



German labor market reform and the rise of Eastern Europe: dissecting their effects on employment

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Abstract

From the early 1990s until 2005 the unemployment rate rose in Germany from 7.3 to 11.7%. While the unemployment rate reached its peak in 2005, it decreased steadily in the following years. The fourth stage of the German labor market reform (Hartz IV) was implemented in 2005 with the intent to cut the unemployment rate. This paper investigates the employment and welfare effects of the Hartz IV reform. Moreover, I am interested in the employment impact of German labor market reform due the rise of the East, which is the productivity increase in Germany and Eastern Europe that has fostered joint fast-growing trade. The focus lies on the national and county level (including 402 counties). As the effects on regional labor markets differ and take time, the paper builds on the dynamic and spatial trade model of Caliendo et al. (2019). I find that the Hartz IV reform is responsible for a 25% drop in unemployment, with a particular impact on eastern German counties. The rise of the East leads to an additional positive contribution to the labor market.

Keywords Dynamic trade model · Labor market reform · Productivity shocks · Welfare implications · Germany · Eastern Europe

JEL Classification F14 · F16 · F17

1 Introduction

A pivotal year in the German labor market development was 2005: After the German reunification the unemployment rate grew from 7.30 to 11.4% in 1997. Followed by a phase of recovery, which was mainly driven by the “new economy”. The bursting of the dot-com bubble led to an increase of the German unemployment rate

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to its all-time high in 2005 with 11.7%. However, up to the financial crisis in 2008 the unemployment rate fell sharply to 7.8% and even to 5% in the following decade. Figure 1 illustrates the development of the unemployment rate and the number of unemployed over the period 1991–2019. Hereby, the question about the cause of the strong decrease in the unemployment rate since 2005 naturally arises.

At this time, an important labor market policy milestone took place in Germany. In this regard, the German Hartz reforms stand out as a potential channel for the reversal of unemployment.¹ They had their focus on the restructuring of the low-wage sector in Germany. The labor market reforms were implemented between 2003 and 2005 in four stages (Hartz I–Hartz IV). Especially through the fourth stage (Hartz IV) and the introduction of the long-term unemployment benefit “Arbeitslosengeld II” (hereafter “ALG II”) on January 1st, 2005 it was hoped to cut the unemployment: On the one hand, the long-term unemployment benefit was initiated to provide a life of human dignity for all people living in Germany between the age of 15 and 65 (or 67), who are capable of working and cannot afford to satisfy their basic material needs.² On the other hand, the long-term unemployment benefit is conditional, and the recipients are obliged to aim actively for integration into the labor market. In the case of a breach of duty, the long-term unemployment benefit is reduced by 30%, in the case of a second time by 60%, and in the case of a third time the benefit is cut all together. The long-term unemployment benefit is financed by the federal government via the Federal Employment Agency (“Bundesagentur für Arbeit”), except for housing and other costs that are usually paid by municipalities and counties (§6 SGB II). Typically, the long-term unemployment benefit (“ALG II”) is paid after a person is unemployed for more than 12 months and thus is not eligible for the short-term unemployment benefit “Arbeitslosengeld I” (“ALG I”) anymore. Moreover, a person can be eligible for the long-term unemployment benefit even if the person is working, yet earns less than he needs to satisfy the basic demands. This group makes about one third of all long-term unemployment benefit (“ALG II”) recipients.³

This paper investigates the impact of the German labor market reform (Hartz IV) on the German labor market at the German county level (“Kreisebene”). For my analysis I build on the new spatial multi-country and multi-sector equilibrium model of Caliendo et al. (2019). It includes a dynamic set-up, which considers the adjustments of the labor market, as the economic and policy effects on employment differ

¹ Other factors could also have contributed to the rapid fall of unemployment, e.g. wage moderation, economic improvement or the increasing flexibility of the labor market institution, see Dustmann et al. (2014).

² According to the Second Book of the Code of Social Law (§8 SGB II), a worker is capable of working if he is able to work for at least three hours a day and not handicapped due to illness or disability. Foreigners can also receive the unemployment benefits if they live in Germany and have a valid work permit (not for the first three months), and if they are no asylum seekers, see §7 SGB II.

³ Besides those main groups there are other groups (e.g. students) which are eligible for the long-term unemployment benefit. But, as those groups are not part of the accessible workforce, I will not consider them in the analysis in more detail.

for each sector and need time to adapt. Further, the model provides a rich theoretical framework which takes input–output linkages, labor mobility frictions, goods mobility frictions as well as spatial factors into account. In order to incorporate the German labor market reform (Hartz IV) in a dynamic general equilibrium setting I apply the extension of the basic Caliendo et al. (2019) model, as it considers the policy effects of the Social Security Disability Insurance (SSDI) program in the United States. In doing so, I borrow closely from the SSDI framework and modify the model to make it suitable for analyzing the effects of German labor market reform.

I add value through my empirical and counterfactual analysis. In particular, I conduct an analysis of the Hartz IV reform's employment and welfare effects. Thereby, I answer the question: How would German employment and welfare have evolved, if the Hartz IV reform would not have taken place? I do this by constructing first a baseline economy where the data develop as they actually did. Second, I then construct a counterfactual economy for the case of the Hartz IV reform. By taking the difference between the baseline and the counterfactual economy I am able to identify the employment and welfare impact of the Hartz IV reform. In this regard, I undertake a comprehensive study of the German labor market effect that includes the county level and covers all 402 German counties (NUTS-3 level).

The time of interest of my analysis are the years between 2005 and 2014, as during that time the German labor market reforms were introduced. Hereby, I construct an input–output table for the German counties, compatible with the World Input–Output Database (WIOD). I follow the approach of Krebs and Pflüger (2018) and use the production value added data for each county. The data is obtainable from the regional statistic data (“Regionalstatistik”) of the German Federal and Regional Statistical Offices, Statistische Ämter des Bundes und der Länder (2020). It includes seven sectors, which are the sectors of interest in my analysis.⁴ With those seven sectors I am able to construct the input–output table on the county level. Further I include a short-term unemployment sector and a sector for the long-term unemployment (“ALG II”).⁵ To identify income taxes and the costs of the long-term unemployment benefit (“ALG II”) I rely on the data of the federal government budget (“Bundeshaushalt”). Employment, short-term unemployment and long-term unemployment data are provided by the Statistics of the Federal Employment Agency (“Bundesagentur für Arbeit”). In order to identify the movement of households across sectors and counties, I construct a labor mobility matrix. In addition,

⁴ The sectors include four manufacturing and three service sectors: Agriculture and forestry, fisheries (Sector 1); production industry without construction (Sector 2); manufacturing and processing (Sector 3); construction (Sector 4); trade, transport, hotels and restaurants, information and communication (Sector 5); financial, insurance services (Sector 6); public services, education, health services (Sector 7).

⁵ Regarding the trade flow data, I make use of the data provided by Statistisches Bundesamt (Destatis) (2020) and the World Input–Output Database (WIOD), that includes data on 43 countries and an aggregate of the rest of the world. I combine the 56 sectors of the database into the seven sectors used in my simulation.

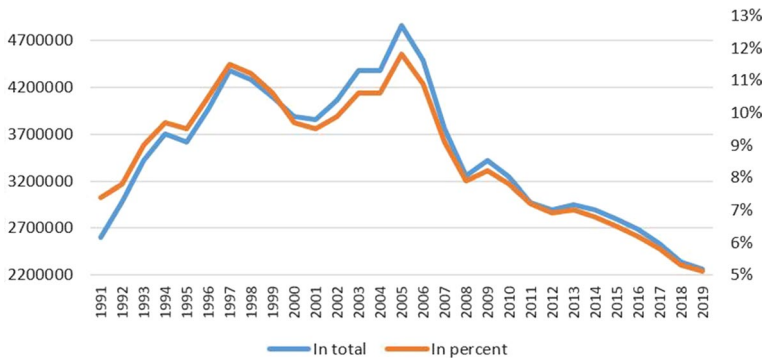


Fig. 1 Development of Unemployment in Germany. *Source* Statistik der Bundesagentur für Arbeit (2020); Author's own calculations

I identify the probabilities of households becoming employed, short-term unemployed and long-term unemployed.

My analysis shows, that without the labor market reform (Hartz IV) the German short-term unemployment would have been 0.4 percentage points larger. This is equivalent to a 385,000 decrease in the number of unemployed and explains a 25% decrease in unemployment between 2005 and 2014. Furthermore, I can demonstrate that welfare would decline as a result of the labor market reform, since the increased labor supply puts pressure on wages and thus reduces welfare. This is especially true for the East German counties.

In the empirical part of this paper, I am additionally interested in the employment effects of German labor market reform through the rise of the East. That is the increase in trade between Germany and Eastern Europe due to strong productivity growth in Eastern Europe and Germany. Figure 2 shows that the German imports from Eastern Europe and the German exports to Eastern Europe grew stronger since 2005 (up to the financial crisis in 2008/09), compared to the previous years. This is indicated by the fact that the actual German imports from and exports to Eastern Europe are larger since 2005 than the import and export trend (if the imports and exports of 2005 would rise as between 2004 and 2005).

Dauth et al. (2014) find that the growing trade flows have led to net-employment gains in Germany, as new export opportunities economically stimulated regions with strong export-oriented sectors. Yet, other regions with sectors vulnerable to import competition experienced higher levels of unemployment triggered by the trade exposure. This led to unevenly distributed employment gains or even losses across different regions.⁶ Dauth et al. (2021) suggest the rising productivity in Eastern Europe

⁶ In addition to the rise in trade with Eastern Europe, the rising trade with China could also have impacted the labor market in Germany. Dauth et al. (2014) investigate in their paper the employment

as a driving force behind the increasing trade flows.⁷ Especially through the economic transformation the Eastern European productivity levels grew substantially, and hence, could have led to more pressure on the German labor market through increasing import competition. At the same time the German productivity grew as well and could have contributed to the increase in exports to Eastern Europe. However, less is known about the precise impact of productivity on the rising trade between Germany and Eastern Europe, and henceforth on the effects on the German labor market.

Depending on which effect prevails, the rise of the East can contribute to the decline in German unemployment and accelerate the effect of the Hartz IV reform. The question then becomes, how would the German labor market have reacted if the Hartz IV reform had taken place, but without the simultaneous rise of the East? In other words: How substantial would the marginal employment effects of the Hartz IV reform have been as a result of the rise of the East?

My focus is on eleven Eastern European countries, which are represented in the World Input–Output Database (WIOD) (Release 2016) by Timmer et al. (2015). Namely Czech Republic, Hungary, Poland, Slovakia, Estonia, Latvia, Lithuania, Slovenia, Bulgaria, Croatia and Romania. Since productivities play a crucial part in my study, I identify the precise productivity changes on the sectoral level driving the rising trade between Germany and Eastern Europe. I calibrate for Germany the changes in productivity that corresponds to the increase of Eastern European imports. For Eastern Europe I conduct the productivity changes, which are responsible for the import increase in Germany. I calibrate the productivity changes in two steps: In the first step, I use the instrumental-variable strategy by Autor et al. (2013) to conduct the predicted import changes for Germany and also for Eastern Europe, which arise from the productivity shocks. In the second step, I apply the iteration approach of Caliendo et al. (2019) to detect the productivity changes. By iteration the productivity changes are identified, when the predicted import changes match with the model's import changes.

Footnote 6 (Continued)

effect of the so-called “China Shock” and the increase in trade with Eastern Europe. Their findings indicate that the impact of the increasing trade flows of the “China Shock” was less significant than the effects of the increase in trade with Eastern Europe. The authors argue that the reason for a smaller impact of the “China Shock” is that Germany already imported goods from other countries where China had its comparative advantage in. For example Germany imported labor intensive goods like textiles from Italy, but after the “China Shock” trade divergence took place and the source of imports to China changed. Through this trade divergence the German labor market was less impacted by the increase in import competition from China.

⁷ Several other factors could also play major roles behind the rising trade flows between Germany and the Eastern European countries. Especially the trade integration of the Eastern European countries could have led to a decrease in trade cost and hence to an increasing trade flow with Germany. Particularly, the eastward enlargement of the European Union between 2004 and 2007 could have contributed to the reduction of the unemployment level in Germany. However, the precise impact on the German labor market by the trade liberalization remains unclear, as the estimation of the economic effect of the trade barrier reduction is empirically challenging, Dauth et al. (2014).

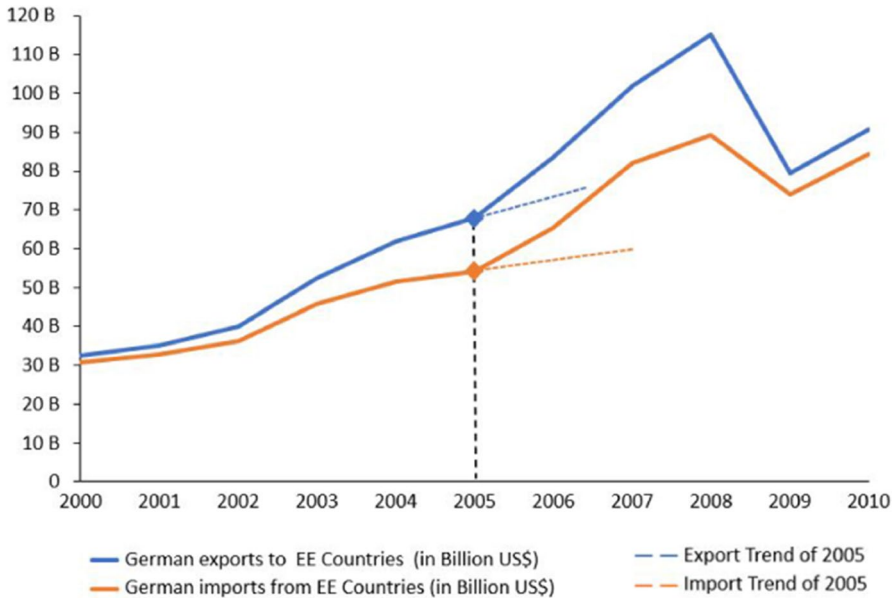


Fig. 2 German Trade Development to Eastern Europe. The analysis in my study includes eleven Eastern European countries. Thus, the data on Eastern Europe (in this graph) include those same countries, namely Czech Republic, Hungary, Poland, Slovakia, Estonia, Latvia, Lithuania, Slovenia, Bulgaria, Croatia, Romania. *Source* World Bank (2021); Author's own calculations

I then conduct the counterfactual simulation in the following manner, closely using the approach of the SSDI model: First, I carry out a counterfactual analysis in which the rise of the East happens, but the Hartz IV reform does not occur. Second by running a counterfactual analysis in which both the rise of the East and the Hartz IV reform do not take place. The difference between the two analyses then gives the marginal effects of the Hartz IV reform through rise of the East. I observe that the rise of the East leads to an additional positive contribution to the labor market, as employment increases by 0.05%. The largest impact is in the manufacturing sector, where 40,000 additional jobs are created.

My paper is based on several ideas from previous research. The approach of “dynamic hat algebra” used in my paper and developed by Caliendo et al. (2019) is based on the approach of relative changes of Dekle et al. (2008) and its “hat algebra”. Moreover, the applied Caliendo et al. (2019) model builds on the work of Eaton and Kortum (2002), Artuç et al. (2010) and Dvorkin (2014). It is linked to a strand of dynamic equilibrium models such as Artuç and McLaren (2010) and Dix-Carneiro (2014). Compared to the reduced form approach à la Autor et al. (2013), the general equilibrium framework of Caliendo et al. (2019) has several advantages: It allows for a comprehensive general equilibrium setting with input–output linkages and a spatial multi-country and multi-sector framework. Furthermore, it makes it possible to evaluate many different policy interventions. The general equilibrium framework enables analysis in multiple domains, e.g., employment and welfare effects in different labor markets. As Caliendo et al. (2019) point out that the

reduced-form approach can only determine changes in workers in one labor market relative to another labor market. It is therefore more straightforward to examine aggregate welfare and employment effects in a general equilibrium framework. Muendler (2017) argues that the reduced-form approach delivers empirical results, albeit with less conclusiveness, and indicates that general equilibrium models provide clearer outcomes.

Concerning the effect of the Hartz reforms several major studies have been conducted. Using different approaches and matching models the results vary from an unemployment decrease of 0.1% estimated by Launov and Wälde (2013) to 2% by Hochmuth et al. (2021) and of 2.82% by Krause and Uhlig (2012) as well as around 3% by Hartung et al. (2018). Krebs and Scheffel (2014) discover an unemployment reduction through the German labor market reforms (Hartz I to Hartz IV) by around 3%. However, they trace a 2% decrease to the impact of Hartz I to Hartz III (e.g. restructuring and increasing the number of “jobcenters” as well as the establishment of “minijobs”) and a 1% reduction to Hartz IV. I am able to show that using the comprehensive dynamic general equilibrium model that takes into account multiple sectors and counties, the impact of Hartz IV might be smaller. In addition, I complement the literature with a detailed evaluation of the labor market reform at the level of German counties. As a further effect, I include the rise of the East (increase in trade between Germany and Eastern Europe due to productivity growth in Germany and Eastern Europe), which amplifies the employment impact of the Hartz IV reform. The most recognizable work on the German trade exposure of Eastern Europe with its effect on the German labor market has been explored in a series of papers by Dauth et al. (2014, 2017, 2021). However, they do not explore the underlying fundamentals of the rising trade flows, e.g. fall of trade costs and rise in productivity. Related work has explored the effect of the “China Shock” on the U.S. labor market. Autor et al. (2013, 2014) and Acemoglu et al. (2016) suggest the productivity growth in China led to the “China Shock”, whilst Pierce and Schott (2016) demonstrate that the reduction of trade barriers, e.g. China joining the World Trade Organization (WTO) in 2001, led to the growth of Chinese trade flows.

The structure of this paper is as follows: In Sect. 2, I introduce a long-term unemployment state into an otherwise standard dynamic trade model à la Caliendo et al. (2019). Section 3 provides a description of the calibration of the data necessary to numerically solve the model. In Sect. 4 I present my findings of the economic impact of the German labor market reform (Hartz IV) and the additional labor market effects due to the rise of the East. In Sect. 5 I conclude.

2 Model

The Caliendo et al. (2019) model is a dynamic version of a multi-sector, multi-country Ricardian trade model à la Eaton and Kortum (2002). It incorporates a spatial general equilibrium and allows for labor market dynamics via labor mobility. I closely follow the extension of the Social Security Disability Insurance (SSDI) model and include long-term unemployment benefits in the framework. The model further consists of many exogenous factors (*fundamentals*) which are constant or

time-varying. To avoid the need to solve the *fundamentals* the model applies the equilibrium conditions in relative changes. Thus it includes the “*dynamic hat algebra*” approach, which embeds the “*hat algebra*” method of Dekle et al. (2008) in a time-varying environment. Regarding the mechanisms of the Hartz IV reform, it is argued that the Hartz IV reform has two main mechanisms that lead to a decrease in short-term unemployment via negative incentives. In the old labor market system, the unemployment benefits “Arbeitslosengeld” (60% of income) was paid for 12 and even up to 32 months. Afterwards the lower unemployment help “Arbeitslosenhilfe” (53% of income) was paid. Under the new system the “Arbeitslosengeld I” (60% of income) is only paid 12 months (in rare occasions 18 months). Hence, the unemployed would have an incentive to get a job. In addition, the long-term unemployment benefit “Arbeitslosengeld II” is much lower than the former unemployment help “Arbeitslosenhilfe” which gives an additional incentive for the unemployed to get into workforce again. In the model I focus on the effect of the “Arbeitslosengeld II” and not explicitly count for the time of the first mechanism.

2.1 Households

The model consists of a world with N regions labeled as n or i and of J sectors, indexed as j or k . As the model concentrates on the labor market reform in Germany regions can be seen as German counties. In the numerical analysis the German labor market model is incorporated into the multi-country context. A competitive labor market exists in each sector j of region n . Households can either be *employed* and work in sector j or they can be *short-term unemployed* (in “sector 0”) or *long-term unemployed* (in “sector A”). Representative consumers in region n that are employed in sector j get the market wage w_j^{nj} and provide in turn one-unit of labor. Depending on their preferences $U(C_t^{nj})$, they can choose from a consumption bundle of final local goods C_t^{nj} . The consumption bundle consists of local consumption goods $(c_t^{nj,k})$ from different sectors: $C_t^{nj} = \prod_{k=1}^J (c_t^{nj,k})^{\eta^k}$, where η^k is the share of final consumption of sector k and $\sum_{k=1}^J \eta^k = 1$. The households are forward looking and consider their potential future utility levels. This also includes the option of becoming short-term unemployed and even long-term unemployed.

The households decide, depending on the expected value, in what region-sector combination they want to provide their unit of labor. I apply a standard approach used in dynamic discrete choice models to solve the households’ optimization problem. A key to identify the lifetime utility plays the idiosyncratic shock e_t^{ik} , which is standardized distributed Type I Extreme Value. In this context, the idiosyncratic shock can be interpreted as additional benefits the households receive, when moving into region i and sector k (including the short-term unemployment “sector 0”). However, the households do not know the value of the idiosyncratic shock beforehand.⁸

The value of being employed in region n and sector j at time t is given by:

⁸ Here, the 2.2, 2.3 and 2.4 equations are based on the SSDI extension focusing on the German labor market reform.

$$V_t^{nj} = U(C_t^{nj}) + v(1 - \alpha_{t+1}^{nj}) \log \left(\sum_{i=1}^N \sum_{k=0}^J \exp(\beta V_{t+1}^{ik} - \tau^{nj,ik})^{1/v} \right) + \alpha_{t+1}^{nj} \beta V_{t+1}^{nA} \tag{2.1}$$

The discount factor is given by β and the scale variance of the idiosyncratic shock is denoted by v . The second term is the expected value when working in any sector of any region. Hereby $\tau^{nj,ik}$ is the transition cost of moving from region n in sector j into region i and sector k . The third term is the expected value of being long-term unemployed. Thus, V_{t+1}^{nA} is the value of the long-term unemployed households in period $t + 1$. Furthermore, α_{t+1}^{nj} is the probability that workers from region n of sector j end up in the long-term unemployed “sector”. Vice versa $(1 - \alpha_{t+1}^{nj})$ is the probability that households in region n and sector j in that particular region-sector combination either earn an income above the ALG II threshold or are short-term unemployed.

The utility value for short-term unemployed households is

$$V_t^{n0} = \log b^n + v(1 - \delta_{t+1}) \log \left(\sum_{i=1}^N \sum_{k=0}^J \exp(\beta V_{t+1}^{ik} - \tau^{nj,ik})^{1/v} \right) + \delta_{t+1} \beta V_{t+1}^{nA} \tag{2.2}$$

The households in the short-term unemployment sector receive and consume the value of their home production b^n . I assume the value of home production to be time invariant, as the home production value is less changing over time and therefore can be seen as a constant in the model. With a probability δ_{t+1} the households become long-term unemployed,⁹ while the probability $1 - \delta_{t+1}$ denotes the likelihood that households will not enter into ALG II in the next period. The second term indicates the expected value if one is moving to any sector in any region. This includes the possibility of being short-term unemployed denoted by $k = 0$. The third term represents the expected value if short-term unemployed households become long-term unemployed in the next period.

The value of the long-term unemployed households at time t can be written as

$$V_t^{nA} = \log(b_t^A / P_t^n) + (1 - \rho_{t+1}^{nA}) \beta V_{t+1}^{nj} + \rho_{t+1}^{nA} \beta V_{t+1}^{nA} \tag{2.3}$$

Recipients receive long-term unemployed benefit of b_t^A , which is time varying. Unlike the short-term unemployed benefit b^n (in terms of home production), the real long-term unemployed benefits b_t^A / P_t^n depend on the price index of the specific region n . With $1 - \rho_{t+1}^{nA}$, it is the probability that the households start working again, the second term denotes the expected value if the households will enter into the workforce. With the probability of ρ_{t+1}^{nA} , the third term indicates the expected utility value if the households will stay in the long-term unemployment program.

⁹ In the quantitative analysis, it is the probability that households become long-term unemployed after 12 months.

2.2 Migration share and labor mobility

The share of moving households is given by

$$\mu_t^{nj,ik} = \frac{\exp(\beta V_{t+1}^{ik} - \tau^{nj,ik})^{1/\nu}}{\sum_{m=1}^N \sum_{h=0}^J \exp(\beta V_{t+1}^{mh} - \tau^{nj,mh})^{1/\nu}} \tag{2.4}$$

which is the expected utility value a household would gain from moving to region i in sector k relative to the sum of the expected value of all sectors J and all regions N . In other words, region-sector combinations which have higher expected values attract more households than other region-sector combinations.¹⁰

Next, I show how the *employed*, *short-term unemployed* and *long-term unemployed* mass of households evolve over time. The mass of employed households in period $t + 1$ in region n and sector j is given by:

$$L_{t+1}^{nj} = \sum_{i=1}^N \sum_{k \neq 0}^J \mu_t^{ik,nj} (1 - \alpha_t^{ik}) L_t^{ik} + \sum_{i=1}^N \mu_t^{i0,nj} (1 - \delta) L_t^{i0} + (1 - \rho_t^{nA}) L_t^{nA} / J \tag{2.5}$$

The first term is the mass of employed households, which earn enough to satisfy their basic needs. The second term represents the mass of short-term unemployed households that are moving into the workforce of sector j . The third term displays the mass of households which transfer from long-term unemployment into a new job in region n in sector j .¹¹ Further, the mass of households which are short-term unemployed is:

$$L_{t+1}^{n0} = \sum_{i=1}^N \sum_{k \neq 0}^J \mu_t^{ik,n0} (1 - \alpha_t^{ik}) L_t^{ik} + \sum_{i=1}^N \mu_t^{i0,n0} (1 - \delta_t) L_t^{i0} \tag{2.6}$$

It consists of the mass of employed households that become short-term unemployed and those households that stay short-term unemployed in period t . The number of households that are long-term unemployed in period $t + 1$ can be represented as:

$$L_{t+1}^{nA} = \rho_t^{nA} L_t^{nA} + \delta_t L_t^{n0} + \sum_{j \neq 0}^J \alpha_t^{nj} L_t^{nj} \tag{2.7}$$

The first part is the mass of ALG II households that stay in the program, the second part shows the amount of short-term unemployed households getting into ALG II and the third part of the equation represents the mass of employed households earning too less and therefore are applicable for ALG II.¹²

¹⁰ In this context, $1/\nu$ can be considered as a migration elasticity.

¹¹ Note, that in the third term, J does not include the short-term and the long-term unemployment sector in this case.

¹² In principle the households can move across counties and enter the long-term unemployment benefit from other counties. However, the number of moving people is relatively low as the long-term unemploy-

2.3 Production

On the production side, intermediate goods are produced with labor, materials, and structures. The structures are composite local factors; firms rent the structures from rentiers. The intermediate goods go into the production of local sectoral aggregate goods from the same sector. The local sectoral aggregate goods are then used by the firms either to produce intermediate goods or final goods. The firms' productivities are Fréchet distributed and depend on the sectoral Fréchet distribution parameter θ^j . The model then yields the remaining equilibrium conditions, following the SSDI extension:

Unit price of an input bundle¹³

$$x_t^{nj} = B^{nj} ((r_t^{nj})^{\xi^n} (\omega_t^{nj})^{1-\xi^n}) \gamma^{nj} \prod_{k=1}^J (P_t^{nj,nk})^{\gamma^{nj,nk}} \tag{2.8}$$

Price of the sectoral aggregate good¹⁴

$$P_t^{nj} = \Gamma^{nj} \left(\sum_{i=1}^N (x_t^{ij} \kappa_t^{nj,ij})^{-\theta^j} (A_t^{ij})^{\theta^j \gamma^{ij}} \right)^{-1/\theta^j} \tag{2.9}$$

Share of total expenditure

$$\pi_t^{nj,ij} = \frac{(x_t^{ij} \kappa_t^{nj,ij})^{-\theta^j} (A_t^{ij})^{\theta^j \gamma^{ij}}}{\sum_{m=1}^N (x_t^{mj} \kappa_t^{nj,mj})^{-\theta^j} (A_t^{mj})^{\theta^j \gamma^{mj}}} \tag{2.10}$$

Total expenditure¹⁵

Footnote 12 (Continued)

ment benefit is paid by the Federal Employment Agency and each recipient receives the same standard rate independent of the location. Hereby, I neglect the extra subsidies paid by the local council for costs like housing since the focus of my study lies on the federal payments.

¹³ B^{nj} is a constant, r_t^{nj} is the factor price of the structure and ω_t^{nj} is the factor price of labor. ξ^n is the value added share of the structure. $\gamma^{nj,nk}$ is the share of intermediates from sector k that goes into sector j of the same region n .

¹⁴ Here Γ^{nj} is a constant, with $\kappa_t^{nj,ij}$ as the iceberg trade costs and A_t^{ij} as the time-varying sectoral-regional component of total factor productivity (TFP).

¹⁵ The effective total labor income revenue is $(1 - \tau_t^T) \sum_{k=1}^J \omega_t^{nk} L_t^{nk}$, with τ_t^T as labor income tax. $b_t^A L_t^A$ represents the total long-term unemployment benefit. Rentiers transfer their rents to a global portfolio χ_t in which they have a r^n stake. The government levies a lump-sum taxes or transfer G_t on rentiers so that $(r^n \chi_t - G_t/N)$ is their effective income. N is the total number of counties, allocated to spread the lump-sum tax/transfer for each rentier uniformly across counties.

$$\begin{aligned}
 X_t^{jn} &= \sum_{k=1}^J \gamma^{nk,nj} \sum_{i=1}^N \pi_t^{ik,nk} X_t^{ik} \\
 &+ \eta^j \left((1 - \tau_t^T) \sum_{k=1}^J \omega_t^{nk} L_t^{nk} + b_t^A L_t^A + r^n \chi_t - G_t/N \right)
 \end{aligned}
 \tag{2.11}$$

Labor market clearing in region n and sector j

$$L_t^{nj} = \frac{\gamma^{nj}(1 - \xi^n)}{\omega_t^{nj}} \sum_{i=1}^N \pi_t^{ij,nj} X_t^{ij}
 \tag{2.12}$$

Market clearing for structures in region n and sector j

$$H^{nj} = \frac{\gamma^{nj} \xi^n}{r_t^{nj}} \sum_{i=1}^N \pi_t^{ij,nj} X_t^{ij}
 \tag{2.13}$$

2.4 Solving the model

The model consists of two types of equilibria. Equations 2.1–2.7 represent the *sequential competitive equilibrium*. These are dynamic equations in which households decide where to move depending on the evolution of real wages over time and across labor markets. The *temporary equilibrium* is composed of Eqs. 2.8–2.13. It is a static subproblem that solves prices and wages under the condition of labor supply in a given market. The model contains a large number of exogenous state parameters, and the amount of necessary parameters increases with each time period. These exogenous state parameters are defined as *constant fundamentals* $\tilde{\Theta} = (Y, H, b)$ or *time-varying fundamentals* $\Theta = (A_t, \kappa_t)$. To make the model more tractable, the concept of “dynamic hat algebra” based on Dekle et al. (2008) is introduced. It transforms the equilibrium conditions into relative time differences. Thus, the *baseline economy* is constructed, with $\hat{y}_{t+1} \equiv \left(\frac{y_{t+1}^1}{y_t^1}, \frac{y_{t+1}^2}{y_t^2}, \dots \right)$ as the relative change of a vector’s value y between two periods. This approach has the advantage that it does not require information about the initial fundamentals.

To perform the counterfactual analysis, the *counterfactual equilibrium in relative time differences* is introduced. That is, the counterfactual economy in relative time differences, which includes the change in policy, is set in relation to the baseline economy. In this setting, the ratio of time changes between the counterfactual variable y'_{t+1} and the baseline economy variable \hat{y}_{t+1} is given by $\hat{y}'_{t+1} = \frac{y'_{t+1}}{\hat{y}_{t+1}}$. To solve the *counterfactual sequential equilibrium in relative time differences*, requires the *initial allocation of the economy* $\{L_t, \mu_{t-1}, \pi_t, X_t\}_{t=0}^\infty$ and the *baseline allocations in relative time differences* $\{\hat{L}_t, \hat{\pi}_t, \hat{\mu}_{t-1}, \hat{X}_t\}_{t=0}^\infty$ as well as the *changes in counterfactual fundamentals* $\{\hat{\Theta}_t\}_{t=1}^\infty$ as inputs. Moreover, for the *counterfactual sequential equilibrium in relative time differences*, and thus for the solution of the model, the conditions of the *counterfactual temporary equilibrium* must be satisfied for each period.

3 Data sources & measurement

In this chapter I concentrate on the empirical strategy to bring the data to the model. Thus, I pave the way to simulate the impact of the long-term unemployment benefit on employment in Germany. The strategy for the empirical simulation is provided in online appendix A.1, which involves the algorithm to solve the *sequential competitive equilibrium* and the algorithm for *counterfactuals*.¹⁶ My analysis centers its attention on the German county-level “*Kreisebene*” which includes in total 402 counties. The sectors of interest consist of four manufacturing and three service sectors plus a short-term unemployment and a long-term unemployment sector. Moreover, the years after the introduction of the long-term unemployment benefit in 2005 are in the spotlight of my study (2005 to 2014). In the following Sect. 1 describe the data calibration of those parameters used in the simulation that have to be empirically determined.¹⁷

3.1 Country- and county-trade data

As a main data source, I rely on the World Input–Output Database (WIOD) (Release 2016) by Timmer et al. (2015). I use the input–output data for the time period between 2005 and 2014, which cover in total 43 countries plus an aggregate of the rest of the world. To simulate the “rise of the East” I rely on the 11 eastern European countries provided in the data set: Czech Republic, Hungary, Poland, Slovakia, Estonia, Latvia, Lithuania, Slovenia, Bulgaria, Croatia and Romania. In addition, the data includes in total 56 sectors which are classified according to the ISIC Rev. 4.

However, since I am interested in the policy effects on the county level in Germany, I need the input–output data on the regional level. Unfortunately, the input–output data at this level is not available for Germany. Therefore, I construct the input–output table following the approach of Krebs and Pflüger (2018): Hereby, I use value added data on the county level from the “Regionalstatistik” of the German Federal and State Statically Office. I consider that the production value added share for each sector is constant, therefore it is possible to determine the county share for each sector in Germany. Through the county share I can construct the German input–output table at the county level, that is then put in alignment to the World Input–Output Database (WIOD). As the value added data of the regional statistic includes only seven sectors, I put my focus on these industries: Agriculture and forestry, fisheries (Sector 1); production industry without construction (Sector 2); manufacturing and processing (Sector 3); construction (Sector 4); trade, transport, hotels and restaurants, communication (Sector 5); financial, insurance services (Sector 6); public services, education, health services (Sector 7). To bring the input–output data on the sectoral level in alignment with the data of the World Input–Output Database (WIOD), I aggregate the 56 sectors to those seven described above. For the purpose

¹⁶ I am thankful for the *Matlab-Code* provided by Caliendo et al. (2019) which my simulation builds on. I included the features of the long-term unemployment benefit described in the model into the algorithm, which can be found in the online appendix A.2 and A.3.

¹⁷ The other parameters resolute endogenously by the modification of the model.

of data preparation, eliminate the negative inventories using the approach of Costinot and Rodríguez-Clare (2014). I do this to avoid possible negative values when summing up for the final demand. In addition, I compute the bilateral trade flows and the gross output¹⁸ for the 43 countries plus the 402 German counties.

3.2 Population composition

The population composition consists of employed, short-term unemployed and long-term unemployed people, I am interested in the distribution of those groups on the county level.¹⁹ Regarding the employment data L_t^{nj} , I rely on the data “Beschäftigungsstatistik” of the Federal Employment Agency. I aggregate the sectors to obtain the seven sectors used in my analysis. Data of short-term unemployment L_t^{n0} (according to SGB III people are short-term unemployed if they are out of work for up to 12 months) are taken from the statistics of the Federal Employment Agency as well.²⁰ As mentioned in the introduction, recipients of the long-term unemployment benefit do not necessarily have to be long-term unemployed to be applicable for the long-term unemployment benefit. To be applicable for the benefits people have to be able to work, but are not able to satisfy their basic material needs by their employment. Out of this group, people can be long-term unemployed recipients “arbeitslose Erwerbsfähige Leistungsberechtigte” (over 12 months unemployed) and non-unemployed recipients “nicht-arbeitslose Erwerbsfähige Leistungsberechtigte”. The group of non-unemployed recipients can consist of different cases: 1. People can be employed, but earn less than a certain minimum existence wage to be applicable. 2. People are able to receive “ALG II” benefit if they are in job training programs with the goal of getting into the workforce again (“in arbeitsmarktpolitischen Maßnahmen”). 3. People can be in school or in university and can receive under certain conditions “ALG II” benefit (“in Schule, Studium, ungefährdeter Ausbildung”). 4. People are in full-time caring for their family members (“in Erziehung, Haushalt, Pflege”). 5. People are unable to work (“in Arbeitsunfähigkeit”). 6. Under some conditions elderly people are applicable for “ALG II” benefit (§§428 SGB III/65 SGB II, 53a SGB II). As my analysis focuses on the employment effects, I consider, out of the mass of people which are in principle applicable for the “ALG II” benefit, those who are already working, but earn less than the minimum existence wage (“in ungeförderter Erwerbstätigkeit”) and those who are over 12 months long-term unemployed. Those two groups make up the majority of people who receive the “ALG II” benefit. I collect the data for each county from the statistics of the Federal

¹⁸ Gross output includes the total sales of each sector (for final and intermediate goods).

¹⁹ Immigration also influences the composition of the labor market, as do other economic activities such as offshoring, which involves the relocation of businesses and thus affects employment. The data from the Federal Employment Agency and its composition of the labor market take these effects into consideration.

²⁰ Data is available on the county level only for the years 2008 to 2014. I take the development of short-term unemployment for 2008 and 2009 and use the change as an approximation to calculate the years 2005 to 2007 for each sector.

Employment Agency.²¹ In Table 1 I provide an overview of the development of the population composition in Germany.

3.3 Probabilities

In this section let us turn to the probabilities that households are changing their status between employed, short-term unemployed and long-term unemployed. The probability that an employed person of region n of sector j at time t earns less than the minimum existence wage (“in ungeförderter Erwerbstätigkeit”) and therefore is applicable for the “ALG II” benefit is given by α_t^{nj} . In this case the person receives a certain part of the benefit, till the total income is equivalent to the amount of the primary “ALG II” benefit.²² To calculate α_t^{nj} I rely on the data of the statistics of the Federal Employment Agency for the years 2007 to 2014. Hereby I consider α_t^{nj} at t for each year. The probability α_t^{nj} is calculated as the share of people in unsubsidized employment (“in ungeförderter Erwerbstätigkeit”) in terms of total employment.²³ For the years 2005 and 2006 the dataset is restricted, therefore I construct the average of the years 2007 to 2014 for each sector and apply them for each sector in 2005 and 2006.

The probability that a short-term unemployed person at time t is longer than 12 months unemployed and therefore enters into the status of long-term unemployment is given by δ_t . In order to conduct δ_t I use the unemployment data of the statistics of the Federal Employment Agency. I define δ_t as the inflow of people who are short-term unemployed and are getting long-term unemployed compared to the total stock of short-term unemployed people at time t . As the data of inflows are only available at the national level, I consider δ_t to be a constant for each region-sector combination. I construct δ_t for the years 2005 to 2014. The inflow data as well as the stock data of short-term unemployed people are merely available for the years 2007 to 2014. For the years 2005 and 2006 only the stock data are available, for the inflow data I rely on the change rate between 2007 and 2008. I use this as a trend to construct the data for 2005 and 2006.

ρ_t^{nA} defines the probability that a person in region n who is long-term unemployed will stay in the long-term unemployed program and will further receive the long-term unemployed benefit. My focus of interest is again on the time between 2005 and 2014 for each county. I make use of the short-term and long-term unemployment data of the statistics of the Federal Employment Agency and use the outflow of people of long-term unemployment compared to the stock of the long-term unemployed.²⁴ However, the county data is only available for the years 2009 to 2014. For

²¹ As the data is only available for the years 2007 to 2014, I use the change rate of the years 2007 to 2008 for each county, and use this as an approximate to calculate the values for the years 2005 and 2006.

²² The group consists mainly of self-employed, mini-jobbers, part-time employees, but also full-time employees are applicable for the “ALG II” benefit.

²³ As noted in 2.1, the equation involves also short-term unemployment. Therefore, I calculate the probability of remaining in short-term unemployment and not moving to ALGII, which is $1 - \alpha_t^{n0}$. I do this separately for all short-term unemployment sectors.

²⁴ In a one minus relationship.

Table 1 Overview unemployment, long-term unemployment and employment shares in Germany. *Source* Statistik der Bundesagentur für Arbeit (2020); Author's own calculations

in %	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Unemployed	4.6%	4.2%	3.6%	3.1%	3.7%	3.3%	2.7%	2.7%	2.9%	2.7%
ALG II	11.5%	10.9%	9.8%	9.0%	8.9%	8.8%	8.5%	8.2%	8.1%	8.0%
Employed	84.0%	84.9%	86.6%	87.8%	87.4%	87.9%	88.8%	89.1%	89.1%	89.3%

the years 2005 to 2008 I take the average of the years 2009 to 2014. In some cases data for sector-region combination are not available. Hence, I use the average of the previous year of the sector-region combination as an approximation.

3.4 Productivity shock

As the growing productivities of the Eastern European countries and Germany are thought to be possible drivers of the “rise of the East“, they play a crucial role in my simulation. I am specifically interested in those productivity changes, which are responsible for the increasing trade flows between Germany and Eastern Europe.

By applying the approach of Caliendo et al. (2019) I calibrate the productivity changes. For Germany, I conduct the changes in productivity corresponding with the rising imports into the eleven Eastern European countries. Vice versa I calibrate for each of those eleven Eastern European countries the productivity changes which cause the import increase to Germany (imports from the particular country into Germany). Moreover, I conduct for every country the productivity changes on the sectoral level. In order to attain the productivity changes two steps based on Caliendo et al. (2019) are necessary: First, I apply the instrumental-variable strategy of Autor et al. (2013) to get the predicted import changes for Germany and the eleven Eastern European countries respectively. In the second step I calibrate by iteration the productivity changes as the model's import changes have to match with the predicted import changes. The instrumental-variable strategy of Autor et al. (2013) contains the import change from Germany (or one of the eleven Eastern European countries) by other advanced economies. At the core of the instrumental-variable strategy lies a first-stage regression:

$$\Delta M_{GER,j} = a_1 + a_2 \Delta M_{other,j} + u_j \quad (3.1)$$

The dependent variable $\Delta M_{GER,j}$ is the sectoral j import change in Germany for the years between 2005 and 2014, which the regression tries to predict by the explanatory variable. $\Delta M_{other,j}$ is the sectoral change of imports by advanced countries. Following Caliendo et al. (2019) I use here Australia, Denmark, Finland, Japan and Spain as advanced economic countries and rely on the World Input Output Database (WIOD) as data source. For Germany, I find the coefficient a_2 to be 3.058

with a standard error of 0.022 and a high R-squared of 0.99.²⁵ The regressions for each of the eleven Eastern European countries are similar:

$$\Delta M_{EE,i,j} = a_1 + a_2 \Delta M_{other,j} + u_j \quad (3.2)$$

Where $\Delta M_{EE,i,j}$ denotes the sectoral import change for each Eastern European country i in the same time period. Likewise, $\Delta M_{other,j}$ is the change of sectoral j imports of the advanced economies between 2005 and 2014. The results are displayed in Table 2, most countries, besides Estonia and Latvia, have high R-squared values that indicate respectable prediction power.

After having estimated the coefficients I use the baseline economy and the counterfactual economy²⁶ of the model to calibrate the sectoral productivity changes for each of the eleven Eastern European countries and Germany. This is done by iteration to find the optimal productivity change of each sector and country in order that the model's import changes matches the predicted import changes $a_2 \Delta M_{other,j}$ respectively. For Germany, I find a productivity change in “agriculture and forestry, fisheries” (Sector 1) of 0.1%; in “production industry without construction” (Sector 2) of 2.8%; in “manufacturing and processing” (Sector 3) of 3.4% and in “construction” (Sector 4) of 9.4%. The findings are supported by a high correlation between the model's import changes and the predicted import changes $a_2 \Delta M_{other,j}$ of 0.998. The results of the sectoral productivity changes of the eleven Eastern European countries are displayed in the online appendix Table A.4.

3.5 Labor income tax & long-term unemployment benefit

The labor income tax τ_t^T plays a major role in financing the long-term unemployment benefit. The tax is levied on every German labor income. The total amount of labor income tax revenue varies each year. To compute the labor income tax, I rely on the data of the federal budget (“Bundeshaushalt”). Thereby τ_t^T is composed by using the federal expenditure of the long-term unemployment benefit as a share of the total amount of income taxes. An overview of the development of the labor income tax for the years between 2005 and 2014 is provided in Table 3. Besides that, it is necessary for my analysis to identify the per capita long-term unemployment benefit b^A for the base year of 2005. By taking the data from statistics of the Federal Employment Agency I calculate a per capita expenditure for the recipients of 4080 Euro.²⁷ Having identified the labor income tax and the long-term unemployment

²⁵ Caliendo et al. (2019) find for the U.S. a coefficient of 1.386 with a standard error 0.033 and an R-squared of 0.99.

²⁶ Similar to Caliendo et al. (2019), the fundamentals in the baseline economy develop as they did between 2005 and 2014 and the counterfactual economy includes the same development of fundamentals. However, the sectoral productivity changes are set in such a way that the import changes of the model are close to the predicted import changes $a_2 \Delta M_{other,j}$.

²⁷ Thus, I use the total expenditure of 14.6 billion Euros (based on federal budget “Bundeshaushalt”) and divide it by 3578719 recipients which leads us to a per capita expenditure for the recipients of 4080 Euro. For calculation reasons it is in U.S. Dollar \$5534.

Table 2 Coefficient Results for a_2 (for Eastern European Countries). *Source* World Input Output Database, Release 2016; Author's own calculations

	Coefficient	Standard error	R-squared
CZE	5.402	0.201	0.997
HUN	5.813	0.256	0.996
POL	4.154	0.413	0.982
SVK	4.892	0.351	0.986
EST	0.113	0.081	0.235
LVA	0.787	0.638	0.516
LTU	2.305	0.296	0.974
SVN	15.298	0.083	0.999
BGR	18.097	0.605	0.998
HRV	3.177	0.441	0.984
ROU	7.173	0.583	0.988

benefit I can endogenously determine the lump sum tax/transfer G_t charged by the German rentiers by applying the equation of the government budget.

3.6 Share of value added in gross production

The share of the value added in gross production by sector j of region n (countries and counties) is denoted as γ^{nj} . In order to conduct the share of the value added in gross production for the 42 countries (without Germany) of the year 2005 I rely on the value added and gross production data provided by the socio-economic accounts (WIOD 2016 Release). For each country, I aggregate the 56 sectors of the dataset to fit the seven sectors used in my analysis. Regarding the aggregate of the “Rest of the World” of the World Input–Output Database (WIOD), I take the average of the 42 countries for each of those seven sectors. For the 402 counties in Germany I set up the share of the value added in gross production by applying the data from the regional statistic and of the German Federal and State Statistics Office. Especially for the manufacturing and processing (Sector 3) and construction sector (Sector 4) the value added and the gross production is available by the regional statistic.²⁸ For the other five sectors the value-added data is provided, however, I have no gross output data available on the county level. Therefore, I construct the value added in gross production of Germany from the socio-economic accounts for those sectors and apply those shares as a constant on the county level.²⁹

²⁸ For 44 counties data points are missing in the manufacturing and processing sector. Thus, I take the average share of the value added in gross production of the rest of the counties and implement the average share for those 44 counties.

²⁹ A similar approach is used in Caliendo et al. (2019).

Table 3 Development of Labor Income Tax responsible for financing ALG II. *Source* Bundesministerium der Finanzen (2020); Author's own calculations

2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
0.076	0.129	0.098	0.087	0.098	0.098	0.078	0.061	0.063	0.066

3.7 Share of structures in value added

The value-added share of structures is denoted as ξ^n . On the country level I make use of the socio-economic accounts (WIOD 2016 Release) to construct the share of structures in value added for each of the 42 countries (Germany not included) plus the aggregate of the “rest of the world” for the year 2005. The value-added share of structures is not directly taken from the data. However, as a work-around I use the relationship of one minus the share of labor compensation in value added which gives the value-added share of structures. I apply this relationship and use the labor compensation (in millions of national currency) and the gross value added at current basic prices (in millions of national currency) to identify the value-added share of structures for each country. As there is no data available for the aggregate of the “rest of the world” I use the average of the 42 countries as an approximation for the value-added share of structures. For the German county level, I make use of the regional statistics data of the German Federal and State Statistics Office. Since no data are available for the year 2005 I rely on the closest available data of 2004 to construct the value added share of structures. I apply the same approach as above for the relationship of the share of labor compensation in value added to identify the share of value added for the structures at the county level. I construct the share of labor compensation in value added by dividing the total amount of income per person in employment by the gross domestic product per person in employment of each county. For some counties data points are missing, thus, I use the average of the other German counties as an estimate.

3.8 Dispersion of sector productivity

In my analysis θ reflects the dispersion of productivity of each sector. I rely on the values for Germany on the sector-specific productivity dispersion parameter of Aichele et al. (2014),³⁰ which are based on the approach of Eaton and Kortum (2002) and are Fréchet distributed. For agriculture and forestry, fisheries (Sector 1) I take the average of the dispersion of productivity of the grains & crops; cattle, sheep, goats, horses; forestry; fishing sectors in Aichele et al. (2014). The same approach holds true for the production industry without construction (Sector 2), manufacturing and processing (Sector 3); construction (Sector 4) as I rely on the respective sectors of Aichele et al. (2014). Regarding the service sectors: Trade, transport, hotels and restaurants, communication (Sector 5); financial, insurance services (Sector

³⁰ Note there is also an updated version available Aichele et al. (2016).

6); public services, education, health services (Sector 7). I consider the approach of Egger et al. (2012) which is applied in Aichele et al. (2014) and Walter (2022). Hereby θ can be considered a constant in the service sectors. Egger et al. (2012) estimate an inverse θ of 5.959. This translates in my case to a θ of 0.1678. Table 4 summarizes all dispersion productivity parameters used in my paper.

3.9 Labor mobility & mobility elasticity

In order to estimate the labor mobility μ for the years 2005 to 2014, I construct a matrix of counties-sector input-outflows. The matrix shows the mobility of labor across counties and sectors (including the short-term unemployed and long-term unemployed sector). The value of each element of the county-sector input-outflow matrix represents the probability that a household working in sector j of county n and will be doing work in this county-sector combination (of the element) in the following year. Hereby, I denote higher probabilities to the circumstance that the household will stay in the same sector j and the same county n in the next time period. I make further assumptions that when a household decides to move, it is more likely to move into another neighbor region but staying in the same sector. Moving to more distant regions further decreases the probability. Also changing jobs to less similar sectors (e.g. having a job in construction and moving to the financial sector is less likely) reduces the probability of the element. My assumptions are based on the findings of Dauth et al. (2021), who identify the labor mobility across the county and sector level in Germany by using the data of Integrated Labor Market Biographies (IEB) from the German Institute for Employment Research (2020). 70% of the workforce stay in the sector and do not move to a different county. Out of the remaining 30% I assume that roughly two-third stay in the same sector, but move into other counties.³¹ The other one third consists of the people staying in the same county, but switching work to another sector (25%), the rest being people who move to other counties and switching work. My assumptions of the 30% of worker switching jobs and/or counties are differing to the findings of Dauth et al. (2021) which find that 10% get a new job in the same sector with or without switching counties, and the other 20% changing sectors with or without switching counties. As they consider 3-digit industry and I am only considering 7 sectors, my probability to stay in the same sector is higher than the finding of Dauth et al. (2021). In order to construct the mobility for short-term unemployed and long-term unemployed people I rely on the regional statistics data and as well the statistics of the Federal Employment Agency. Applying those assumptions, I denote for each possible element of the region-sector input-outflow matrix a certain probability, by which I can construct the labor mobility matrix μ for 2005 to 2014. As an estimation for the mobility elasticity ν I adopt the result of the annual rate of $\nu = 2.02$ of Caliendo et al. (2019).

³¹ Out of the 73% of workers staying, 52% of workers move into neighbor counties, while the other 21% move to other counties in Germany, with the same probability.

Table 4 Dispersion of German Sector Productivity. *Source* Aichele et al. (2014), Egger et al. (2012); Author's own calculations

Dispersion of productivities	θ
Agriculture and forestry, fisheries (Sector 1)	0.3542
Manufacturing without construction (Sector 2)	0.1849
Manufacturing (Sector 3)	0.3201
Construction (Sector 4)	0.1678
Trade, transport, hotels and restaurants, communication (Sector 5)	0.1678
Financial, Insurance services (Sector 6)	0.1678
Public services, education, health services (Sector 7)	0.1678

3.10 Discount interest rate

As my analysis relies on a dynamic model and considers the time change, it is necessary to identify the interest rates. In particular, β reflects the discount interest rate. To conduct the discount factor, I rely on the long-term interest-rate data from the OECD (2020) for the years 2005 to 2014. I find an average discount factor of annually 0.9687 and apply this value in my analysis.

4 Simulation

After having derived the key variables let us turn our attention to the analysis. In the following I present a short outline of the approach to conduct the simulation. Hereby the simulations build on the Caliendo et al. (2019) extension of the Social Security Disability Insurance (SSDI) program. I construct the baseline economy for the years 2005 and 2014 which consist of the development of the actual fundamentals. The baseline economy is needed to solve for the counterfactual equilibrium. In my counterfactual analysis I simulate the impact of the German labor market reform. In order to estimate the impact of the German labor market reform (in particular Hartz IV) I conduct the counterfactual economy. Specifically, I let the fundamentals develop as they did, but eliminate the parameters of the long-term unemployment benefit and cut the respective labor income tax.³²

4.1 Long-term unemployment benefit

I start by focusing on the impact of long-term unemployment benefits introduced as part of labor market reforms. My counterfactual question to answer is: What would have happened to the German labor market, if the long-term unemployment benefit would have been eliminated? Through this question I can examine the labor market changes due to Hartz IV. In addition, I examine the welfare implications of labor

³² In the counterfactual analysis, the agent expects to receive the long-term unemployment benefit, however, it is eliminated for the rest of the time period. Due to the elimination of the benefit, also the taxes which are financing the long-term unemployment benefit are cut.

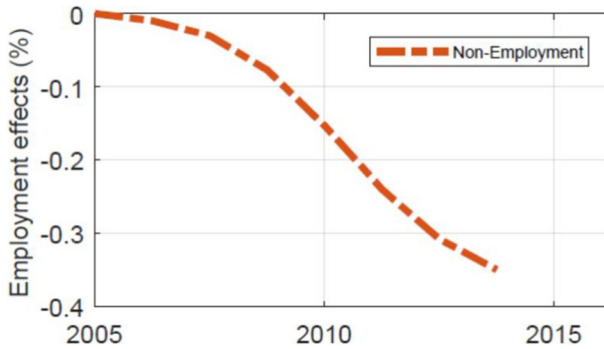


Fig. 3 Short-Term Unemployment Decrease due to the Long-Term Unemployment Benefit. The figures are based on the Author's own calculations and rely on the data explained in chapter 3

market reform. Figure 3 shows the effect of the long-term unemployment benefits on the German unemployment between 2005 and 2014.

Thus, the long-term unemployment benefit would account for an around 0.4% decrease in short-term unemployment.³³ That would correspond to an approximated reduction of unemployed people by 385,000 over time. This explains a 25% decrease in unemployment between 2005 and 2014. I further find that some sectors are profiting from the introduction of the long-term unemployment benefit as for example the employment of the manufacturing sector would increase by 0.15%. I also see an increase in the service sectors: Trade and commerce increase by 0.2%, public sector by 0.2% and finance sector by 0.08%. Other sectors as for example agriculture, production and construction would decrease in the long run, see online appendix A.5.

Next, I present the findings for the impact of the long-term unemployment benefit introduction on the German county level. Figure 4 displays the decreasing regional short-term unemployment shares. The regional unemployment shares are more affected by the German labor market reform than counties in the west. Although, some counties, especially in Bavaria experience a stronger decline as well. However, as Fig. 5 shows, the counties in the East contribute more to the decline of aggregate unemployment in Germany. Berlin has with 1.25% the highest contribution to the total reduction of Germany's unemployment.

The decrease of short-term unemployment leads to an increase of employment in other sectors. For the manufacturing sector I find an increase in the regional manufacturing share in Baden-Württemberg and Bavaria. In Mecklenburg-Western Pomerania and Brandenburg some counties experience the highest increase in the regional manufacturing share, which together with the named counties in the south contribute the largest to the aggregate increase of the manufacturing sector

³³ A brief explanation of the approach to identify the labor market impact of the long-term unemployment benefit: First, I let the fundamentals develop as they did in the data. Second, I simulate the counterfactual analysis and cut the long-term unemployment benefit as well as the responsible taxes. This leads to a higher unemployment level in the counterfactual scenario. The difference between the unemployment levels of the baseline and the counterfactual scenario is the short-term unemployment effect due to the introduction of the Hartz IV reform.

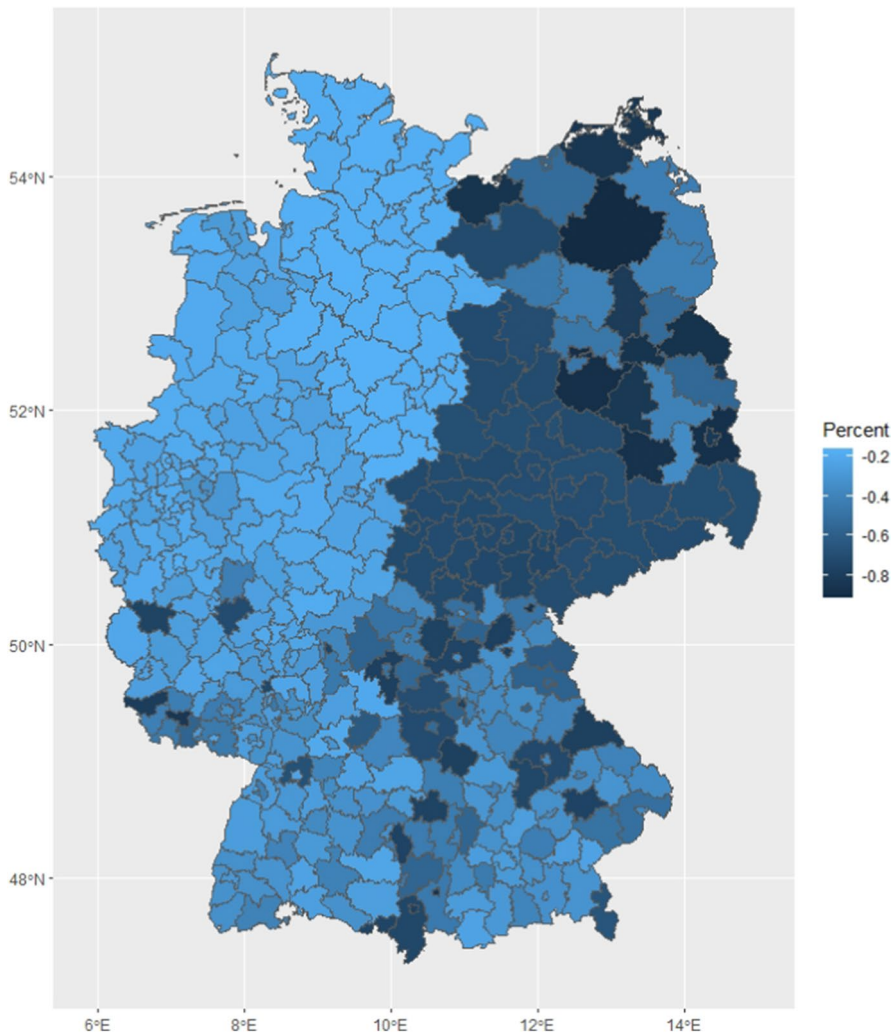


Fig. 4 Change in Regional Unemployment Shares. The figures are based on the Author's own calculations and rely on the data explained in chapter 3

in Germany, see Figs. 6 and 7. Further, I discover a shift into the trade and commerce sector as well as into the public sector. I find a similar pattern for counties in the southern part of Germany as well as in Mecklenburg-Western Pomerania and Brandenburg that contribute the largest to the employment increase in those sectors.

Next, I conduct a welfare analysis of labor market reform that looks at the overall change in real wages. Figure 8 shows the long-term percentage change in welfare in each county. I find that welfare falls by -0.08% in the long run due to Hartz IV reform. Welfare is falling above all in the new federal states. Especially in the federal states of Saxony Anhalt, Saxony and Thuringia. The impact of the labor market

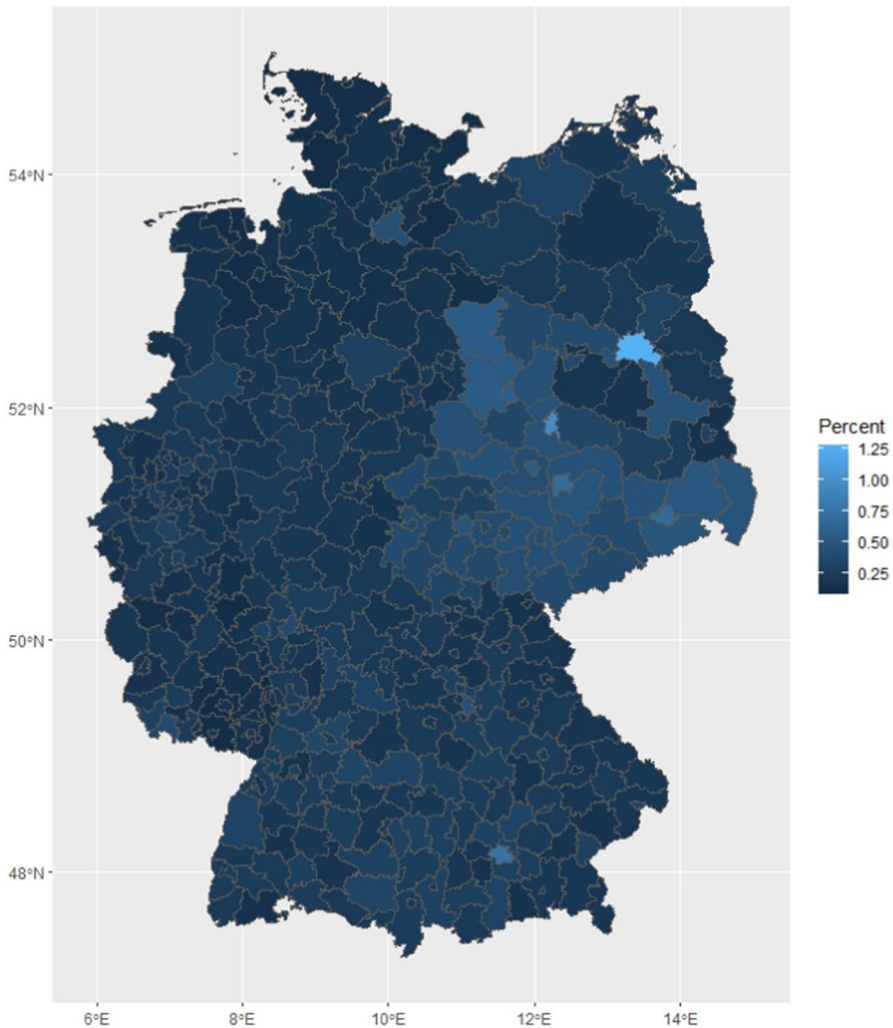


Fig. 5 Regional Contribution to total Short-Term Unemployment Decrease. The figures are based on the Author's own calculations and rely on the data explained in chapter 3

reform on welfare in the western German counties is small and almost negligible. However, there are some exceptions, e.g. in Neunkirchen in Saarland, where welfare falls by -0.12% . The labor market reform has a negative impact on welfare, because although the reform employs more people, the increase in labor supply puts pressure on wages, which has a negative impact on real wages. The increase in employment does reduce production costs, which lowers overall prices. However, these effects are smaller than the decline in wages, so that welfare falls. Particularly in the counties with higher employment effects of the Hartz IV reform, there is therefore a decline in overall welfare. Looking at the sectoral level, Fig. 9, the largest impact

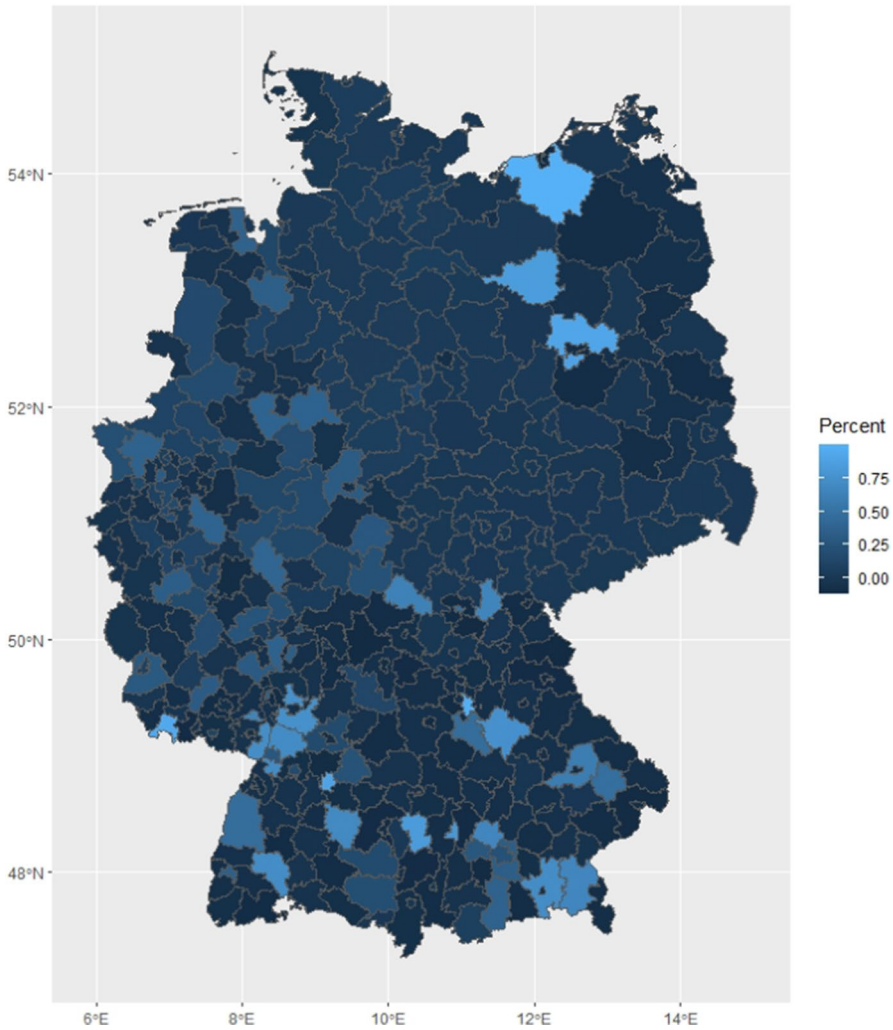


Fig. 6 Changes in Regional Manufacturing Shares. The figures are based on the Author's own calculations and rely on the data explained in chapter 3

on employment, as mentioned above, is in manufacturing, which also generates the largest welfare effects at the regional level. In the manufacturing sector, welfare falls by -0.1% on average. Here, again, it can be seen that welfare is declining most sharply in the eastern German counties. But welfare in the manufacturing sector is also declining overall in southern Germany, for example in Baden-Württemberg and Bavaria, where there is a strong manufacturing sector. But also in the counties of North Rhine-Westphalia due to the increase in labor supply.

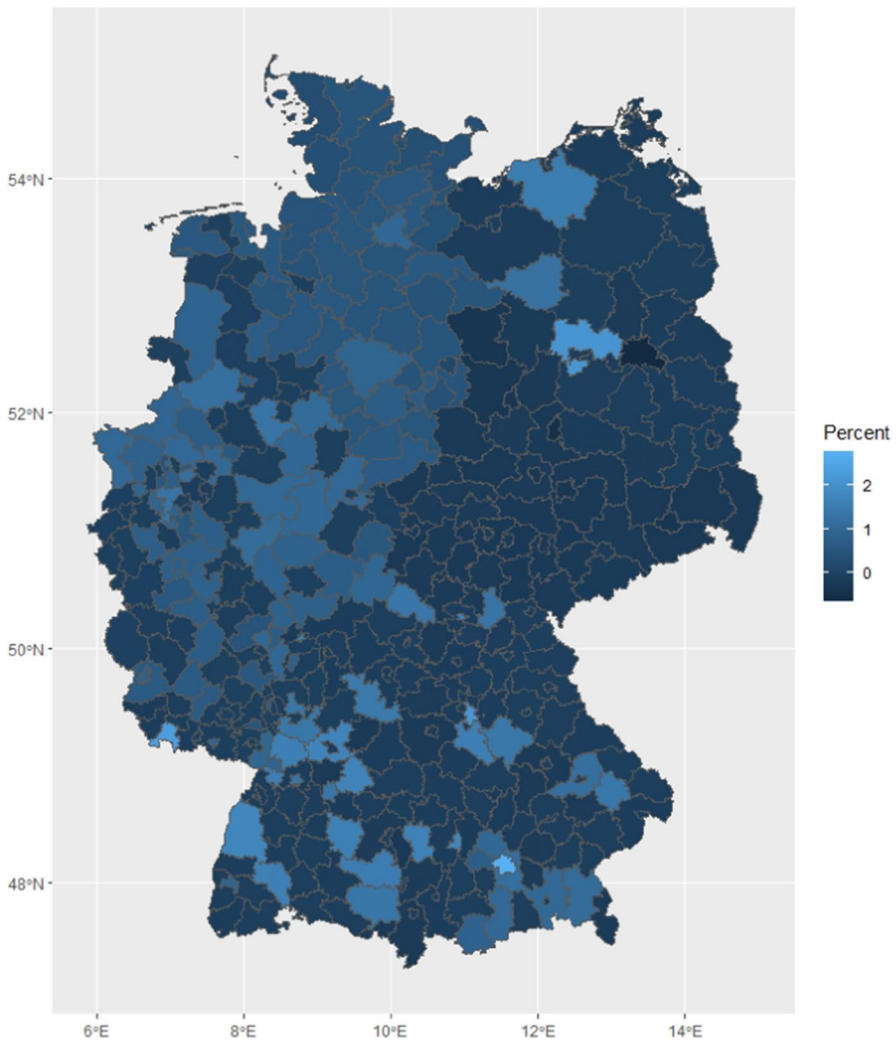


Fig. 7 Regional Contribution to total Manufacturing Increase. The figures are based on the Author's own calculations and rely on the data explained in chapter 3

4.2 Rise of the east

Having examined the effects of the Hartz IV reform, I want to turn to another possible cause of the decline in unemployment in Germany that occurred at the same time. As mentioned in the introduction, I will now focus on the joint analysis of the Hartz IV reform and the rise of the East. Since the rise of the East may have had an impact on the effects of the Hartz IV reform, I am interested in the labor market's reaction to the Hartz IV reform due to the rise of the East.

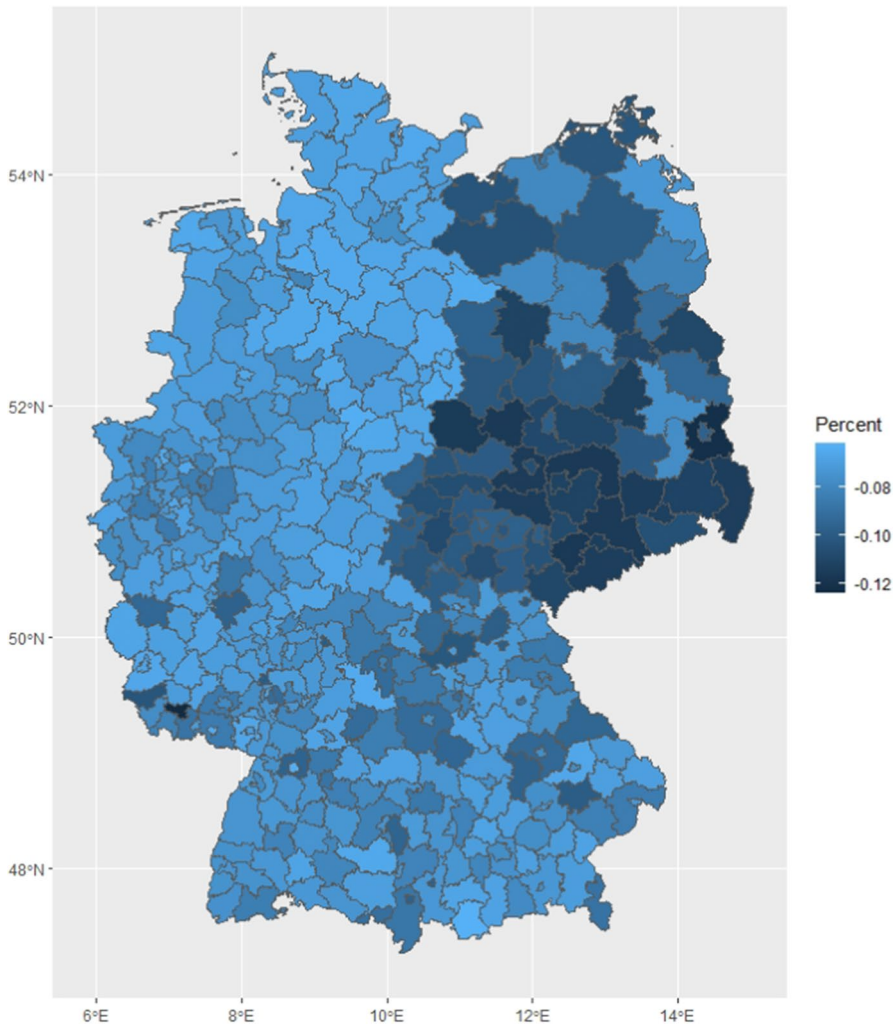


Fig. 8 Regional Welfare Effects. The figures are based on the Author's own calculations and rely on the data explained in chapter 3

To identify the effects, I first conduct a counterfactual analysis in which the rise of the East takes place, but the Hartz IV reform would not occur. In my second counterfactual analysis, I compute the analysis in which the rise of the East and also the Hartz IV reform do not occur. The difference between the two analyses then yields the marginal effects of the Hartz IV reform due to the rise of the East.

My first finding is that the overall employment effect of the rise of the East is positive. In doing so, I consider the overall effect of the rise of the East, i.e. the productivity growth of Germany and Eastern Europe. Analyzing and decomposing the effects of the respective productivities, I find that German productivity growth has

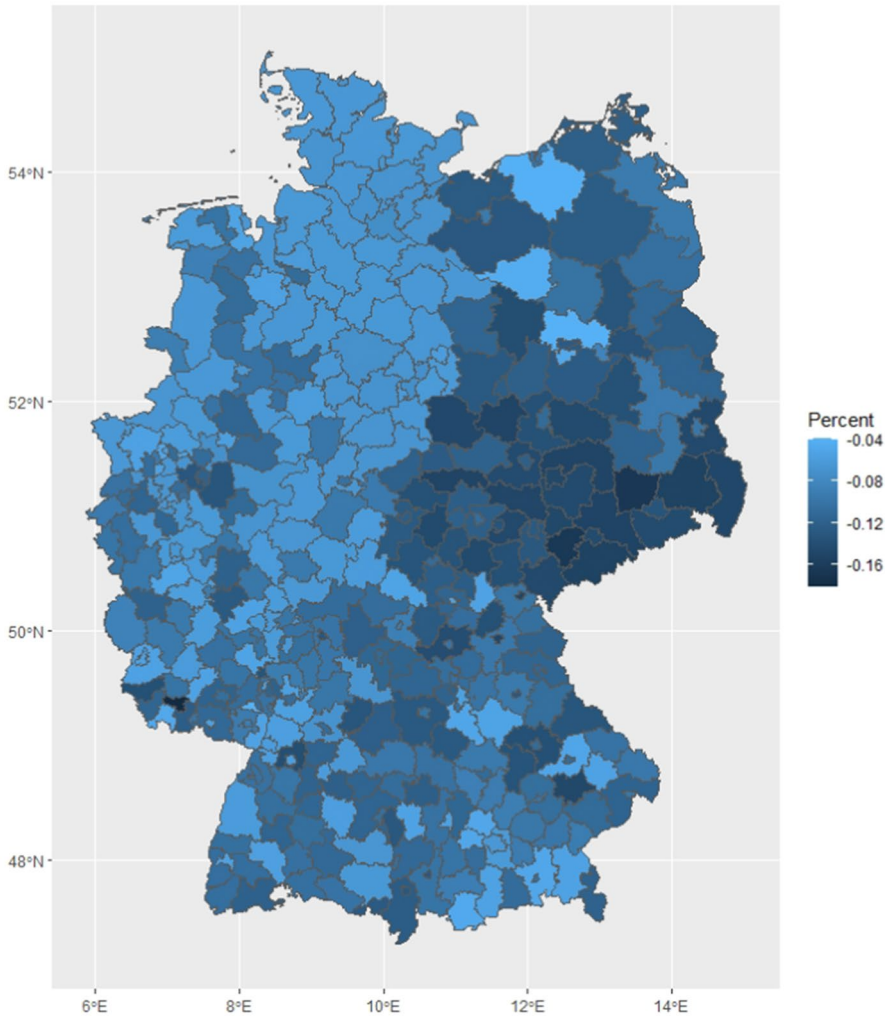


Fig. 9 Manufacturing Welfare Effects. The figures are based on the Author's own calculations and rely on the data explained in chapter 3

a positive effect on the German labor market, while Eastern European productivity growth has a negative effect on the German labor market. However, the impact of German productivity growth is by far larger than that of Eastern European productivity growth.

Figure 10 shows the contour of labor market effects in Germany. I find that the rise of the East makes a positive contribution to the labor market as employment increases by 0.05%. In particular, short-term unemployment falls by -0.036% and long-term unemployment by -0.014% . The change in employment is largely driven by manufacturing, as this sector records an increase of 0.041%. Other sectors vary

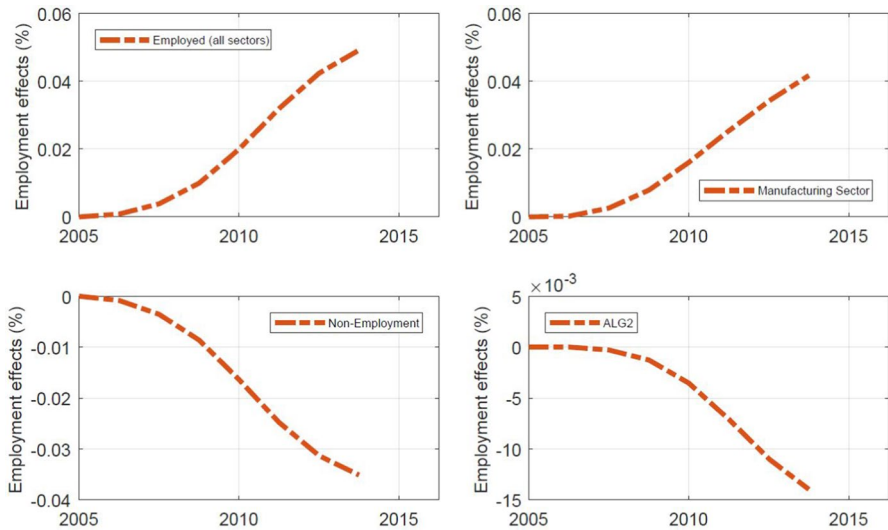


Fig. 10 German Productivity Effect on the German Labor Market (between 2005 and 2014). The figures are based on the Author’s own calculations and rely on the data explained in chapter 3

only slightly. This corresponds to about 40,000 additional jobs in manufacturing and about 10,000 new jobs in the other sectors attributable to the rise of the East. In Fig. 11 the regional short-term unemployment shares decrease more strongly in Eastern German counties. Districts close to the Polish border are facing the strongest reduction of the regional unemployment shares, due to increasing exports to Eastern Europe. Counties in the north west experience almost no changes of the regional unemployment shares, while in the south the reduction of the regional unemployment shares varies between counties. As regards the weight of the aggregate reduction in short-term unemployment, counties in the east contribute the strongest to the decline, Fig. 12. Cities with a larger population as Berlin and Munich, but also Magdeburg and Dresden are the highest contributors in the reduction of unemployment.

Looking at the changes in regional shares of long-term unemployment as shown in Fig. 13, I find that due to the decline in the labor force in Saxony-Anhalt, Thuringia and Saxony, the share of long-term unemployment in these areas is growing. Together with larger cities such as Berlin, Leipzig and Dresden those counties are in fact contributing the most to the decline of the total long-term unemployment in Germany, Fig. 14. The manufacturing sector is highly impacted by the German productivity gain. Figure 15 shows that the manufacturing sector in the counties of North Rhine Westphalia and Hessen are profiting the most as a consequence of the productivity improvement. Especially Kassel is experiencing the highest growth of the regional manufacturing share with an increase of 0.3%. Likewise, some counties in the south are showing increasing regional manufacturing shares. However, regions in the east as well in Bavaria are mostly unaffected by a change, though some even display negative regional

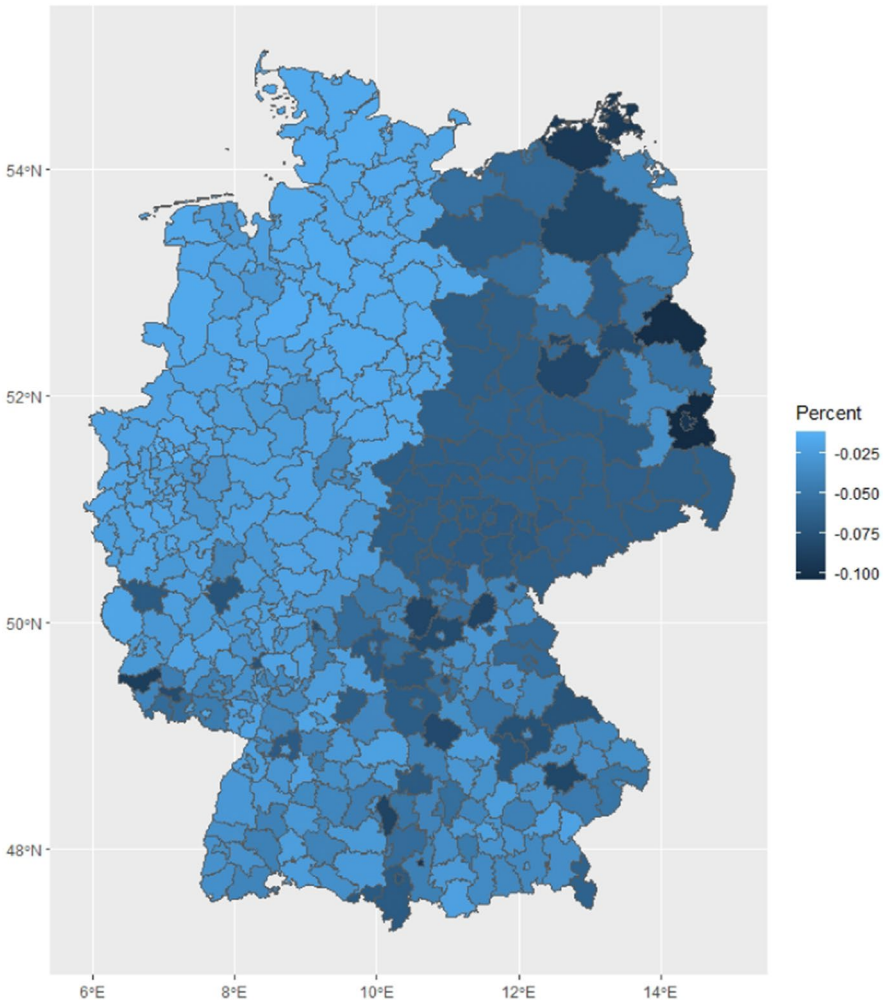


Fig. 11 Changes in Regional Unemployment Shares. The figures are based on the Author's own calculations and rely on the data explained in chapter 3

manufacturing shares. Further, I can show that those counties which have increasing regional manufacturing shares, add correspondingly to the aggregate employment rise of the manufacturing sector, see Fig. 16.

5 Conclusion

Germany has seen a rapid decline in unemployment after 2005. This paper attempts to shed more light on the causes of this development, focusing on the employment effects of the Hartz IV reform (especially the long-term unemployment benefit

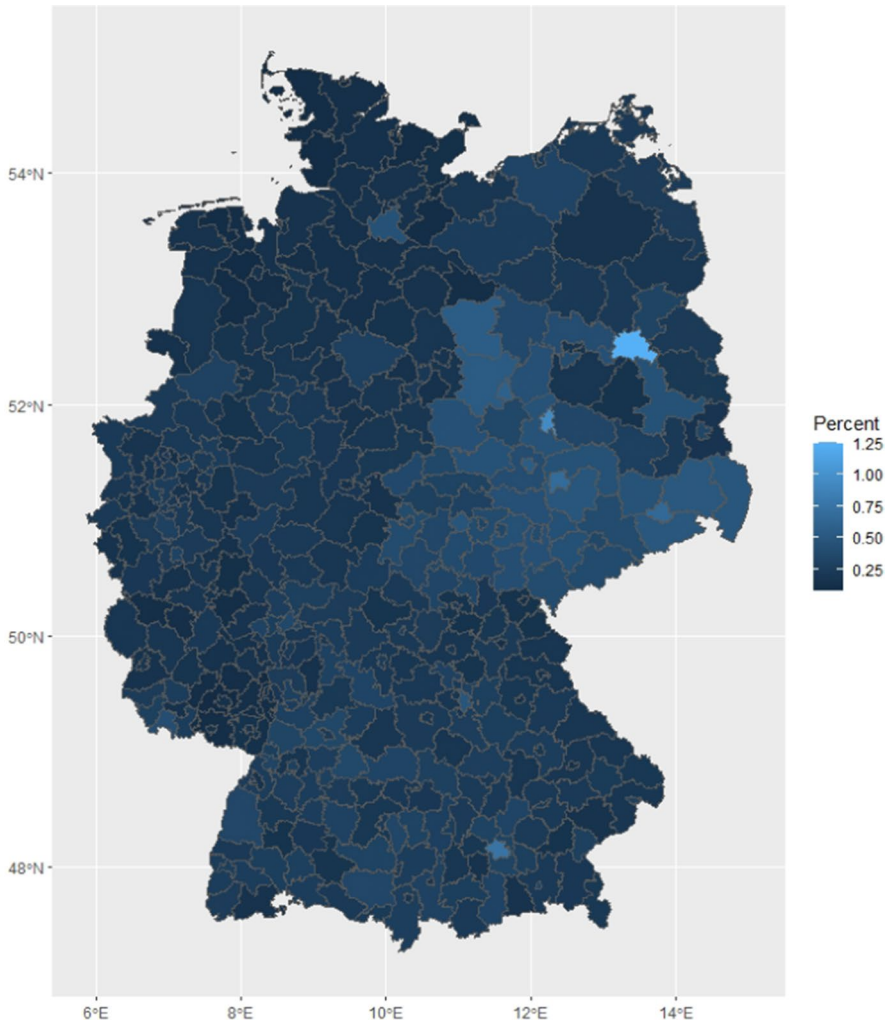


Fig. 12 Regional Contribution to total Short-Term Unemployment Decrease. The figures are based on the Author's own calculations and rely on the data explained in chapter 3

effect). In order to capture the full impact of labor market reform, my work builds on the dynamic spatial multi-country and multi-sector equilibrium Caliendo et al. (2019) model. I apply the model by including the structure of the long-term unemployment benefit in order to simulate the impact of the Hartz IV reform. I conduct a comprehensive study on the Hartz IV reform at the German county level, covering 402 German counties and 43 states with 7 sectors plus an unemployment sector and a long-term unemployment sector. To run the analysis, I use the World Input–Output Database (WIOD) and data from the German Federal and Regional Statistical Offices as well as the statistics from the Federal Employment Agency as the main data sources.

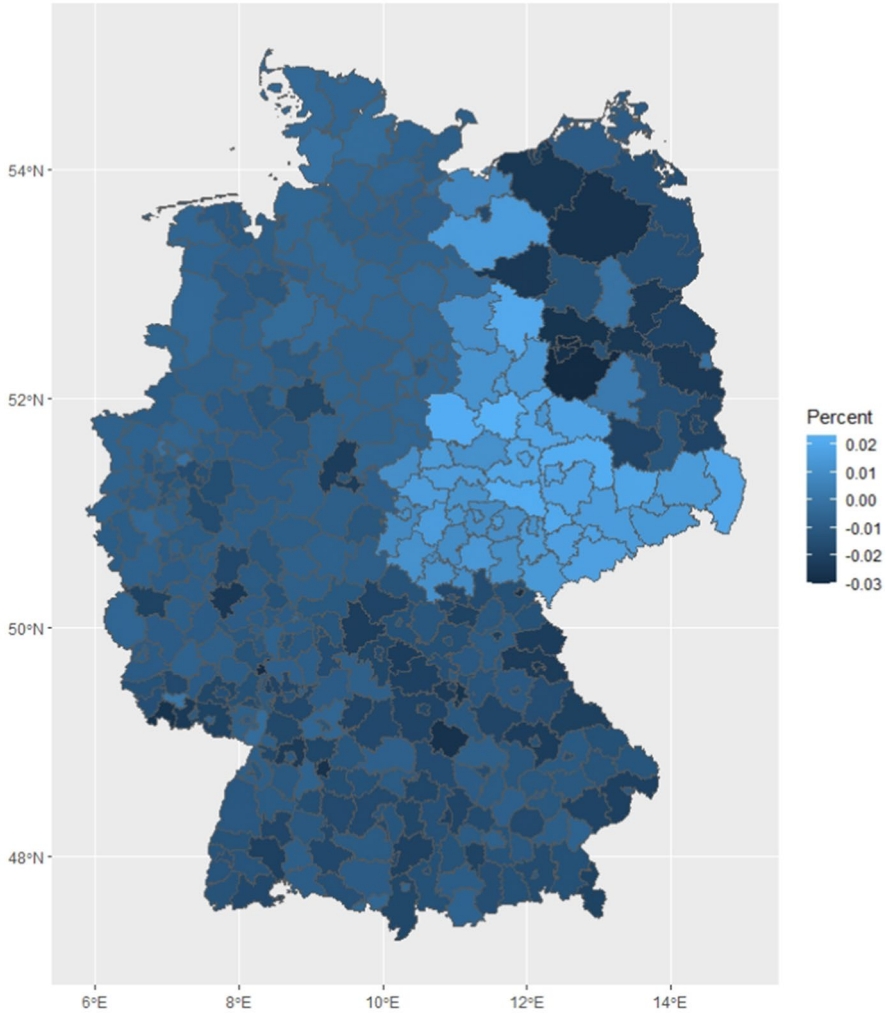


Fig. 13 Changes in Regional Long-Term Unemployment Shares. The figures are based on the Author's own calculations and rely on the data explained in chapter 3

My main finding is that the Hartz IV reform reduces the short-term unemployment by 0.4%. Further I find evidence that Hartz IV reform reduces short-term unemployment in eastern German counties. The results suggest that the long-term unemployment benefit (Hartz IV) certainly had its impact on the unemployment in Germany, though other parts of the Hartz reform (e.g. restructuring the Federal Labor Institution) could have played a major role as well.

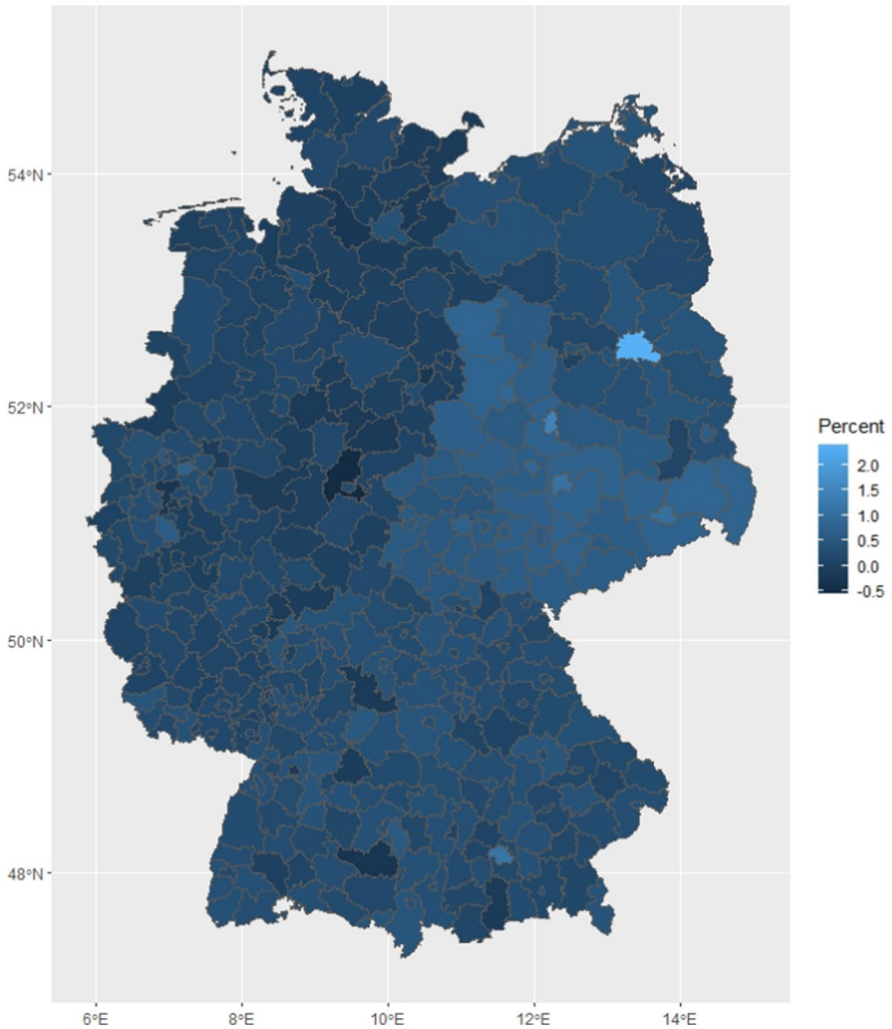


Fig. 14 Regional Contribution to total Long-term Unemployment Decrease. The figures are based on the Author’s own calculations and rely on the data explained in chapter 3

Moreover, I identify a modest impact of the Hartz IV reform through the rise of the East. Without the productivity growth of the rise of the East the short-term unemployment would have been 0.036% larger. Dissecting the effects on employment I find that the labor market effects caused by the German productivity shock is larger than those of Eastern Europe.

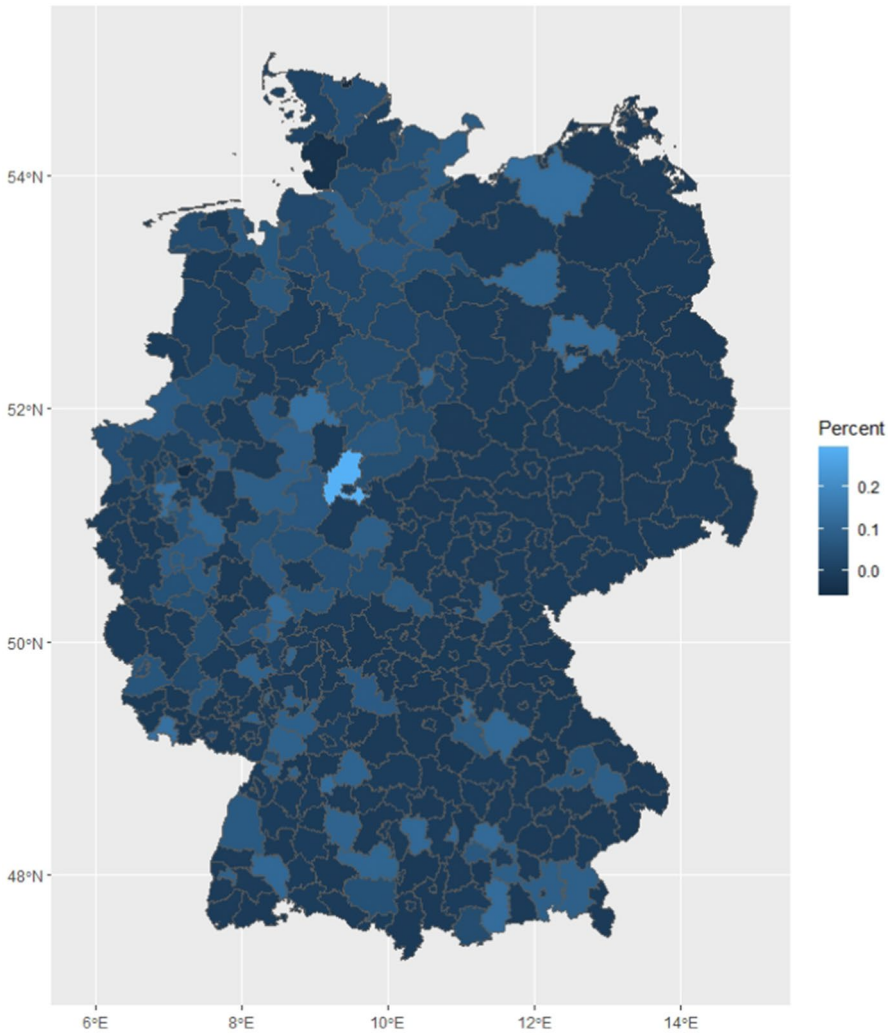


Fig. 15 Changes in Regional Manufacturing Shares. The figures are based on the Author's own calculations and rely on the data explained in chapter 3

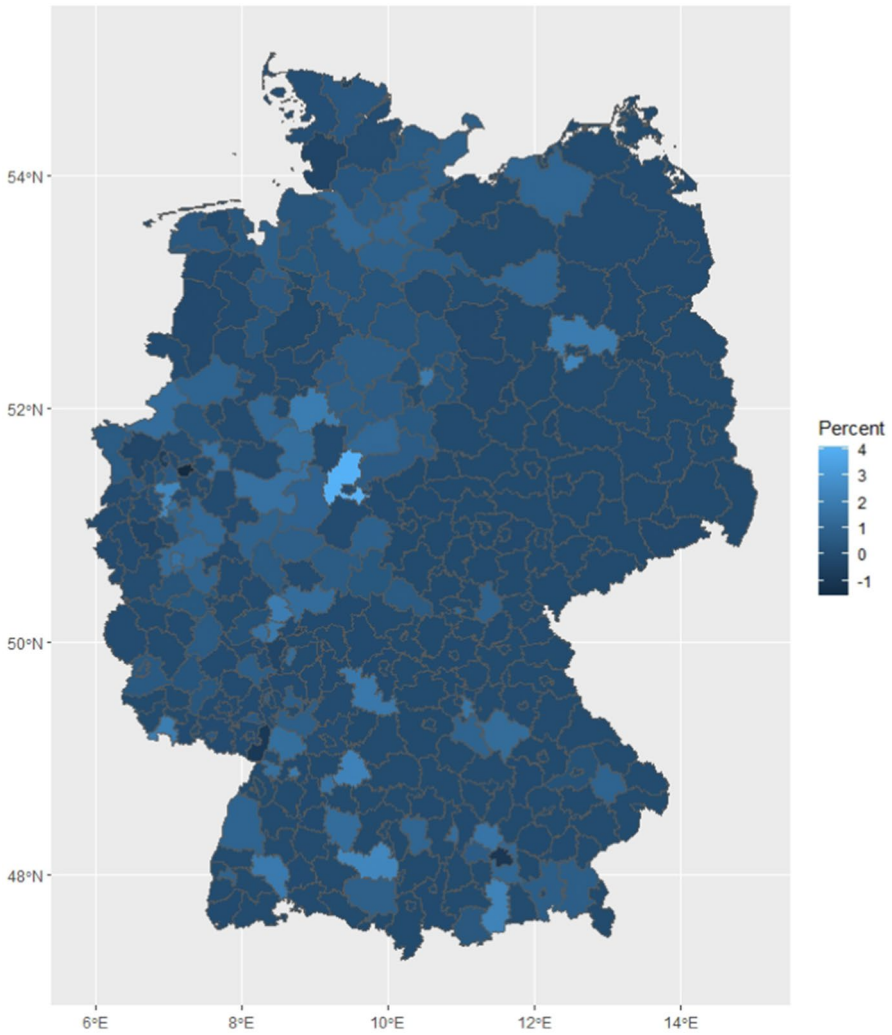


Fig. 16 Regional Contribution to total Manufacturing Increase. The figures are based on the Author's own calculations and rely on the data explained in chapter 3

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References

- Acemoglu D, Autor D, Dorn D, Hanson GH, Price B (2016) Import competition and the great US employment sag of the 2000s. *J Labor Econ* 34(1):141–198
- Aichele R, Felbermayr G, Heiland I (2016) Going deep: the trade and welfare effects of TTIP revised. Ifo-Working Paper 219
- Aichele R, Felbermayr GJ, Heiland I (2014) Going deep: the trade and welfare effects of TTIP. CESifo Working Paper Series
- Artuç E, Chaudhuri S, McLaren J (2010) Trade shocks and labor adjustment: a structural empirical approach. *Am Econ Rev* 100(3):1008–45
- Artuç E, McLaren J (2010) A structural empirical approach to trade shocks and labor adjustment: an application to turkey. *Adjustment Costs and Adjustment Impacts of Trade Policy*, World Bank, p 33
- Autor D, Dorn D, Hanson GH (2013) The china syndrome: local labor market effects of import competition in the United States. *Am Econ Rev* 103(6):2121–68
- Autor DH, Dorn D, Hanson GH, Song J (2014) Trade adjustment: worker-level evidence. *Q J Econ* 129(4):1799–1860
- Bundesministerium der Finanzen (2020) Federal budget data, Retrieved from <https://www.bundeshaushalt.de> accessed 21.05.2020
- Caliendo L, Dvorkin M, Parro F (2019) Trade and labor market dynamics: general equilibrium analysis of the China trade shock. *Econometrica* 87(3):741–835
- Costinot A, Rodríguez-Clare A (2014) Trade theory with numbers: quantifying the consequences of globalization. In: *Handbook of international economics*, vol 4. Elsevier, pp 197–261
- Dauth W, Findeisen S, Suedekum J (2014) The rise of the East and the Far East: German labor markets and trade integration. *J Eur Econ Assoc* 12(6):1643–1675
- Dauth W, Findeisen S, Suedekum J (2017) Trade and manufacturing jobs in Germany. *Am Econ Rev* 107(5):337–42
- Dauth W, Findeisen S, Suedekum J (2021) Adjusting to globalization in Germany. *J Labor Econ* 39(1):263–302
- Dekle R, Eaton J, Kortum S (2008) Global rebalancing with gravity: measuring the burden of adjustment. *IMF Staff Papers* 55(3):511–540
- Dix-Carneiro R (2014) Trade liberalization and labor market dynamics. *Econometrica* 82(3):825–885
- Dustmann C, Fitzenberger B, Schönberg U, Spitz-Oener A (2014) From sick man of Europe to economic superstar: Germany's resurgent economy. *J Econ Perspect* 28(1):167–88
- Dvorkin M (2014) Sectoral shocks, reallocation and unemployment in competitive labor markets. Technical Report, Yale University
- Eaton J, Kortum S (2002) Technology, geography, and trade. *Econometrica* 70(5):1741–1779

- Egger PH, Larch M, Staub KE (2012) Trade preferences and bilateral trade in goods and services: a structural approach. CEPR Discussion Paper No. DP9051
- German Institute for Employment Research (2020) Integrated employment biographies (IEB), Retrieved from <https://www.iab.de> accessed 11.06.2020
- Hartung B, Jung P, Kuhn M (2018) What hides behind the German labor market miracle? Unemployment insurance reforms and labor market dynamics. CEPR Discussion Paper No. DP13328
- Hochmuth B, Kohlbrecher B, Merkl C, Gartner H (2021) Hartz IV and the decline of German unemployment: a macroeconomic evaluation. *J Econ Dyn Control* 127:104114
- Krause MU, Uhlig H (2012) Transitions in the German labor market: structure and crisis. *J Monetary Econ* 59(1):64–79
- Krebs O, Pflüger M (2018) How deep is your love? A quantitative spatial analysis of the transatlantic trade partnership. *Rev Int Econ* 26(1):171–222
- Krebs T, Scheffel M (2014) Labor market reform and the cost of business cycles. ZBW-Deutsche Zentralbibliothek, Kiel und Hamburg
- Launov A, Wälde K (2013) Estimating incentive and welfare effects of nonstationary unemployment benefits. *Int Econ Rev* 54(4):1159–1198
- Muendler M-A (2017) Trade, technology, and prosperity: an account of evidence from a labor-market perspective. WTO Staff Working Paper
- Organisation for Economic Co-operation and Development (OECD) (2020) Long-term interest rates, Retrieved from <https://data.oecd.org/interest/long-term-interest-rates.htm> accessed 15.06.2020
- Pierce JR, Schott PK (2016) The surprisingly swift decline of US manufacturing employment. *Am Econ Rev* 106(7):1632–62
- Statistik der Bundesagentur für Arbeit (2020) Labour market data, Retrieved from <https://statistik.arbeitsagentur.de> accessed 23.05.2020
- Statistische Ämter des Bundes und der Länder (2020) Regional statistic data, Retrieved from <https://www.regionalstatistik.de> accessed 20.05.2020
- Statistisches Bundesamt (Destatis) (2020) Trade flow data, Retrieved from <https://www.destatis.de> accessed 06.04.2020
- Timmer MP, Dietzenbacher E, Los B, Stehrer R, De Vries GJ (2015) An illustrated user guide to the world input-output database: the case of global automotive production. *Rev Int Econ* 23(3):575–605
- Walter T (2022) Trade and welfare effects of a potential free trade agreement between Japan and the United States. *Rev World Econ* 158(4):1199–1230
- World Bank (2021) World integrated trade solution. Retrieved from <https://wits.worldbank.org> accessed 23.03.2021

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