What hides behind the German labor market miracle? Unemployment insurance reforms and labor market dynamics*

Benjamin Hartung† Philip Jung‡ Moritz Kuhn§

October 2018

Abstract

A key question in labor market research is how the unemployment insurance system affects unemployment rates and labor market dynamics. We revisit this old question studying the German *Hartz reforms*. On average, lower separation rates explain 76% of declining unemployment after the reform, a fact unexplained by existing research focusing on job finding rates. Reduction in separation rates are heterogeneous with long-term employed, high-wage workers being most affected. We causally link our empirical findings to the reduction in long-term unemployment benefits using a heterogeneous-agent labor market search model. Absent the reform, unemployment rates would be 50% higher today.

Preliminary and Incomplete

JEL-Classification: E24, J63, J64

Keywords: Unemployment, labor market reforms, worker flows

*We thank Rudi Bachmann, Christian Bayer, Marcus Hagedorn, Simon Jäger, Leo Kaas, Tom Krebs, Iourii Manovskii, Kurt Mitman, Thijs van Rens, Joost Roettgers, and Harald Uhlig for their comments and remarks. We thank Philipp vom Berge for help regarding the IAB data. We also thank seminar and conference participants at Bonn, Cologne, Konstanz, the joint IAB-Nuremberg workshop, SED Warsaw, ECB Conference on Job Creation after the Crisis, 2015 Annual Conference of the VfS, MMF Conference Bath, CESIfo Conference on Macroeconomics and Survey data 2015, and the NBER SI 2018 (EFMPL) for helpful comments and remarks. The usual disclaimer applies. Hartung, Jung, and Kuhn thank the German Research Foundation (*Deutsche Forschungsgemeinschaft*) for financial support of this research project as part of the priority program SPP 1764 *The German Labour Market in a Globalised World: challenges through Trade, Technology, and Demographics*.

†University of Bonn

‡TU Dortmund and IZA

§University of Bonn, CEPR, and IZA

1 Introduction

A key question in labor market research is how the unemployment insurance (UI) system affects unemployment rates and labor market dynamics. We revisit this old question and provide new answers based on an analysis of one of the largest UI reforms in industrialized countries over recent decades, the German *Hartz reforms*. Economists have extensively studied how changes in the UI system affect job finding rates of the unemployed (unemployment *outflows*) either through their incentive effects on workers to search for new jobs (**?**, **?**) or through their incentive effects on firms to post new vacancies (**?**, **?**).[1] In this paper, we scrutinize the existing focus on job finding rates and draw attention to separation rates into unemployment (unemployment *inflows*). While the link between separation rates and the UI system is known in theory, little is known about its quantitative importance (**?**). The goal of this paper is to fill this void.

The *Hartz reforms* in Germany took place in the mid-2000s. At the heart of the reform was a change in the UI system that abolished long-term, wage-dependent unemployment benefits. We document based on social security microdata that 76% of the changes in German unemployment rates after the reform resulted from changes in separation rates and changes in job finding rates only account for the remainder. We provide a first link between the UI reform and changes in labor market dynamics by documenting that the heterogeneity in the reform-induced reductions in benefit eligibility is also mirrored in the reduction of separation rates across workers. We find the largest reduction for long-term employed, high-wage workers. In a second step, we explain and causally link our empirical findings to the UI reforms using economic theory. Our results explain two key aspects of the German labor market miracle: notoriously high unemployment rates that are cut in half within less than a decade and a small increase in unemployment during the financial crisis. Theory and empirics jointly highlight the important role of changing separation rates as adjustment channel after changes in the UI system.

Our findings do not square with *any* of the narratives told so far about the Hartz reforms and the German labor market miracle that highlight changes in search effort (**?**), changes in matching efficiency (**?**, **?** and **?**), or changes in vacancy posting behavior (**?**). All of these narratives explain the decline in unemployment by an increase in job finding rates. Our empirical findings provide an upper bound for the contribution of these explanations. Understanding the relative importance of the different adjustment channels after an UI

[1] The existing literature on job search incentives builds on theoretical grounds on the large literature studying the (optimal) design of UI systems. This literature focuses on the trade-off between providing insurance and the cost of additional unemployment due to reduced search effort (**?**, **?**, **?**, **?**). Recently, there has been renewed interest in quantifying the incentive effects for firms' vacancy posting in relation to changes in UI benefits during the Great Recession in the United States (**?**, **?**).

reform is not merely of academic interest to better understand the workings of the labor market, but also implies very different welfare effects for different subgroups of the labor force. We show that the current reform has resulted in substantial welfare losses for the large group of long-term employed, high-wage workers. Our narrative can therefore provide one potential explanation for the widespread discontent with the reforms among the German electorate despite the massive reduction in unemployment rates.

For our empirical analysis, we rely on social security microdata of individual employment histories in West Germany from the employment panel of integrated employment histories (SIAB). We construct worker-flow rates for one decade before and after the Hartz reforms and find that separation rates declined by 28% after the reform while job finding rates increased by only 13%. As a consequence, separation rate changes account for 76% of the German labor market miracle. We demonstrate that this stylized fact is robust to a wide range of sensitivity checks and is also found using alternative data sources. The average decline in separation rates hides a lot of heterogeneity. We exploit the institutional setting that the cuts in benefit generosity by the reform was staggered by age, employment duration, and wages. We find correspondingly, in line with a causal effect of the reform, that after grouping workers by age, employment duration, and wages that it was the long-term employed, high-wage workers who reduced separation rates by up to 60%, while low-wage, short-term employed workers show a comparatively modest decline of 20% in their separation rates after the reform.

In our theoretical analysis, we develop a labor market search model with worker heterogeneity, aggregate fluctuations, and endogenous separation decisions to establish a causal link from the UI reform to changes in labor market dynamics. Workers in the model differ in their employment status, skills, job duration, wages, and UI benefit eligibility. Worker skills increase with job duration. An individually efficient bargaining protocol over wages and separation decisions then implies that high-skilled workers are also high-wage workers in stable jobs. Our model incorporates key institutional features of Germany's UI benefit eligibility rules with respect to the dependence on employment duration and wages as in **?**.[2] We allow a UI reform to affect labor market dynamics via three channels: workers incentives to search and accept job offers, firms' incentives to post vacancies, and the decision of workers and firms to separate. We calibrate the model to the pre-reform period and introduce the Hartz reform as abolishing long-term wage-dependent benefits. After the reform, the model matches closely the observed time series for average separation

[2]We share several modeling choices with **?**, but differ in focus. Their findings and calibration strategy focuses on changes in job finding rates through effects on vacancy posting rendering separation rates effectively exogenous in their quantitative analysis. Their model also does not include aggregate fluctuation to put discipline on the elasticity of separation and job finding rates that we exploit for the calibration as described below.

and job finding rates. To tighten the causal link from the UI reform to observed changes in labor market dynamics, we explore a range of additional model predictions linked to the UI reform. First, we study the heterogeneous effects of the reform on labor market participants and show that the model matches the heterogeneous responses closely. In the model like in the data the long-term employed, high-wage workers are most adversely affected. Second, we perform counterfactual simulations of the German labor market in the absence of the reform. We find that the reform also explains a second aspect of Germany's labor market miracle, namely, the good performance during the financial crisis when other labor markets experienced skyrocketing unemployment rates. In the absence of the reform, our model predicts that German unemployment rates would have skyrocketed as well during the financial crisis of 2008 and would have been 50% higher today. We also show that the German unemployment rate would have, without the reform, closely tracked the labor market experience of Germany's close neighbor, Austria, supporting the validity of our quantitative predictions. Third, we provide empirical evidence that workers traded off wages against job stability to avoid separations into unemployment in line with the theoretical mechanism. In a final step, we use the model to explore the welfare consequences of the UI reform. We find that the long-term employed, high-wage workers experienced large welfare losses in the absence of any government compensation.

In the model, a UI reform affects workers' search incentives, firms' incentives to post vacancies, and separation decisions. A crucial question is how to discipline the relative importance of these three different adjustment channels. In theory, there is a tight link between aggregate labor market fluctuations from productivity fluctuations and the responsiveness to changes in UI benefits (**?**). Through the lens of the model, productivity changes and benefit changes both directly affect the value of employment relative to the outside option and are like two sides of the same coin. We therefore calibrate the model to be consistent with business-cycle moments for separation rates and job finding rates before the Hartz reforms. In this way, we tie our hands regarding the responsiveness of labor market flows to the UI reform. For the responsiveness of workers' search behavior, we target existing estimates on the elasticity of the search intensity to changes in UI benefits from the empirical literature.[3] Our calibration only targets unconditional moments of worker-flow rates, but matches the time series of labor market flows before the reform well, thereby, providing support for the model mechanism. After the reform, the model still matches the time series of labor market flow rates very closely lending support to the independently calibrated elasticities. Matching both the timeseries and cross-sectional

[3] A broad empirical consensus has emerged suggesting that this effect is modest. Typical estimates find that granting one additional month of UI benefits leads to 0.15 more months of unemployment (**?**, **?**).

heterogeneity of changes in separation rates offers important evidence in favor of a causal link from the UI reform to the observed changes in labor market dynamics.

We use the calibrated model to ask the counterfactual question what would have happened to the German labor market absent the Hartz reforms. The counterfactual simulations provide striking results. German unemployment rates would not have fallen over time, would have skyrocketed during the financial crisis like in most other industrialized countries, and would be today 50% higher than observed. This counterfactual simulation also provides a way to decompose changes in unemployment between 2004 and 2014, from the trough of a recession to a long-lasting boom. We find that business cycle dynamics account for at most 10% of the decline in unemployment rates leaving most of the changes to the structural reform. We validate our counterfactual analysis relying on ideas inspired by the literature using control groups to identify and quantify causal effects of policy interventions. In the spirit of such an approach, we consider Austria, Germany's close neighbor, as our control group that did not reform its UI system. Comparing counterfactual unemployment rates for Germany and Austria, we obtain again results that are striking. Absent the reform, our model predicts that the German and Austrian unemployment rate would have evolved in lockstep over the two decades under consideration. In case of the reform, unemployment rates diverge strongly after the implementation of the reform providing further evidence for the causal impact of the UI reform on labor market dynamics. A final prediction of the theoretical model that we explore is that in the model workers trade-off wages against job stability in response to the reform. In particular, high-wage workers are willing to accept wage cuts in exchange for lower separation rates. In the data, we find evidence that such a trade-off took place.

In a final step, we use our microfounded framework to quantify the welfare effects from the reform for different labor market participants. We consider welfare effects abstracting from compensating transfers that the government could finance due to the lower spending on UI benefits after the reform. Put differently, we quantify how a transfer system needs to be designed to receive the support of the electorate. This question is key when it comes to the political feasibility of UI reforms. We find that losses amount to 2.11% in terms of consumption equivalent variation for the recipients of unemployment assistance benefits. Unemployment assistance benefits represent the long-term wage-dependent benefits that have been abolished by the reform so that the large welfare losses for workers in this group ought to be expected. Probably, these losses also explain the widespread grandfathering rules and hardship regulation that accompanied the reform and that were targeted towards this group. Among the employed, we find the largest welfare losses among the long-term employed, high-wage workers. We find that their consumption equivalent vari-

ation to forgo the reform amounts to 0.64%. Long-term employed workers account for almost two-thirds of the German labor market and the fact that their separation rates are the lowest among the employed might suggest that these workers are very detached from any changes in the UI system. Yet, we show that this is not the case and that in hindsight their large welfare costs might explain the widespread discontent among the electorate with the reform.

Two potentially important policy implications for labor market and social security reforms arise from our findings. The first relates to UI reform proposals in other European countries taking the Hartz reforms as a role model. Regarding the political feasibility of such reforms, our findings imply that appropriate compensation schemes have to be designed to avoid discontent in large parts of the electorate like in the German case among the long-term employed, high-wage workers. Our model suggests that a quantitatively important role for changes in separation rates and therefore welfare costs among the employed ought to be expected in most European countries in line with findings in **?**. By contrast, UI reforms in the United States will likely show the largest reaction in job finding rates. The theoretical justification for this conjecture comes from the cross-country analysis in **?**. Second, the strong reaction of separation rates after changes in nonemployment benefits suggests that similar reactions should also be expected and taken into account when evaluating other social security reforms like early retirement programs or disability insurance programs that are widely discussed in Germany and elsewhere.

The remainder of the paper is structured as follows: we next provide a short description of the Hartz reforms. In section **??**, we describe our data and present the empirical results. We describe the labor market search model in section **??**. Section **??** shows the model results and discusses the counterfactual analysis. Before we conclude in Section **??**, we discuss alternative explanations for the German labor market miracle in the light of our empirical results.

1.1 The Hartz reforms

In 2002 the German government entrusted an expert commission consisting of various representatives from business, unions, and academia to work out reforms for the German labor market. Chairman was Peter Hartz, at that time director of human resources at Volkswagen, the commission and subsequent reforms are commonly referred to as *Hartz reforms*.[4] The main focus of the reforms was to restructure the federal employment agency and to enhance the matching process of unemployed workers to jobs. The ensuing reforms were enacted in four separate legislative packages commonly referred to as *Hartz*

[4]The official title of the commission was *Commission for modern labor market services*.

I to *Hartz IV* between 2003 and 2005.[5] They consisted of comprehensive measures to *promote and demand* the unemployed — ranging from subsidies for self-employment to the restructuring of the unemployment benefit system and a tighter supervision of benefit recipients.[6] We provide further details in Appendix **??**.

In the next section, we provide empirical evidence that points towards a causal mechanism associated with the fourth step of the reform package (Hartz IV). In that step, the formerly three-tier system of unemployment benefits, unemployment assistance, and subsistence benefits was transformed into a two-tier system of unemployment and subsistence benefits. The reform constituted a substantial overhaul of the German unemployment insurance system and implied a drastic cut in benefits for long-term employed workers who were before the reform eligible to long-term, wage-dependent unemployment assistance. In addition to lower subsistence benefits, these benefits were unlike unemployment assistance asset-tested and thresholds for asset-testing were tightened (and extended to the household level). We will focus on exploring the causal link from the unemployment insurance system, labor market dynamics, and the unemployment rate in our structural model below.

2 Data and empirical results

This section introduces the microdata we use to analyze changes in unemployment rates and labor market flows. We demonstrate that the microdata matches the macroeconomic trends and how we adjust for administrative changes that otherwise impede a consistent measurement over time. In the second part, we present empirical results on changes in labor market flows and document large heterogeneity in these changes.

2.1 Data

Our main data source is the microdata on individual employment histories from the employment panel of integrated employment histories (SIAB) provided by the Institute for Employment Research (IAB) for the period from 1975 to 2014.[7] The SIAB is a 2% representative sample of administrative data on all workers who are subject to social security contributions and on all unemployed in Germany. It excludes self-employed and civil servants, thus covering approximately 80% of Germany's labor force. Besides its large

[5] The official title of the acts were *First, Second, Third* and *Fourth Act for modern labor market services.*

[6] **?** provides a detailed chronicle of the German social security system.

[7] We use the weakly anonymous Sample of Integrated Labour Market Biographies (SIAB) 1975-2014. The data were accessed on-site at the Research Data Centre (FDZ) of the Federal Employment Agency (BA) at the Institute for Employ-ment Research (IAB) and via remote data access at the FDZ.

size (1.8 million individuals) and its long panel dimension (up to 40 years), one further advantage of the administrative data is that it is virtually free of measurement error for the variables of interest in this paper. The data is taken from social security records and is merged with records on unemployment periods from the federal employment agency. The data contains the exact start and end dates of each employment and unemployment spell. In total, the data comprises almost 60 million individual spells. See **?** for further details on the data and its construction.

2.2 Sample selection, construction of worker flow rates, and inflow correction

We restrict our sample to workers in West Germany and exclude marginal employment in our benchmark sample. We drop few individuals with missing information on employment status or geographic information, and all individuals who only receive social assistance benefits while in the sample. We consider the effect of including marginal employment and looking at East and West Germany as part of our sensitivity analysis.

The data contain daily employment history information and we follow **?** to aggregate daily labor market histories to histories at monthly frequency. We assign monthly employment spells based on a reference week within each month. We assign the employment state in this week following a hierarchical ordering where employment supersedes unemployment and unemployment supersedes out of the labor force. This approach follows closely labor force surveys like the Current Population Survey (CPS). We count workers as employed if they are full- or part-time employed or work as apprentices. For unemployed, we count workers as unemployed if they are not working, are actively looking for a job, and are registered as unemployed at the employment agency. The registration is required to be eligible for unemployment benefits. The German unemployment insurance system distinguishes between unemployed workers and benefit recipients. In the microdata, reliable information on the registered unemployment status is available from 2000 onwards. We use this information to assign employment states. We assign employment states for earlier periods based on records of benefit recipient status. After computing worker flow rates based on benefit-recipient status before 2000, we construct growth rates of these worker flow rates and use them to extend the registration-based flow rates backwards. This leaves the dynamics of the flow rates unaffected but removes the level differences between the two definitions. We assign out of the labor force as a residual employment state to workers with intermittent nonemployment spells that are not unemployment spells. We provide further details on the construction of monthly employment states and transition rates in Appendix **??**. For our empirical analysis, we

focus on the decade from 1993-2002 before the first reform steps have been implemented. For the period after the reform, we consider the decade from 2005 to 2014.

The goal of our empirical analysis is to study changes in labor market dynamics underlying the changes in the unemployment rate. In the first step, we demonstrate therefore that the micro data matches the reported trends on unemployment rates. The micro data does not include public servants (*Beamte*), and hence, for the micro data to be comparable to unemployment rates reported in the statistics of the German employment office, public servants have to be included. Figure **??** shows the unemployment rate for West Germany as reported by the German federal employment agency and the unemployment rate constructed from the SIAB micro data for the period between 1993 and 2014. The data from the German employment office covers dependent employment only and therefore excludes self-employed workers.[8] Both unemployment rates track each other closely in trends and levels. We conclude that the micro data is consistent with developments in the unemployment rates and can hence be used to study the underlying changes in labor market dynamics.

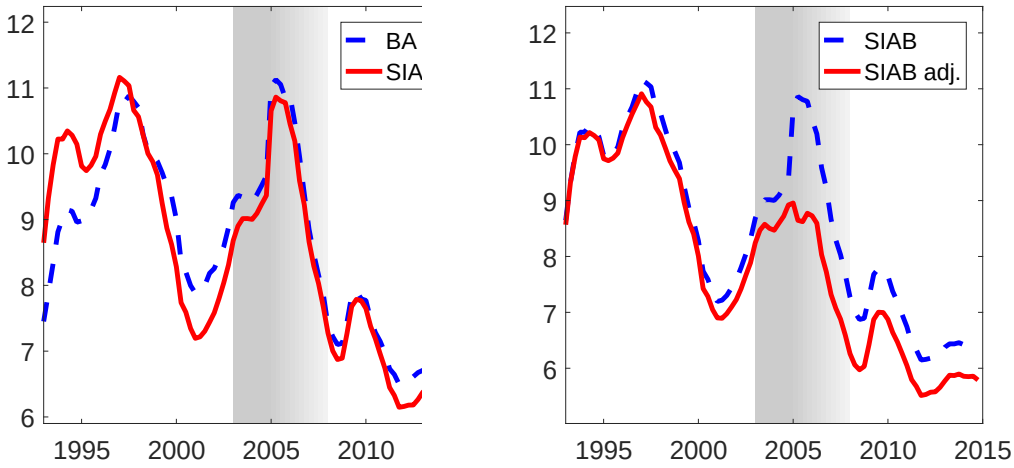
The data show a large spike in unemployment in January 2005. The reason for the spike are regulatory changes as part of the Hartz reforms that became effective in January 2005. These regulatory changes required all workers who are able to work to register as unemployed to remain eligible for UI benefits. This caused an inflow of former social assistance recipients and spouses of unemployed into the unemployment pool and poses a challenge to a consistent measurement of worker flows before and after the reform of the UI system. The affected persons were mainly individuals who were much less attached to the labor market than the previously registered unemployed (see Table **??**). We propose what we refer to as *inflow correction* for constructing comparable and consistent transition and unemployment rates over this period.

The key challenge is that we cannot observe either of the two groups, who were forced to register as unemployed to retain their unemployment benefit eligibility, directly. We therefore exclude persons who simultaneously satisfy three conditions: (1) entered unemployment in the first six months[9] of 2005, (2) had a non-employment spell before registering as unemployed, and (3) did not work for at least one month until the end of 2006. We compare in table **??** the characteristics of new entrants into unemployment from out of the labor force in January 2004 and January 2005. We find large differences

[8]The German employment office reports two unemployment rate one including all employees and one for employees in dependent employment, excluding self-employed. We consider the unemployment rate for dependent employment.

[9]There is evidence that administrative problems and incomplete data records during the transition period make the records for the affected group in the first months after the reform less reliable.

Figure 1: German unemployment rates (1993 - 2014)



(a) BA and SIAB (b) SIAB with inflow correction

Notes: Unemployment rate for West Germany 1993 - 2014 in percent. Left panel: Red solid line shows reported unemployment rate by employment agency (BA) and blue dashed line shows the unemployment rate from SIAB micro data including imputed numbers for public servants not covered by the micro data. Right panel: Shows unemployment rate from SIAB micro data as in the left panel (blue dashed line) and the unemployment rate from SIAB micro data after inflow correction (red solid line). See text for details. The grey area marks the period from 2003 to 2005 when the Hartz reforms were enacted. The fading out indicates the first transition years 2006 to 2008 after the reforms. Data are quarterly averages of monthly rates.

across the two years. In January 2004, new entrants are slightly younger, substantially more female (57 vs. 37 percent) and less educated (43 percent vs. 28 percent with high school are less). When looking at all other entrants into unemployment (columns *other* U), we find the same distribution across these worker characteristics in January 2004 and 2005. Our inflow correction excludes entrants into the unemployment pool in early 2005 who are very detached from the labor market and are likely to have registered as unemployed solely due to the new registration requirements in 2005. Comparing the composition of the inflows in table **??** suggests that a large group of entrants from out of the labor force in January 2005 falls into this category. The third column in *entrants from* N reports worker characteristics for entrants after the inflow correction. We find that now worker characteristics of entrants in 2005 resemble much more closely those of the entrants in 2004 although some differences still remain. We refer to the sample after excluding these persons as inflow-corrected sample. We will use the inflow-corrected sample as our benchmark sample for the rest of the paper.

Figure **??** shows the unemployment rate of the inflow-corrected sample (red solid line) and the full sample (blue dashed line). The spike in January 2005 disappears almost com-

Table 1: Worker characteristics of entrants into unemployment

	entrants from N			other U	
	2004-01	2005-01	2005-01 (corr.)	2004-01	2005-01
female	43.3%	60.9%	45.8%	41.1%	42.1%
age	36.9	37.3	36.0	40.9	40.9
highschool	23.2%	44.2%	32.5%	16.6%	18.8%
secondary	70.4%	53.0%	62.9%	78.0%	76.0%
college	6.5%	2.9%	4.6%	5.5%	5.2%

pletely in the inflow-corrected sample. The persistently lower level of the inflow-corrected sample shows that the inflow of formerly non-employed persons into the unemployment pool in early 2005 changed the composition towards persons who are less attached to the labor market. Given that we remove these workers completely from the sample, we also change unemployment rates before 2005. As can be seen directly, this change is small and provides therefore additional evidence that the excluded group had weak attachment to the labor force before 2005. In 2014, unemployment rates in the inflow-corrected sample are about 0.75 percentage points lower. Looking at relative changes, we find that the inflow correction reduces the decrease of unemployment rates from roughly 40% to 30%. Still, unemployment rates declined between 2005 and 2014 by more than 30%. We provide a sensitivity analysis for skipping the inflow correction in Appendix **??**.

2.3 Empirical results

We consider the time period from 2003 to 2005 as the period of the reforms and use 10 years before (1993 - 2002) and 10 years after the reform (2005 - 2014) as the two time periods of comparison. The sample period includes three recessions and in particular the financial crisis of 2008. One challenge is to disentangle the relative importance of structural changes in the labor market and changes from business cycle fluctuations when comparing the pre- and post-reform periods. We will rely on the structural model and provide in Section **??** a decomposition that disentangles structural changes and business cycle effects on workers flows and unemployment rates. We also provide an extensive sensitivity analysis to our empirical results that we summarize at the end of this section. We relegate details to Appendix **??**.

2.3.1 Changes in separation and job finding rates

Figure **??** shows the relative change in the separation rate for the period from 1993 to 2014. The separation rate is indexed to its average pre-reform level (1993-2002). This level is low in the German labor market over the entire time period. About 0.5% of workers transit from their employer to unemployment each month (see Table **??**). Looking at the relative changes, we find a substantial 28% decline in separation rates between the pre-reform average and the separation rate in 2014. When we consider the post-reform average including the Great Recession, then the decline is smaller but still at 22%.

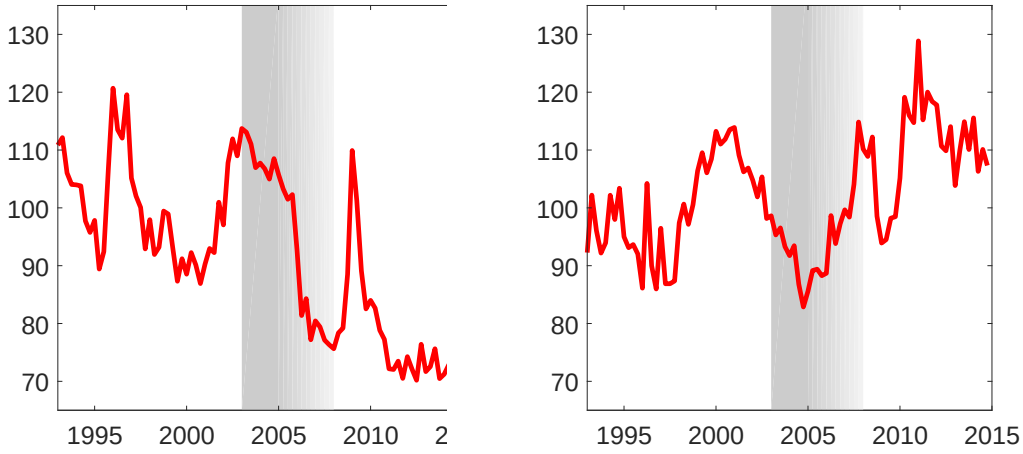
Figure **??** shows the relative change of the job finding rate over time again indexing it to its average pre-reform level. Job finding rates are typically slightly above 5% before the reform period and increase to slightly below 6% after the reform. In relative terms, the increase until 2014 constitutes a 13% increase in the job finding rate. If we include the Great Recession in the post-reform average, the increase amounts to only 10%. Compared to the 28% decline in the separation rates, this suggests already that declining separation rates were the main driver behind the decline in unemployment rates over the decade following the Hartz reforms. The relative differences in changes remains largely unaffected when we include the Great Recession. The decline in separation rates is twice as large as the increase in job finding rates.

Table **??** uses a steady state decomposition from a two-state stock-flow model to quantify the relative contribution of separation rates and job finding rates in explaining the 32% decline in unemployment rates until 2014.[10] We consider the period from 1993 to 2002 as the pre-reform steady state and the period from 2011 to 2014 as post-reform steady state to abstract from transition dynamics and the Great Recession as two exceptional periods. The last column of table **??** reports the relative contributions of changes in the separation rate and the job finding rate to the unemployment rate. According to this decomposition, the declining separation rate accounts for 76% of the decline in the unemployment rate. The small residual of 4% relative to the empirically observed changes demonstrates that the simple two-state stock-flow model captures changes in the unemployment rate over this time period well. As Table **??** shows including the Great Recession in the decomposition leads to the same quantitative findings for the relative importance of separation and job finding rates for the decline in unemployment.

The large contribution of changes in the separation rate to changes in the unemployment rate over time shows that explanations that focus on the link between changes in the

[10] We use a two state model so that the steady state unemployment rate is $\bar{u} = \frac{\bar{\pi}_{eu}}{\bar{\pi}_{eu}+\bar{\pi}_{ue}}$ where $\bar{\pi}_{eu}$ denotes the steady state separation rate (unemployment inflow) and $\bar{\pi}_{ue}$ denotes the steady state job finding rate (unemployment outflow).

Figure 2: Separation and job finding rates (1993 - 2014)



(a) Separation rate (indexed) (b) Job finding rate (indexed)

Notes: Separation and job finding rates for West Germany 1993-2014. Both series have been indexed to their pre-reform level (1993-2002). Both series exclude non-employed entering the unemployment pool in the first half of 2005 who did not become employed until the end of 2006. The grey area marks the period from 2003 to 2005 when the Hartz reforms were enacted. The fading out indicates the first transition years 2006 to 2008 after the reforms. Data are quarterly averages of monthly rates.

unemployment benefit system and job finding rates either from changes in search effort or changes in contact rates for unemployed workers from more vacancy posting will fall short of explaining the data.

2.4 Heterogeneity of changes in separation rates

The last section documented that the decline in separation rates has been the main driver of the reduction in unemployment rates in Germany after 2005. The decline of average rates hides a lot of heterogeneity that is informative about the underlying causal mechanism. Figure **??** shows unemployment benefit eligibility by employment duration and age before and after the reform. This benefit duration determines when workers lose eligibility for UI benefits and transit to unemployment assistance benefits before and benefits at subsistence level after the reform as unemployment assistance benefits have been abolished by the Hartz reforms. If this abolition of the unemployment assistance benefits is the driver of the observed changes in separation rates, we should see heterogeneity in the changes of separation rates by employment duration and age. Looking at the pre-reform situation in Figure **??**, we see that for workers younger than age 45 the maximum benefit duration was 12 months. For older workers, we find a steep gradient in employment duration from 14 months after 30 months of previous employment duration

Table 2: Before- and after-reform unemployment rates, transition rates, and steady state decomposition

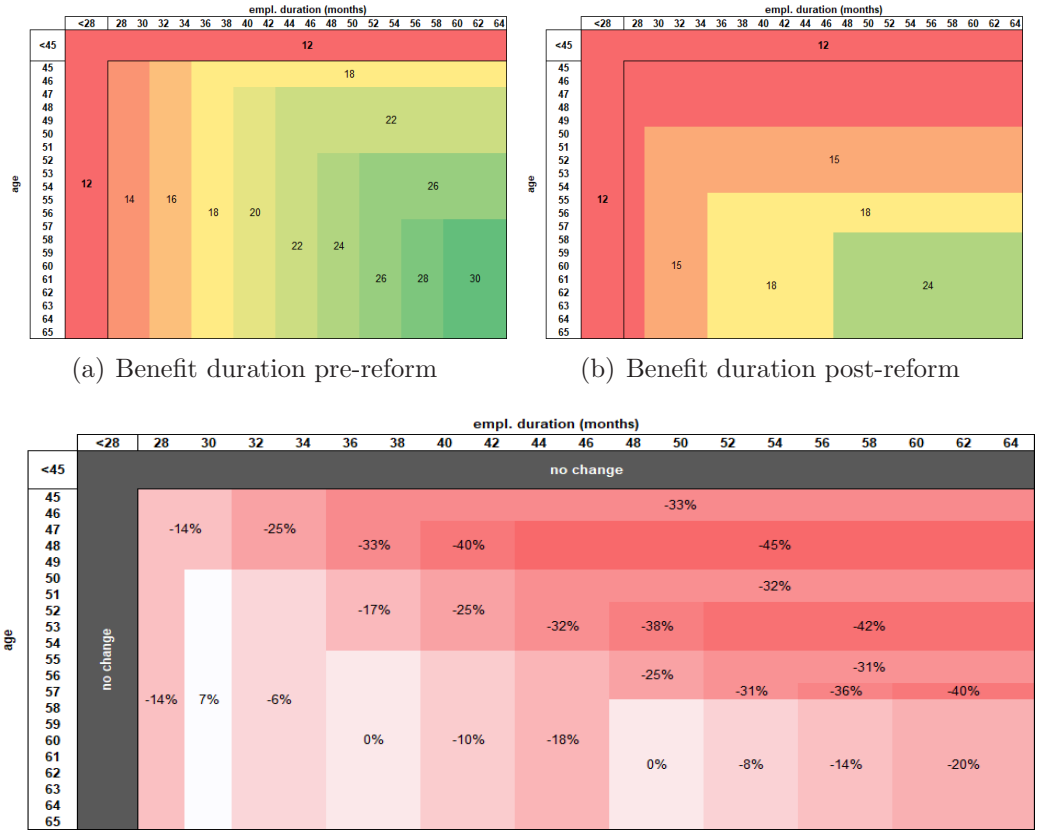
				2008-2014		2011-2014	
	1993-2002	2008-2014	2011-2014	Δ	$\frac{\Delta\pi}{\Delta\bar{u}}$	Δ	$\frac{\Delta\pi}{\Delta\bar{u}}$
unemployment rate	10.5%	7.6%	7.2%	-27.5%		-31.5%	
separation rate	0.6%	0.5%	0.5%	-22.0%	74.9%	-27.7%	75.8%
job finding rate	5.2%	5.7%	5.9%	10.1%	30.8%	13.3%	31.6%

Notes: Columns 2-4 show the level of the unemployment rate, separation rate, and job finding rate before the Hartz reforms (1993 - 2002), after the Hartz reforms including the Great Recession (2008-2014), and after the Hartz reforms excluding the Great Recession (2011-2014). Columns labeled Δ report the percentage change in rates from before to after the reforms. Columns labeled $\frac{\Delta\pi}{\Delta u_{ss}}$ show the relative contribution to changes in steady state unemployment rates from changes in separation and job finding rates. $\Delta\bar{u}$ indicates the change in the steady-state unemployment rate from before to after the Hartz reforms based on average rates before and after the reform.

to up to 30 months after five years of previous employment. Comparing this pattern to the post-reform regulation in Figure **??**, we see that there is much less variation and that especially older, long-term employed workers see a strong decline in their benefit duration. For example, a 49-year-old worker with four years of previous employment receives after the reform UI benefits for 12 months while before the reform she received UI benefits for 22 months. Figure **??** shows the relative changes in UI benefit durations for the different groups from before to after the reform. We find the largest decline for workers with more than three years of previous employment duration between ages 45 and 55. By contrast, there have been no changes for short-term employed workers (less than 28 months) and workers younger than 45 years. If the Hartz reforms with their abolition of unemployment assistance benefits were causal for the decline in separation rates, we expect this heterogeneity in changes of benefit eligibility duration to be mirrored in the changes of separation rates.

A further dimension where we should see differences in separation rates changes, if the causal mechanism is related to the abolition of the long-term benefits, is wages because unemployment assistance were tied to a worker's last wage. A decoupling of long-term benefits from previous wages disproportionately affects workers with high wages because after the reform these workers face benefits at subsistence level, independent of the previous wage, once UI benefits have expired.

Figure 3: Changes in benefit duration by age and employment duration



(a) Benefit duration pre-reform

(b) Benefit duration post-reform

(c) Change in benefit duration

Notes: Maximum eligibility duration for short-term unemployment benefits in months by age and employment duration. Employment duration refers to a reference period of 5-7 years prior to the unemployment spell. Panel (a) shows maximum durations before the reform. Panel (b) shows the maximum durations after the reform in 2008, i.e. after all grandfathering rules had expired. Panel (c) shows the relative change in maximum durations in percent for each combination of age and employment duration.

We explore the changes in the separation rates along these dimensions of heterogeneity. In line with a causal mechanism that works through the cut in long-term wage-dependent benefits, we find that long-term employed and high-wage workers show stronger declines in separation rates compared to short-term employed and low-wage workers.

2.4.1 Employment duration

For the analysis of heterogeneity among workers with different employment duration, we split in the first step employed workers into two groups. The first group are short-term employed workers with at most three years of employment duration and the second group are long-term employed workers with more than three years of employment duration.

Table ?? shows the corresponding average levels for the pre- and post-reform decade. Looking at the levels, we see that short-term employed workers have more than five times higher separation rates than the long-term employed workers in the period from 1993 to 2002 (1.37% vs 0.24%). This difference further increases in the period from 2005 to 2014 (1.23% vs 0.19%). After 2005, separation rates differ by more than a factor of six. The reason is the much stronger relative decline in the separation rate for long-term employed workers after 2005.

Table 3: Change in separation rates by employment duration and age

	1993 - 2002	2008 - 2014	Δ %
all	0.63%	0.49%	-22.0%
emp. duration $\leq$ 3 years	1.37%	1.15%	-16.2%
emp. duration $>$ 3 years	0.26%	0.18%	-33.3%

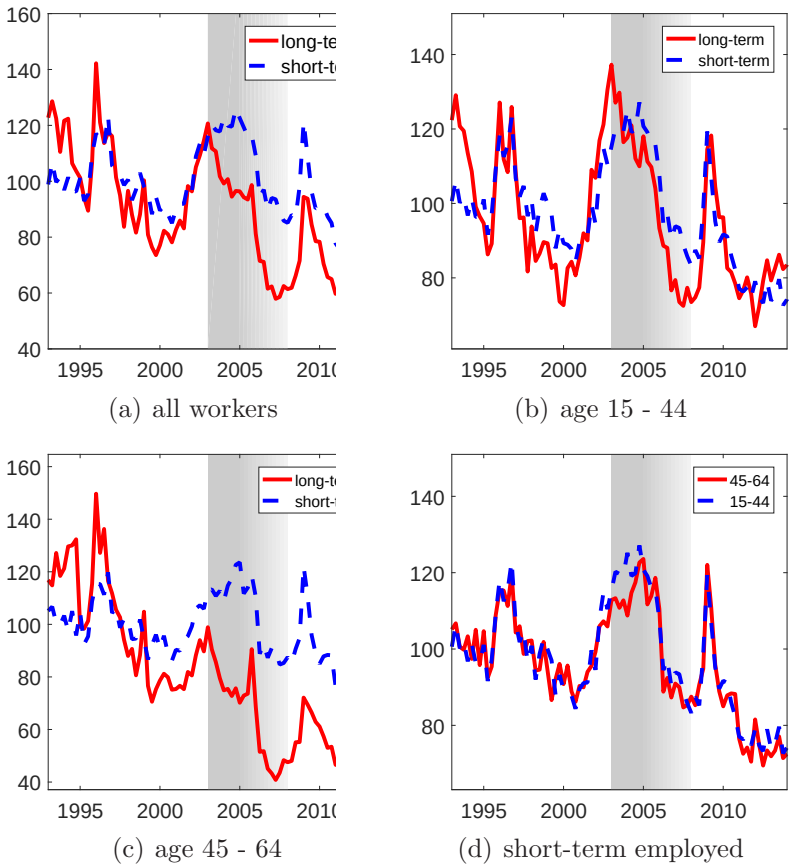
Notes: Separation rates before and after the Hartz reforms by employment duration and age. We use averages of quarterly rates over the time periods. Column Δ reports the percentage change in rates from the period before the Hartz reforms to the period after the Hartz reforms.

The stronger decline can be seen in Figure ?? that shows the time series of relative changes in separation rates for different groups of short-term and long-term employed workers. Looking at Figure ??, we find a strong divergence in the time series of separation rates between short-term and long-term employed workers after the Hartz reforms. The strong divergence persists so that after the reform separation rates of long-term employed workers have declined twice as much as for short-term employed workers.

2.4.2 Age

In addition to employment duration, age determines the duration of benefit eligibility in the UI system (Figure ??). We therefore dissect the data in Figures ?? and ?? further by looking at young and old workers by employment duration. Looking at younger workers in Figures ??, we find in line with the changes in eligibility duration no differential changes between short-term and long-term employed workers. Separation rates decline in lockstep for these two groups. By contrast but in close alignment with the changes in eligibility duration, we find that long-term employed, older workers show the strongest reduction in separation rates while older short-term employed show a reduction that is only half as large (Figure ??). Looking at short-term employed workers across age groups provides a further sanity check for heterogeneous changes in separation rates because there has been

Figure 4: Separation rates by age and employment duration (1993 - 2014)



(a) all workers (b) age 15 - 44

(c) age 45 - 64 (d) short-term employed

Notes: Separation rates by employment duration and age for West Germany 1993 - 2014, indexed to their pre-reform level (1993-2002). The red solid line in panels (a)-(c) marks the separation rate for long-term employed workers who were continuously employed for three years or more. The blue dashed line in panels (a)-(c) marks the separation rate for short-term employed workers with at most three years of continuous employment. Panel (d) shows the separation rate for short-term employed workers separately for young (blue dashed line) and old employees (red solid line). The grey area indicates the period of the implementation of the Hartz reforms.The grey area marks the period from 2003 to 2005 when the Hartz reforms were enacted. The fading out indicates the first transition years 2006 to 2008 after the reforms. Data are quarterly averages of monthly rates.

no differential changes in benefit eligibility duration for short-term employed workers. In line with no such heterogeneity, we find a strikingly close tracking of separation rate changes for short-term employed young (age 15- 44) and old workers (age 45- 64) in Figure **??**. For both age groups separation rates decline in lockstep following the Hartz reforms. These results by age further strengthen our finding that separation rates decline more for workers who have been more adversely affected by the cut in benefits eligibility form the Hartz reforms. This additional heterogeneity in changes of separation rates provides

therefore further support for a causal link from the UI reform to the observed changes in labor market dynamics.

In Appendix **??**, we provide a more detailed analysis of changes by age groups. One finding from this analysis is that workers closer to retirement show an even stronger decline in separation rates. Their separation rate decline follows a longer-run trend that accelerated during the 2000s so that over time unemployment rates for older workers decreased more than for younger workers. This trend was accompanied by a strongly rising labor force participation rate of workers close to retirement age. We abstract from this fact of independent interest as it is beyond the scope of this paper. In our theoretical analysis, we will abstract from the additional age heterogeneity to keep the model parsimonious and because most of the heterogeneity in separation rate changes is captured by differences in employment duration.

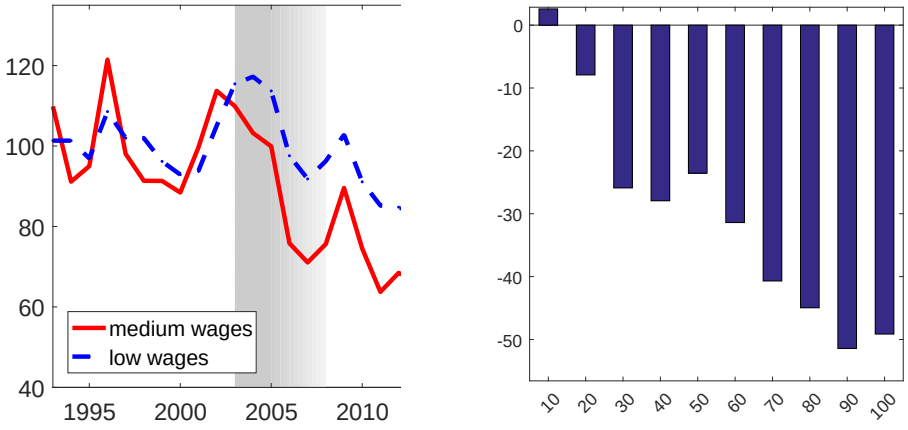
2.4.3 Wages

Figure **??** shows the relative changes in separation rates from before to after the UI reform along the wage distribution. Figure **??** compares workers above the median wage to workers below the median wage and changes in their separation rates over time. Separation rates closely comove before 2005 when they start to diverge. By 2014, above median-wage workers saw their separation rates decline by almost twice as much as below-median wage workers. Figure **??** dissects the wage distribution finer and compares long-run changes. It quantifies for each wage decile by how much the average separation rate decreased from the decade before the reform (1993-2002) to the decade after the reform (2005-2014). Evidently, the higher wage deciles experienced the largest declines in separation rates.[11] Separation rates do hardly change at the bottom of the wage distribution, decline by between 20 to 30 percent in the middle, and plummet by almost 50% at the top. The stronger decline of separation rates for high-wage workers further supports a causal link from the UI reform to the observed changes in labor market dynamics because the reform replaced long-term wage-dependent benefits by subsistence benefits independent of previous wages. This change affected in particular high-wage workers.

The results on employment duration, age, and wage heterogeneity all show a larger drop in separation rates for groups that have been more adversely affected by the Hartz reforms (Figure **??**). We speak to the observed heterogeneity in our quantitative model below. In the model, the removal of long-term wage-dependent benefits will lead to heterogeneous reactions in separation rates and high-wage, long-term employed workers will see a stronger reduction in their separation rates in line with the empirical evidence from

[11] The picture in the left panel is robust to changes in the exact reference period.

Figure 5: Changes in separation rates by wages



(a) Separation rate by wage bracket

(b) Relative change post reform (in %)

Notes: Left panel shows changes in separation rates for high and low wage groups of workers in West Germany 1993-2014. The red solid line (left axis) shows workers with earnings between 40% and 70% of the earnings distribution. The blue dashed line (right axis) shows workers with earnings up to 30% of the earnings distribution. The grey area marks the period from 2003 to 2005 when the Hartz reforms were enacted. The fading out indicates the first transition years 2006 to 2008 after the reforms. Data are pooled at the annual level. Right panel shows relative declines of average separation rates for the entire earnings distribution from before the reform (1993-2002) to after the reform (2008-2014) in %. Deciles of the earnings distribution are shown on the horizontal axis.

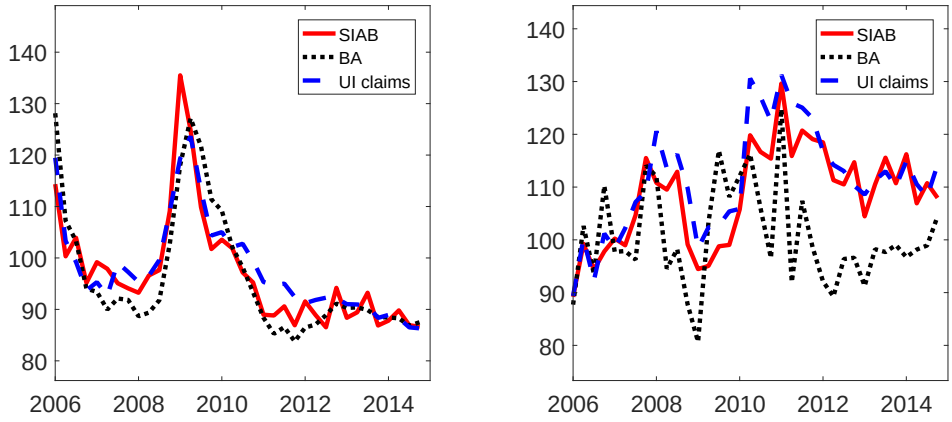
this section.

2.5 Sensitivity and comparison to other data sources

In the first step, we discuss evidence from other independent data sources to further support our empirical evidence on the dominant role of falling separation rates for explaining the decline in German unemployment rates after 2005. The first additional data source are the reports of the employment agency on monthly unemployment benefit claims. In **?**, we construct a historical series on worker flows for the period from 1967 to 2014 based on this data and demonstrate that during the period of overlap it matches closely worker flows from SIAB data. We explain in **?** how this data series can be constructed in real time from publically available data sources. The second data source are flow rates in and out of unemployment that are reported by the German employment office since 2006. These flow rates are based on registered cases of workers transiting from employment into unemployment and vice versa. These rates are based on case counts rather than worker counts. To be consistent with our structural model, we use worker counts based

on reference weeks for our empirical analysis. This difference in measurement will lead to differences in the level of rates because multiple cases can occur for one worker within one month. This is the well-known time aggregation problem, as discussed, for example, in **?**.

Figure 6: Alternative measures for transition rates



(a) Separation rates (b) Job finding rates

Notes: The figures show separation and job finding rate for the benchmark sample from the SIAB micro data (red solid line). The blue dashed line shows flow rates reported by the German employment office. The black dotted line shows flow rates constructed in **?** based on new unemployment benefit claims. All rates are indexed to the level in the first two years displayed in the graphs (2006-2007). See text for further details.

Figure **??** shows three alternative measures for the separation rate and the job finding rate. The first one is our benchmark measure constructed from the SIAB micro data (red solid line), the second one is constructed by the German employment office (blue dashed line), the so-called inflow hazard rate (*Zugangsrisiko*) and departure rate (*Abgangschance*), the third one is the measure constructed from UI benefit claims in **?** (black dotted line). We find that the two additional measures strongly support our finding of decreasing separation as the macroeconomic driver of decreasing unemployment.

Next, we also summarize the findings from our sensitivity analysis. We relegate details to Appendix **??**. In a first step of our sensitivity analysis, we demonstrate that skipping the inflow correction mainly leads to lower job finding rates after the reform due to the larger pool of unemployed (see **??**). In a second step, we control for changes in the composition of the employed in terms of worker characteristics using a linear regression model. Fixing the composition of the employed at the level of 2000, we find that compositional changes alone are negligible for explaining changes in separation rates over time (see **??**).[12] In a

[12]We use sex, two age dummies, two education dummies, tenure dummies, a dummy for temporary

third step, we provide results for including workers in East Germany (see **??**), counting marginally employed unemployed workers among the employed (see **??**), and counting workers in active labor market programs among the employed (see **??**).[13] We find the documented results to be robust.

3 Model

This section applies economic theory to causally link the changes in the unemployment insurance system to the observed changes in labor market dynamics and unemployment rates. We develop a labor market search and matching model with aggregate fluctuations, endogenous separations, and worker heterogeneity. In the model, time is discrete and there is a continuum of workers of measure one and a positive measure of firms. Workers and firms are risk neutral and discount the future at rate $\tilde{\beta}$. Each period there is a positive probability that a worker leaves the labor force for good. We denote this probability by ω and the product of the time discount factor and the probability to remain in the labor market by $\beta = \tilde{\beta}(1-\omega)$. A worker who leaves the labor force is immediately replaced by a newborn worker so that there is always a constant mass of workers. Workers in the model are either employed or unemployed. We consider single-worker firms and refer to a worker-firm pair as a match.

Employed workers have one of two skill levels x_1 or x_2 with $x_1 < x_2$. We refer to workers with skill level x_1 as low skilled and workers with skill level x_2 as high skilled. Workers who enter the labor force start as low skilled. While working, workers accumulate skills by learning-by-doing. An employed low-skilled worker stochastically gains skills at rate α. The accumulated skills are lost at separation. Employed workers gain eligibility to unemployment benefits with employment duration. Since skill accumulation and benefit eligibility both depend on employment duration, we economize on the state space and assume that eligibility and skill level are perfectly correlated so that all high skilled workers are eligible to unemployment benefits.[14,15] Low skilled workers are eligible to social assistance benefits in case they separate and enter into unemployment. We denote the share of employed workers in the population in state x_1 by e_1 and the share of

employment, and dummies for the different wage deciles in the regression.

[13] After the reform workers who participate in active labor market programs were no longer counted as unemployed.

[14] We abstract from age heterogeneity that would lead to the introduction of an additional state variable but the underlying economic mechanism would be identical to the mechanism that works along the employment duration dimension. **?** follow the same modelling approach.

[15] In general, experience and skill accumulation need not be perfectly correlated. The empirical evidence on wage growth for the German labor market finds strong returns to experience in the first two years (**?**). This suggests that productivity gains and eligibility in the data are also highly correlated so that we are confident that our assumption to economize on the state space is of minor importance.

employed workers in state x_2 by e_2. Denoting current period's state by x and next period's state by x', the law of motion for x conditional on staying employed is

$$x' = x_2 \qquad \text{if } x = x_2$$

and if $x = x_1$, the law of motion is

$$x' = \begin{cases} x_2 & \text{with probability } \alpha \\ x_1 & \text{with probability } 1 - \alpha \end{cases} \tag{1}$$

We denote the state of unemployed workers by b and the state can take three values b_j with $j = 1, 2, 3$. The different states describe the current eligibility level of the unemployed: social assistance (b_1), unemployment assistance (b_2), and unemployment benefits (b_3). It holds that $b_1 \leq b_2 < b_3$. Upon entering unemployment, high-skilled workers are eligible to unemployment benefits b_3. When entering unemployment, low-skilled workers enter in state b_2 with probability γ and with probability $1-\gamma$ they enter unemployment in state b_1. Stochastic eligibility for low-skilled workers captures in a parsimonious way the more complex eligibility rules in the actual system.[16] While staying unemployment, the eligibility state stochastically changes over time. Workers in state b_3, receiving unemployment benefits, transit to state b_2, receiving unemployment assistance, with probability δ_3. Workers who are in state b_2 transit to state b_1, receiving social assistance, with probability δ_2. We denote the share of workers in each state by u_j for $j = 1, 2, 3$. Denoting current period's state by b and next period's state by b', the law of motion for b conditional on staying unemployed is

$$b' = b_1 \qquad \text{if } b = b_1$$

and if $b = b_j$ for $j = 2, 3$, the law of motion is

$$b' = \begin{cases} b_j & \text{with probability } 1 - \delta_j \\ b_{j-1} & \text{with probability } \delta_j \end{cases} \tag{2}$$

When unemployed workers reenter into employment, they enter with state x_1. The law of motion for the worker state at the transition from unemployment to employment is hence $x' = x_1$ independent of b. When transiting from employment into unemployment,

[16] There are two main reasons for the misalignment of employment duration and eligibility: First, employees with more than 1 year of employment duration already become eligible for UI benefits a period of 6 months which then gradually increases to 12 months the longer a person has been working. Second, employment duration in the legislation does not refer to the latest continuous employment spell but the accumulated duration in a reference period of the last 3-5 years.

the law of motion is

$$b' = b_3 \qquad \text{if } x = x_2 \tag{3}$$

and if $x = x_1$, the law of motion is

$$b' = \begin{cases} b_2 & \text{with probability } \gamma \\ b_1 & \text{with probability } 1-\gamma. \end{cases} \tag{4}$$

Each period consists of two stages. The first stage is the separation stage when each match decides about separating into unemployment or entering the production stage. The second stage is the production stage for the employed and the search stage for the unemployed. Search happens simultaneously with production. We refer to this stage respectively as search or production stage depending on whether unemployed or employed are considered. We abstract from on-the-job search. Labor market exit happens with probability ω at the end of the period. A match that does not separate, enters the production stage and produces $y = \exp(a + x)$ units of output depending on skill level x and the aggregate productivity state a. The aggregate productivity state a follows an AR(1) process with autocorrelation ρ and variance σ_a^2.

The aggregate state of the economy s comprises the aggregate productivity state a and the distribution of workers over states $s = \{a, e_1, e_2, u_1, u_2\}$ where we dropped u_3 due to the identity $e_1 + e_2 + u_1 + u_2 + u_3 = 1$. The state of a match at the beginning of the period is described by the tuple (x, s) of the idiosyncratic state x and the aggregate state s. The state of an unemployed worker is (b, s) where the idiosyncratic state is the current benefit eligibility.

At the separation stage, each match draws an idiosyncratic cost shock ε and then, depending on the state of the match (x, s), decides whether to enter the production stage. For analytical tractability, we assume that the shock ε is independently and identically distributed across matches and time and is drawn from a logistic distribution F with mean $\bar{\varepsilon}$ and variance $\sigma_\varepsilon^2 = \pi^2 \frac{\psi_\varepsilon^2}{3}$. A match that decides to separate does not pay these costs. Optimal behavior follows a threshold rule where separations happen when the idiosyncratic cost shock ε is larger than a state-specific threshold $\varepsilon^u(x, s)$. This threshold is determined as part of the bargaining process between the worker and the firm so that separation decisions will be individually efficient. The average separation rate of a match with state (x, s) is $\pi_{eu}(x, s) = Prob(\varepsilon \geq \varepsilon^u(x, s))$. Workers who separate at the separation stage enter unemployment in the current period, receive benefits, and start searching during the search stage of the current period. Aggregate output in a period is $y = \sum_i e_i(1 - \pi_{eu}(x_i, s)) \exp(a + x_i)$ where $e_i(1 - \pi_{eu}(x_i, s))$ is the mass of employed

workers of type i who produce at the production stage.[17]

We denote the value of a firm matched to a worker of skill type x before the realization of the idiosyncratic shock ε by $J(x,s)$. The value $J(x,s)$ expressed recursively is

$$J(x,s) = \int_{-\infty}^{\varepsilon^u(x,s)} \Big(\exp(a+x) - \varepsilon - w(x,s) + \beta \mathbb{E}[J(x',s')|x,s] dF(\varepsilon) \Big) \tag{5}$$

where $w(x,s)$ denotes the wage for the worker and expectations are taken over the realization of the idiosyncratic and aggregate state next period (x',s') conditional on the current state (x,s). The upper integration bound is the threshold value $\varepsilon^u(x,s)$ that determines separation. We assume that the continuation value of the firm after separation is zero. Below, we explain how $\varepsilon^u(x,s)$ and $w(x,a)$ are determined. We exploit the properties of the logistic distribution to get a closed form for the integral of the idiosyncratic shocks ε that we denote by $\Psi_\varepsilon(\pi_{eu})$

$$\Psi_\varepsilon(\pi_{eu}) = \int_{-\infty}^{\varepsilon^u} -\varepsilon dF(\varepsilon) = -(1-\pi_{eu})\overline{\varepsilon} - \psi_\varepsilon \Big((1-\pi_{eu}) \log(1-\pi_{eu}) + \pi_{eu} \log(\pi_{eu}) \Big)$$

with $\pi_{eu} = 1 - F(\varepsilon^u)$ denoting the separation probability given the threshold value ε^u. The firm value simplifies to

$$J(x,s) = (1-\pi_{eu}(x,s)) \Big(\exp(a+x) - w(x,s) + \beta \mathbb{E}[J(x',s')|x,s] \Big) + \Psi_\varepsilon(\pi_{eu}(x,s)) \tag{6}$$

The state of an unemployed worker at the beginning of the period is (b,s) with the idiosyncratic state b describing the worker's current benefit level. The worker's flow utility in unemployment is $b+h$ where h is the utility value of leisure relative to working (disutility of working is normalized to zero). Search is random so all workers receive job offers with the same probability $\lambda(s)$ that only depends on the aggregate state of the economy. We assume that each job offer is associated with an idiosyncratic stochastic utility component ν capturing the personal valuation of workers for jobs. This stochastic non-pecuniary job component comprises among other things commuting time, workplace atmosphere, or working schedules of the offered job. It captures in a parsimonious way endogenous search behavior of the unemployed. Unemployment workers optimally follow a reservation utility rule and accept all job offers with ν larger than a state-dependent threshold $\nu^u(b,s)$. We assume ν is independently and identically distributed and is drawn

[17] The share e_i is at the beginning of the period before the separation stage. Of all employed workers in state (x,s) only a fraction $1-\pi_{eu}(x,s)$ will not separate and produce at the production stage.

from a logistic distribution G with state-specific mean $\overline{\nu}(b)$ and variance $\sigma_\nu^2 = \pi\frac{\psi_\nu^2}{3}$. The average acceptance probability of an unemployed worker in state (b,s) is $q(b,s) = 1-G(\nu^u(b,s))$ and the transition rate into employment is $\pi_{ue}(b,s) = \lambda(s)q(b,s)$ combining contact rate $\lambda(s)$ and acceptance rate $q(b,s)$. The recursive formulation of the value of an unemployed worker in state (b,s) is

$$\begin{aligned} V_u(b,s) &= b + h + \beta\Bigg(\lambda(s)\int\limits_{\nu^u(b,s)}^{\infty}\Big(\mathbb{E}[V_e(x',s')|b,s] - \nu\Big)dG(\nu) \\ &\quad + \pi_{ue}(s)\int\limits_{-\infty}^{\nu^u(b,s)}\mathbb{E}[V_u(b',s')|b,s]dG(\nu) + (1-\lambda(s))\mathbb{E}[V_u(b',s')|b,s]\Bigg) \\ &= b + h + \beta\Bigg(\pi_{ue}(b,s)\mathbb{E}[V_e(x',s')|b,s] + (1-\pi_{ue}(b,s))\mathbb{E}[V_u(b',s')|b,s] \\ &\quad + \lambda(s)\Psi_\nu(q(b,s))\Bigg) \end{aligned} \tag{7}$$

where $V_e(x,s)$ denotes the value of being employed in state (x,s) and the last line exploits again the properties of the logistic distribution with $\Psi_\nu(q) = -q\overline{\nu}(b) - \psi_\nu((1-q)\log(1-q) + q\log(q))$. The state-specific means $\overline{\nu}(b)$ allow us to obtain job finding rates that are falling with unemployment duration. Such changing utility shocks capture, for example, decreasing motivation to apply for jobs, more effort to prepare for job interviews, and to be up to date with job requirements.

An employed worker who does not separate at the separation stage, receives her wage at the production stage. At the end of the production stage, the stochastic skill accumulation takes place. The recursive representation of the value function of employed workers is

$$V_e(x,s) = (1-\pi_{eu}(x,s))\Big(w(x,s) + \beta\mathbb{E}[V_e(x',s')|x,s]\Big) + \pi_{eu}(x,s)\mathbb{E}[V_u(b',s)|x]. \tag{8}$$

Note that in case of separation, expectations are only over the idiosyncratic benefit state b. Although the worker becomes unemployed at the second stage of the current period, we denote the stochastic benefit level in an abuse of notation by b'. The benefit level follows the laws of motion for b in eq. (**??**) and (**??**).

A Cobb-Douglas matching function $m = \varkappa v^{1-\varrho}u^\varrho$ determines the number of matches m between vacancies v and unemployed workers $u = u_1 + u_2 + u_3$ during the search stage of each period. The contact rates from a worker's perspective is $\lambda = \frac{m}{u} = \varkappa\theta^{1-\varrho}$ and from a firm's perspective is $\lambda_v = \frac{m}{v} = \varkappa\theta^{-\varrho}$ with labor market tightness $\theta = \frac{v}{u}$. The number

of vacancies at the search stage of each period is determined by a free-entry condition

$$\kappa = \lambda_v(s)\beta \sum_{j=1}^{3} q(b_j, s)\frac{u_j}{u}\mathbb{E}[J(x', s')|b_j, s] \tag{9}$$

where κ denotes the per-period cost to post a vacancy. Firms posting vacancies take acceptance rates $q(b_j, s)$ of workers with different unemployment benefit eligibility into account. Recall that all newly hired workers start with $x' = x_1$ so there is only uncertainty regarding the aggregate state s' for next period when posting a vacancy.

Wages and threshold values for separation decisions $\varepsilon^u(x, s)$ (or, equivalently by monotonicity, separation probabilities $\pi_{eu}(x, s)$) are determined by a state-contingent Nash-bargaining between the worker and firm over the joint surplus of the match $S(x, s) = J(x, s)+V_e(x, s)-\mathbb{E}[V_u(b', s)] \equiv J(x, s)+\Delta(x, s)$ (see **?**, Ch. 2). We denote the bargaining power of the worker by μ. The Nash-bargaining problem reads $\arg\max_{\{w,\varepsilon^u\}} J(x, s)^{1-\mu}\Delta(x, s)^{\mu}$. The first-order condition with respect to wages delivers the standard surplus sharing rule

$$\mu J(x, s) = (1 - \mu)\Delta(x, s). \tag{10}$$

The first-order condition with respect to the separation cut-off ε^u characterizes the cut-off value in terms of the separation rate $\pi_{eu} = 1 - F(\varepsilon^u)$ as

$$\pi_{eu}(x, s) = \left(1 + \exp\left(\psi_{\varepsilon}^{-1}\left(\exp(a + x) - \bar{\varepsilon} + \tilde{S}(x, s)\right)\right)\right)^{-1} \tag{11}$$

with $\tilde{S}(x, s) = \beta\mathbb{E}[S(x', s')|x, s] + \beta\mathbb{E}[V_u(b', s')|x, s] - \mathbb{E}[V_u(b', s)|x]$ where $\mathbb{E}[V_u(b', s)|x]$ denotes the expected value from unemployment in the current period taking into account stochastic eligibility (see eq. (**??**)). We get that the optimal separation probability $\pi_{eu}(x, s)$ is decreasing in current output $\exp(a + x)$ net of mean costs $\bar{\varepsilon}$ and in an adjusted future match surplus $\tilde{S}(x, s)$ that takes into account the option value from skill accumulation on unemployment benefit eligibility $\beta\mathbb{E}[V_u(b', s')|x, s] - \mathbb{E}[V_u(b', s)|x]$.

3.1 Calibration

We calibrate the model to match the pre-reform labor market dynamics of the German labor market. We show all calibrated parameters in Table **??**. For the calibration, we take a model period to be one month. We set a first group of parameters outside the model. The discount factor $\tilde{\beta}$ is set to match an annual interest rate of 4% so that $\tilde{\beta} = 0.996$, the parameter ϱ of the matching function and the bargaining power of the worker μ are set to $\varrho = \mu = 0.5$.

Table 4: Calibrated parameters

	Parameter	Value	Description
search and matching	ϱ	0.5	elasticity of the matching function
	$\varkappa$	0.163	efficiency of the matching function
	κ	0.657	vacancy posting costs
	μ	0.5	worker's bargaining power
	ω	0.010	labor market exit rate
preferences	$\tilde{\beta}$	0.996	time discount factor
	h	0.276	flow leisure utility
	$\bar{\nu}(b_1)$	0.520	
	$\bar{\nu}(b_2)$	0.520	means of non-pecuniary shocks
	$\bar{\nu}(b_3)$	1.004	
	ψ_ν	0.075	dispersion of non-pecuniary shocks
skills and costs	$\bar{\varepsilon}$	0.520	mean of cost shocks
	ψ_ε	0.700	dispersion of cost shocks
	α	0.028	probability of skill accumulation
	Δx	0.029	skill level difference $x_2 - x_1$

We describe below how we set the parameters of the unemployment insurance system using independent evidence. Remaining model parameters are set within the model by targeting data moments. Dynamics in the model are driven by a single aggregate productivity shocks a. To simulate the model, we linearize the model around its deterministic steady state and use a Kalman filter on GDP growth per capita to determine the time series of aggregate productivity shocks a (see **?**).[18] We follow with this approach ideas from **?**. Within our calibration routine, we adjust model parameters until the simulated model moments match their data counterparts. We next provide intuitive identification arguments but abstain from a formal proof of identification.

Vacancy posting costs κ determine directly how many vacancies are posted and the contact rates in the search market. The contact rate determines the average job finding rate that we take from the data ($\pi_{ue} = 0.052$). To separately identify matching efficiency $\varkappa$ from vacancy posting costs κ, we use data on the average duration to fill a vacancy from the firm's perspective. In the IAB vacancy survey, the average vacancy duration is 2.8 months. The flow utility parameter of leisure h determines the worker surplus from

[18] We use GDP per capita for Germany as data on West German GDP is not available at a quarterly frequency.

employment Δ and as part of the total match surplus S, it determines the average probability of separating into unemployment (see eq. (??)). We match an average separation rate $\pi_{eu} = 0.006$.

Matching the observed volatility of job creation over the business cycle is a challenge for this class of models (?, ?). The variation in acceptance rates $q(b, s)$ of workers over the business cycle provides additional amplification to job creation decisions (see eq. (??)). To put discipline on the level and variation in acceptance rates, we target the estimated elasticity of job finding rates with respect to changes in unemployment benefits from the literature (? for Germany). We use the elasticity of average acceptance probabilities with respect to changes in unemployment benefits $\frac{\partial q}{\partial b}\frac{b}{q}$ and target a value of 0.53 from ?.[19] For a given dispersion of non-pecuniary shocks, this elasticity pins down one of the means of the non-pecuniary shocks. We use to pin down $\bar{\nu}(b_3)$ for recipients of unemployment benefits. We impose that recipients of unemployment assistance benefits b_2 and benefits at subsistence level b_1 have the same mean of shocks $\bar{\nu}(b_1) = \bar{\nu}(b_2)$. This effectively results in different means for short- and long-term unemployed. Hence, duration dependence in job finding rates is informative about the difference between $\bar{\nu}(b_1)$ and $\bar{\nu}(b_2)$. For the duration dependence, we use a difference in job finding rate between 6 and 12 month of 25%.[20] Very related is the identification of the parameter ψ_ν determining the dispersion of the non-pecuniary shock distribution. While we use cross-sectional variation of job finding rates to determine means of the non-pecuniary shock distribution, we leverage the time-series variation in job finding rates to identify ψ_ν. We target a volatility of job finding rates that corresponds to 6.4 times the volatility of output. Similarly, we use the time series volatility of separation rates, to identify the dispersion of cost shocks ψ_ε. We target a volatility of separation rates that corresponds to 7.8 times the volatility of output. The volatility of separations is higher than the volatility of job finding rates in line with existing evidence (?, ?).

These elasticities are key when we change the unemployment insurance system. To see this, recall that a 1% change in the surplus of the match from a change productivity over time works similarly to a 1% percent change in the surplus from a change in the outside option. Hence, time series variation of transition rates are informative about the effects from structural changes in labor market institutions (?).

[19] This elasticity of search $\frac{\partial q}{\partial b}\frac{b}{q}$ is in the model the percentage change in the acceptance probability of an unemployed worker receiving unemployment benefits with respect to a percentage change in the benefit level for given contact and separation rates.

[20] Mean job finding rates of these two benefit groups are computed from aggregate data between 1996 and 2004 on average durations in the respective group. We assume constant job-finding rates within each benefit-type. To obtain the job finding-rate of short-term benefit recipients we further assume that they transit to long-term benefits after 12 months. We can then back out the implied job finding-rate from the mean duration of the truncated distribution.

For the skill process, we use the one-to-one relation between the average duration of short-term employment that we set to 3 years and the probability of skill accumulation α. Similarly, we use the one-to-one relation between the share of long-term employed workers and the probability of labor market exit ω. Short-term and long-term employed workers differ in their productivity levels x_1 and x_2. We exploit the documented separation rate differences between the two groups to pin down the skill difference $\Delta x = x_2 - x_1$. We normalize x_1 and use the separation rate difference between short-term employed workers 0.014 and long-term employed workers 0.002 from Table **??** to determine the skill difference Δx.

Table 5: Parameters of the unemployment insurance system

pre-reform		post-reform	
b_1	0.245	b_1	0.245
b_2	0.330	b_2	**0.245**
b_3	0.366	b_3	0.366
δ_2	0.021	δ_2	0.021
δ_3	0.083	δ_3	0.083

We calibrate parameters of the unemployment insurance system to independent evidence on replacement rates from the OECD. Parameters for the period before and after the reform are shown in Table **??**. According to the OECD, a single worker with averages wages received before 2004 unemployment insurance benefits corresponding to 60% of average wages during the first year of unemployment and 53% of average wages for the following four years. We use these replacement rates to pin down b_3 and b_2. Consistently, we set δ_3 to match an average duration of one year and δ_2 to match an average duration of four years. For the subsistence level b_1, we match the average ratio of subsistence benefits to unemployment benefits over the period from 1996 to 2002 based on data from the German Statistical Office (earlier data not available). The average ratio corresponds to $\frac{b_1}{b_3}$ in the model and we fit it to be 67% as in the data ($\frac{b_1}{b_3} = 0.67$).

When exploring the effects of changes in the UI system from the Hartz reforms on labor market dynamics, we focus on the abolition of long-term unemployment benefits (unemployment assistance benefits). Like in **?**, we implement the reform in the model by setting long-term unemployment benefits b_2 to the level of subsistence social security benefits b_1, i.e. we set $b_1 = b_2$. The duration parameter δ_2 becomes irrelevant because transitions happen between states with the same benefit levels and mean utility shocks $\bar{\nu}(b_1)$ and

$\bar{\nu}(b_2)$ are set identical across the two states in the calibration.

In the model, this change becomes effective in January 2006. As described above the law became effective in January 2005, but the law scheduled the new benefit rules to affected workers only if they became unemployed after February 2006. In addition, a wide range of grandfathering rules and hardship clauses were provided with the law such that it became only slowly applicable to all workers. We implement the complex and detailed legislation by gradually increasing the impact of the reform on labor market dynamics. Specifically, we use different policy functions based on linear approximation of the steady state systems before and after the Hartz reforms. We assume a linear weighting scheme that spreads the implementation over four years so that the reform is fully effective in January 2010.[21] When implementing the Hartz reforms in the model, we keep *all* other parameters except for the UI system constant over time.

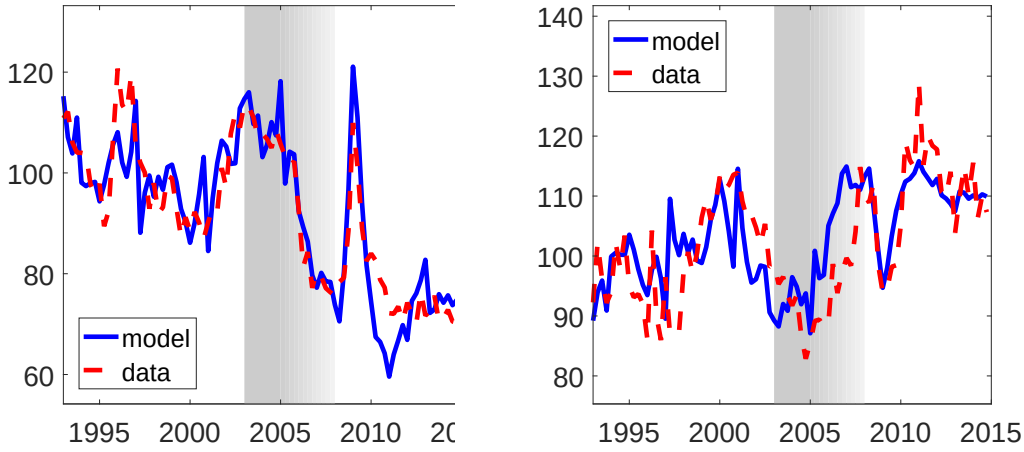
4 Results

In the first step, we demonstrate the model's ability to match the dynamics of observed labor market flows over time. Dynamics in the model are driven by two sources: aggregate productivity fluctuations and the structural change of the UI system due to the Hartz reforms. As described before, parameters are only calibrated to match selected means and volatilities of labor market flow rates before the Hartz reforms and the Hartz reform constitutes a parsimonious change in parameters of the unemployment insurance system. Figure **??** shows simulated times series of separation and job finding rates from the model together with the data counterparts of these series. We index all series to the pre-reform steady state that is matched as part of the calibration.

Figure **??** shows how closely the model fits the separation rate from the data. The empirical and simulated time series largely lie on top of each other. This is true both before the reform as well as after the reform. Except for a short period around 2010, the model matches the decrease of the separation rate and the dynamics during the financial crisis of 2008 very well. Overall, the fit for the average separation rate must be considered very close. Figure **??** shows the simulated job finding rate together with the data counterpart. Job finding rates before 2005 are again matched very closely. After the reform, the model matches the dynamics and level changes closely with the exception of a period between 2005 and 2009 when the model predicts a more immediate increase in job finding rates compared to the data. This is the transition period after the Hartz reforms

[21] We also tried implementing the reform directly with the only difference that the dynamics during the transition period are matched less well. Obviously, this assumption does not affect changes in steady states but only the behavior of the model during the transition phase. Hence, our key results do not depend on the specific implementation of the transition period.

Figure 7: Fit for average labor market mobility (1993 - 2014)



(a) separation rates (b) job finding rates

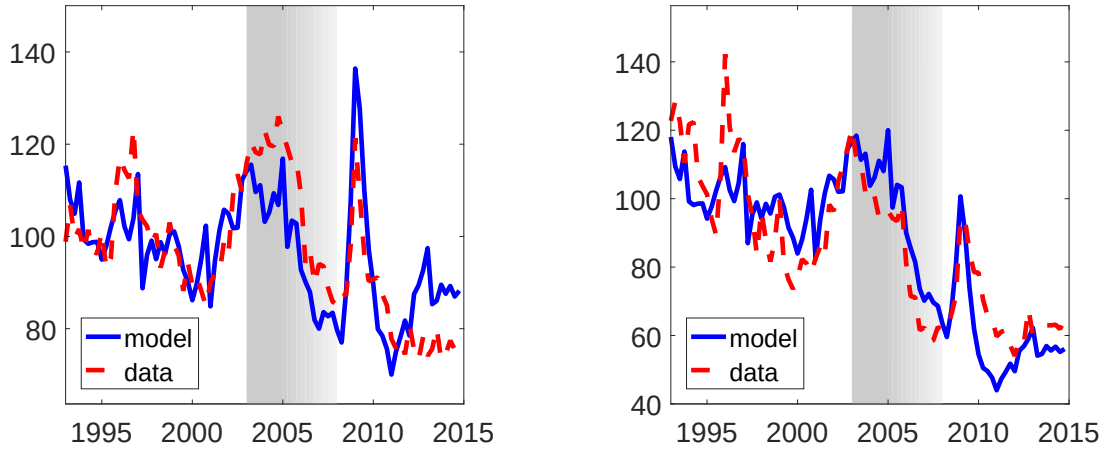
Notes: Model fit 1993 - 2014. The blue solid line marks the model prediction, the red dashed line marks the respective flow rate in the SIAB micro data. The grey area marks the period from 2003 to 2005 when the Hartz reforms were enacted. The fading out indicates the first transition years 2006 to 2008 after the reforms. All series are log deviations from an HP-filtered trend ($\lambda = 100{,}000$).

when our implementation of grandfathering rules and hardship cases is very rudimentary. Important for our analysis below, however, is that the change in average rates between the pre-reform period and the post-reform period is explained almost exactly with the model matching average rates after 2010.

Our empirical analysis uncovers large heterogeneity in changes of separation rates after the reform. Figure **??** demonstrates the model's ability to match such heterogeneity in changes of separation rates. As for the average separation rate, levels and level differences between short-term and long-term employed workers before the reform have been calibrated so that they are matched by construction. Heterogeneity in changes after the reform are untargeted and provide a first test to the hypothesis of a causal relationship of the reform to the observed changes in separation rates. Results in Figure **??** support the hypothesis of a causal relationship from the reform to observed changes in labor market dynamics by demonstrating a close match of the heterogeneous responses in separation rates between model and data.

Figure **??** shows the simulated and empirical separation rates for short-term employed workers with employment durations of less than three years. The model matches the time series very closely including the volatility. Unlike for the average separation rates, heterogeneous volatilities of separation rates for short-term and long-term employed workers

Figure 8: Fit for heterogeneity in labor market mobility (1993 - 2014)



(a) separation rates ($\leq$ 3 years) (b) separation rates ($>$ 3 years)

Notes: Model fit 1993 - 2014. Model fit of EU-rates with low ($\leq$ 3 years, left panel) and high ($>$ 3 years, right panel) employment duration from 1993 - 2014. The blue solid line marks the model prediction, the red solid line marks the respective flow rate in the SIAB micro data. The grey area marks the period from 2003 to 2005 when the Hartz reforms were enacted. The fading out indicates the first transition years 2006 to 2008 after the reforms. All series are log deviations from an HP-filtered trend (λ=100,000).

have not been part of the calibration, but are an endogenous prediction of the model. Over the long-run, the model predicts a slightly lower decline in separation rates for short-term employed workers relative to the data (10% vs. 20%). Importantly, however, the model shows like the data a substantially smaller decline in separation rates for short-term employed workers relative to the average in Figure **??**.

Figure **??** compares the separation rates of long-term employed workers between model and data. We find that time series for the long-term employed workers are matched closely both in volatility and long-run trend. We find for the long-term employed workers that the model slightly overstates the decline of separation rates. Again, and importantly, we find that in line with the argument that the reduction of long-term benefits was the causal mechanism behind the labor market miracle that the separation rates of long-term employed workers decline more than the average separation rates.

Overall, our parsimonious model of labor market dynamics captures the key empirical pattern for the changes of separation rates and job finding rates closely. The causal mechanism in the model is the decline of long-term unemployment benefits to subsistence levels. We will show based on counterfactual simulations that absent this change in the UI system, the model provides very counterfactual predictions for the evolution of labor

market transition rates and unemployment rates.

The results of a large but heterogeneous response in separation rates after changes in non-work benefits in this section might also have implications beyond the case of the unemployment insurance system. Many social security reforms like changes in early retirement programs or disability insurance programs likely show similar changes following changes in program benefits. Arguably, the responses of separation rates in these programs might even be larger due to the longer duration of benefit eligibility in these programs. Our results suggest that elasticities of separation decision from employment in these programs with respect to changes in the attractiveness of program benefits on macroeconomic employment might be large. Neglecting such endogenous separation decisions when evaluating such programs can lead to very misleading evaluations of program reforms.

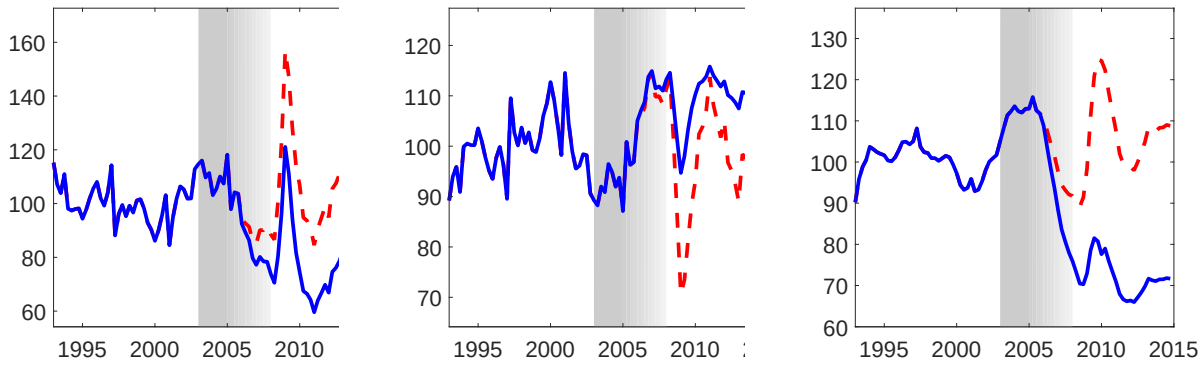
4.1 Counterfactual simulations

This section further builds on our approach to estabilish a causal link from the unemployment insurance system to the German labor market miracle relying on economic theory in form of our structural labor market model. We do this by running counterfactual model simulations in the absence of the labor market reforms. The simulated labor market dynamics of this counterfactual are strongly at odds with the data, while as we have just demonstrated, the same model matches labor market dynamics in Germany for the two decades from 1994 to 2014 closely when the Hartz reforms are implemented. This finding provides further support for a causal effect from the Hartz reforms to the observed changes in the German labor market. Furthermore, the counterfactual simulation provides an approach to decompose the contribution of changes in labor market dynamics in structural changes and business-cycle fluctuations.

The counterfactual simulation to demonstrate the impact of the Hartz reforms on labor market dynamics is simple and transparent. We keep all model parameters constant over time including the parameters of the UI system, so that no structural change takes place. We also keep the aggregate shock series identical and feed in the previously estimated productivity shocks from the Kalman filter. This counterfactual simulation provides time series of separation rates, job finding rates, and unemployment rates in the absence of the Hartz reforms. Figure **??** shows the counterfactual simulation results for the time period from 1993 to 2014.

By construction, the time series from the baseline and the counterfactual in the period before the implementation of the Hartz reforms lie exactly on top of each other as we

Figure 9: Counterfactual model simulation absent Hartz reforms (1993 - 2014)



(a) Separation rates (b) Job finding rates (c) Unemployment rates

Notes: Policy experiment 1993 - 2014. The blue solid line shows the model with the benefit cuts from 2006 onwards, the red-dashed line shows the counterfactual rate without policy change. The grey area marks the period from 2003 to 2005 when the Hartz reforms were enacted. The fading out indicates the first transition years 2006 to 2008 after the reforms.

also rule out any anticipation effects.[22] After the implementation of the reform, the two simulated time series strongly diverge. Separation rates of the counterfactual remain high and fluctuate around their pre-reform level as shown in Figure **??**. Separation rates of the counterfactual simulation strongly spike during the financial crisis of 2008 to almost 160% of their steady state level. In case of the reform, the separation rate still spikes but increases only to slightly more than 120% of the old steady state level. Job finding rates in Figure **??** evolve again identical between baseline and counterfactual up to the implementation of the reform when the two series start to diverge. In the new steady state with the reform, the job finding rates increase persistently by 10%. Over time, the divergence is strongest during the financial crisis. In the counterfactual scenario job finding rates plummet to around 70% of their steady state level. In the case of the Hartz reforms, the job finding rate still decrease but only to a level slightly below its old steady state level. The divergence of the separation and job finding rates manifest themselves in very a different dynamics of the unemployment rate. While unemployment declines in the baseline simulation with the Hartz reforms by 30% relative to the pre-reform steady state, the unemployment rate stays by construction put at its pre-reform level absent the reform. We find a marked difference in the evolution of unemployment rates between the two simulations during the financial crisis. The counterfactual simulation shows an increase of the unemployment rate of almost 30% over its long-run average, reminiscent of the typical European country and the United States during these years

[22] Anticipation effects are likely small as the implementation of the reform happened on short notice. The parliament approved the law that became effective in January 2005 only in June 2004.

who saw sharply and strongly rising unemployment rates. In case of the implementation of the Hartz reforms, the labor market remained very ignorant of what most other countries experienced as one of the largest labor market crisis over decades. Unemployment rates increased about 10% over their new steady state level that itself is 30% below the pre-reform level. The strikingly different dynamics based on our theoretical labor market model provide a further argument for a causal relationship of the reduction of long-term unemployment benefits of the Hartz reforms on the German labor market miracle.

4.2 Decomposing cyclical and structural changes

We use the counterfactual simulations further to quantify the contribution of the business cycle to the decline in unemployment since 2004. Figure **??** shows that in 2004 all data series are away from their respective steady states. Our motivating evidence in Figure **??** like most of the public debate focuses, however, on 2004 as year of reference to assess the effect of the Hartz reforms on the labor market. Taking 2004 as reference, the decline of the unemployment rate between 2004 and 2014 contains some part that is due to the business cycle and not due to a structural change. We rely on the counterfactual simulation to isolate the business cycle component. Our decomposition approach is straightforward: We attribute all changes in the counterfactual simulation to the business cycle and by subtracting these changes from the baseline model, we isolate the structural component of the changes in separation rates, job finding rates, and unemployment rates. Table **??** shows average unemployment, separation, and job finding rates in 2004 and 2014 from model simulations with and without the implementation of the Hartz reforms. The columns labeled *change* show the change in the respective rates between 2004 and 2014. The change in the baseline case with the Hartz reforms are a combination of business cycle effects and structural reform effects, while the change in case when the reform is not implemented result only from business cycle variation. We report the derived contribution of the business cycle in the last column of Table **??**.

Looking first at columns of the baseline case with the implementation of the reform. The key driver of the lower unemployment rates is the decline of the separation rate by 30%, the job finding rate increased by 17%. Comparing these effects to the case absent the reform in the middle columns isolates the business cycle effect and shows that business cycle effects are small. The last column shows the constructed business cycle contributions to unemployment, separation, and job finding rate changes and we find them to never exceed 10%. We conclude that business-cycle effects are small and of minor importance for the German labor market miracle.

Table 6: Business cycle contribution

	with reform			absent reform			Business cycle
	2004	2014	change	2004	2014	change	contribution
unemployment rate	10.2	6.5	-36.4%	10.2	9.9	-3.7%	10.0%
job finding rate	4.9	5.7	16.6%	4.9	5.0	1.6%	9.7%
separation rate	0.7	0.5	-29.9%	0.7	0.7	-1.2%	3.9%
separation rate (short-term)	1.6	1.3	-16.7%	1.6	1.5	-1.4%	8.6%
separation rate (long-term)	0.3	0.2	-47.5%	0.3	0.3	-1.7%	3.6%

Notes: This table shows the unemployment and flow rates in the model before the reform (2004) and in the most recent year (2014). Columns 1-3 show the rates implied by a model with the benefit reform in place, columns 4-6 show the rates without the benefit reform but the same business cycle shocks. The last column shows the relative contribution of the business cycle to the overall change in the respective variable.

4.3 Germany and its neighbors

We argue that the strong deviation of the counterfactual simulation in the absence of the Hartz reforms supports the claim of a causal relationship between the unemployment benefit changes of the Hartz reforms and the German labor market miracle. An important question is if the quantitative size of the effects is realistic, i.e. if the counterfactual provides a good description of what would have happened had the reforms not been implemented. Given that such a counterfactual evolution of the German labor market always remains unobserved, we apply an idea inspired by the control-treatment approach from the microeconometric literature. We will use one of Germany's close neighbors, Austria, as control group that did not get treated by the Hartz reforms and compare the unemployment rates of Austria and Germany over time. This should be seen as inspired by the idea of the control-treatment approach rather than a formal implementation.

Austria has traditionally business cycle dynamics that resemble closely those of Germany (see Figure **??** in appendix). Although the business cycle dynamics for Germany

and Austria track each other closely, the level of the Austrian unemployment rate has been on average 52% lower than the German unemployment rate over the decade before the Hartz reforms. We abstract from these level differences by adjusting the level of the Austrian unemployment rate using a multiplicative constant factor.[23] For our comparison, we are interested in the relative changes of the unemployment rate over time that remain unaffected by this level adjustment. Figure **??** shows the evolution of the Austrian unemployment rate together with the simulated unemployment rates from our baseline model and from the counterfactual simulation absent the Hartz reforms. The comparison is striking. Looking at the evolution since 1993 in Figure **??**, we find that the dynamics of the Austrian unemployment rate track the simulated unemployment rate of the counterfactual almost one-for-one, while the baseline simulation diverges after the implementation of the reform to a much lower level. Figure **??** zooms in on the evolution of the unemployment rate starting in 2008 and over the course of the Great Recession. Again, the results are striking. While the Austrian unemployment rate, like the counterfactual German unemployment rate, increases by almost 40% after four quarters into the recession, the unemployment rate from the baseline model increases by less than 20% four quarters into the Great Recession. Looking at the recovery, the Austrian and counterfactual German unemployment rate revert only slowly back to the pre-recession levels. Three years after the onset of the recession, they reach levels close to pre-recession times. As for the rise of the unemployment rate, we also find for the recovery that the Hartz reforms have reshaped the reaction of the German unemployment rate. After two years, the unemployment rate is already back to its pre-recession levels.

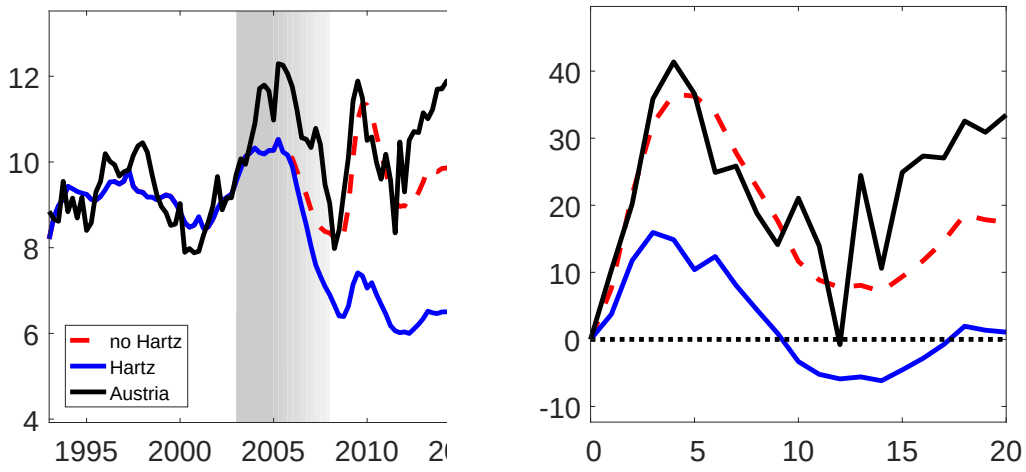
The comparison to the Austrian case provides further evidence for a causal relationship of the changes in the unemployment benefit system during the Hartz reforms in Germany and the German labor market miracle. Absent the reform, our model predicts a close comovement of Germany's unemployment rate with its Austrian counterpart. Germany's unemployment rate would be 50% higher today (9.9% vs. 6.5% see Table **??**). Comparison over the course of the Great Recession also highlights the changes in the business cycle dynamics of the German labor market after the reform.

4.4 Reform effects on wages

Changes in workers' outside option affect the surplus split in the bargaining between workers and firms so that when lowering unemployment benefits, wages decline. This mechanism plays the key role in **?** who quantify the effect of changes in unemployment benefits on the U.S. labor market during the Great Recession. This mechanism is also

[23] Data on the Austrian unemployment rate are taken from Eurostat. For 1993, we use OECD data to extend the data Eurostat series as the Eurostat data is only available from 1994 onwards.

Figure 10: Austrian unemployment rates and model simulations for Germany



(a) unemployment rate

(b) unemployment change during Great Recession

Notes: Austrian unemployment rates in comparison to model simulations for Germany. Left panel shows unemployment rates in percent for Austria (level adjusted) and model simulations for Germany for the period from 1993 to 2014. Black solid line shows Austrian unemployment rate, red dashed line shows counterfactual German unemployment rate from model simulation absent the Hartz reforms, and blue solid line shows simulation for Germany for the baseline model. The grey area marks the period from 2003 to 2005 when the Hartz reforms were enacted. The fading out indicates the first transition years 2006 to 2008 after the reforms. Right panel shows percentage increase of the unemployment rate for Austria and model simulations for Germany during Great Recession. The onset of the Great Recession for Austria is 2008q2 and 2008q3 for Germany. The horizontal axis shows time in quarters relative to the onset of the recession. Black solid line shows Austrian unemployment rate (level adjusted), red dashed line shows counterfactual German unemployment rate from model simulation absent the Hartz reforms, and blue solid line shows simulation for Germany for the baseline model.

present in our model so that wages of long-term employed workers fall by 1% in the new steady state after the reform. The outside option for short-term employed workers improves after the reform because benefits do not change but job finding rates increase, hence, the same mechanism leads in our model to a wage increase of 0.8% for short-term employed workers. If wages decline, profits will increase, and firms will post more vacancies, as a consequence, job finding rates will increase and unemployment rates will decline. Our empirical evidence attributes a minor role to such a mechanism for the German labor market miracle by documenting only small changes in job finding rates.[24]

[24] **?** exploit in their empirical analysis cross-state variation in the United States. Such variation does not exist for the case of the German Hartz reforms rendering the implementation of their approach infeasible for Germany. Absent the ability to exploit differential cross-sectional variation in labor market responses, it will require very strong assumptions on wage dynamics across different worker groups to isolate a reform effect on wage levels in the German data.

Theoretically, two reasons explain the minor role of this channel for the German case. First, unemployment benefits for newly hired workers in the model do not change, so that the attractiveness to post vacancies hinges on indirect effects. Second, job finding rates are empirically less sensitive to surplus changes in Germany (**?**), as a consequence, unemployment benefits changes will affect job finding rates less (**?**). Indeed, the relative contribution of job finding rates to unemployment volatility, that governs the importance of this mechanism from vacancy creation, is rather small in most OECD countries when compared to the United States (see **?**). This observations suggests that the relative importance of changes in job finding rates in the United States might be a particularity of the U.S. labor market rather than a good description of the adjustment processes in other OECD countries. We provide the evidence for the German case.

While the reform effect on wages for the vacancy creation mechanism are of minor importance, our theory has additional implications for the interaction of wage changes and separation rate changes from the reform that this section explores. In our model, separations decisions are part of the bargaining between the worker and the firm. When benefits decline, workers want to trade off job stability in form of lower separation rates against wages (**?**). Workers and firms will agree in the bargaining to stay together even after larger cost shocks, so that the option values and wages will decline (see eq. (**??**)). The ability to adjust wages and separation decisions in the bargaining implies a negatively sloped locus of bargained separation rates and wages across productivity levels. After a change in the outside option, this wage-separation rate locus will turn and become steeper. Long-term employed workers want to trade lower wages for lower separation rates, hence, we should expect a stronger negative relationship between wages and separation rates after the reform. Uncovering a direct estimate of the elasticity from the data is intricate because of many confounding factors on wage growth. We will therefore focus on verifying that the qualitative model predictions can be found in the data. We follow the approach in **?** based on residual wage differences and regress the probability of separating into unemployment for individual i over the next six months $\pi^6_{eu,i}$ on the contemporaneous (log-)wage $\log(w_{i,0})$ controlling for worker observables X_i

$$\pi^6_{eu,i} = \alpha + \beta \log(w_{i,0}) + \gamma X_i. \tag{12}$$

For the regression, worker characteristics are observed contemporaneously with the wage. The vector X_i contains dummies for gender, 10-year age brackets, education levels, time and industry dummies; $\log(w_{i,t})$ refers to average daily earnings.[25] The dependent variable $\pi^6_{eu,i}$ is a binary variable that is equal to one if the worker separates into unemploy-

[25] We focus only on full-time workers for this regression.

ment at least once over the next six months. The coefficient of interest β corresponds to the elasticity of separation rates with respect to wages after dividing by the average separation rate $\bar{\pi}^6_{eu}$. The approach estimates the effect of residual wage differences as resulting from productivity differences and their effect on the wage.

Table 7: Wages and separation rates

period	$\bar{\pi}^6_{eu}$	β	elasticity
pre-reform	0.020	-0.020***	-0.99
post-reform	0.013	-0.017***	-1.28

Notes: Regression results for the relationship of wages on separation rates before and after the Hartz reforms. The column labeled $\bar{\pi}^6_{eu}$ shows average 6-month separation rate. The column labeled β shows the regression coefficient from equation (**??**). The last column reports the implied elasticity of separation rates on wages. See text for further details.

Table **??** reports the key regression coefficient β for the period before the Hartz reforms (1993-2002) and after the reforms (2008-2014). The last column reports the implied elasticity of separation rates with respect to wages. Before the reform, we find an elasticity of -0.99 so that a (residual) productivity increase associated with a 1% wage increase reduces the separation rate by 1%. This elasticity increases by almost one third to -1.28 after the Hartz reforms. Hence, workers choose a stronger trade off between wages and job stability. This stronger trade off between wages and separation rates is predicted by theory and provides further support for our proposed mechanism.[26]

4.5 Welfare effects

Our empirical and theoretical analysis demonstrates that changes in separation rates have been the driver of the German labor market miracle starting in the mid-2000s. We document and explain why the decline in separation rates has not been uniform in the population and that long-term employed, high wage workers saw the strongest decline in their separation rates in reaction to the reform. Job finding rates increased, and thereby, the probability that both short- and long-term unemployed can find jobs and enter into employment. Our structural model allows us to investigate the welfare consequences from these changes for the different groups of workers. We derive welfare consequences as the

[26]We also ran a logit regression that directly estimates the elasticities. The estimated elasticities are similar in level and change to the case of the linear regression. We estimate an elasticity of -0.87 before and -1.06 after the reforms.

consumption equivalent variation in steady state consumption for a worker, i.e., we quantify a worker's willingness to pay to avoid the reform. We compute welfare consequences by relying on a steady state comparison for all worker types: short- and long-term employed workers and workers in each of the three tiers of the unemployment insurance system.[27] Note that this equivalent variation is uncompensated in the sense that due to lower unemployment after the reform the government could redistributed gains from the reform. Our equivalent variation is before any redistribution and indicates the compensation necessary to make workers of each group indifferent between implementation of the reform and not implementing it.

Table 8: Welfare effects from the unemployment insurance reform

	employed		unemployed		
worker group	short-term employed	long-term employed	social assistance	unemployment assistance	unemployment benefits
equivalent variation	0.11%	0.64%	0.03%	2.11%	1.18%

Notes: Welfare effects of the reform expressed as consumption equivalent variation for avoiding the implementation of the unemployment insurance reform.

Table **??** shows the welfare effects for the different groups of workers. We find the largest welfare losses for former recipients of unemployment assistance benefits with a consumption equivalent variation larger than 2%. Such a large welfare loss likely explains the grandfathering and hardship regulation that accompanied the reform. Note that we compare here steady states so that even in our model with the staggered implementation the welfare effects including the transition would be lower for this group. The group with the second largest welfare losses have been the unemployed with an equivalent variation of 1.2%. Unemployed workers receiving social assistance benefits experience hardly any welfare effect because their benefits remain unchanged by the reform. The non-zero effect results from an indirect effect from lower wages after skill accumulation in case of reemployment. Turning to the employed, we find much larger effects for the long-term employed compared to short-term employed workers. The group of workers with very low separation rates (see Table **??**) experiences a welfare loss corresponding to a consumption equivalent variation of 0.7%. This group corresponds to more than 60% of all employed workers in the German labor market and has very low separation rates.

[27] The assumption of risk neutrality leads to simple formulas for the consumption equivalent variation. Denote the value function before the reform by V_0 and after the reform by V_1, then the consumption equivalent variation is $\Delta = \frac{V_0 - V_1}{V_1}$.

The low separation rates might therefore suggest that this group is the least affected by the reform, yet, we find large welfare losses for them. The reason is very intuitive and is closely connected to the causal mechanism of this paper. Welfare effects are large because the outside option for these workers deteriorates most strongly with the abolition of long-term, wage-dependent unemployment benefits. Hence, a group of almost two-thirds of the German labor market experienced large welfare losses from the reform. These losses remained largely uncompensated in the aftermath of the reform and might therefore explain the large discontent with the reform by large parts of the German electorate.

These results might have again important implications beyond the specific case of the German Hartz reforms for reform proposals in other European countries. The results suggest that the political feasibility of UI reforms might critically depend on the compensation of the large group of long-term employed workers with save jobs, who at first glance might appear very detached from the topic of unemployment benefit reforms.

4.6 Alternative explanations

In this paper, we provide empirical evidence in connection with economic theory to argue that the cause of the German labor market miracle has been the unemployment benefit reform that was part of the Hartz reforms in the mid-2000s. The German labor market miracle (see **?**) has been widely studied and various narratives have been proposed in addition to the ones that highlight changes in job-findings as a key driver. We provide a short summary of our investigation regarding such alternative explanations for the German labor market miracle, details can be found in Appendix **??**. Maybe the most prominent narrative is **?**, who argue that Germany's unit labor cost and wages were declining relative to other European countries way before the Hartz reforms were introduced. They point to declining union power as a possible source and downplay the role of the Hartz reforms. However, wage trends alone are hard to interpret when viewed through the lens of a standard search model and need to be discussed relative to productivity trends net of trends in the outside option. We show in **??** that the declining trend in unit labour cost, possibly caused by a decline in unions, is hard to reconcile with the time-series pattern of the unemployment rate, in particular it can not explain the dramatic increase in unemployment rates during the 90's and can not explain the sudden reversal after the year 2005 once the business cycle is accounted for. Another explanation could be related to globalization and an export demand driven boom in Germany (see **?** for some evidence on globalization effects among particular industries classified as open to export/import competition). To the extend that aggregate factors jointly affect GDP growth our business cycle analysis has taken these trends out already. Looking

at particular sectors in more detail we use the industry classification of **?** to show in Appendix **??** that separation rate changes in industries classified as exposed to exports behave similarly to the ones classified as non-exposed, suggesting that export exposure is not the main driver of the decline in separation rates. Finally we study whether the Hartz-reforms have affected in particular the long-term unemployment (see **?** for a more extensive empirical analysis). Reducing long-term unemployment was one of the explicit goals of the reform. We show in Appendix **??** that the share of long-term unemployed was largely unaffected and is at its Pre-Hartz level now. This suggests - together with the evidence on the job-finding rates presented before - that the effects via a reduction of long-time unemployment are likely to be very modest.

5 Conclusions

What hides behind the German labor market miracle? This paper combines an empirical analysis of microdata on worker flows with economic theory on labor market dynamics to provide an answer to this question. We trace the German labor market miracle back to the reform of the German unemployment insurance system that happened during the Hartz reforms in Germany in the mid-2000s. Our analysis highlights changes in separation rates after unemployment benefit reforms as the quantitatively important channel through which the unemployment insurance system affects unemployment rates and labor market dynamics. We contribute thereby to a key question of labor market research.

We provide evidence that a decrease in separation rates after the reform explains 75% of declining unemployment. Existing studies on the German labor market miracle leave this empirical fact unexplained by focusing on changes in job finding rates. Reduction in separation rates are heterogeneous with long-term high-wage workers being most affected. We use economic theory to causally link our empirical findings to the reduction in long-term unemployment benefits. Using our quantitative labor market model, we find that absent the reform, unemployment rates would be 50% higher today. We also find a close comovement of the German and Austrian unemployment rates over the last decade for a counterfactual without the labor market reforms in Germany.

Exploring the welfare consequences of the labor market reforms, we find that long-term employed high-wage workers suffered substantial welfare losses in the absence of compensating transfers. This worker group accounts for almost two-thirds of the German workforce. Separation rates of these workers are the lowest in the labor market and it might therefore appear as if these workers are very detached from any changes in the unemployment insurance system. We show that this is not the case and that in hindsight this might explain the discontent of a large part of the German electorate with these

reforms.

Our results have two important implications for labor market reforms. The first relates to future labor market reforms in other European countries as they have been widely discussed after observing Germany's labor market miracle. For the political feasibility of these reforms, the welfare effects must be a key part of the consideration and the compensation scheme to avoid discontent in large parts of the electorate. Second, the strong reaction of separation rates after changes in non-work benefits highlights the importance of this channel also for other labor market reforms like early retirement programs or disability insurance programs.

References

Antoni, Manfred, Andreas Ganzer, and Philipp vom Berge, "Sample of Integrated Labour Market Biographies (SIAB) 1975-2014," Technical Report, Data report 04/2016, Institute for Labor Market Research (IAB), Nuremberg 2016.

Autor, David, David Dorn, and Gordon Hanson, "The china syndrome: Local labor market effects of import competition in the united states," *American Economic Review*, 2013, *103*, 2121–68.

Baily, Martin, "Some aspects of optimal unemployment insurance," *Journal of Public Economics*, 1978, *10*, 379–402.

Burda, Michael and Stefanie Seele, "No Role for the Hartz Reforms? Demand and Supply Factors in the German Labor Market 1993-2014," *SFB 649 Discussion Paper*, 2016.

Chetty, Raj, "A general formula for the optimal level of social insurance," *Journal of Public Economics*, 2006, *90*, 1879–1901.

Chodorow-Reich, Gabriel and Loukas Karambarbounis, "The Limited Macroeconomic Effects of Unemployment Benefit Extension," *Working paper*, 2016.

Costain, James and Michael Reiter, "Business Cycles, Unemployment Insurance, and the Calibration of Matching Models," *Journal of Economic Dynamics and Control*, 2008, *32* (4), 1120 – 1155.

Dauth, Wolfgang, Sebastian Findeisen, and Jens Suedekum, "Adjusting to Globalization - Evidence from Worker-Establishment Matches in Germany," *mimeo, Duesseldorf Institute for Competition Economics*, 2016.

Dustmann, C., B. Fitzenberger, U. Schnberg, and A. Spitz-Oener, "From Sick Man of Europe to Economic Superstar: Germany's Resurgent Economy," *Journal of Economic Perspectives*, 2014, *28* (1), 167–188.

Dustmann, Christian and Costas Meghir, "Wages, Experience and Seniority," *Review of Economic Studies*, 2005, *72* (1), 77–108.

_ , Bernd Fitzenberger, Uta Schönberg, and Alexandra Spitz-Oener, "From sick man of Europe to economic superstar: Germany's resurgent economy," *The Journal of Economic Perspectives*, 2014, *28* (1), 167–188.

Elsby, Michael WL, Bart Hobijn, and Ayşegül Şahin, "Unemployment dynamics in the OECD," *Review of Economics and Statistics*, 2013, *95* (2), 530–548.

Hagedorn, Marcus and Iourii Manovskii, "The Cyclical Behavior of Equilibrium Unemployment and Vacancies Revisited," *American Economic Review*, 2008, *98* (4), 1692–1706.

_ , Fatih Karahan, Kurt Mitman, and Iourii Manovskii, "The Macro and Micro-effects of Macroeconomic Policy," *Working paper*, 2016.

Hartung, Benjamin, Philip Jung, and Moritz Kuhn, "Etiopathology of Europe's Sick Man: Worker Flows in Germany, 1959-2016," 2016, (10341).

Hertweck, M. and O. Sigrist, "The Ins and Outs of German Unemployment: A Transatlantic Perspective," *Oxford Economic Papers*, 2015, *67* (4), 1078–1095.

Hopenhayn, Hugo and Juan Pablo Nicolini, "Optimal Unemployment Insurance," *Journal of Political Economy*, 1997, *105* (2).

Jung, Philip and Moritz Kuhn, "Labour market institutions and worker flows: comparing Germany and the US," *The Economic Journal*, 2014, *124* (581), 1317–1342.

_ and _ , "Earnings Losses and Labor Mobility Over the Life Cycle," *The Journal of the European Economic Association*, 2018 (forthcoming).

Katz, Lawrence F and Bruce D Meyer, "The impact of the potential duration of unemployment benefits on the duration of unemployment," *Journal of public economics*, 1990, *41* (1), 45–72.

Klinger, Sabine and Enzo Weber, "Decomposing Beveridge Curve Dynamics BY Correlated Unobserved Components," *Oxford Bulletin of Economics and Statistics*, 2016, *78* (6), 877–894.

_ and Thomas Rothe, "Der Rueckgang der Langzeitarbeitslosigkeit in Deutschland: Ein Erfolg der Hartz-Reformen oder konjunktureller Effekt," *Schmollers Jahrbuch*, 2012, *132* (1), 89–121.

Krause, Michael U and Harald Uhlig, "Transitions in the German labor market: Structure and crisis," *Journal of Monetary Economics*, 2012, *59* (1), 64–79.

Krebs, Tom and Martin Scheffel, "Macroeconomic evaluation of labor market reform in Germany," *IMF Economic Review*, 2013, *61* (4), 664–701.

Launov, Andrey and Klaus Wälde, "Estimating incentive and welfare effects of nonstationary unemployment benefits," *International Economic Review*, 2013, *54* (4), 1159–1198.

Millard, Stephen P. and Dale T. Mortensen, "The unemployment and welfare effects of labour market policy: a comparison of the USA and the UK," in Dennis J. Snower and Guillermo de laEditors Dehesa, eds., *Unemployment Policy: Government Options for the Labour Market*, Cambridge University Press, 1997, pp. 545–572.

Murtin, Fabrice and Jean-Marc Robin, "Labor market reforms and unemployment dynamics," *Labour Economics*, 2016.

Pissarides, Christopher A, *Equilibrium unemployment theory*, MIT press, 2000.

Schmieder, Johannes F and Till Von Wachter, "The effects of unemployment insurance benefits: New evidence and interpretation," *Annual Review of Economics*, 2016, *8*, 547–581.

Shavell, Steven and Laurence Weiss, "The Optimal Payment of Unemployment Insurance Benefits over Time," *Journal of Political Economy*, 1979, *87* (6), 1347–1362.

Shimer, Robert, "The Cyclical Behavior of Equilibrium Unemployment, Vacancies, and Wages: Evidence and Theory," *American Economic Review*, 2005, *95* (1), 25–49.

_ , "Reassessing the ins and outs of unemployment," *Review of Economic Dynamics*, 2012, *15* (2), 127 – 148.

Steffen, Johannes, "Sozialpolitische Chronik," *Arbeitslosenversicherung (seit 1969). Arbeitnehmerkammer Bremen. Bremen*, 2008.

Tuit, Sanders and Jan van Ours, "How changes in unemployment benefit duration affect the inflow into unemployment," *Economic Letters*, 2010, *109* (2), 105–107.