

# The Macroeconomic Causes and Consequences of Changing Labor Mobility and Unemployment

Inaugural-Dissertation

zur Erlangung des Grades eines Doktors  
der Wirtschafts- und Gesellschaftswissenschaften

durch die

Rechts- und Staatswissenschaftliche Fakultät  
der Rheinischen Friedrich-Wilhelms-Universität  
Bonn

vorgelegt von

**Benjamin Hartung**

aus Leipzig

Bonn 2019

Dekan: Prof. Dr. Jürgen von Hagen  
Erstreferent: Prof. Dr. Petr Sedláček  
Zweitreferent: Prof. Dr. Moritz Kuhn

Tag der mündlichen Prüfung: 25. April 2019





# Acknowledgements

First of all, I would like to thank Petr Sedláček, my principle supervisor, for his support and encouragement throughout these years. His advice and guidance were invaluable for my research and shaped the way I think about labor markets and economics in general. I especially appreciate that he would always have an open ear and would take his time to talk things through. I am equally indebted to my second supervisor, Moritz Kuhn, with whom I had the pleasure of working on one of the chapters of this thesis. He not only taught me how to work with data and organize complex projects but also inspired many of the research ideas I pursued in the past years. I would also like to extend my gratitude to Christian Bayer who has been extraordinarily supportive, especially in the later stages of my PhD. I also want to thank my second co-author, Philip Jung, for the lively and inspiring discussions we had, not to mention the modeling skills I acquired while working with him. I owe a lot to Jürgen von Hagen, who gave me the unique opportunity to teach an introductory course during the last year of my PhD - an experience I really enjoyed and learned a lot from. I would like to thank Wouter den Haan who invited me to stay at the LSE and whose comments, ideas and feedback were quintessential for my research, in particular the first chapter of this thesis.

I want to thank the *Bonn Graduate School of Economics* and the faculty at the *Institute for Macroeconomics and Econometrics* for the excellent research environment. I would also like to acknowledge the financial support which I received from the German Research Foundation (*Deutsche Forschungsgesellschaft*), both within the priority program SPP 1764 and as a member of the *Research Training Group*.

Lacking a background in economics, the first year at the BGSE was a challenging and daunting experience for me. I therefore would like to express my utmost gratitude towards my fellow PhD students, in particular Sebastian Schaube, Yao Chen, Daniel Becker, Niklas Radü and Cornelius Veith. Without their selfless support, I would not have made it through the first semester.

I would also like to thank my other office mates, especially Ulrike Steins, Lisa Dähne, Thomas Drechsel and Andreas Ek, for the many inspiring discussions and fun we had. Finally, none of this would have been possible without my parents and my sister. Their perseverance and courage taught me more than any school or university could ever have. I also want to thank my grandpa who taught me to stay curious and inspired me to go into research.

My deepest gratitude belongs to Laura, whose love, compassion and support have carried me through every single moment of doubt and despair .



# Contents

<b>Introduction</b>	<b>1</b>
<b>1 The specialization of firms and the secular decline in worker reallocation in the U.S.</b>	<b>9</b>
1 Introduction . . . . .	9
2 Empirical evidence . . . . .	13
2.1 Data . . . . .	13
2.2 Aggregate trends . . . . .	15
2.3 Compositional shifts as explanation for aggregate dynamics . . .	17
2.4 Labor market dynamism and outsourcing . . . . .	20
3 Stylized Model . . . . .	27
4 Model. . . . .	29
4.1 Model setup . . . . .	29
4.2 Calibration . . . . .	32
4.3 Policy experiment: lower price markup for external services . . .	33
5 Markups and profits in the PBS-sector. . . . .	37
6 Concluding Remarks . . . . .	39
Appendices . . . . .	41
A Alternative worker reallocation measures . . . . .	41
B Robustness of correlation occupational worker flows vs. PBS-share change . . . . .	42
C Robustness of correlation sectoral job flow rates vs. PBS-share change . . . . .	46
D Robustness of labor elasticity regression on PBS-share changes .	48
<b>2 What hides behind the German labor market miracle? Unemployment insurance reforms and labor market dynamics</b>	<b>51</b>
1 Introduction . . . . .	51
1.1 The Hartz reforms . . . . .	55
2 Data and empirical results . . . . .	56
2.1 Data . . . . .	56
2.2 Sample selection, construction of worker flow rates, and inflow correction . . . . .	56
2.3 Empirical results . . . . .	60

2.4	Heterogeneity of changes in separation rates . . . . .	62
2.5	Sensitivity and comparison to other data sources . . . . .	66
3	Model. . . . .	68
3.1	Calibration . . . . .	73
4	Results . . . . .	77
4.1	Counterfactual simulations . . . . .	79
4.2	Decomposing cyclical and structural changes . . . . .	81
4.3	Germany and its neighbors . . . . .	82
4.4	Reform's effects on wages . . . . .	83
4.5	Welfare effects . . . . .	86
4.6	Alternative explanations . . . . .	87
5	Conclusions . . . . .	88
	Appendices . . . . .	90
A	The Hartz reforms . . . . .	90
B	Data details . . . . .	91
A	Sample selection . . . . .	91
B	Definition of labor market states . . . . .	91
C	Sensitivity analysis . . . . .	92
A	Worker flows without inflow correction . . . . .	93
B	Controlling for composition . . . . .	94
C	Heterogeneity in transition rates by age groups . . . . .	95
D	East Germany . . . . .	97
E	Including marginally employed . . . . .	99
F	Effect of active labor market policy . . . . .	100
G	Economic activity in Austria and Germany . . . . .	100
D	Alternative explanations . . . . .	102
A	Unit labor costs . . . . .	102
B	Export demand . . . . .	103
C	Long-term unemployment . . . . .	104
<b>3</b>	<b>Optimal UI policies in heterogeneous labor markets</b>	<b>107</b>
1	Introduction . . . . .	107
2	Empirical evidence . . . . .	112
2.1	Cross-country data on worker flow rates . . . . .	113
2.2	Fit with existing data sources . . . . .	115
2.3	Decomposition of business cycle variation . . . . .	118
2.4	Job finding rates by unemployment duration . . . . .	120
3	Model. . . . .	125
3.1	General approach . . . . .	125
3.2	Model setup . . . . .	125
3.3	Calibration . . . . .	132
3.4	Optimal policies: duration dependent benefits . . . . .	136
3.5	Optimal policies: flat unemployment benefits . . . . .	141
3.6	Benefits of smoothing asymmetric shocks . . . . .	144
4	Concluding Remarks . . . . .	146



Appendices . . . . .	148
A Data fit of Eurostat survey with new flow rate measure . . . . .	148
B Data fit of implied steady-state unemployment rate . . . . .	148
C Business cycle decomposition of worker flow rates . . . . .	149
D UE-transition rates by duration . . . . .	150
E Marginally attached workers . . . . .	152
F Net replacement rates . . . . .	152
G Deriving a quantitative measure of firing costs . . . . .	153
<b>References</b>	<b>157</b>



# List of Tables

1.1	PBS-industries . . . . .	15
1.2	Summary statistics: Worker and job flows, PBS-shares . . . . .	16
1.3	Composition effects . . . . .	19
1.4	Change job reallocation rates vs. change PBS inputs (across industries)	24
1.5	Labor elasticity vs. PBS-shares . . . . .	26
1.6	Calibration . . . . .	34
1.7	Model vs. data (in %) . . . . .	35
1.8	Efficiency loss in the model . . . . .	37
1.9	Labor elasticity vs. PBS-shares (window size: 7 years) . . . . .	48
1.10	Labor elasticity vs. PBS-shares (Firm expansions and contractions) . .	49
2.1	Worker characteristics of entrants into unemployment . . . . .	59
2.2	Before- and after-reform unemployment rates, transition rates, and steady-state decomposition . . . . .	61
2.3	Change in separation rates by employment duration and age . . . . .	64
2.4	Calibrated parameters . . . . .	74
2.5	Parameters of the unemployment insurance system . . . . .	76
2.6	Business cycle contribution . . . . .	82
2.7	Wages and separation rates . . . . .	85
2.8	Welfare effects from the unemployment insurance reform . . . . .	86
2.9	Change in separation rates by employment duration and age . . . . .	96
2.10	Change in separation rates by trade exposure . . . . .	104
3.1	Cross-country measures for worker flow rates . . . . .	115
3.2	Correlation of flow rates with Eurostat survey data . . . . .	118
3.3	UE-rates by duration . . . . .	124
3.4	Parameters Baseline ( $b_1 \neq b_2$ ) . . . . .	133
3.5	Optimal net replacement rates ( $b_1 \neq b_2$ ) . . . . .	139
3.6	Unemployment and welfare ( $b_1 \neq b_2$ ) . . . . .	140
3.7	Calibration flat benefits ( $b_1 = b_2$ ) . . . . .	142
3.8	Optimal net replacement rates ( $b_1 = b_2$ ) . . . . .	143
3.9	Unemployment and welfare ( $b_1 = b_2$ ) . . . . .	144
3.10	Compensating differentials: Eliminating TFP shocks . . . . .	145
3.11	Flow rate statistics . . . . .	150



## List of Figures

1.1	Aggregate changes over time . . . . .	17
1.2	Coefficient $\beta_{PBS}$ : 1980-2016 . . . . .	20
1.3	Reallocation rate changes and outsourcing (by occupation) . . . . .	21
1.4	Reallocation rates grouped by changes in PBS-share . . . . .	22
1.5	Job reallocation rate changes and outsourcing (by industry) . . . . .	23
1.6	Labor input choices with adjustment costs . . . . .	28
1.7	Allocative efficiency gap with high and low $\chi$ . . . . .	37
1.8	Profit shares of value added . . . . .	38
1.9	Worker reallocation rates (including non-employment) . . . . .	42
1.10	Worker reallocation rates (intermittent non-employment spells) . . . . .	42
1.11	Reallocation rate changes and outsourcing (different window size) . . . . .	43
1.12	Reallocation rates grouped by changes in PBS-share (different window size) . . . . .	43
1.13	Reallocation rate changes and outsourcing (alternative change measure) . . . . .	44
1.14	Reallocation rates grouped by changes in PBS-share (alternative change measure) . . . . .	44
1.15	Reallocation rate changes and outsourcing (by occupation, PBS without temp. workers) . . . . .	45
1.16	Reallocation rates grouped by changes in PBS-share (PBS without temp. workers) . . . . .	45
1.17	Job reallocation rate changes and outsourcing (1992-93 vs. 2014-16) . . . . .	46
1.18	Job reallocation rate changes and outsourcing (alternative change measure) . . . . .	47
1.19	Job reallocation rate changes and outsourcing (outlier correction) . . . . .	47
2.1	German unemployment rates (1993 - 2014) . . . . .	58
2.2	Separation and job finding rates (1993 - 2014) . . . . .	61
2.3	Changes in benefit duration by age and employment duration . . . . .	63
2.4	Separation rates by age and employment duration (1993 - 2014) . . . . .	65
2.5	Changes in separation rates by wages . . . . .	67
2.6	Alternative measures for transition rates . . . . .	68
2.7	Fit for average labor market mobility (1993 - 2014) . . . . .	77
2.8	Fit for heterogeneity in labor market mobility (1993 - 2014) . . . . .	78
2.9	Counterfactual model simulation absent Hartz reforms (1993 - 2014) . . . . .	80
2.10	Austrian unemployment rates and model simulations for Germany . . . . .	84

2.11	Unemployment rates 2000-2014 . . . . .	92
2.12	Separation and job finding rates (1993 - 2014) . . . . .	93
2.13	Separation rates controlling for worker characteristics . . . . .	94
2.14	Separation and job finding rates by age . . . . .	96
2.15	Changes in separation and job finding rates East Germany (1995 - 2014)	97
2.16	Separation rates by age and employment duration (1993 - 2014) East Germany . . . . .	98
2.17	Separation and job finding rates including marginal employment . . . . .	99
2.18	Unemployment and job finding rates including active labor market pro- grams . . . . .	101
2.19	Cyclical component of GDP for Germany and Austria (1993-2014) . . . . .	101
2.20	Unit labor costs and unemployment rates in the EU . . . . .	103
2.21	Share of long-term unemployed in Germany (1998-2015) . . . . .	105
3.1	Quarterly worker flow rates: Eurostat vs. new measure . . . . .	116
3.2	Fit of flow rates with Eurostat survey data . . . . .	117
3.3	Business cycle decomposition: $u^{ss}$ . . . . .	120
3.4	UE-rates by unemployment duration . . . . .	123
3.5	Average quarterly worker flow rates: Eurostat vs. new measure . . . . .	148
3.6	Steady-state approximation of unemployment rate . . . . .	149

# Introduction

Every month 1.7 million workers in the US are laid off and an additional 3.3 million quit their job voluntarily.<sup>1</sup> At the same time more than 5.5 million workers are newly hired every month, accounting for 3.8% of all employees in the US. Constant turnover is a fundamental feature of labor markets not only in the US but across developed economies.

At the same time, the causes and consequences of worker mobility and its broader implications for labor market efficiency and welfare are complex and have been widely discussed in both the public debate and the academic literature. This thesis contributes to that discussion in three ways: The first chapter explores the drivers behind the secular decline in worker mobility in the US since the 1980s and puts forward a new explanation that has been overlooked in the literature so far. I argue that the specialization of firms and the outsourcing of non-core activities was a key determinant of declining reallocation rates and had more benign effects in terms of efficiency than conventional explanations suggest. Turning from secular trends to labor market policies, the second and third chapter investigate the role of unemployment insurance policies (UI) in shaping labor markets through their effects on job finding and job separation rates. While the second chapter focuses on the macroeconomic effects of structural reforms to the German UI system in the mid-2000s, the third chapter explores the merits and welfare costs of a common European UI scheme. In both chapters, accounting for the differential impact of UI policies on job finding and separation rates is crucial for assessing the impact of UI policies on broader economic outcomes such as the unemployment rate and aggregate welfare.

## **The importance of understanding labor mobility patterns**

Before laying out in more detail the research questions, methodological approaches and results of these three chapters, it is useful to shed some light on why we should care about measuring and explaining labor mobility patterns in the first place.

In the public debate, labor mobility often carries a negative connotation, as it is associated with lower job stability, the loss of firm-specific human capital and not rarely

---

<sup>1</sup>Data from the Job Opening and Labor Turnover Survey (JOLTS) in the US for the first half of 2018.

accompanied by intermittent spells of unemployment. Workers switching jobs at a high rate can also be an indicator of a malfunctioning matching mechanism where workers and firms constantly end up in bad matches and thus decide to separate more often. From that perspective, worker mobility is a sign of poorly functioning and inefficient labor markets. It could therefore be worthwhile to pursue policies which improve the initial matching of workers and firms while at the same time reducing the rate at which workers are hired and fired, e.g. through stricter employment protection.

However, there is a second view on the role of worker mobility with diametrically different policy implications: In that view, labor mobility naturally arises as workers reallocate from less productive to more productive firms and from jobs they dislike to jobs that are better suited to their skills and interests. Workers switching jobs is therefore an indication of a well-functioning labor market in which workers freely move towards the job in which they can make the most efficient use of their human capital. Following that reasoning, regulations and policies that preserve job stability but inhibit the free flow of labor, e.g. through occupational licensing or employment protection, reduce the efficiency of the labor market which leads to aggregate output and welfare losses.

Given these contrasting perspectives, it is therefore not straightforward to assess the macroeconomic impact and the welfare consequences of changing patterns in labor mobility and cross-country differences. Evaluating the merits of adjusting labor market policies, such as unemployment benefits, is equally challenging in light of the variety of contrasting factors that determine the level and evolution of labor market flows. Understanding the drivers behind labor market mobility patterns is therefore essential in order to assess the ensuing macroeconomic implications and to draw policy conclusions. In addition to these conceptual issues, measures of worker and job flows contain valuable information about the transmission of business cycle shocks as well as policy changes into the labor market. Regarding business cycle shocks, several studies have used worker flow rates to disentangle the relative importance of changing unemployment inflow and outflow rates for unemployment fluctuations.<sup>2</sup> These studies find large differences both in the level of inflow and outflow rates across countries as well as regarding the importance of both margins for unemployment fluctuations. Jung and Kuhn (2014a) show that these cross-country differences extend beyond the transmission of business cycle shocks: They find that the separation rate is more sensitive not only to business cycle fluctuations but also to changes in UI benefits in countries with low job finding rates. This evidence suggests that it is crucial to explicitly account for the level, the cyclicity and the endogenous reaction of worker flow rates to changes in labor market policies when investigating and assessing the impact of policy changes on the unemployment rate, aggregate output and welfare.

---

<sup>2</sup>Prominent examples are Fujita and Ramey (2009), Elsby et al. (2013) and Jung and Kuhn (2014a).



Understanding the determinants of labor market mobility and assessing the reaction of worker flow rates to policy changes is therefore at the very core of this thesis. In doing that, the thesis contributes to the existing literature along various dimensions: Empirically, the first chapter presents novel evidence on the secular decline of worker flow rates in the US, disaggregated by occupations and industries. The second chapter documents the heterogeneous evolution of worker flow rates across demographic groups following a major labor market reform in Germany. The last chapter presents a new measure of high-frequency worker flow rates across European countries that allows to compute job finding rates by detailed unemployment durations. Based on these empirical contributions, each of the three chapters presents a structural DSGE-model tailored to the specific research question and calibrated to match relevant moments in the data. In the first chapter, the model is used to assess quantitatively the relevance of one particular mechanism for explaining the secular decline in worker flow rates in the US. In the second chapter, the model allows to conduct counterfactual policy experiments and compute the welfare effects of the German labor market reforms for different groups of employees. In the third chapter, the model is quintessential to compute optimal labor market policies in different economic environments. The remainder of this introduction explains in more detail the contributions and the key results separately for each chapter.

CHAPTER ONE investigates the reasons behind the secular decline in a broad set of worker flow rates in the US since the early 1980s. In contrast to existing studies, the chapter offers a new explanation for the falling labor mobility: In the past decades, firms focused increasingly on their core activities and started to outsource tasks, they do not have a comparative advantage in, to external service providers. That fragmentation of production processes allowed firms to adjust their labor input more flexibly by procuring more or less external services rather than hiring or firing their own employees. This, in turn, reduced the need for worker reallocation between firms and thus attenuated the efficiency losses that arise as workers move from one employer to another in a frictional labor market.

The chapter presents new empirical evidence from worker and job flow rates by occupation and industry supporting this hypothesis. Using the Current Population Survey, I find that worker reallocation rates declined significantly more since the 1980s in those occupations that experienced a particularly strong shift towards the professional and business services sector (PBS). Similarly, industries that increasingly resorted to service inputs from the PBS sector, experienced larger declines in job reallocation rates since the 1990s. In addition they became less responsive to cyclical output fluctuations in terms of employment growth.

The chapter then proceeds with a structural labor market model which allows to quantify the strength of the proposed outsourcing channel. In addition, the model allows to assess the aggregate implications of the proposed channel for labor market efficiency. In the model, firms employ inhouse staff, who are costly to hire and fire, and procure labor

inputs from external service providers at a price markup, akin to a flexibility premium. The higher piece rate for external services introduces a trade-off between adjusting in-house staff at a fixed adjustment cost and procuring labor inputs flexibly from external providers. If the price markup falls, firms procure more services externally rather than employing inhouse staff. They also respond to idiosyncratic shocks increasingly by adjusting their labor input along the external-services margin rather than hiring or firing workers. In a counterfactual experiment, I decrease the price markup for external services to match the rise of externally procured services since the 1980s in the data. The resulting fall in worker reallocation rates explains 29% of the corresponding decline in the data. Furthermore, allocative efficiency in the labor market increases as labor inputs are allocated more smoothly across firms. As a consequence output increases by 0.3%. This result is in stark contrast to existing studies which attribute the falling reallocation rates to regulatory barriers which increasingly impede worker mobility. According to that view, declining reallocation rates are a symptom of the labor market becoming more sclerotic which reduces allocative efficiency and output. The first chapter of this thesis contrasts this conventional view with a more benign interpretation: Declining worker flow rates arise as a by-product of more efficient production processes that allow to reallocate labor inputs smoothly without workers having to switch employers.

While the first chapter focuses on the drivers of reallocation and job stability in the labor market, the remaining two chapters investigate the effect of unemployment insurance schemes on aggregate labor market outcomes through their impact on labor market flows.

CHAPTER TWO is joint work with Philip Jung and Moritz Kuhn and studies the effect of the German *Hartz reforms* on labor market flow rates. The *Hartz reforms* were a comprehensive reform package that was implemented in the mid-2000s and re-organized the German UI system. In particular, long-term UI benefits were decoupled from previous wages and merged with social welfare assistance which effectively reduced UI benefits drastically for long-term employed, high-wage workers. In a first step, we compute monthly job separation and job finding rates using administrative micro data provided by the German federal employment agency.<sup>3</sup> We find empirically that lower separation rates explain 76% of the aggregate decline in unemployment rates that followed the reforms. Accordingly, higher job finding rates played only a moderate role in the German “labor market miracle” since 2005. Furthermore, the fall in separation rates is particularly pronounced among those employees who were most affected by the UI benefit reduction, i.e. employees with high employment duration and wages. We causally link these empirical findings to the cut in long-term UI benefits in a labor market search model with heterogeneous workers and aggregate fluctuations. Calibrating the model to match the level and cyclicity of worker flow rates before the reform, we

---

<sup>3</sup>Panel of integrated employment histories (SIAB)

find that the UI benefit cuts can rationalize the subsequent evolution of job finding and job separation rates. The model also matches the differential behavior of job separation rates for workers with high versus low employment duration. In a counterfactual experiment, we show that unemployment rates would be 50% higher today without the reforms.

Although the reforms were effective in reducing the unemployment rate, the associated welfare effects are less clear-cut: In particular high-wage employees in stable jobs were increasingly afraid to become long-term unemployed after the reforms as they faced substantially lower benefits once their short-term benefits expired. We show, both in the model and in the data, that these employees were more willing to forgo wage increases after the reforms in order to stay employed as a result of this “scaring effect”. Without compensation or transfers, high-wage employees in stable jobs therefore experienced substantial welfare losses of 0.64% in terms of consumption equivalent variation due to the reforms.

Although the overall impact of the reforms on unemployment and output is very positive, the heterogeneous welfare effects call for a more intensive debate about the distribution of the aggregate gains of the reforms and the compensation of those worker most severely affected by the UI benefit cuts.

CHAPTER THREE investigates the merits and costs of replacing the current national UI policies in the European Union with an optimally chosen UI scheme at the European level. It relates to the public and academic debate of implementing a common UI policy in the EU as an automatic fiscal stabilizer that allows member states to insure against asymmetric shocks. Although it is relatively undisputed that a common UI benefit policy can facilitate risk-sharing across European countries, it is not clear whether a common UI policy is a suitable tool for that purpose: UI policies critically affect the hiring decisions of firms, the job search behavior of unemployed and the insurance of idiosyncratic labor market risk. Thus, they have a profound impact on labor market outcomes. Not tailoring these policies to country-specific institutions and other labor market characteristics can therefore fundamentally distort the labor market and lead to first-order welfare losses, potentially offsetting the gains of macroeconomic stabilization. The aim of the chapter is to quantify these welfare losses.

As chapter two highlights, a structural cross-country analysis of the impact of UI benefits on labor market outcomes requires high-frequency data on the level and cyclicity of current labor market flow rates. However, existing data sources are either not available at a high frequency, cover only short time periods or are not comparable across a wider set of countries. In order to fill that gap, I present a new measure of quarterly job finding and job separation rates going back to 1998 for 27 European countries. The measure uses detailed data on unemployment stocks by unemployment duration from the EU Labor Force Survey to compute quarterly transition rates between employment and unemployment. In a first step, I decompose the relative contribution of both rates

in explaining business cycle fluctuations of the unemployment rate. I find that the job separation margin plays a sizable role in explaining unemployment fluctuations over time in most European economies. In addition to average flow rates, the new measure also allows to compute job finding rates by detailed unemployment duration brackets. I find that job finding rates significantly depend on unemployment duration in 15 out of the 27 countries - mostly negatively. Especially in the largest European economies (Germany, Spain, France, UK) long-term unemployed are significantly less likely to find a job than short-term unemployed.

Motivated by the empirical evidence, I then present a labor market search model with risk averse workers which features endogenous separations and duration dependence in both job finding rates and UI benefits. In a first step, the model is calibrated to match the level and cyclicalities of worker flow rates observed in the data, given the labor market policies currently in place. That allows to back out the structural policy-invariant parameters for each of the countries. Given these country-specific parameters, I then compute in a second step optimal UI policies at the national level. Optimality in the model implies that the UI benefit scheme maximizes welfare by balancing the moral hazard costs of reduced search incentives for unemployed with the consumption smoothing gains of unemployment insurance. In a third step, I compute the optimal federal UI policy that a European planner would choose if she could only set a single UI policy which is applicable in all countries. In stark contrast to the UI schemes currently in place, I find that the optimal benefit profile is *increasing* in unemployment duration, both for optimal country-specific as well as for the optimal federal UI policy. The welfare gains of replacing the sub-optimal UI schemes currently in place with optimal country-specific policies are large (2.96% of consumption). Compared to that, the welfare losses of moving in a second step from country-specific optimal policies to an optimal union-wide policy are small (-0.22%). The unemployment rate falls across all European countries. These results imply that welfare would rise substantially if the current UI schemes which are less generous towards long-term unemployed were replaced by optimally increasing UI benefit profiles - both in the case of country-specific policies as well as for a common UI policy determined at the European level.

In order to illustrate the importance of duration dependence for the optimal design of UI policies, I redo the model exercise without duration dependence and only one level of UI benefits. The results differ dramatically: The welfare gains of optimal national policies are much smaller than in the baseline calibration with duration dependence (0.72%). At the same time, the welfare losses of adopting a common UI benefit scheme instead of tailoring UI schemes to country-specific characteristics are much larger than in the baseline case (-1.48%). On average, the unemployment rate in the EU increases if benefits are chosen optimally.

Two lessons can be learned from these policy experiments: First, duration dependence in both job finding rates and UI benefits is a key feature of European labor markets and should be taken into account when designing optimal UI benefit policies. Second, labor

market institutions and preferences differ substantially across European countries. Not tailoring UI benefit policies to country-specific characteristics can therefore lead to large welfare losses. That is particularly the case, if duration dependence is not accounted for.



## CHAPTER 1

---

# The specialization of firms and the secular decline in worker reallocation in the U.S.

### 1. Introduction

Since the early 1980s the US labor market has become less dynamic along various dimensions: Workers move into and out of unemployment less often and they are less likely to switch jobs. The rate at which jobs are created and destroyed has fallen, as has the geographic mobility of workers. These secular patterns have sparked a lively debate on what caused the declining dynamism of the labor market and its implications for the US economy: According to one view declining reallocation rates imply that employees do not move towards more productive matches as rapidly as they used to. That diminishes allocative efficiency, thereby reducing aggregate productivity. On the other hand, more stable worker-firm relationships might only be a sign that the value of existing worker-firm matches has increased, for example through more job-specific training or a better matching of workers and firms in the first place. Whether the decline in reallocation rates has a positive or negative impact on aggregate productivity and more importantly whether there is space for policy interventions therefore depends crucially on the economic drivers behind these trends.

While existing studies have focused either on the legislative impediments to hiring and firing (Davis and Haltiwanger (2014), Autor et al. (2007)) or technological advances that raise the value of existing matches (Cairo (2013), Fujita (2015)), this study puts forward a different explanation that has been overlooked in the literature so far: Since the 1980s firms in the US have increasingly outsourced tasks in which they do not have a comparative advantage to external service providers. The ensuing fragmentation in production processes allowed firms to adjust their labor input in response to idiosyncratic shocks by cutting or expanding externally procured services rather than hiring or firing employees. The possibility to adjust labor inputs flexibly through external services reduced the need for worker reallocation across firms which is reflected in lower aggregate worker flow rates in the US.

In exploring that channel, the paper has two main contribution: First, I present empirical evidence suggesting that there is indeed a meaningful link between the secular fall in labor market turnover and the well-documented rise in the ‘professional and business services’ sector (PBS) since the 1980s. In particular, I use detailed data on worker and

job flows by occupations and industries as well as data on the input-output structure of the US economy to establish three new stylized facts:

1. Worker reallocation rates declined more in occupations which experienced a larger shift towards PBS-industries.
2. Job reallocation rates declined more in those industries which experienced a more pronounced rise of external services as a share of gross output.
3. Within industries, a higher utilization of external services is associated with a falling labor elasticity with respect to gross output fluctuations.

The second part investigates the importance of this channel quantitatively in a heterogeneous labor market model with labor adjustment frictions and assesses the implications of rising PBS-utilization for allocative efficiency in the labor market. An exogenous decrease in the price of external services that matches the rise of PBS-utilization in the data can explain 29% of the fall in worker reallocation rates in the data which is unexplained by observable characteristics. Allocative efficiency increases by 0.3 percent of GDP which corresponds to 6.6% of the overall “efficiency gap” caused by the labor adjustment frictions. The paper therefore offers a more benign interpretation of the secular decline in worker reallocation rates than existing explanations: Almost one third of the decline is driven by a reduced need for worker reallocation as firms shifted from inhouse provision to more fragmented, yet specialized, production processes.

The empirical part starts off by documenting the aggregate dynamics of both trends for different measures and investigating obvious candidates that could be driving the decline in worker flow rates: I find that shifts in the composition of the labor force and the industry- and occupation structure can explain only one half of the fall in worker flow rates since the 1980s. Furthermore, I find that workers in the PBS-sector are more likely to be hired or fired, even after controlling for worker characteristics and occupation. A purely mechanical shift of employees who used to work inhouse to the PBS-sector would therefore imply *higher* worker reallocation rates over time.

To explore the link between the two trends further, I compute worker separation rates into and from unemployment by occupation from the Current Population Survey (CPS) from 1980-2016, as well as the share of each occupation working in the PBS-sector over time. The trends are significantly negatively correlated: Occupations which larger shifts towards the PBS-sector experienced more pronounced declines in worker flow rates. A similar exercise with PBS-utilization across industries reveals the same pattern: Industries which increasingly procured intermediate inputs from the PBS-sector experienced larger declines in job creation and job destruction rates<sup>1</sup> since 1992.

These two tests show that *average* levels of worker and job flows are linked with the rising importance of the PBS-sector across occupations and industries. A different implication of the suggested outsourcing channel is that firms which use PBS-services intensively respond less in terms of hiring and firing to business cycle fluctuations. To test this hypothesis, I first compute labor elasticities with respect to gross output fluctuations by detailed industries for 9-year moving time windows. In a second stage, I

---

<sup>1</sup>Data based on the Business Employment Dynamics data base.



regress these elasticities on the average PBS-utilization in the respective 9-year window, controlling for year- and industry fixed effects. I find that a higher PBS-utilization is associated with a lower labor elasticity with respect to gross-output fluctuations.

Motivated by this evidence, I build a structural model to explore in a first step qualitatively how changes in the market for PBS-services can affect worker reallocation rates and to quantify in a second step how much of the aggregate decline in worker reallocation rates can be explained by the increased procurement of external services. In addition, the model allows to compute the efficiency losses caused by labor adjustment frictions and assess how these efficiency losses are affected by a more affordable outsourcing option.

In the model, firms face a trade-off between either employing inhouse staff subject to non-convex labor adjustment costs or alternatively procuring these services as an intermediate input from external providers at a marginally higher piece rate. As that “flexibility premium” declines, firms outsource more services to external providers that formerly used to be procured inhouse. Firms not only hold a larger buffer stock of external services in their portfolio of production inputs, but are also more likely to respond to idiosyncratic shocks by cutting or expanding external services rather than hiring or firing workers. In turn, the elasticity of employment with respect to idiosyncratic firm shocks falls. This is in line with Decker et al. (2014) who find that the decline in firm-level volatility in the US is not due to smaller shocks which firms face but rather a smaller reaction of firms to these shocks. The model is calibrated to match the flow rates of different occupation groups and the PBS-employment share in the early 1980s. Reducing the “flexibility premium” for external services exogenously to exactly match the quantitative rise of the PBS-sector observed in the data, the model predicts a fall in worker reallocation by 4.5% which explains 14% of the decline in aggregate reallocation rates. As approximately 50% of the aggregate decline in labor market flows in the data is due to a mechanical shift in the labor force composition towards older and more educated workers, which is not modeled in this paper, this number is a lower bound. Controlling for these compositional shifts, the rising PBS-utilization in the model can account for 29% of the flow rate decline in the data which is not explained by observable characteristics.

Finally, the model allows to compare the baseline calibration featuring labor adjustment costs with a frictionless economy in which labor can be adjusted flexibly. The labor adjustment friction inhibits the flow of workers from unproductive to more productive firms which causes efficiency losses amounting to 4.5% of GDP compared to the flexible benchmark. Cheaper external services allow firms to adjust their labor input more flexibly without hiring or firing inhouse staff. That raises allocative efficiency by 0.3% of GDP, which accounts for 6.6% of the overall efficiency gap. Given that the employment share of the additional PBS-services is only 7%, this is a remarkable increase.

While the model treats the increase in the PBS-share in a reduced form by imposing an exogenous rise in the competitiveness of PBS-firms relative to final good firms, this paper also investigates the drivers behind the surge of PBS-services. In particular, the paper addresses the question whether increased competition in the PBS-sector has supported the wide-spread utilization of external services. I find that in contrast to the

rest of the US economy, the PBS-sector has experienced marked declines in profit shares which is in line with evidence that the PBS-sector is one of the few sectors where price markups have fallen since the 1980s (Loecker and Eeckhout (2017)). That suggests that an increased competition in the PBS-sector putting downward-pressure on prices may be an important driver for the rising utilization of external services by final-goods firms since the 1980s.

**Related literature.** Empirically, this paper builds upon a large literature documenting the secular decline in job creation and job destruction rates as well as worker flow rates in the US since the 1980s (Davis and Haltiwanger (2014), Decker et al. (2014), Hyatt and Spletzer (2013), Molloy et al. (2016), Cairo and Cajner (2013)). It is also related to studies which document declining rates of geographical mobility both within and between states (Molloy et al. (2013), Kaplan and Schulhofer-Wohl (2017)). In addition to the empirical literature, there are several structural explanations for the declining labor market mobility: These explanations have focused mainly on stricter employment protection legislation (Autor et al. (2006), Autor et al. (2007)), higher on-the-job training costs (Cairo (2013)) and higher skill depreciation in unemployment that incentivizes employees to accept lower wages in exchange for more employment stability (Fujita (2015)).

Another strand of literature investigates the secular rise of professional and business services. Most notably Berlingieri (2014) documents a shift in the input-output structure showing that a substantial fraction of the newly created service jobs were formerly produced inhouse in manufacturing firms. Other studies largely focus on the rise of employment services, a sub-category of the PBS-sector (Autor (2003)), or alternative working arrangements (Dey et al. (2010), Katz and Krueger (2017)), whereas this study takes a broader perspective including all business services that are used as intermediate inputs for production. In addition, there is a literature showing that offshoring reduces employment volatility in domestic labor markets (Bergin et al. (2009), Bergin et al. (2011), Zlate (2016)). However, this literature focuses on business cycles rather than on long-run trends and it is more related to the impact of offshoring rather than domestic outsourcing.

This paper is structured as follows: Section 2 contains the empirical evidence on the secular trends in worker and job reallocation rates and the rising importance of the PBS-sector. It presents the correlation between these trends across occupations and industries and the effect of a higher PBS-share on labor elasticities with respect to gross output fluctuations. Section 3 presents a simple stylized model to illustrate how declining price markups for external services affect the hiring and firing elasticity of firms with respect to idiosyncratic shocks. Section 4 presents the structural model and the quantitative exercise. Section 5 presents empirical evidence on declining profit shares in the PBS-sector as a potential source of the increased demand for PBS-services. Section 6 concludes.

## 2. Empirical evidence

This paper investigates how the shift of production processes from inhouse employment to external procurement affected the hiring and firing decisions of firms, and in turn aggregate labor reallocation rates. This section therefore starts by documenting the secular decline in worker and job reallocation rates on the one hand and the secular increase in the utilization of external services as a production input on the other hand. It then moves on to investigate the link between the two trends using detailed data on worker flows, job flows and the procurement of PBS-services across occupations and industries to establish three novel stylized facts:

1. Worker reallocation rates declined more in occupations which experienced a larger shift towards PBS-industries.
2. Job reallocation rates declined more in those industries which experienced a more pronounced rise of external services as a share of gross output.
3. Within industries, a higher utilization of external services is associated with a falling labor elasticity with respect to fluctuations in gross output.

These facts do not allow for a causal interpretation. However, they do support the main hypothesis of this paper, that the increase in domestic outsourcing and the declining labor market dynamism are linked through the firms' changing labor adjustment strategy in the face of an easier access to external services.

### 2.1 Data

#### Worker reallocation rates

The worker flow series are constructed using the basic monthly files of the Current Population Survey (CPS) between 1980 and 2016. The main advantage of the CPS compared to other surveys is the fact that it tracks individuals for 4 months in a row, which allows to compute worker transition rates at a high frequency.<sup>2</sup> That reduces the time aggregation bias, which arises as within-period transitions cannot be measured (e.g. from employment to unemployment and back). Furthermore, the CPS allows to construct time-consistent occupation and industry codes.<sup>3</sup>

Using the CPS, I construct occupation- and industry-specific monthly transition rates from 1980 to 2016 between employment, unemployment and non-employment. As persons in non-employment are by definition not searching actively for new jobs, transitions to and from non-employment are not considered in the benchmark scenario.<sup>4</sup> The CPS also allows to identify direct job-to-job transitions of workers from 1994 onwards. However, they will not be considered in the reallocation measure for two reasons: First,

---

<sup>2</sup>Individuals are actually tracked longer: They are first interviewed every month for 4 consecutive months, then exit the sample for 4 months and are then interviewed again for 4 months.

<sup>3</sup>The monthly files are obtained from the IPUMS-data which constructed time-consistent measures for occupations and industries for different base years. The measures used here are for the base year 1990.

<sup>4</sup>Appendix A contains the empirical results for transitions including non-employment which are qualitatively similar, although less pronounced quantitatively.

the time span for which a secular decline has been documented starts in the early 1980s, some studies even point to the late 1970s (Cairo and Cajner (2013)). Including job-to-job moves would therefore not allow to construct consistent data series for the entire time period of interest. Secondly, job-to-job moves are often the result of workers climbing the career ladder (e.g. Topel and Ward (1992)) and therefore arguably less directly related to the idiosyncratic productivity of an individual firm at a given point in time compared to separations into or hires from unemployment. Worker separations and hires are therefore defined as:

$$\pi_{EU} = \frac{EU_{t-1,t}}{E_{t-1}} \quad (1.1)$$

$$\pi_{UE} = \frac{UE_{t-1,t}}{E_t} \quad (1.2)$$

The hiring rate considered here should not be confused with the job-finding rate from unemployment. It represents the share of new hires from unemployment among all employees in a given period. That is closer to the main interest of this paper which investigates how turnover in the labor force evolved rather than the likelihood with which unemployed find new jobs.

Alternatively, one could focus on worker transitions between two jobs that are interrupted by only short intermittent unemployment spells of up to one month (“EUE”-transitions). Arguably, this would be a more direct measure for reallocation that is neither induced by career moves (such as job-to-job moves) nor distorted by EU- or UE-transitions that are followed or preceded by long unemployment spells. However, that reduces the number of observations in the data substantially which becomes problematic when computing reallocation rates by occupation or industry. Appendix A shows that the aggregate picture for EUE-transitions is similar to the time series of separation and hiring rates.

### **Job reallocation rates**

Instead of looking at individual worker transitions, labor market dynamism can be captured through the lens of the firm by measuring the flow of jobs between firms. In order to do that, this paper uses the Business Employment Dynamics data set (BDM) which reports quarterly statistics on job gains and job losses by detailed industries from 1992 onwards. The BDM defines job gains (job losses) as the sum of all jobs created (lost) at expanding (contracting) firms, including firm births (deaths). In addition, the BDM reports firm expansions and contractions which is the same as job gains and losses, but excludes jobs created and destroyed by newly established and dying firms respectively. In either case, these measures only account for net gains and net losses at the firm level, disregarding replacement hires or other within-firm job turnover that does not affect the overall size of the firm. That is the main difference to the worker-based measures described in the previous section. Quarterly job flow rates are then obtained by dividing the number of job gains or losses in a given quarter by the beginning-of-quarter employment stock.

## Professional and business service sector

Since the 1970s the US economy has experienced a steady and well-documented shift towards the service sector, both in terms of employment as well as in terms of value added. A closer look into the evolution of the input-output structure of the US economy reveals that this increase was to a large extent driven by services that are used as intermediate inputs to other sectors rather than for final consumption (Berlingieri (2014)). The NAICS-industry classification allows to identify these intermediate service inputs relatively clearly as the ‘Professional and Business Services’ sector (PBS): More than 85% of gross output produced in this sector is used as an intermediate input for other sectors. They consist of a broad range of sub-industries, summarized in Table 1.1. It should be noted that these industries comprise a broad range of activities, ranging from high-skill professional jobs (e.g. legal services, computer systems design, scientific research) to tasks that require less skills or formal training (waste management, security and janitorial services).

To highlight the rising importance of the PBS-sector in the aggregate economy over time, the share of the PBS-sector relative to all sectors is reported for three statistics: (1) Value-added, (2) the value of all intermediate inputs used and (3) employment. The first two statistics can be directly obtained from the input-output (IO) tables provided by the BEA for every year since 1963. The employment share of the PBS-sector is computed using the CPS, taking yearly averages.<sup>5</sup>

Table 1.1: PBS-industries

Legal services	Management of companies and enterprises
Accounting, tax, bookkeeping and payroll services	Employment services
Architectural, engineering, and related services	Business support services
Specialized design services	Travel arrangements and reservation services
Computer systems design and related services	Investigation and security services
Management, scientific and technical consulting services	Services to buildings and dwellings
Scientific research and development services	Landscaping services
Advertising and related services	Other administrative and support services
Other professional, scientific and technical services	Waste management and remediation services

## 2.2 Aggregate trends

Table 1.2 summarizes the time trends for worker flows, job flows and PBS-shares as defined above. The first two columns show the averages in the first 5 years of the respective sample (job reallocation measures are available only from 1992 onwards) and the third column contains the averages in the last 5 years of the sample (2012-2016).

<sup>5</sup>The most detailed level for which the IO-tables are available at the BEA on a yearly basis distinguishes 65 industries from 1963-1996 and 71 industries from 1997 onwards. Crosswalks between these two BEA-codings for the IO-tables and between the BEA-codings and the CPS-industry codes are available upon request.

The last column highlights that all measures of worker and job flows experienced marked declines: The baseline measures for worker reallocation fell by more than 30%. Even job flows - despite the later reference period starting in 1992 - decreased by more than 20%.

At the same time, the PBS-sector has grown rapidly: The employment share more than doubled since the early 1980s from 5.5% to more than 12% and the share of value-added produced in the PBS-sector increased by 83%. While 10.6% of all intermediate inputs were produced by PBS-firms in the early 1980s, their share doubled, now accounting for more than a fifth of all intermediate inputs used. The disproportionately large share among intermediate inputs (compared to employment or value added) directly arises from the nature of the PBS-sector's business model: PBS-firms almost exclusively produce services that are used as intermediate inputs by other firms rather than for final consumption.

Table 1.2: Summary statistics: Worker and job flows, PBS-shares

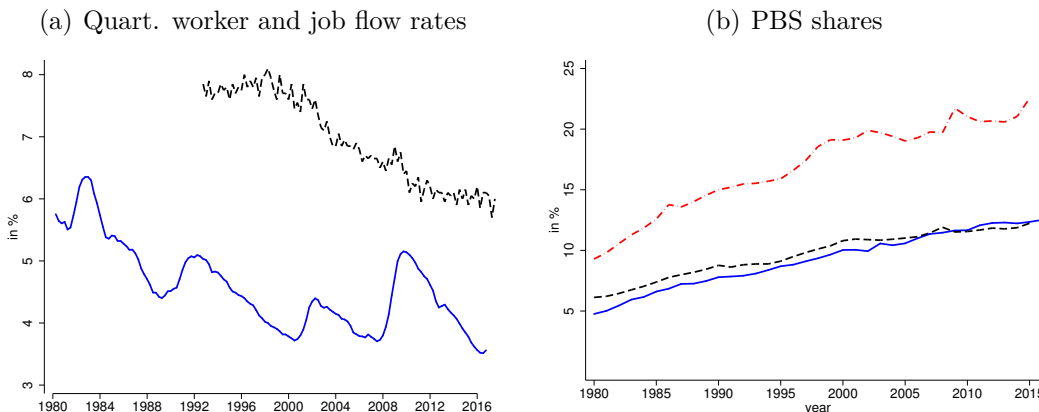
		1980-84	1992-96	2012-16	$\Delta$ (in %)
Worker flows	EU	1.9		1.2	-34.5
	UE	2.1		1.4	-30.8
	EU+EN	5.4		4.2	-21.3
	UE+NE	5.2		4.1	-21.5
	EUE	0.7		0.5	-29.4
	EUE+ENE	1.9		1.5	-18.9
Job flows	job gains		8.1	6.3	-22.4
	job losses		7.4	5.8	-22.0
	firm expansions		6.3	5.1	-19.1
	firm contractions		5.9	4.7	-19.7
PBS shares	value added	6.5		11.9	83.1
	intermediates	10.6		21.2	100.9
	employment	5.5		12.3	125.5

Notes: Average worker and job flow rates as well as the average size of the PBS-sector in percent for the respective first 5 years of the sample and the last 5 years of the sample. The last column displays the relative change between these two periods in percent. Worker flow rates: Yearly averages of monthly rates. Job flow rates: Yearly averages of quarterly rates.

In order to consolidate the different worker and job flow rates into singular measures, worker reallocation is from now on defined as the average of the separation rate into and the hiring rate from unemployment (“EU+UE”) in a given year. Similarly, the average of job gains and job losses relative to employment serves as the benchmark job flow measure (“JG+JL”). The mean of total separations and hires (“SEP+HIR”) as well as the mean of firm expansion and contraction rates (“FE+FC”) are computed as robustness checks in the same way. Figure 1.1(a) illustrates the pronounced decline in these benchmark worker and job flow rates. The monthly worker flow rate from the CPS (“EU+UE”, blue solid line) has been aggregated to a quarterly frequency in order to make it comparable to the job flow rate (“JG+JL”, black dashed line). In contrast to

that, figure 1.1(b) shows the remarkable rise of the PBS-sector relative to employment (blue solid line), total value added (black dashed line) and intermediate inputs (red dash-dotted line).

Figure 1.1: Aggregate changes over time



Notes: Left panel: Blue solid line shows the mean of separation rate to unemployment (EU) and the hiring rate from unemployment (UE) 1980-2016 based on monthly transition rates in the CPS, aggregated to quarterly frequency. The black-dashed line displays the mean of all job gains and job losses relative to total employment from 1992-2016 obtained from the BDM (quarterly rates). Right panel: PBS-shares of aggregate employment (blue solid), value added (black dashed) and intermediate inputs (red dash-dotted).

### 2.3 Compositional shifts as explanation for aggregate dynamics

The rate with which employees move into and out of unemployment and the rate with which firms create and destroy jobs depends to a large extent on observable characteristics, such as age and education on the worker side or establishment size and industry on the firm side. Before delving into possible economic explanations for either of the trends shown in table 1.2, it is therefore necessary to investigate how much of the aggregate changes can be explained mechanically by shifts in the composition of workers and firms over time. In order to do that, this section documents (1) the importance of a changing labor force composition for aggregate worker flows and (2) the marginal effect of working in the PBS-sector on workers' transition probabilities.

#### Role of changing labor force composition

Young workers with low education typically move between employment and unemployment more frequently than their older and more educated peers. One potential explanation for the secular decline in labor market dynamics is therefore the demographic shift towards an older and more educated labor force, which mechanically increases the share of workers with low transition probabilities, thus reducing aggregate reallocation. But how much of the declining worker reallocation rates can be explained by this compositional shift in the labor force?

Previous studies have already investigated this question: Cairo and Cajner (2013) for example find that shifts in the age and educational distribution explain more than 70% of the decline in worker reallocation. I replicate their result with the worker reallocation measures (EU- and UE-rates) outlined above with a slightly different reference period and find an even larger effect.

However, this approach neglects that there were sizable changes in the composition of occupations and industries as well. Especially the rise of sectors in which worker turnover is higher on average, works against the compositional shift in worker demographics. In order to account for both trends, I regress workers' transition probabilities on a set of demographic controls (age, age-squared, education, race, gender) as well as dummies for the time-consistent occupation and industry codes in every year separately. I then conduct two counterfactual experiments: First, I fix the means of the explanatory variables at their respective levels in the early 1980s and vary only the regression coefficients (including the constant) over the years. The resulting predictions show how separation and hiring rates would have evolved, had the demographic composition and occupational and industry structure remained unchanged since the 1980s. Second, I fix the regression coefficients at their 1980s level and vary only the means of all right-hand side variables over time. The resulting time series show how reallocation rates would have evolved if *only* the demographic, occupational and industrial composition had changed.

Table 1.3 displays the results of both experiments together with the benchmark prediction, i.e. the actual flow rate averages as in table 1.2. Taken separately, each counterfactual experiment can explain approximately two thirds of the secular decline in worker flow rates.<sup>6</sup> Both experiments then allow to compute the contribution of compositional shifts towards the overall decline in the respective flow rate: in the first experiment as a residual, in the second experiment directly (see last column). Compositional shifts account for 35-69% (43-66%) of the overall decline in separation (hiring) rates. Taking the average of the lower and upper bound, the mean contribution of changing demographics and changing occupation and industry compositions is slightly above 50%. That is clearly less than the 70% which arise if only demographic shifts regarding age and education are considered. A substantial fraction of the downward trend in worker mobility therefore remains unexplained by observable characteristics.

---

<sup>6</sup>The contributions do not add up to 100 because of interaction effects that do not enter in the regression.



Table 1.3: Composition effects

		1980-84	2012-16	$\Delta$	contribution	compos. effect
EU	benchmark	1.9	1.2	-36.6	100.0	-
	only vary coefficients	1.9	1.5	-23.7	64.9	35.1
	only vary composition	1.9	1.4	-25.3	69.3	69.3
	average contribution	-	-	-	-	<b>52.2</b>
UE	benchmark	2.0	1.4	-30.5	100.0	-
	only vary coefficients	2.0	1.6	-17.5	57.3	42.7
	only vary composition	2.0	1.6	-20.1	65.9	65.9
	average contribution	-	-	-	-	<b>54.3</b>

Notes: Counterfactual EU- and UE-transition rates with a constant demographic, industrial and occupational composition (second row) and if only composition changes (third row). Column 1 and 2 show average rates at the beginning and end of the sample. Column 3 shows relative change in %. Column 4 shows the respective contribution of each counterfactual towards the overall decline in EU- and UE-rates. The last column takes the residual in the second row to obtain the contribution of compositional shifts. “Average contribution” denotes the mean between row 2 and 3 in the last column.

### Role of shift towards PBS-sector

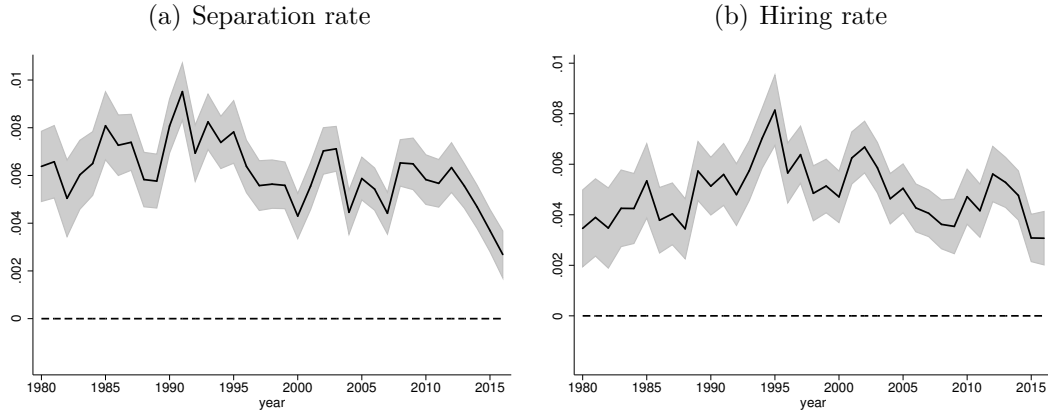
This paper investigates the link between falling worker reallocation rates and the rise of domestic outsourcing over time. One potential explanation for this link could be that the PBS-sector generally exhibits lower worker reallocation rates on average than other industries. If workers who would have been employed in non-PBS firms in the 1980s now work in the PBS-sector, then the aggregate worker reallocation rate would have decreased mechanically as a result of this cross-industry shift.

Evidently, employees in the PBS-sector might differ dramatically from workers in non-PBS firms regarding their demographic characteristics as well as the occupations they work in. Merely looking at the average reallocation rate in the PBS-sector and comparing it to the non-PBS sectors would therefore neglect potentially large selection effects. In order to accommodate that concern, I redo the same year-by-year regression of worker flow rates on observable characteristics as in the previous section, now including a dummy variable for PBS-industries rather than detailed industry controls. The resulting coefficients on the PBS-dummy variable illustrates the marginal effect of working in a PBS-firm compared to a non-PBS firm, after controlling for age, education, race, gender and occupation.

Figure 1.2 shows the coefficient of the PBS-dummy over time for separation and hiring rates. The gray-shaded area marks the 95%-confidence interval. The coefficient is always significantly positive, indicating that everything else equal, employees in PBS-firms actually face *higher* reallocation rates compared to their peers in non-PBS firms. A purely mechanical shift of employees towards the PBS-sector therefore works against falling worker flow rates. Doing a simple counterfactual exercise as in the previous section illustrates that result: If the PBS-sector had not grown as a share of employment

over time, then worker flow rates would have fallen by approximately two percentage points *more* than observed in the data.

Figure 1.2: Coefficient  $\beta_{PBS}$ : 1980-2016



Notes: Marginal effects of working in the PBS-sector on separation and hiring rates from 1980-2016 after controlling for observable characteristics (age, education, race, gender, occupation).

## 2.4 Labor market dynamism and outsourcing

Given the secular trends in labor market dynamism and external service provision, the question arises whether these trends are related empirically - apart from the time dimension. A natural starting point for that is to explore the heterogeneity of occupations and industries regarding both, the declining dynamism in the labor market as well as the increased utilization of external services. The rationale behind this approach is to investigate whether workers and firms which were more affected by the increased utilization of external services also experienced larger declines in the rate at which employees and jobs are reallocated between firms.

### Worker reallocation rates and PBS-shares

Assuming that jobs differ in the degree to which they can be outsourced to external service providers, one would expect that different types of jobs were differentially affected by the increased utilization of external services. Taking occupations as a proxy for different job types, this section therefore takes a closer look at occupation-specific worker reallocation rates and the share of each occupation working in the PBS-sector over time. I resort to the CPS which allows to define 44 time-consistent occupations<sup>7</sup> and to identify whether an employee is working in a PBS- or a non-PBS firm. As in the aggregate time series, worker reallocation rates are defined as the mean between the separation rate into unemployment and the hiring rate from unemployment (“EU+UE”).

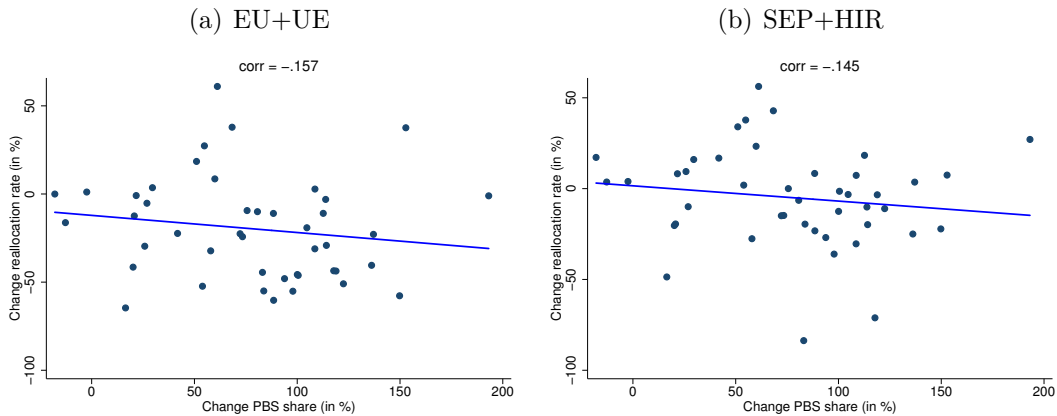
<sup>7</sup>The CPS-IPUMS data provides time-consistent occupation classifications for various points in time. This paper relies on the 1990-classification as a baseline.

I then compute the average fraction employed in PBS-industries as well as the mean reallocation rates in the first 5 years of the sample (1980-1984) and the last 5 years (2012-2016). I then compute the relative changes in percent for both the reallocation rates and the PBS-shares between these periods for each occupation. As PBS-shares are very low in many occupations in the 1980s, using the initial PBS-share as the denominator yields exorbitantly large percentage changes. In the benchmark, relative changes are therefore computed using as the denominator the weighted average of period  $t$  and  $t + 1$ :<sup>8</sup>

$$\Delta_x = \frac{x_{t+1} - x_t}{\frac{1}{2}(x_{t+1} + x_t)} \quad (1.3)$$

Figure 1.3 shows the change in the share of employees working in PBS-industries for every occupation (horizontal axis) and the change in the reallocation rates of that occupation (vertical axis). The left panel uses the benchmark rate “EU+UE” as a measure for worker reallocation and the left panel includes separations to and hires from non-employment in the worker reallocation measure, thus comprising all separations and hires (“SEP+HIR”). For both measures two things stand out: First, there is substantial variation across occupations along both dimensions. That means that occupations not only vary in the *level* of reallocation and outsourcing shares but also in the extent to which reallocation rates and the share working in the PBS-sector have changed over time. Second, these changes are negatively correlated, indicating that those occupations which were most affected by outsourcing from non-PBS to PBS-firms in relative terms also experienced the largest declines in reallocation rates. Appendix B shows that these results are robust for different time windows as comparison and if personnel supply services are excluded from PBS-industries.

Figure 1.3: Reallocation rate changes and outsourcing (by occupation)

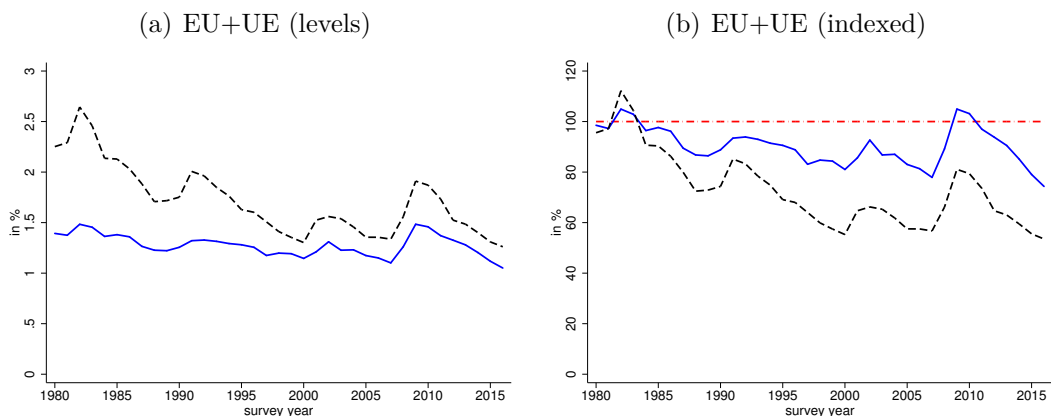


Notes: Correlation of change in worker-based reallocation measures (CPS) and change in share of employees working in PBS-industries between 1980-84 and 2012-16 across occupations.  $N = 44$ . Left panel: Mean of separation rate to unemployment (EU) and hiring rate from unemployment (UE). Right panel: Mean of all separations (SEP) and hires (HIR). Relative changes computed as  $\frac{x_{t+1} - x_t}{\frac{1}{2}(x_{t+1} + x_t)}$ .

<sup>8</sup>The appendix B shows that the results are robust to using conventional percent changes instead.

In order to illustrate the magnitude of these differences, I group occupations with above and with below median increases in PBS-shares and compute the time series of the benchmark reallocation rate (“EU+UE”) for these two groups separately. Figure 1.4 shows that both level and trend are substantially different for the two groups. Throughout the sample, occupations which experienced above-median growth in their PBS-share (black dashed line) had higher reallocation rates than occupations which were less affected by the secular shift towards the PBS-sector (blue solid line). However, this gap narrows over time (see figure 1.4(a)): While worker flow rates fell by only 20% in the group hardly affected by increased outsourcing to PBS-firms (blue solid line), flow rates declined by more than 40% in those occupations which experienced a larger shift towards the PBS-sector. Figure 1.4(b) illustrates these differential trends by normalizing both time series to their respective levels in the early 1980s.

Figure 1.4: Reallocation rates grouped by changes in PBS-share



Notes: Worker reallocation rate in occupations with below-median growth in the employment share of PBS (blue solid line) and above-median growth (black dashed line) from 1980-2016 in levels (left panel) and normalized to average level in 1980-1984 (right panel). The worker reallocation rate is measured as the mean of separation rate to unemployment (EU) and hiring rate from unemployment (UE).

## Job reallocation rates across industries

If there is indeed a link between the rise of outsourcing and declining labor market dynamics, then this should not only show up in worker reallocation rates but also in the rate at which jobs are reallocated between firms. This section therefore investigates whether industries that have seen larger increases in the utilization of external services also experienced more pronounced declines in the rate at which jobs are created and destroyed within these industries. In order to do that, I merge quarterly data on job flows within industries from 1992-2016 from the Business Employment Dynamics data base (BDM) with the annual input-output tables provided by the BEA.<sup>9</sup> That allows

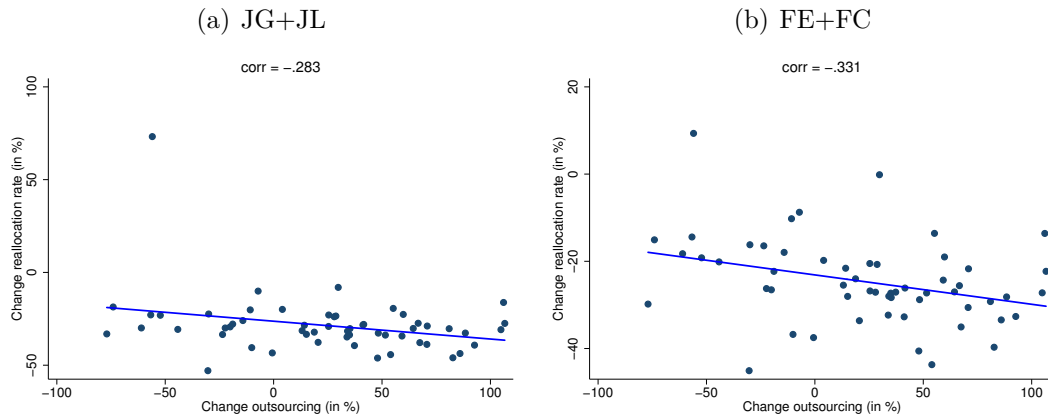
<sup>9</sup>The crosswalk between the two data sets is based on the 3-digit NAICS-2007 codes and is available upon request.

to connect measures of job reallocation with the usage of external services across 56 industries over time. As in the aggregate data series, I define two different job reallocation measures: The average of job gains and losses (“JG+JL”) and the average of firm expansions and contractions (“FE+FC”) relative to overall employment in a given industry and quarter. The utilization of external services is defined as the fraction of intermediate inputs procured from PBS-providers relative to gross output of an industry in a given year.<sup>10</sup>

Similar to the analysis of worker reallocation rates, I compute the average job reallocation rates and the average PBS-input shares for the first five years of the sample (1992-1996) and the last five years of the sample (2012-2016). Figure 1.5 correlates the relative changes in reallocation rates (vertical axes) with the relative changes in PBS-shares (horizontal axes)<sup>11</sup>.

There is a significant negative correlation across industries between the extent to which intermediate PBS-inputs increased as a share of gross output and the decline in job reallocation rates.<sup>12</sup> Table 1.4 shows that this correlation remains significant after controlling for the initial level of job reallocation rates and PBS-input shares.

Figure 1.5: Job reallocation rate changes and outsourcing (by industry)



Notes: Correlation of change in job reallocation rates (BDM) and change in PBS-utilization between 1992-96 and 2012-16 across industries. The horizontal axis refers to the relative percentage change in job reallocation measures (left panel: job gains and losses, right panel: job gains/losses in expanding/contracting firms only). The vertical axis refers to the relative percentage change in the share of intermediate inputs from PBS-firms as a fraction of gross output. Relative changes computed as  $\frac{x_{t+1}-x_t}{\frac{1}{2}(x_{t+1}+x_t)}$ . N = 56.

<sup>10</sup>In order to work with quarterly data series regarding the job reallocation measures, it is assumed that the share of PBS-inputs is constant within a year.

<sup>11</sup>As in the section on worker reallocation rates, relative changes are computed using a weighted average of reallocation rates and PBS-levels in  $t$  and  $t + 1$  in the denominator.

<sup>12</sup>Appendix C shows that these results are robust to different time periods of comparison, different change measures and excluding outliers.

Table 1.4: Change job reallocation rates vs. change PBS inputs (across industries)

	(1)	(2)	(3)	(4)
	$\Delta_{JG+JL}$	$\Delta_{JG+JL}$	$\Delta_{FE+FC}$	$\Delta_{FE+FC}$
$\Delta_{PBS}$	-0.0960** (0.0443)	-0.0988** (0.0491)	-0.0673** (0.0261)	-0.0626** (0.0288)
Initial level rate		-0.816 (45.45)		15.01 (33.99)
Initial fraction PBS		-12.98 (72.99)		10.42 (43.07)
Constant	-26.29*** (2.361)	-25.27*** (7.277)	-23.12*** (1.394)	-24.86*** (4.317)
Observations	56	56	56	56
R-squared	0.080	0.081	0.110	0.113
Pre	1992-1996	1992-1996	1992-1996	1992-1996
Post	2012-2016	2012-2016	2012-2016	2012-2016

Notes: The table shows coefficients from regressing the change in job reallocation measures across industries on the change in PBS-shares from 1992-96 to 2012-16.  $JG + JL$  defines job reallocation as the average of quarterly job gains and job losses relative to employment.  $FE + FC$  defines job reallocation equivalently, taking into account only job gains in expanding firms and job losses in contracting firms. PBS-shares are defined as the share of PBS inputs as a fraction of gross output in an industry. Relative changes are computed as  $\frac{x_{t+1}-x_t}{\frac{1}{2}(x_{t+1}+x_t)}$ .

### Labor elasticity with respect to business cycle

The previous two sections showed a positive association across occupations and industries between increased outsourcing and reduced worker and job reallocation. Both approaches support the hypothesis that firms' labor adjustment choices became less responsive with respect to *idiosyncratic* firm-level shocks as external services proliferated, thus reducing the *average* level of reallocation within an industry or occupation. However, if there was indeed a link between the increased use of PBS-services and the hiring and firing decisions of firms, then this should not only hold for firms' responses to firm-level shocks but also for their responses to aggregate shocks.

Ideally, one would empirically test whether firms with larger PBS-input shares have responded less in terms of hiring and firing to aggregate or sector-level shocks. Lacking access to detailed data on individual firms, this section resorts to industry-level data on PBS-input shares and job gains and losses over time to test the following hypothesis: An increased utilization of PBS-inputs in an industry is associated with a falling labor elasticity with respect to gross output fluctuations over time.

Obtaining a time series for the explanatory variable (PBS-input shares) is straight forward: As in the previous section, PBS-utilization in a given industry is defined as the share of PBS-inputs in gross output based on the IO-tables from the BEA. Constructing a time series for the dependent variable - the labor elasticity with respect to gross output fluctuations - is more challenging: Labor elasticities are typically computed by

regressing percent changes in labor on percent changes in the respective explanatory variable - in this case gross output. That yields an average elasticity within the time period on which the regression is based. In order to obtain a time series of labor elasticities for each industry rather than a single number, I construct moving time windows (9 years in the benchmark)<sup>13</sup> akin to a simple moving average. The labor elasticity in year  $t$  is then defined as the elasticity of labor growth with respect to gross output growth  $\epsilon_{t,i}$  estimated in the 9-year window around year  $t$ :

$$\Delta L_{i,t+\tau} = \text{const}_{i,t} + \epsilon_{i,t} \Delta y_{i,t+\tau} + u_{i,t+\tau} \quad \text{for } \tau \in [-4, 4] \quad (1.4)$$

Labor growth  $\Delta L_{i,t+\tau}$  is thereby computed as the difference between job gains and job losses relative to total employment in a given quarter which is then aggregated to an annual growth rate.<sup>14</sup> With these industry-specific time series of labor elasticities at hand, the main regression is then given by:

$$\hat{\epsilon}_{i,t} = \alpha + \beta_{PBS} PBS_{i,t} + \lambda_i + \delta_t + v_{i,j} \quad (1.5)$$

Here,  $\hat{\epsilon}_{i,t}$  denotes the labor elasticity estimated on the 9-year time window around  $t$  in the first stage and  $PBS_{i,t}$  is the average share of PBS-inputs in the 9-year time window around  $t$ .  $\lambda_i$  and  $\delta_t$  denote industry- and year fixed effects respectively.

Table 1.5 presents the results from the main regression. The coefficients deserve some discussion: Without controlling for industry-fixed effects, the coefficient on PBS utilization is significantly positive (columns 1 and 2). When industry-fixed effects are included, the coefficient turns negative. One explanation for that sign switch is that in the cross-section of industries the labor elasticity with respect to gross output fluctuations is positively correlated with the utilization of external services. Some industries simply have a more variable labor demand which means that they are more likely to adjust their labor input in response to shocks *and* they are more likely to use external services as these can be scaled up or down flexibly. Once these industry-fixed effects are controlled for, the coefficient turns significantly negative (columns 3 and 4): Within industries, a larger share of intermediate PBS-inputs as a share of gross output is associated with a lower labor elasticity with respect to gross output fluctuations. Appendix D shows that these estimates are robust to different window sizes and to using firm expansions and contractions rather than job gains and losses for the computation of labor growth rates.

---

<sup>13</sup>The results are robust to other window sizes. See appendix D.

<sup>14</sup>As in the previous section an alternative labor growth rate is computed using firm expansions and contractions rather than job gains and losses. To be consistent, PBS-shares are also computed as the moving average of annual PBS-shares in a 9-year window around period  $t$ .

Table 1.5: Labor elasticity vs. PBS-shares

	(1)	(2)	(3)	(4)
	OLS	YE	FE	FE+YE
PBS-share	0.667*** (0.252)	0.652** (0.254)	-1.285*** (0.464)	-1.551*** (0.476)
Constant	0.351*** (0.0232)	0.365*** (0.0434)	0.515*** (0.0393)	0.534*** (0.0438)
Observations	896	896	896	896
R-squared	0.008	0.016	0.009	0.036
Industry FE	NO	NO	YES	YES
Year FE	NO	YES	NO	YES
window size	9	9	9	9
Number of industries			56	56

Notes: Regression of industry-specific labor elasticities with respect to gross output on the average share of PBS-inputs as a fraction of gross output. Labor elasticities are estimated in a first stage by regressing separately for each industry quarterly net job growth on gross output in 9-year moving windows. Net job growth is defined as difference between job gains and job losses in a quarter. Average PBS-shares are computed equivalently for the same 9-year windows.

Although these empirical results do not allow for a causal interpretation, they suggest that there is a tight link between the proliferation of externally procured service inputs and firms becoming less responsive to idiosyncratic and aggregate shocks in terms of hiring and firing. In what follows, I build a structural model consistent with the presented empirical evidence and evaluate quantitatively (i) to what extent increased outsourcing opportunities account for the observed decline in worker and job reallocation rates and (ii) how the increase in outsourcing affected allocative efficiency in the labor market.



### 3. Stylized Model

Before laying out the full model, it is helpful to investigate in a simple set-up how the possibility to outsource labor affects the hiring and firing decision of firms in the face of fixed labor adjustment costs.

Consider a one-period model in which a firm produces output with a decreasing returns to scale production function and labor input  $L$ . It faces an idiosyncratic productivity shock  $x$  and has to pay a wage  $w$  which it takes as given. The firm enters the period with a stock of employees  $\bar{L}$  which is taken as fixed in this example. After learning the realization of  $x$  the firm can adjust its labor input by either hiring and firing employees at a fixed cost  $\kappa$  or by procuring additional labor input from external providers paying a flexibility premium over the wage  $\chi$ . The main purpose of this section is to show how labor adjustment decisions change qualitatively as  $\chi$  decreases which makes external services cheaper for final-goods firms.

Note first, that without any labor adjustment costs the firm would not use any external services due to the price markup  $\chi$ . Instead it would choose its own staff flexibly by maximizing:

$$\max_{L^*} \{x(L^*)^\rho - wL^*\} \quad (1.6)$$

The first order condition (FOC) yields the optimal labor choice  $L^* = (\frac{\rho x}{w})^{\frac{1}{1-\rho}}$ . Accordingly, one can define  $\bar{x} = \frac{w}{\rho} \bar{L}^{1-\rho}$  as the productivity level at which the optimal labor choice coincides with the existing labor stock  $\bar{L}$  with which the firm enters the period. The labor choice for the flexible case is illustrated by the blue-dotted line in figure 1.6(a).

In the case with fixed labor adjustment costs, the firm's optimization problem becomes:

$$\max_{L^*} \{x(L^*)^\rho - wL^* - \kappa \mathbf{1}_{L^* \neq \bar{L}}\} \quad (1.7)$$

The non-convex fixed cost creates an inaction region around  $\bar{x}$  in which the gains from adjusting inhouse labor do not outweigh the adjustment cost  $\kappa$  and the firm keeps the employment level at  $\bar{L}$  (light-shaded area in figure 1.6(a)). If the firm does adjust, the fixed costs are sunk and the firm chooses the same employment level as in the flexible scenario without acquiring any external services. Therefore the black-solid line depicting the labor input with adjustment costs coincides with the blue-dotted line in figure 1.6(a) outside of the inaction region. The range of the inaction region is determined by two threshold productivity levels  $\{\tilde{x}_1, \tilde{x}_2\}$ . At the lower threshold  $\tilde{x}_1$  the firm is indifferent between firing inhouse staff at fixed cost  $\kappa$  and keeping its staff unchanged at  $\bar{L}$ .<sup>15</sup> Note that for low productivity realizations between  $\tilde{x}_1$  and  $\bar{x}$  the firm is willing to reduce its labor input and therefore does not acquire additional external services ( $S^* = 0$ ). Hence, the total labor input (black-solid line) coincides with the amount of inhouse staff (red-dashed line) for productivity levels lower than  $\bar{x}$ .

---

<sup>15</sup>For the special case of  $\rho = \frac{1}{2}$  the lower threshold can be calculated analytically as  $\tilde{x}_1 = 2(w\sqrt{\bar{L}} - \sqrt{\kappa w})$ .

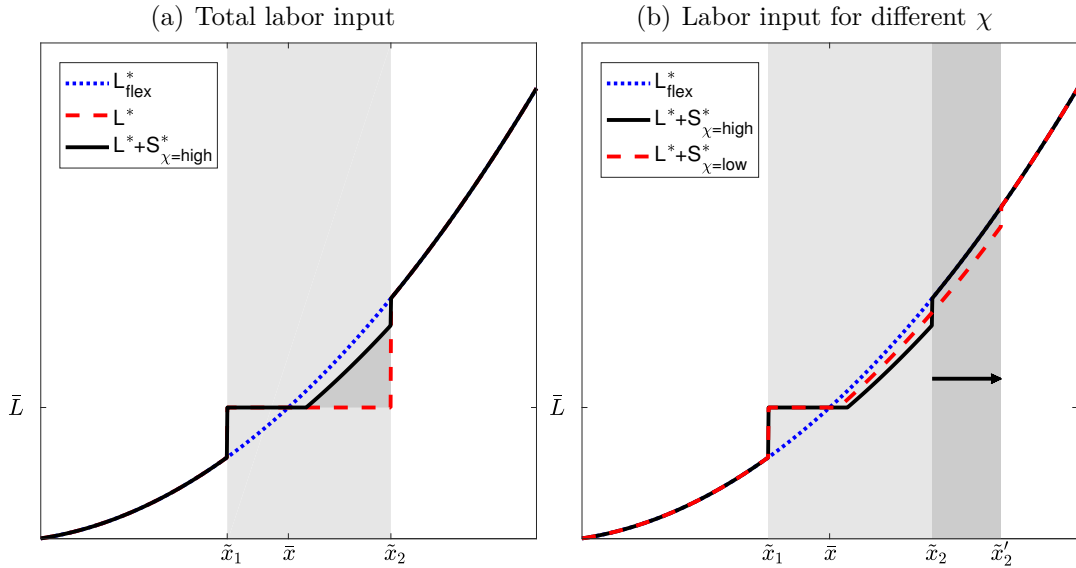
For small positive shocks  $x \in [\bar{x}, \tilde{x}_2]$ , the firm expands its labor input by procuring external services at the marginal cost  $w + \chi$  instead of hiring more inhouse staff at fixed cost  $\kappa$ . The total labor input (black-solid line) therefore exceeds the amount of inhouse labor (red-dashed line) in figure 1.6(a) but falls short of the labor choice in the flexible case due to the markup  $\chi$ :

$$S_{outs}^* + \bar{L} = \left( \frac{\rho x}{w + \chi} \right)^{\frac{1}{1-\rho}} < L_{flex}^* = \left( \frac{\rho x}{w} \right)^{\frac{1}{1-\rho}} \quad (1.8)$$

Here the dark-shaded area denotes the amount of external services acquired. However, each unit of external services is marginally more expensive than an inhouse employee. For  $x$ -realizations large enough, it is more profitable to incur the fixed cost and hire more employees instead of procuring additional external services at the higher piece rate  $w + \chi$ . This point is determined by the second threshold  $\tilde{x}_2$ :

$$\tilde{x}_2 = \left[ \frac{\kappa + \chi \bar{L}}{\left( \rho^{\frac{\rho}{1-\rho}} - \rho^{\frac{1}{1-\rho}} \right) \left( w^{\frac{-\rho}{1-\rho}} - (w + \chi)^{\frac{-\rho}{1-\rho}} \right)} \right]^{1-\rho} \quad (1.9)$$

Figure 1.6: Labor input choices with adjustment costs



Now what happens if external services become more feasible due to a lower price markup  $\chi$ ? In this static model, a decrease in the markup  $\chi$  has two effects: First, at the intensive margin the firm will choose a larger amount of external services for a given level of  $x$ , thus bringing the total labor input closer to the flexible adjustment scenario (the left-hand side in equation 1.8 increases as  $\chi$  goes down). Second, at the extensive margin, the threshold productivity level  $\tilde{x}_2$  at which it becomes more profitable to hire additional workers at the fixed cost  $\kappa$  instead of procuring external services moves up

(as long as the adjustment cost  $\kappa$  is large enough).<sup>16</sup> The inaction region in which the firm does not adjust its workforce therefore widens. Figure 1.6(b) illustrates these two effects. The dark-shaded area denotes the extended inaction region for the lower  $\chi$  with the new upper threshold  $\tilde{x}'_2$ .

Of course, this illustrative example abstracts from any dynamic consideration in particular the optimal choice of  $\bar{L}$  before the shock is realized. Also prices are fixed and there is only one type of labor. The next section therefore introduces a dynamic general equilibrium model. However, the intuition built in the static example also applies in the richer framework.

## 4. Model

The purpose of the model is twofold: First, it allows to evaluate quantitatively how much of the aggregate decline in reallocation rates since the 1980s can be explained by lower costs of purchasing service inputs for production from external providers and the resulting increase in outsourcing. Second, the model can be used to compare the baseline economy with labor adjustment frictions to a fully flexible economy (as in the stylized model) without adjustment costs. In particular, one can investigate how the “efficiency gap” between the flexible case and the baseline version evolves if prices for external services decline, thus making flexible labor adjustment cheaper for final-good firms. Finally, I can decompose how much of the ensuing efficiency gain is due to reduced labor adjustment costs and how much is due to higher allocative efficiency.

In the policy experiment, it is assumed that the rising demand for outsourced services is triggered by an exogenous decrease in the price markup for these services. Section 5 will provide empirical evidence that price markups have indeed fallen in the PBS-sector since the 1980s - in stark contrast to most other sectors.

### 4.1 Model setup

In the model, there are two types of firms and two types of labor input: Final-good firms use production line workers  $P$  and administrative services  $S$  to produce the final good according to a Cobb-Douglas production function with decreasing returns to scale. Production line workers are employed directly at the firm. The administrative service input can either be produced inhouse by employing administrative workers  $A^I$ , or obtained as an intermediate input  $S^O$  from external service providers. The total output of final-good firm  $i$  is therefore given by:

$$F_{i,t} = x_{i,t} P_{i,t}^\alpha \underbrace{(A_{i,t}^I + S_{i,t}^O)}_{S_{i,t}}^\beta \quad (1.10)$$

The production function implies that administrative inhouse staff and external services are perfect substitutes. The latter are produced by a continuum of external service

---

<sup>16</sup>For the special case of  $\rho = \frac{1}{2}$  this can be shown analytically by taking the derivative of equation 1.9 with respect to  $\chi$ : This derivative is negative as long as  $\chi < \sqrt{\frac{\kappa w}{L}}$ .

providers  $j$  which produce intermediate services with the same linear production function as inhouse employees:

$$S_{j,t} = A_{j,t} \tag{1.11}$$

External service providers have to pay a variable cost  $\chi$  for each unit of services they produce. This exogenous cost component stands in as a proxy for the transaction costs of procuring external services and integrating them with services provided by inhouse employees. The market for external services is perfectly competitive such that the price of one unit of externally procured service is the equilibrium wage and the variable cost accruing to the external provider:  $w_A + \chi$ . An alternative approach to introduce a higher marginal cost of services produced by external providers would be to treat  $\chi$  as an endogenous price markup charged by service firms. That would require heterogeneous service input goods that are combined through a CES-aggregator to an intermediate input good. As the marginal cost wedge is treated as exogenous here, thus ruling out any feedback effects, I use the computationally more feasible reduced form of linear transaction costs rather than introducing explicit price markups through a CES-aggregator.

Final-good firms face idiosyncratic productivity shocks,  $x_{i,t}$ , that are independent across firms and follow an AR-1 process:

$$x_{i,t} = \rho_x x_{i,t-1} + \epsilon_{i,t}^x \tag{1.12}$$

The innovations  $\epsilon_{i,t}^x$  are log-normally distributed with mean zero and variance  $\sigma_x$  respectively. There is no aggregate risk.

At the beginning of the period each firm learns its idiosyncratic shock. Taking wages  $\{w_P, w_A\}$  as given, final-good firm  $i$  chooses optimally the amount of production line workers  $P_{i,t}$ , administrative workers employed inhouse  $A_{i,t}^I$  and administrative services bought from external providers  $S_{i,t}^O$ . Final-good firms face worker type-specific fixed costs  $\kappa_P$  and  $\kappa_A$  when adjusting the amount of production line workers or administrative employees. Production line workers can only be employed inhouse and therefore the firm can only adjust their amount through hiring and firing at fixed cost  $\kappa_P$ . In contrast to that, the final-good firm can avoid the fixed cost of adjusting its stock of administrative employees by decreasing or increasing the amount of services it procures from external providers at the marginal cost  $w_A + \chi$ . The marginal cost component  $\chi$  therefore introduces a trade-off between hiring and firing administrative staff employed inhouse or adjusting the amount of services procured from external providers.

Final-good firms cannot sell intermediate services themselves ( $S_{i,t}^O \geq 0$ ).<sup>17</sup> The

---

<sup>17</sup>Without that constraint, final-good firms which receive negative productivity shocks would utilize their redundant administrative workers to sell intermediate service inputs to other final-good firms.

final-good firm's value function is therefore given by:

$$V_F(P_{i,t-1}, A_{i,t-1}^I, x_{i,t}) = F_{i,t} - w_P P_{i,t} - w_A A_{i,t}^I - (w_A + \chi) S_{i,t}^O \quad (1.13)$$

$$- \kappa_P \mathbf{1}_{P_{i,t} \neq P_{i,t-1}} \quad (1.14)$$

$$- \kappa_A \mathbf{1}_{A_{i,t}^I \neq A_{i,t-1}^I} \quad (1.15)$$

$$+ \mathbb{E} \left\{ \frac{1}{1+r} V_F(P_{i,t}, A_{i,t}^I, x_{i,t+1}) \right\} \quad (1.16)$$

External services can be adjusted flexibly in every period and are therefore not a state variable. Hence, they are chosen optimally as a function of the amount of inhouse employees:

$$S_{i,t}^* = \left( \frac{\beta x_{i,t} (P_{i,t}^*)^\alpha}{w_A + \chi} \right)^{\frac{1}{1-\beta}} - A_{i,t}^{I*} \quad (1.17)$$

The first term on the right-hand side is the total amount of service inputs demanded by firm  $i$  at time  $t$ .

The model is closed by assuming a fixed supply of labor for both types, where the share of production line workers in the economy is  $\lambda \in (0, 1)$  and the total amount of workers is normalized to 1. The two wages are then pinned down by

$$\lambda = \sum_i \omega_i^I P_i^* \quad (1.18)$$

$$1 - \lambda = \sum_i \omega_i^I (A_i^{I*} + S_i^{O*}) \quad (1.19)$$

Here,  $\omega_i^I$  denotes the weights of final good firms in the joint distribution of the stochastic states  $x_i$ .

### Worker reallocation

Due to the decreasing returns to scale technology in the final-goods sector ( $\alpha + \beta < 1$ ), there will be a stationary distribution of final-good firms with heterogeneous labor choices. Reallocation arises endogenously as final-good firms move between different idiosyncratic states and adjust the amount of employees. There is no matching friction and therefore workers move directly from firms with negative productivity shocks to firms with positive productivity shocks without going through unemployment. The aggregate reallocation rates in the final goods sector are therefore given by:

$$\pi_P = \frac{1}{2 \sum_i \omega_i^I P_i^{I*}} \sum_i \sum_{i'} \omega_i^I \pi_{i,i'} |P_{i'}^* - P_i^*| \quad (1.20)$$

$$\pi_A = \frac{1}{2 \sum_i \omega_i^I A_i^{I*}} \sum_i \sum_{i'} \omega_i^I \pi_{i,i'} |A_{i'}^* - A_i^*| \quad (1.21)$$

The reallocation is given by the sum of individual adjustment decisions of all firms weighted with their respective weights  $\omega_i^I$  and the stochastic transition probabilities  $\pi_{i,i'}$ . Note that in the stationary distribution each transiting worker is counted twice -

as a separation in the previous firm and as a hire in the new firm. The absolute sum of labor adjustments therefore has to be divided by two.

In contrast to the final-goods sector, service firms do not face idiosyncratic shocks and have a linear production function. Hence, there is no scope for endogenous reallocation. In order to match aggregate reallocation rates in the data, there will be a fraction  $\pi_S$  of service firms exiting the market in every period which are replaced by new service firms. That triggers exogenous reallocation of workers in the service sector. As there are no aggregate shocks, wages and the aggregate amount of worker reallocation are constant over time. The following analysis therefore concerns the steady state in the economy rather than the reaction to aggregate shocks.

### Mechanics of the model

Before laying out the calibration, it is helpful to reconsider how the final-good firm reacts to idiosyncratic TFP-shocks compared with the simple example in the stylized model. The case for production line workers is equivalent to the *benchmark* scenario in the stylized model: Adjusting the amount of these employees comes at a fixed adjustment cost  $\kappa_P$ . That creates an inaction region in which shocks are sufficiently small that the firm refrains from paying  $\kappa_P$  and holds on to its production staff from last period.

For administrative workers the basic mechanism from the stylized model holds as well. However, the dynamic setting implies that the firm might choose to always procure a positive amount of administrative services externally. The rationale for procuring a “buffer stock” of external services stems from the asymmetry outlined in the stylized model: The firm can always buy more external services but cannot utilize its overcapacity of service workers in case of negative shocks to sell their services as intermediate input to other firms. Through buying a certain amount of services externally the firm hedges against negative shocks as it provides the opportunity to cut down on administrative labor input in case of negative shocks without having to pay the fixed adjustment costs.

Nonetheless, this additional feature does not alter the main intuition from the stylized static model: The possibility to outsource administrative service inputs to external providers makes it more profitable for firms to respond to positive (negative) TFP-shocks by procuring more (less) external services rather than hiring (firing) inhouse staff. Administrative workers employed with final-good firms are therefore shielded from idiosyncratic shocks and reallocate less often between firms.

## 4.2 Calibration

The model is calibrated to match the quarterly dynamics of the labor market between 1980 and 1984 as a benchmark. The calibration is based on worker flows rather than job flows because they allow to distinguish between occupations as a proxy for different tasks within a firm.<sup>18</sup> That can be used to map the two worker types in the model to

---

<sup>18</sup>Also, the CPS worker flows are available for the entire time period from 1980-2016, rather than just the period 1992-2016

different occupations in the data: Production line workers represent those occupations which experienced a below-median increase in the share of employees working in the PBS-sector and administrative workers are those that saw an above-median increase. The weight  $\lambda$ , denoting the share of worker type  $P$  in the model, is therefore set to 39.5%, the share of employees in the CPS working in occupations with below-median increases in outsourcing. The labor type specific adjustment costs  $\kappa_P$  and  $\kappa_A$  are then used to target the respective occupation-specific worker reallocation rates of the two groups in the early 1980s. The worker reallocation rate is defined as the baseline “EU+UE” measure, which comprises the average of monthly separations into and hires from unemployment. These rates are then aggregated to quarterly frequencies. Note, that there is no unemployment in the model. However, the quarterly frequency in the model implies that most transitions going through unemployment would actually happen within periods and therefore not show up as unemployed. Assuming that only a small fraction of employees stay unemployed for more than three months (or are hired after being unemployed for more than three months), the “EU+UE” measure in the data corresponds to the reallocation rate in the model sufficiently well.

The stochastic process is calibrated to match the moments of physical TFP estimates from firm-level data in Foster et al. (2008): The variance of idiosyncratic shocks  $\sigma_x$  is chosen to match the cross-sectional dispersion of physical TFP (0.26 in logs) and  $\rho_x$  is pinned down by the annual persistence of firm-level TFP shocks. The exogenous reallocation rate in the PBS-sector  $\pi_S$  is set to the worker flow rate of service workers in the PBS-sector (7.2%).

The interest rate is set to target an annual interest rate of 4%. The curvature of the decreasing returns to scale production function ( $\alpha + \beta$ ) is taken from Basu and Fernald (1997) who estimate the overall curvature to be 0.83. The last free parameter is  $\chi$  which is pinned down by the share of service workers that works in the PBS-industry as a fraction of all service workers which was 3.3% in the early 1980s. In equilibrium this implies a markup over the wages of service workers of 8.3%.

To test the model fit, I compute the cross-sectional dispersion of firm growth rates and the volatility of employment over time as computed in table 2 of Davis et al. (2010). While firm level volatility is slightly below the volatility reported in Davis et al. (2010) based on firm-level data in the LBD, the dispersion of firm growth rates is slightly higher than in the data. However, the model predictions are still fairly close to the data.

### 4.3 Policy experiment: lower price markup for external services

How much of the decline in worker reallocation rates since the 1980s can be explained by a shift in the production processes away from employing workers inhouse towards procuring services flexibly from external providers? And how does that alter allocative efficiency in the labor market? In order to tackle this question, I consider the following experiment: I decrease the marginal transaction cost  $\chi$  in the model to mimic the rise of the PBS-sector in terms of employment shares since the 1980s. It is then possible to assess how worker reallocation rates change as firms procure more external services

Table 1.6: Calibration

parameter	value	target	value (data)	value (model)
$r$	0.010	annual interest rate	0.04	
$\alpha + \beta$	0.830	Basu, Fernald (1997)		
$\alpha$	0.290	$\frac{w_P}{w_A} - 1$	-0.028	-0.030
$\lambda$	0.395	$\frac{P}{P+A}$	0.395	
$\chi$	0.020	$\frac{A^O}{A^I+A^O}$	0.033	0.033
$\kappa_A$	0.011	$\pi_{Fa}$ , reall. service empl. (inhouse)	0.069	0.066
$\kappa_P$	0.133	$\pi_{Fp}$ , reall. production employees	0.042	0.041
$\pi_S$	0.072	$\pi_{Sa}$ , reall. service empl. (PBS sector)	0.072	
$\sigma_x$	0.240	st. dev. TFP (Foster et. al, 2008)	0.260	0.260
$\rho_x$	0.946	persistence TFP shocks (Foster et. al, 2008)	0.800	0.800
		dispersion firm growth (Davis et. al, 2010)	0.617	0.687
		volatility firm growth (Davis et. al, 2010)	0.479	0.432

due to the exogenous fall in the price markup  $\chi$ .<sup>19</sup> The model also allows to compare aggregate output to a benchmark economy in which firms can adjust labor costlessly and compute how the resulting efficiency gap changes as  $\chi$  decreases.

### Declining worker reallocation

Table 1.7 summarizes the results on labor adjustment and worker reallocation rates in the model. The price markup for external services  $\frac{\chi}{w_A}$  has to fall by more than half from 8.3% to 3.5% to generate the observed increase in the share of outsourced service activities of more than 220% (column 1 and 4). The cheaper access to flexible service inputs reduces the share of firms who hire or fire employees in a given period by half from 7.7% to 3.6%. Consequently, the volatility of firm-level growth falls from 43.2% to 40.7%.

In terms of worker reallocation rates, the hiring and firing rates of administrative in-house employees falls by 7.7% explaining close to one fifth of the 41%-drop in the data. The flow rate of production line workers does not change, indicating that there is no spillover from the reduced reallocation of their inhouse administrative colleagues. In total, the falling reallocation of inhouse employees pushes down the aggregate flow rate in the economy by 4.5% (last column), explaining 13.5% of the 33%-decline observed in the data.

It should be noted however, that the corresponding rates in the data refer to the un-

<sup>19</sup>Assuming that all of the rise in PBS-industries is due to an exogenous change in transaction costs might seem like a strong assumption. However, this paper is not trying to answer what caused the increase in external service provision but rather focuses on how the rise of the PBS-sector affected worker reallocation by shifting the firm's reaction to idiosyncratic shocks from hiring and firing towards cutting and expanding external service inputs.



adjusted flow rates which do not control for shifts in the composition of workers, occupations and industries. As outlined in section 2.3, these compositional shifts alone account for approximately 53% of the overall decline in worker reallocation rates. The model does not account for these shifts and therefore delivers a lower bound. Comparing the change in flow rates generated by the model to the *unexplained* component of the aggregate flow rate decline in the data (-15.4%), the model is able to explain 28.9% of the observed empirical decline since the 1980s.

Table 1.7: Model vs. data (in %)

		$\frac{\chi}{w_A}$	<i>adj.firms</i>	$\sigma_{vol}$	$\frac{A^O}{A^I+A^O}$	$\pi_A$	$\pi_P$	$\pi_a$	$\pi_{agg}$
Data	1980-84				3.3	6.9	4.2	6.9	5.8
	2012-16				10.6	4.0	3.5	4.1	3.9
	$\Delta$ in %				224.3	-41.2	-14.8	-40.0	-33.0
	$\Delta$ in % (unexpl.)				-	-	-	-	-15.4
Model	1980-84	8.3	7.7	43.2	3.3	6.6	4.1	6.6	5.7
	2012-16	3.5	3.6	40.7	10.8	6.1	4.1	6.2	5.4
	$\Delta$ in %	-58.3	-53.0	-5.9	231.3	-7.7	0.0	-6.1	-4.5
Contribution	(total)	-	-	-	103.1	18.7	0.0	15.2	13.5
Contribution	(unexpl. comp.)	-	-	-	-	-	-	-	28.9

Notes: Empirical moments in the data (upper panel), in the model (central panel) and the contribution of the model in explaining the change over time in the data (lower panel). All numbers in percent. The last row in the upper and lower panel controls for compositional shifts as reported in section 2.3 (unexplained component is 48% of the fall in the reallocation rate). First column shows price markup over wages of administrative workers. Column 2 is the share of firms that adjust their labor stock. Column 3 is the volatility of firm growth rates. Column 4 is the share of administrative workers employed in PBS-firms. Last 4 columns show quarterly reallocation rates by worker type.

### Effect on aggregate efficiency

Labor adjustment frictions impede the smooth reallocation of employees from less productive firms to more productive firms. They therefore trigger aggregate efficiency losses compared to a benchmark in which labor can move flexibly at no cost between companies. How large is this efficiency loss and how does it change as outsourcing to external service providers gets cheaper? The structural model outlined above allows to answer both questions.

To do that, I compare the value-added in the baseline calibration with non-convex adjustment costs  $\kappa_A$  and  $\kappa_P$  to a flexible benchmark economy in which firms can adjust both types of labor costlessly (keeping all other parameters constant). This flexible benchmark corresponds to the blue dotted line in figure 1.6 in the stylized model. Given that they can hire and fire their own staff at no cost, firms are not willing to pay the flexibility premium  $\chi$  for external services and therefore the PBS-sector does not exist in this flexible benchmark.

In order to compare these two cases in terms of allocative efficiency, two aspects regarding the accounting in the model should be kept in mind: First, labor supply in the model is normalized to one and capital is absent. Hence, differences in aggregate value-added (GDP) can only arise from different allocations of labor input across firms with different idiosyncratic productivities. Value-added therefore serves as a direct measure of allocative efficiency throughout this section. In that respect, the flexible scenario without adjustment costs yields the optimal allocation of labor across firms given their idiosyncratic productivities and therefore serves as the benchmark.

Second, the adjustment costs which firms pay in the baseline calibration, are a part of GDP but are treated as waste. Accounting-wise they therefore resemble depreciation, marking the gap between net domestic product (NDP) and GDP. The flexibility premium  $\chi$  on the other hand, is treated as profit which accrues to the service-sector firms. It is assumed that these service firms are owned by all workers in the economy, who receive dividend payments in every period. The transaction costs  $\chi$  therefore enters both NDP and GDP.

This accounting framework implies the following identity:

$$\begin{aligned}
 GDP_{flex} &= \underbrace{\lambda w_P + (1 - \lambda)w_A + \chi \sum_i S_i^{O*}}_{NDP} \\
 &+ \underbrace{\kappa_P \sum_i w_i \mathbf{1}_{\Delta P_i \neq 0} + \kappa_A \sum_i w_i \mathbf{1}_{\Delta A_i \neq 0}}_{adj.costs} \\
 &+ \Delta_{AEG}
 \end{aligned}$$

The first two terms on the right-hand side (NDP + adjustment costs) constitute total GDP in the baseline scenario with adjustment frictions. The “allocative efficiency gap”  $\Delta_{AEG}$  is then defined as the residual between GDP in the flexible benchmark and GDP in the scenario with adjustment costs.

Table 1.8 shows the three right-hand side terms relative to  $GDP_{flex}$ . The first column refers to the baseline calibration for the early 1980s and the second column displays the results for the policy experiment with a reduced price markup as described in the previous section. The efficiency loss  $\Delta_{AEG}$  due to a sub-optimal labor allocation across firms in the face of non-convex adjustment costs amounts to 4.51% of GDP in the baseline calibration. On top of that, the direct cost of hiring and firing workers reduces net output (NDP) further by 0.52%. The actual output available for final consumption is therefore 5.02% lower than without labor adjustment frictions.

This gap shrinks by 0.36 percentage points as external services become more affordable, thus enabling final-good firms to adjust their labor input more flexibly without having to hire or fire employees. The reduced need for costly reallocation directly increases output net of adjustment costs by 0.06 percentage points. Yet, the bulk of the net output gains (0.3 percentage points) arises from the indirect effect of a more efficient labor allocation across firms: The allocative efficiency gap falls from 4.5% to 4.2% which is quite substantial, given the small size of the PBS-sector in terms of employment. In relative terms, the increased utilization of external services due to lower prices reduces

the allocative efficiency gap by 6.6%.

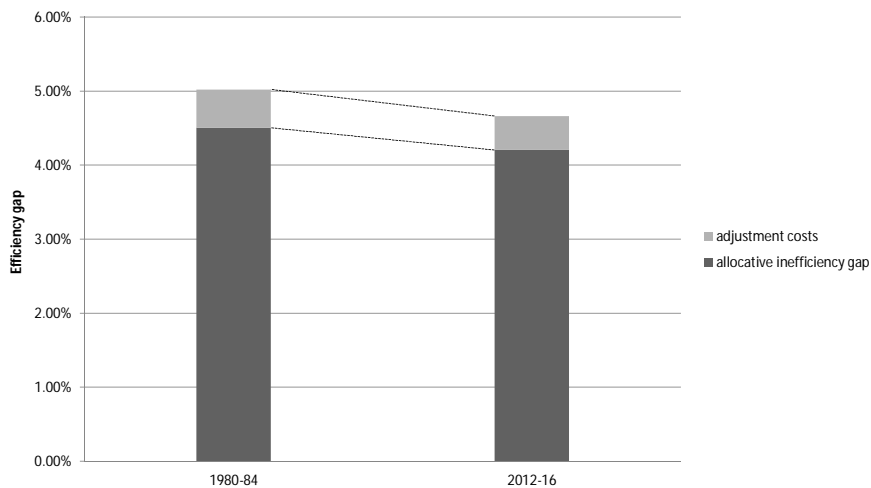
Figure 1.7 illustrates how the efficiency losses shrink due to the direct and the indirect effect. Evidently, efficiency gains do not arise mechanically as less resources are wasted on adjustment costs, but because the cheaper technology to reallocate labor inputs without hiring or firing leads to a more efficient labor allocation across firms.

Table 1.8: Efficiency loss in the model

	1980-84	2012-16	$\Delta$ in ppt.
GDP (flexible)	100.00	100.00	-
NDP	94.98	95.34	0.36
adjustment costs	0.52	0.45	-0.06
allocative efficiency gap	4.51	4.20	-0.30

Notes: GDP and GDP components relative to the flexible benchmark (top row). First column shows baseline calibration, second shows model predictions after reduction in price markup  $\chi$ . “Allocative inefficiency” is obtained as residual between  $GDP_{flex}$  and GDP in the baseline (NDP + adjustment costs).

Figure 1.7: Allocative efficiency gap with high and low  $\chi$



Notes: Adjustment costs and allocative efficiency gap as computed in table 1.8

## 5. Markups and profits in the PBS-sector

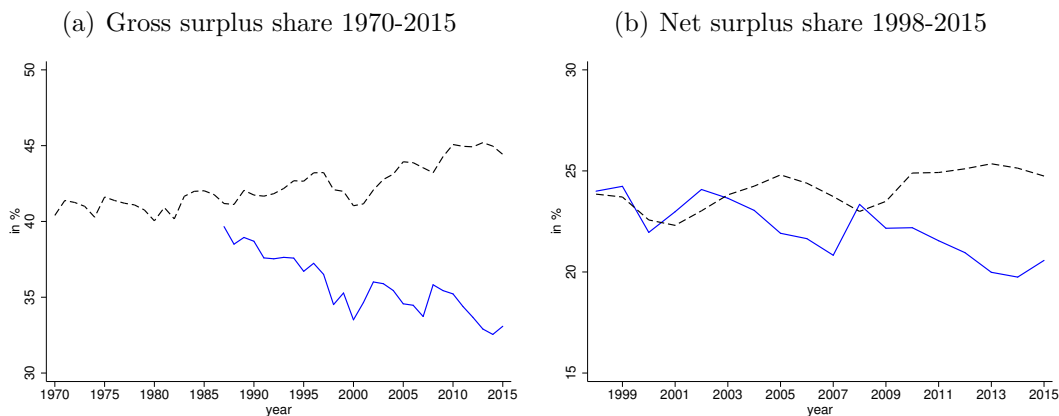
In the model the rise of PBS-services results from an exogenous decrease in the “flexibility premium” which final-good firms have to pay on external services. However, the model remains agnostic about the possible sources of this change. This section therefore sheds some light on potential drivers of this structural shift. As mentioned earlier,

one way to interpret the reduced-form premium in the model is to view it as a price markup over marginal costs in the PBS-sector stemming from imperfect competition among service providing firms. One reason for a lower premium on intermediate service inputs is therefore a more intense competition among PBS-firms which reduces price markups, thus making these services more feasible for final-good firms. At the same time that would imply that profit shares in the PBS-sector have decreased since the 1980s.

Indeed, there is evidence on the aggregate level for both phenomena - lower price markups and lower profit shares in the PBS-sector. Figure 1.8 shows the share of gross surplus (profits plus capital expenditures) and the net surplus (profits) as a share of value added for the US economy as a whole (black-dashed line) and for the PBS-sector (blue-solid line) over time. In contrast to the aggregate economy, the surplus share in the PBS-sector has decreased since the late 1980s from 40% to 33%, indicating that profits in the PBS-sector have decreased.<sup>20</sup> Furthermore, there is direct evidence on falling price markups in the PBS-sector: Estimating price markups from firm-level data in the US, Loecker and Eeckhout (2017) document a secular increase of price markups in the US economy as a whole. At the same time, they also find that the PBS-industry is one of the few sectors in which price markups over marginal costs have actually fallen considerably since the 1980s.

Falling price markups and declining profit shares indicate that a more competitive environment has contributed to the rise of the PBS-sector, thereby transforming the way in which final-goods firms procure intermediate services as an input for their production.

Figure 1.8: Profit shares of value added



Notes: Left panel: Gross operating surplus (profit plus capital expenditures) as share of value added for total economy (black-dashed line) and the PBS-sector (blue-solid line). Right panel: Net operating surplus (profit) as share of value added. Based on OECD data.

<sup>20</sup>Data on capital stocks and expenditures is only available from 1998 onwards, therefore profit shares cannot be computed before 1998.

## 6. Concluding Remarks

Since the 1980s, the US economy has experienced two secular trends: A fall in the dynamism of its labor market by almost one third and a twofold increase in the share of professional and business services in terms of employment and value-added. This paper explores whether these trends are related empirically, suggests a structural channel through which a rising PBS-share affects worker reallocation rates and quantifies the potential contribution of this channel to the overall fall in reallocation rates.

The paper finds that the intensity of both trends varies substantially across occupations and that they are negatively correlated: Those occupations which saw the largest shift towards the PBS-sector also experienced larger declines in worker reallocation rates. Additionally, the PBS-sector experienced falling profit shares and declining price markups since the 1980s in contrast to the rest of the US economy. That suggests that external services have become more affordable for final-goods firms as the PBS-sector became more competitive relative to the inhouse provision of these service inputs. Nonetheless, the heterogeneity of rising PBS-shares across occupations and industries suggests that not all jobs were affected by this shift in the production structure in the same way: While some jobs are more likely to be outsourced as external services become cheaper, other tasks remain in the realm of inhouse production.

I therefore build a structural model that mirrors this heterogeneity of tasks by incorporating two different labor types that are subject to non-convex adjustment costs, one of which can be outsourced to external providers. An exogenous decline in the markup charged by service providers alters the trade-off which final-good firms face between hiring inhouse staff and external procurement: The lower “flexibility premium” allows firms to hold a larger buffer stock of external services which they can adjust flexibly in reaction to idiosyncratic shocks. That reduces the necessity to hire or fire inhouse employees as shocks materialize, thus reducing the aggregate amount of worker reallocation.

Quantitatively, this channel can account for 29% of the aggregate fall in reallocation rates since the early 1980s which is unexplained by shifts in the demographic, occupational and industrial composition of the US. The cheaper access to a more flexible labor adjustment option renders the labor allocation more efficient and reduces the efficiency losses caused by labor market frictions by 6.6%.

The paper adds to a broad literature on the declining dynamism of the US labor market and offers a new perspective on possible causes of this trend: Besides regulatory changes and technological advances, the shift in the production structure of firms from inhouse production to external procurement plays an important role in explaining why firms’ hiring and firing decisions have become less responsive to idiosyncratic shocks. The slightly higher aggregate productivity in the model implies that the declining dynamism in the US labor market is less problematic for the efficiency and productivity of the US economy than approaches focusing on stricter regulation or employment protection would suggest. Whereas this paper mainly concentrated on trends in worker reallocation, it is worthwhile to investigate what a shift in the production structure towards more external service provision implies for other secular trends such as the de-

clining start-up rate and the increased wage inequality especially between firms. These are interesting topics to be addressed in future research.

## Appendices

### A Alternative worker reallocation measures

This section documents the main results for four alternative measure of worker reallocation rates:

$$\pi_{sep}^{alt} = \frac{EU_{t,t+1} + EN_{t,t+1}}{E_t} \quad (1.22)$$

$$\pi_{hir}^{alt} = \frac{UE_{t-1,t} + NE_{t-1,t}}{E_t} \quad (1.23)$$

$$\pi_{EUE} = \frac{EUE_{t,t+2}}{E_t} \quad (1.24)$$

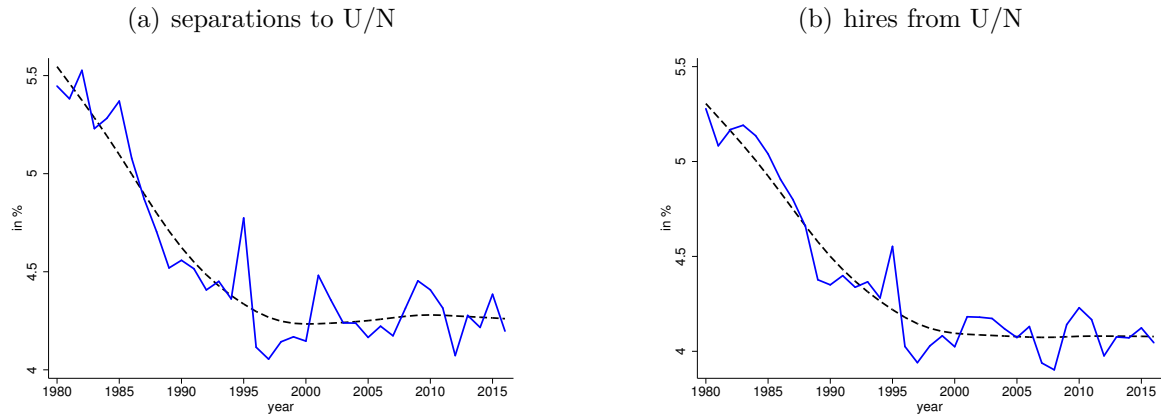
$$\pi_{ENE} = \frac{EUE_{t,t+2} + ENE_{t,t+2}}{E_t} \quad (1.25)$$

The first two rates add transitions into and from non-employment to the benchmark separation and hiring rates. The latter two rates comprise transitions between two employment spells that are interrupted by short (at most one month) unemployment or non-employment spells. Note, that the last measure does contain both intermittent unemployment as well as non-employment spells.

As figure 1.9 shows, the separation and the hiring rate (equations 1.22 and 1.23) fall by 21% which is less than in the baseline and flatten out in the late 1990s. The less pronounced decline is mainly due to relatively stable EN- and NE-transition rates compared to EU- and UE-rates particularly until the mid-1990s. They then start increasing, thereby counteracting the continuing fall in the separations to and hires from unemployment.

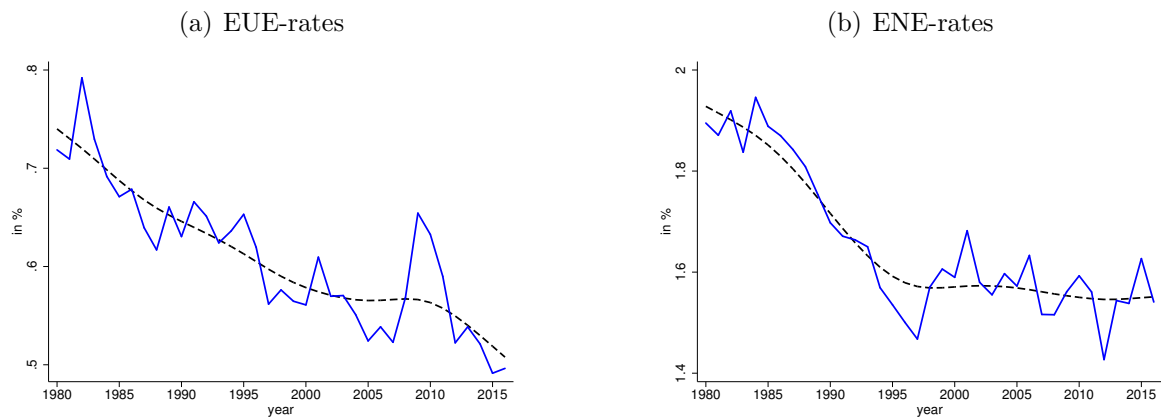
Figure 1.10 displays the reallocation rates through unemployment and non-employment considering a 3-month window. The aggregate picture is similar to the benchmark with EUE-rates falling by 29% (benchmark EU-rate: -34%) and with ENE-rates falling by 19% (benchmark separations to U/N in top left panel: -21%).

Figure 1.9: Worker reallocation rates (including non-employment)



Notes: Yearly averages of monthly transition rates for alternative worker reallocation measures from 1980-2016. Figure shows total separations into and hires from unemployment and non-employment. Black-dashed lines display HP-filtered trends ( $\lambda = 100$ ).

Figure 1.10: Worker reallocation rates (intermittent non-employment spells)



Notes: Yearly averages of monthly transition rates for alternative worker reallocation measures from 1980-2016. Left panel denotes transitions employment-unemployment-employment (EUE) transitions in a 3-month periods. Right panel shows the same series, including also transitions going through non-employment (EUE and ENE). Black-dashed lines display HP-filtered trends ( $\lambda = 100$ ).

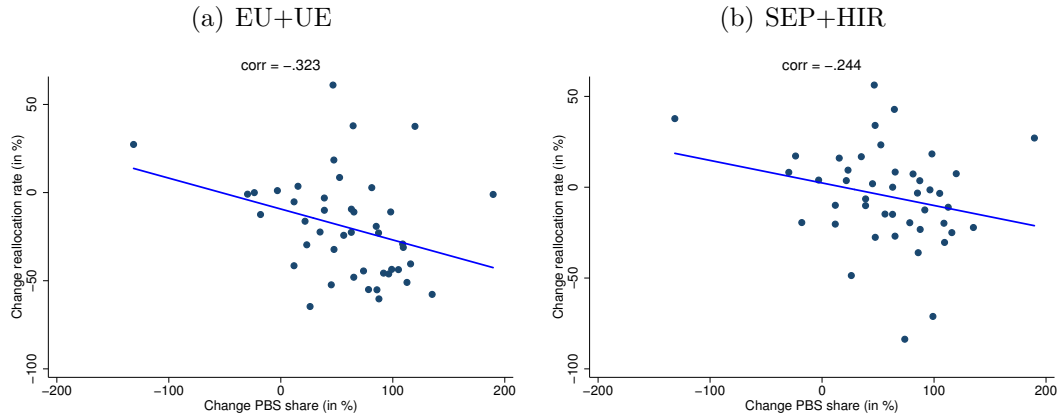
## B Robustness of correlation occupational worker flows vs. PBS-share change

This section shows that the correlations in figures 1.3 and 1.4 are robust to different empirical specifications. Figures 1.11 and 1.12 use 10-year instead of 5-year windows to compute relative differences (1980-89 and 2007-2016). Figure 1.13 and figure 1.14 compute the relative change of the PBS-share over time as  $\frac{PBS_{t+1} - PBS_t}{PBS_t}$  instead of using the weighted average of  $PBS_t$  and  $PBS_{t+1}$  in the denominator. Figures 1.15 and 1.16 show the benchmark statistics when personnel supply services



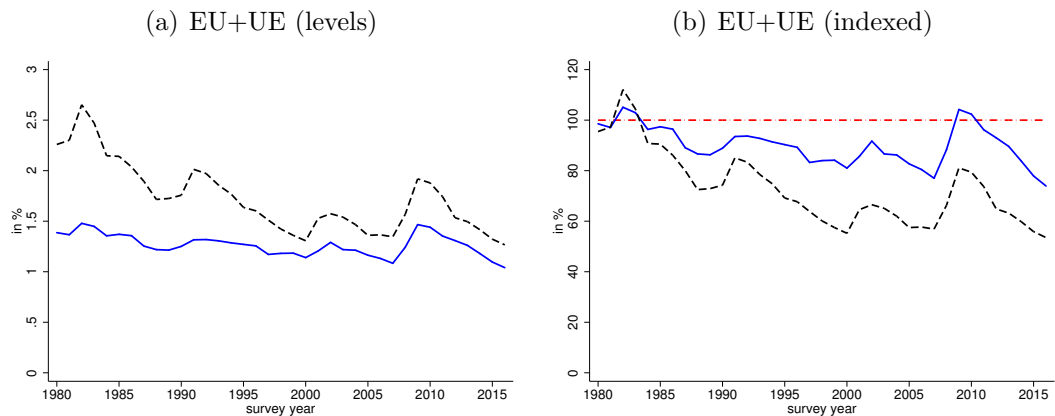
are excluded from the PBS-sector. Excluding personnel supply services attenuates the results but still there is a more pronounced decline in worker flow rates in those occupations that experienced a large shift towards the PBS sector.

Figure 1.11: Reallocation rate changes and outsourcing (different window size)



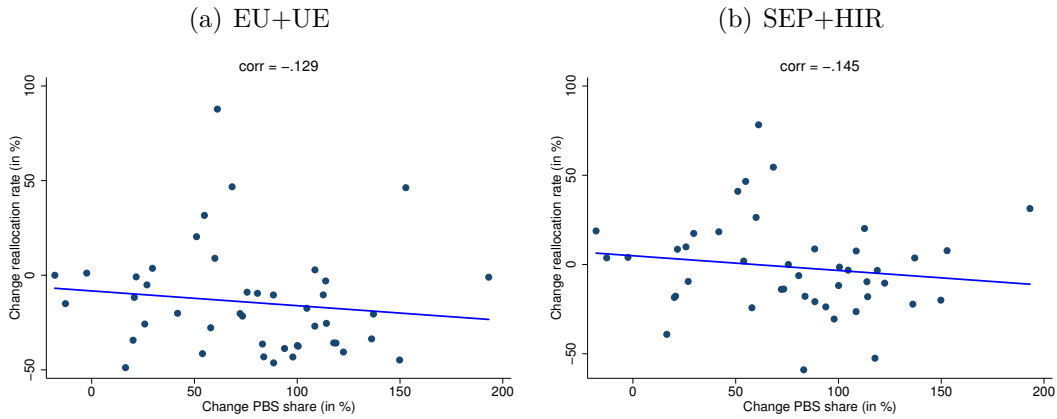
Notes: Correlation of change in worker-based reallocation measures (CPS) and change in share of employees working in PBS-industries between 1980-89 and 2007-16 across occupations.  $N = 44$ . Left panel: Mean of separation rate to unemployment (EU) and hiring rate from unemployment (UE). Right panel: Mean of all separations (SEP) and hires (HIR). Relative change in PBS-share computed as  $\frac{PBS_{t+1} - PBS_t}{\frac{1}{2}(PBS_{t+1} + PBS_t)}$  where  $PBS$  denotes the average share of each occupation working in the PBS-sector. Changes in reallocation rate are computed as  $\frac{\pi_{t+1} - \pi_t}{\frac{1}{2}(\pi_{t+1} + \pi_t)}$ .

Figure 1.12: Reallocation rates grouped by changes in PBS-share (different window size)



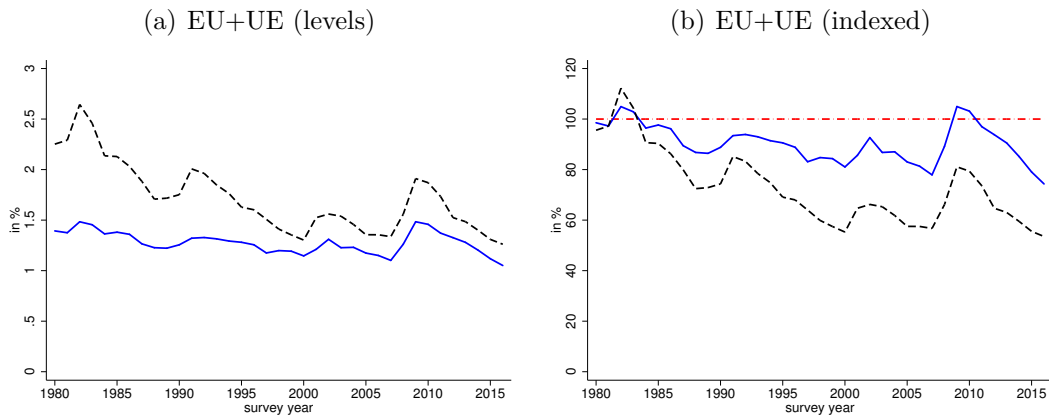
Notes: Worker reallocation rate in occupations with below-median growth in the employment share of PBS (blue solid line) and above-median growth (black dashed line) from 1980-2016 in levels (left panel) and normalized to average level in 1980-1989 (right panel). The worker reallocation rate is measured as the mean of separation rate to unemployment (EU) and hiring rate from unemployment (UE). Changes in the PBS-share are computed as  $\frac{PBS_{t+1} - PBS_t}{\frac{1}{2}(PBS_{t+1} + PBS_t)}$ .

Figure 1.13: Reallocation rate changes and outsourcing (alternative change measure)



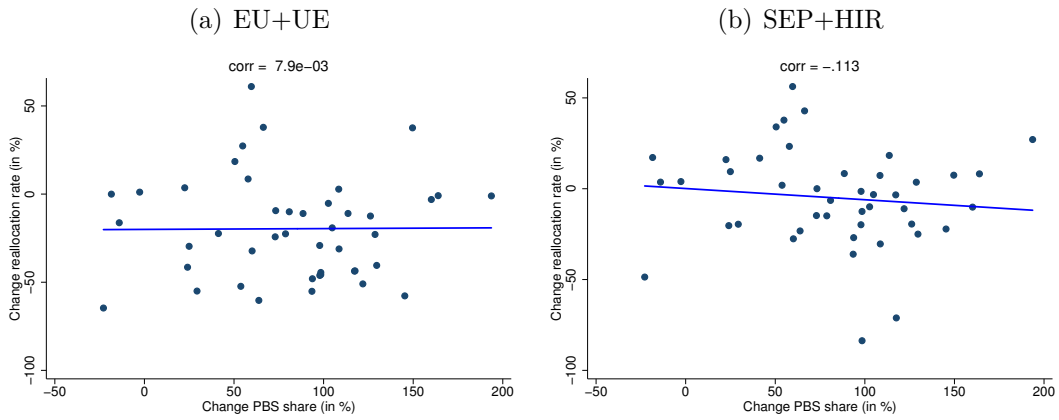
Notes: Correlation of change in worker-based reallocation measures (CPS) and change in share of employees working in PBS-industries between 1980-89 and 2012-16 across occupations.  $N = 44$ . Left panel: Mean of separation rate to unemployment (EU) and hiring rate from unemployment (UE). Right panel: Mean of all separations (SEP) and hires (HIR). Relative change in PBS-share computed as  $\frac{PBS_{t+1}-PBS_t}{PBS_t}$  where  $PBS$  denotes the average share of each occupation working in the PBS-sector. Changes in reallocation rate are computed as  $\frac{\pi_{t+1}-\pi_t}{\frac{1}{2}(\pi_{t+1}+\pi_t)}$ .

Figure 1.14: Reallocation rates grouped by changes in PBS-share (alternative change measure)



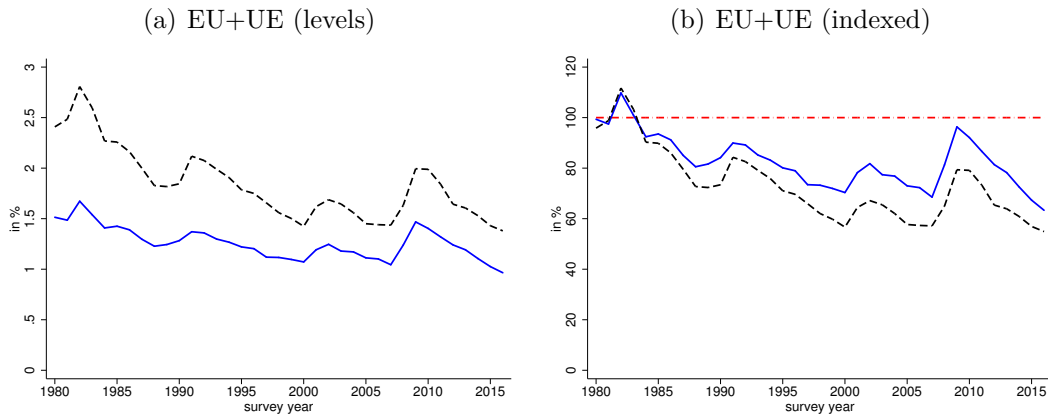
Notes: Worker reallocation rate in occupations with below-median growth in the employment share of PBS (blue solid line) and above-median growth (black dashed line) from 1980-2016 in levels (left panel) and normalized to average level in 1980-1984 (right panel). The worker reallocation rate is measured as the mean of separation rate to unemployment (EU) and hiring rate from unemployment (UE). Changes in the PBS-share are computed as  $\frac{PBS_{t+1}-PBS_t}{PBS_t}$ .

Figure 1.15: Reallocation rate changes and outsourcing (by occupation, PBS without temp. workers)



Notes: Correlation of change in worker-based reallocation measures (CPS) and change in share of employees working in PBS-industries between 1980-84 and 2012-16 across occupations.  $N = 44$ . Left panel: Mean of separation rate to unemployment (EU) and hiring rate from unemployment (UE). Right panel: Mean of all separations (SEP) and hires (HIR). Relative change in PBS-share computed as  $\frac{PBS_{t+1} - PBS_t}{\frac{1}{2}(PBS_{t+1} + PBS_t)}$  where  $PBS$  denotes the average share of each occupation working in the PBS-sector. PBS-sector excludes personnel supply services.

Figure 1.16: Reallocation rates grouped by changes in PBS-share (PBS without temp. workers)

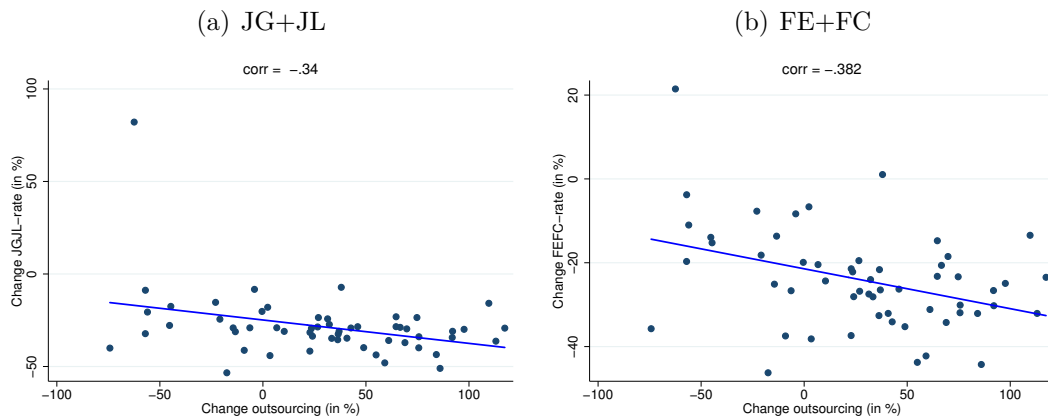


Notes: Worker reallocation rate in occupations with below-median growth in the employment share of PBS (blue solid line) and above-median growth (black dashed line) from 1980-2016 in levels (left panel) and normalized to average level in 1980-1984 (right panel). The worker reallocation rate is measured as the mean of separation rate to unemployment (EU) and hiring rate from unemployment (UE). PBS-sector excludes personell supply services. Changes in the PBS-share are computed as  $\frac{PBS_{t+1} - PBS_t}{\frac{1}{2}(PBS_{t+1} + PBS_t)}$ .

### C Robustness of correlation sectoral job flow rates vs. PBS-share change

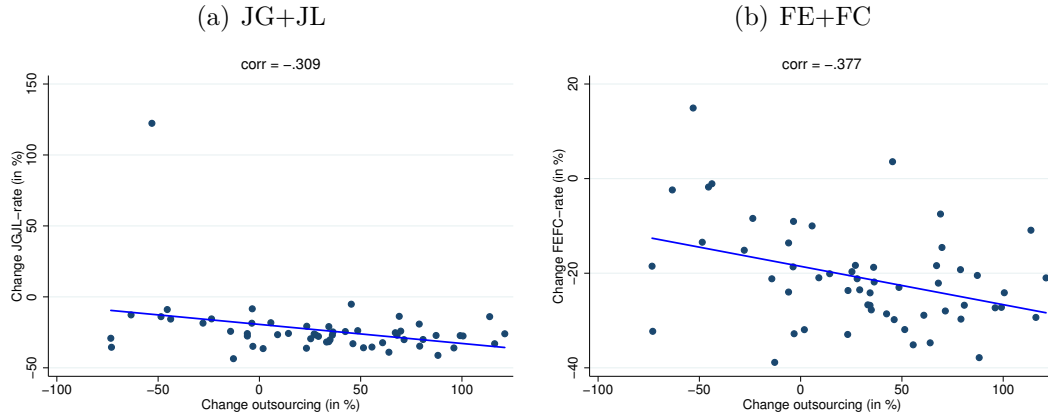
This section documents that the correlations shown in figure 1.5 are robust to different empirical specifications. Figure 1.17 shows that changing the window size of the periods of comparison from five to two years does not alter the correlation between changes in PBS utilization and the change in job reallocation at the industry level. Figure 1.18 shows the correlation for a different change measure of the job reallocation rates (using the level in the 1990s in the denominator instead of the weighted average). Finally, figure 1.19 removes the industry “Funds, trusts, and other financial vehicles” from the sample as it displays an extraordinarily large increase in its job reallocation rate. Removing this outlier industry does change the slope but not the overall correlation between changing job reallocation rates and changing PBS-utilization.

Figure 1.17: Job reallocation rate changes and outsourcing (1992-93 vs. 2014-16)



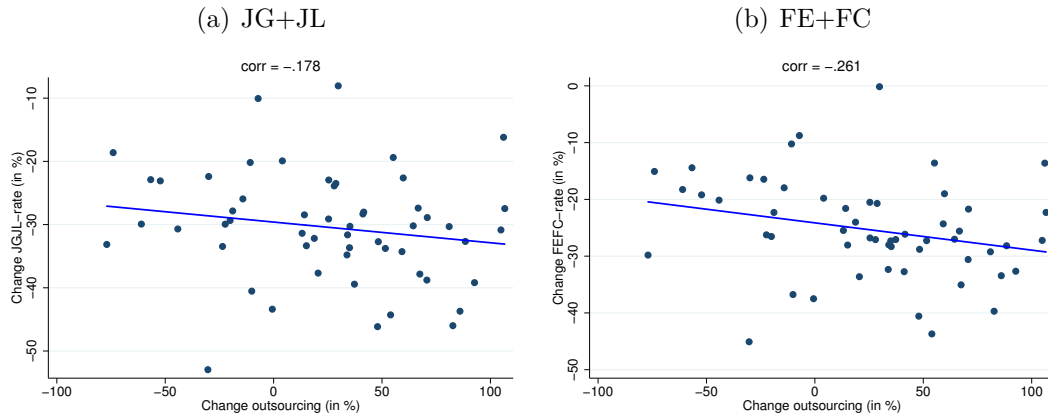
Notes: Correlation of change in job reallocation rates (BDM) and change in PBS-utilization between 1992-94 and 2014-16 across industries. The horizontal axis refers to the relative percentage change in job reallocation measures (left panel: job gains and losses, right panel: job gains/losses in expanding/contracting firms only). The vertical axis refers to the relative percentage change in the share of intermediate inputs from PBS-firms as a fraction of gross output. Relative changes computed as  $\frac{x_{t+1}-x_t}{\frac{1}{2}(x_{t+1}+x_t)}$ .  $N = 56$ .

Figure 1.18: Job reallocation rate changes and outsourcing (alternative change measure)



Notes: Correlation of change in job reallocation rates (BDM) and change in PBS-utilization between 1992-96 and 2012-16 across industries. The horizontal axis refers to the relative percentage change in job reallocation measures (left panel: job gains and losses, right panel: job gains/losses in expanding/contracting firms only). The vertical axis refers to the relative percentage change in the share of intermediate inputs from PBS-firms as a fraction of gross output. Relative changes computed as  $\frac{x_{t+1}-x_t}{x_t}$ . N = 56.

Figure 1.19: Job reallocation rate changes and outsourcing (outlier correction)



Notes: Correlation of change in job reallocation rates (BDM) and change in PBS-utilization between 1992-96 and 2012-16 across industries. The horizontal axis refers to the relative percentage change in job reallocation measures (left panel: job gains and losses, right panel: job gains/losses in expanding/contracting firms only). The vertical axis refers to the relative percentage change in the share of intermediate inputs from PBS-firms as a fraction of gross output. Relative changes computed as  $\frac{x_{t+1}-x_t}{\frac{1}{2}(x_{t+1}+x_t)}$ . N = 55.

## D Robustness of labor elasticity regression on PBS-share changes

Table 1.9 shows that the coefficients reported in table 1.5 are robust to a shorter window size of seven years (instead of nine years). Table 1.10 shows that these estimates are robust to using firm expansions and contractions rather than job gains and losses for the computation of quarterly labor growth rates.

Table 1.9: Labor elasticity vs. PBS-shares (window size: 7 years)

	(1)	(2)	(3)	(4)
	OLS	YE	FE	FE+YE
PBS-share	0.489*	0.413	-0.885*	-1.517***
	(0.264)	(0.257)	(0.537)	(0.517)
Constant	0.339***	0.160***	0.454***	0.304***
	(0.0244)	(0.0466)	(0.0456)	(0.0502)
Observations	1,008	1,008	1,008	1,008
R-squared	0.003	0.082	0.003	0.146
Country FE	NO	NO	YES	YES
Year FE	NO	YES	NO	YES
window size	7	7	7	7
Number of industries			56	56

Notes: Regression of industry-specific labor elasticities with respect to gross output on the average share of PBS-inputs as a fraction of gross output. Labor elasticities are estimated in a first stage by regressing separately for each industry quarterly net job growth on gross output in 7-year moving windows. Net job growth is defined as difference between job gains and job losses in a quarter. Average PBS-shares are computed equivalently for the same 7-year windows.

Table 1.10: Labor elasticity vs. PBS-shares (Firm expansions and contractions)

	(1)	(2)	(3)	(4)
	OLS	YE	FE	FE+YE
PBS-share	0.387* (0.226)	0.355 (0.227)	-0.816** (0.395)	-1.183*** (0.401)
Constant	0.324*** (0.0208)	0.327*** (0.0389)	0.424*** (0.0335)	0.445*** (0.0369)
Observations	896	896	896	896
R-squared	0.003	0.017	0.005	0.054
Country FE	NO	NO	YES	YES
Year FE	NO	YES	NO	YES
window size	9	9	9	9
Number of industries			56	56

Notes: Regression of industry-specific labor elasticities with respect to gross output on the average share of PBS-inputs as a fraction of gross output. Labor elasticities are estimated in a first stage by regressing separately for each industry quarterly net job growth on gross output in 9-year moving windows. Net job growth is defined as difference between firm expansions and firm contractions in a quarter. Average PBS-shares are computed equivalently for the same 9-year windows.





## CHAPTER 2

---

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

### 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 in 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 (Katz and Meyer (1990) and Schmieder and Von Wachter (2016)) or through their incentive effects on firms to post new vacancies (Millard and Mortensen (1997), Krause and Uhlig (2012)).<sup>1</sup> 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 (Tuit and van Ours (2010)). 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 that 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 in separation rates across workers. We find the

---

<sup>1</sup>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 (Baily (1978), Shavell and Weiss (1979a), Hopenhayn and Nicolini (1997a), and Chetty (2006)). Recently, there has been renewed interest in quantifying the incentive effects for firms' vacancy postings in relation to changes in UI benefits during the Great Recession in the United States (Hagedorn et al. (2016), Chodorow-Reich and Karabarbounis (2016)).

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 point to the important role of changes in separation rates as an adjustment channel after changes in the UI system.

Alternative narratives told so far about the Hartz reforms and the German labor market miracle have looked at job finding rates as the key margin of adjustment, either by highlighting changes in search effort (Krebs and Scheffel (2013)), changes in matching efficiency (Launov and Wälde (2013), Hertweck and Sigrist (2015) and Klinger and Weber (2016)), or changes in vacancy posting behavior (Krause and Uhlig (2012)). All of these narratives explain the decline in unemployment by an increase in outflows from unemployment. Our findings provide an upper bound for the contribution of these explanations. Understanding the relative importance of different adjustment channels after a UI 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 workers in 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, changes in separation rates 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 cuts in the generosity of benefits brought about by the reform were 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, 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 a recent study, Jäger et al. (2018) explore a staggered extension of UI benefit durations by age on older male workers in Austria. In line with our findings, they also find large increases in separation rates due to increased benefit generosity.

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-skill 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 Krause and Uhlig (2012).<sup>2</sup> 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 by abolishing long-term wage-dependent benefits. After the reform, the model matches closely the observed time series for average separation 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, as 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 (Costain and Reiter (2008)). 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.<sup>3</sup> Our

---

<sup>2</sup>We share several modeling choices with Krause and Uhlig (2012), but differ in focus. Their findings and calibration strategy focus on changes in job finding rates through effects on vacancy postings rendering separation rates effectively exogenous in their quantitative analysis. Their model also does not include aggregate fluctuation to impose discipline on the elasticity of separation and job finding rates, which we exploit for the calibration as described below.

<sup>3</sup>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 (Chetty (2006), Schmieder and Von Wachter (2016)).

calibration only targets unconditional moments of worker-flow rates, but matches well the time series of labor market flows before the reform, 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 time series and cross-sectional 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 as in most other industrialized countries, and would today be 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 the 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 again obtain 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 the 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 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 to 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 variation 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, as 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 in line with findings in Elsby et al. (2013) and therefore welfare costs among the employed ought to be expected in most European countries. 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 Jung and Kuhn (2014b). 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 such as 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 2, we describe our data and present the empirical results. We describe the labor market search model in Section 3. Section 4 shows the model results and discusses the counterfactual analysis. Before we conclude in Section 5, we discuss alternative explanations for the German labor market miracle in 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 with the task of working out reforms for the German labor market. The chairman was Peter Hartz, at that time director of human resources at Volkswagen. The subsequent reforms are commonly referred to as *Hartz reforms*.<sup>4</sup> 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 I* to *Hartz IV* between 2003 and 2005.<sup>5</sup> They consisted of comprehensive measures to *promote and challenge* the unemployed — ranging from subsidies for self-employment to the restructuring of the unemployment benefit system and a tighter supervision of benefit recipients.<sup>6</sup> We provide further details in Appendix A.

In the next section, we provide empirical evidence that points toward a causal mechanism associated with the fourth step of the reform package (Hartz IV). In that step, the former three-tier system of unemployment benefits, unemployment assistance,

---

<sup>4</sup>The official title of the commission was the *Commission for Modern Labor Market Services*.

<sup>5</sup>The official title of the acts were *First, Second, Third and Fourth Act for Modern Labor Market Services*.

<sup>6</sup>Steffen (2008) provides a detailed chronicle of the German social security system.

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, before the reform, were eligible for long-term, wage-dependent unemployment assistance. In addition to lower subsistence benefits, these benefits, unlike unemployment assistance, were asset-tested and the 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 to 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 explain 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 1975 to 2014.<sup>7</sup> The SIAB is a 2% representative sample of administrative data on all workers who are subject to social security contributions and on all unemployed workers in Germany. It excludes self-employed and civil servants, thus covering approximately 80% of Germany's labor force. Apart from its large size (1.8 million individuals) and its long panel dimension (up to 40 years), one further advantage of the administrative data is that they are virtually free of measurement error for the variables of interest in this paper. The data are taken from social security records and are merged with records on unemployment periods from the federal employment agency. The data contain the exact start and end dates of each employment and unemployment spell. In total, the data comprise almost 60 million individual spells. See Antoni et al. (2016) 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 a few individuals with missing information on employment status or missing geographic information, and all individuals who only receive social assistance benefits while in the sample. We consider the effect of including

---

<sup>7</sup>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 Employment Research (IAB) and via remote data access at the FDZ.

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 Jung and Kuhn (2014b) 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 closely follows labor force surveys such as the Current Population Survey (CPS). We count workers as employed if they are employed full or part time or work as apprentices. For the unemployed, we count workers as unemployed if they are registered as unemployed at the employment agency, which requires that they are not working and are actively looking for a job. 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 onward. 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 backward. This leaves the dynamics of the flow rates unaffected but removes the level differences between the two definitions. We provide further details on the construction of monthly employment states and transition rates in Appendix B. For our empirical analysis, we focus on the decade from 1993 to 2002 to document work flows before the first reform steps were implemented. We report the entire time series of worker flows for the period after the reform but take the time from 2008 to 2014 as the period when the transition period after the reform was completed.

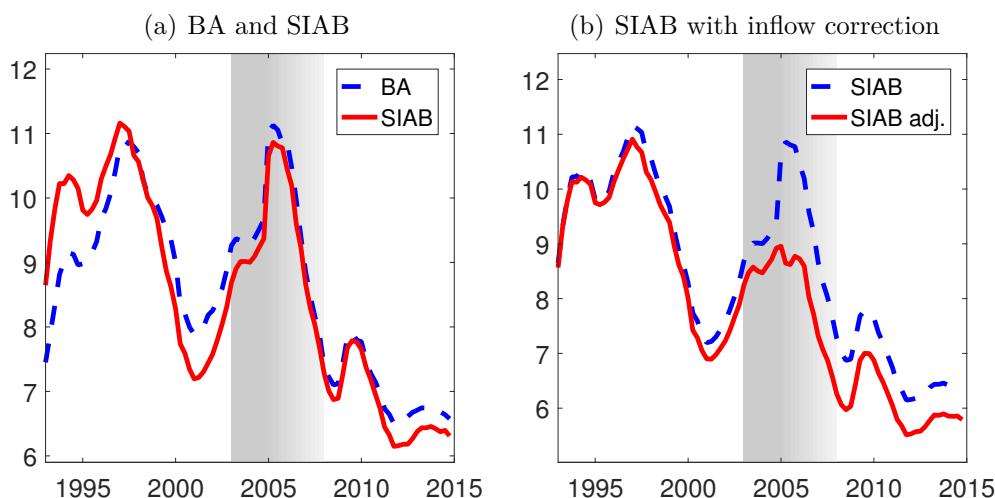
The goal of our empirical analysis is to study the changes in labor market dynamics that determine the evolution of the unemployment rate. In the first step, we demonstrate therefore that the microdata match the reported trends on unemployment rates. The microdata do not include public servants (*Beamte*), and hence, for the microdata to be comparable to the unemployment rates reported in the statistics of the German employment office, public servants have to be included. Figure 2.1(a) shows the unemployment rate for West Germany as reported by the German federal employment agency and the unemployment rate constructed from the SIAB microdata for the period between 1993 and 2014. The data from the German employment office cover dependent employment only and therefore exclude self-employed workers.<sup>8</sup> Both unemployment rates track each other closely in trends and levels. We conclude that the microdata are consistent with developments in the unemployment rates and can hence be used to study the underlying changes in labor market dynamics. In Appendix B, we provide further discussion and demonstrate that the constructed worker flow rates in a stock-flow model account for the dynamics of the unemployment rate over time.

The data show a large spike in unemployment in January 2005. The reason for

---

<sup>8</sup>The German employment office reports two unemployment rates: one including all employees and one for employees in dependent employment, excluding the self-employed. We consider the unemployment rate for dependent employment.

Figure 2.1: German unemployment rates (1993 - 2014)



Notes: Unemployment rate for West Germany 1993 - 2014 in percent. Left panel: Blue dashed line shows reported unemployment rate by employment agency (BA) and red solid line shows the unemployment rate from SIAB microdata including imputed numbers for public servants not covered by the microdata. Right panel: Shows unemployment rate from SIAB microdata as in the left panel (blue dashed line) and the unemployment rate from SIAB microdata after inflow correction (red solid line). See text for details. The grey area marks the period 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.

the spike is regulatory changes as part of the Hartz reforms that became effective in January 2005. These regulatory changes required all nonemployed 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 2.1). 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 directly observe either of the two groups that were forced to register as unemployed to retain their unemployment benefit eligibility. We therefore exclude persons who simultaneously satisfy three conditions: (1) entered unemployment in the first six months<sup>9</sup> of 2005, (2) had a nonemployment spell before registering as unemployed, and (3) did not work for at least one month until the end of 2006. We compare in Table 2.1 the characteristics of new entrants into unemployment from out of the labor force in January 2004 and January 2005.<sup>10</sup> We find large differences across the two years. In January 2004, new entrants are slightly younger, substantially

<sup>9</sup>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.

<sup>10</sup>Out of the labor force is not directly observed in the data and we assign out of the labor force as a residual employment state to nonemployed workers who have intermittent nonemployment spells that are not unemployment spells.



Table 2.1: 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
high school	23.2%	44.2%	32.5%	16.6%	18.8%
vocational training	70.4%	53.0%	62.9%	78.0%	76.0%
college	6.5%	2.9%	4.6%	5.5%	5.2%

Notes: Demographic characteristics of workers who transit to unemployment from out of the labor force (*entrants from N*) or all other states (*other U*) in January 2004 and 2005. The column for the entrants from N labeled *corr.* applies the inflow correction. See text for details. Row *female* shows the share of females in inflows, row *age* shows average age, and the bottom three rows show the shares of workers with at most a high school education, vocational training, and a college education.

more female (61% vs. 43%) and less educated (44% vs. 23% with high school or less). When looking at all other entrants into unemployment (columns *other U*), we find that worker characteristics do not differ notably 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 2.1 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 the inflow-corrected sample. We will use the inflow-corrected sample as our benchmark sample for the rest of the paper.

Figure 2.1(b) 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 completely in the inflow-corrected sample. The persistently lower level of the inflow-corrected sample shows that the inflow of formerly nonemployed persons into the unemployment pool in early 2005 changed the composition toward 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, but this change is small. In 2014, unemployment rates in the inflow-corrected sample are about 0.75 percentage point lower. Looking at relative changes, we find that the inflow correction reduces the decrease in 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 A.

## 2.3 Empirical results

We consider the time period from 2003 to 2005 as the period of the reforms and use the years from 1993 to 2002 to represent the labor market before the reform and use the years from 2008 to 2014 to represent the situation after the reform and an associated transition period. 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 4.2 a decomposition that disentangles structural changes and business cycle effects on worker 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 C.

### Changes in separation and job finding rates

Figure 2.2(a) 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 2.2). Looking at the relative changes, we find a substantial 28% decline in separation rates between the pre-reform average and the separation rate in the post-reform period. When we consider the post-reform average including the Great Recession, the decline is smaller but still at 22%.

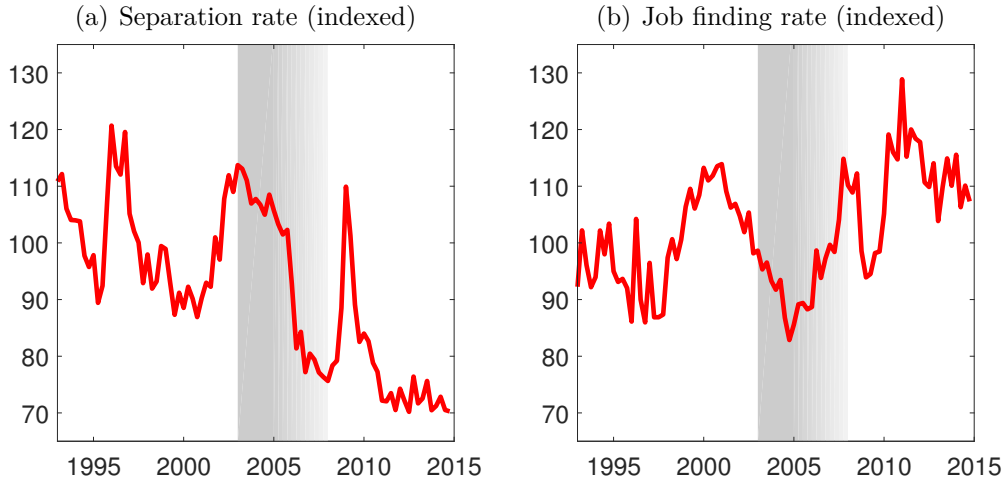
Figure 2.2(b) shows the relative change in the job finding rate over time again indexed to its average pre-reform level. Job finding rates are typically slightly above 5% before the reform period and increase to slightly below 6% after the reform. In relative terms, the increase until 2014 constitutes 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 remain largely unaffected when we include the Great Recession. The decline in separation rates is twice as large as the increase in the job finding rates.

Table 2.2 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.<sup>11</sup> We consider the period from 1993 to 2002 as the pre-reform steady state and the period from 2011 to 2014 as the post-reform steady state to abstract from transition dynamics and the Great Recession as two exceptional periods. The last column of Table 2.2 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

---

<sup>11</sup>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 2.2: Separation and job finding rates (1993 - 2014)



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 nonemployed 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 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.

observed changes demonstrates that the simple two-state stock-flow model captures well the changes in the unemployment rate over time. 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 (see columns labeled 2008-2014).

Table 2.2: Before- and after-reform unemployment rates, transition rates, and steady-state decomposition

	1993-2002	2008-2014	2011-2014	2008-2014		2011-2014	
				$\Delta$	$\frac{\Delta\pi}{\Delta\bar{u}}$	$\Delta$	$\frac{\Delta\pi}{\Delta\bar{u}}$
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  $\Delta$  report the percentage change in rates from before to after the reforms. Columns labeled  $\frac{\Delta\pi}{\Delta\bar{u}}$  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.

Existing studies that explore the effect of UI reforms on the labor market focus on the effects on the job finding rate, either from changes in search effort or changes in contact rates for unemployed workers from more vacancy postings. The large contribution of changes in the separation rate to changes in the unemployment rate over time shows that such explanations fall short of explaining the data.

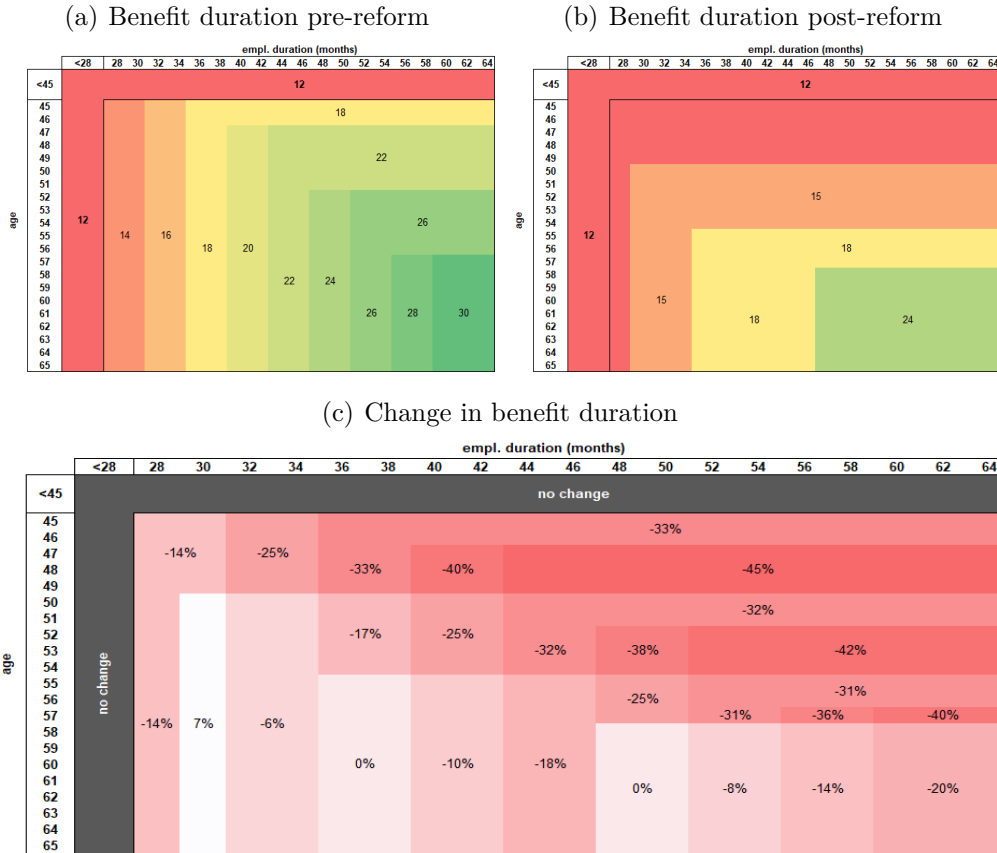
## 2.4 Heterogeneity of changes in separation rates

The last section documented that the decline in separation rates was 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 2.3 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 were 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 2.3(a), we see that for workers younger than 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 to up to 30 months after five years of previous employment. Comparing this pattern to the post-reform regulation in Figure 2.3(b), 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 2.3(c) 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. If the Hartz reforms are causal for the decline in separation rates, we expect this heterogeneity in the changes in the duration of benefit eligibility to be mirrored in the changes in separation rates.

A further dimension where we should see differences in separation rate changes, if the causal mechanism is related to the abolition of the long-term benefits, is wages because unemployment assistance was 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 a subsistence level, independent of the previous wage, once UI benefits have expired.

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.

Figure 2.3: Changes in benefit duration by age and employment 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.

## Employment duration

For the analysis of heterogeneity among workers with different employment duration, we split employed workers into two groups. The first group is short-term employed workers with at most three years of employment duration, and the second group is long-term employed workers with more than three years of employment duration. Table 2.3 shows the corresponding average levels for the pre- and post-reform period. Looking at the levels, we see that short-term employed workers have separation rates that are more than five times higher than those of the long-term employed workers in the period 1993 to 2002 (1.37% vs 0.26%). This difference further increases in the period 2008 to 2014 (1.15% vs 0.18%). After 2008, 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 2008.

The stronger decline can be seen in Figure 2.4, which shows the time series of relative

Table 2.3: Change in separation rates by employment duration and age

	1993 - 2002	2008 - 2014	$\Delta$ %
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  $\Delta$  reports the percentage change in rates from the period before the Hartz reforms to the period after the Hartz reforms.

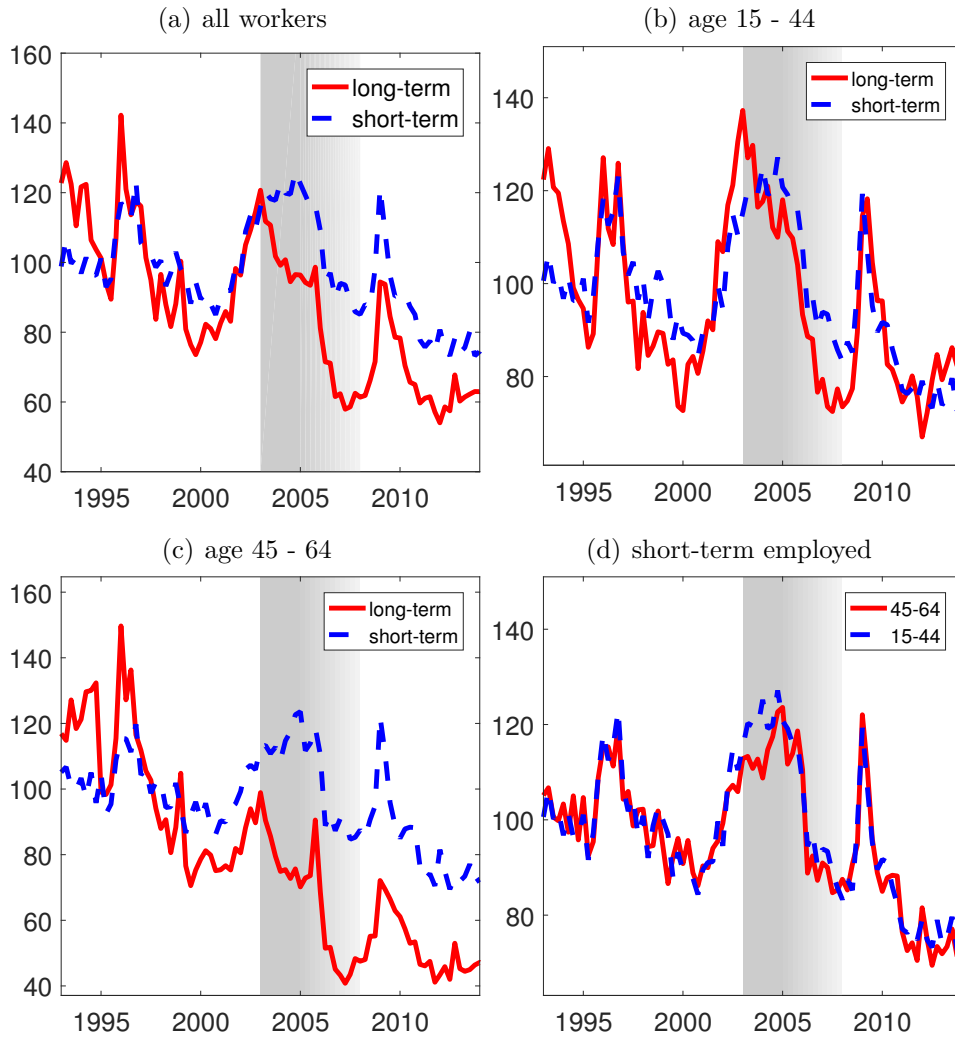
changes in separation rates for different groups of short-term and long-term employed workers. Looking at Figure 2.4(a), we find a strong divergence in the time series of separation rates between short-term and long-term employed workers after the Hartz reforms. The strong divergence persists so that, after the reform, separation rates of long-term employed workers have declined twice as much as those for short-term employed workers.

### Age

In addition to employment duration, age determines the duration of benefit eligibility in the UI system (Figure 2.3). We therefore dissect the data in Figures 2.4(b) and 2.4(c) further by looking at young and old workers by employment duration. Looking at younger workers in Figures 2.4(b), 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 workers show a reduction that is only half as large (Figure 2.4(c)). Looking at short-term employed workers across age groups provides a further sanity check for heterogeneous changes in separation rates because there have been 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 2.4(d). 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 benefit eligibility from the Hartz reforms. Therefore, this additional heterogeneity in changes in separation rates provides further support for a causal link from the UI reform to the observed changes in labor market dynamics.

In Appendix C, 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 decline in separation rates follows a longer-run trend

Figure 2.4: Separation rates by age and employment duration (1993 - 2014)



Notes: Separation rates by employment duration and age for West Germany 1993 - 2014, indexed to their pre-reform level (1993-2002). The red solid lines in panels (a)-(c) mark the separation rate for long-term employed workers who were continuously employed for three years or more. The blue dashed lines in panels (a)-(c) mark 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 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.

that accelerated during the 2000s so that, over time, unemployment rates for older workers decreased more than those 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.<sup>12</sup>

<sup>12</sup>Jäger et al. (2018) provide a detailed investigation of this topic. They study changes in separation rates of male workers towards the end of working life (50 years and older) in Austria after changes in UI benefit durations. They exploit staggered changes in UI eligibility similar to those shown in

In our theoretical analysis, we will abstract from the additional age heterogeneity to keep the model parsimonious and because most of the heterogeneity in the changes in separation rates is captured by differences in employment duration.

## Wages

Figure 2.5 shows the relative changes in separation rates from before to after the UI reform along the wage distribution. In a first step, we consider two groups of workers: low-wage workers in the bottom three deciles of the wage distribution and high-wage workers in the fourth to seventh deciles. In a second step, we provide more granular changes showing that the differences further up in the wage distribution are, if anything, larger. Figure 2.5(a) compares changes in separation rates for low-wage workers and high-wage workers over time. Separation rates before 2005 comove closely and start to diverge thereafter. By 2014, high-wage workers saw their separation rates decline by almost twice as much as those for low-wage workers. Figure 2.5(b) dissects the wage distribution finer. It quantifies for each wage decile by how much the average separation rate decreased from the decade before the reform (1993-2002) to the post-reform period (2008-2014). Evidently, the higher wage deciles experienced the largest declines in separation rates. Separation rates hardly change at the bottom of the wage distribution, decline by between 20% to 30% in the middle, and plummet by almost 50% at the top. The stronger decline in 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 2.3). 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 this section.

### 2.5 Sensitivity and comparison to other data sources

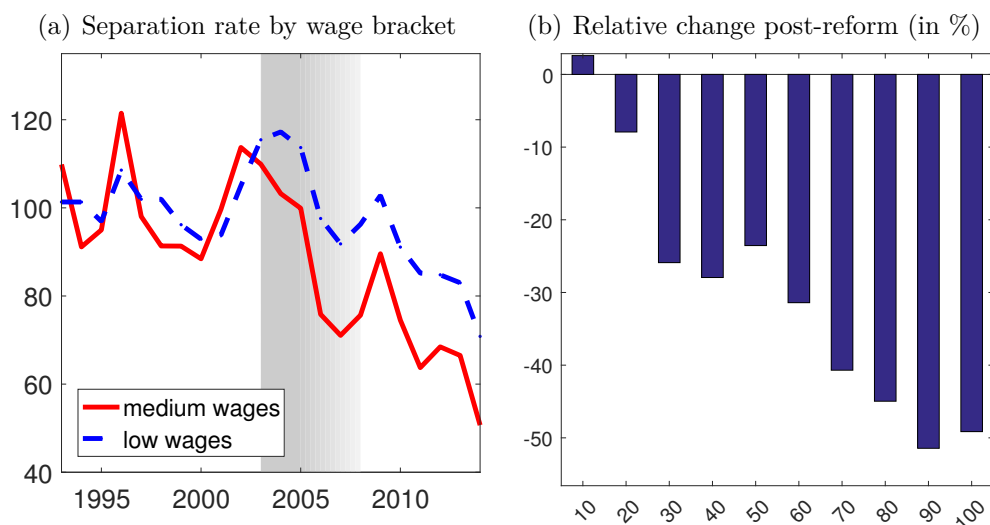
In the first step, we discuss evidence from other independent data sources to further support our empirical evidence on the dominant role of falling separation rates in explaining the decline in German unemployment rates after 2005. The first additional data source is the reports of the employment agency on monthly unemployment benefit claims. In a previous study (Hartung et al. (2016)), we construct a historical series on worker flows for the period 1967 to 2014 based on these data and demonstrate that, during the period of overlap, it closely matches worker flows from the SIAB microdata.

---

Figure 2.3 in combination with regional variation. Jäger et al. rely on a microeconomic analysis to characterize marginal jobs separating after changes in workers' outside options. In line with our empirical results, they document large changes in separation rates after changes in potential benefit duration.



Figure 2.5: Changes in separation rates by wages



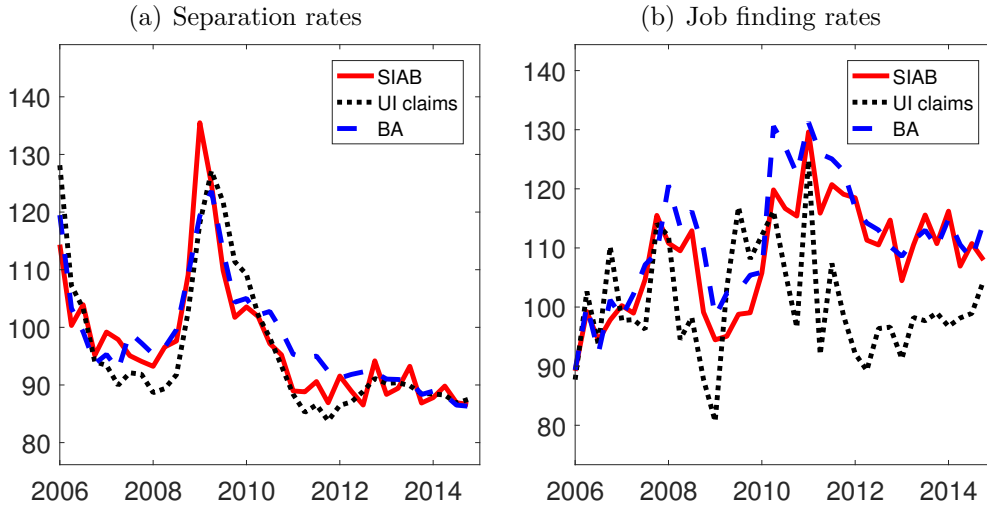
Notes: Left panel shows changes in separation rates for high and low wage groups of workers in West Germany 1993-2014. The red solid line (left axis) shows workers with wages between 40% and 70% of the wage distribution. The blue dashed line (right axis) shows workers with wages up to 30% of the wage distribution. The grey area marks the period 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 wage distribution are shown on the horizontal axis.

We explain in Hartung et al. (2016) how this data series can be constructed in real time from publicly available data sources. The second data source is flow rates in and out of unemployment that have been 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 Shimer (2012).

Figure 2.6 shows three alternative measures for the separation rate and the job finding rate. The first one is our benchmark measure constructed from the SIAB microdata (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*); and the third one is the measure constructed from UI benefit claims in Hartung et al. (2016) (black dotted line). We find that the two additional measures strongly support our finding of decreasing separation rates as the macroeconomic driver of falling unemployment.

Next, we also summarize the findings from our sensitivity analysis. We relegate details to Appendix C. 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

Figure 2.6: Alternative measures for transition rates



Notes: The figures show separation and job finding rates for the benchmark sample from the SIAB microdata (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 Hartung et al. (2016) 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.

due to the larger unemployment pool (see A). 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 in 2000, we find that compositional changes alone are negligible for explaining changes in separation rates over time (see B). In a third step, we provide results for East Germany (see D), counting marginally employed workers who are registered as unemployed as employed (see E), and counting workers in active labor market programs among the employed (see F).<sup>13</sup> 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  $\omega$  and the product of the time discount factor and the probability of remaining 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

<sup>13</sup>After the reform, workers who participate in active labor market programs were no longer counted as unemployed.

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 skill and workers with skill level  $x_2$  as high skill. Workers who enter the labor force start as low skill. While working, workers accumulate skills by learning-by-doing. An employed low-skill worker stochastically gains skills at rate  $\alpha$ . The accumulated skills are lost upon separation. Employed workers become eligible for unemployment benefits with employment duration. Since the accumulation of skills 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-skill workers are eligible for unemployment benefits.<sup>14,15</sup> Low-skill workers are eligible for social assistance benefits if 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 employed workers in state  $x_2$  by  $e_2$ . Denoting the current period's state by  $x$  and the next period's state by  $x'$ , the law of motion for  $x$  conditional on staying employed is

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

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

$$x' = \begin{cases} x_2 & \text{with probability } \alpha \\ x_1 & \text{with probability } 1 - \alpha \end{cases} \quad (2.1)$$

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-skill workers are eligible for unemployment benefits  $b_3$ . When entering unemployment, low-skill workers enter in state  $b_3$  with probability  $\gamma$ , and with probability  $1 - \gamma$ , they enter unemployment in state  $b_1$ . Stochastic eligibility for low-skill workers captures in a parsimonious way the more complex eligibility rules in the actual system.<sup>16</sup> During 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  $\delta_3$ . Workers who are in state  $b_2$  transit to state  $b_1$ , receiving social assistance, with probability  $\delta_2$ . We denote the mass of workers in each state by

---

<sup>14</sup>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. Krause and Uhlig (2012) follow the same modelling approach.

<sup>15</sup>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 (Dustmann and Meghir (2005)). 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.

<sup>16</sup>There are two main reasons for the misalignment of employment duration and eligibility: First, employees with more than one year of employment duration are already eligible for UI benefits for 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 that varied between 2 and 7 years.

$u_j$  for  $j = 1, 2, 3$ . Denoting the current period's state by  $b$  and the next period's state by  $b'$ , the law of motion for  $b$  conditional on staying unemployed is

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

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

$$b' = \begin{cases} b_j & \text{with probability } 1 - \delta_j \\ b_{j-1} & \text{with probability } \delta_j \end{cases} \quad (2.2)$$

When unemployed workers re-enter 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, the law of motion is

$$b' = b_3 \quad \text{if } x = x_2 \quad (2.3)$$

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

$$b' = \begin{cases} b_3 & \text{with probability } \gamma \\ b_1 & \text{with probability } 1 - \gamma. \end{cases} \quad (2.4)$$

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 the search or production stage depending on whether the unemployed or the employed are considered. We abstract from on-the-job search. Labor market exit happens with probability  $\omega$  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  $\rho$  and variance  $\sigma_a^2$ .

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  $\varepsilon$  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  $\varepsilon$  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  $\varepsilon$  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  $\pi_{eu}(x, s) = \text{Prob}(\varepsilon \geq \varepsilon^u(x, s))$ . 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.<sup>17</sup>

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

$$J(x, s) = \int_{-\infty}^{\varepsilon^u(x, s)} \left( \exp(a + x) - \varepsilon - w(x, s) + \beta \mathbb{E}[J(x', s') | x, s] dF(\varepsilon) \right) \quad (2.5)$$

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  $\varepsilon$  that we denote by  $\Psi_\varepsilon(\pi_{eu})$

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

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

$$J(x, s) = (1 - \pi_{eu}(x, s)) \left( \exp(a + x) - w(x, s) + \beta \mathbb{E}[J(x', s') | x, s] \right) + \Psi_\varepsilon(\pi_{eu}(x, s)) \quad (2.6)$$

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  $\nu$  capturing the personal valuation of workers for jobs. This stochastic non-pecuniary job component comprises, among other things, commuting time, workplace atmosphere, and working schedules of the offered job. It captures in a parsimonious way endogenous search behavior of the unemployed. Unemployed workers optimally follow a reservation utility rule and accept all job offers with  $\nu$  larger than a state-dependent threshold  $\nu^u(b, s)$ . We assume  $\nu$  is independently and identically distributed and is drawn from a logistic distribution  $G$  with state-specific mean  $\bar{\nu}(b)$  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

---

<sup>17</sup>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.

recursive formulation of the value of an unemployed worker in state  $(b, s)$  is

$$\begin{aligned}
V_u(b, s) &= b + h + \beta \left( \lambda(s) \int_{\nu^u(b, s)}^{\infty} \left( \mathbb{E}[V_e(x', s')|b, s] - \nu \right) dG(\nu) \right. \\
&\quad \left. + \lambda(s) \int_{-\infty}^{\nu^u(b, s)} \mathbb{E}[V_u(b', s')|b, s] dG(\nu) + (1 - \lambda(s)) \mathbb{E}[V_u(b', s')|b, s] \right) \\
&= b + h + \beta \left( \pi_{ue}(b, s) \mathbb{E}[V_e(x', s')|b, s] + (1 - \pi_{ue}(b, s)) \mathbb{E}[V_u(b', s')|b, s] \right. \\
&\quad \left. + \lambda(s) \Psi_\nu(q(b, s)) \right) \tag{2.7}
\end{aligned}$$

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  $\Psi_\nu(q) = -q\bar{\nu}(b) - \psi_\nu((1 - q) \log(1 - q) + q \log(q))$ . The state-specific means  $\bar{\nu}(b)$  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

$$V_e(x, s) = (1 - \pi_{eu}(x, s)) \left( w(x, s) + \beta \mathbb{E}[V_e(x', s')|x, s] \right) + \pi_{eu}(x, s) \mathbb{E}[V_u(b', s)|x]. \tag{2.8}$$

Note that in the case of separation, expectations are only over the idiosyncratic benefit state  $b$ , and although the worker becomes unemployed in 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. (2.3) and (2.4).

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 rate 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

$$\kappa = \lambda_v(s) \beta \sum_{j=1}^3 q(b_j, s) \frac{u_j}{u} \mathbb{E}[J(x', s')|b_j, s] \tag{2.9}$$

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

Wages and threshold values for separation decisions  $\varepsilon^u(x, s)$ , equivalently separation probabilities  $\pi_{eu}(x, s)$ , are determined by a state-contingent Nash bargaining be-

tween 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 Pissarides (2000, Ch. 2)). We denote the bargaining power of the worker by  $\mu$ . 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

$$\mu J(x, s) = (1 - \mu) \Delta(x, s). \quad (2.10)$$

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

$$\pi_{eu}(x, s) = \left( 1 + \exp \left( \psi_\varepsilon^{-1} \left( \exp(a + x) - \bar{\varepsilon} + \tilde{S}(x, s) \right) \right) \right)^{-1} \quad (2.11)$$

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. (2.8)). 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 2.4. 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  $\tilde{\beta} = 0.996$ , and the parameter  $\varrho$  of the matching function and the bargaining power of the worker  $\mu$  are set to  $\varrho = \mu = 0.5$ .

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 only driven by 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 Jung and Kuhn (2014b)).<sup>18</sup> This approach builds on ideas from Murin and Robin (2016). 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.

Each match produces output with labor and a stochastic cost component, which we interpret as payments to capital. We therefore target the mean of the cost shock  $\bar{\varepsilon}$  to a capital share of 40%. Vacancy posting costs  $\kappa$  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

---

<sup>18</sup>We use GDP per capita for Germany as data on West German GDP are not available at a quarterly frequency.

Table 2.4: Calibrated parameters

	Parameter	Value	Description
search and matching	$\varrho$	0.5	elasticity of the matching function
	$\varkappa$	0.163	efficiency of the matching function
	$\kappa$	0.657	vacancy posting costs
	$\mu$	0.5	worker's bargaining power
	$\gamma$	0.4	eligibility rate of low-skill workers
	$\omega$	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	
	$\psi_\nu$	0.075	dispersion of non-pecuniary shocks
skills and costs	$\bar{\varepsilon}$	0.400	mean of cost shocks
	$\psi_\varepsilon$	0.700	dispersion of cost shocks
	$\alpha$	0.028	probability of skill accumulation
	$\Delta x$	0.029	skill level difference $x_2 - x_1$



separately identify matching efficiency  $\varkappa$  from vacancy posting costs  $\kappa$ , we use data on the average duration to fill a vacancy from the firm’s perspective. In the IAB vacancy survey, the average time to fill a vacancy is 2.2 months. For the UI eligibility parameter  $\gamma$ , we target a share of 58% UI benefit recipients among all inflows to unemployment. The flow utility parameter of leisure  $h$  determines the worker surplus from employment  $\Delta$ , and as part of the total match surplus  $S$ , it determines the average probability of separating into unemployment (see eq. (2.11)). 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 (Shimer (2005b), Hagedorn and Manovskii (2008)). The variation in acceptance rates  $q(b, s)$  of workers over the business cycle provides additional amplification to job creation decisions (see eq. (2.9)). To impose 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 (Schmieder and Von Wachter (2016) 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 Schmieder and Von Wachter (2016).<sup>19</sup> For a given dispersion of non-pecuniary shocks, this elasticity pins down one of the means of the non-pecuniary shocks. We use it to pin down  $\bar{\nu}(b_3)$ . We impose the condition that recipients of unemployment assistance benefits  $b_2$  and benefits at a 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 the 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 rates between 6 and 12 months of 25%.<sup>20</sup> Very related is the identification of the parameter  $\psi_\nu$  determining the dispersion of the non-pecuniary shock distribution. While we use the cross-sectional variation in job finding rates to determine means of the non-pecuniary shock distribution, we leverage the time series variation in job finding rates to identify  $\psi_\nu$ . 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  $\psi_\varepsilon$ . 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 (Jung and Kuhn (2014b), Elsby et al. (2013)).

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 in productivity works similar to a 1% 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 (Costain and Reiter (2008)).

---

<sup>19</sup>This elasticity of search  $\frac{\partial q}{\partial b} \frac{b}{q}$  in the model is 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.

<sup>20</sup>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  $\alpha$ . Similarly, we use the one-to-one relation between the share of long-term employed workers and the probability of labor market exit  $\omega$ . 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 difference between short-term employed workers' separation rate of 0.014 and long-term employed workers' separation rate of 0.003 from Table 2.3 to determine the skill difference  $\Delta x$ .

Table 2.5: Parameters of the unemployment insurance system

pre-reform		post-reform	
$b_1$	0.245	$b_1$	0.245
$b_2$	0.330	$b_2$	<b>0.245</b>
$b_3$	0.366	$b_3$	0.366
$\delta_2$	0.021	$\delta_2$	0.021
$\delta_3$	0.083	$\delta_3$	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 2.5. According to the OECD, a single worker with the average wage before 2004 received unemployment insurance benefits corresponding to 60% of the previous wage during the first year of unemployment and 53% of the previous wage for the following four years. We use these replacement rates to pin down  $b_3$  and  $b_2$ . Consistently, we set  $\delta_3$  to match an average duration of one year and  $\delta_2$  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 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). As in Krause and Uhlig (2012), 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  $\delta_2$  becomes irrelevant because transitions happen between states with the same benefit levels and mean utility shocks  $\bar{v}(b_1)$  and  $\bar{v}(b_2)$  are set identical across the two states in the calibration.

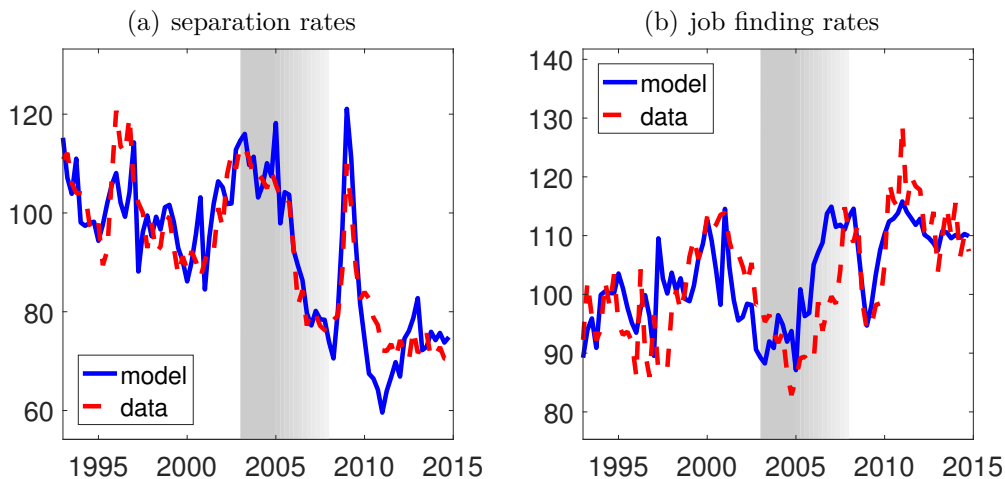
In the model, this change becomes effective in January 2006. As described above, the law became effective in January 2005, but the law scheduled the new benefit rules to affect workers only if they became unemployed after February 2006. In addition, a wide

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.<sup>21</sup> 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 reforms constitute a parsimonious change in the parameters of the unemployment insurance system. Figure 2.7 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 2.7: Fit for average labor market mobility (1993 - 2014)



Notes: Model fit 1993 - 2014. The blue solid lines mark the model prediction and the red dashed lines mark the respective flow rate in the SIAB microdata. The grey area marks the period 2003 to 2005 when the Hartz reforms were enacted. The fading out indicates the first transition years 2006 to 2008 after the reforms.

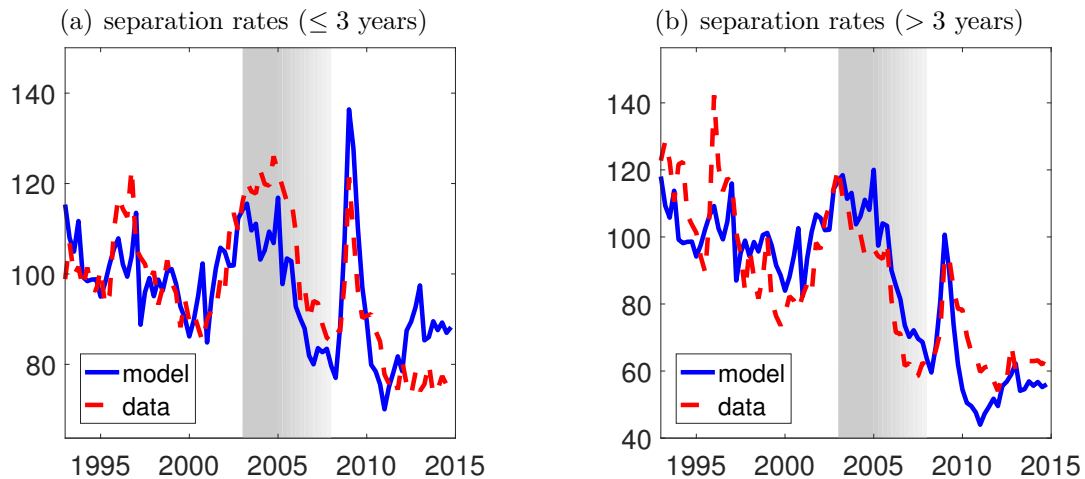
Figure 2.7(a) shows how closely the model fits the separation rate from the data.

<sup>21</sup>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.

The empirical and simulated time series largely lie on top of each other. This is true both before the reform and after the reform. Except for a short period around 2010, the model matches the decrease in 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 2.7(b) 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 when our implementation of grandfathering rules and hardship cases is very rudimentary. However, what is important for our analysis below is that the changes in average rates between the pre-reform period and the post-reform period are matched almost exactly by the model.

Our empirical analysis uncovers large heterogeneity in changes in separation rates after the reform. Figure 2.8 demonstrates the model's ability to match such heterogeneity in changes in 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 check to the hypothesis of a causal relationship of the reform to the observed changes in separation rates. Results in Figure 2.8 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 the model and the data.

Figure 2.8: Fit for heterogeneity in labor market mobility (1993 - 2014)



Notes: Model fit of separation rates with low ( $\leq 3$  years, left panel) and high ( $> 3$  years, right panel) employment duration from 1993 to 2014. The blue solid lines mark the model prediction and the red solid lines mark the respective flow rate in the SIAB microdata. The grey area marks the period 2003 to 2005 when the Hartz reforms were enacted. The fading out indicates the first transition years 2006 to 2008 after the reforms.

Figure 2.8(a) 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 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, like the data the model shows a substantially smaller decline in separation rates for short-term employed workers relative to the average in Figure 2.7(a).

Figure 2.8(b) compares the separation rates of long-term employed workers between the model and the 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 in separation rates. Again, and importantly, we find that, in line with the argument that the reduction in long-term benefits was the causal mechanism behind the labor market miracle, 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 in 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, such as 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 be even larger due to the longer duration of benefit eligibility in these programs. Our results suggest that the elasticities of the decision to separate 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.

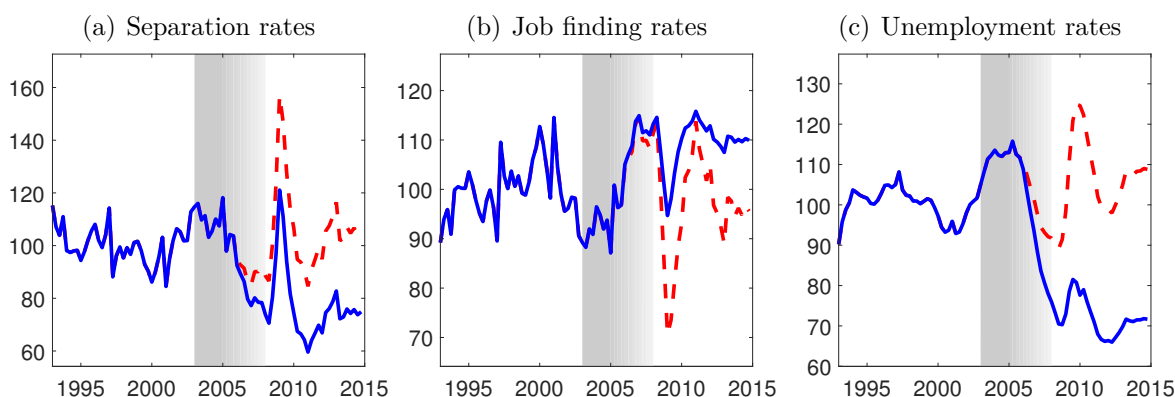
#### 4.1 Counterfactual simulations

This section further builds on our approach to establish a causal link from the unemployment insurance system to the German labor market miracle relying on economic theory. 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 closely matches labor market dynamics in Germany for the two decades from 1994 to 2014 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 determine

the contributions of structural changes and business-cycle fluctuations to changes in labor market dynamics.

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 2.9 shows the counterfactual simulation results for the time period from 1993 to 2014.

Figure 2.9: Counterfactual model simulation absent Hartz reforms (1993 - 2014)



Notes: Model simulations with and without the Hartz reforms for the period 1993 to 2014. The blue solid lines show the model with the benefit cuts from 2006 onward and the red dashed lines show the counterfactual rate without policy change. The grey area marks the period 2003 to 2005 when the Hartz reforms were enacted. The fading out indicates the first transition years 2006 to 2008 after the reforms.

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 also rule out any anticipation effects.<sup>22</sup> 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 by the red dashed line in Figure 2.9(a). Separation rates of the counterfactual simulation strongly spike during the financial crisis of 2008, to almost 160% of their steady-state level. In the 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 2.9(b) again evolve identically 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 permanently 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

<sup>22</sup>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.

finding rate still decreases but only to a level slightly below its old steady-state level. The divergence of the separation and job finding rates manifests itself in very different dynamics of the unemployment rate. While unemployment in the baseline simulation with the Hartz reforms declines by 30% relative to the pre-reform steady state, the unemployment rate, by construction, stays 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 in the unemployment rate of almost 30% over its long-run average, reminiscent of the typical European country and the United States during these years, which saw sharply and strongly rising unemployment rates. In the case of the implementation of the Hartz reforms, the rise in unemployment rates is substantially smaller compared to what most other countries experienced as the largest labor market crisis in decades. Unemployment rates increased about 10% over their new steady-state level that itself is 30% below the pre-reform level. The reason for the modest increase in unemployment after the reform is that while separation rates spike in both simulations, the relative decline in the job finding rate is much smaller in the case of the Hartz reforms. These strikingly different dynamics based on our theoretical labor market model provide a further argument for a causal relationship between the reduction in long-term unemployment benefits of the Hartz reforms and 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 2.9 shows that in 2004 all data series are away from their respective steady states. Our motivating evidence in Figure 2.1, like most of the public debate, focuses, however, on 2004 as a year of reference to assess the effect of the Hartz reforms on the labor market. Taking 2004 as reference, the decline in 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 2.6 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 percentage change in the respective rates between 2004 and 2014. The change in the baseline case with the Hartz reforms compounds the business cycle effects with the effects from the structural reform, whereas the change in the case when the reform is not implemented results only from business cycle variation. We report the derived contribution of the business cycle in the last column of Table 2.6.

Let's look first at columns of the baseline case with the implementation of the reform. The key driver of the lower unemployment rates is the decline in 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

Table 2.6: Business cycle contribution

	with reform			absent reform			Business cycle contribution
	2004	2014	change	2004	2014	change	
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, and 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.

cycle contributions to changes in the unemployment, separation, and job finding rates and we find that they never exceed 10%. We conclude that business cycle effects are small and of minor importance for the German labor market miracle.

### 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 whether the quantitative size of the effects is realistic, i.e., whether 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 microeconomic literature. We use one of Germany's close neighbors, Austria, as a control group that was treated by the Hartz reforms and compare the unemployment rates of Austria and Germany over time. This should be seen as being inspired by the idea of the control-treatment approach rather than a formal implementation.

Austria traditionally has business cycle dynamics that resemble those of Germany (see Figure 2.19 in the appendix). Although the business cycle dynamics for Germany



and Austria track each other closely, the level of the Austrian unemployment rate was on average 52% lower than the German unemployment rate in 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.<sup>23</sup> For our comparison, we are interested in the relative changes in the unemployment rate over time that remain unaffected by this level adjustment. Figure 2.10 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 2.10(a), 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 2.10(b) 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 the counterfactual German unemployment rate revert only slowly back to pre-recession levels. Three years after the onset of the recession, they reach levels close to pre-recession times. As for the rise in 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 between 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 2.6). 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.

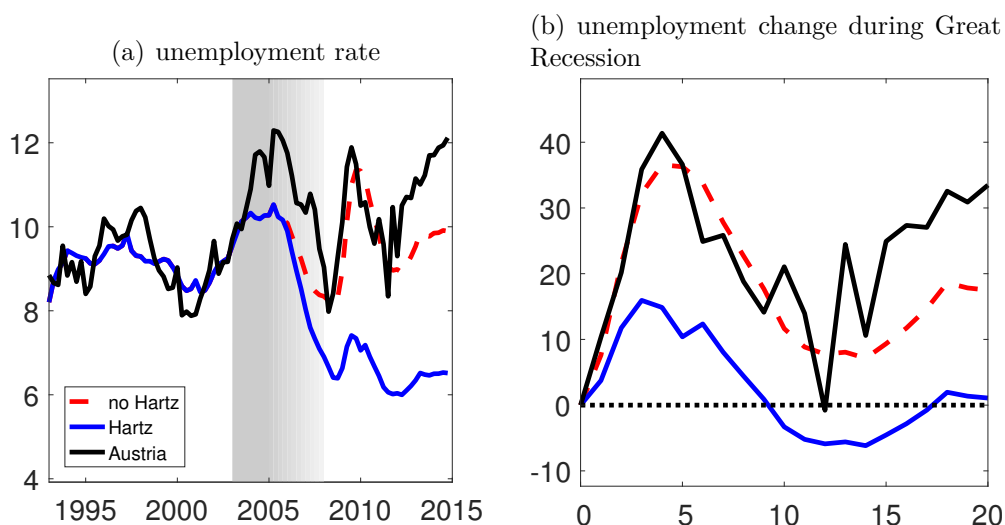
#### 4.4 Reform's effects on wages

Changes in workers' outside option affect the surplus split in the bargaining between workers and firms so that wages decline if unemployment benefits are cut. This mechanism plays the key role in Hagedorn et al. (2016), who quantify the effect of changes in unemployment benefits on the U.S. labor market during the Great Recession. This mechanism is also 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 in our model leads 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

---

<sup>23</sup>Data on the Austrian unemployment rate are taken from Eurostat. For 1993, we use OECD data to extend the Eurostat data series as the Eurostat data are only available from 1994 onward.

Figure 2.10: Austrian unemployment rates and model simulations for Germany



Notes: Austrian unemployment rates in comparison to model simulations for Germany. The left panel shows unemployment rates in percent for Austria (level adjusted) and model simulations for Germany for the period 1993 to 2014. Black solid lines show Austrian unemployment rate, red dashed lines show counterfactual German unemployment rate from model simulation absent the Hartz reforms, and blue solid lines show simulation for Germany for the baseline model. The grey area marks the period 2003 to 2005 when the Hartz reforms were enacted. The fading out indicates the first transition years 2006 to 2008 after the reforms. The right panel shows the percentage increase in the unemployment rate for Austria and model simulations for Germany during the 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.

mechanism for the German labor market miracle by documenting only small changes in job finding rates.<sup>24</sup> 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 (Jung and Kuhn (2014b)); as a consequence, changes in unemployment benefits will affect job finding rates less (Costain and Reiter (2008)). Indeed, the relative contribution of job finding rates to unemployment volatility, which governs the importance of this mechanism for vacancy creation, is rather small in most OECD countries when compared to the United States (see Elsbey et al. (2013)). This observation 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 and need not be a good description of the adjustment processes in other OECD countries. We provide the evidence for the German case.

While the reform's effect on wages is of minor importance for the vacancy creation

<sup>24</sup>In their empirical analysis, Hagedorn et al. (2016) exploit 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.

mechanism, our theory has additional implications for the interaction of wage changes and separation rate changes brought about by the reform that this section explores. In our model, separation decisions are part of the bargaining between the worker and the firm. When benefits decline, workers want to trade off job stability in the form of lower separation rates against wages (Jung and Kuhn (2018)). Workers and firms will agree in the bargaining to stay together even after larger cost shocks, so that wages will decline (see eq. (2.5)). 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 are willing to accept lower wages in order to reduce their separation rate. 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 Jung and Kuhn (2018) based on residual wage differences and regress the probability of separating into unemployment for individual  $i$  over the next six months  $\pi_{eu,i}^6$  on the contemporaneous (log-)wage  $\log(w_{i,0})$  controlling for worker observables  $X_i$

$$\pi_{eu,i}^6 = \alpha + \beta \log(w_{i,0}) + \gamma X_i. \quad (2.12)$$

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, and time and industry dummies;  $\log(w_{i,t})$  refers to average daily earnings.<sup>25</sup> The dependent variable  $\pi_{eu,i}^6$  is a binary variable that is equal to one if the worker separates into unemployment at least once over the next six months. The coefficient of interest  $\beta$  corresponds to the elasticity of separation rates with respect to wages after dividing by the average separation rate  $\bar{\pi}_{eu}^6$ . The approach estimates the effect of residual wage differences as resulting from productivity differences and their effect on separation rates.

Table 2.7: Wages and separation rates

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

Notes: Regression results for the relationship between wages and separation rates before and after the Hartz reforms. The column labeled  $\bar{\pi}_{eu}^6$  shows the average 6-month separation rate. The column labeled  $\beta$  shows the regression coefficient from equation (2.12). The last column reports the implied elasticity of separation rates on wages. See text for further details.

<sup>25</sup>We focus only on full-time workers for this regression.

Table 2.7 reports the key regression coefficient  $\beta$  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.<sup>26</sup>

#### 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 of these changes for the different groups of workers. We derive welfare consequences as the 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.<sup>27</sup> Note that this equivalent variation is uncompensated in the sense that due to lower unemployment after the reform, the government could redistribute 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 2.8: 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.

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

<sup>27</sup>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  $\Delta = \frac{V_0 - V_1}{V_1}$ .

Table 2.8 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 has 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 the case of re-employment. 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 2.3) experiences a welfare loss corresponding to a consumption equivalent variation of 0.6%. This group corresponds to more than 60% of all employed workers in the German labor market and has very low separation rates. 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 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 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 secure 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 Burda and Seele (2016)) has been widely studied, and various narratives have been proposed in addition to the ones that highlight changes in job finding rates as a key driver. We provide a short summary of our investigation regarding such alternative explanations and relegate details to Appendix D. Maybe the most prominent narrative comes from Dustmann et al. (2014), who argue that Germany's unit labor costs and wages were declining relative to other European countries even before the Hartz reforms. They point to declining union power as a possible source for the decline. From the viewpoint of economic theory, wage trends alone are hard to interpret and need to be discussed relative to productivity trends and trends in the outside option. We show in section A of Appendix D that the declining trend in unit labor costs in Germany is hard to reconcile with the relative evolution of the unemployment rate

in Germany relative to other European countries. In particular, this explanation struggles to account for the increase in unemployment rates in Germany during the 1990s and the sudden reversal after 2005. Another related narrative focuses on globalization and an export-demand-driven boom in Germany (see Dauth et al. (2016) for some evidence on globalization effects in export- and import-exposed industries). Looking at industries by export exposure following the industry classification used by Dauth et al. (2016), we show in Appendix B that separation rate changes in industries classified as export-exposed behave similarly to the ones classified as non-exposed, suggesting that export exposure is likely not the main driver of the decline in separation rates. Generally, explanations that, through different channels, affect aggregate GDP growth will be already captured by our analysis as we include aggregate GDP changes in our analysis. Section 4.2 provides an upper bound of the contribution of these effects. Finally, we study whether the Hartz reforms have affected in particular long-term unemployed workers (see Klinger and Rothe (2012) for a more extensive empirical analysis). Reducing long-term unemployment was one of the explicit goals of the reform. We show in Appendix C that the share of long-term unemployed remained largely constant between the pre- and post-reform period. Together with the evidence on the job finding rates, this suggests that the effects via a reduction in long-term 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 the unemployment benefit reform 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 76% of declining unemployment. Existing studies on the German labor market miracle leave this empirical fact unexplained by focusing on changes in job finding rates. The reduction in separation rates is heterogeneous, with long-term employed, high-wage workers being most affected. We use economic theory to causally link our empirical findings to the abolition of long-term, wage-dependent unemployment benefits that was implemented by the Hartz reforms. 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. The 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, their welfare losses 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 is related to future labor market reforms in other European countries as they have been widely discussed after observing Germany's labor market miracle. For these reforms to be politically feasible, the welfare effects must be a key part of the consideration, and compensation schemes must be designed 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 for other labor market reforms such as early retirement programs or disability insurance programs.

## Appendices

### A. The Hartz reforms

The *Hartz reforms* in Germany consisted of four legislative packages (*Hartz I - Hartz IV*) that became effective between 2003 and 2005. The first two parts of the reform were enacted in 2003 and contained several steps: *Hartz I* changed the legal framework for temporary work, making it more attractive for firms to hire temporary workers by lifting restrictions. *Hartz II* changed the regulations for marginal employment and introduced an additional form of social security tax-favored employment (*midi-jobs*) and subsidies for unemployed workers starting their own business.

*Hartz III* was enacted in 2004 and restructured the federal employment agency. In particular, placement agencies (*Arbeitsämter*) and social security offices (*Sozialämter*) were combined into single institutions (*Arbeitsagenturen*). Newly created *job centers* were set up and case managers supported the job search of unemployed workers.

*Hartz IV* was enacted in 2005. This part of the reform constituted the large overhaul of the German UI system that is the focus of our investigation. It is also the publicly most debated and controversial part of the reforms because it substantially reduced unemployment benefits for several groups of workers by abolishing the system of unemployment assistance benefits (*Arbeitslosenhilfe*). Before the reform, unemployment assistance could be received for several years after unemployment benefits expired, depending only on some weak eligibility criteria. Net replacement rates were at 57% with dependent children and 53% without. Workers who were not eligible for unemployment assistance received a minimum subsistence level (*Sozialhilfe*) that included rent payments but was not linked to previous wages. *Hartz IV* abolished the wage-dependent benefits for the long-term unemployed so that after the reform they would receive the minimum subsistence level (*Arbeitslosengeld II*). Unemployment benefits (*Arbeitslosengeld I*) remained largely unchanged at a net replacement rate of 67% with dependent children and 60% without.

The duration of eligibility for unemployment benefits depends on past employment under social security legislation and changed simultaneously with the Hartz reforms. The changes became effective in February 2006. Before the change, workers were eligible for age-specific maximum benefit durations ranging from a maximum of 12 months for workers younger than 45 years up to 32 months for workers 57 years and older (see Figure 2.3). The general rule was that two months of employment resulted in one month of benefit eligibility up to the maximum eligibility threshold. Hence, for most workers two years of employment guaranteed maximum eligibility. After the reform, the maximum benefit duration was set at one year, and three months of employment were necessary for one additional month of eligibility. For workers 55 and older, the maximum duration was cut to 18 months.<sup>28</sup> We exploit this variation in our empirical analysis. The fact that this change only became effective in 2006 and the fact that additional grandfathering and hardship regulations were introduced motivate our reasons for introducing the reform with a transition phase in our quantitative model.

---

<sup>28</sup>In 2009 this change was partly reversed again. Workers of age 50, 55 and 58 could then receive benefits for up to 15, 18, and 24 months again.



To summarize, the Hartz IV reform transformed the former three-tier system of unemployment benefits, unemployment assistance, and subsistence benefits into a two-tier system of unemployment benefits and subsistence benefits.

## B. Data details

### A Sample selection

In our baseline analysis, we focus on the West German labor market from 1993 to 2014 in order to reduce the impact of the German reunification on unemployment and transition rates. We restrict our sample to persons who had employment or unemployment spells only in West Germany. We also drop persons for whom the SIAB does not contain any information on their geographic location or employment status. We provide results for East Germany as part of our sensitivity analysis in Section D of this appendix.

### B Definition of labor market states

We define a worker as employed if the worker is full- or part-time employed or employed as an apprentice. We require current wages to be non-zero to exclude dormant employment relationships, for example, workers on maternity leave. We also exclude marginally employed workers in our baseline definition of employment and define them as being unemployed if they have a parallel unemployment spell and as not in the labor force if there is no parallel spell. The SIAB microdata are derived from social security records with information on dependent employment under social security legislation, so that we do not cover self-employed workers and public servants (*Beamte*) in our employment definition.

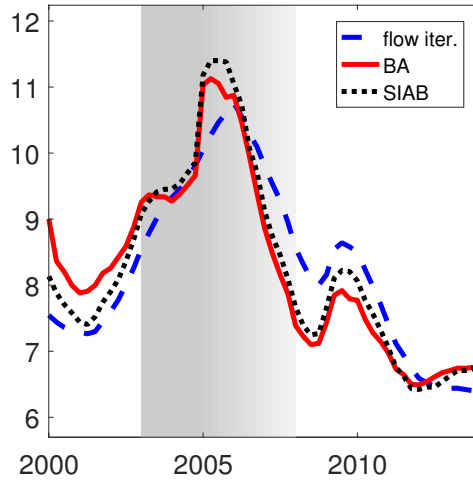
We define a worker as unemployed if the person is registered as unemployed at the federal employment agency.<sup>29</sup> The SIAB microdata provide comprehensive information on unemployment registrations from 2000 onward. For the period 1993 to 2000, we rely on information on benefit-recipient status to define workers as unemployed. This includes all workers who receive unemployment benefits and unemployment assistance. To construct worker flow rates for the entire period 1993 to 2014, we extend the registration-based worker flow rates backward starting in 2000 using the growth rates of benefit-based worker flow rates for the period 1993 to 2000. Extending the time series using growth rates avoids level breaks in the series but preserves the cyclical properties of worker flow rates.

In our empirical analysis, we study the evolution of worker flow rates to uncover changes in the underlying dynamics of the inflows and outflows to unemployment. Hence, what is most important for our analysis is that the constructed worker flow rates account for the changes in the unemployment rate over time. Figure 2.11 shows the unemployment rate from the SIAB microdata (black dotted line) and the unemployment rate from the federal employment agency (red solid line) as in Figure 2.1. In addition, we construct a flow-based unemployment rate using the law of motion of a two-state

---

<sup>29</sup>Workers can remain registered as unemployed as long as they work less than 15 hours per week.

Figure 2.11: Unemployment rates 2000-2014



Notes: Red solid line displays the registered unemployment rate in the SIAB data for West Germany 2000-2014. The blue dashed line displays the unemployment rate obtained by iterating forward the SIAB unemployment rate in January 2000 using monthly separation and job finding rates:  $u_{t+1} = u_t(1 - \pi_{ue,t}) + (1 - u_t)\pi_{eu,t}$ . In the sample used here, we do not use the inflow correction for the inflows to registered unemployment in early 2005 (see Section 2.2). The grey area marks the period 2003 to 2005 when the Hartz reforms were enacted. The fading out indicates the first transition years 2006 to 2008 after the reforms.

approximation of unemployment dynamics

$$u_{t+1} = u_t(1 - \pi_{ue,t}) + e_t\pi_{eu,t}. \quad (2.13)$$

where  $e_t$  denotes the employment rate of workers covered by social security legislation (see Section 2.2). Such a two-state approximation of unemployment dynamics also underlies our labor market model in Section 3. We use this law of motion to iterate forward the unemployment rate over time. Changes in the unemployment rate using this flow-based approach are only determined by changes in separation rates  $\pi_{eu,t}$  and job finding rates  $\pi_{ue,t}$  over time. The unemployment rate from this flow-based approach is shown as the blue dashed line in Figure 2.11. We find that this unemployment rate closely tracks the dynamics of the aggregate unemployment rates over time. Hence, changes in the transition rates based on these definitions and construction account for the observed changes in the unemployment rate over time and are therefore informative about the drivers of declining unemployment.

### C. Sensitivity analysis

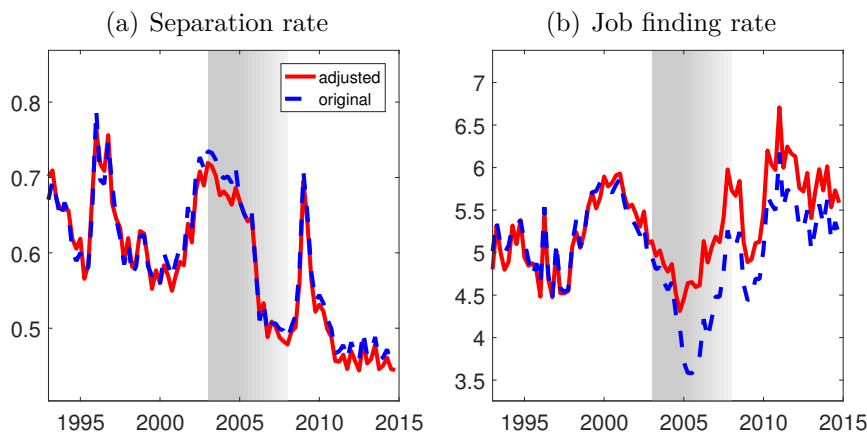
This section provides a sensitivity analysis of the empirical analysis of Section 2. We consider in Section A a sample where we do not apply the inflow correction described in Section 2.2. Related to skipping the inflow correction, we explore in Section B how much changes in the composition of the employed have contributed to the changes in the separation rates over time. We provide a further detailed discussion of heterogeneity in separation rate changes by age and employment duration in Section C. In Section

D of the sensitivity analysis, we compare East and West German worker flow rates. In the main part of the paper, we restrict attention to West Germany. Section E includes marginally employed workers in the definition of employment. In the main part, we do not include marginally employed workers in the definition of the employment state. Section F looks at the effect on job finding rates from changes in how workers in active labor market programs are counted before and after the reform.

### A Worker flows without inflow correction

Figure 2.12 shows separation and job finding rates for the baseline sample with the inflow correction and for a sensitivity sample where we skip the inflow correction.

Figure 2.12: Separation and job finding rates (1993 - 2014)



Notes: Left panel shows separation rates in percentage points. Right panel shows the job finding rate in percentage points. The red solid lines exclude non-employed entering the unemployment pool in the first half of 2005 who did not become employed until the end of 2006. The blue dashed lines show the original separation rates without inflow correction. Horizontal axis shows the years from 1993 to 2014. The grey area marks the period 2003 to 2005 when the Hartz reforms were enacted. The fading out indicates the first transition years 2006 to 2008 after the reforms.

Looking at separation rates in Figure 2.12(a), we see that the inflow correction hardly affects separation rates. The reason is that those workers whom we exclude with our inflow correction are only weakly attached to the labor market. In the case where they become employed, they constitute only a negligible fraction of total employment so that separation rates remain almost unaffected. This is not true for job finding rates in Figure 2.12(b). Job finding rates are almost 20% lower in January 2005 in the full sample compared to the inflow-corrected sample. This difference decreases over time but remains sizable even at the end of our sample in 2014. Job finding rates before 2005 remain largely unaffected in line with the idea that these workers are only weakly attached to the labor force. Hence, if we do not apply the inflow correction the increase in job finding rates would be smaller and the contribution of the decreasing separation rate to the decrease in the unemployment rate would be even larger.

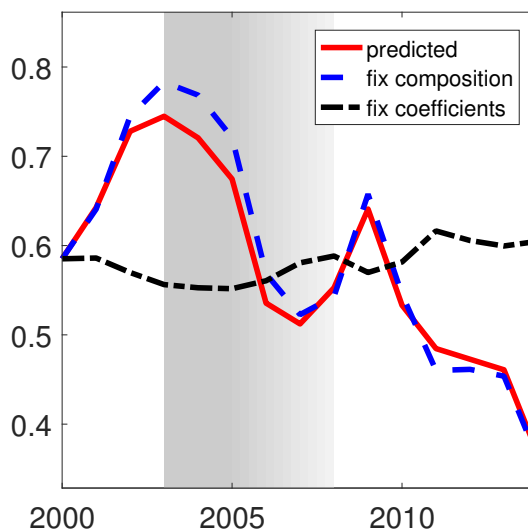
## B Controlling for composition

Our empirical analysis in Section 2 and Section C of this appendix documents substantial heterogeneity in separation rates across worker groups. One potential reason for decreasing separation rates that would be unrelated to the UI reform could be changes in the composition of worker groups with different separation rates over time. To assess the quantitative importance of composition effects on separation rates, we run a linear probability model of separation rates on a large set of observable worker characteristics. We run the following regression

$$\mathbf{1}_{eu,i,t} = X_{i,t}\beta_t + \varepsilon_{i,t}$$

where  $\mathbf{1}_{eu,i,t}$  denotes an indicator function that is one if in year  $t$  we observe a transition from employment into unemployment of individual  $i$ .  $X_{i,t}$  denotes a vector with dummies for individual characteristics of individual  $i$  in year  $t$ ,  $\beta_t$  denotes the coefficient vector that we allow to vary across years, and  $\varepsilon_{i,t}$  denotes the error term. We include dummies for gender, age, education, employment duration, temporary work, and wage percentiles. We pool all transitions of one year in the regression so that one worker can have multiple transitions within one year. Predicted average transition rates are then average population characteristics that we denote by  $\bar{X}_t$  times the coefficient vector  $\hat{\pi}_{eu,t} = \bar{X}_t\beta_t$ . The predicted average separation rate corresponds by construction to the observed average rate.<sup>30</sup>

Figure 2.13: Separation rates controlling for worker characteristics



Notes: Yearly averages of monthly separation rates 2000-2014. The red solid line marks the predicted (actual) separation rate. The blue dashed line marks the separation rate keeping the composition of all observables fixed at their level in 2000. The black dotted line marks the separation rate keeping the coefficients of all observables fixed at their level in 2000. The grey area marks the period 2003 to 2005 when the Hartz reforms were enacted. The fading out indicates the first transition years 2006 to 2008 after the reforms.

<sup>30</sup>We pool all transitions within a year to compute the transition rates. This can lead to small deviations in comparison to an average of monthly rates, but in our case, the difference is negligible.

We then construct two counterfactual transition rates. For the first counterfactual transition rate, we keep population shares at their level in 2000 and only vary coefficients over time  $\tilde{\pi}_{eu,t}^{2000} = \bar{X}_{2000}\beta_t$ . This captures changes in separation rates for a fixed population of workers. Through the lens of our structural model in Section 3, these are changes in behavior, for example, due to changes in the UI system. For the second counterfactual transition rate, we keep coefficients at their level in 2000 and only vary population shares over time  $\tilde{\pi}_{eu,t}^{2000} = \bar{X}_t\beta_{2000}$ . This captures the effects from changes in the composition of worker groups over time. Figure 2.13 shows the predicted separation rate  $\hat{\pi}_{eu,t}$  (red solid line), the counterfactual transition rate with fixed population shares  $\tilde{\pi}_{eu,t}^{2000}$  (blue dashed line), and the counterfactual transition rate with fixed coefficients  $\tilde{\pi}_{eu,t}^{2000}$  (black dashed-dotted line). We find that the counterfactual transition rate with changes in coefficients  $\beta_t$  tracks the drop in separation rates over time very closely. The counterfactual transition rate that keeps all coefficients fixed at their level in 2000 and where we only vary population shares over time hardly changes. This evidence strongly supports the idea that it was behavioral changes due to changes in the macroeconomic environment that explain the decline in the separation rate over time rather than changes in the composition of the workforce.

### C Heterogeneity in transition rates by age groups

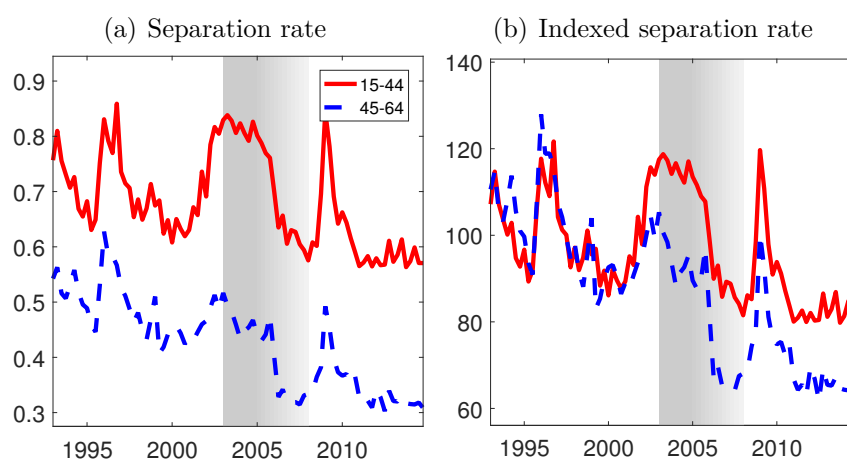
This section provides further details on the heterogeneity in the changes in separation rates by age discussed in Section 2.4. Table 2.9 provides detailed information on separation rate changes by age and employment duration. The upper part of the table shows results for all workers and for three different age groups. Workers age 15-44 show the smallest decline in separation rates (-14.2%) and workers in the age group from 45 to 64 years show the strongest decline in separation rates (-25.2%). These age differences still hide important heterogeneity arising from employment duration because age and employment duration are strongly correlated (Jung and Kuhn (2014b)). The lower part of Table 2.9 distinguishes workers by age and employment duration. Here, we find that changes in separation rates mirror the relative differences in changes in benefit eligibility from Figure 2.3. Short-term employed workers show across age groups a rather uniform decline in separation rates varying between 14.6% and 17.7%. The decline is always less than the average decline over this time period of 22.0%. We also find a much stronger decline for long-term employed workers age 45 and older. Their separation rates decline by 32.5% and 48.8%. For younger long-term employed workers, we find a smaller decline. This is in line with the relative cut in benefits shown in Figure 2.3 that does not show any variation in the cuts in benefit eligibility among young workers. The larger decline among the oldest age group of long-term employed workers cannot be explained by the cut in benefit eligibility from Figure 2.3 alone. Looking at the longer-run trend in Figure 2.14(a) suggests that the likely explanation predates the Hartz reforms. The separation rates for the oldest group of workers seem to follow a longer-run downward trend starting in the mid-1990s. A detailed investigation of this trend is of independent interest but beyond the scope of this paper. We leave a detailed investigation of the reasons behind this trend to future research.

Table 2.9: Change in separation rates by employment duration and age

	1993 - 2002	2008 - 2014	$\Delta$ %
age: 15-44	0.72%	0.61%	-14.2%
age: 45-54	0.43%	0.35%	-18.3%
age: 45-64	0.46%	0.35%	-25.2%
age: 15-44, emp. duration $\leq$ 3 years	1.36%	1.13%	-16.8%
age: 15-44, emp. duration $>$ 3 years	0.26%	0.22%	-15.4%
age: 45-54, emp. duration $\leq$ 3 years	1.47%	1.25%	-14.6%
age: 45-54, emp. duration $>$ 3 years	0.18%	0.12%	-32.5%
age: 45-64, emp. duration $\leq$ 3 years	1.48%	1.22%	-17.7%
age: 45-64, emp. duration $>$ 3 years	0.27%	0.14%	-48.8%

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  $\Delta$  reports the percentage change in rates from the period before the Hartz reforms to the period after the Hartz reforms.

Figure 2.14: Separation and job finding rates by age

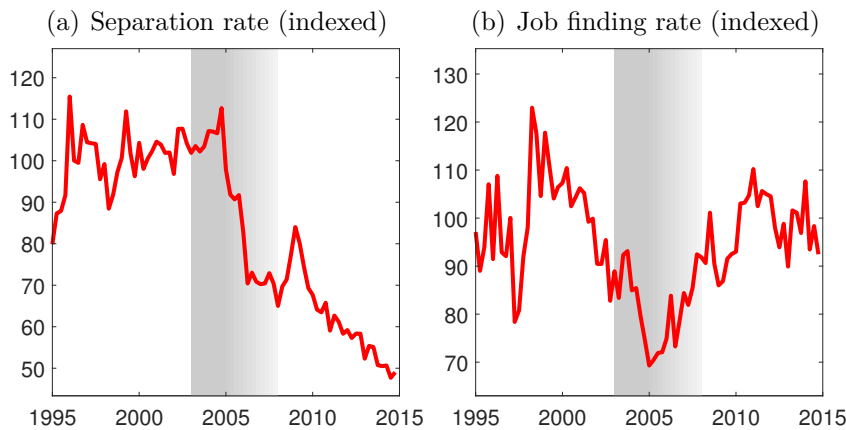


Notes: Separation rates for age groups 15-44 years (red solid lines) and 45-64 (blue dashed lines). The left panel shows the level of the separation rate. The right panel shows the change in the separation rate relative to its pre-reform level (1993-2002). The grey area marks the period 2003 to 2005 when the Hartz reforms were enacted. The fading out indicates the first transition years 2006 to 2008 after the reforms.

## D East Germany

For our empirical analysis in Section 2.3, we exclude workers who have employment or unemployment spells in East Germany. We do this to abstract from any effects of a transition of the East German labor market in the decade after reunification. In this section, we explore separation and job finding rates for East Germany starting in 1995. Figure 2.15 shows the time series for separation rates and job finding rates for East German workers and applies the inflow correction described in Section 2.2. The corresponding results for the West German labor market are in Figure 2.2.

Figure 2.15: Changes in separation and job finding rates East Germany (1995 - 2014)



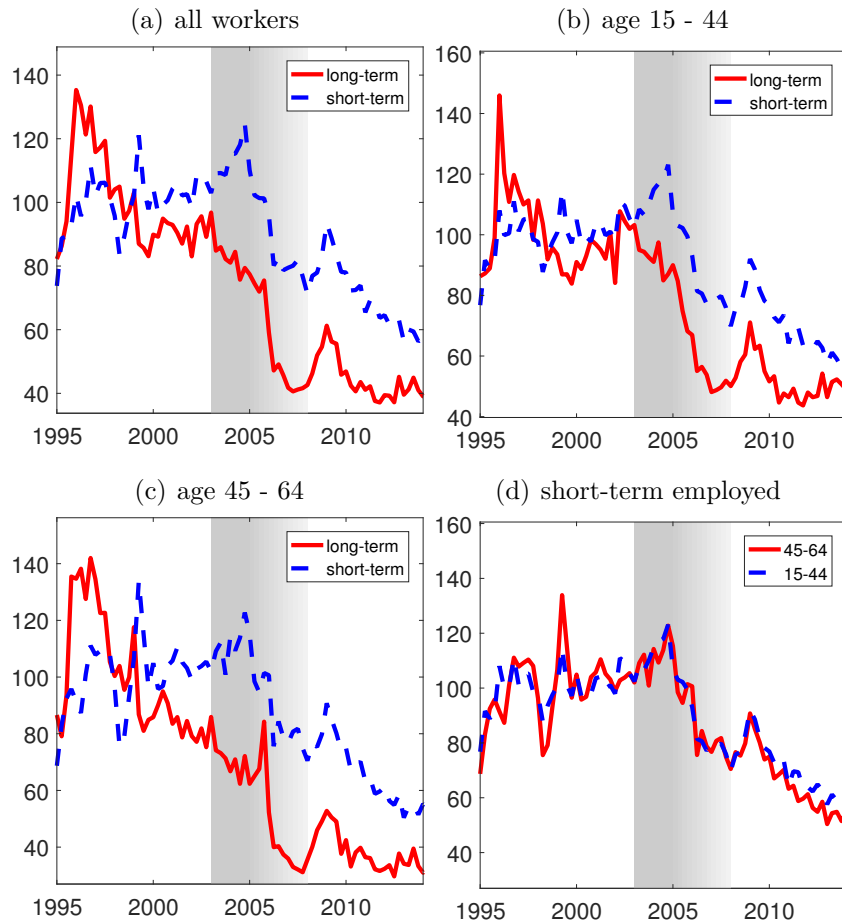
Notes: Separation and job finding rates for East Germany 1995-2014. Both series have been indexed to their pre-reform level (1995-2002). Both series exclude non-employed entering the unemployment pool in the first half of 2005 who did not become employed until the end of 2006. The grey area marks the period 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.

Separation rates in East Germany are higher than in our baseline West German sample. Before the reform, the monthly separation rate is slightly higher than 1.4%. Figure 2.15(a) shows that separation rates in East Germany plummet in 2006 to 70% of their pre-reform level and in 2014 stand at 50% of their pre-reform trend. The data suggest that there is an ongoing falling trend in the separation rate. Hence, the decline in the separation rate is stronger in the East than in the West German labor market. Regarding job finding rates, the results are even more striking. Relative to their pre-reform level of 5.4%, the job finding rate in the East German labor market stands in 2014 at its pre-reform level. All changes in East German unemployment result therefore from a decline in separation rates, thereby further reinforcing our findings from the West German labor market.

Figure 2.16 provides results on the heterogeneity in the changes in separation rates for the East German labor market over time. The corresponding results for the West German labor market are shown in Figure 2.4.

The changes in separation rates by age and employment duration in the East German labor market corroborate the findings for the West German labor market. We find that long-term employed workers show a much stronger decline than short-term employed

Figure 2.16: Separation rates by age and employment duration (1993 - 2014) East Germany



Notes: Separation rates by employment duration and age for East Germany 1995 - 2014, indexed to their pre-reform level (1995-2002). The red solid lines in panels (a)-(c) mark the separation rate for long-term employed workers who were continuously employed for three years or more. The blue dashed lines in panels (a)-(c) mark 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 gray area marks the period 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.

workers (Figure 2.16(a)). Looking at workers in the age range from 15 to 44 years in Figure 2.16(b), we find a roughly equal decline by 50% from the pre-reform period to 2014. The short-term employed typically show a slightly smaller decline than the long-term employed but also started from a higher level in 2005. For workers in the age group 45-64 years, we find a much stronger decline for the long-term employed in line with our results for the West German labor market (Figure 2.16(c)). Separation rates for the long-term employed workers decline roughly 20% more than those for the short-term employed workers. The average decline in East Germany is larger. Finally, when comparing short-term employed workers in the age group 15-44 years to workers in the age group 45-64, we find again, as in the case of the West German labor market,

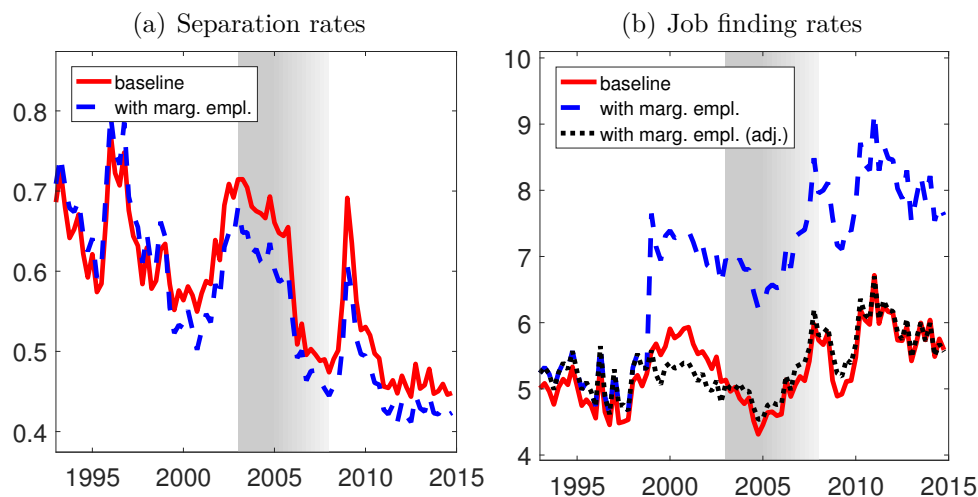


that their separation rates lie virtually on top of each other and decline in lockstep between 2005 and 2014 (Figure 2.16(d)).

### E Including marginally employed

For our baseline sample, we do not define workers as employed if their only employment relationship is under a marginal employment contract. As described in Section B of this appendix, we count these persons as either unemployed or out of the labor force depending on whether or not they have a parallel unemployment spell in that month. A main reason for excluding marginal employment in our baseline sample is to derive consistent time series for worker flows. Information on marginal employment becomes comprehensive in the microdata after 1999 so that we cannot construct a consistent time series going back to 1993. Before 1999, information on marginal employment is typically not recorded. As a sensitivity analysis, we include all available information on marginal employment when defining employment states. Figure 2.17 shows the separation rates and job finding rates including marginal employment information in comparison to the rates from the baseline sample.

Figure 2.17: Separation and job finding rates including marginal employment



Notes: Separation rates and job finding rates in West Germany 1993-2014 for the baseline sample (red solid line) and for a sample where marginal employment is included in the employment definition (blue dashed line). The black dotted line in the right panel shows the job finding rates including the marginally employed adjusted for the structural break in 1999. The grey area marks the period 2003 to 2005 when the Hartz reforms were enacted. The fading out indicates the first transition years 2006 to 2008 after the reforms.

Figure 2.17(a) shows separation rates for the baseline sample (red solid line) and the sensitivity sample including marginal employment information (blue dashed line). Marginal employment accounts only for a small fraction of total employment so that the change in aggregate separation rates is small. The decline in separation rates becomes slightly more pronounced in the sensitivity sample and including marginal employment would lead to a larger decline of separation rates compared to the baseline sample. Figure 2.17(b) shows job finding rates from the baseline sample (red solid line) and

sensitivity sample (blue dashed line). The job finding rate in the sensitivity sample shows a structural break in 1999 when complete information on marginal employment becomes available. We provide an additional estimate for the sensitivity sample, where we remove the structural break by removing the level shift (black dotted line).<sup>31</sup> We find that after we remove the structural break in 1999, the job finding rates from the baseline and sensitivity sample track each other closely. If anything, the job finding rate in the adjusted sensitivity sample is slightly higher before 1999, implying a slightly smaller increase in job finding rates after the reform. We conclude that our empirical findings on the importance of the decline in separation rates are robust to a change in the employment definition to include marginal employment information.

## **F Effect of active labor market policy**

Section 2.2 discusses changes in regulation for unemployment registration and the inflow correction to adjust for this change. A second change that affects the microdata records and was enacted as part of the Hartz reforms was the treatment of active labor market programs. Starting in 2005, unemployed persons who participate in training programs, internships, or other measures that are part of active labor market policy are no longer recorded as unemployed in the microdata while they are taking part in such programs. Our baseline definition of employment states assigns workers in active labor market programs as out of the labor force. If these workers go from a program to regular employment, the baseline sample would not count this as a transition from unemployment to employment; as a consequence, the job finding rate would be lower. To explore the quantitative effect of this change in recording, we exploit the information from the unemployment records that provide a reason for why the worker is no longer registered as unemployed. We exploit this information to identify workers who participate in active labor market programs and explore how our estimates for job finding rates are affected if we include workers as unemployed while they are in active labor market programs. Figure 2.18 shows the unemployment rate and the job finding rate for the baseline sample and for the sensitivity sample that still counts all participants in measures of active labor market programs after 2005 as unemployed if they were unemployed before the program started.<sup>32</sup>

Looking at the unemployment rate in Figure 2.18(a), we find a very small increase in unemployment, yet the effect is negligible. Job finding rates in Figure 2.18(b) are hardly affected. We conclude that the change in the recording of active labor market programs in the microdata has a quantitatively negligible effect on our results.

## **G Economic activity in Austria and Germany**

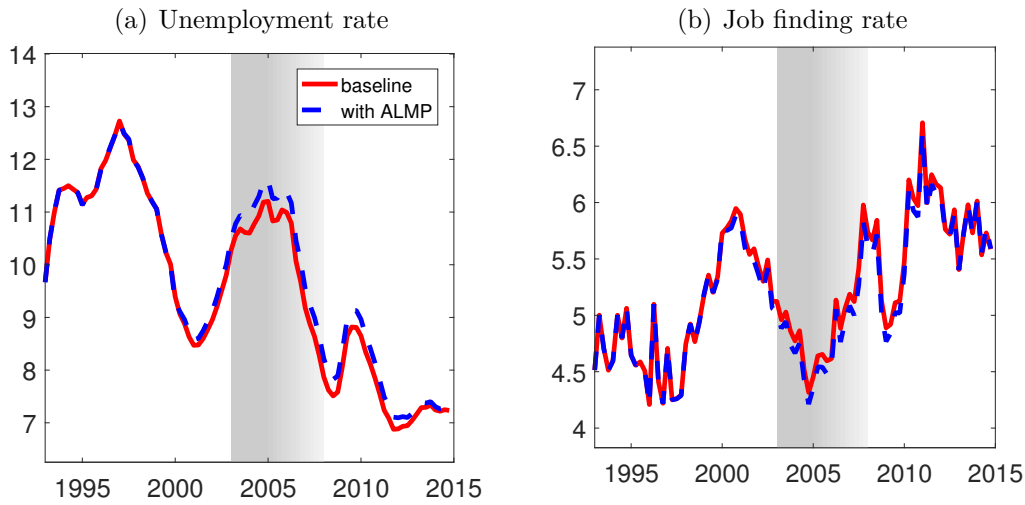
Section 4.3 contrasts the actual performance of the German labor market and a counterfactual performance absent the Hartz reforms with the Austrian experience. We choose Austria as a comparison because of its close business-cycle comovement with the German economy. Figure 2.19 demonstrates this close comovement over the two

---

<sup>31</sup>The level shift at the structural break corresponds to a 37% increase in the job finding rate in the sensitivity sample.

<sup>32</sup>Due to the inflow correction, the samples differ slightly before 2005.

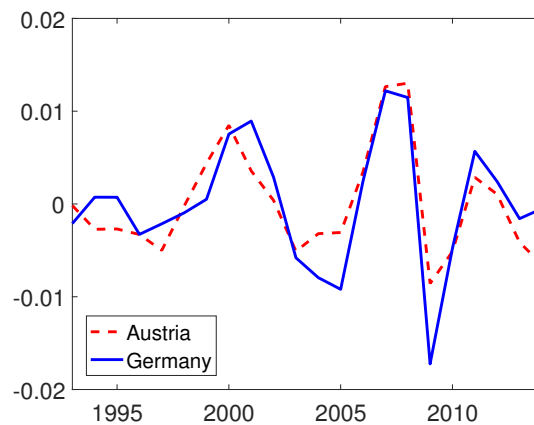
Figure 2.18: Unemployment and job finding rates including active labor market programs



Notes: Unemployment and job finding rates from the baseline sample and a sensitivity sample that includes workers in active labor market policy (ALMP) programs in the group of the unemployed. See text for further details. The grey area marks the period 2003 to 2005 when the Hartz reforms were enacted. The fading out indicates the first transition years 2006 to 2008 after the reforms.

decades considered in the counterfactual simulation from 1993 to 2014. As in the main part of the paper, we use GDP per capita to trace out the business cycle. We transform GDP per capita by taking the logarithm and we extract the cyclical component using an Hodrick-Prescott filter with smoothing parameter  $\lambda = 100$ . We find a very high correlation and also very similar volatility of the business cycle over time.

Figure 2.19: Cyclical component of GDP for Germany and Austria (1993-2014)



Notes: Cyclical component of annual GDP per capita for Austria and Germany for the period 1993-2014. GDP per capita is transformed to log and the cyclical component is extracted using an HP filter with smoothing parameter  $\lambda = 100$ .

## D. Alternative explanations

The German labor market miracle has received a lot of attention in the public debate as many European countries struggle with high unemployment rates and the question arises whether Germany can serve as a role model for these countries. Our paper provides new empirical evidence, together with a causal explanation based on economic theory that the UI reforms that were part of the Hartz reforms in the mid-2000s are responsible for the German labor market miracle. Other explanations for the German labor market miracle have been proposed and we discuss three of the most prominent alternative explanations in this section. A prominent idea put forward by Dustmann et al. (2014) is falling unit labor costs in Germany relative to its European neighbors. In Section A, we look at changes in unemployment rates and unit labor costs in a cross-section of European countries to explore this idea. A closely related explanation is an export-driven boom in the labor market due to demand from China and other European countries. In Section B, we compare worker flows in export industries to those that produce for the domestic market. Finally, section C looks at the composition of unemployment and the share of long-term unemployed. One goal of the Hartz reforms was to reduce long-term unemployment and that might have contributed to a decline in unemployment after the reforms.

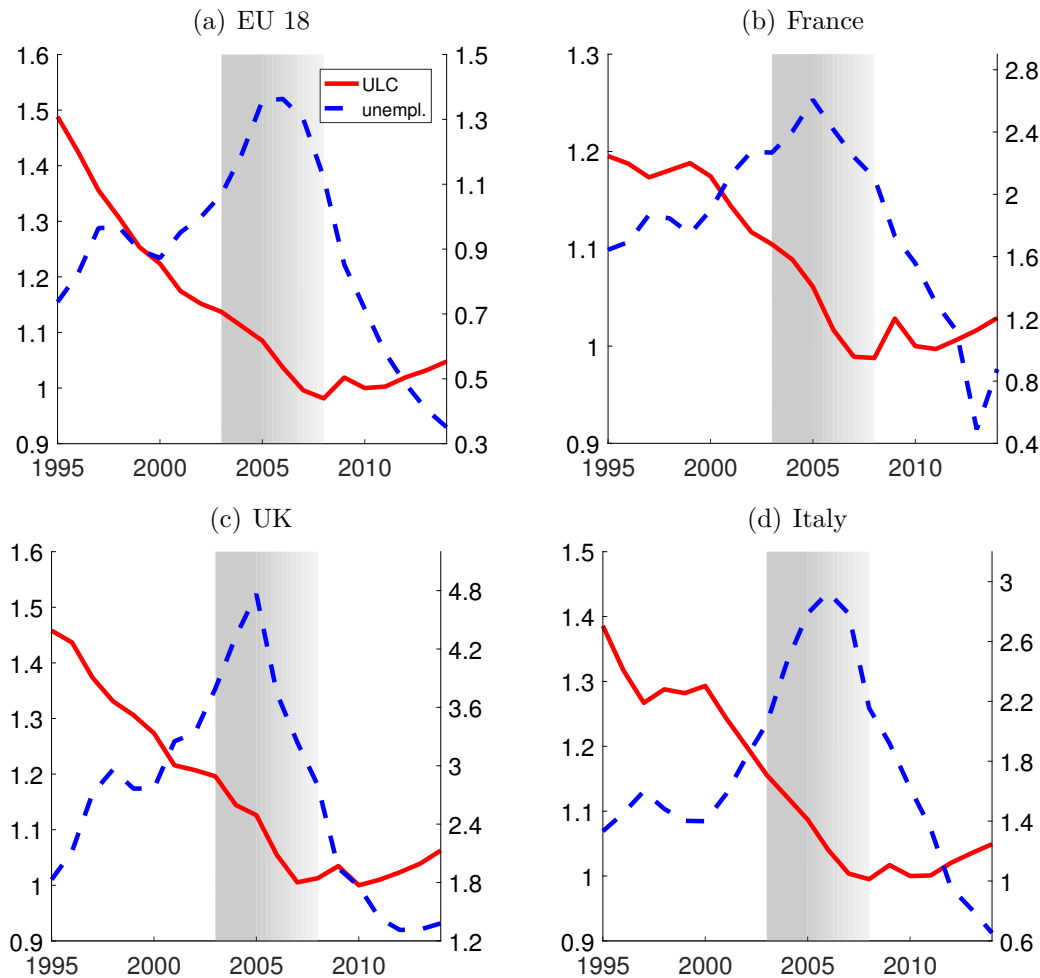
### A Unit labor costs

One prominent narrative of the German labor market miracle comes from Dustmann et al. (2014), who link the German labor market miracle to a decline in Germany's unit labor cost and wages relative to other European countries. Figure 2.20 shows the ratio of German unit labor costs (ULC) (red solid line) and unemployment rate (blue dashed line) relative to other European countries.<sup>33</sup> We find that the relative decline of Germany's ULC had already started in the 1990s, long before the Hartz reforms were enacted. The idea behind how changes in ULC are related to changes in unemployment rates is that with falling ULC production became relatively cheaper in Germany, thereby increasing labor demand in Germany at the cost of falling labor demand in other European countries. As a result, stronger labor demand leads to declining unemployment rates in Germany, and in comparison, unemployment rates in other European countries with weakened labor demand rise. The relative unemployment trends in Figure 2.20 paint a different picture. During the period when German ULC were falling relative to other European countries, its unemployment rate was rising in comparison to these countries, whereas the fall in unemployment rates between 2005 and 2014 was accompanied by stagnating or even increasing relative ULC in Germany. Without drawing causal conclusions, these negatively correlated time series are intricately reconciled with the hypothesis that declining ULC were the main driver of the German labor market miracle.

---

<sup>33</sup>EU-18 is the employment-weighted average of 18 EU countries: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Hungary, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Spain, and the UK.

Figure 2.20: Unit labor costs and unemployment rates in the EU



Notes: The red solid lines (left axis) show ULC in Germany divided by ULC in other European countries. The blue dashed lines (right axis) show the German unemployment rate relative to the unemployment rate in these countries. The grey area marks the period 2003 to 2005 when the Hartz reforms were enacted. The fading out indicates the first transition years 2006 to 2008 after the reforms.

## B Export demand

Related to the idea of falling unit labor costs in Germany relative to its European competitors is the idea that rising export demand for German goods has spurred labor demand in the German labor market and has led to a decline in separation rates contemporaneously with the labor market reforms. To investigate this idea, we follow Dauth et al. (2016) and classify industries by their export or import exposure. If labor demand from abroad is a key driver of the labor market miracle, we expect separation rates to decline in the export-exposed industries relative to import-exposed or unexposed industries. We adopt the classification of import- and export-exposed industries from Dauth et al. (2016). Their classification follows the methodology used in the seminal paper by Autor et al. (2013) on the impact of Chinese import competition

on industries in the United States. Import exposure is defined as the absolute value of trade flows into an industry from a particular region relative to the trade flows into that industry stemming from all countries; export exposure is defined equivalently. Dauth et al. (2016) classify 93 industries at the 3-digit level in the SIAB sample. Out of these industries, they report the 25 most import-exposed and the 25 most export-exposed industries in Table A.2 of their appendix. We take the classification from this table to define the import-exposed and export-exposed industries in our sample.

Table 2.10: Change in separation rates by trade exposure

industries	1993-2002	2008-2014	$\Delta$ %
all	0.63%	0.49%	-22.0%
no exposure	0.63%	0.50%	-20.0%
export exposure	0.44%	0.26%	-40.8%
import exposure	0.62%	0.34%	-44.4%

Notes: Separation rates before and after the Hartz reforms by trade exposure. We use averages of quarterly rates over the time periods. Column  $\Delta$  reports the percentage change in rates from the period before the Hartz reforms to the period after the Hartz reforms.

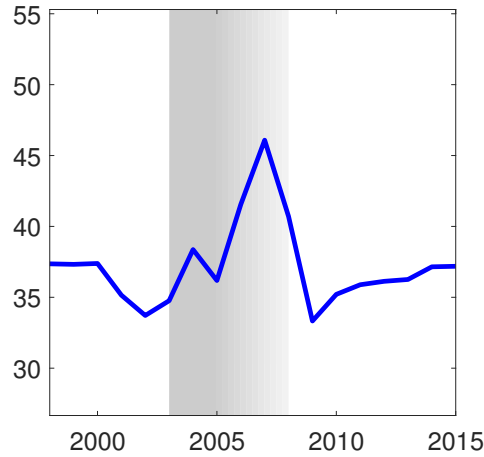
Table 2.10 shows the decline in separation rates across industries with no trade exposure, with export exposure, and with import exposure. Industries with neither import nor export exposure show a decline in separation rates from the pre-reform to the post-reform period of 20%, close to the average decline of 22%. We find that both import-exposed and export-exposed industries show much stronger declines relative to other industries. Separation rates in trade-exposed industries decline by more than 40%. The effect on the overall separation rates remains modest, however, because employment shares of these industries are small and account for less than 10% of employment. Furthermore, the declines in the import-exposed and export-exposed industries are about the same size so that export-induced demand as a driver of the decline in separation rates seems at odds with the observed pattern. The evidence therefore does not support a prominent role for export-driven labor demand as an explanation for the German labor market miracle.

### C Long-term unemployment

One goal of the Hartz reforms was to reduce long-term unemployment. To explore whether the reduction in long-term unemployment was an important driver behind the reduction in overall unemployment, we examine the composition of the unemployment pool over time. If the Hartz reforms increased, in particular, job finding rates of long-term unemployed, this should have shifted the composition of the unemployment pool toward short-term unemployment after the reforms. Figure 2.21 shows that apart from a spike during the Great Recession between 2006 and 2008, the share of unemployed

who have been out of work for more than one year did not change relative to the pre-Hartz period.

Figure 2.21: Share of long-term unemployed in Germany (1998-2015)



Notes: Share of long-term unemployed (more than 12 months). The grey area marks the period 2003 to 2005 when the Hartz reforms were enacted. The fading out indicates the first transition years 2006 to 2008 after the reforms.

The analysis in Section 4 provides evidence that higher job finding rates are not the main reason for the decline in the unemployment rate after 2005. The fact that we find a largely constant share of long-term unemployed after the Hartz reforms implies that there have also been no differential effects among the unemployed and a stronger increase in job finding rates among the long-term unemployed.





## CHAPTER 3

---

# Optimal UI policies in heterogeneous labor markets

### 1. Introduction

Since the European Monetary Union (EMU) was established, there is an open debate whether and if so how the monetary union should be supplemented by a fiscal stabilization mechanism that allows member states to share the risk of asymmetric shocks across countries. One possible instrument that has been discussed intensely in both policy and academic circles, is a European unemployment insurance (EUI). A federal UI scheme implicitly transfers resources from regions with low to regions with high unemployment rates. It can therefore supplement national fiscal stabilizers and allows countries to insure against asymmetric shocks, thus stabilizing aggregate demand. At the same time, implementing a common UI policy across heterogeneous labor markets can cause first-order welfare losses: An unemployment benefit level that is optimal in terms of welfare in one country might be too high (or too low) from a welfare perspective in another country with different labor market institutions, preferences and technology. If these structural differences across European labor markets are substantial, then the welfare losses of not tailoring UI policies to country-specific characteristics might outweigh the welfare gains from risk sharing across countries. It is therefore crucial to understand how large the distortions of implementing a *one-size-fits-all* policy across heterogeneous labor markets are when discussing the merits and costs of a European UI scheme as a fiscal stabilizer.<sup>1</sup> This paper addresses this question in detail and quantifies the welfare distortions of implementing a common UI scheme across heterogeneous labor markets. The main contribution of this paper is twofold: First, it takes into account that UI benefits as well as job-finding rates vary with unemployment duration, which turns out to be an essential feature for the design of optimal UI policies. For that purpose, this paper presents a novel data set of quarterly inflow rates into and outflow rates from unemployment by unemployment duration for 27 European economies. Second, the paper provides a more nuanced welfare analysis than existing studies by comparing the

---

<sup>1</sup>Alternatively, fiscal transfers that are linked to the unemployment rate could serve as an automatic stabilizer. However, a common unemployment insurance has the advantage of directly targeting those people most affected by a recession (unemployed). Furthermore, an institutionalized common UI scheme has a more immediate effect than discretionary transfers that are typically subject to political discussions, even if linked to the unemployment rate (see Beblavy and Lenaerts (2017)).

welfare across three different scenarios: (i) the status-quo with sub-optimal UI policies, (ii) optimal country-specific UI policies and (iii) an optimally chosen single UI policy that is applicable in all member states of the union.

This second contribution is not a mere technicality but essential for interpreting the welfare effects and for drawing policy conclusions: In theory, unemployment benefits are chosen optimally to balance the trade-off between insuring individuals against labor market risk and preserving the search incentives of unemployed. However, there is no reason to assume that the national UI policies currently in place across European countries are optimal in that respect. Therefore, comparing the potentially sub-optimal current national policies with an optimally chosen federal UI scheme confounds the welfare gains of optimization and the welfare losses of moving from country-specific optimal policies to a *one-size-fits-all* scheme that is applicable in all European countries. The overall effect of replacing the status-quo with an optimally chosen European UI scheme might therefore well be positive *despite* the distortions of not tailoring UI policies to country-specific characteristics. The main contribution of the structural analysis in this paper is therefore not only to quantify the overall welfare effects but also to disentangle the gains from optimization and the losses from imposing a *one-size-fits-all* policy in order to understand the size and importance of both channels.

It should be noted that this paper focuses on the welfare consequences of a European UI scheme through its impact on the labor market. In the scenario laid out here, a European UI scheme which is not tailored to country-specific characteristics has distortionary effects by altering the search decisions of unemployed, the vacancy posting behavior of firms and the extent to which idiosyncratic labor market risk is insured. In doing that, the paper abstracts from the actual benefits a common UI scheme may have as an automatic stabilizer that insures countries against asymmetric shocks through transitory transfers. The aim of this paper is therefore not to give an overall assessment of whether a European UI scheme is welfare improving in general but rather provides a quantification of the welfare effects such a policy has through its distortionary impact on the labor market.

When comparing different labor markets, the first question to be addressed, however, is not related to optimal policy design but concerns measurement. It is well known that labor markets vary substantially across countries both in terms of institutions (e.g. UI policies, employment protection, unionization) and labor market outcomes (unemployment and worker flow rates, wages etc.). At the same time, it is less obvious how one can actually measure this heterogeneity of labor markets empirically. From a theoretical viewpoint, the variables and parameters that characterize labor markets can be broken down into three categories: The first category comprises labor market institutions which can be directly changed by the policy maker such as the generosity of UI benefits or the strictness of employment protection. The second group of variables encompasses endogenous labor market outcomes that are affected by labor market institutions, the business cycle and exogenous parameters. These are for example wages, the unemployment rate or the level and cyclicalities of worker flows between employment and unemployment. Finally, the third category comprises exogenous parameters

that affect labor market outcomes but are not directly controlled by the policy maker, such as the preference for leisure, the utility costs of search for unemployed workers or the matching technology connecting vacant jobs with workers.<sup>2</sup> Evidently, this last category is hard to measure empirically. The strategy of this paper is therefore to use available data on labor market policies and observed labor market outcomes - the first two categories - to pin down these “deep” parameters for each country within a structural labor market model. Given these parameters, one can then investigate how to change policies optimally in order to maximize welfare.

Evidently, an essential prerequisite for this approach is reliable data encompassing the broad heterogeneity of labor market institutions and labor market outcomes across European countries. While statistics on labor market policies can be computed using data provided by the OECD, data on worker flow rates as a key labor market outcome variable is scarce: Existing measures are either not available for a larger set of countries, can be computed only at an annual frequency or span relatively short time series. Addressing these shortcomings, the first part of this paper presents a novel measure of quarterly employment-to-unemployment (EU) and unemployment-to-employment (UE) transition rates for 27 European economies that can be computed from 1998 onwards. The measure is based on quarterly Eurostat-data on unemployment stocks by quarterly and biannual duration brackets. Using a system of stock-flow equations, these unemployment stock time series can be used to back out not only the quarterly EU- and UE-transition rates but also the UE-transition rates by unemployment duration. The resulting time series fit existing flow rate measures remarkably well in the period of overlap and track the evolution of unemployment rates closely.

With these high-frequency time series at hand, the paper proceeds with two empirical tests that are not possible to do with existing worker flow rate measures for a large set of countries: First, I do a business cycle decomposition as in Fujita and Ramey (2009) to investigate how much of the cyclical unemployment fluctuations are driven by fluctuations in EU- versus UE-transition rates. While the latter are dominant in most countries, EU-transition rates play a sizable role as well: In Germany and France, the two largest economies in the sample, EU-transitions explain 40% and 50% of unemployment fluctuations, respectively.

In the second step, I aggregate the UE-transition rates by duration to long- and short-term duration brackets (less than or more than 12 months of unemployment). Using the time series variation on a quarterly level, I test whether the UE-rates of both groups are significantly different from each other. In 15 out of the 27 countries this is the case. In 12 out of these 15 countries long-term unemployed have significantly lower job-finding rates than short-term unemployed. These include some of the largest European economies (Germany, France, UK, Spain). Only in 3 Eastern European countries long-term unemployed are more likely to exit unemployment.

These two empirical tests show that (i) job separations explain a sizable fraction of unemployment fluctuations over the business cycle and are therefore potentially an important margin along which policy changes affect the unemployment rate (see Jung and

---

<sup>2</sup>Throughout this paper, it is assumed that the policy maker cannot directly control matching efficiency nor is matching efficiency affected if other institutions change.

Kuhn (2014a)). And (ii), the odds of finding a job depend on unemployment duration in slightly more than half of all European countries.

With these new time series on EU-flows and UE-flows by unemployment duration at hand, the second part of the paper presents a structural labor market model to address the optimal policy question outlined in the beginning. The model builds upon the framework in Jung and Kuester (2015) and features the basic trade-off between consumption smoothing and search incentives for risk-averse unemployed workers which determines the optimal level of UI benefits. Motivated by the empirical evidence on the importance of the separation margin for unemployment fluctuations and the duration dependence in job-finding rates, the model features endogenous separations as well as short-term and long-term unemployed who decide whether or not to search for a job. Ex-ante all unemployed are identical but the search costs depend on unemployment duration which is the reason why short- and long-term unemployed exit unemployment at different rates. Hence, duration dependence in the model arises as “true” duration dependence rather than through the selection of ex-ante heterogeneous workers. In the first step, the model is calibrated for each country separately imposing the actual labor market policies currently in place. These policies comprise short- and long-term unemployment benefits and a quantitative measure of firing costs which is derived from the detailed data underpinning the OECD’s EPL-indicators<sup>3</sup>. Given the status-quo policies of each country, the calibration allows to back out the structural parameters of the model that rationalize the level and the cyclicity of the worker flow rates observed in the data. These structural country-specific parameters reflect the value of home production, matching frictions and the costs of search for unemployed workers of different durations. Assuming that these parameters are invariant to policy changes, the second step computes the optimal UI policy for each country. In the third step, I take the model to the federal level and search for the optimal *common* policy, taking as weights the size of the labor force in each country.

It turns out, that in contrast to the status quo in which unemployment benefits decline with duration, both the country-specific and the federal optimal UI schemes are actually *increasing* in unemployment duration. While the median replacement rate for short-term (long-term) unemployed across countries is 73% (45%) in the status quo, the median optimal replacement rate is significantly lower for short-term unemployed (50%) and close to one for long-term unemployed (94%). What is the explanation for that reversed optimal UI profile? The reason is that in most countries long-term unemployed have a significantly lower job-finding rate than short-term unemployed, despite receiving lower benefits. That means they have more difficulties finding a job although their surplus of being employed is larger than for short-term unemployed. In the model that can only be the case if it is inherently more arduous for long-term unemployed to search for jobs. These higher utility costs of search in turn imply that the moral hazard costs of providing long-term unemployed with larger benefits are relatively low as their search behavior is hardly affected by monetary incentives. The social planner there-

---

<sup>3</sup>The OECD provides regular indicators covering various dimensions of employment protection legislation (EPL). See section 3.3 for details.

fore grants long-term unemployed larger benefits in order to smooth their consumption, knowing that they will not reduce search much further.

In the model, replacing the sub-optimal status-quo policies with an optimal UI scheme where benefits increase with unemployment duration yields substantial welfare gains of close to 3% of consumption. At the same time, the national and federal optimal policies are relatively similar, such that the welfare losses of having a *one-size-fits-all* UI scheme instead of country-specific policies are moderate (0.22%). At the same time, unemployment decreases by more than 40% because the low short-term benefits reduce inflow rates into unemployment and increase the outflow rate of short-term unemployed workers.

To test whether these welfare effects are driven by the duration dependence of benefits and outflow rates, I do a counterfactual exercise in which I re-calibrate the model with only one benefit level and a homogeneous pool of unemployed. Computing again optimal policies, the results differ substantially: First, the welfare gains of having optimal national policies are significantly smaller (0.72%). That suggests that the *average* replacement rates currently in place are relatively close to their optimal levels. In contrast, the distortions of moving from national policies to a federal scheme are large (-1.48%), more than offsetting the gains from optimization. Explicitly accounting for duration dependence in job-finding rates is therefore an essential feature of optimal UI policies - both on a national and on a European level.

In interpreting both the level of optimal UI benefits and the welfare effects, it should be kept in mind that the social planner in this setup has only a limited set of policy tools available (short- and long-term UI benefits) to implement the decentralized constrained-efficient allocation. That abstracts from other policy tools that have been shown to be quite effective in reducing unemployment, ranging from active labor market policies to retraining of long-term unemployed and hiring subsidies as well as layoff taxes. Jung and Kuester (2015) for example show that over the business cycle, UI benefits actually play a minor role in terms of welfare, once layoff taxes and hiring subsidies are chosen optimally. Nonetheless, this paper abstracts from these tools to focus on the optimal choice of UI benefits, which is front and center in the academic and policy discussion on automatic fiscal stabilizers in the European Union.

**Related Literature.** This paper contributes to an existing literature that investigates the costs and merits of a European UI scheme from a macroeconomic perspective. Closely related to this paper is the study by Abraham et al. (2017) which compares welfare and unemployment in different optimal policy scenarios for a union of heterogeneous labor markets. Their paper is more detailed regarding various implementation options and explicitly models the insurance benefits of a common UI scheme. However, their model abstracts from endogenous separations and duration dependence in benefits and job-finding rates - both of which are a key feature of European labor markets and play a crucial role for the optimal design of UI policies and the ensuing welfare effects, as shown in this paper. A similar exercise is provided by Moyen et al. (2016) in a two-country model, which also features exogenous separations and a homogeneous

unemployment pool. In contrast to these papers, Ignaszak et al. (2018) focus on the moral hazard concerns of having a common UI fund when member states retain their legislative power to adjust other national policies. Their paper is complementary to the paper presented here as it outlines a different channel through which a common UI-scheme might have first-order distortions. In that sense, the welfare costs of having a union-wide policy presented here, should be viewed as a lower bound as I abstract from moral hazard considerations on the country-level. However, their paper abstracts from heterogeneity across countries in terms of labor market institutions and outcomes. In addition, this paper is related to a literature on optimal UI benefit schemes depending on unemployment duration. While theoretical papers with representative agents mostly find that optimal benefits are either decreasing (Shavell and Weiss (1979b), Hopenhayn and Nicolini (1997b)) or flat (Shimer and Werning (2008)) over the unemployment spell, studies with duration dependence or heterogeneity among unemployed find more ambiguous predictions (Shimer and Werning (2006)). On the empirical side, Kolsrud et al. (2018) use detailed micro data to exploit a Swedish UI benefit reform in a regression-discontinuity design. They find that the optimal benefit scheme is increasing in unemployment duration. As in the paper presented here, they find that long-term unemployed hardly respond to monetary incentives and therefore should receive higher benefits from a social planner’s perspective. They confirm this result in a structural model in which duration dependence arises both generically in the form of “true” duration dependence and through the dynamic selection of heterogeneous job searchers. Quantitatively, the optimal UI scheme they obtain (48% for short-term and 68% for long-term unemployed) is very close to the estimate for Sweden obtained in this paper (47% and 71% respectively).

The remainder of this paper is structured as follows: Sections 2.1 and 2.2 describe the construction of the novel worker flow rate measure and compare it to existing data sources. Sections 2.3 and 2.4 present the business cycle decomposition of unemployment fluctuations and the evidence on duration dependence. Sections 3.1 to 3.3 outline the labor market model and the calibration strategy. Section 3.4 shows the optimal policies and welfare effects for the calibration with duration dependence. Section 3.5 presents the counterfactual experiment with homogeneous unemployed and flat UI benefits. Section 4 concludes.

## 2. Empirical evidence

This paper aims to evaluate the effect of labor market institutions, such as unemployment insurance schemes, on labor market outcomes and welfare. The core of this analysis is a structural model that captures the main features of labor market policies across countries and replicates the empirical patterns of labor market flows and unemployment rates both in terms of their level and their cyclical behavior. Bringing these two aspects - labor market policies and labor market outcomes - together is essential for the welfare analysis and the resulting policy implications: Jung and Kuhn (2014a) and Hartung et al. (2018) show that the effectiveness of UI benefit changes depends to a large extent on the level of worker flow rates and their sensitivity with respect to

aggregate fluctuations. It is therefore important to use reliable high-frequency data on worker flow rates into and out of unemployment for the structural analysis.

Furthermore, most UI benefit schemes in Europe are significantly more generous towards short- than towards long-term unemployed. The ensuing differences in search incentives and insurance has potentially large implications for the welfare analysis in the structural part of this paper. To account for that, it is necessary to have detailed data on worker flow rates by unemployment duration to calibrate the model such that it matches the duration-specific outflow rates.

To capture these features it is necessary to have data which (i) is available and comparable for a large set of European countries, (ii) covers a sufficiently long time span, (iii) has a high frequency (e.g. quarterly) and (iv) allows to compute outflow rates from unemployment by duration. Although there are several data sources on worker flow rates in Europe, none of these sources fulfills all of these four criteria. The following section therefore presents a novel measure for worker flow rates which is based on detailed quarterly unemployment stocks by unemployment duration and matches all of the criteria listed above.

## 2.1 Cross-country data on worker flow rates

Before presenting the new measure of worker flow rates, it is helpful to review the existing data sources on flow rates in Europe: The first data source is provided by the European statistical office (Eurostat) and based on the EU Labor Force Survey. It contains quarterly transitions between employment, unemployment and inactivity for most European countries from the second quarter of 2010 onwards (see for example Abraham et al. (2017)). Aside from the lack of data for Belgium and Germany - two major EU-countries - the main drawback of the reported flow rates is the relatively short time span which overlaps to a large extent with the Eurozone crisis. Especially for Southern European countries which experienced extraordinarily large increases in unemployment rates during the crisis, the resulting flow rates in that period are arguably not representative for the labor market dynamism of these economies in less extraordinary times.

The second measure of worker flow rates has been established by Elsby et al. (2013) and is based on annual data provided by the OECD on unemployment stocks for different unemployment durations from 1971 onwards.<sup>4</sup> They develop a more sophisticated version of the method pioneered by Shimer (2007) to compute average monthly hazard rates on an annual frequency for job finding and separation probabilities. In line with the Shimer-imputation, they exploit the stock-flow relationship between employment and unemployment in a two-state model which is represented in discrete time by the following two flow identities:

$$F_t = 1 - \frac{u_{t+1} - u_{t+1}^s}{u_t} \quad (3.1)$$

$$u_{t+1} = u_t(1 - F_t) + \underbrace{(1 - u_t)S_t}_{u_{t+1}^s} \quad (3.2)$$

---

<sup>4</sup>The time span for which data on unemployment by duration is available varies across countries. While only Sweden has data going back to 1971, most time series start between 1983 and 1994.

Here,  $F_t$  and  $S_t$  denote the UE- and EU-transition rate respectively.  $u_t$  denotes the overall unemployment rate and  $u_{t+1}^s$  the short-term unemployment rate in period  $t + 1$ . Due to its annual frequency, the OECD data does not allow to compute worker flow rates on a quarterly basis. Hence, the resulting time series have difficulties in tracking business cycle fluctuations of the unemployment rate.<sup>5</sup>

Given the shortcomings of these existing data sources on worker flow rates, this paper presents an alternative measure of worker flow rates which can be computed on a quarterly frequency from 1998 onwards<sup>6</sup>. The measure is based on quarterly data provided by Eurostat on the number of unemployed by detailed unemployment duration brackets. In contrast to the OECD data, the quarterly frequency is consistent with the quarterly unemployment duration brackets (less than 3 months, 3-6 months etc.) such that the number of newly unemployed  $u_{t+1}^s$  in equation 3.1 is equal to the number of all separations  $S_t$  between  $t$  and  $t+1$  in equation 3.2. The quarterly UE- and EU-transition rates  $F_t$  and  $S_t$  respectively can then be directly computed from equations 3.1 and 3.2. Furthermore, the detailed quarterly and biannual unemployment duration brackets allow to not only compute the *aggregate* outflow rate from unemployment but also the outflow rate for different unemployment durations on a quarterly frequency (see section 2.4 for details). As mentioned at the beginning of this section, this is essential for the structural analysis later on.

Table 3.1 summarizes the differences between the existing and the proposed measures of labor market flows. It should be noted that none of the measures allows to compute worker flow rates for all European countries, albeit each measure is lacking data on a different set of countries. Methodologically, the Shimer imputation does not allow to distinguish flows into and out of the labor force and therefore comprises only two rather than three labor market states. That is a clear advantage of the EU-LFS which explicitly measures flows between all three labor market states (employment, unemployment, inactivity).

Aside from these differences, the proposed flow rate measure has three main advantages over the existing measures: First, the high frequency allows to track business cycle fluctuations in both EU- and UE-flow rates over time. Second, the long time span allows to compute average levels and volatilities of flow rates excluding the period of the Great Recession and the Eurozone crisis, in particular for Southern European countries. Third, the proposed measure allows to compute UE-transition rates by unemployment duration on a quarterly basis. To the best of my knowledge, this is the first cross-country data on heterogeneous job finding rates with respect to unemployment duration on a higher frequency and for detailed duration brackets.<sup>7</sup>

---

<sup>5</sup>See the business cycle decomposition of steady-state unemployment in table 3 of their paper.

<sup>6</sup>For some countries, in particular Eastern European countries that joined the EU in the 2000s, data is only available for a shorter time span.

<sup>7</sup>Eurostat does provide annual data from 2011 onwards on job finding rates separately for unemployment durations less than one year and more than one year.



Table 3.1: Cross-country measures for worker flow rates

	EU-LFS	OECD	new measure
Frequency	quarterly	annual	quarterly
Start	2010q2	1971	1998q1
Method	survey	Shimer imputation	Shimer imputation
Labor market states	E/U/I	E/U	E/U
UE-rate by duration	NO	NO	YES
# European countries	27	26	29
Not in sample	Malta	Malta	Malta
	Belgium	Romania	Switzerland
	Germany	Croatia	
	Luxembourg	Cyprus	
		Bulgaria	

Notes: The last column refers to the new measure presented in this paper. It is based on the method developed in Shimer (2005a) to compute EU- and UE-transition rates and uses data on the stock of unemployed and short-term unemployed at a quarterly frequency (see text for details).

## 2.2 Fit with existing data sources

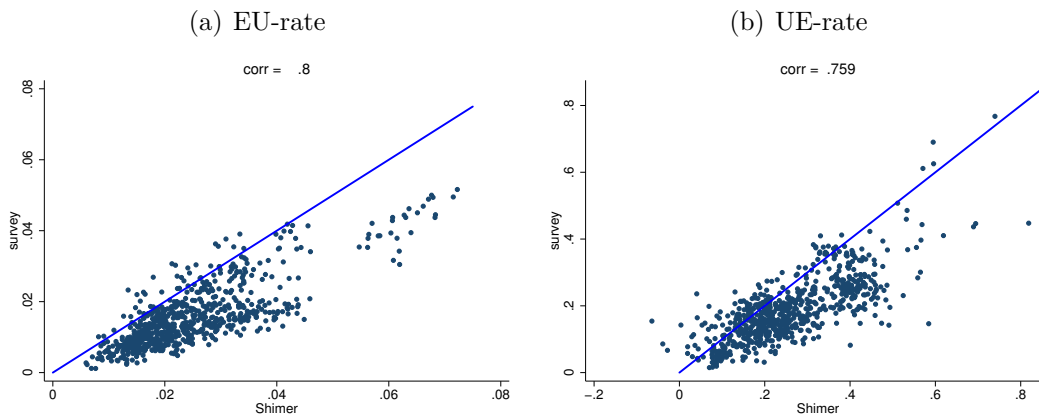
To test whether the proposed new measure of worker flows delivers reasonable estimates, it is natural to compare the obtained rates with existing data. This section does that along two dimensions: First, it shows that the time series of the obtained EU- and UE-transition rates closely track their respective survey-based counterpart reported by Eurostat in the period of overlap. Second, it shows that the implied steady-state unemployment rate based on the obtained EU- and UE-flow rates tracks the actual unemployment rate remarkably well for most European countries.

Before looking at these time series patterns, a first glance at the average level of transition rates reveals that there is a sizable level difference in most countries between the survey-based flow rates and the new flow rate measure imputed from data on short-term unemployed: Figure 3.1 plots the quarterly EU- and UE-transition rates in 24 European countries<sup>8</sup> based on the proposed Shimer-imputation (horizontal axis) against the corresponding flow rates in the Eurostat survey data (vertical axis). One dot is one quarter-country observation and the blue solid line marks the 45-degree line. Appendix A shows the same plot with average flow rates by country. Evidently, the imputed flows are larger than the corresponding survey measures for most countries and quarters. This level difference arises to some extent by construction because the EU Labor Force Survey contains transitions between three different employment states (employment, unemployment, inactivity), whereas the Shimer imputation is based on

<sup>8</sup>These are the countries for which data is available in both data sets, i.e. the survey measure provided by Eurostat and the Shimer-imputed flow rates based on short-term unemployment data.

a two-state model: In the Shimer imputation all newly unemployed are assumed to be inflows from employment (EU-transitions), neglecting that a certain fraction of these inflows into unemployment actually stems from the inactive population (NU-transitions). The measured separation rate in equation 3.2 is therefore higher in the two-state Shimer-imputation than in the survey data which explicitly distinguishes between EU- and NU-transitions. Given that the measured unemployment rate is the same in both data sets, this implies a higher UE-transition rate as well.

Figure 3.1: Quarterly worker flow rates: Eurostat vs. new measure



Notes: Left (right) panel shows quarterly EU (UE) transition rate for 24 European countries according to the survey data provided by Eurostat (vertical axis) and according to the new measure based on a Shimer imputation using data on short-term unemployment (horizontal axis). The graph combines time- and country-dimension. For country averages see appendix A. Blue solid line is the 45-degree line.

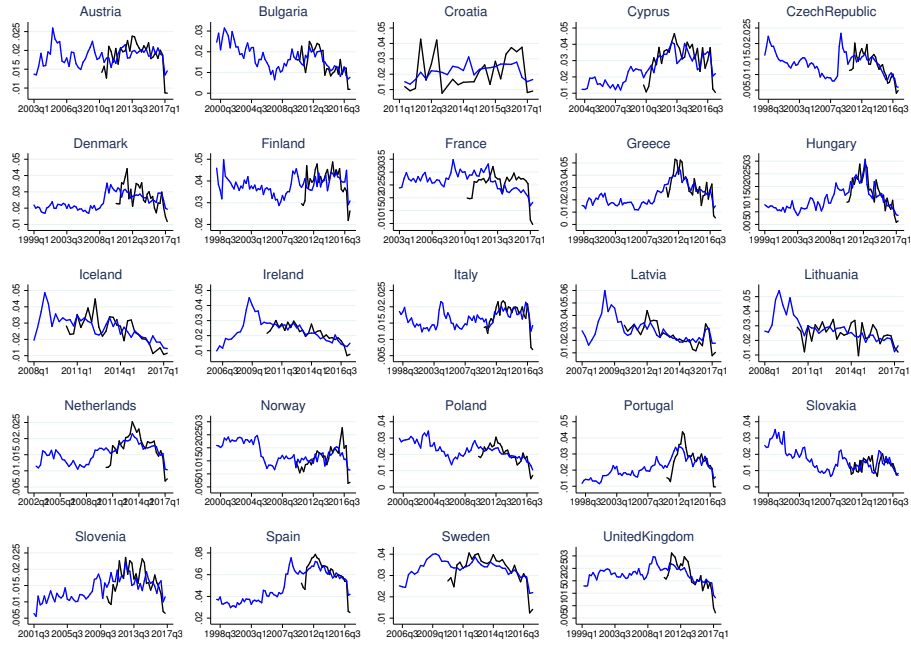
Apart from this level difference, the evolution of both measures over time matches remarkably well. Figure 3.2 shows the EU- and UE-transition rates respectively over time for 24 countries for which data is available in both data sets. The Eurostat survey series (black lines) are adjusted by a constant factor for each country to match the mean level of the proposed new worker flow measure (blue lines). The proposed measure tracks the existing time series quite well for most countries during the period of overlap which is consistent with the high correlations in figure 3.1.

A different approach to show the validity of the new measure is to compare the steady-state unemployment rate which is implied by these flow rates in each quarter with the actual counterpart. Appendix B describes in more detail how the steady-state unemployment rate is computed and shows the time series for each of the countries together with the actual unemployment rate.

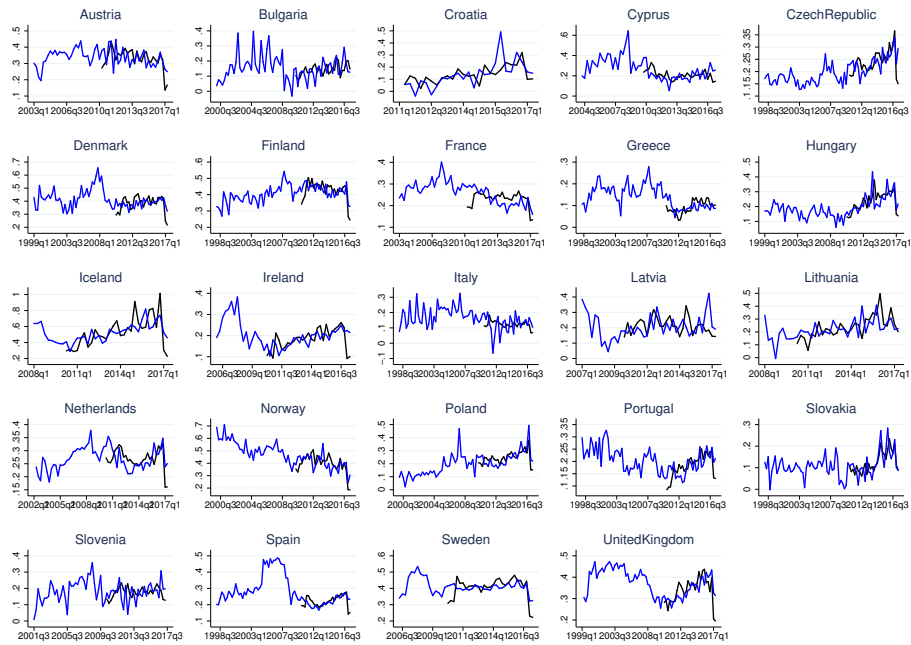
In order to test more formally whether the new time series are consistent with existing measures in figure 3.2 and figure 3.6 in appendix B, table 3.2 reports the corresponding time series correlations for each country. The EU-rates fit the existing survey-based EU-flows quite well. The UE-rates are positively correlated with the Eurostat time series for most countries. The implied steady-state unemployment rates is highly correlated with the actual unemployment rate in the data.

Figure 3.2: Fit of flow rates with Eurostat survey data

(a) EU-rates



(b) UE-rates



Notes: Quarterly Employment-to-unemployment (EU) transition rates for 24 European countries. Black-dashed line shows EU-transition rates based on Eurostat data (from 2010 onwards). Blue solid line shows EU-rates computed from stock-flow-equation and data on unemployment by duration as described in the text. Level of the black-solid line is adjusted by a constant factor for each country.

Table 3.2: Correlation of flow rates with Eurostat survey data

country	$corr(EU_t^{sur}, EU_t^{shim})$	$corr(UE_t^{sur}, UE_t^{shim})$	$corr(U_t^{ss}, U_t)$
Austria	0.58***	0.34*	0.16
Belgium			-0.09
Bulgaria	0.77***	0.11	0.17
Croatia	0.47**	0.49**	-0.02
Cyprus	0.72***	0.17	0.71***
Czech Republic	0.85***	0.39**	0.62***
Denmark	0.52***	0.25	0.82***
Finland	0.52***	0.50***	0.77***
France	0.35*	0.15	0.56***
Germany			0.88***
Greece	0.81***	0.20	0.76***
Hungary	0.80***	0.54***	0.57***
Iceland	0.62***	0.63***	0.79***
Ireland	0.79***	0.38**	0.70***
Italy	0.74***	-0.18	0.53***
Latvia	0.77***	-0.01	0.37**
Lithuania	0.49***	0.21	-0.01
Luxembourg			-0.19
Netherlands	0.87***	0.28	0.67***
Norway	0.61***	0.49***	0.69***
Poland	0.81***	0.64***	0.67***
Portugal	0.74***	0.47**	0.80***
Slovakia	0.33*	0.71***	0.11
Slovenia	0.42**	-0.16	0.08
Spain	0.89***	0.41**	0.91***
Sweden	0.85***	0.59***	0.75***
United Kingdom	0.89***	0.56***	0.86***

Notes: Time series correlation within countries between EU- and UE flow rates obtained from Eurostat survey data (“*sur*”) and from the new measure proposed in this paper following the Shimer-imputation (“*shim*”). The last column shows the correlation over time between the implied steady-state unemployment rate obtained from the novel flow-rate measure (see text for derivation) and the actual unemployment rate. Asterisks \*, \*\* and \*\*\* denote significance at the 10%-, 5%- and 1%-significance levels respectively.

### 2.3 Decomposition of business cycle variation

The new flow rates obtained from a quarterly Shimer imputation in this paper can therefore rationalize both the level and the cyclical movements of the unemployment rate in most European economies. That allows to investigate not only the average level differences across countries but also to address the question, how much of the cyclical unemployment fluctuations are driven by variations in unemployment inflow rates versus changing outflow rates.

Assessing the relative importance of the inflow and the outflow margin is important

in order to understand the drivers behind business cycle patterns. While most studies have mainly focused on specific countries (see Fujita and Ramey (2009) for the US and Jung and Kuhn (2014a) for a comparison between Germany and the US), the first paper that compared the importance of both margins across countries is Elsby et al. (2013). However, the annual OECD data they use does not allow to decompose business cycle fluctuations at a higher frequency. The worker flow rates established in this paper fill this gap as they are available at a quarterly frequency and for a broad set of countries. The method used here follows closely Fujita and Ramey (2009) who decompose deviations of the implied steady-state unemployment rate  $u_t^{ss}$  from trend into deviations of the EU- and the UE-transition rates from their respective trends and a residual term  $\epsilon_t$ :

$$\ln\left(\frac{u_t^{ss}}{\bar{u}_t^{ss}}\right) = (1 - \bar{u}_t^{ss})\ln\left(\frac{\pi_t^{EU}}{\bar{\pi}_t^{EU}}\right) - (1 - \bar{u}_t^{ss})\ln\left(\frac{\pi_t^{UE}}{\bar{\pi}_t^{UE}}\right) + \epsilon_t \quad (3.3)$$

Based on this identity, one can derive a simple variance decomposition and define the relative contribution of the three right-hand side terms towards cyclical fluctuations as  $\beta_{EU}$ ,  $\beta_{UE}$  and  $\beta_\epsilon$  respectively:

$$1 = \underbrace{\frac{Cov(du_t^{ss}, d\pi_t^{EU})}{Var(du_t^{ss})}}_{\beta_{EU}} + \underbrace{\frac{Cov(du_t^{ss}, d\pi_t^{UE})}{Var(du_t^{ss})}}_{\beta_{UE}} + \underbrace{\frac{Cov(du_t^{ss}, d\epsilon_t)}{Var(du_t^{ss})}}_{\beta_\epsilon} \quad (3.4)$$

The cyclical deviations from trend are obtained by first-differencing the log time series. Figure 3.3 summarizes the relative contributions of the three right-hand side terms for all European countries in the data set (for all numbers, mean rates and business cycle statistics see appendix C).

Three aspects stand out: First, the absolute size of the error term  $\beta_\epsilon$  is below 5% for all but five Eastern European countries and 4.7% on average. That is small compared to the average error terms of 21% obtained from the same steady-state decomposition in Elsby et al. (2013) using annual data. Using quarterly instead of annual data therefore seems to go a long way towards a precise picture of the relative contributions of inflow and outflow margins - without the need to do a more sophisticated non-steady-state decomposition.

Second, the outflow margin is the dominant driver of cyclical unemployment fluctuations in all but three countries.<sup>9</sup> Nonetheless, the inflow margin plays a non-negligible role as well, accounting for 20% or more of unemployment fluctuations in 22 out of the 29 countries.

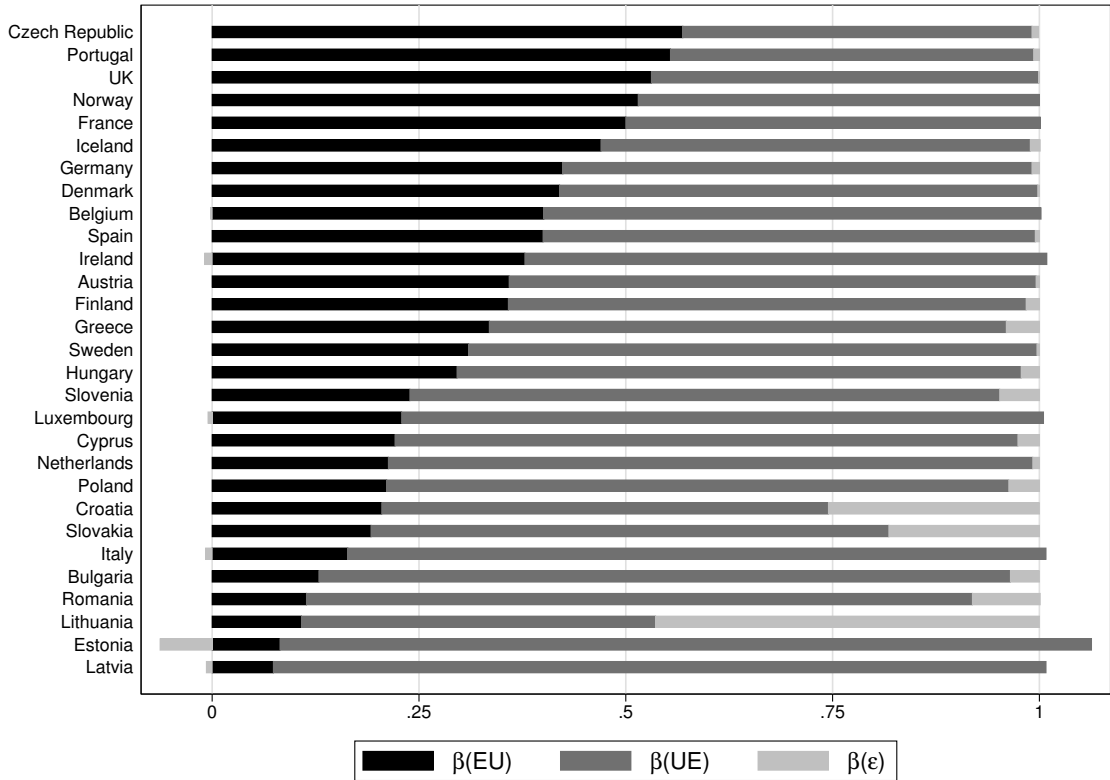
Third, the relative contributions of the inflow and outflow margins display a large heterogeneity across countries ranging from a 57/43 split in favor of inflow rates in the Czech Republic to a 7/93 split in Latvia. When trying to understand the drivers of cyclical unemployment fluctuations in Europe, it is therefore essential to take into account these large differences in the relative contributions of inflow and outflow rates over

---

<sup>9</sup>Somewhat surprisingly one of these three countries is the UK which has been marked as a highly dynamic labor market in which fluctuations in the outflow rate explain most of the unemployment fluctuations. This does not seem to be the case here.

the business cycle. This argument goes beyond the descriptive analysis of unemployment fluctuations: As Jung and Kuhn (2014a) show, the average size and cyclicity of inflow and outflow rates in a labor market influence how the unemployment rate reacts to changes in UI benefits as well. Hence, accounting for the differences in the cyclicity of worker flow rates across countries - as exemplified in the different relative contributions in figure 3.3 - is important in order to derive optimal UI policies in a structural model.

Figure 3.3: Business cycle decomposition:  $u^{ss}$



Notes: Relative contributions of EU-rate and UE-rate fluctuations towards cyclical movements in steady-state unemployment. Cyclical movements are based on first-differenced quarterly data as described in the text. Relative contributions are computed using the method by Fujita and Ramey (2009). The light-shaded area shows the contribution of the residual term  $\epsilon_t$ .

## 2.4 Job finding rates by unemployment duration

As mentioned in the introduction, there is evidence on the micro-level that outflow rates from unemployment potentially depend on unemployment duration (see e.g. Kol-srud et al. (2018)). This is important for designing optimal UI policies: Unemployed persons with different unemployment durations and job finding rates potentially react differently to changes in UI benefits. If there is large heterogeneity among the job finding rates of unemployed, then that could have an impact on the *aggregate* elasticity of job finding rates with respect to benefit changes. Furthermore, if job finding rates depend on duration, then an optimal UI policy scheme should take that into account

and condition on unemployment duration. Hence, it is essential to understand whether there is significant duration dependence of job finding rates in European labor markets. While the existing empirical evidence on duration dependence has relied on micro-data of particular countries, the existing cross-country data on job-finding rates by duration (Eurostat) is too sparse in terms of frequency and duration brackets to test for duration dependence. This section shows how the Eurostat data on unemployment *stocks* by duration can instead be used to fill this gap by computing quarterly job finding rates for six unemployment duration brackets across European countries. The resulting time series can then be used to test directly whether there is duration dependence in job finding rates by exploiting the time series variation.

The Eurostat data on unemployment stocks by duration is available on a quarterly frequency for 25 European countries<sup>10</sup> and for 8 different duration brackets<sup>11</sup>. These brackets can be grouped into 6 quarterly or bi-annual bins. The consistency of the duration brackets with the time series frequency allows to track cohorts of unemployed over the duration of their unemployment spell. As an example, consider a person who has been unemployed for 3 to 5 months in quarter  $t$ . That implies he became unemployed in quarter  $t - 1$  and did not find a job with the retention rate  $R_{t-1}^{<3} = 1 - F_{t-1}^{<3}$ . Here  $F_{t-1}^{<3}$  denotes the average job finding probability of persons with an unemployment duration of less than three months in the previous quarter  $t - 1$ . Equivalently, persons who have been unemployed for 6 to 11 months in quarter  $t$ , became unemployed in period  $t - 2$  or  $t - 3$  and did not find a job since then with the respective quarter-duration-specific retention rates. Following the same logic, one can link the stocks of unemployed in all available duration brackets over time to compute quarterly time series of duration-specific job finding rates. Appendix D shows in more detail how to compute these rates.

Before testing formally for duration dependence, figure 3.4 shows graphically how unemployment outflow rates vary with unemployment duration (horizontal axis) for 27 European countries. The blue line marks the average UE-rate in each country, while the black solid line shows duration-specific UE-transition rates. The vertical intervals mark a one-standard deviation of the variation of these rates over time. The picture is mixed: While in some countries job finding rates do not seem to depend on unemployment duration, other countries exhibit a clearly downward-sloping profile (e.g. Austria, Denmark, Finland, Germany, Spain, Sweden, UK). In these countries a longer unemployment duration is associated with lower job-finding rates.

This suggests to test more formally for duration dependence in job finding rates for each country. To do that, I pool the duration brackets into short-term ( $\leq 12$  months) and long-term unemployed ( $> 12$  months) and compute the UE-transition rates over time for each of the two groups. A simple pairwise t-test can then be used to test whether these two rates are significantly different from each other.

Table 3.3 summarizes the results. The first three columns show the mean share of long-term unemployed and the average quarterly UE-transition rates for short- and long-term unemployed. The last column shows the average ratio of the UE-rates of

---

<sup>10</sup>Due to a lack of duration-specific data for Iceland and Luxembourg

<sup>11</sup>All numbers in months: <1; 1-2; 3-5; 6-11; 12-17; 18-23; 24-48; >48

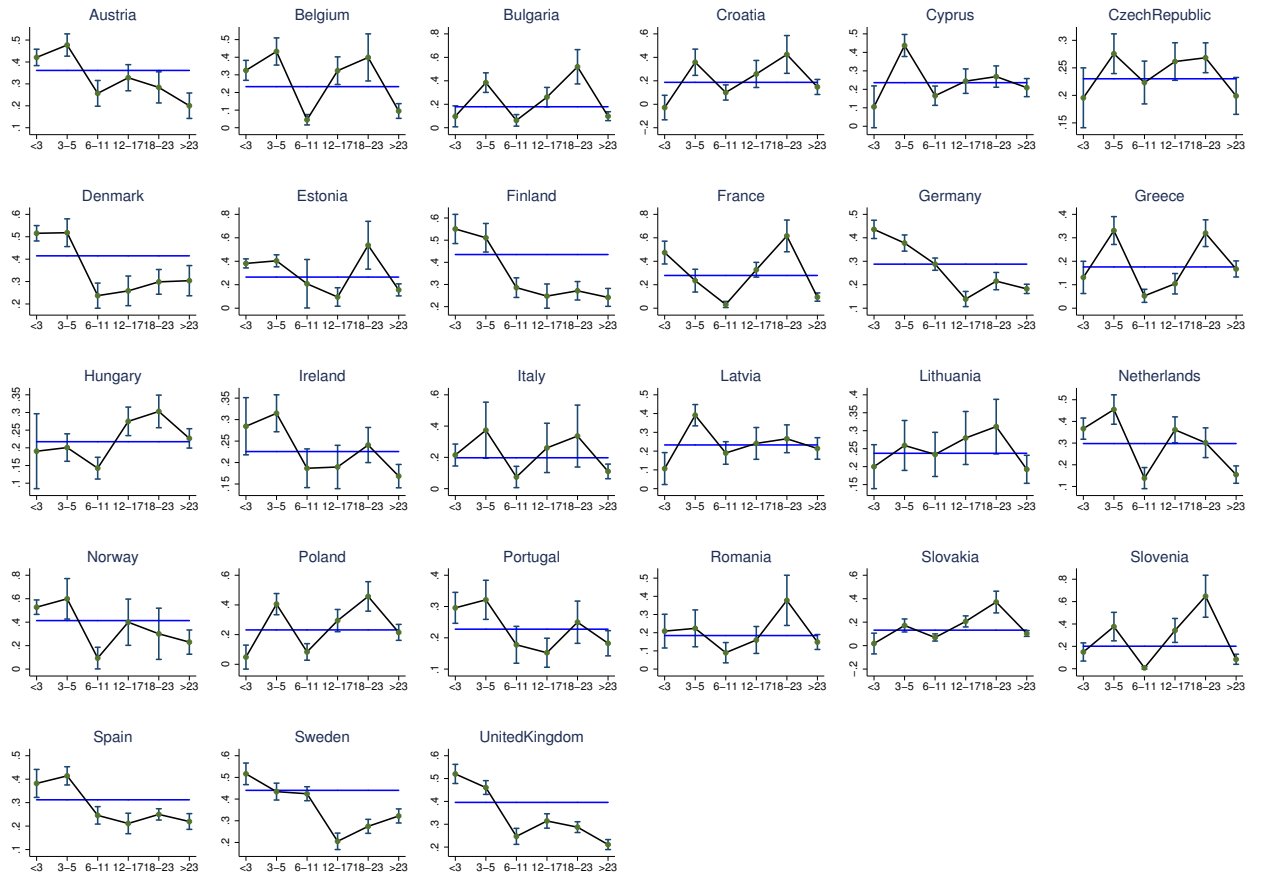
short-term and long-term unemployed, where asterisks mark whether the difference between the two rates is statistically significant.

Two aspects stand out: First, the share of long-term unemployed varies largely across countries ranging from 18% in Sweden to 67% on average in Slovakia. Second, there is significant negative duration dependence for 12 out of the 27 countries and among these countries are some of the largest labor markets in Europe (e.g. Germany, France, UK, Spain). Furthermore the differences in job finding rates in countries with negative duration dependence are sizable: In Germany, short-term unemployed are twice as likely to exit unemployment as long-term unemployed. In Spain, Sweden or the UK the difference is lower but still between 50% and 80%. In contrast, there are only three Eastern European countries (Poland, Hungary, Slovakia) which show significant positive duration dependence, i.e. long-term unemployed find new jobs on average with higher probability than short-term unemployed.

This evidence suggests that in most countries short- and long-term unemployed indeed differ substantially regarding the likelihood of exiting unemployment. Additionally, countries differ substantially both in the share of short- versus long-term unemployed *and* in the relative likelihoods of these groups to exit unemployment. Accounting for these cross-country differences in job-finding rates and the composition of the unemployment pool is potentially crucial for the design of optimal UI policies and will therefore be the basis for the following structural analysis.



Figure 3.4: UE-rates by unemployment duration



Notes: Average quarterly UE-rates by unemployment duration. Duration brackets on the horizontal axis refer to months of unemployment (< 3m; 3-5m; 6-11m; 12-17m; 18-23m;  $\geq$  23m). The blue solid horizontal line is the average UE-rate in the country. Vertical intervals mark a one-standard deviation around the average duration-specific UE-rate based on time series variation.

Table 3.3: UE-rates by duration

country	$\frac{U_{>12m}}{U}$	$UE_{\leq 12m}$	$UE_{>12m}$	$\frac{UE_{<12m}}{UE_{>12m}}$
Austria	0.268	0.397	0.263	1.512***
Belgium	0.487	0.278	0.185	1.502***
Bulgaria	0.573	0.176	0.181	0.974
Croatia	0.572	0.153	0.211	0.725
Cyprus	0.411	0.238	0.233	1.021
Czech Republic	0.460	0.231	0.227	1.016
Denmark	0.259	0.456	0.289	1.578***
Estonia	0.560	0.342	0.200	1.709
Finland	0.241	0.490	0.251	1.949***
France	0.412	0.299	0.247	1.210***
Germany	0.469	0.380	0.179	2.120***
Greece	0.568	0.167	0.178	0.933
Hungary	0.454	0.185	0.255	0.725***
Iceland	-	-	-	-
Ireland	0.487	0.262	0.181	1.449***
Italy	0.551	0.220	0.178	1.231
Latvia	0.487	0.229	0.235	0.976
Lithuania	0.469	0.236	0.233	1.011
Luxembourg	-	-	-	-
Netherlands	0.367	0.330	0.243	1.355***
Norway	0.285	0.447	0.343	1.305
Poland	0.436	0.176	0.291	0.606***
Portugal	0.477	0.265	0.186	1.425***
Romania	0.567	0.177	0.187	0.942
Slovakia	0.670	0.091	0.150	0.603***
Slovenia	0.500	0.170	0.228	0.743
Spain	0.364	0.359	0.222	1.619***
Sweden	0.180	0.477	0.268	1.783***
UK	0.275	0.444	0.258	1.722***

Notes: Column 1 shows the average share of long-term unemployed ( $> 12m$ ). Column 2 and 3 show the average quarterly UE-transition rates for short-term and long-term unemployed respectively. Column 4 shows the average ratio of the UE-transition rates of short- versus long-term unemployed. Asterisks \*, \*\* and \*\*\* denote significance at the 10%-, 5%- and 1%-significance levels of the corresponding pairwise t-test ( $H_0$ : Time series of UE-rates for short- and long-term unemployed are identical).

## 3. Model

### 3.1 General approach

As mentioned in the introduction, a structural welfare analysis that compares existing - and potentially sub-optimal - national policies with an optimally chosen federal UI scheme for the entire Eurozone confounds two steps: Moving from sub-optimal to optimal policies and replacing national policies with a single UI scheme applicable in all countries. This paper tackles this problem by comparing explicitly the welfare of each country in three different scenarios: The first scenario is the status quo with the current labor market policies in place (*status quo*). Given these policies the structural model allows to back out the country-specific parameters (e.g. preference for leisure) that rationalize the labor market outcomes observed in the data, in particular the level and cyclicity of EU- and UE-transition rates. With these country-specific parameters at hand, the second scenario (*optimal national*) computes the optimal, i.e. welfare-maximizing, national UI policy for each country separately. The third scenario (*optimal union*) then introduces a European union which chooses one optimal common UI policy which is applicable in all countries by maximizing the labor-force-weighted welfare of all countries in the union.

That approach allows to compute first the welfare gains of having optimal national policies instead of the current policies and then in a second step to compute the welfare losses of moving from an optimal national to an optimal union level policy. Third, it allows to compute in a third step the welfare effects for each country of moving from the status quo to the optimal common UI scheme. These welfare effects could go either way, depending on whether the optimal common UI policy moves the country closer to its country-specific optimal policy or further away from it.

In doing that, the analysis focuses on the welfare effects of the labor market distortions due to changing UI policies and is agnostic about other channels such as transfers across countries or moral hazard on the country level. Therefore, the model abstracts from genuine economic links between the member states of the union apart from the union government choosing one labor market policy for all member states. In addition, there is no feedback from the national to the union level as the national governments cannot adjust their country-specific policies (e.g. layoff taxes). The only local parameter that adjusts mechanically is the labor tax in order to balance the national budget, which implies that there are no transfers across countries.

However, section 3.6 provides a back-of-the envelope estimation of the benefits associated with full insurance against aggregate shocks. The exercise does not model an integrated union in detail but instead computes the welfare gains of eliminating aggregate shocks entirely. That is comparable to a union of small open economies with uncorrelated shocks and full insurance through transitory transfers across countries.

### 3.2 Model setup

The model follows closely the decentralized economy in Jung and Kuester (2015) and inherits most of the key assumptions and features in their paper, two of which are crucial

for the optimal UI policy later on: First, the search effort of unemployed workers cannot be observed by the government which introduces a moral-hazard insurance tradeoff. Second, separations are endogenous and therefore the job separation rate reacts to aggregate productivity fluctuations as well as policy changes. The main difference is that in this paper there are two types of unemployed (short- and long-term unemployed) with heterogeneous job-finding probabilities, which turns out to be essential for the optimal policy design.

There is a continuum of risk-averse workers with measure one who are homogeneous regarding their ex-ante idiosyncratic productivity. There are infinitely many potential one-worker firms which produce a homogeneous good that cannot be stored. Together with the closed-economy assumption, that implies that workers cannot insure themselves against individual labor market risk. Time is discrete and workers live infinitely. There is an aggregate productivity shock that applies to all worker-firm matches. In addition to this aggregate shock, each match receives an idiosyncratic cost shock upon which it can either separate or incur the cost and enter the production stage. In the model the worker and the firm will negotiate jointly the wage and the cost threshold above which they separate *after* learning the aggregate shock but before the realization of the idiosyncratic cost shock. Separations arise endogenously in this setup because the aggregate productivity realization affects the negotiated separation threshold which is identical across matches and therefore pins down the total amount of separations after idiosyncratic shocks are realized. Similarly, unemployed workers decide whether or not to search during the search stage at the end of the period subject to an idiosyncratic search cost shock. The distribution of this search cost shock depends on unemployment duration resulting in duration-dependent unemployment outflow probabilities.

### Labor market and matching

The measure of workers employed at the beginning of period  $t$  is denoted by  $e_t$  and evolves according to

$$e_{t+1} = (1 - \zeta_t)e_t + m_t \quad (3.5)$$

where  $\zeta_t$  denotes the share of existing worker-firm matches which are separated at the beginning of the period and  $m_t$  the number of new matches formed at the end of the period. There are short-term and long-term unemployed  $u_{1,t}$  and  $u_{2,t}$  such that the number of unemployed is  $u_{1,t} + u_{2,t} = 1 - e_t$ . Short-term unemployed move into long-term unemployment with probability  $\delta$ .

Firms post vacancies  $v$  at resource cost  $\kappa_v$ . New matches are created according to the matching function

$$m_t = \chi v_t^\gamma [(\zeta_t e_t + u_{1,t}) s_{1,t} + u_{2,t} s_{2,t}]^{1-\gamma} \quad (3.6)$$

Unemployed workers can choose whether or not to search for a job. Therefore, the mass of searchers is given by the term in parentheses on the right-hand side  $[\zeta_t e_t + u_{1,t}] s_{1,t} + u_{2,t} s_{2,t}$  where  $s_{1,t}$  is the fraction of newly separated employees and short-term unem-

ployed that is searching for a job. Similarly,  $s_{2,t}$  is the share of long-term unemployed searching for a job.

Note that the timing is such that existing matches are dissolved at the beginning of the period. Therefore newly separated workers  $\zeta_t e_t$  enter the pool of job searchers when matching takes place at the end of the period. Accordingly, labor market tightness  $\theta_t$  and the average job-finding rate of unemployed searchers  $\bar{f}_t$  are defined as

$$\theta_t = \frac{v_t}{(\zeta_t e_t + u_{1,t}) s_{1,t} + u_{2,t} s_{2,t}} \quad (3.7)$$

$$\bar{f}_t = \frac{m_t}{(\zeta_t e_t + u_{1,t}) s_{1,t} + u_{2,t} s_{2,t}} \quad (3.8)$$

Although this contact rate  $\bar{f}_t$  is equal for short- and long-term unemployed job searchers, the different shares of searchers  $s_{1,t}$  and  $s_{2,t}$  in the two groups imply that the actual outflow rates out of unemployment are different. The factor  $\Delta f_t^{1,2} = s_{1,t}/s_{2,t}$  therefore reflects the difference in job finding rates of short-term relative to long-term unemployed.<sup>12</sup>

### Value of employed workers

Workers are risk averse and have standard utility functions that are strictly increasing, twice differentiable and concave in the period's consumption level. They discount future utility with time-discount factor  $\beta \in (0, 1)$ . Workers who are employed throughout period  $t$  consume  $c_t^e$  and newly separated workers consume  $c_t^{eu}$ . Newly separated workers are fully insured by their employer through a pre-negotiated severance payment  $w_t^{eu}$  which will be equal to their previous wage in equilibrium. Short- and long-term unemployed workers receive  $c_{1,t}^u$  and  $c_{2,t}^u$ , respectively. The value of an employed worker at the start of the period, i.e. before idiosyncratic shocks are realized, is then given by

$$V_t^e = (1 - \zeta_t) [U(c_t^e) + \beta \mathbb{E}_t V_{t+1}^e] + \zeta_t V_t^{eu} \quad (3.9)$$

Here,  $\zeta_t$  is the probability that the match separates. If the match does not separate, the worker enters the production stage, consumes  $c_t^e$  and the match continues into the next period. If the match is dissolved, the worker consumes  $c_t^{eu}$  and enters the search stage at the end of the period. If he does not find a job during the search stage, he will enter the next period as a short-term unemployed worker. The value function of a newly separated employee  $V_t^{eu}$  is therefore identical to the value of a short-term unemployed worker except for the consumption level in the period of separation:

$$V_t^{eu} = V_{1,t}^u + U(c_t^{eu}) - U(c_{1,t}^u) \quad (3.10)$$

As workers are not allowed to save or dissave, the budget constraint of an employed worker is given by  $c_{e,t} = w_t + \Pi_t$  if he is not separated and  $c_t^{eu} = w_t^{eu} + \Pi_t$  if he is separated. Here,  $\Pi_t$  denotes the dividend flow from all firms which are owned equally by all workers in the economy.

---

<sup>12</sup>This relative formulation is chosen as it directly maps to the data presented in table 3.3.

## Value of unemployed workers

Unemployed workers receive unemployment benefits  $B_{j,t}$  where  $j = 1$  indicates short-term and  $j = 2$  long-term unemployed workers. The budget constraint is therefore given by  $c_{j,t}^u = B_{j,t} + \Pi_t$ . In addition to the utility stream from consumption, unemployed workers receive utility from leisure  $\bar{h}$  which can alternatively be interpreted as home production. To simplify notation, it is helpful to define the surplus of being employed versus being unemployed of type  $j$  as

$$\Delta_{j,t}^e = V_t^e - V_{j,t}^u \quad (3.11)$$

Unemployed workers need to actively search in order to find a job. Search is associated with an idiosyncratic utility cost  $\iota_i \sim F_\iota(\mu_j, \sigma_{j,\iota}^2)$  which is independently and identically distributed across workers and across time. For analytical tractability,  $F_\iota(\mu_{j,\iota}, \sigma_{j,\iota}^2)$  follows a logistic distribution with mean  $\mu_j$  and variance  $\sigma_{j,\iota}^2 = \pi \frac{\psi_{s,j}^2}{3}$ . Note that the parameters of this distribution depend on the unemployment type  $j$ , i.e. short- and long-term unemployed differ regarding the distribution of search cost shocks they receive.

Upon learning the realization of their idiosyncratic search cost shock, unemployed can decide whether or not to search for a job (there is no intensive margin of search). The worker is indifferent between searching or not, if the benefits of finding a job offset the costs of searching. This indifference point is described by the type-specific cut-off value  $\bar{\iota}_{j,t}$  at which the utility cost of search equals the expected discounted surplus of being employed weighted with the probability of finding a job:

$$\bar{\iota}_{j,t} = \bar{f}_t \beta \mathbb{E}_t \Delta_{j,t+1}^e \quad (3.12)$$

Note that  $\bar{f}_t$  is the probability of finding a job *conditional* on searching, which is the same for both types of unemployed. Hence, there is no index  $j$  on the contact rate  $\bar{f}_t$ . Unemployed decide to search if their realization of the search cost shock is smaller than  $\bar{\iota}_{j,t}$ . The properties of the logistic distribution then allow to define the share of unemployed workers of type  $j$  who search for a job as a function of the cut-off value  $\bar{\iota}_{j,t}$  and the parameters of the distribution:

$$s_{j,t} = Pr(\iota \leq \bar{\iota}_{j,t}) = \frac{1}{1 + \exp\{(\mu_j - \bar{\iota}_{j,t})/\psi_{s,j}\}} \quad (3.13)$$

The value of an unemployed worker of type  $j \in \{1, 2\}$  before the realization of the idiosyncratic search cost shock  $\iota_i$  can then be described as

$$\begin{aligned} V_{1,t}^u &= U(c_{1,t}^u) + \bar{h} + \int_{-\infty}^{\bar{\iota}_{1,t}} [-\iota_i + \bar{f}_t \beta \mathbb{E}_t V_{t+1}^e] dF_{\iota_1}(\iota_i) \\ &\quad + (1 - \bar{f}_t F(\bar{\iota}_{1,t})) \beta [\delta \mathbb{E}_t V_{2,t+1}^u + (1 - \delta) \mathbb{E}_t V_{1,t+1}^u] \end{aligned} \quad (3.14)$$

$$\begin{aligned} V_{2,t}^u &= U(c_{2,t}^u) + \bar{h} + \int_{-\infty}^{\bar{\iota}_{2,t}} [-\iota_i + \bar{f}_t \beta \mathbb{E}_t V_{t+1}^e] dF_{\iota_2}(\iota_i) \\ &\quad + (1 - \bar{f}_t F(\bar{\iota}_{2,t})) \beta \mathbb{E}_t V_{2,t+1}^u \end{aligned} \quad (3.15)$$

The first two terms of each value function describe the contemporaneous value of consumption and leisure. The integral contains the costs of search and the expected value of employment if a job is found, both conditional on searching. The second line describes the continuation value of staying unemployed in case the worker decides not to search or searches unsuccessfully. Short-term unemployed (equation 3.14) become long-term unemployed with probability  $\delta$ .

This setup implies that there is “true” duration dependence in job finding rates, i.e. all workers are ex-ante identical when entering unemployment but their ability to find a job depreciates over time. In particular, they face a different distribution of search cost shocks once they become long-term unemployed which results in different job-finding probabilities.

An alternative way to introduce duration dependence would be to have ex-ante heterogeneous types of unemployed with different search cost distributions that do not change over their respective unemployment spell. As those unemployed who have on average low search costs move out of unemployment at a faster pace, there is a selection effect where mostly unemployed persons with high search costs end up in long-term unemployment. This selection effect based on different unemployment types also results in different job finding probabilities by duration and therefore has qualitatively similar implications as the setup with “true” duration dependence chosen here.

Ideally, the model would feature both sources of duration dependence. However, disentangling the relative importance of both channels empirically is quite challenging and beyond the scope of this paper. Section 3.4 discusses this assumption in more detail and shows that the results obtained here are similar to results obtained in other models featuring both sources of heterogeneity.

### Value of the firm

Each firm  $k$  that enters the period matched to a worker can decide to produce or separate from the worker. Production entails an idiosyncratic resource cost  $\epsilon_k \sim F_\epsilon(\mu_\epsilon, \sigma_\epsilon^2)$  which is independently and identically distributed across time and across matches.  $F_\epsilon(\mu_\epsilon, \sigma_\epsilon^2)$  follows the logistic distribution with mean  $\mu_\epsilon$  and variance  $\sigma_\epsilon^2 = \pi \frac{\psi^2}{3}$ .

The match separates if the resource cost shock exceeds a threshold  $\bar{\epsilon}_t^\xi$ . The value of the firm before the realization of the resource cost shock is given by

$$\begin{aligned}
 J_t &= - \int_{\bar{\epsilon}_t^\xi}^{\infty} [\tau_{\xi,t} + w_t^{eu}] dF_\epsilon(\epsilon_k) \\
 &\quad + \int_{-\infty}^{\bar{\epsilon}_t^\xi} [\exp\{a_t\} - \epsilon_k - w_t - \tau_{J,t} + \mathbb{E}_t Q_{t,t+1} J_{t+1}] dF_\epsilon(\epsilon_k)
 \end{aligned} \tag{3.16}$$

If the resource cost shock is larger than the threshold  $\bar{\epsilon}_t^\xi$  (first line), the match is separated in which case the firm has to pay a layoff tax  $\tau_{\xi,t}$  and a severance payment  $w_t^{eu}$  to the worker. If the resource cost is below the separation threshold, the match is not separated (second line) and the firm produces with production function  $y = \exp\{a_t\}$  where  $a_t$  denotes the aggregate productivity level in period  $t$ . Aggregate productivity follows an AR-1 process  $a_t = \rho_a a_{t-1} + \epsilon_{a,t}$  where  $\rho_a \in [0, 1)$  and  $\epsilon_a \sim N(0, \sigma_a^2)$ . The firm

pays the resource cost  $\epsilon_k$ , the wage  $w_t$  and a payroll tax  $\tau_{J,t}$ , and the match continues into the future. As shares in the firm are held in equal amounts by the workers in the economy, the future profits are discounted with the factor  $Q_{t,t+s} = \beta \frac{\lambda_{t+s}}{\lambda_t}$  where  $\lambda_t$  is defined by the weighted marginal utilities of the firm's owners:

$$\lambda_t := \left( \frac{e_t(1 - \zeta_t)}{U'(c_t^e)} + \frac{e_t \zeta_t}{U'(c_t^{eu})} + \frac{u_{1,t}}{U'(c_{1,t}^u)} + \frac{u_{2,t}}{U'(c_{2,t}^u)} \right) \quad (3.17)$$

Similarly as for the search decision, the properties of the logistic distribution allow to express the probability of separation  $\zeta_t$  ex-ante, i.e. before the realization of the idiosyncratic production cost shock, analytically as a function of the threshold shock realization  $\bar{\epsilon}_t^\xi$ :

$$\zeta_t = Pr(\epsilon_k \geq \bar{\epsilon}_t^\xi) = \frac{1}{1 + \exp\{(\bar{\epsilon}_t^\xi - \mu_\epsilon)/\psi_\epsilon\}} \quad (3.18)$$

As firms are homogeneous ex-ante, this probability  $\zeta_t$  is equal to the aggregate separation rate in the economy.

Firms that are not matched with a worker at the beginning of the period can post a vacancy at resource cost  $\kappa_v > 0$ . In equilibrium, firms post vacancies until the prospective gains from hiring are offset by the costs of posting a vacancy:

$$\kappa_v = q_t \mathbb{E}_t [Q_{t,t+1} J_{t+1}] \quad (3.19)$$

Here,  $q_t = m_t/v_t$  denotes the vacancy filling rate which is determined by the number of vacancies posted and the matching function in equation 3.6.

### Timing and Bargaining

The timing is such that matched workers and firms observe the aggregate shock  $a_t$  at the beginning of the period. Conditional on that information they jointly bargain over state-contingent wages  $w_t$ , the severance payment  $w_t^{eu}$  and the separation threshold  $\bar{\epsilon}_t^\xi$ . They then observe the idiosyncratic resource cost  $\epsilon_k$  and either separate or produce depending on whether the  $\epsilon_k$  is above or below the bargained separation threshold. After the production stage, unemployed and newly separated workers observe the realization of their idiosyncratic search cost shock  $\iota_i$  and decide whether or not to search for a job. At the same time unmatched firms decide whether or not to post a vacancy and matching takes place according to the matching function. At the end of the period a fraction  $\delta$  of short-term unemployed workers becomes long-term unemployed.

These timing assumptions have two noteworthy implications. First, the outside option of matched workers is always to become *short-term* unemployed if the match breaks up. Even long-term unemployed who find a match in the search stage and then immediately separate at the beginning of the next period, move into short-term unemployment without having actually worked. This assumption implies that the wage negotiated in new matches does not depend on the unemployment history, in particular on whether the worker was short- or long-term unemployed before meeting the firm. Second, the



severance payment  $w^{eu}$  does not affect the search decision of unemployed workers for the next period as it is paid only in the period of separation. Newly separated workers therefore search with the same intensity as persons who already entered the period as short-term unemployed.

Worker and firm use generalized Nash bargaining and maximize

$$\{w_t, w_t^{eu}, \bar{c}_t^\xi\} = \operatorname{argmax} \left( \Delta_{1,t}^e \right)^{(1-\eta_t)} (J_t)^{\eta_t} \quad (3.20)$$

Here,  $\eta_t$  is the bargaining power of the firm. The outcome of the bilateral bargaining is privately efficient and the match will therefore only separate if the joint surplus of the match is negative. As in Jung and Kuester (2015), the firm fully insures the worker against the idiosyncratic risk of the resource cost shock. Therefore the wage is independent of the shock realization  $\epsilon_k$  and the severance payment equals the wage ( $w_t = w_t^{eu}$ ), implying that  $c_t^{eu} = c_t^e$ . The first-order conditions then pin down the bargained wage and separation threshold through the two equations

$$(1 - \eta_t)J_t = \eta_t \frac{\Delta_{i,t}^e}{U'(c_t^e)} \quad (3.21)$$

$$\begin{aligned} \bar{c}_t^\xi &= [\exp\{a_t\} - \tau_{J,t} + \tau_{\xi,t} + \mathbb{E}_t Q_{t,t+1} J_{t+1}] \\ &\quad + \frac{\beta E_t \Delta_{1,t+1}^e + \psi_{s,1} \log(1 - s_{1,t}) - \bar{h}}{U'(c_t^e)} \end{aligned} \quad (3.22)$$

The separation threshold  $\bar{c}_t^\xi$  has an intuitive interpretation: The term in parentheses denotes the actual output produced net of taxes plus the expected value of the match at the beginning of next period. If productivity  $a_t$  is high, this term increases which raises the separation threshold and reduces the likelihood with which the match separates. Separations therefore arise endogenously and are counter-cyclical. Similarly, layoff taxes  $\tau_{\xi,t}$  raise the separation threshold and therefore reduce the likelihood of the match separating. The term on the second line captures the employee's surplus of staying employed compared to becoming unemployed. A larger worker surplus implies that the employee is reluctant to separate which results in a higher separation threshold.

### Profits, Government and Market Clearing

Profits are given in the aggregate by

$$\Pi_t = e_t \left( \int_{-\infty}^{\bar{c}_t^\xi} [\exp\{a_t\} - \epsilon - \tau_{J,t}] dF_\epsilon(\epsilon) - \int_{\bar{c}_t^\xi}^{\infty} [\tau_{\xi,t}] dF_\epsilon(\epsilon) - w_t \right) - \kappa_v v_t \quad (3.23)$$

These profits are distributed as dividends to a mutual fund which is owned by all workers in equal amounts.

The government levies payroll and layoff taxes and pays unemployment benefits. The

government budget constraint is therefore given by

$$e_t(1 - \zeta_t)\tau_{J,t} + e_t\zeta_t\tau_{\xi,t} = \sum_{j \in \{1,2\}} u_{j,t}b_{j,t} \quad (3.24)$$

The aggregate output is  $y_t = e_t(1 - \zeta_t)\exp\{a_t\}$ , i.e. the number of non-separated matches that produce with aggregate productivity  $a_t$ . The goods market clears if the aggregate output equals aggregate demand which is given by

$$y_t^D = e_t c_t^e + \sum_{j \in \{1,2\}} u_{j,t} c_{j,t}^u + e_t \int_{-\infty}^{\bar{\epsilon}_t} \epsilon dF_{\epsilon}(\epsilon) + \kappa_v v_t \quad (3.25)$$

Equation 3.25 shows that a fraction of total production is spent on vacancy posting costs and the resource cost of production  $\epsilon$ . Note that in contrast to the resource cost, the search cost accruing to unemployed searchers is a pure utility cost and therefore does not enter aggregate demand.

### 3.3 Calibration

The model is calibrated separately for 11 European countries. The number of countries is smaller than outlined in the data section due to data limitations, in particular regarding information on vacancies and labor market policies. Some countries are excluded because the time series on worker flow rates are not sufficiently long to obtain reasonable cyclical variations.<sup>13</sup> The countries in the sample cover 62% of employment in the EU. The model is calibrated for each country separately.

The calibrated parameters can be grouped into three categories: First, there are parameters that are identical across countries. Second, there are country-specific parameters describing preferences and utility or resource costs of workers and firms as well as the matching technology. These parameters are pinned down by data on the level and cyclicity of labor market flows and additional labor market outcomes, such as the vacancy filling rate. The third group comprises country-specific parameters describing the labor market policies in each country, i.e. net replacement rates, which are reported in the OECD statistics, and layoff taxes. Table 3.4 summarizes all three groups of parameters for the 11 countries in the baseline sample.

Note that this paper assumes the country-specific structural parameters to be time- and policy-invariant. In reality, it could be the case that differences in preferences and technological constraints arise endogenously from differences in labor market policies and institutions. As the direction of this causality is notoriously difficult to identify, this paper focuses on the case without a feedback from institutions to preferences.

#### Common parameters

The calibration of parameters that are identical across countries closely follows Jung and Kuester (2015). The risk-averse workers have a log-utility function. One period in

---

<sup>13</sup>Missing data on labor market policies: Bulgaria, Croatia, Cyprus, Iceland, Latvia, Lithuania, Slovenia. Missing data on vacancies: Denmark. Time series too short: Estonia, Luxembourg, Romania.

Table 3.4: Parameters Baseline ( $b_1 \neq b_2$ )

Parameter	AUS	FIN	FRA	GER	GRE	ITA	NED	NOR	POR	ESP	SWE
$\beta$ Time-discount factor	0.996	-	-	-	-	-	-	-	-	-	-
$\rho_a$ AR(1) aggr. productivity	0.980	-	-	-	-	-	-	-	-	-	-
$\sigma_a$ SD aggr. productivity (x100)	0.182	-	-	-	-	-	-	-	-	-	-
$\eta$ Bargaining power firm	0.300	-	-	-	-	-	-	-	-	-	-
$\gamma$ matching elasticity	0.300	-	-	-	-	-	-	-	-	-	-
$\mu_{1,t}$ Mean search cost ( $j = 1$ )	0.000	-	-	-	-	-	-	-	-	-	-
$\delta$ Prob( $j = 2 j = 1$ )	0.083	-	-	-	-	-	-	-	-	-	-
$\bar{h}$ Home prod. unemployed	-1.284	-1.052	-0.488	-1.009	-1.627	-0.348	-1.355	-2.854	-1.098	-0.576	-0.758
$\mu_{2,t}$ Mean search cost ( $j = 2$ )	1.508	1.488	0.475	0.938	-0.825	0.499	1.176	2.403	1.139	0.940	1.423
$\psi_s$ Dispersion search cost ( $j = 1, 2$ )	1.008	0.444	0.257	0.441	0.989	0.450	1.193	2.683	0.169	0.137	0.274
$\kappa_v$ Vacancy posting cost	2.529	1.766	2.394	1.304	10.580	2.760	1.175	1.089	4.334	2.380	1.861
$\chi$ Matching efficiency	0.206	0.246	0.187	0.125	0.134	0.113	0.138	0.209	0.161	0.231	0.252
$\mu_\epsilon$ Mean resource cost	0.161	0.213	0.148	0.180	0.309	0.175	0.132	0.182	0.219	0.211	0.230
$\psi_\epsilon$ Dispersion resource cost	4.218	3.039	2.862	5.475	8.283	5.098	3.995	4.892	6.185	3.071	3.654
$\gamma_w$ Cyclical bargaining power	13.712	1.749	11.836	26.583	24.239	24.183	48.530	19.243	19.305	46.000	10.399
$\tau_\zeta$ Layoff tax (in months)	7.683	3.964	3.905	12.000	1.824	9.776	6.644	10.867	14.283	4.959	7.021
$b_1$ Short-term UI benefits	0.666	0.784	0.729	0.726	0.479	0.546	0.789	0.731	0.839	0.703	0.564
$b_2$ Long-term UI benefits	0.598	0.536	0.491	0.447	0.277	0.224	0.461	0.452	0.451	0.390	0.466
$\tau_J$ Payroll tax	-0.004	0.015	0.022	-0.024	0.019	-0.014	0.011	-0.036	-0.031	-0.002	-0.038

the model is a month. The time discount factor  $\beta$  is 0.996, implying an annual interest rate of 4%. The serial correlation of aggregate productivity shocks is set to  $\rho_a = 0.98$  and the standard deviation  $\sigma_a$  is 0.182%. This follows closely Ignaszak et al. (2018) and replicates the volatility and persistence of measured labor productivity in the Euro area. The elasticity of the matching function with respect to vacancies is set to  $\gamma = 0.3$ , within the range deemed reasonable by Pissarides and Petrongolo (2001). The firm's bargaining power is set to  $\eta = \gamma = 0.3$  such that absent risk aversion the Hosios-condition would be fulfilled (see Hosios (1990)). The mean of the search cost shock is normalized to  $\mu_{1,t} = 0$  for short-term unemployed workers.<sup>14</sup> This normalization allows to use the mean search cost of long-term unemployed  $\mu_{2,t}$  later on to pin down the relative unemployment outflow rates of short- versus long-term unemployed for each country. Lastly, the probability to move from short- to long-term unemployment is set to  $\delta = 1/12$  so that the average duration in short-term unemployment is one year.

### Country-specific preferences and costs

The data on labor market flows is based on the time series described in the empirical section of this paper. For each country, EU- and UE-transition rates are computed on a quarterly frequency and transformed into monthly levels. The time span for most countries is as reported in table 3.11 in appendix C. For Southern European countries (Greece, Spain, Portugal, Italy), the years after 2008 are disregarded for the calibration.<sup>15</sup>

<sup>14</sup>This does not imply that all of these workers are searching because there is a mean-shifting effect of the variance  $\psi_s$  as well (see equation 3.13).

<sup>15</sup>The reason is that these countries experienced extraordinarily large increases in unemployment rates driven by persistently high separation and low job finding rates during the Great Recession and the subsequent Eurozone crisis. Arguably, these large and persistent developments were to some

Business cycle volatilities of worker flow rates are obtained by first taking the logarithm of seasonally adjusted time series and then computing the deviations from an HP-filtered trend with a smoothing parameter of 100,000 as in Jung and Kuester (2015). Business cycle volatilities are expressed relative to the volatility of real GDP per-capita which is computed analogously in the model.<sup>16</sup>

The preference for leisure of unemployed workers  $\bar{h}$  is set to match the average UE-transition rate in the data. Note, that the UE-transition rate in the data corresponds to the contact rate  $\bar{f}$  in the model which is conditional on searching. The vacancy posting cost  $\kappa_v$  is used to target the average EU-transition rate. Together with the UE-transition rate that pins down the steady-state unemployment rate in the model (see equation 3.31).

The mean idiosyncratic search cost shock of long-term unemployed  $\mu_{2,l}$  is set such that the relative search effort  $s_1/s_2$  equals the relative unemployment outflow rate of short-term versus long-term unemployed in the data (see last column of table 3.3).<sup>17</sup> The dispersion parameter of the search cost shock  $\psi_s$  is assumed to be equal for both types. Due to the properties of the logistic distribution,  $\psi_s$  directly affects the share of searchers among all non-employed (see equation 3.13). Therefore, it is calibrated to match the gap between the BLS’s “U3”-measure of unemployment, which requires active search, and “U5”-unemployment which includes unemployed who are not actively searching but ready to take up work. This gap is computed using data provided by the OECD on the incidence of marginally attached workers (for details on the computation see appendix E).

The matching efficiency  $\chi$  is chosen to match the average monthly vacancy-filling rate in the data. Vacancy data is taken from Eurostat which reports quarterly vacancy statistics from 2001 onwards.<sup>18</sup> Using the unemployment and UE-transition rates, one can directly compute the vacancy filling rate  $q$  as defined in the model.

It is well known, that search and matching models as presented here have difficulties in replicating the high volatility of worker flow rates observed in the data (see Shimer (2005a)). I adopt the same mechanism as Jung and Kuester (2015) to solve this problem and introduce a procyclical bargaining power of firms. That implies that workers have a relatively large bargaining power in recessions such that wages are “too high” relative to productivity. That dampens the wage response to productivity shocks and thereby increases the elasticity of unemployment with respect to productivity. To be precise, the bargaining power takes the following form:

$$\eta_t = \eta \exp\{\gamma_w a_{t-1}\}, \gamma_w \geq 0 \quad (3.26)$$

---

extent driven by events outside of the scope of this model (e.g. sovereign debt crisis, banking crisis, international capital flight). In order to obtain labor market parameters that are not entirely driven by these extraordinary events, the years post-2008 are excluded from the data for these four countries.

<sup>16</sup>Alternatively one could also use productivity.

<sup>17</sup>Given that both types of unemployed face the same contact rate  $\bar{f}$  the relative search effort in the model and the relative outflow rates in the data are equivalent.

<sup>18</sup>For all countries except for Spain and France, the data is restricted to firms with more than 10 employees.

The rigidity parameter  $\gamma_w$  is chosen to match the volatility of the unemployment rate relative to the volatility of real GDP per capita in the data.<sup>19</sup>

The remaining country-specific parameters are  $\mu_\epsilon$  and  $\psi_\epsilon$ . The mean resource cost shock  $\mu_\epsilon$  is chosen such that on average realized resource costs are zero. Lastly, I use  $\psi_\epsilon$  to target the volatility of the EU-transition rate in the data (again relative to real GDP per capita), as this parameter affects the separation margin directly.

### Country-specific policies: Net replacement rates

The government has four different policy tools at its disposal, one of which (the labor-tax  $\tau_J$ ) is chosen to balance the budget in every period. That leaves three government policies to be calibrated - the layoff tax  $\tau_\zeta$  as well as short-term and long-term unemployment benefits. Note that the model abstracts from vacancy subsidies which are an additional policy tool in Jung and Kuester (2015).

The level of unemployment benefits  $b_j$  is chosen such that the replacement rates in the model  $b_j = c_j^u/c_e$  equal the corresponding net replacement rates in the data. Duration-specific replacement rates are computed from detailed OECD data on UI benefits for six different household types at different unemployment durations. This data is supplemented by Eurostat census data on the composition of households in each country. Appendix F describes in detail how these type- and duration-specific replacement rates are aggregated. It is noteworthy that there is a sizable drop in benefits once a person moves from short-term to long-term unemployment: Across countries, replacement rates fall by 25 percentage *points* on average.

### Country-specific policies: Layoff taxes

The layoff tax  $\tau_\zeta$  as a proxy for firing costs is inherently difficult to quantify for both conceptual as well as empirical reasons. First, the term firing costs typically refers to the explicit and implicit costs accruing to an employer if he dismisses one or more employees. These costs arise from various different sources, such as severance and compensation payments, mandatory notice periods, uncertainty due to judicial delay or explicit costs e.g. for lawyers or for resources tied up in the firm. However, these components which are often associated with firing costs empirically, differ substantially regarding their economic meaning if one tries to map them into theory: Some of these components could be interpreted as taxes accruing directly or indirectly to the government (e.g. court expenses), other factors could be interpreted as costs the firm has to pay for intermediate inputs (hiring lawyers, tying up inhouse resources) and yet other components are direct transfers from the firm to the laid-off employee (severance and compensation payments).

Collapsing these different components of firing costs into one parameter of a labor market model is therefore challenging from a theoretical standpoint. In the model presented here, the distinction between taxes or costs for intermediates and a pure transfer to the employee is crucial: Transfers to the worker enter the Nash bargaining and therefore only affect the *sharing* of the match surplus and hence, the bargained wage but *not* the separation probability. Taxes and costs for intermediates, on the other hand,

---

<sup>19</sup>One could alternatively use the volatility of the job finding rate  $\bar{f}_t$  relative to output.

affect the *size* of the surplus and therefore the separation probability.

In addition to the conceptual challenges, some of these components are difficult to measure in the first place, in particular the legal expenses, the costs of judicial uncertainty or compensation payments which often depend on worker-specific factors. Furthermore, existing measures of employment protection, such as the EPL-indicator of the OECD or the EPLEX-indicator of the ILO, are usually ordinal indicators and therefore do not allow to derive indicators with interpretable quantitative differences across countries.

This paper deals with these conceptual and empirical problems in the following ways: First, I derive explicit quantitative measures for all components that are considered a part of employment protection related costs by the OECD from the detailed country reports (OECD (2013)). These components include tenure-dependent severance pay, compensation in case of unfair dismissals and the length of mandatory notice periods. I then follow the methodology in Boeri et al. (2017) to obtain the average likelihood with which a court rules a dismissal to be “unfair”. Given these payoffs and likelihoods I compute the expected costs of a dismissal for a firm in terms of monthly wages. To check the validity of the measure, I compute the same expected value using the sub-components outlined in Boeri et al. (2017) and find that the correlation is 0.87 across countries ( $R^2 = 0.75$ ). A detailed description of this derivation can be found in appendix G.

Conceptually, this composite measure of firing costs still lumps together costs for intermediate inputs, layoff taxes accruing to the government and transfers to the worker. However, all of these components are taxed to at least some extent (e.g. severance payments are subject to payroll taxes) and therefore fully or partially flow to the government, thus increasing the match surplus and reducing the separation rate. In the model, the firing costs derived from the data are therefore introduced in the form of a direct tax  $\tau_\zeta$  rather than a transfer to the worker. That causes of course a level discrepancy because not all of the costs in the data are actually taxes as in the model. To overcome that level difference, I normalize the layoff tax to 12 monthly wages for Germany which is roughly 55% of the layoff tax computed in the data and express the layoff taxes in all other countries *relative* to that.<sup>20</sup> The resulting average across all European countries of 10.5 monthly wages is close to the value used in Ignaszak et al. (2018).

### 3.4 Optimal policies: duration dependent benefits

As outlined in the beginning of this section, the calibration allows to back out the country-specific structural parameters that can rationalize the observed level and cyclicity of worker flow rates, given the labor market policies that are currently in place. These structural parameters are summarized in the second block of the calibration table 3.4 and comprise the utility costs of search and leisure of unemployed workers as well as the rigidity of wages, vacancy posting costs of firms and the efficiency of the matching process. Assuming that these “deep” country-specific parameters are invariant and do not respond to policy changes, it is possible to investigate what an optimal UI policy

---

<sup>20</sup>This works under the assumption that the relative share of taxes or tax-equivalent costs versus transfers to the worker is the same across countries.

should look like from a welfare perspective.<sup>21</sup>

In a first step, I do that separately for each country by computing the country-specific replacement rates  $b_1^{ON}$  and  $b_2^{ON}$  which maximize the average utility in the economy:

$$\max_{b_1^{ON}, b_2^{ON}} eU(c^e) + \sum_{j \in \{1,2\}} u_j U(c_j^u) + (e\zeta + u_1)(\Psi_{s,1} + \bar{h}) + u_2(\Psi_{s,2} + \bar{h}) \quad (3.27)$$

Here, the terms  $\Psi_{s,j}$  reflect the option value of search<sup>22</sup> of unemployment type  $j$  and the superscript  $ON$  stands for *optimal national*. This formulation focuses on the steady-state consumption levels and the steady-state unemployment rate, thus abstracting from aggregate shocks. Nonetheless, the average steady-state utility captures the basic trade-off between smoothing individual labor market risk and reducing moral hazard, i.e. incentivizing unemployed persons to search for jobs.

In the second step, I then search for the *common* UI policy  $\{b_1^{OU}, b_2^{OU}\}$  which is applied in all countries and optimal from a union perspective. That is more involved because one has to decide which weights to assign to each of the countries and because the absolute utility levels are not directly comparable across the country-specific calibrations. The former is resolved by taking the labor force share of each country  $i$  as weights  $\omega_i$ .<sup>23</sup> In order to deal with the second issue, I compute the compensating differential  $\lambda_i$  for each country which equates the utility under the status-quo regime  $\{b_{i,1}^{SQ}, b_{i,2}^{SQ}\}$  and the alternative policy  $\{\tilde{b}_1, \tilde{b}_2\}$ :

$$U(c_i^e, c_{i,1}^u, c_{i,2}^u; b_{i,1}^{SQ}, b_{i,2}^{SQ}) = U(\tilde{c}_i^e(1 + \lambda_i), \tilde{c}_{i,1}^u(1 + \lambda_i), \tilde{c}_{i,2}^u(1 + \lambda_i); \tilde{b}_1, \tilde{b}_2) \quad (3.28)$$

The optimal common UI policy for the union of countries is then obtained by minimizing the weighted sum of the country-specific compensating differentials  $\lambda_i$  which solve equation 3.28:

$$\{b_1^{OU}, b_2^{OU}\} = \underset{\tilde{b}_1, \tilde{b}_2}{\operatorname{argmin}} \sum_i \omega_i \lambda_i \quad (3.29)$$

Here,  $OU$  indicates the optimal union policy. Minimizing the weighted sum of compensating differentials is akin to a welfare maximization of steady-state allocations and resolves the problem that utilities are not directly comparable across countries in the model. Note that in this setup the labor tax  $\tau_J$  always adjusts to balance the government budget. Hence, there are no transfers across countries.

### Optimal replacement rates

Table 3.5 summarizes the resulting optimal UI policies in both scenarios (national and union-wide UI policies). The first three columns show the status quo replacement rates

<sup>21</sup>Given the complex nature of layoff taxes which are to a large extent beyond the realm of fiscal policies (e.g. the efficiency of the judicial system), this paper focuses on unemployment insurance only.

<sup>22</sup>Thanks to the properties of the logistic distribution, this option value is defined in a closed form:  $\Psi_{s,j} = \exp(\psi_s)((1 - s_j)\log(1 - s_j) + s_j\log(s_j))$

<sup>23</sup>Alternatively, one could take the population share which does not change the results.

as in the calibration together with the fraction  $b_1/b_2$ . Columns 4 to 6 display the optimal country-specific policies and the last three columns the optimal union-wide scheme. There is one aspect that clearly stands out: While all existing UI policies are declining with unemployment duration, the optimal UI profile is steeply *increasing*, both in the national as well as the union-wide scenario. In particular, the optimal replacement rate for long-term benefits is very high (on average 90%), exceeding the optimal short-term benefits by 30 to 40 percentage points.

This striking pattern is rooted in the difference between short- and long-term unemployed regarding their job-finding rates: In the policy regimes which are currently in place long-term unemployed receive lower benefits than short-term unemployed. In the model that would translate into a larger surplus of finding a job for long-term than for short-term unemployed - absent any differences between the two types. Thus, long-term unemployed would have an incentive to search harder for jobs than their short-term unemployed peers, resulting in higher job-finding rates. However, this is in stark contrast to the data which shows that job-finding rates are typically lower among long-term unemployed (see table 3.3). The calibration reconciles the declining patterns of both benefits and outflow rates over the unemployment spell by making search inherently more costly for long-term unemployed in terms of utility. This is the reason why for most countries in table 3.4, the mean search cost of long-term unemployed  $\mu_{2,t}$  is positive and therefore larger than the cost for short-term unemployed  $\mu_{1,t}$  which is normalized to zero.

Turning to optimal replacement rates, that cost structure results in an optimal UI scheme which is increasing in unemployment duration: As it is very arduous for long-term unemployed to search for jobs, their search effort responds less to monetary incentives than in the case of short-term unemployed. Hence, the moral hazard concerns of high replacement rates are less pronounced for long-term unemployed such that the consumption smoothing motive becomes more prevalent. The social planner therefore provides long-term unemployed with higher benefits than short-term unemployed. Although the extent to which that pattern occurs varies across countries, this upward slope is present in all countries - both in the case of national policies as well as for the European scheme. It is noteworthy that this changing tilt not necessarily reflects a higher *average* level of unemployment benefits. Section 3.5 shows that with homogeneous UI benefits, the optimal level is higher than the current level for some countries but lower for others. The results are therefore not driven by a generic level shift in benefits as section 3.5 shows in more detail.

## Unemployment and welfare

The central question of this policy experiment is how unemployment rates and welfare change if the European countries move from the current status quo to optimal national and optimal union-wide UI policies. In order to assess the welfare implications, I compute the compensating differentials  $\lambda_i$  for each of the three following scenarios: (i) moving from the status quo to optimal national policies ( $SQ \rightarrow ON$ ), (ii) moving from the optimal national to the optimal union-wide policy ( $ON \rightarrow OU$ ) and (iii) from the



Table 3.5: Optimal net replacement rates ( $b_1 \neq b_2$ )

		Status Quo			Optimal National			Optimal Union		
country	weight	$b_1$	$b_2$	$\frac{b_1}{b_2}$	$b_1$	$b_2$	$\frac{b_1}{b_2}$	$b_1$	$b_2$	$\frac{b_1}{b_2}$
Austria	3	67	60	1.11	51	93	0.55	49	92	0.53
Finland	2	78	54	1.46	47	82	0.57	49	92	0.53
France	19	73	49	1.48	50	96	0.52	49	92	0.53
Germany	27	73	45	1.62	62	94	0.66	49	92	0.53
Greece	3	48	28	1.73	36	94	0.38	49	92	0.53
Italy	17	55	22	2.44	45	97	0.47	49	92	0.53
Netherlands	6	79	46	1.71	49	96	0.52	49	92	0.53
Norway	2	73	45	1.62	77	95	0.81	49	92	0.53
Portugal	4	84	45	1.86	65	92	0.71	49	92	0.53
Spain	15	70	39	1.80	52	84	0.62	49	92	0.53
Sweden	3	56	47	1.21	46	71	0.65	49	92	0.53

Notes: Net replacement rates for short- and long-term unemployed in the baseline calibration (with duration dependence) representing the status quo, in the case if country-specific optimal UI policies are implemented (optimal national) and if one common UI policy is chosen optimally for the entire union (optimal union).  $b_1$  and  $b_2$  are in percent,  $\frac{b_1}{b_2}$  are fractions.

status-quo to the optimal union-wide policy ( $SQ \rightarrow OU$ ). Table 3.6 reports the resulting welfare effects together with changes in unemployment rates. The welfare gains of optimally chosen national UI policies are sizable amounting to 2.96% of consumption, i.e. workers would be willing to forfeit almost 3% of their average consumption to move from the current status quo to country-specific optimal UI schemes with low short-term and high long-term benefits. That welfare gain is accompanied by a large decline in the unemployment rate which is driven by a lower separation rate and a higher job finding rate of short-term unemployed who face substantially lower benefits than in the status quo (see table 3.5).

Moving from the optimal national to the optimal union-wide benefit scheme by construction leads to welfare losses in all countries.<sup>24</sup> However, the distortions of imposing a *one-size-fits-all* solution are relatively small (-0.22%) compared to the welfare gains of moving away from the status quo of high short-term and low long-term benefits. Accordingly the total effect of moving from the status quo to an optimal union-wide UI scheme (last column) is still sizable and only slightly lower than having optimal country-specific policies.

Replacing the existing UI schemes with an optimally chosen union-wide UI policy therefore moves almost all countries closer to their nationally optimal UI policy. The large gains of replacing the current suboptimal scheme in which benefits decline over the unemployment spell with an optimal European UI scheme clearly outweigh the rel-

<sup>24</sup>In France and the Netherlands the optimal union-wide UI policies are very close to the optimal national policies, such that the welfare losses are roughly zero.

atively small distortions of having a *one-size-fits-all* policy instead of country-specific UI schemes. It is therefore still better in terms of welfare to have an optimally chosen common UI policy than staying with the country-specific suboptimal policies currently in place.

Table 3.6: Unemployment and welfare ( $b_1 \neq b_2$ )

country	$u_{ss}$			$\Delta u_{ss}$			Welfare gain		
	SQ	ON	OU	SQ→ON	ON→OU	SQ→OU	SQ→ON	ON→OU	SQ→OU
Austria	4.6	2.9	2.7	-37.2	-6.2	-41.1	0.99	-0.01	0.98
Finland	7.5	3.4	3.7	-54.0	6.8	-50.9	4.52	-0.02	4.49
France	8.5	2.9	2.7	-66.3	-6.3	-68.5	3.10	0.00	3.09
Germany	5.4	4.3	3.0	-19.9	-31.4	-45.1	0.94	-0.39	0.55
Greece	9.2	6.9	10.9	-25.3	58.0	18.1	3.30	-0.82	2.46
Italy	8.7	5.4	7.0	-37.6	28.6	-19.8	5.90	-0.16	5.73
Netherlands	4.9	1.5	1.5	-69.9	-1.2	-70.3	3.35	0.00	3.35
Norway	3.1	3.4	2.0	9.3	-41.3	-35.8	0.46	-0.82	-0.36
Portugal	6.6	4.6	3.1	-29.8	-32.7	-52.8	2.32	-0.71	1.61
Spain	9.2	5.2	4.7	-43.2	-9.6	-48.7	4.05	-0.05	4.00
Sweden	6.4	5.0	5.6	-21.4	10.4	-13.2	0.91	-0.23	0.68
<b>Aggregate</b>	7.2	4.2	4.1	-41.4	-3.6	-43.5	2.96	-0.22	2.74

Notes: Changes in unemployment rates ( $\Delta u_{ss}$ ) and welfare gains  $\lambda_i$  upon switching between the three scenarios outlined in the text: Status quo (SQ), optimal national (ON), optimal union-wide policy (OU). All numbers in percent. Aggregate numbers in last row are computed using the labor-force weights reported in table 3.5. The calibration features duration dependence in search costs and UI benefit levels.

### Plausibility of optimally increasing UI profile

The optimally increasing UI profile obtained in the previous section seems to be in stark contrast with other studies which find that UI benefits should optimally fall with unemployment duration (e.g. Shavell and Weiss (1979b) and Hopenhayn and Nicolini (1997b)). According to these papers, raising long-term benefits at longer durations has a larger impact on unemployment durations than raising short-term benefits because it not only affects the search incentives of long-term unemployed but also the incentives of forward-looking short-term unemployed: As they anticipate high long-term benefits, they have less incentives to exit unemployment quickly. Optimal UI schemes should therefore decline with duration to offset the larger moral hazard costs of long-term benefits.

With duration dependence, however, there is a second mechanism that works in the different direction and can potentially overturn the result of optimally declining UI benefits: Kolsrud et al. (2018) show that duration dependence alters the elasticity of outflow rates with respect to long-term UI benefits, making unemployed less responsive

to benefit changes later on in the unemployment spell. That holds regardless of the exact channel through which duration dependence arises - whether it is in the form of depreciation in returns to search over time or through selection of ex-ante heterogeneous workers: In the case of the former, as exemplified in the model here, a larger increase in the search costs for long-term unemployed - i.e. more duration dependence - reduces the relative importance of financial incentives later on in the spell compared to the high utility costs of search. That renders the search decision of both short- and long-term unemployed less responsive to changes in long-term benefits. In the case of duration dependence arising from the dynamic selection of heterogeneous job searchers, a similar mechanism applies: Worker types who have low search costs are very responsive to financial search incentives, but as they expect to exit unemployment quickly anyway, the generosity of long-term benefits does not concern them too much. At the same time, worker types with inherently high search costs are quite irresponsive to financial incentives as their utility costs of search plays a dominant role for their search decision throughout their entire unemployment spell.

This duration-dependence channel, highlighted among others by Kolsrud et al. (2018), implies that optimal UI benefits might actually be increasing with unemployment duration if duration dependence is large enough to offset the forward-looking moral hazard costs emphasized by Hopenhayn and Nicolini (1997b). Using a regression-kink design on Swedish administrative micro data Kolsrud et al. (2018) show that for Sweden this is indeed the case: They find that UI benefits should be optimally increasing with duration. In a partial equilibrium model which features both duration dependence and dynamic selection, they confirm this result and show that UI benefits should be increasing from 48% for short-term to 68% for long-term unemployed. This is very much in line with the estimates obtained in table 3.5 for Sweden (46% and 71%). The optimally increasing UI profiles presented here are therefore not necessarily in contrast to what other studies that account for duration dependence have found. Furthermore, it should be noted that their model result of an increasing UI scheme arises in a setting with “true” duration dependence *and* dynamic selection of heterogeneous job searchers. That indicates that the results obtained here are not entirely driven by attributing duration dependence entirely to “true” duration dependence while abstracting from worker heterogeneity. Ideally, the model would of course feature both sources of duration dependence. Given a lack of data to identify the relative importance of both channels, this is however beyond the scope of this paper.

### 3.5 Optimal policies: flat unemployment benefits

The previous section emphasized that the duration dependence both regarding job-finding rates and regarding benefit levels is important for the design of optimal UI policies. Taking this duration dependence into account, moving from suboptimal national policies to an optimal common UI scheme is welfare improving despite the distortions of imposing a *one-size-fits-all* policy. However, it is not clear how important duration dependence is for the size and the sign of this welfare effect. Would a model with only one type of unemployed and one benefit level - as for example in Abraham et al. (2017)

- still yield a positive welfare gain of moving from the suboptimal status quo to an optimal European UI scheme?

This section investigates that question by re-calibrating the model and re-doing the optimal policy experiments of the previous section without any duration dependence in either benefits or job-finding rates. The calibration therefore changes only in two respects: First, there is only one type of unemployed with mean search costs  $\mu_u = 0$  and second, there is only one net replacement rate for each country which is set to match the average replacement rate over the first 5 years of unemployment as reported by the OECD. The parameters in the re-calibrated model are displayed in table 3.7.

Table 3.7: Calibration flat benefits ( $b_1 = b_2$ )

Parameter	AUS	FIN	FRA	GER	GRE	ITA	NED	NOR	POR	ESP	SWE
$\beta$ Time-discount factor	0.996	-	-	-	-	-	-	-	-	-	-
$\rho_a$ AR(1) aggr. productivity	0.980	-	-	-	-	-	-	-	-	-	-
$\sigma_a$ SD aggr. productivity (x100)	0.182	-	-	-	-	-	-	-	-	-	-
$\eta$ Bargaining power firm	0.300	-	-	-	-	-	-	-	-	-	-
$\gamma$ matching elasticity	0.300	-	-	-	-	-	-	-	-	-	-
$\mu_u$ Mean search cost	0.000	-	-	-	-	-	-	-	-	-	-
$\bar{h}$ Home prod. unemployed	-2.298	-1.783	-0.536	-0.495	-1.060	-0.367	-2.212	-4.230	-0.899	-0.386	-1.039
$\psi_s$ Dispersion search cost	2.684	1.942	0.550	0.676	0.783	1.087	3.085	5.229	0.830	0.684	1.124
$\kappa_v$ Vacancy posting cost	2.695	2.164	3.219	1.052	10.230	3.905	1.218	1.146	4.661	2.626	2.050
$\chi$ Matching efficiency	0.206	0.246	0.187	0.125	0.134	0.113	0.138	0.209	0.161	0.231	0.252
$\mu_\epsilon$ Mean resource cost	0.168	0.241	0.180	0.158	0.296	0.218	0.133	0.185	0.225	0.218	0.242
$\psi_\epsilon$ Dispersion resource cost	4.379	3.444	3.481	4.806	7.951	6.333	4.027	4.976	6.374	3.185	3.837
$\gamma_w$ Cyclical bargaining power	11.052	1.208	10.632	24.298	25.002	18.714	32.043	17.373	12.894	94.743	7.660
$\tau_\zeta$ Layoff tax (in months)	7.683	3.964	3.905	12.000	1.824	9.776	6.644	10.867	14.283	4.959	7.021
$\bar{b}$ UI benefits	0.612	0.587	0.540	0.501	0.316	0.294	0.527	0.509	0.529	0.454	0.486
$\tau_J$ Payroll tax	-0.005	0.009	0.016	-0.028	0.016	-0.018	0.007	-0.040	-0.036	-0.010	-0.040

As in the previous section, I first compute the optimal UI policy for each country separately and in a second step the optimal common UI policy by minimizing the weighted sum of compensating differentials  $\lambda_i$ . Table 3.8 displays these optimal policies together with the average replacement rate currently in place. If each country chose its unemployment benefit level optimally, 8 out of the 11 countries would opt to increase their UI benefits. Accordingly, an optimal union-wide replacement rate would be slightly higher than the weighted average of the status quo (52% instead of 47%). In contrast to the previous experiment in section 3.4, the average unemployment rate therefore increases rather than decreases if the status-quo is replaced with either national or union-wide optimal policies (see columns 4-6 in table 3.9).

More importantly, however, table 3.8 illustrates that implementing a common UI policy has heterogeneous implications in terms of optimality across countries: Some countries - such as France, Germany or the Netherlands - move closer to their nationally optimal replacement rate if a common UI scheme is implemented whereas other countries actually move away from their optimal benefit level (e.g. Austria, Italy, Portugal). As a consequence, replacing the sub-optimal national policies with an optimal common UI scheme (last column:  $SQ \rightarrow OU$  in table 3.9) creates winners and losers in terms of welfare and has heterogeneous effects in terms of unemployment.

On average, the welfare effects are substantially different from the previous section with duration dependence: The distortions of having a *one-size-fits-all* policy for heterogeneous countries leads to relatively large distortions (-1.48% of consumption on average) while the gains from optimization ( $SQ \rightarrow ON$ ) are comparatively small (0.72%). Therefore, an optimally chosen common scheme on average *reduces* welfare by 0.97% of consumption.

Table 3.8: Optimal net replacement rates ( $b_1 = b_2$ )

country	weight	Status Quo	Optimal National	Optimal Union
Austria	3	61	62	52
Finland	2	59	55	52
France	19	54	47	52
Germany	27	50	61	52
Greece	3	32	36	52
Italy	17	29	36	52
Netherlands	6	53	48	52
Norway	2	51	83	52
Portugal	4	53	66	52
Spain	15	45	49	52
Sweden	3	49	65	52

Notes: Net replacement rates in the calibration without duration dependence in either search costs or UI benefits. The columns refer to the status quo, country-specific optimal UI policies (optimal national) and a common UI policy chosen optimally for the entire union (optimal union). All values are in percent.

Comparing the welfare effects in a model without duration dependence with the baseline results in section 3.4, there are two lessons to be learned: First, the positive welfare effects in the model with duration dependence are to a large extent driven by the changing benefit *profile* rather than changes in the average benefit *level*. Replacing the current policies where benefits decline over the unemployment spell by an increasing profile leads to relatively large welfare gains. In contrast, the welfare gains of optimally choosing the flat benefit level in the setting without duration dependence are comparatively small.

Second, the distortions of implementing a single policy across heterogeneous countries are larger if duration dependence is neglected (-1.48% instead of -0.22%). In total, the larger gains from optimization together with the smaller distortions of the *one-size-fits-all* policy explain why the overall welfare gain is positive if the model takes duration dependence into account and negative if the model abstracts from unemployment duration.

When assessing whether or not to implement a common UI policy, duration-specific policies as well as duration-specific job-finding rates are therefore a crucial dimension which needs to be accounted for.

Table 3.9: Unemployment and welfare ( $b_1 = b_2$ )

country	$u_{ss}$			$\Delta u_{ss}$			Welfare gain		
	SQ	ON	OU	SQ→ON	ON→OU	SQ→OU	SQ→ON	ON→OU	SQ→OU
Austria	4.6	4.9	3.2	5.3	-34.9	-31.5	0.01	-0.31	-0.30
Finland	7.5	6.5	5.8	-13.2	-10.6	-22.4	0.07	-0.04	0.03
France	8.5	5.6	7.5	-34.4	35.0	-11.4	0.35	-0.16	0.19
Germany	5.4	9.4	5.9	75.0	-37.3	9.7	0.90	-0.66	0.23
Greece	9.2	11.3	24.9	21.8	120.8	168.9	0.17	-5.01	-4.60
Italy	8.7	17.9	45.9	105.4	156.9	427.7	1.50	-5.71	-5.54
Netherlands	4.9	3.5	4.6	-29.1	33.5	-5.4	0.13	-0.09	0.04
Norway	3.1	7.2	3.2	132.4	-55.7	3.0	2.48	-2.35	0.13
Portugal	6.6	10.8	6.3	63.9	-41.1	-3.5	1.06	-1.20	-0.13
Spain	9.2	11.2	13.8	22.2	22.9	50.3	0.15	-0.21	-0.06
Sweden	6.4	11.0	7.2	71.6	-35.1	11.4	1.47	-1.01	0.46
<b>Aggregate</b>	7.2	10.0	14.5	37.4	45.5	100.0	0.72	-1.48	-0.97

Notes: Changes in unemployment rates ( $\Delta u_{ss}$ ) and welfare gains  $\lambda_i$  upon switching between the three scenarios outlined in the text: Status quo (SQ), optimal national (ON), optimal union-wide policy (OU). All numbers in percent. Aggregate numbers in last row are computed using the labor-force weights reported in table 3.5. The calibration features duration dependence in search costs and UI benefit levels.

### 3.6 Benefits of smoothing asymmetric shocks

The approach chosen in this paper focuses entirely on the labor market distortions and the ensuing welfare costs of a European UI scheme but abstracts from the potential benefits of such a scheme. As mentioned in the introduction, a common UI scheme allows countries to pool the risk of asymmetric aggregate shocks and therefore can serve as a macroeconomic stabilization tool. That is in particular of value if other fiscal stabilizers are impaired in a severe recession and if private insurance across country borders is inhibited for structural reasons. To get an indication of how large the welfare gains of international risk sharing are in the model presented here, I follow the approach in Lucas (2003) to compute the costs of business cycles in the model. He computes the compensating differential  $\lambda$  which risk-averse agents in a canonical real business cycle model need to receive in order to be indifferent between an environment with and without aggregate risk:

$$\sum_{t=0}^{\infty} \beta^t U(c_t(1 + \lambda)) = \sum_{t=0}^{\infty} \beta^t U(\tilde{c}_t) \quad (3.30)$$

Here, the left-hand side denotes the average utility in an environment with aggregate shocks and the right-hand side without aggregate shocks. I follow Lucas' approach and compute the compensating differential  $\lambda$  separately for each country by simulating the baseline economy with aggregate shocks and comparing it to the utility obtained in an economy without aggregate shocks.

Table 3.10 reports the compensating differential in percent of consumption for each country separately and at the federal level (weighted with the labor force share as before). For the baseline case with duration-dependent benefits, the aggregate welfare gains of 0.38% are actually larger than the welfare losses of replacing optimal national with optimal union-wide policies (-0.22% in table 3.6). However, they are small compared to the welfare gains of having optimally chosen policies in the first place (2.74% - 2.96%).

In the case with flat benefits, the distortions arising from not tailoring optimal UI policies to country-specific characteristics computed in section 3.5 are larger than in the calibration with duration dependence (-1.48% instead of -0.22%). Therefore they more than offset the potential welfare gains from eliminating aggregate fluctuations (0.31%).

Table 3.10: Compensating differentials: Eliminating TFP shocks

country	$b_1 \neq b_2$	$b_1 = b_2$
Austria	0.06	0.03
Finland	0.02	0.01
France	0.06	0.04
Germany	0.18	0.07
Greece	0.28	0.23
Italy	0.30	0.11
Netherlands	0.67	0.18
Norway	0.07	0.04
Portugal	0.20	0.04
Spain	1.41	1.62
Sweden	0.05	0.02
<b>Aggregate</b>	0.38	0.31

Two aspects regarding these estimates should be noted: On the one hand, the method of Lucas (2003) delivers an upper bound of the potential benefits of a common UI scheme as it assumes that this scheme can eliminate *all* aggregate fluctuations in productivity. For that to be true, it would need to be the case that (i) there is no insurance at all in the benchmark (neither private nor through country-level fiscal stabilizers) and (ii) that aggregate shocks are not correlated across countries and can be fully insured through a common UI scheme. Clearly, both assumptions are not fulfilled in reality. At the same time, there is an extensive literature showing that the approach chosen by Lucas (2003) potentially underestimates the welfare costs of business cycles because amplification mechanisms for example through changes in growth rates (Barlevy (2004)) or the average level of output (Den Haan and Sedlááček (2014)) are abstracted from. Following that reasoning, the estimates in table 3.10 represent a lower rather than an upper bound.

Without modeling these feedback effects as well as the scope for cross-country risk sharing in detail, it is not clear ex-ante which of the two biases dominates. The estimates in

table 3.10 indicate that it would be worthwhile to explore these welfare gains in more detail in future research. The results also indicate that such an exercise should feature duration dependence in UI benefits and job finding rates as the gains from smoothing aggregate shocks differ quite substantially across column 1 and 2, in particular relative to the welfare costs presented in tables 3.6 and 3.9.

## 4. Concluding Remarks

Since the inception of the EMU, policy makers and economists alike have been discussing the merits of fiscal tools that allow member states to share risk across countries and thereby stabilize output. While the associated gains from risk sharing across countries are relatively well understood, the negative side effects of these tools - such as a common unemployment insurance - are still disputed intensely. This paper offers new insights into this debate by quantifying the distortions and welfare effects of having a common unemployment insurance policy across heterogeneous labor markets. As a first step towards that aim, this paper presents a novel measure of quarterly worker flow rates that allows to take a closer look at the level, cyclicity and duration dependence of labor market flows in a large set of European economies. I find that job separations play an important role for business cycle fluctuations and that job-finding rates decrease with unemployment duration in most European countries. Taking this evidence as a starting point, I use a structural model with risk-averse workers, endogenous separations and duration-dependent search costs to compute optimal UI policies, both on the national level and from the perspective of a European social planner who has to choose a single policy for all countries. If duration-dependence is accounted for, the gains from moving from sub-optimally decreasing UI profiles to optimally increasing profiles are large and outweigh the comparatively small welfare losses of imposing a *one-size-fits-all* policy on heterogeneous countries.

There are two main lessons to be learned: First, policy makers should take duration-dependence seriously when designing optimal policies, be it on the national or on the European level. The wide-spread negative duration dependence despite the falling UI schedules suggests that it is inherently more difficult for long-term unemployed to find jobs. A social planner who has to trade off search incentives with consumption smoothing gains, should take into account that moral hazard is hardly a concern when it comes to long-term unemployed.

Second, the welfare losses of having a common UI scheme across heterogeneous labor markets can be quite large, in particular if duration dependence is not accounted for. The heterogeneity of country-specific institutions and preferences should therefore be a key concern of policy makers when discussing the merits and costs of a common UI scheme. These distortions can possibly be reduced, if a less rigid European UI scheme was implemented. One example would be a re-insurance fund that complements national UI policies. Such an option should therefore be considered in future work as the welfare distortions are likely to be smaller than in this paper.

Although this paper goes into detail along multiple dimensions, e.g. unemployment duration or employment protection, it does not model the potential benefits of risk-



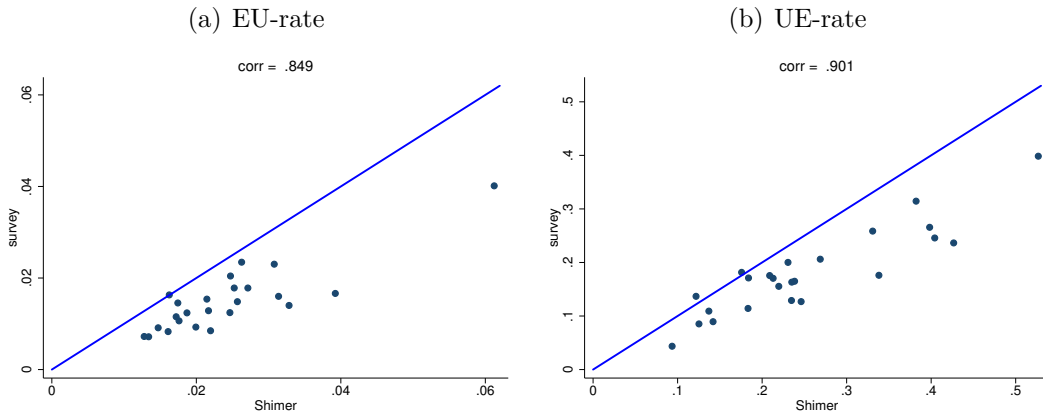
sharing in detail and abstracts from other costs of a common UI scheme (e.g. moral hazard across countries). Incorporating the framework presented here into a richer environment with risk-sharing across countries therefore provides an interesting field for future research.

## Appendices

### A Data fit of Eurostat survey with new flow rate measure

Figure 3.5 shows the average quarterly EU- and UE-rates of each country for the Eurostat survey measure (vertical axis) and the new measure based on a Shimer imputation (horizontal axis). As elaborated in the main text, the average flow rates are higher in the new measure because flows through intermittent non-employment spells are not separately accounted for.

Figure 3.5: Average quarterly worker flow rates: Eurostat vs. new measure



Notes: Left (right) panel shows average quarterly EU (UE) transition rate for 24 European countries according to the survey data provided by Eurostat (vertical axis) and according to the new measure based on a Shimer imputation using data on short-term unemployment (horizontal axis). Blue solid line is the 45-degree line.

### B Data fit of implied steady-state unemployment rate

Another approach to test the validity of the proposed quarterly flow rates, is to compare the implied steady-state unemployment rate with the actual unemployment rate in the data. In a two-state model, the steady-state unemployment follows directly from equation 3.2 by dropping the time indices and rearranging to get:

$$u^{ss} = \frac{S}{S + F} \quad (3.31)$$

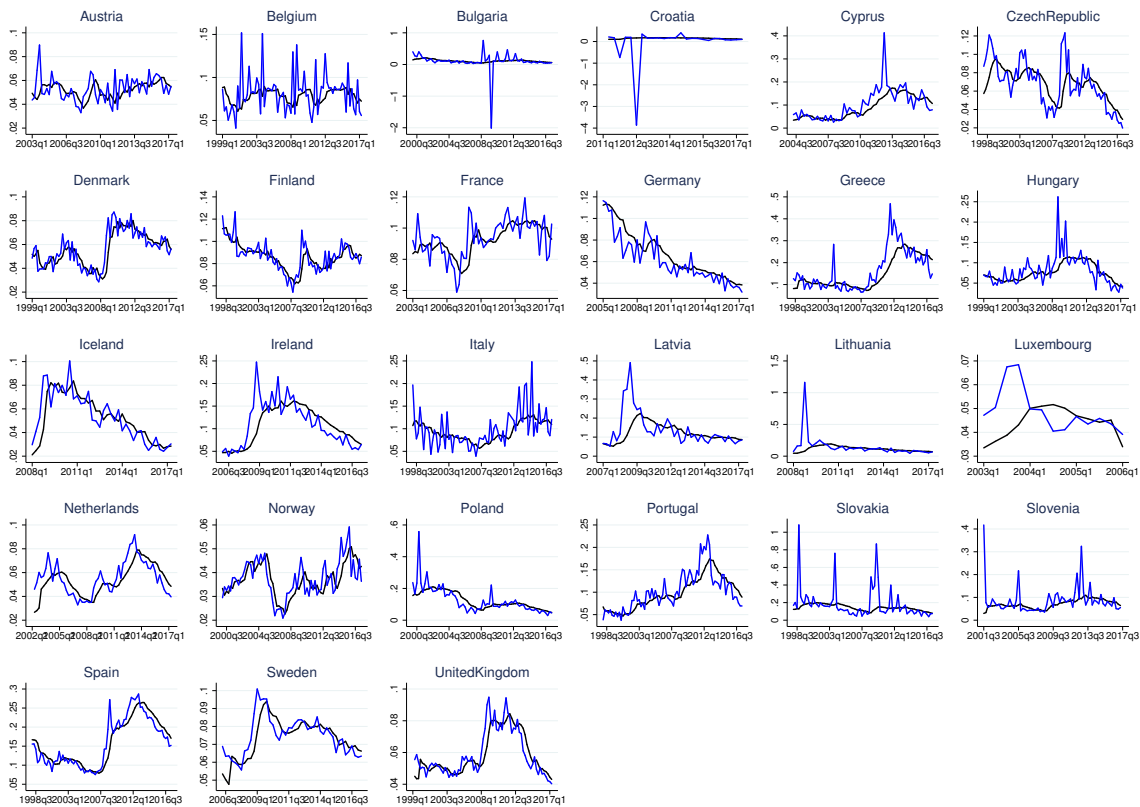
Hence, one can compute the steady-state unemployment rate  $u_t^{ss}$  which is implied by the EU- and UE-transition rates  $S_t$  and  $F_t$  in each quarter as:

$$u_t^{ss} = \frac{S_t}{S_t + F_t} \quad (3.32)$$

Figure 3.6 shows the resulting time series of implied steady-state unemployment  $u_t^{ss}$  (blue solid line) together with the actual unemployment rate (black solid line) for 27 European countries. Aside from some spikes in a few Eastern European countries

(Bulgaria, Croatia, Lithuania, Latvia) and Luxembourg, the implied steady-state unemployment rates not only match the level in each country but also track the cyclicity of unemployment rates quite well. This is noteworthy, given that Elsby et al. (2013) have emphasized that the implied steady-state unemployment rate delivers a poor approximation of real-time unemployment in countries with generally low levels of worker flow rates. They argue that in countries with low levels of reallocation, deviations from steady-state unemployment are quite persistent and therefore unemployment takes relatively long to revert back to its steady state. Although that is generally true for the annual data Elsby and co-authors compute from OECD data, it appears to be less of an issue at quarterly frequency as figure 3.6 shows.

Figure 3.6: Steady-state approximation of unemployment rate



Notes: Quarterly unemployment rates for 27 European countries. Black-dashed line shows actual unemployment rate (Eurostat). Blue solid line shows steady-state approximation using the new EU- and UE-transition rates based on a Shimer imputation using data on short-term unemployment.

### C Business cycle decomposition of worker flow rates

Table 3.11 summarizes the main information of the new measure of worker flow rates by country. Columns 2 and 3 denote the average quarterly EU- and UE-transition rates and columns 4 and 5 show their volatilities relative to the volatility of per capita

GDP. The last 3 columns summarize the business cycle decomposition of unemployment fluctuations as illustrated in figure 3.3.

Table 3.11: Flow rate statistics

country	start	end	$\pi_{EU}$	$\pi_{UE}$	$\frac{\sigma_{EU}}{\sigma_y}$	$\frac{\sigma_{UE}}{\sigma_y}$	$\beta_f$	$\beta_s$	$\beta_{eps}$
Austria	2003q1	2017q3	0.019	0.341	6.2	8.2	0.637	0.359	0.004
Belgium	1999q1	2017q3	0.018	0.218	6.5	12.9	0.601	0.401	-0.002
Bulgaria	2000q1	2017q3	0.017	0.156	4.4	11.9	0.836	0.129	0.035
Croatia	2011q2	2017q3	0.023	0.153	2.4	8.1	0.54	0.205	0.255
Cyprus	2004q2	2017q3	0.026	0.278	4.0	7.6	0.753	0.221	0.026
CzechRepublic	1998q1	2017q3	0.014	0.202	5.9	4.1	0.422	0.569	0.008
Denmark	1999q1	2017q3	0.024	0.417	5.9	6.5	0.578	0.42	0.002
Estonia	2008q3	2012q2	0.033	0.220	1.9	4.8	0.981	0.082	-0.063
Finland	1998q1	2017q3	0.038	0.411	2.4	2.5	0.626	0.358	0.016
France	2003q1	2017q3	0.027	0.264	6.1	8.9	0.501	0.5	0
Germany	2005q1	2017q3	0.016	0.252	3.4	5.3	0.567	0.424	0.009
Greece	1998q2	2017q3	0.024	0.142	3.3	4.0	0.625	0.335	0.04
Hungary	1999q1	2017q3	0.015	0.193	5.1	6.3	0.682	0.296	0.022
Iceland	2008q1	2017q3	0.027	0.528	3.3	3.8	0.519	0.47	0.012
Ireland	2006q1	2017q3	0.023	0.209	3.5	3.4	0.631	0.378	-0.009
Italy	1998q1	2017q3	0.016	0.165	4.2	19.1	0.844	0.164	-0.008
Latvia	2007q1	2017q3	0.028	0.213	3.0	4.8	0.934	0.074	-0.007
Lithuania	2008q1	2017q3	0.028	0.226	2.5	3.5	0.428	0.108	0.464
Luxembourg	2003q1	2006q2	0.015	0.297	4.0	5.1	0.776	0.229	-0.005
Netherlands	2002q2	2017q3	0.016	0.276	6.3	6.4	0.779	0.213	0.008
Norway	2000q1	2017q3	0.018	0.472	6.6	4.8	0.485	0.515	0
Poland	2000q1	2017q3	0.023	0.203	6.8	13.7	0.752	0.211	0.037
Portugal	1998q1	2017q3	0.021	0.207	6.0	8.3	0.439	0.554	0.007
Romania	1999q1	2005q1	0.013	0.161	3.9	9.2	0.805	0.114	0.082
Slovakia	1998q1	2017q3	0.017	0.109	6.0	14.0	0.626	0.192	0.182
Slovenia	2001q3	2017q3	0.014	0.188	3.1	10.1	0.713	0.239	0.048
Spain	1998q1	2017q3	0.05	0.286	3.4	6.3	0.595	0.4	0.005
Sweden	2006q2	2017q3	0.034	0.424	2.7	2.8	0.687	0.31	0.003
UK	1999q2	2017q3	0.023	0.381	3.2	4.6	0.468	0.531	0.001

Notes: Level and cyclicity of quarterly EU- and UE-transition rates obtained in the data based on a Shimer imputation using data on short-term unemployment. Standard deviations  $\sigma_{EU}$ ,  $\sigma_{UE}$  and  $\sigma_y$  are based on log-deviations from an HP-filtered trend ( $\lambda = 100,000$ ).  $\sigma_y$  refers to GDP per capita. The last three columns show the relative contributions of the job-finding margin ( $\beta_f$ ) and the job-separation margin ( $\beta_s$ ) to business cycle fluctuations of the steady-state unemployment rate. Last column shows the residual component  $\beta_\epsilon$ . See section 2.3 for details.

## D UE-transition rates by duration

This section shows how to compute the quarterly time series of duration-specific job finding rates from unemployment in section 2.4. The data provided by Eurostat contains unemployment stocks for 8 different duration brackets. These can be aggregated to the following 6 duration brackets:

- <3 months (1 quarter)
- 3-5 months (2 quarters)
- 6-11 months (3-4 quarters)
- 12-17 months (5-6 quarters)
- 18-23 months (7-8 quarters)
- >23 months (>8 quarters)

Eurostat reports quarterly unemployment stocks for each of these duration brackets. Let  $U_t^d$  denote the number of unemployed in duration bracket  $d$  in quarter  $t$ . The retention rate  $R_t^d$  is defined as the fraction of unemployed  $U_t^d$  who did not exit unemployment from period  $t$  to  $t + 1$ . The retention rate is directly linked to the duration-specific job finding rate  $R_t^d = 1 - F_t^d$ . Under the assumption that there are no flows from unemployment to inactivity or vice versa, that results in the following set of equations for each period:

$$\begin{aligned}
U_{t+1}^{[3,5]} &= U_t^{<3} R_t^{<3} \\
U_{t+1}^{[6,11]} &= U_t^{[3,5]} R_t^{[3,5]} + U_{t-1}^{[3,5]} R_{t-1}^{[3,5]} R_t^{[6,11]} \\
U_{t+1}^{[12,17]} &= U_{t-2}^{[3,5]} R_{t-2}^{[3,5]} R_{t-1}^{[6,11]} R_t^{[6,11]} + \\
&\quad U_{t-3}^{[3,5]} R_{t-3}^{[3,5]} R_{t-2}^{[6,11]} R_{t-1}^{[6,11]} R_t^{[12,17]} \\
U_{t+1}^{[18,23]} &= U_{t-4}^{[3,5]} R_{t-4}^{[3,5]} R_{t-3}^{[6,11]} R_{t-2}^{[6,11]} R_{t-1}^{[12,17]} R_t^{[12,17]} + \\
&\quad U_{t-5}^{[3,5]} R_{t-5}^{[3,5]} R_{t-4}^{[6,11]} R_{t-3}^{[6,11]} R_{t-2}^{[12,17]} R_{t-1}^{[12,17]} R_t^{[18,23]} \\
U_{t+1}^{>23} &= U_{t-6}^{[3,5]} R_{t-6}^{[3,5]} R_{t-5}^{[6,11]} R_{t-4}^{[6,11]} R_{t-3}^{[12,17]} R_{t-2}^{[12,17]} R_{t-1}^{[18,23]} R_t^{[18,23]} + \\
&\quad U_{t-7}^{[3,5]} R_{t-7}^{[3,5]} R_{t-6}^{[6,11]} R_{t-5}^{[6,11]} R_{t-4}^{[12,17]} R_{t-3}^{[12,17]} R_{t-2}^{[18,23]} R_{t-1}^{[18,23]} R_t^{>23} + \\
&\quad U_t^{>23} (1 - R_t^{>23})
\end{aligned}$$

In that system of equations every new period  $t$  introduces 6 additional unknown retention rates which are matched by 6 additional known unemployment stocks:

$$\begin{aligned}
\text{unknown: } & \{R_t^{<3}, R_t^{[3,5]}, R_t^{[6,11]}, R_t^{[12,17]}, R_t^{[18,23]}, R_t^{>23}\} \\
\text{known: } & \{U_t^{<3}, U_{t+1}^{[3,5]}, U_{t+1}^{[6,11]}, U_{t+1}^{[12,17]}, U_{t+1}^{[18,23]}, U_{t+1}^{>23}\}
\end{aligned}$$

Once all previous retention rates are known, it is straight forward to solve this linear system of equations. The only issue that needs to be resolved are the initial periods. Evidently, it is not possible to solve for all retention rates in all quarters: The retention rate  $R_t^{>23}$  for example can only be computed from quarter  $t = 8$  onwards because the last equation uses data on  $U_{t-7}^{[3,5]}$ . Similarly,  $R_t^{[18,23]}$  can only be computed from  $t = 6$  onwards as it uses  $U_{t-5}^{[3,5]}$  and so on. In addition, none of the 6 retention rates can be computed in the last period by construction due to the lagged structure of the equation system. In total, there are 22 retention rates that cannot be computed either at the beginning or the end of the sample. These are matched by 22 unemployment stocks in the first 7 quarters which do not enter the system of equations. The total number

of known and unknown variables is therefore given by the number of quarters times 6 duration brackets minus 22 (e.g. Spain with 20 years of data has 538 equations and unknowns). This can be solved using a standard equation solver.

### E Marginally attached workers

The model calibration uses the gap between “U5”- and “U3”-unemployment as used in the terminology of the BLS. Formally these measures are defined as

$$u_3 = \frac{U}{E + U} \quad (3.33)$$

$$u_5 = \frac{U + M}{E + U + M} \quad (3.34)$$

where  $E$ ,  $U$  and  $M$  correspond to the stocks of employed ( $E$ ), unemployed and searching ( $U$ ) and marginally attached workers who are unemployed but not actively searching ( $M$ ). Neither the OECD nor Eurostat report a direct measure of “U5”-unemployment, but the OECD does report the “incidence of marginally attached workers” for a range of countries which is defined as

$$m = \frac{M}{E + U} \quad (3.35)$$

Equations 3.34 to 3.35 can be combined to compute the OECD-equivalent of the BLS’s “U5”-measure of unemployment:

$$u_5 = u_3 + (1 - u_3) \frac{m}{1 + m} \quad (3.36)$$

### F Net replacement rates

This section describes how to compute aggregate data on net replacement rates (NRR) for unemployed with less than 12 months of unemployment duration (in the model  $b_1$ ) and with more than 12 months duration ( $b_2$ ) from data on NRR by family status available in the OECD database.

The level of net replacement rates (NRR) in case of unemployment does not only depend on the duration of unemployment but also the family status and the number of dependent children. The OECD therefore reports replacement rates for three different family types: Single person, one-earner married couple, two-earner married couple - and each of these types separately for the case of no children and for families with two children.<sup>25</sup> For each of these six family types  $j$  the OECD reports the NRR of newly unemployed ( $b_s^j$ ) and long-term unemployed (at unemployment duration of 60 months, here denoted  $b_l^j$ ). It also reports the average NRR over five years of unemployment ( $\bar{b}$ ), unfortunately not separately for each family type.

---

<sup>25</sup>The OECD data on NRR also distinguishes by different income levels and whether or not the person is eligible for top-up social assistance. Regarding the former, I use the average wage (“100%AW”). Regarding the latter, I take the simple average of both types as there is no data on the number of persons in either of the two groups available.

In a first step, I compute the average duration of short-term benefits  $D_s$  using the unweighted average of  $\bar{b}_s$  and  $\bar{b}_l$  for all family types together with the identity:

$$\bar{b} = \bar{b}_s \frac{D_s}{D_T} + \bar{b}_l \frac{D_T - D_s}{D_T}$$

As  $D_T = 60$  months and  $\{\bar{b}_s, \bar{b}_l, \bar{b}\}$  are known, one can back out  $D_s$  from this equation.

In the next step, I convert the benefit levels  $\{b_s^j, b_l^j\}$  for each family type  $j$  into the short- and long-term benefits  $\{b_1^j, b_2^j\}$  as defined in the model. The difference is that in the data, unemployed are eligible for  $D_s$  months of short-term benefits  $b_s^j$  (as just computed), whereas in the model, unemployed receive short-term benefits for 12 months, irrespective of the country. This transformation is a straight-forward weighted average of  $b_s^j$  and  $b_l^j$  in the first 12 months and the subsequent 48 months of a given unemployment spell, depending on the respective durations  $D_s$  and  $D_l = 60 - D_s$ .

In the third and last step, these type-specific NRR's  $b_1^j$  and  $b_2^j$  are aggregated across family types  $j$ :

$$b_1 = \sum_j \omega^j b_1^j$$

$$b_2 = \sum_j \omega^j b_2^j$$

As weights  $\omega^j$  I use the share of persons living in each of the six family types in 2011. Data on the number of persons in each family type are available in the Eurostat household census of 2011.

## G Deriving a quantitative measure of firing costs

This section describes the derivation of the quantitative measure of firing costs as outlined in section 3.3. The data is based on the OECD EPL Database which reports 25 ordinal sub-indicators covering various facets of employment protection legislation. I focus on three broad groups of indicators that are key components of firing costs according to Boeri et al. (2017): Mandatory notice periods, severance payments following fair dismissal for economic reasons and compensation payments upon unfair dismissal. In a first step, I retrieve the underlying quantitative measures by tenure from the detailed country reports (OECD (2013)) which are available for the year 2013. To obtain the average measures for each country, these tenure-specific policies need to be weighted with the share of employees who have accumulated that tenure with their employer. To do that, I fit OECD data on employment by tenure, which is available for seven tenure brackets,<sup>26</sup> to a Weibull distribution to get the employment-weights for each year of tenure. These weights are used to obtain average measures of:

- severance pay in case of a fair dismissal for economic reasons:  $S$
- compensation in case of unfair dismissal:  $C$
- mandatory notice period:  $N$

---

<sup>26</sup>Tenure brackets:  $< 1m, 1 - 5m, 6 - 11m, 12 - 23m, 24 - 59m, 60 - 119m, \geq 12m$

In order to obtain a measure of expected costs, it is necessary to attribute likelihoods to these three distinct cost components. To do that, I closely follow the categorization of firing costs developed in Boeri et al. (2017):

In principle, laying off a worker can happen for two reasons in all European economies: One possibility is that an employee is laid off for economic reasons, e.g. because the specific job a person did becomes obsolete or because the company is facing serious economic difficulties and has to lay off a certain fraction of its work force. The second reason is related to the specific behavior of the person being laid off and in particular covers personal misconduct or persistently low performance. Each of these two cases can be contested in court. Courts typically have to decide whether a dismissal was "fair" or "unfair". In any case the firm has to pay the employee during the notice period  $N$  monthly wages. In case of a fair dismissal for economic reasons, it also pays a severance payment  $S$ . In case of an unfair dismissal, firms typically have to pay a compensation  $C$  to the (former) employee which is higher than the usual severance pay. In addition, the court might force the firm to reinstate the worker in his old job. Reinstatement happens with a certain probability  $\xi$ . I follow Boeri et al. (2017) and assume that upon reinstatement, the firm has to additionally compensate the employee for the time of the court proceedings  $d$  and faces a second compensation payment  $C$ . If a dismissal is ruled unfair the firm therefore has to pay  $S + N + C + \xi(d + C)$ .

The layoff decision can therefore be illustrated by a reduced-form game where the firm first decides whether to dismiss an employee for economic ( $E$ ) or for personal ( $P$ ) reasons. In a second step a court decides with a certain probability which is specific to the type of dismissal whether the dismissal was fair ( $\pi_E$  and  $\pi_P$  respectively).

Hence, there are four potential outcomes from the viewpoint of the firm ex-ante:

1. Economic/Fair Dismissal:  $S + N$
2. Economic/Unfair Dismissal:  $S + N + C + \xi(d + C)$
3. Personal/Fair Dismissal:  $N$
4. Personal/Unfair Dismissal:  $S + N + C + \xi(d + C)$

What needs to be pinned down are the likelihoods of these 4 scenarios occurring. I assume that the likelihoods are such that firms are ex-ante indifferent between an economic and a personal dismissal such that either strategy is played with probability 1/2 (otherwise one option would strictly dominate the other in this simple game). I assume that the *average* probability of a fair dismissal  $\bar{\pi}$  depends on whether the burden of proof in front of the court is with the employer or with the employee (see Boeri et al. (2017)).<sup>27</sup> The indifference condition then implies that

$$\begin{aligned}
 S + N + (1 - \pi_E)(C + \xi(d + C)) &= N + (1 - \pi_P)(C + \xi(d + C)) \\
 &\downarrow \\
 \frac{\pi_E}{\pi_P} &= 1 + \frac{S}{C + \xi(d + C)}
 \end{aligned}$$

---

<sup>27</sup>If the burden of proof is with the firm:  $\bar{\pi} = 0.25$ . If it is with the employee:  $\bar{\pi} = 0.75$ . If it is with both firm and employee:  $\bar{\pi} = 0.5$ .



Combined with the identity  $\bar{\pi} = \frac{1}{2}(\pi_E + \pi_P)$ , this can be solved for the likelihoods of fair rulings  $\pi_E$  and  $\pi_P$ . That in turn allows to compute the expected value of laying off an employee from the viewpoint of the firm ex ante.



# Bibliography

- Abraham, A., de Sousa, J. B., Marimon, R., and Mayr, L. (2017). On the design of a european unemployment insurance mechanism. *mimeo*.
- Antoni, M., Ganzer, A., and vom Berge, P. (2016). Sample of integrated labour market biographies (siab) 1975-2014. Technical report, Data report 04/2016, Institute for Labor Market Research (IAB), Nuremberg.
- Autor, D. (2003). Outsourcing at will: The contribution of unjust dismissal doctrine to the growth of employment outsourcing. *The University of Chicago Press*, 21(1).
- Autor, D., Donohue, J., and Schwab, S. (2006). The costs of wrongful-discharge laws. *The Review of Economics and Statistics*, 88(2):211–231.
- Autor, D., Dorn, D., and Hanson, G. (2013). The china syndrome: Local labor market effects of import competition in the united states. *American Economic Review*, 103:2121–68.
- Autor, D., Kerr, W., and Kugler, A. (2007). Does employment protection reduce productivity? evidence from us states. *The Economic Journal*, 117(521):F189–F217.
- Baily, M. (1978). Some aspects of optimal unemployment insurance. *Journal of Public Economics*, 10:379–402.
- Barlevy, G. (2004). The cost of business cycles under endogenous growth. *American Economic Review*, 94(4):964–990.
- Basu, S. and Fernald, J. (1997). Returns to scale in u.s. production: Estimates and implications. *Journal of Political Economy*, 105(2):249–283.
- Beblavy, M. and Lenaerts, K. (2017). Stabilising the european economic and monetary union: What to expect from a common unemployment benefits scheme? *CEPS Research Report*.
- Bergin, P., Feenstra, R., and Hanson, G. (2009). Offshoring and volatility: Evidence from mexico’s maquiladora industry. *American Economic Review*, 99(4):1664–1671.
- Bergin, P., Feenstra, R., and Hanson, G. (2011). Volatility due to offshoring: Theory and evidence. *Journal of International Economics*, 85(2):163–173.

- Berlingieri, G. (2014). Outsourcing and the rise in services. *CEP Discussion Paper*, (1199).
- Boeri, T., Garibaldi, P., and Moen, E. (2017). Inside severance pay. *Journal of Public Economics*, 145:211–225.
- Burda, M. and Seele, S. (2016). No Role for the Hartz Reforms? Demand and Supply Factors in the German Labor Market 1993-2014. *SFB 649 Discussion Paper*.
- Cairo, I. (2013). The slowdown in business employment dynamics: The role of changing skill demands. *mimeo*.
- Cairo, I. and Cajner, T. (2013). The fading dynamism of the us labor market: The role of demographics. *mimeo*.
- Chetty, R. (2006). A general formula for the optimal level of social insurance. *Journal of Public Economics*, 90:1879–1901.
- Chodorow-Reich, G. and Karabarbounis, L. (2016). The limited macroeconomic effects of unemployment benefit extensions. *Working paper*.
- Costain, J. and Reiter, M. (2008). Business cycles, unemployment insurance, and the calibration of matching models. *Journal of Economic Dynamics and Control*, 32(4):1120 – 1155.
- Dauth, W., Findeisen, S., and Suedekum, J. (2016). Adjusting to globalization - evidence from worker-establishment matches in germany. *mimeo, Duesseldorf Institute for Competition Economics*.
- Davis, S., Faberman, J., Haltiwanger, J., Jarmin, R., and Miranda, J. (2010). Business volatility, job destruction and unemployment. *American Economic Journal: Macroeconomics*, 2(2):259–287.
- Davis, S. and Haltiwanger, J. (2014). Labor market fluidity and economic performance. *NBER Working Paper no. 20479*.
- Decker, R., Haltiwanger, J., Jarmin, R., and Miranda, J. (2014). The secular decline in business dynamism in the u.s. *mimeo*.
- Den Haan, W. and Sedlááček, P. (2014). Inefficient continuation decisions, job creation costs, and the cost of business cycles. *Quantitative Economics*, 5(2).
- Dey, M., Houseman, S., and Polivka, A. (2010). What do we know about contracting out in the united states? *Labor in the New Economy, University of Chicago Press*.
- Dustmann, C., Fitzenberger, B., Schönberg, U., and Spitz-Oener, A. (2014). From sick man of europe to economic superstar: Germany’s resurgent economy. *The Journal of Economic Perspectives*, 28(1):167–188.
- Dustmann, C. and Meghir, C. (2005). Wages, Experience and Seniority. *Review of Economic Studies*, 72(1):77–108.

- Elsby, M. W., Hobijn, B., and Şahin, A. (2013). Unemployment dynamics in the oecd. *Review of Economics and Statistics*, 95(2):530–548.
- Foster, L., Haltiwanger, J., and Syverson, C. (2008). Reallocation, firm turnover and efficiency: Selection on productivity or profitability? *American Economic Review*, 98(1):394–425.
- Fujita, S. (2015). Declining labor turnover and turbulence. *Federal Reserve Bank of Philadelphia*.
- Fujita, S. and Ramey, G. (2009). The cyclicalty of separation and job finding rates. *International Economic Review*, 50(2):415–430.
- Hagedorn, M., Karahan, F., Mitman, K., and Manovskii, I. (2016). The macro and micro-effects of macroeconomic policy. *Working paper*.
- Hagedorn, M. and Manovskii, I. (2008). The cyclical behavior of equilibrium unemployment and vacancies revisited. *American Economic Review*, 98(4):1692–1706.
- Hartung, B., Jung, P., and Kuhn, M. (2016). Etiopathology of europe’s sick man: Worker flows in germany, 1959-2016. (10341).
- Hartung, B., Jung, P., and Kuhn, M. (2018). What hides behind the german labor market miracle? *mimeo*, 124(581):1317–1342.
- Hertweck, M. and Sigrist, O. (2015). The ins and outs of german unemployment: A transatlantic perspective. *Oxford Economic Papers*, 67(4):1078–1095.
- Hopenhayn, H. and Nicolini, J. P. (1997a). Optimal unemployment insurance. *Journal of Political Economy*, 105(2).
- Hopenhayn, H. and Nicolini, J. P. (1997b). Optimal unemployment insurance. *Journal of Political Economy*, 105(2):412–438.
- Hosios, A. (1990). On the efficiency of matching and related models of search and unemployment. *Review of Economic Studies*, 57:279–298.
- Hyatt, H. and Spletzer, J. (2013). The recent decline in employment dynamics. *IZA Journal of Labor Economics*, 2:5.
- Ignaszak, M., Jung, P., and Kuester, K. (2018). Federal unemployment insurance: Theory and an application to europe. *mimeo*.
- Jäger, S., Schoefer, B., and Zweimüller, J. (2018). Marginal jobs and job surplus: Evidence from separations and unemployment insurance. Technical report, Working Paper.
- Jung, P. and Kuester, K. (2015). Optimal labor-market policy in recessions. *American Economic Journal: Macroeconomics*, 7(2):124–56.

- Jung, P. and Kuhn, M. (2014a). Labor market institutions and worker flows: Comparing germany and the u.s. *The Economic Journal*, 124(581):1317–1342.
- Jung, P. and Kuhn, M. (2014b). Labour market institutions and worker flows: comparing germany and the us. *The Economic Journal*, 124(581):1317–1342.
- Jung, P. and Kuhn, M. (2018). Earnings Losses and Labor Mobility Over the Life Cycle. *The Journal of the European Economic Association*.
- Kaplan, G. and Schulhofer-Wohl, S. (2017). Understanding the long-run decline in interstate migration. *International Economic Review*, 58(1).
- Katz, L. and Krueger, A. (2017). The rise and nature of alternative work arrangements in the united states. *Working Paper*.
- Katz, L. F. and Meyer, B. D. (1990). The impact of the potential duration of unemployment benefits on the duration of unemployment. *Journal of Public Economics*, 41(1):45–72.
- Klinger, S. and Rothe, T. (2012). Der Rueckgang der Langzeitarbeitslosigkeit in Deutschland: Ein Erfolg der Hartz-Reformen oder konjunktureller Effekt. *Schmollers Jahrbuch*, 132(1):89–121.
- Klinger, S. and Weber, E. (2016). Decomposing beveridge curve dynamics by correlated unobserved components. *Oxford Bulletin of Economics and Statistics*, 78(6):877–894.
- Kolsrud, J., Landais, C., Nilsson, P., and Spinnewijn, J. (2018). The optimal timing of unemployment benefits: Theory and evidence from sweden. *American Economic Review*, 108:985–1033.
- Krause, M. U. and Uhlig, H. (2012). Transitions in the german labor market: Structure and crisis. *Journal of Monetary Economics*, 59(1):64–79.
- Krebs, T. and Scheffel, M. (2013). Macroeconomic evaluation of labor market reform in germany. *IMF Economic Review*, 61(4):664–701.
- Launov, A. and Wälde, K. (2013). Estimating incentive and welfare effects of nonstationary unemployment benefits. *International Economic Review*, 54(4):1159–1198.
- Loecker, J. d. and Eeckhout, J. (2017). The rise of market power and the macroeconomic implications. *mimeo*.
- Lucas, R. J. (2003). Macroeconomic priorities. *American Economic Review*, 93(1).
- Millard, S. P. and Mortensen, D. T. (1997). The unemployment and welfare effects of labour market policy: A comparison of the USA and the UK. In Snower, D. J. and Dehesa, G. d. l., editors, *Unemployment Policy: Government Options for the Labour Market*, pages 545–572. Cambridge University Press.
- Molloy, R., Smith, C., Trezzi, R., and Wozniak, A. (2016). Understanding declining fluidity in the u.s. labor market. *Brookings Papers Conference Draft*.

- Molloy, R., Smith, C., and Wozniak, A. (2013). Declining migration within the us: The role of the labor market. *Finance and Economics Discussion Series*.
- Moyen, S., Stähler, N., and Winkler, F. (2016). Optimal unemployment insurance and international risk sharing. *Finance and Economics Discussion Series: Board of Governors of the Federal Reserve System*, 54.
- Murtin, F. and Robin, J.-M. (2016). Labor market reforms and unemployment dynamics. *Labour Economics*.
- OECD (2013). Detailed description of employment protection legislation 2012-2013. *OECD EPL Database*.
- Pissarides, C. and Petrongolo, B. (2001). Looking into the black box: A survey of the matching function. *Journal of Economic Literature*, 39(2):390–431.
- Pissarides, C. A. (2000). *Equilibrium Unemployment Theory*. MIT press.
- Schmieder, J. F. and Von Wachter, T. (2016). The effects of unemployment insurance benefits: New evidence and interpretation. *Annual Review of Economics*, 8:547–581.
- Shavell, S. and Weiss, L. (1979a). The optimal payment of unemployment insurance benefits over time. *Journal of Political Economy*, 87(6):1347–1362.
- Shavell, S. and Weiss, L. (1979b). The optimal payment of unemployment insurance benefits over time. *Journal of Political Economy*, 87(6):1347–1362.
- Shimer, R. (2005a). The cyclical behavior of equilibrium unemployment and vacancies. *American Economic Review*, 95(1).
- Shimer, R. (2005b). The cyclical behavior of equilibrium unemployment, vacancies, and wages: Evidence and theory. *American Economic Review*, 95(1):25–49.
- Shimer, R. (2007). Reassessing the ins and outs of unemployment. *Review of Economic Dynamics*, 15:127–148.
- Shimer, R. (2012). Reassessing the ins and outs of unemployment. *Review of Economic Dynamics*, 15(2):127 – 148.
- Shimer, R. and Werning, I. (2006). On the optimal timing of benefits with heterogeneous workers and human capital depreciation. *NBER Working Papers*, 12230.
- Shimer, R. and Werning, I. (2008). Liquidity and insurance for the unemployed. *American Economic Review*, 98(5):1922–42.
- Steffen, J. (2008). Sozialpolitische chronik. *Arbeitslosenversicherung (seit 1969)*. *Arbeitnehmerkammer Bremen*. Bremen.
- Topel, R. and Ward, M. (1992). Job mobility and the careers of young men. *Quarterly Journal of Economics*.

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

Zlate, A. (2016). Offshore production and business cycle dynamics with heterogeneous firms. *Journal of International Economics*, 100:34–49.



## **Lebenslauf**

Benjamin Hartung wurde am 2. Februar 1989 in Leipzig geboren und erlangte 2007 die allgemeine Hochschulreife an der Werner-Heisenberg-Schule in Leipzig. Nach dem Bachelor-Studium in Internationalen Beziehungen an der Technischen Universität Dresden und der Staatlichen Universität Tomsk, hat er 2012 die Promotion in Volkswirtschaftslehre an der Bonn Graduate School of Economics begonnen. Vom September 2015 bis April 2016 war er für einen Forschungsaufenthalt an der London School of Economics and Political Science (LSE). Im Januar 2018 hat er den Abschluss Master of Science in Economics erlangt.