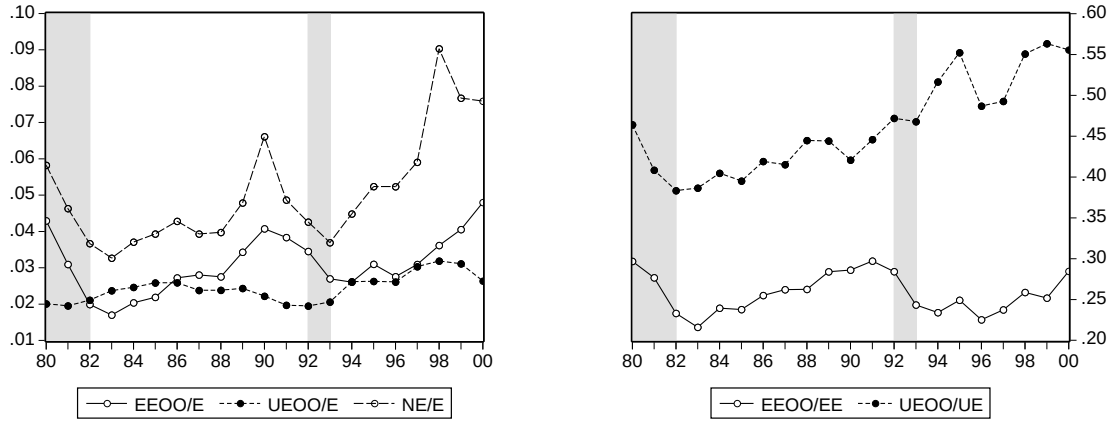
Source: IABS-R01 and authors' calculations.

Figure A.3: Labor market transitions normalized by the employment stock (left panel), and fraction involving a change of sector conditional on a certain labor market transition (right panel)



Source: IABS-R01 and authors' calculations.
Notes: EE are all direct job-to-job transitions, UE and NE all transitions from unemployment and non-participation to employment, respectively. EEOS and UEOS are the direct job-to-job transitions and transitions from unemployment to employment associated with a sectoral change. Yearly figures for male employees aged 30-49.

Figure A.4: Fraction of new employment relationships involving a change of occupation and a certain labor market transition (left panel), and fraction involving a change of occupation conditional on a certain labor market transition (right panel)



Source: IABS-R01 and authors' calculations.
Notes: EE are all direct job-to-job transitions, UE and NE all transitions from unemployment and non-participation to employment, respectively. EEOO and UEOO are the direct job-to-job transitions and transitions from unemployment to employment associated with a change of occupation. Yearly figures for male employees aged 30-49.