APPLIED POLICY RESEARCH THROUGH THE LENS OF NEW QUANTITATIVE TRADE MODELS

Dissertation zur Erlangung des Doktorgrades der Wirtschaftswissenschaften (Dr. oec.)

Fakultät Wirtschafts- und Sozialwissenschaften

Universität Hohenheim

Institut für Volkswirtschaftslehre

vorgelegt von

Timo Walter, M.Sc.

aus Stuttgart

2021

Dekan: Prof. Dr. Karsten Hadwich
1. Gutachter: Prof. Dr. Benjamin Jung
2. Gutachter: Prof. Dr. Thomas Beißinger
Datum der Abgabe: 7. Mai 2021
Datum der mündl. Prüfung: 15. Dezember 2021

Acknowledgements

First and foremost, I want to express my gratitude to Prof. Dr. Benjamin Jung for being an exceptional supervisor. I am truly thankful for his support and the many opportunities he gave me in academia. It was a privilege to conduct joint research and to benefit from his broad experience and profound knowledge. I enjoyed working with such a great trade scholar and being inspired by him for my own work. I want to thank him for all the valuable comments and feedback. Furthermore, he provided a pleasant working atmosphere with his door always being open for me when we shared the neighboring office. My gratitude goes also to Prof. Dr. Thomas Beißinger as my second supervisor. I want to thank him for all the productive conversations and thoughts during many lunches, in the university hallway as well as on the ETSG conference in Warsaw.

I want to thank all my colleagues who became friends over the last years. Particularly, I want to thank Henning, Jonas and Sophie for all the great memories we shared together in Hohenheim, on conferences, planes and joint train rides. Thank you for all the productive discussions and encouraging words. I want to thank Martyna for sharing her profound academic knowledge and thoughts. I want to thank Sebastian and Dario for contributing a lot to the enjoyable atmosphere where it was fun to come to work every day. Special tribute goes to Anita for all the pleasant conversations on the professional and personal level and for her excellent administrative assistance.

Exceptional gratitude goes to my wife Séphora for her unconditional belief in me. I cannot thank her enough for all the inspiration and motivation she gave me and for backing me up in countless ways. Many thanks go to my siblings and my entire family for their ongoing support. I am especially thankful for Nonno's tireless proofreading efforts. Moreover, I am deeply grateful to my parents for being there for me and cheering me on throughout my whole life.

Herzlichen Dank, Mama und Papa!

Declaration of Co-Authorship

Chapter 3: Trade and Welfare Effects of a Potential Free Trade Agreement between Japan and the United States

The text in this chapter is my own work.

Chapter 4: Trade and Welfare Effects of a "Zero Tariff Solution": Elimination of EU and U.S. Import Tariffs in the Automotive Sector

The text of this chapter originates from a joint work with Benjamin Jung (University of Hohenheim). By joint discussions the idea and concept evolved. Data and the simulation have been my own work. Benjamin Jung contributed to the motivation, analysis and conclusion part.

Chapter 5: The Rise of Eastern Europe and the German Labor Market Reform: Dissecting their Effects on Employment

The text in this chapter is my own work.

Chapter 6: Social Welfare and Income Inequality in Germany

The text of this chapter comes from joint work with Benjamin Jung (University of Hohenheim). The idea developed through joint discussions. Benjamin Jung contributed to the theoretical section, whilst the Motivation, the Parameter Identification, the "Tax-Reform 2000" and the Trade Liberalization and the Conclusion sections have been my own work.

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Chapter 1

Introduction

1.1 Motivation

"We are caught in an inescapable network of mutuality, tied in a single garment of destiny. Whatever affects one directly, affects all indirectly."

Rev. Martin Luther King Jnr. (1963)

Over the past 70 years the world became increasingly interconnected and globalized. Compared to the 1950s, the world today appears to be much more intertwined in a sense that economies all over the world are more integrated into international markets, global value chains and global networks. Nowadays, it is nothing special anymore that software developers in Walldorf (Germany) are connected to their colleagues in the Silicon Valley (USA) and in Bangalore (India) via real time online meetings. The rising connectiveness between countries can be illustrated by the growth of the Liner Shipping Connectivity Index (LSCI).[1] The index (world average) grew from 17.1 in 2006 to 26.7 in 2020 and demonstrates that countries (on average) became more attached to the global shipping network (UNCTAD LSCI (2020)). The globalization upsurge can be linked to the fall in transportation costs through rapid technology improvements on the one hand, see Baldwin

[1] The Liner Shipping Connectivity Index (LSCI) is generated from six components of the maritime transport sector, for details see UNCTAD LSCI (2020).

(2016). On the other hand, trade policy plays a crucial role when it comes to the decline in transportation costs, as tariffs decreased globally (the unweighted world average tariff declined from about 13 percent in 1950 (Clemens and Williamson (2004)) to 4.4 percent in 2018 (World Bank (2020))). Hereby, the World Trade Organization (WTO) (with its 164 member countries contributes to 98 percent of the global trade (WTO (2020c))) and the General Agreement on Tariffs and Trade (GATT) as its predecessor organization played a crucial role with nine rounds of trade negotiations and over 306 enforced regional trade agreements (RTAs) (WTO (2020b)). The data show that since the 1950s the world trade has skyrocketed from 10 percent (world trade as percent of the world GDP) to over almost 60 percent in 2014 (PIIE (2020b)).[2] As these aspects of globalization are impressive in numbers, they come with non-deniable issues and challenges: Inequality within countries rose worldwide through the improvements in technology and trade, see Helpman (2018) for a discussion. Additionally, improvements in transport technologies through ships, planes and trains and the tighter global network paved the way to the rapid spread of the COVID-19 pandemic. Moreover, it is argued that the rise of global trade and production is an accelerator of climate change (WTO (2020a)). Therefore, critics argue that for the globalization to be beneficial for society not only quantity (such as trade), but quality aspects (such as inequality decrease) matter (PIIE (2020a)).

In this context a paradigm shift from an "old world of trade" to a "new world of trade" occurred on the policymaker side (see Lamy (2015)). Thus, the paradigm changed from the administration of protection (focus on the protection of domestic producers through tariffs, quotas and subsidies) to the administration of precaution (focus on the consumer and health and safety regulations and environment standards). Therefore, the paradigm shift from the "old" to the "new world of trade" was a change of the focus group for the policymaker. In the "old world of trade" producers had a strong policy influence and the (one-dimensional) aim

[2]The globalization process still continues, though as Antràs (2020) shows, the rapid growth rate of globalization has slowed down in recent years.

was to protect producers from foreign competition. In contrast, it is the voice of the consumer in the "new world of trade" that become stronger through consumer organizations and social networks impacting policy decisions. In turn, the trade policy agenda became multi-dimensional and more complex through "a different purpose, different politics, different actors" (Lamy (2015), p.6).

Research from the field of international trade - especially, general equilibrium models of the quantitative trade literature - provide a rich set of methods and tools to analyze issues of globalization. General equilibrium models try to capture the entire economy, including the demand and the supply side of every market. The quote of *Rev. Martin Luther King Jnr.* cited at the beginning of my dissertation, states that everything is connected through a network of mutuality and can also be applied in a figurative sense to describe the characteristics of the general equilibrium. A policy change or an external shock does not only impact the market, which is directly affected, but can also affect other markets indirectly through input-output linkages in a multi-sector, multi-country set-up.

In my thesis "New Quantitative Trade Models" (NQTMs) play an important role and are at the heart of my dissertation. The NQTMs rely on micro-economic foundations of general equilibrium models as well as on structural gravity models, which provide a tractable model structure due to the structural gravity approach.

NQTMs have several advantages: (i) NQTMs use the sufficient statistic approach by Chetty (2009), that allows for the computation of the model by applying reduced-form elasticities. Thus, it reduces the need for the estimation of structural parameters. (ii) NQTMs permit the computation of quantitative simulations of fundamental changes. (iii) NQTMs allow for an ex-post as well as an ex-ante trade policy analysis[3]. (iv) The set-up of NQTMs can comprise multiple sectors, multiple countries as well as input-output linkages, which offer realistic numerical

[3] The approach uses past trade agreements as a benchmark for the estimation of parameters necessary for the conduction of ex-ante counterfactual simulations.

results. To put the NQTMs into the theoretical context of the quantitative trade theory I give a brief methodological review on NQTMs in chapter 2.

As I will describe in the next subchapter, my dissertation project covers issues on income distribution and inequality. However, NQTMs have a methodological "blind spot" on distribution issues, which is why I draw on the "New New Trade Theory" as another strand of quantitative trade literature when focusing on social welfare and inequality. Hereby the model involves heterogeneous agents and inequality aversion of the social planner to account for the impact of inequality on social welfare. Further, I make use of the symmetric country set-up instead of the multi-sector, multi-country approach, common in NQTMs.

1.2 Contribution

"Perhaps the most important policy insight from the past 70 years is that countries and governments can do a lot to boost economic welfare, but they cannot do it alone. [. . .] Nowhere are the issues of economic interdependency greater than in the area of trade."

Former Managing Director of the IMF Christine Lagarde (2016)

The focus of my dissertation is set on policy research in the area of trade. I contribute to the literature by applying state-of-the-art trade models to relevant policy research questions arising from a globalized and interconnected world. Through my dissertation project I demonstrate that models of the quantitative trade theory can be applied to classical trade subjects such as free trade agreements, tariff policies and trade liberalization. However, the models can also be useful to investigate labor market reforms as well as tax-reforms with its implication on inequality and social welfare. As my thesis studies those topics from an economic perspective, focusing on interdependencies in terms of international trade of goods and services, it offers new policy insights in that area.

The core of my dissertation form chapter 3 to chapter 6. In Table 1.1 I provide an overview of the topics that I investigate in those chapters. In all chapters I apply state-of-the-art trade models and run counterfactual simulations to tackle the corresponding policy research questions. I carry out the policy research in two ways: In chapter 3 and 4, I conduct policy analysis. In particular, I explore and discuss potential trade policies before they are implemented and their expected impacts on trade and welfare (ex-ante). In chapter 5 and 6, I evaluate policies after they are implemented as well as related ex-post effects. In order to conduct the empirical analyses, I rely throughout my dissertation on several well-established databases. Yet, in every study I make use of the World Input-Output Database (WIOD) by Timmer et al. (2015), as it includes multiple sector and multiple countries as well as input-output linkages. In addition, the chapters have in common, that they focus on Germany. This is especially true for chapter 4 to chapter 6 where I study various policy effects on Germany. In chapter 3 Germany is not the prior focus. However, I explore in this study, among others, the third-country effects of a potential Japan-United States free trade agreement (FTA) and the Trans-Pacific Partnership (TPP), that include Germany. Next, I give an outline of each of the main chapters.

Table 1.1: Overview of Topics

Chapter	Topic	Policy Research	Methodology	Main Database
3	Trade and Welfare Effects of a Potential Free Trade Agreement between Japan and the United States	*Ex-ante:* • Free Trade Agreement (FTA) • Regional Trade Agreement (RTA)	*New Quantitative Trade Model* (Caliendo & Parro (2015), Aichele et al. (2014)) *Static Analysis:* • Multi-Sector • Multi-Country • Input-Output Linkages	• UNCTAD's TRAINS Database • World Input-Output Database (WIOD)
4	Trade and Welfare Effects of a "Zero Tariff Solution": Elimination of EU and U.S. Import Tariffs in the Automotive Sector	*Ex-ante:* • Tariff Policy		
5	The Rise of Eastern Europe and the German Labor Market Reform: Dissecting their Effects on Employment	*Ex-post:* • Labor Market Reform • Trade Liberalization • Productivity Shocks	*New Quantitative Trade Model* (Caliendo et al. (2019)) *Dynamic Analysis:* • Regional Mobility • Labor Mobility	• Statistics of the Federal Employment Agency • World Input-Output Database (WIOD)
6	Social Welfare and Income Inequality in Germany	*Ex-post:* • Tax-Reform • Trade Liberalization	*"New" New Trade Theory* (Antras et al. (2017)) *Static Analysis:* • Heterogeneous Agents • Inequality Aversion	• Socio-Economic Panel (SOEP) • World Input-Output Database (WIOD)

In chapter 3, I explore the *Trade and Welfare Effects of a Potential Free Trade Agreement between Japan and the United States.*[4] A possible agreement is currently being discussed between Washington and Tokyo. Under the Trump administration the trade strategy shifted from the focus on regional trade agreements (such as the TPP) to bilateral free trade agreements. Through this change in the trade policy strategy, the United States aim at a higher bargaining power within the trade negotiations. It is compelling to analyze the potential bilateral trade agreement between Japan and the United States (ex-ante) as Japan is the most important

[4]This chapter has appeared in an earlier version as Walter (2018).

trading partner of the United States that has no trade agreement with the United States.

On the basis of the New Quantitative Trade Model by Caliendo and Parro (2015), which relies on a multi-country, multi-sector Ricardian set-up with sectoral linkages and intermediate goods, I study the trade effects and welfare gains of such a bilateral free trade agreement. For the ex-ante analysis, I use the empirical approach and the non-tariff measure (NTM) parameters of Aichele et al. (2014), who apply past trade agreements as a benchmark in order to estimate the impact of NTMs. To carry out the analysis I rely on the UNCTAD's Trade Analysis Information System (TRAINS) database for tariffs and the World Input-Output Database (WIOD), which contains input-output linkages that cover 50 sectors and 43 countries. I contribute to the trade literature by simulating three scenarios for various levels of economic integration: The reduction of tariffs only, the scenario of a shallow FTA, and a deep FTA. The shallow and the deep FTA involve different levels of economic integration with the aim to reduce tariffs and non-tariff barriers. Especially the attention on non-tariff barriers takes care of the "new world of trade" and the policy shift to the administration of precaution. In addition, I compare the trade and welfare changes of a deep FTA to the welfare effects of the TPP. Based on the simulations, the following conclusion can be made: Japan has the highest welfare gains with a bilateral free trade agreement (0.085%), whilst the United States benefits the most from the Trans-Pacific Partnership with a welfare gain of 0.05 percent.

In chapter 4, we investigate the *Trade and Welfare Effects of a "Zero Tariff Solution": Elimination of EU and U.S. Import Tariffs in the Automotive Sector.*[5] In the trade dispute between the European Union and the United States, the President of the European Union Commission Jean-Claude Juncker and U.S. President Donald Trump agreed the phasing out of tariffs in all sectors with the exception of the automotive sector by the end of July 2018. Less than three weeks before, it

[5]This chapter has appeared in *Ifo Schnelldienst* 71/15 as Jung and Walter (2018).

had been proposed to exclusively strive for the complete elimination of tariffs in the automotive sector.

In this chapter, which is a joint work together with Benjamin Jung, we demonstrate that the Caliendo and Parro (2015) framework can be applied to the analysis of other relevant trade policy questions. In this chapter we investigate the elimination of EU and U.S. import tariffs in the automotive sector (ex-ante). Using the words of Pascal Lamy, we put our attention to the "old world of trade". Hereby we rely on the same theoretical background and empirical set-up as presented in chapter 3. We examine three possible scenarios on the tariff dispute between the European Union and the United States. The center of the policy analysis is on the "Zero Tariff Solution" in the automotive sector and its impact on trade and welfare. The first scenario eliminates the import tariffs in the automotive sector in Germany and the United States (assuming Germany can set the tariffs independently) leading to a bilateral "Zero Tariff Solution". Whereas in the second scenario the automobile tariffs are removed between the European Union and the United States. In the third scenario ("grand solution"), the European Union and the United States cut the automotive tariffs against all WTO countries.

Our findings reveal that Germany profits in every scenario. However, the bilateral "Zero Tariff Solution" in the automotive sector between the United States and Germany, as well as the "Zero Tariff Solution" between the EU and the U.S. would be less beneficial from an economic perspective. The key result is that Germany, the EU and the U.S. benefit the most under the third scenario ("grand solution"), in which the EU and the U.S. reduce the automotive tariffs for all WTO countries, as this scenario leads to the highest welfare gains. Our findings contribute to the recent political debate on a potential trade war between the U.S. and the EU. The results clearly indicate that the proposed "Zero Tariff Solution" (preferably the "grand solution") can be an alternative solution, which could help to calm the trade dispute between the U.S. and the EU.

In chapter 5, I study *The Rise of Eastern Europe and the German Labor Market Reform: Dissecting their Effects on Employment.*[6] From the early 1990s until 2005 the unemployment rate rose in Germany from 7.3 percent to 11.7 percent. While the unemployment rate reached its peak in 2005, it steadily decreased in the following years. The decrease of the unemployment rate could have had several economic and political reasons. However, two occurrences stand out: On the one hand the fourth stage of the German labor market reform (Hartz IV) was implemented in 2005 with the intent to cut the unemployment rate. On the other hand, the productivities in Germany and Eastern Europe grew strongly during the same period. The growth of productivities contributed to the rise of joint trade flows, which Dauth et al. (2014) characterized as the "rise of the East". This "rise of the East" is likely to have had an ambiguous effect on the German labor market. In this chapter I investigate the employment effect of the "Hartz IV-Reform". Moreover, I concentrate on the labor market effects of the "rise of the East" in terms of trade flows, which were steered by the German and Eastern European productivity shock. For the analysis I extend the state-of-the art dynamic trade model of Caliendo et al. (2019), which draws on the "New Quantitative Trade Theory". As in chapter 3 and chapter 4 the model has a multi-sector, multi-country set-up with input-output linkages. Additionally, the model includes the county level (including 402 German counties in the empirical analysis), as well as labor market mobility across sectors and counties. The adjustments of labor mobility take time to materialize; therefore I apply a dynamic approach instead of the static analysis (which I use in chapter 3 and 4). I find that the "Hartz IV-Reform" and the German productivity contribute positively to the decline of unemployment, whereas the increase in Eastern European productivity is responsible for a minor increase in German unemployment.

Chapter 6 is a joint work together with Benjamin Jung. In this chapter we examine policy effects on *Social Welfare and Income Inequality in Germany.* Compared to

[6]This chapter has appeared in an earlier version as Walter (2021).

the other chapters of my dissertation, we build in this chapter primarily on public finance literature and taxation theory and draw on the “New New Trade Theory”. In economics the effect of a policy is commonly assessed on its impact on social welfare (in terms of aggregated real income growth), without taking income inequality into account. In this context the well-known Kaldor-Hicks compensation principle (Kaldor (1939), Hicks (1939)) is often applied. It states that those who benefit from the policy change can in principle compensate those who lose through the policy change - via a costless lump-sum transfer. However, it is doubtful whether such a compensation actually takes place, if not income inequality might occur out of it. In addition, it is questionable, if the lump-sum transfer is really costless. The recent Antràs et al. (2017) model tries to correct the two short comings of the Kaldor-Hicks compensation principle by including two correction terms in the social welfare formula. Hereby the model compromises workers that are heterogeneous in their ability levels and produce tradable tasks using a constant returns to scale production function with (endogenous) labor as the only input. Further the model includes inequality aversion as well as symmetric countries (in the open economy).

We contribute to the literature in two ways: First, by presenting the model in a clearly structured and comprehensible way, as the model in Antràs et al. (2017) is written in a complicated form, making it for the reader sometimes harder to follow. Second, by applying the approach to conduct several simulations. In particular, we focus on the closed economy and explore the impact of the German “Tax-Reform 2000”. By drawing to the German Socio-Economic Panel (SOEP) as the main data source, we find that the tax-reform is responsible for an average annual income growth of 0.6 percent. Through the tax-reform the Gini coefficient annually increases by 0.32 percent. We show that the average annual welfare growth depends strongly on the social planner’s inequality aversion. By the use of the new framework, we deduce the optimal welfare maximizing tax progressivity for each year of the period. Our findings indicate that through the tax-reform the actual tax progressivity approaches the optimal welfare maximizing tax progressivity in

2007.

With the new framework we further investigate the distributional consequences of trade liberalization in Germany (in an open economy). Our results show that a counterfactual move of the German economy of 2014 to the trade openness of the year 1995 (with higher variable trade costs) decreases the aggregated income and the social welfare, but leads to a more equal society as the Gini coefficient declines.

In chapter 7, I summarize my dissertation and close with some concluding remarks on the most recent political and economic trends, which have the potential to (re)shape the landscape of the global economy.

Chapter 2

A Brief Review of "New Quantitative Trade Models"

"New Quantitative Trade Models" (NQTMs) were first labeled by Ottaviano (2014) and aim at quantifying the gains from trade (in terms of change in real income). The structural gravity approach and the general equilibrium theory form the microeconomic foundations of NQTMs and permit a tight connection between theory, data and simulations. The simulations are conducted counterfactually, comparing a baseline scenario to a counterfactual situation, as for example setting the actual state relative to a situation under autarky.

As part of general equilibrium models NQTMs have been used in trade policy research for the last two decades. Another type of general equilibrium models, which are applied by policymakers far longer back are "Computable General Equilibrium" (CGE) models (or "Applied General Equilibrium" (AGE) models). The theoretical framework was set by Johansen (1960) and Dixon et al. (1982), who pioneered CGE models. CGE models are comparative-static models including multiple sectors and multiple countries with input-output linkages. To describe the economy, CGE models comprise multiple features, resulting in a rather complex set-up. To conduct the counterfactual simulations the necessary parameters are often not taken from one consistent data source, but borrowed from different empirical estimates. Hereby CGE models are considered as "black-box types" and opaque, as it is sometimes not obvious, how the model's computation results in certain outcomes. Nonetheless of these downsides policymakers employ CGE models, especially for ex-ante policy simulations.

In comparison to the CGE models the methodology of NQTMs is more parsimonious and more tractable. The structural gravity approach with the gravity equation at the core, plays hereby the key role. The gravity concept originates from physics and was first introduced into economics by Tinbergen (1962). Armington (1969), Anderson (1979) and Bergstrand (1985) laid the theoretical concept for the gravity-trade models. The structural gravity theories were then popularized by Eaton and Kortum (2002) and Anderson and Van Wincoop (2003). Hereby the structural gravity approach connects the key parameters of the gravity equation (e.g. trade cost and trade elasticity) to the actual trade flows. Thereby the structural gravity approach allows for a good fit between theory and empirical analysis as the key parameters can be derived and estimated from theory. Yotov et al. (2016) offer a good summary of these types of models. Another main characteristic of NQTMs is the "exact hat algebra" approach by Dekle et al. (2008). The "exact hat algebra" approach has two advantages: First, it allows for the counterfactual simulation in fundamental changes. Thereby simulations move away from a marginal analysis to an analysis of discrete changes, especially those of trade costs. Second, the approach allows for a counterfactual equilibrium in relative changes, which puts the equilibrium of a counterfactual scenario relative to the equilibrium of the baseline scenario. Through the counterfactual equilibrium in relative changes the models become easier to handle, as structural parameters, which are difficult to estimate are canceled out.

An important step stone of NQTMs is the Eaton and Kortum (2002) Ricardian model. The novelty of the model is that technology is not deterministic, but rather stochastically determined. The productivities of countries differ according to their absolute advantage (by the scale parameter) while the sector productivities vary depending on the variance of productivities (by the dispersion parameter). Eaton and Kortum (2002) apply the independent Fréchet distribution to determine the productivity levels. Due to the different productivity levels costs and prices vary by country and sector. The limitation of the Eaton and Kortum (2002) framework is that it assumes homogeneous firms and perfect competition. During the time of the rise of the Eaton and Kortum (2002) model also the "New New Trade Theory" developed. The foundation was set by the Melitz (2003) model that build on the "New Trade Theory" by Krugman (1980) and its monopolistic competition set-up. Thus, Melitz (2003) includes heterogeneous firms and firm selection with its firm entry and exit mechanism.

NQTMs can have different micro economic assumptions, as they draw on the methodology foundation of Eaton and Kortum (2002) but also on aspects of Armington (1969), Krugman (1980) and Melitz (2003). Therefore, the models can depart regarding the degree of competition, the market structure and they can have multiple factors of production. These differences can lead to varying results on the macro-gravity level. Arkolakis et al. (2012) outline what the "New Quantitative Trade Models" and the "New Trade Models" as "Quantitative Trade Models" have in common: The "Quantitative Trade Models" are embedded in a perfect- or a monopolistic competition framework. The preferences are in the style of Dixit-Stiglitz, use one factor of production and have linear cost functions. Moreover, the models are restricted on the macro-level in the following ways: They assume that aggregate profits are a part of aggregate revenues, as constant shares. An excellent survey of the empirical methodology of "Quantitative Trade Models" is provided by Costinot and Rodriguez-Clare (2014), who show that the choice of market structure matter regarding the gains from trade. However, compared to other economic channels as multiple sectors or tradable intermediate goods the implications are less profound. Kehoe et al. (2017) provide a critical discussion on Quantitative Trade Models when comparing those types of models to the CGE methodology.

As regards the examination of trade policies one study is worth mentioning. In the influential work of Caliendo and Parro (2015), they investigate the trade and welfare effects of the North American Free Trade Agreement (NAFTA) ex-post. Hereby the multi-country Ricardian Eaton and Kortum (2002) model is extended to a multi-sector setting. Furthermore, the model involves input-output linkages and intermediate goods. The approach makes use of the algorithm of Alvarez and Lucas (2007) that solves the multi-sector multi-country model. Aichele et al. (2014) extend the Caliendo and Parro (2015) framework by taking non-tariff measures (NTM) into account, while exploring the trade and welfare effects of Transatlantic Trade and Investment Partnership (TTIP) ex-ante. A similar multi-sector, multi-country study on TTIP is conducted by Krebs and Pflüger (2018), however, taking land input, labor mobility and a spatial equilibrium into consideration. Further, I want to allude the recent Caliendo et al. (2019) model which brings a NQTM into a dynamic equilibrium setting while investigating the China Shock effect on the U.S.. Moreover, the model includes labor mobility frictions, goods mobility frictions and spatial factors.

Jung and Kohler (2017) point out that NQTMs are typically silent regarding the issues of income distributions (exceptions are for example Costinot and Vogel (2015)). Thereby the gains from trade are seen from a Kaldor-Hicks perspective (Kaldor (1939), Hicks (1939)). In the Kaldor-Hicks economy, gains from trade occur when the aggregated surpluses of those agents benefiting from the policy change have the potential to compensate the agents negatively impacted by the policy change via costless lump-sum transfers. In this context income inequality is not considered. However, income inequality is likely to occur in reality, as the aggregated surplus has the potential to compensate, though it might not actually be realized. In addition, it is questionable if the redistribution-system in a society is really costless, as distortion effects might arise. Antràs et al. (2017) extend the

Kaldor-Hicks approach by the introduction of two correction terms in the social welfare formula: The *welfarist-correction term* considers the inequality aversion of the society, while the *costly-redistribution correction term* captures the distortion effects evolving from the redistribution-system. The authors use the model to quantify the trade-induced inequality effects on social welfare in the United States. We apply the approach to investigate the social welfare effects of the "Tax-Reform 2000" and trade liberalization in Germany. Additionally, we derive for Germany the optimal (social welfare maximizing) tax progressivity, that takes income inequality into consideration.

Chapter 3

Trade and Welfare Effects of a Potential Free Trade Agreement between Japan and the United States[1]

3.1 Introduction

In the last decade, the value of U.S. exports has grown strongly from 1.3 trillion U.S.$ in 2005 to over 2.2 trillion U.S.$ in 2015.[2] Hereby, trade agreements play a significant role as they open up foreign markets for U.S. companies and products. In 2015, 47% of U.S. exports went to countries with an established U.S. trade agreement.[3] Remarkably, Japan as the third largest global economy is the most important trading partner of the United States without a trade agreement in place. To address this, the Trans-Pacific Partnership (TPP) was sought to structure the trade relationship between both countries. But TPP also involves other countries such as Australia, Canada, Chile, and Mexico. It is expected to bring additional economic growth to the TPP member countries including the United States. How-

[1]Appeared as Walter (2018).

[2]In current U.S.$. Data source: World Bank (2018).

[3]International Trade Administration (2018).

ever, after the U.S. election in 2016 one of the first steps of the new administration was to put the negotiations on TPP on a hold. The newest trade strategy for the Trump administration is now to focus on bilateral free trade agreements (FTA) in order to have a higher bargaining power. According to the U.S. Commerce Secretary Wilbur Ross a bilateral agreement between two of the world's largest economies has "a very high priority" and is considered to be a front-runner for further bilateral trade agreements.[4] However, there are also tendencies from the White House to restart the negotiations on TPP, particularly, to strengthen the exports of the U.S. agriculture sector. The aim of this paper is to explore the trade and welfare gains of an FTA between Japan and the United States and to compare these results to the potential trade effects of the TPP.

Surprisingly, not much research has been done on the welfare effects of this trade agreement. Research has been conducted on a potential FTA between the EU and Japan (Benz and Yalcin (2013) and Felbermayr et al. (2017b), both studies being conducted ex-ante). But for a bilateral FTA between the United States and Japan there are only reports, investigating the FTA from a geopolitical and advisory perspective but not from the economic side (Scissors and Blumenthal (2017) and Cooper (2014)). With this paper I fill the indicated gap, by analyzing the potential welfare gains of the FTA using the theoretical model of Caliendo and Parro (2015)[5], which builds on assumptions adopted from the New Quantitative Trade Theory (NQTT)[6]. Applying the Caliendo and Parro (2015) model provides several advantages: First, following the theoretical model of Eaton and Kortum (2002), Caliendo and Parro (2015) allow producers to purchase goods from the lowest cost supplier in the economy. This assumption paves the way to use the gravity equation, which explains the trade flows between countries and is comfortable to apply. Second, the model solves for a counterfactual equilibrium in relative

[4]U.S. Commerce Secretary Wilbur Ross in The Diplomat (2017).

[5]For the analysis of this paper I rely on the codes and data files thankfully provided by Caliendo and Parro (2015).

[6]See Ottaviano (2014) and Costinot and Rodriguez-Clare (2014) for more details. Kehoe et al. (2017) compare the New Quantitative Trade Models, particularly Caliendo and Parro (2015), with standard applied general equilibrium (AGE) models (also known as computable general equilibrium models) and find ambiguous effects on the performance of both types of models.

changes through which structural parameters that are difficult to identify cancel out and do not have to be estimated empirically. Caliendo and Parro (2015) borrow this approach from Dekle et al. (2008). Third, their model is a multi-sector multi-country model with intermediate goods. The focus on trade in intermediates (global supply chains) is particularly useful for the investigation of the FTA between Japan and the United States, as the impact of trade agreements does not only depend on the degree of policy changes but also on the interrelation between industries. Hereby, the input-output analysis (Leontief (1951)) plays an important role. The international economy can be seen as an interlinked production network where the output of one sector can become the input for another. An impulse of trade policy can be passed on and impact other sectors as well. A difference between this paper and Caliendo and Parro (2015) is that this analysis tries to predict the effect of the potential FTA ex-ante whereas Caliendo and Parro (2015) estimate the effect of NAFTA ex-post. Several studies rely on Caliendo and Parro (2015) and use an ex-ante trade policy analysis, such as for TTIP (Aichele et al. (2014)) or for the Brexit scenario (Felbermayr et al. (2018)).

To solve for the welfare gains I apply the ex-ante empirical strategy of Aichele et al. (2014). The approach is useful as it takes not only tariffs, but also the non-tariff measures (NTM) into account. In general, trade agreements can take on different intensity levels to remove trade impediments. These can vary from reducing tariffs to deeper integration, where NTMs are minimized. The reduction of NTMs can include the standardization of regulatory legislation and industry standards as well as the opening of markets to foreign investments. The details of the potential FTA between the U.S. and Japan are not known, as the negotiations have not officially started yet, even though it is commonly assumed that the FTA will lead to deeper integration. To estimate the impact of NTMs, I therefore apply the top-down method and use past trade agreements as a benchmark to quantify the possible welfare impact of the FTA.[7]

This paper contributes to the literature in two ways. It is not only one of the first

[7] In order to estimate the impact of the NTMs I use the necessary dummy variables from Aichele et al. (2014). Note there is also an updated version of Aichele et al. (2016) available.

on the welfare effects of the potential FTA between Japan and the U.S., but it also simulates different scenarios by conducting a counterfactual analysis. In the first scenario, all tariffs are cut, whereas the second scenario cuts the tariffs to zero and additionally reduces the NTMs slightly (shallow FTA). The third scenario (deep FTA) cuts all bilateral tariffs to zero and reduces the NTMs strongly. In addition, I compare the trade and welfare changes of the deep FTA to the case if the Trans-Pacific Partnership (including the United States) is established. To exercise the counterfactual simulation, I use the most recent World Input-Output Database (WIOD) (Release 2016) as well as the UNCTAD's TRAINS database for the tariffs as the main data sources. The WIOD contains only data of six TPP countries, namely Japan, United States, Canada, Mexico, Chile and Australia.[8] However, those countries are responsible for 96% of the TPP members' GDP, through which valid interpretations are possible.

One of the key findings is that Japan has the largest welfare gains in the case of a deep FTA (0.085%), when comparing the three counterfactual trade scenarios. This is not surprising as the more trade costs are reduced the higher the welfare gains will be. More unexpected is that the United States gets its highest welfare gains in the first scenario where all tariffs are cut (0.003%).[9] In the shallow and deep scenario, the welfare effects for the United States are even negative with -0.001% and -0.007% respectively. The negative welfare effects are caused by the terms of trade, which results from an increase in the bilateral trade deficit through

[8]The other TPP countries not included in the input-output table are Brunei, New Zealand, Peru, Singapore, Vietnam and Malaysia.

[9]Note that in the model the change in real wages is not equal to the welfare change due to the fact that the income of households also depends on lump sum tariff revenue. As Caliendo and Parro (2015, p.12) point out the welfare change in this model is the "weighted average measure of the change in real wages and real tariff revenue." When estimating the change in real wages I find therefore higher results: For Tariff Reduction (Scenario 1) I find a change in real wages of 0.03% for Japan and for the United States of 0.01%. A Shallow FTA (Scenario 2) would lead to a higher change in real wages for Japan of 0.17% and for the United States of 0.06%. For the Deep FTA (Scenario 3) I find a welfare change for Japan of 0.29% and for the United States of 0.13%. The highest impact has the TPP-Scenario. For Japan, I estimate a change in real wages of 0.4% and for the United States of 0.76%. The other countries would also experience larger change in real wages as Canada of 3.1%, Mexico of 3%, Australia of 0.72% and Chile of 0.58%. In comparison to TTIP Aichele et al. (2014) estimate (without the focus on the change in real tariff revenue) an increase of real wages of 0.4% for the EU and 0.5% for the United States.

the trade cost reduction. In addition, I find that the United States should prefer TPP by comparing the FTA scenarios with TPP, as it leads to the largest welfare gains (0.05%). Japan will still favor a deep FTA as its welfare gains with TPP will only be 0.05%.[10] It is important to note that this paper looks at the welfare changes not from a dynamic but from a static level. The starting point is the status quo from which I simulate the impact of changing trade policy on trade and welfare.

The structure of the paper is as follows. Section 2 elaborates the stylized facts, while section 3 presents the gravity model of Caliendo and Parro (2015). Section 4 displays the strategy to determine the change in trade costs as well as the parameter identification. Section 5 presents the research findings. Finally, section 6 concludes.

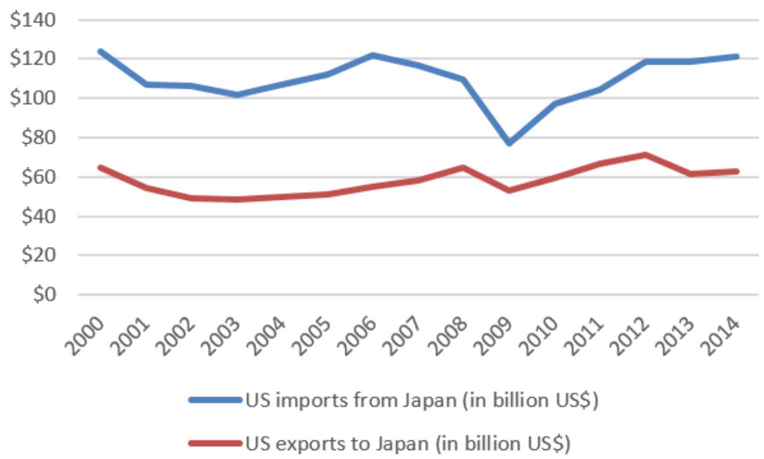
3.2 Stylized Facts

The import values from Japan to the United States are constantly larger than the exports to Japan from the United States, as Figure 3.2.1 displays. For the year 2014, the United States has a trade deficit to Japan of approximately 58 billion U.S.$. The graph shows that the trade flows between the two countries were strongly hit during the financial crisis in 2008. Imports to the United States from Japan were much more affected than exports from the United States to Japan. One of the reasons for this was the decrease of the domestic demand in the United States. As the global economic situation stabilized, trade between the United States and Japan reached the pre-crisis level.
Figure 3.2.2 indicates, the importance of the bilateral trade relationship for Japan. It presents the import and export shares for both countries of the last two decades.[11] Hereby, both shares are significantly larger for Japan. However, the import

[10] My findings are similar in size to Caliendo and Parro's (2015) welfare effect findings. For NAFTA they identify a welfare rise of 0.08% for the United States and a decrease of welfare in Canada by 0.06%, whereas the welfare increases in Mexico by 1.31%. Further Caliendo and Parro (2015) simulate and compare the welfare effects with different model types and find a similar impact for the United States and Canada, however, the welfare effects for Mexico are lower.

[11] The export shares are defined as U.S. exports to Japan relative to all U.S. exports, the same

Figure 3.2.1: U.S. Imports & Exports in Current Values



Source: World Input Output Database, Release 2016; Author's own illustration.

and export shares decreased for Japan by almost 50%, e.g. the import share for Japan declined from 2000 to 2014 from 28% to 14%. Note, that the largest reduction for both shares was between 2000 and 2004. Regarding the United States, the import and export shares decreased less than those of Japan and reached an import share level of 5% and an export share level of 3% in 2014.

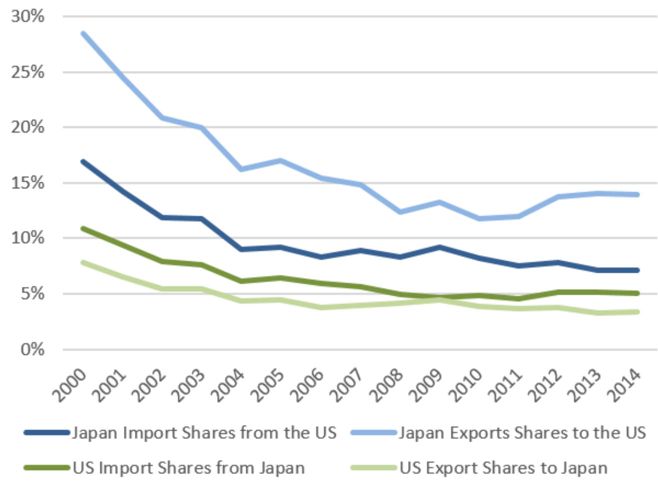
In Figure 3.2.3 I display the bilateral exports consisting of the aggregated sectors of manufacturing, services, and agriculture. Particularly the manufacturing sector stands out. In 2014, Japan exported around 120 billion U.S.$ of manufacturing goods to the United States. Hereby, the car industry is the largest export industry, followed by the computer & electronics and, the chemical industry. The aggregated manufacturing sector is the largest export sector to Japan of the U.S. with roughly 45 billion U.S.$. Among the U.S. manufacturing sector, the manufacturers of food products, transport equipment, and chemicals are the largest exporters to Japan.

The other aggregated sectors play a minor role: For Japan, expenditure in services account for 3 billion U.S.$ and 300 million U.S.$ for the agriculture sectors, whereas the U.S. is exporting around 9.1 billion U.S.$ in services and 7.6 billion U.S.$ in agricultural products to Japan.

The average import tariff of the United States for Japanese products is with 4%

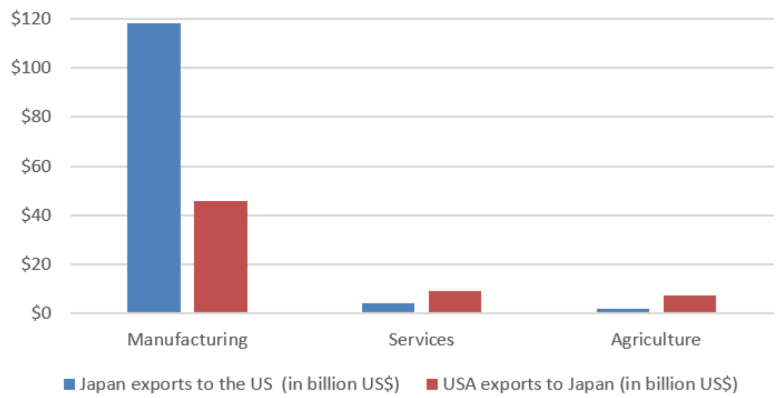
holds for import shares.

Figure 3.2.2: Import & Export Shares



Source: World Input Output Database, Release 2016; Author‘s own illustration.

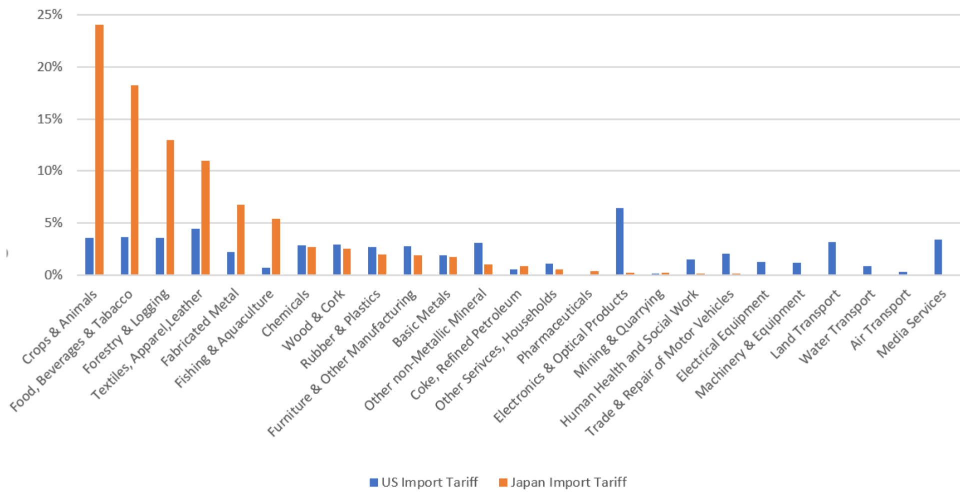
Figure 3.2.3: Bilateral Sector Exports (in 2014)



Source: World Input Output Database, Release 2016; Author‘s own illustration.

already low and was fairly constant over the last 15 years, whereas the import tariffs on the Japanese side are higher on average. However, the tariff decreased from around 10% in 2001 to around 8% in 2014. Therefore, it can be said that Japan runs a more protective bilateral trade policy in terms of tariffs than its U.S. counterpart. Looking at the tariffs in more detail, Figure 3.2.4 displays that especially Japan is shielding its agriculture sectors from U.S. imports. The largest import tariffs being (on average) in the Corps & Animals, Food, Beverages & Tobacco industry. However, as Felbermayr et al. (2017b) point out there is a large tariff heterogeneity in Japan's agriculture sectors. On the one hand, Japan particularly protects its rice industry (consisting out of many small farms) with tariffs, quotas and subsidies. On the other hand, Japan is also depending on other imports in the food sector. This heterogeneity is also reflected in the trade policy: According to Felbermayr et al. (2017b), 25% of the tariffs in agriculture is duty free, whereas other agriculture products are charged with tariffs up to 300%. On the U.S. side tariffs are smoother across sectors. The largest tariffs are charged on average on electronics (6%) as well as on textile (4.4%) and food products (3.6%).

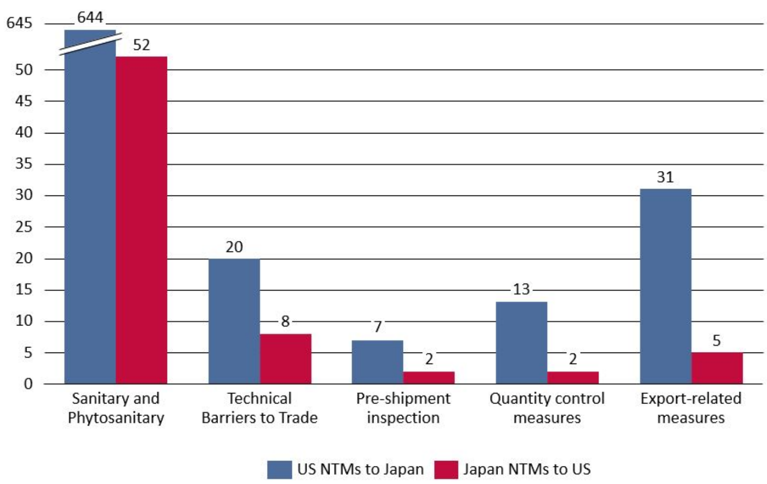
Figure 3.2.4: Sectoral Import Tariffs (in 2014)



Source: UNCTAD TRAINS 2014; Author‘s own illustration.

However, trade costs do not only depend on tariffs, but also involve non-tariff measures. Figure 3.2.5 shows the number of non-tariff measures active between the United States and Japan in 2018. As the quality of the NTMs are in general harder to measure, the quantity of the NTMs I present in Figure 3.2.5 can give an indication about the costs of the trade barriers. Clearly, the United States has more non-tariff measures in place than Japan. Especially U.S. regulations in the area of sanitary and phytosanitary outweighs Japan's regulation by far: 644 NTMs of the United States compared to 52 NTMs of Japan. Also, in the area of export-related measures and technical barriers to trade the number of barriers is much larger from the American side.

Figure 3.2.5: Total Non-Traiff Measures (in 2018)



Source: UNCTAD NTB 2018; Author's own illustration.

To conclude, Japan and the United States have a significant economic relationship, however, over the last decade the trade shares have slightly decreased between both countries. This is due to the stronger Japanese trade relationship with China and other Asian countries, as well as the growing trade of the U.S. with Mexico and China.[12] The trade deficits of the United States with Japan are mainly caused by trade deficits of the manufacturing sectors. On average, the U.S. import tariffs on Japanese goods and services are 4% points lower than vice versa. Furthermore, Japan is protective of its agriculture sector, particularly the corps and animal sector, which includes the rice industries. Also, the Japanese car industry is less open to foreign carmakers. As Cooper (2014) points out, only 6.7% of all Japanese

[12]The United States has 20 FTAs with various countries in place, covering 25% of the total U.S. exports, whilst Japan has 16 active trade agreements that is 7% of its total exports. Note, that the calculation is based on the WIOD 2016.

cars come from abroad. I discuss the impact of a potential trade agreement in the form of either a bilateral or regional trade agreement in section 3.5.

3.3 Model

The model of Caliendo and Parro (2015) builds on the well-known Eaton and Kortum (2002) multi-sector multi-country Ricardian model. It also considers the input-output linkages between tradable and non-tradable sectors. The setup of the model includes intermediate goods, composite intermediate goods and heterogeneity in sectoral productivity. It involves the following assumptions: There are $n = 1, .., N$ countries which are referred to as n and i; and include $j = 1, .., J$ sectors indicated by j and k. The only factor of the country that counts into production is labor L_n. Labor can shift between sectors, but it is immobile across countries. The model assumes perfect competition for all markets, hence price equals marginal cost.

3.3.1 Households

In each country n there are L_n representative households with Cobb-Douglas preferences. The households buy final goods in the amount of C_n^j for the price of P_n, hence the consumer maximization problem becomes:

$$\max_{C_n^j} U(C_n) = \prod_{j=1}^{J} \left(C_n^j\right)^{\alpha_n^j} \quad s.t. \quad \sum_{j=1}^{J} P_n^j C_n^j = I_n \tag{3.1}$$

Here, α_n^j is the share of demand for the final good in sector j of country n. It is an exogenous parameter, and it holds $\sum_{j=1}^{J} \alpha_n^j = 1$ as well as $\alpha_n^j \geq 0$. I_n is the income of the household of country n and includes labor income, tariff revenue and trade surplus. The solution of the price index of the final good is given by $P_n = \prod_{j=1}^{J} \left(P_n^j / \alpha_n^j\right)^{\alpha_n^j}$ and the equilibrium condition is defined as $P_n^j C_n^j = \alpha_n^j I_n$. The household uses a share of its income represented by α_n^j to purchase final goods in the amount of C_n^j.

3.3.2 Composite Intermediate Goods

Composite intermediate goods (materials) are produced by intermediate goods from the same sector. Composite intermediate goods (q_n^j) are used for the production of sector-specific final goods C_n^j and intermediate goods $q_n^j(x_n^j)$. They can be tradable, then the input can come from a variety of countries, or they can be non-tradable.

In the case of tradable goods Ricardian motives of trade are introduced.[13] It is assumed that the access to technology varies by sector and country, which leads to different efficiency levels in intermediate good production. Therefore, the level of total factor productivity, also often interpreted as "costs" for each intermediate good, can vary. The inverse total factor productivities are modeled as random and independent variables with a common density of Φ^j. The common density Φ^j is exponential and has the parameter of λ_n^j : $x_n^j \sim \exp(\lambda_n^j)$. The scale parameter λ_n^j can be seen as the state of technologies in sector j of country n, which determines the absolute advantage in trade. Each intermediate good has its own cost draw $x_n^j > 0$ and is independent of the other intermediate good. Note, that the vector of technology draws of a particular sector j with N countries can be written as $x^j = (x_1^j, \ldots, x_N^j)$, then the joint density of x^j is defined in the following way $\Phi^j(x^j) = \left(\prod_{i=1}^N \lambda_n^j\right) \exp\left\{-\sum_{i=1}^N \lambda_n^j x_n^j\right\}$. Thus, the production function of the composite intermediate good is given by $q_n^j = \left[\int q_n^j(x^j)^{(1-1)/\eta^j} \Phi^j(x^j) dx^j\right]^{\eta^j/(\eta^j-1)}$ where η^j is the constant elasticity of substitution and varies across sectors.

Producers of the composite intermediate good purchase the sector specific intermediate good from that country which offers the lowest price for the intermediate good. Therefore, the minimization problem of the composite intermediate good

[13] The case of composite intermediate goods of non-tradable sectors is displayed in the appendix 3.A. The calculation of the tradable and the non-tradable are based on Caliendo and Parro (2012).

aggregate is:

$$
\begin{aligned}
P_n^j q_n^j = \min_{q_n^j(x_n^j)} & \int p_n^j(x^j) q_n^j(x^j) \Phi^j(x^j) dx^j \\
s.t. & \left[\int q_n^j(x^j)^{(1-1/\eta^j)} \Phi^j(x^j) dx^j \right]^{\eta^j/(\eta^j-1)} \geq q_n^j
\end{aligned}
\tag{3.2}
$$

Here $P_n^j q_n^j$ is the total expenditure on composite tradable goods in sector j of country n. The solution of the minimization problem leads to the intermediate good demand function of $q_n^j(x^j) = \left(\frac{p_n^j(x^j)}{P_n^j}\right)^{-\eta^j} q_n^j$ with P_n^j as the price of the material $P_n^j = \left[\int p_n^j(x^j)^{(1-\eta^j)} \Phi^j(x^j) dx^j\right]^{1/(1-\eta^j)}$ and $p_n^j(x^j)$ as the lowest price for the sector specific intermediate good x^j across all countries. Hence, a change in tariffs affects the aggregated price index of intermediate goods, which influences the material price as well. This is a key mechanism in the model.

3.3.3 Intermediate Goods

Labor and composite intermediate goods from all sectors, tradable and non-tradable, are used as inputs to produce the intermediate good x_n^j. Hereby, the production function is defined as:

$$
q_n^j(x_n^j) = [x_n^j]^{-\theta^j} [l_n^j(x_n^j)]^{\beta_n^j} \left[\prod_{k=1}^{J} m_n^k(x_n^j)^{\gamma_n^{k,j}} \right]^{1-\beta_n^j} \tag{3.3}
$$

where $l_n^j(x_n^j)$ is the labor demand. The production efficiency of intermediate good in sector j in country n is given by $[x_n^j]^{-\theta^j}$. The parameter θ^j captures the dispersion of productivity and intensifies the productivity draws.[14] The amount of materials used in the production of the intermediate good x_n^j from sector k is given by $m_n^k(x_n^j)$. The share of composite intermediate goods from sector k used

[14] There are different notations for the dispersion parameter of productivity in Eaton and Kortum (2002) and Alvarez and Lucas (2007), $(1/\theta)_{EK} = \theta_{AL}$. For Eaton and Kortum (2002) θ is inversely related to the variation of the distribution. Aichele et al. (2014) follow Eaton and Kortum (2002), whereas Caliendo and Parro (2015) use the notation of Alvarez and Lucas (2007) to amplify the cost draws. Further Caliendo and Parro (2015) allow the parameter θ^j to be sector-specific, but common across countries. In this paper the notation of Caliendo and Parro (2015) is followed.

to create the intermediate good x_n^j in sector j is given by $\gamma_n^{k,j} \geq 0$. It holds $\sum_{k=1}^J \gamma_n^{k,j} = 1 - \beta_n^j$, where β_n^j is the share of value added in sector j of country n.[15] Producers of the tradable intermediate goods x_n^j maximize profits in the following way:

$$p_n^j(x_n^j)q_n^j(x_n^j) = \min_{l_n^j(x_n^j), \left\{m_n^k(x_n^j)\right\}_{k=1}^J} \sum_{k=1}^J P_n^k m_n^k(x_n^j) + l_n^j(x_n^j)w_n$$

$$\text{s.t.}[x_n^j]^{-\theta^j}[l_n^j(x_n^j)]^{\beta_n^j}\left[\prod_{k=1}^J m_n^k(x_n^j)^{\gamma_n^{k,j}}\right]^{1-\beta_n^j} \geq q_n^j(x_n^j) \quad (3.4)$$

The solution for labor demand is given by $l_n^j(x_n^j) = \beta_n^j \frac{p_n^j(x_n^j)q_n^j(x_n^j)}{w_n}$ and the demand for composite intermediate goods by $m_n^k(x_n^j) = \gamma_n^{k,j}(1-\beta_n^j)\frac{p_n^j(x_n^j)q_n^j(x_n^j)}{P_n^k}$. The price of an intermediate good is then given by $p_n^j(x_n^j) = \frac{B^j}{[x_n^j]^{-\theta^j}}c_n^j$ where B^j is a constant. The cost of the input bundle, c_n^j, is described by the equation $c_n^j = w_n^{\beta_n^j}\left(\prod_{k=1}^J (P_n^k)^{\gamma_n^{k,j}}\right)^{1-\beta_n^j}$. The equation is crucial, because through this equation the different sectors are connected. The equation shows that the cost of the intermediate goods depends, on the one hand, on the wages of sector j in country n and on the other hand on the composite intermediate good prices from tradable and non-tradable sectors. In particular, the last part of the cost equation is essential $\prod_{k=1}^J (P_n^k)^{\gamma_n^{k,j}}$. It represents the inputs from all sectors and is responsible for the interrelation of the sectors in the economy. Here P_n^k is the price of material in sector k. A price change in this particular sector, e.g. through a change in tariff, impacts all other sectors indirectly through the input cost bundles.

3.3.4 Introduction of Trade Costs

Caliendo and Parro (2015) distinguish between two types of costs. The first type of costs is defined as ad valorem flat-rate tariff τ_{ni}^j, which arises as intermediate

[15]The closer β_n^j gets to 1 the less interactions between sector j of country n and other sectors take place. Note that in the extreme case of $\beta_n^j = 1$ there will be no interrelations between sectors. Also in the case of $\gamma_n^{j,j} = 1$, all materials of sector j are used for production in the same sector. The good is entirely produced by input of the same sector, and there is no interrelation between other sectors.

goods are imported into country n from country i. The second type of trade costs d^j_{ni}, is called "iceberg cost" and is the physical loss goods experience when traded between countries.[16] "Iceberg costs" can take on the form of a function including different variables such as bilateral distance or common border. In this paper I borrow the approach of Aichele et al. (2014) to estimate the impact of non-tariff measures. Aichele et al. (2014) use the top-down approach in order to estimate a realistic reduction of trade costs. This approach investigates past trade agreements and their impact on trade cost reductions. The results are then used as benchmarks to predict the impact of future trade agreements. In this context, Aichele et al. (2014) use two types of dummy variables PTA_{deep} and $PTA_{shallow}$. Combining the two types of international trade costs leads to $k^j_{ni} = \tilde{\tau}^j_{ni} d^j_{ni}$ with $\tilde{\tau}^j_{ni} = (1 + \tau^j_{ni})$ and $d^j_{ni} = D^{\rho^j}_{ni} e^{(\delta^j_{shallow} PTA_{shallow,ni} + \delta^j_{deep} PTA_{deep,ni} + \zeta^j R_{ni})}$. Taking international trade costs into account, the price of the intermediate good also relies on trade costs k^j_{ni}. The producers purchase goods from the supplier who offers the lowest-costs. Hence, the price of intermediate goods of sector j in country n becomes $p^j_n(x^j) = \min_i \left[\frac{B^j c^j_i}{[x^j_i]^{-\theta^j}} k^j_{ni} \right]$. Using the approach of Caliendo and Parro (2015) the gravity equation can be identified, which displays the trade flow and the expenditure share of country n on goods from country i.

$$\pi^j_{ni} = \frac{\lambda^j_i [c^j_i k^j_{ni}]^{-1/\theta^j}}{\sum_{h=1}^{N} \lambda^j_h [c^j_h k^j_{nh}]^{-1/\theta^j}} \tag{3.5}$$

3.3.5 Counterfactual Equilibrium

In the context of sectoral input-output linkages, the equilibrium wages and prices are such that they maximize the consumer's utility and the profit of the firms for each sector in each country. In addition, good- and labor market clearing conditions must hold.[17] Empirically, it is challenging to estimate the total productivity λ^j_i and the iceberg costs d^j_{ni} for each sector and country. To avoid estimating those

[16] Caliendo and Parro (2015) define it in technical terms in the following way: To get one unit from country i to country n, requires to produce $d^j_{ni} \geq 1$ of the unit in country i; with $d^j_{nn} = 1$. In addition, the triangle inequality must hold namely $d^j_{nk} d^j_{ki} \geq d^j_{ni}$ for all n, k, i, otherwise, it would be possible that goods are not necessarily bought from the cheapest supplier.

[17] For more detail on the equilibrium conditions, see appendix 3.A.

exogenous parameters and still being able to solve the equilibrium, Caliendo and Parro (2015) borrowed the method of relative changes from Dekle et al. (2008). Let x be the initial level of a variable and x' the variable under the counterfactual level. The relative change is then defined as $\hat{x} \equiv x'/x$. The equilibrium is found for the change in relative wages and price, by moving the tariff structure from τ to τ'.

Definition: Let (w, P, π, c, X) be an equilibrium under tariff structure τ and let (w', P', π', c', X') be an equilibrium under tariff structure $\hat{\tau}$. Then, define $(\hat{w}, \hat{P}, \hat{\pi}, \hat{c}, \hat{X})$ as an equilibrium under τ' relative to τ. The general equilibrium equations are solved for an equilibrium in relative changes:
Cost change of the input bundle:

$$\hat{c}_n^j = \hat{w}_n^{\beta_n^j} \left(\prod_{k=1}^{J} (\hat{P}_n^k)^{\gamma_n^{k,j}} \right)^{1-\beta_n^j} \tag{3.6}$$

Change in the price index of tradable materials:

$$\hat{P}_n^j = \left[\sum_i [\hat{k}_{ni}^j \hat{c}_i^j]^{(-1/\theta^j)} \pi_{ni}^j \right]^{-\theta^j} \tag{3.7}$$

Change of bilateral trade shares:

$$\hat{\pi}_{ni}^j = \left(\frac{\hat{c}_i^j \hat{k}_{ni}^j}{\hat{P}_n^j} \right)^{-1/\theta^j} \tag{3.8}$$

Expenditure $X_n^{j\prime}$ in each sector j and country n:

$$X_n^{j\prime} = \sum_{k=1}^{J} \gamma_n^{j,k} (1 - \beta_n^j) \left(\sum_{i=1} \frac{\pi_{in}^{k\prime}}{(1 + \tau_{in}^{k\prime})} X_i^{k\prime} \right) + \alpha_n^{j\prime} I_n' \tag{3.9}$$

Trade balance:

$$\sum_{j=1}^{J} F_n^{j\prime} X_n^{j\prime} + S_n = \sum_{j=1}^{J} \sum_{i=1}^{N} \frac{\pi_{in}^{j\prime}}{(1 + \tau_{in}^{j\prime})} X_i^{j\prime} \tag{3.10}$$

Let the income under the new trade policy be
$I'_n = \left[\hat{w}_n w_n L_n + \sum_{j=1}^{J} X_n^{j'}\left[1 - F_n^{j'}\right] - S_n\right]$, where $\hat{w}_n = \frac{w'_n}{w_n}$, $F_n^{j'} = \sum_{i=1}^{N} \frac{\pi_{ni}^{j'}}{(1+\tau_{ni}^{j'})}$ and S_n is the trade surplus. Note that for the general equilibrium in relative changes, the trade cost equation $\hat{k}_{ni}^{j}$ becomes:

$$\hat{k}_{ni}^{j} = \frac{(1+\tau_{ni}^{j'})}{(1+\tau_{ni}^{j})} e^{\delta_{shallow}^{j}(PTA'_{(shallow,ni)} - PTA_{(shallow,ni)}) + \delta_{deep}^{j}(PTA'_{(deep,ni)} - PTA_{(deep,ni)})} \tag{3.11}$$

where the bilateral distance D_{ni} and R_{ni} as the vector which includes other possible trade costs cancel out.

3.3.6 Solving the Model

Given those counterfactual equilibrium conditions, the system of equations can be solved through an algorithm, which reduces the system of equations to one equation per country with the wage as the only unknown parameter.[18] The first step is to calculate the trade cost change $\hat{k}_n^j$, given the trade policies of τ and τ'. To solve the algorithm, it is assumed that π_{in}^{j}, $\gamma_n^{j,k}$, β_n^j, α_n^j as well as the parameter of productivity θ^j are given for each sector. The next step is to guess a vector of wage changes $\hat{w} = (\hat{w}_1, \ldots, \hat{w}_n)$. Together with $\hat{k}_n^j$, π_{in}^j, $\gamma_n^{j,k}$, β_n^j, δ^j the wage vector $\hat{w}$ is used to solve for equilibrium input costs $\hat{c}_n^j(\hat{w})$ and prices $\hat{P}_n^j(\hat{w})$ in each sector and country. After that, the bilateral trade shares under the new trade policy $\pi_{ni}^{j'}(\hat{w})$ are calculated; using $\hat{c}_i^j(\hat{w})$, $\hat{P}_n^j(\hat{w})$ and $\hat{k}_{in}^j$ and θ^j via $\hat{\pi}_{ni}^j$. Given $\pi_{ni}^{j'}(\hat{w})$ and τ', the value of weighted tariffs $F_n^{j}{}'$ can be identified. After that determine the total expenditure of each sector j of country n under the new trade policy, which is $X_n^{j'}(\hat{w})$. This is done by inserting α_n^j, β_n^j, $\gamma_n^{j,k}$, τ' , $F_n^{j}{}'$ and $\pi_{in}^{j'}(\hat{w})$ into equation 3.10 and converting it into $X_n^{j'}(\hat{w})$, which is consistent with the wage vector. This is then inserted together with $\pi_{in}^{j'}(\hat{w})$, S_n, τ' into equation 3.10, which leads to the trade balance conditions of $\sum_{j=1}^{J}\sum_{i=1}^{N} \frac{\pi_{ni}^{j'}(\hat{w})}{(1+\tau_{ni}^{j'})} X_n^{j'}(\hat{w}) + S_n = \sum_{j=1}^{J}\sum_{i=1}^{N} \frac{\pi_{in}^{j'}(\hat{w})}{(1+\tau_{in}^{j'})} X_i^{j'}(\hat{w})$. Through this mechanism the system of equations is

[18] The process to solve the model is based on Caliendo and Parro (2015), for a detailed step-by-step description see appendix 3.A.

reduced to one equation per country, containing the countries' wages as the only unknown parameter. The last step is to identify the correct vector of wage changes $\hat{w} = (\hat{w}_1, \ldots, \hat{w}_n)$. The correct vector is found if the equilibrium equation is in balance. If the equations do not hold, the vector of wage changes has to be guessed again, and the process is repeated. The procedure continues, until the correct vector in wage changes $\hat{w}$ is found.

3.3.7 Decomposing Welfare Effects

Having the system solved the counterfactual change in real wages $\hat{W}_n = \hat{w}_n / \prod_j^J \hat{P}_n^{j\,\alpha_n^j}$ can be identified. However, the change in real wages is not equal to the welfare change, due to the fact that the income of households depends also on lump sum tariff revenue. Therefore, the change in welfare can be determined by taking the total derivative of the real income $W_n = I_n/P_n$, holding iceberg costs and exogenous trade deficits constant, leads to the following equation:

$$\begin{aligned} d\ lnW_n = \frac{1}{I_n} \sum_{j=1}^{J} \sum_{i=1}^{N} & \underbrace{(E_{ni}^j d\ lnc_n^j - M_{ni}^j d\ lnc_i^j)}_{Terms\ of\ Trade} + \\ \frac{1}{I_n} \sum_{j=1}^{J} \sum_{i=1}^{N} & \underbrace{\tau_{ni}^j M_{ni}(d\ lnM_{ni}^j - d\ lnc_i^j)}_{Volume\ of\ Trade} \end{aligned}$$

Hence two multilateral and multisectoral mechanisms affect the change of welfare in the model: Terms of trade and volume of trade. Terms of trade does not depend on sectoral trade deficit as such; however, it depends on the differences between exports (E) and imports (M) that are affected by the change in export and import prices. Volume of trade is a first-order effect from given distortions as it depends on the tariffs and amount of imports and on the change in imports weighted by import prices.

3.4 Data

In this section I bring the data to the model and identify the parameters which are necessary to solve the model empirically, once the trade policy changes are implemented.[19] Due to the use of the general equilibrium in relative changes, I do not have to estimate the parameters λ_i^j, D_{ni} and R_{ni} empirically.

3.4.1 Strategy to determine Changes in Trade Costs

The change in trade cost $\hat{k}_{ni}^j$ depends on the tariffs τ and the counterfactual tariffs τ', as well as the dummy variables $PTA_{shallow}$, $PTA'_{shallow}$, PTA_{deep}, PTA'_{deep} and their parameters δ^j, as seen in equation 3.11.

I collect the tariff data from the UNCTAD Trade Analysis Information System (TRAINS) for the year 2014 at the Harmonized System (HS) based tariff line level (HS 2-digit) and transform them to the International Standard Industrial Classification Revision 4 (ISIC Rev. 4). For the computation of the analysis I set the counterfactual tariffs τ' in every scenario to zero.[20] Furthermore, to simulate the reduction of the NTMs, I use the dummy variables of the top-down method, borrowed from Aichele et al. (2014).[21] For the classification of $PTA_{shallow}$ and PTA_{deep} Aichele et al. (2014) rely on the Design of Trade Agreements (DESTA) database of Dür et al. (2014). This database covers over 790 PTAs, which include different types of FTAs and customs unions for the time span between 1947 and 2010. The database ranks the PTAs according to their strength of NTM reductions. The index of the ranking ranges from 0 to 7. Aichele et al. (2014) classify trade agreements that have an index between 0 and 4 as $PTA_{shallow}$. With values

[19] Hence, the tariff changes from τ to τ' and/or the non-tariff barrier changes from PTA to PTA'.

[20] A detailed description and explanation of the three trade policies is found in section 3.5.

[21] I am aware that Aichele et al. (2014) use the Global Trade Analysis Project (GTAP) as a database for the estimations. Ideally, the parameters should be drawn from the same database. One might argue that the GTAP database would be a better choice, since it also includes the other TPP countries (Brunei, New Zealand, Peru, Singapore, Vietnam and Malaysia) which are not included in WIOD. Due to high access costs of the GTAP database I apply the WIOD as a well-established alternative in my analysis.

above 4 the trade agreements are considered as deep preferential trade agreements. The meaning of a $PTA_{shallow}$ dummy variable is that it captures the impact if the FTA reduces NTMs as in average past trade agreements. The PTA_{deep} captures the effect if the FTA goes beyond the average NTM reduction.[22] In addition, I adopt from Aichele et al. (2014) the parameters $\delta^j_{shallow}$ and δ^j_{deep}. Those parameters are based on the WIOD (Release 2013) for the year 2011, which I transform to fit according to the sectors of the WIOD (Release 2016) of the year 2014. After I have determined the parameters $\delta^j_{shallow}$ and δ^j_{deep} I can estimate the trade cost $\hat{k}^j_{ni}$.

3.4.2 Parameter Identification

I use the WIOD released in 2016 as the main data source. To conduct the counterfactual analysis I take the World Input-Output Table of the year 2014 as it is the most recent year available in the WIOD.[23] It covers 43 countries as well as an aggregate for the rest of the world (ROW) and includes 56 sectors which are classified according to the ISIC Rev. 4. This dataset is useful as it covers around 90% of the global GDP. To avoid calculation difficulties, I apply the approach of Felbermayr et al. (2017a) and summarize the sectors with zero outputs. This is particularly the case for some service sectors.[24] In addition, I use the approach of Costinot and Rodriguez-Clare (2014) to eliminate negative inventories. This is necessary because otherwise the final demand turns out to be negative when summing up over investments, changes in inventories, and the final consumption expenditure by households and government.[25]

I obtain several parameters directly from the World Input-Output Table. I calculate the share of value added β^j_n by dividing the value added VA^j_n over the gross output for each sector j of country n and identify the input-output coefficient

[22]According to Aichele et al. (2014) most trade agreements are shallow PTAs, as for example the ASEAN and MERCOSUR treaties, whereas only 10% of the PTAs are considered deep PTAs, e.g. the European Union.

[23]For the counterfactual analysis I conduct robustness checks for several other years with data of WIOD and find similar counterfactual results without changes in pattern.

[24]For more details, see appendix 3.A.

[25]The approach is also used in other papers as for example in Krebs and Pflüger (2018).

by adding all intermediate inputs of sector i from all countries into sector j and then dividing it by the total intermediate costs of sector j. Further, I obtain the trade flows for each sector j and country n from the WIOD, whereas the trade cost elasticity θ^j for the agriculture, mining and manufacture sectors I take from Felbermayr et al. (2017a).[26] Regarding the service sectors and non-tradable goods sectors Egger et al. (2012) estimate the trade cost elasticity to be 5.959. In this paper I apply the trade cost elasticity of Egger et al. (2012) for the service sectors.[27] Once the parameters above are identified I can calculate the share of the final demand good in sector j and the bilateral trade share.

3.5 Simulation Results

In the following, I analyze the impact of different trade policy scenarios.[28] As shown before, the tariffs between the U.S. and Japan are already small on average. In the first scenario (only) all bilateral tariffs are reduced to zero. It is considered as the weakest possible FTA.[29] The second scenario targets a potential shallow agreement where all tariffs are cut and non-tariff barriers are scaled down moderately. The third scenario covers the implementation of a deep FTA where all tariffs are reduced to zero and the NTMs are profoundly scaled-down. It is assumed that the deep FTA is the most likely scenario, as the Japanese administration is eager to reduce the U.S. non-tariff measures in order to have better market access to the United States. Lastly, I compare the trade effects of TPP (including the U.S.) and a deep bilateral trade agreement between Japan and the United States. Hereby, TPP is considered to be a deep regional trade agreement.

[26]These particular trade cost elasticity θ^j, are used also in other papers, e.g. Felbermayr et al. (2017c).

[27]Other research work also relies on the trade cost elasticity of Egger et al. (2012) as in Aichele and Heiland (2014).

[28]To conduct the simulation I adopt and adjust the codes provided by Caliendo and Parro (2015).

[29]In some sectors the tariffs are still high on average, which is particularly the case for Japan. Here the following sectors stand out: Crops Animals (24%), Food, Beverages Tobacco (18%), Forestry Logging (13%), Textiles, Apparel, Leather (11%). For simplicity reason it is assumed in this paper that tariffs of these sectors are also set to zero. However, the outcome of the negotiations might lead to a different result of the tariff reduction.

3.5.1 Trade Policy Scenarios

Table 3.5.1 presents the results for the three potential FTAs and their impact on bilateral imports between the United States and Japan.[30] The bilateral imports take account of intermediate and final goods from all sectors, including the service sectors. In all scenarios, the U.S. imports more goods and services from Japan as vice versa. Hence, the U.S. bilateral trade deficit increases under every form of trade policy.[31]

Table 3.5.1: Bilateral Imports between the U.S. and Japan (in bn U.S.$)

		U.S.	Japan
Tariff Reduction (Scenario 1)	Bilateral imports	126.6	69.2
	Absolute change	+4.5	+5.6
	Relative change	3.7%	8.9%
Shallow FTA (Scenario 2)	Bilateral imports	152.7	83.8
	Absolute change	+30.7	+20.2
	Relative change	25.2%	31.8%
Deep FTA (Scenario 3)	Bilateral imports	176.6	99.5
	Absolute change	+54.5	+35.8
	Relative change	44.7%	56.4%

Source: World Input Output Database, Release 2016; NTMs by Aichele et al. (2014); TRAINS; Author's own calculations.

In the first trade policy scenario, the import growth is greater in Japan than in the United States (in absolute and relative changes). This is not surprising as Japan charges on average 4% higher tariffs on U.S. products. A reduction of all tariffs has therefore a stronger effect on the Japanese import growth. In the second and third scenario, with tariff cuts and an additional reduction of the NTMs the import rates are even higher in both countries than in the first scenario (in absolute and relative changes). Also, in both scenarios the import of Japanese products to the U.S. grows stronger than the imports of U.S. goods to Japan (in absolute changes). This is due to the fact that the United States applies more NTM to Japanese

[30] I conduct the results from the status quo, without a change in trade policies.

[31] The largest trade deficit occurs in the case of the deep FTA, where the United States imports goods and services worth 176.6 billion U.S.$ from Japan and exports 99.5 billion U.S.$.

products than vice versa, as shown in section 3.2. Thus, a NTM reduction leads to more imports on the U.S. side. However, Japan also benefits from the NTMs reduction and has even higher growth rates than the U.S. in relative changes: The United States experiences an import growth of 25.2% in the shallow and a growth of 44.7% in the deep case, whereas the Japanese import growth is larger with 31.8% in the first scenario and 56.4% in the latter scenario.

Table 3.5.2: Impact of Trade Policies on Welfare

	Country	Total Welfare Effects	ToT	VoT
Tariff Reduction	Japan	-0.001%	*-0.004%*	*0.003%*
(Scenario 1)	U.S.	0.003%	*0.0008%*	*0.002%*
Shallow Integration	Japan	0.045%	*0.026%*	*0.019%*
(Scenario 2)	U.S.	-0.001%	*-0.013%*	*0.012%*
Deep Integration	Japan	0.085%	*0.054%*	*0.031%*
(Scenario 3)	U.S.	-0.007%	*-0.016%*	*0.009%*

Source: World Input Output Database, Release 2016; NTMs by Aichele et al. (2014); TRAINS; Author's own calculations.

Table 3.5.2 displays the impact on the welfare change by the three trade policy scenarios. In the first scenario, Japan is experiencing a negative effect on welfare (-0.001%). The negative effect is mainly driven by terms of trade (ToT) (-0.004%), which is larger than the volume of trade (VoT) (0.003%). As seen in section 3.3.7, the terms of trade of a country depend on the sectoral trade deficit, which is subject to the sectoral change in import- and export prices. On the one hand, Japan has (on average) a sectoral trade deficit, hence it imports more than it exports in the most sectors. On the other hand, the average sectoral export and import prices are decreasing with a relatively stronger reaction in export prices.[32] The effect of the sectoral weights is not as strong as the export and import price changes, which is the most dominant effect. Henceforth, the terms

[32]The export price depends on wage changes and the change of the prices for the composite intermediate goods, which are in turn influenced by the tariff reduction, see equation 3.6 and 3.7. The reduction of tariffs leads to a wage increase by 0.01% and at the same time to a price index change of -0.02%. Hence, the change of export prices is negative.

of trade turn out to be negative.[33] Regarding the shallow and deep scenario, the welfare impact for Japan is positive in both scenarios and becomes stronger as the FTA deepens. The story for the United States is different: In the first scenario the United States experiences welfare gains by a positive volume of trade and terms of trade. However, for a shallow and deep FTA the overall effects are negative. In both scenarios the negative impact on welfare is driven by the terms of trade: -0.013% in the case of a shallow FTA and -0.016% in the deep scenario, which are each larger than the positive effects of the volume of trade.

In the next step, I show the source of the welfare effects in more detail. Table 3.5.3 displays the welfare changes that derive either directly through the trade creation of the FTA or indirectly through the rest of the world (ROW). The results from

Table 3.5.3: Bilateral Welfare Effects of the FTA

		ToT		VoT	
	Country	FTA	ROW	FTA	ROW
Tariff Reduction	Japan	-0.001%	-0.003%	0.005%	-0.002%
(Scenario 1)	U.S.	0.0002%	0.0006%	0.002%	-4.3e-05%
Shallow Integration	Japan	0.004%	0.022%	0.011%	0.008%
(Scenario 2)	U.S.	-0.001%	-0.012%	0.004%	0.008%
Deep Integration	Japan	0.008%	0.046%	0.017%	0.014%
(Scenario 3)	U.S.	-0.002%	-0.014%	0.004%	0.005%

Source: World Input Output Database, Release 2016; NTMs by Aichele et al. (2014); TRAINS; Author's own calculations.

Table 3.5.2 show that in the first scenario the terms of trade are in total negative for Japan. The decline in terms of trade is driven by the FTA (-0.001%) and even more by the ROW (-0.003%). This is because Japan's export prices fall relatively stronger than the import prices of the ROW. In addition, Japan is experiencing a negative impact through the ROW (-0.002%) in volume of trade, though this

[33] Japans imports are larger than its exports (174 billion U.S.$ in imports and 173 billion U.S.$ in exports), yet the average import price change is smaller than the export price change. Therefore, in total the export weighted by the change in export prices (-783 million U.S.$) is smaller than the import weighted by the changes in import prices. This causes the terms of trade to be negative.

effect is outweighed by a positive volume of trade impact via the trade of the FTA (0.005%). These results can be explained by the concept of trade diversion where trading with the members within the FTA, driven by a new trade policy, becomes relatively cheaper than trading with the ROW. Hence, the volume of trade rises within the FTA and falls with the ROW.

In the case of a potential shallow FTA the largest driver of welfare comes from the ROW in terms of trade (0.022%). Regarding the volume of trade, the FTA and the ROW contribute similarly to the welfare growth, with 0.011% and 0.008% respectively. A potential deep FTA contributes the most to Japan's welfare growth, especially through the ROW in terms of trade (0.046%), followed by the FTA (0.017%) and the ROW (0.014%) through the volume of trade.

As regards the United States, the tariff reduction has only a small effect on welfare in terms of trade. In scenario 1 the welfare is almost entirely driven by the FTA via the volume of trade, which comes from the increase of Japanese goods to the United States and the reduction of Japanese export prices. Interestingly, the shallow and deep agreement have a similar impact on the welfare change. In both scenarios the FTA and ROW have a negative impact on the welfare effect through the terms of trade. Considering the volume of trade, the growth rates through the FTA is the same in both cases and is even higher in the shallow scenario with 0.008% compared to the 0.005% in the deep scenario.

Keeping these results in mind, the United States should prefer a shallow agreement whilst Japan should favor a deep FTA. As mentioned in the introduction, a deep FTA is most likely to be established from a political standpoint. Therefore, I will focus in the following on the trade effects of a deep FTA.[34]

Table 3.5.4 shows the sectoral contribution to the welfare change for the deep scenario in terms of trade and volume of trade. Remarkably, there are only a handful of sectors which drive welfare: First, consider the sectoral contribution to welfare by the volume of trade of the United States, displayed in column 4. Here, the Crops and Animals sector, the sector for Food, Beverages & Tobacco, and the

[34] The sectoral results for the tariff and shallow scenario are displayed in the appendix 3.A.

sector for Fabricated Metal stand out. Together they contribute with 109.5% for the welfare gains in the volume of trade. Note, that the high contribution of the Crops and Animals sector (53.7%) is steered by the reduction of NTMs. Comparing it to the case where only the tariffs are reduced, the sector only adds 8% to the welfare gains and rises to 43.4% in the shallow scenario. There are also sectors which contribute negatively to the welfare change in volume of trade, particularly the Electronics & Optical Products, Motor Vehicles, Electrical Equipment as well as the Machinery & Equipment sector. Together they are responsible for 25.15% of the welfare losses.

In the case of a deep FTA, no sector contributes negatively for Japan in terms of volume of trade. Also, the sectors are less concentrated in their contribution to the welfare effect. The largest impact comes through the Electronics & Optical Products sector (19.6%), Food, Beverages & Tobacco (15.6%) and the sector of Crops & Animals (15.1%). Also, the Motor Vehicles sector (11.9%) adds positively to the welfare effect through volume of trade.

The sectoral influence through the terms of trade is displayed in column 1 and 3 of Table 3.5.4. In terms of trade Japan has the highest contribution in the Motor Vehicles sector (15.6%), the sector for Electronics & Optical Products (10.5%) and Machinery (9.73%). Similar to Japan the main growth driver for the United States is the Motor Vehicles sector (29.2%), followed by Other Transport Equipment (11.9%) and Machinery (10.5%). Also, service sectors have a positive impact on welfare gains through the terms of trade. This is due to the fact that the service sectors are influenced by changes in export and import prices as well. Especially services can be impacted directly by the FTA foremost via the reduction of NTMs. Tariffs can hardly be charged on services, only indirectly through the interrelations with non-services sectors, which are directly targeted by the trade policy.[35] In both countries the aggregated service sectors have a large impact on welfare growth, with 18.78% and 30.09% respectively.[36]

[35]The contribution to welfare by volume of trade is small for the service sectors. This is because the volume of trade is stirred mainly by import of goods, which by nature services are not.

[36]The reason for the high shares is that the services are aggregated.

Table 3.5.4: Sectoral Contribution to Welfare Effects in the Case of a Potential Deep FTA

	Japan		U.S.	
Sector	(1) ToT	(2) VoT	(3) ToT	(4) VoT
Crops & Animals	0.50%	15.1%	2.17%	53.7%
Forestry & Logging	0.04%	0.31%	-0.02%	0.24%
Fishing & Aquaculture	0.04%	0.06%	-0.001%	0.45%
Mining & Quarrying	3.26%	1.38%	0.77%	-1.12%
Food, Beverages & Tobacco	1.59%	15.6%	2.99%	33.3%
Textiles, Apparel, Leather	1.47%	3.37%	-0.82%	3.91%
Wood & Cork	0.20%	0.60%	0.07%	0.05%
Paper	0.72%	0.03%	1.14%	-0.06%
Recorded Media Reproduction	0.07%	0.01%	0.14%	0.002%
Coke, Refined Petroleum	2.08%	1.10%	2.32%	0.19%
Chemicals	1.83%	5.46%	4.13%	4.42%
Pharmaceuticals	1.20%	0.74%	1.24%	1.42%
Rubber & Plastics	2.81%	2.34%	1.61%	0.30%
Other non-Metallic Minerals	1.59%	0.91%	0.54%	0.39%
Basic Metals	6.88%	5.38%	1.61%	-0.42%
Fabricated Metal	5.50%	3.21%	3.66%	22.5%
Electronics & Optical Products	10.5%	19.6%	3.85%	-14.5%
Electrical Equipment	6.04%	5.44%	2.80%	-3.07%
Machinery & Equipment	9.73%	1.39%	10.5%	-1.33%
Motor Vehicles	15.6%	11.9%	29.2%	-6.27%
Other Transport Equipment	-3.02%	0.03%	11.9%	0.01%
Furniture & Other Manufacturing	1.28%	1.88%	1.42%	6.00%
Aggregated Services	30.09%	4.16%	18.78%	-0.112%

Source: World Input Output Database, Release 2016; NTMs by Aichele et al. (2014); TRAINS; Author's own calculations.

3.5.2 TPP vs a bilateral FTA

In this section, I present the results of the counterfactual simulation of the TPP and compare it with the trade and welfare effects of a deep FTA. Table 3.5.5 displays the results of TPP's trade effects in relative changes. The findings clearly indicate a strong increase in exports for all TPP countries. Japan exports goods to the United States with the value of 164 billion U.S.$ in total. Compared to the status quo this is an increase of 34.8%, which is however smaller as through the deep FTA (44.7%). The United States exports, 97 billion U.S.$ to Japan - an export increase of 52.8%. This is slightly less when contrasted with the impact of the deep FTA (56.4%).[37] Canada, Mexico and the United States already have

Table 3.5.5: Trade Effects of TPP

Importer / Exporter	Japan	U.S.	Australia	Canada	Chile	Mexico
Japan		52.8%	62.3%	70.1%	57.4%	55%
U.S.	34.8%		40.6%	35.3%	44.7%	49.2%
Australia	41.7%	39.8%		52.6%	53.3%	40%
Canada	27.5%	39.3%	61.6%		48.4%	44.1%
Chile	41.1%	40%	50%	46.4%		47.4%
Mexico	50.6%	51.1%	154%	85%	65.2%	

Source: World Input Output Database, Release 2016; NTMs by Aichele et al. (2014); TRAINS; Author's own calculations.

strong trade relationships with a large amount of exports. This is the case because they are geographically close to each other and well-connected through NAFTA. Additionally, those three countries could intensify their trade through TPP. Explicitly, the high export growth rate between Canada and Mexico (85%) stands out. The reason for this is that the export from Canada to Mexico has been the lowest between the NAFTA members and therefore TPP's trade cost reduction leads to a relatively strong export enhancing effect. In addition, Australia's exports to Canada (61.6%) and to Japan (62.3%)[38] are strongly growing, and the exports to Mexico (154%) increase even more. The low exports between Australia and Mexico before TPP are the reasons for this strong export growth. Within all TPP countries the exports from Australia to Mexico are the smallest (0.4 billion U.S.$) and grow through the regional trade agreement by 0.7 billion U.S.$, which leads to the high export growth in relative changes.

The changes of the export shares by the FTA and TPP are displayed in table 3.5.6. Column 1 and 4 reflect the status quo, which are the export shares without any counterfactual trade policy adjustments. Column 1 shows that the Japanese manufacturing sector has the largest export share, followed by the service sector - the other two sectors play a minor role.[39] The two trade agreements have only

[37] In appendix 3.A I give an overview of absolute changes through TPP.

[38] TPP boosts Australia's exports to Japan from 47 billion U.S.$ to 77 billion U.S.$.

[39] The three largest export industries reflect a similar structure: The Motor Vehicle industry

Table 3.5.6: Export Shares by Sectors and Trade Agreements

	Japan			U.S.		
	(1) Status Quo	(2) FTA	(3) TPP	(4) Status Quo	(5) FTA	(6) TPP
Agriculture	0.11%	0.12%	0.12%	2.82%	2.92%	2.93%
Mining	0.34%	0.34%	0.40%	2.33%	2.41%	4.00%
Manufacturing	81.54%	83.00%	82.94%	54.48%	54.69%	56.12%
Service	18.01%	16.54%	16.99%	40.37%	39.88%	36.95%
Normalized Herfindahl	0.076	0.081	0.078	0.025	0.025	0.024

The export shares from Japan and the United States take the exports to all countries into account. They do not just focus on the bilateral exports between Japan and the United States.

Source: World Input Output Database, Release 2016; NTMs by Aichele et al. (2014); TRAINS; Author's own calculations.

marginal effects on the change of the export shares. In both counterfactual scenarios the largest changes occur between the manufacturing and the service sector. Compared to TPP the bilateral FTA strengthens the export of the manufacturing sectors slightly more and has a moderately lower service export share. The export shares of the United States are more diversified. Focusing first on the baseline, the U.S. agriculture, mining and service sector have higher shares than those of Japan, whereas the manufacturing sector is considerably smaller. Through the FTA and even more through TPP the mining and the manufacturing sectors get larger export shares, whereas the service sector loses. In addition, the normalized Herfindahl index (HHI) also reveals that Japan's export sectors are three times more specialized than those of the United States, when comparing the HHI between Japan (0.076) and U.S. (0.025) in the baseline case. The implementation of the FTA and TPP has small specification effects for Japan, as the HHI indicates. For the U.S. the HHI shows a small diversion of the export shares in the case of TPP and no changes through an FTA.

Table 3.5.7 presents the key findings for the welfare gains of the TPP countries.

(18.9%) as the largest and the Electronics & Optical Products (14%) as the second largest export industry are both part of the manufacturing sector. Whereas the Wholesale Trade (9.42%) industry counts for the service sector.

Table 3.5.7: Welfare Effects of TPP

Country	Total	ToT	VoT
Japan	0.05%	*-0.01%*	*0.06%*
U.S.	0.05%	*-0.04%*	*0.09%*
Australia	0.122%	*0.12%*	*0.002%*
Canada	0.20%	*0.17%*	*0.03%*
Chile	0.35%	*0.34%*	*0.01%*
Mexico	0.56%	*0.46%*	*0.10%*

Source: World Input Output Database, Release 2016; NTMs by Aichele et al. (2014); TRAINS; Author's own calculations.

Both Japan and the U.S. have welfare gains of 0.05%. In comparison to the potential bilateral FTA Japan experiences lower welfare gains, whereas the United States improves its welfare gains through TPP. In both countries the welfare gains are impacted by the negative effects of the terms of trade, as column 2 reflects. Interestingly, the cause of the negative impact in terms of trade differs for Japan and the United States. For Japan, the negative welfare effect in terms of trade can be explained by the larger reduction of average export prices (-0.25%) relative to the average import prices (-0.23%). On the other side, the negative terms of trade of the U.S. are driven by large sectoral trade deficits. It turns out that the United States experiences large amounts of sectoral trade deficits especially with TPP countries. Hence, the TPP members contribute with -0.03% negatively to the of terms of trade (-0.04% in total).[40] Japan and the United States mainly benefit from TPP through the welfare gains in the volume of trade, with 0.06% and 0.09% respectively. Worth mentioning is that for both countries the welfare effects in volumes of trade come predominantly from TPP countries. But at the same time both are negatively impacted by the trade with the ROW in volume of trade.[41] The argument is again that through the implementation of TPP trade diversion occurs. TPP's trade cost reduction makes trade within the TPP group

[40] I show the origin of the bilateral welfare effects by TPP in the appendix 3.A.

[41] Through the trade with TPP members Japanese welfare grows by 0.063% in volume of trade. Whereas the trade with the ROW contributes negatively to the welfare change in volume of trade (-0.008%). The U.S. benefits from the TPP countries in volume of trade by 0.11% and experiences welfare loses via the ROW by -0.024%.

relatively cheaper than with Non-TPP countries. This in turn leads to import growth amongst TPP member states, whilst imports from other countries decline. Hence, TPP impacts the welfare change in volume of trade positively for TPP members and negatively for ROW. As I have mentioned above all other TPP countries have higher welfare gains than Japan and the United States: Australia has a 0.122%, Canada a 0.20%, Chile a 0.35% and Mexico a 0.56% increase in welfare. For all of those countries welfare grows mainly through the contribution of the terms of trade.[42] Especially Chile and Mexico have large amounts of sectoral trade surplus which add positively to their welfare gains in terms of trade.[43]

For a sample of countries, Table 3.5.8 compares the total welfare effects of a deep FTA to the welfare changes driven by TPP. Not surprisingly the TPP members (other than Japan and the U.S.) are all better off when TPP is in place, due to the direct reduction of trade costs. For countries who are already negatively impacted by the deep FTA as for example China, Indonesia or South Korea the trade liberalization of TPP will increase the negative effects on welfare. For most countries the impact on welfare loss is caused by terms of trade. Only marginal effects are caused by volume of trade, as small amounts of imports are directly created for other countries. However, other countries benefit from the FTA and even more from TPP as for example Brazil, where the welfare gains increase mainly due to higher terms of trade. Russia benefits slightly from the deep FTA (0.0002%), which is caused by a higher volume of trade (0.0004%) compared to the negative terms of trade (-0.0002%). However, the discussed welfare changes are small, and the results can therefore change easily through a change in trade policy. This is also the case if TPP is implemented: The total welfare is negative with -0.004%, caused by a larger negative impact of the terms of trade (-0.005%) compared to a small welfare change in volume of trade (0.001%).

[42] The weak contribution to welfare by volume of trade is again caused by trade diversion. The welfare growth by TPP countries is diluted by the welfare loses of the ROW. This is in particular true for Australia and Canada.

[43] Note that Mexico is a supplier of intermediate goods mainly to TPP members. Hence, the largest amount of Mexico's sectoral trade surpluses comes from within the TPP group. Whereas Chile's trade surplus is generated primarily by ROW countries.

Table 3.5.8: Welfare Effects of a Deep FTA and TPP by Countries

	Deep FTA	TPP
Australia	0.004%	0.122%
Brazil	0.001%	0.009%
Canada	0.024%	0.201%
Chile	0.029%	0.353%
China	-0.005%	-0.030%
EU*	-0.002%	-0.016%
France	-0.001%	-0.002%
Germany	-0.016%	-0.087%
Indonesia	-0.016%	-0.075%
India	-0.0007%	-0.002%
Italy	-0.004%	-0.025%
Japan	0.085%	0.042%
South Korea	-0.028%	-0.139%
Mexico	0.094%	0.561%
Norway	-0.003%	-0.018%
Russia	0.0002%	-0.004%
Spain	-0.001%	-0.015%
Turkey	-0.002%	-0.010%
Taiwan	-0.025%	-0.131%
UK	-0.0004%	-0.0008%
U.S.	-0.006%	0.049%
ROW	0.004%	0.030%

∗ Note, that welfare effects of the EU are averages and do not include the UK.

Source: World Input Output Database, Release 2016; NTMs by Aichele et al. (2014); TRAINS; Author's own calculations.

3.6 Conclusion

Although Japan and the United States are responsible for roughly 30% of the global GDP, they are not connected via a trade agreement. A potential trade agreement has the potential to raise the welfare gains of both countries. In this context, two potential trade agreements between Japan and the United States are currently discussed: A bilateral free trade agreement and TPP. This paper provides insights for political discussion. One argument of the U.S. administration for rejoining the negations of TPP is that through TPP the American agriculture sector will benefit from more exporting. This paper confirms that the agriculture export share of the United States will increase (compared to the baseline (2.82%))

through the FTA (2.92%) and slightly more through TPP (2.93%). A major finding is that the United States is indeed better off when joining TPP. The total welfare gains are with 0.05% the highest in the case of TPP compared with any of the three other FTA scenarios. However, Japan is expected to prefer a deep bilateral FTA as it leads to the largest welfare gains of 0.085%. From the perspective of the EU it would be preferred if a bilateral FTA is established, as the welfare losses would be smaller (-0.002%) than in the case of TPP (-0.016%).

To conduct the counterfactual analysis I rely in this paper on the theoretical foundation of Caliendo and Parro (2015), which is part of the NQTT. I then apply the Caliendo and Parro (2015) model empirically using the approach of Aichele et al. (2014). Hereby, the most recent WIOD (Release 2016) is used for the year 2014 including 50 sectors and 43 countries plus the rest of the world. The degree of trade barrier reduction for the trade agreement is not yet known, as a workaround, I apply the top-down method by Aichele et al. (2014) to simulate the trade barrier reduction. The top-down method uses past trade agreements as a benchmark to quantify the possible welfare impact of TPP and the FTA. However, the results will be much more precise once the outcomes of the negotiation of either an FTA or TPP are made public. Thus, the reduction of tariffs and NTMs do not have to be estimated anymore.

3.A Appendix

Composite Intermediate Goods in Non-Tradable Sector

In the case of the non-tradable sector, it is always cheaper to produce the intermediate good domestically. The production function of the composite good is the same as in the case of the tradable sector:

$$q_n^j = \left[\int q_n^j(x^j)^{(1-1)/\eta^j} \Phi^j(x^j) dx^j \right]^{\eta^j/(\eta^j-1)} \tag{3.12}$$

However, the density function is different:

$$\Phi^j(x^j) = (\lambda_n^j) \exp\left\{-\lambda_n^j x_n^j\right\} \tag{3.13}$$

Solving the minimization problem leads to the following result: $p_n^j(x^j) = p_n^j(x_n^j)$. This result is similar to the definition of the non-tradable sector. The lowest intermediate good price of sector j is the price of the intermediate good of country n.

General Equilibrium

In the context of sectoral input-output linkages, the equilibrium wages and prices are such that they maximize the consumer's utility and the profit of the firms for each sector in each country. In addition, good- and labor market clearing conditions must hold. Caliendo and Parro (2012, p.15) specify the general equilibrium in the following way:

Definition 1: Given L_n, S_n, λ_i^j and d_{ni}^j, an equilibrium under trade policy of τ is a wage vector $w \in R_{++}^N$ and P_n^j that solves equilibrium conditions for all J and N:

Input bundle cost of country n in sector j:

$$c_n^j = w_n^{\beta_n^j} \left(\prod_{k=1}^{J} (P_n^k)^{\gamma_n^{k,j}} \right)^{1-\beta_n^j} \tag{3.14}$$

Composite intermediate good price in country n of sector j:

$$P_n^j = A^j B^j \left[\sum_i [k_{ni}^j c_i^j]^{(-1/\theta^j)} \lambda_i^j \right]^{-\theta^j} \tag{3.15}$$

Bilateral trade share of country i with respect to country n in sector j:

$$\pi_{ni}^j = (A^j B^j)^{-1/\theta^j} \left(\frac{c_i^j k_{ni}^j}{P_n^j} \right)^{-1/\theta^j} \lambda_i^j \tag{3.16}$$

Spending on trade in sector j of country n:

$$X_n^j = \sum_{k=1}^{J} \gamma_n^{j,k} (1 - \beta_n^j) \left(\sum_{i=1} \frac{\pi_{in}^k}{(1 + \tau_{in}^k)} X_i^k \right) + \alpha_n^j I_n \tag{3.17}$$

Trade balance:

$$\sum_{j=1}^{J} F_n^j X_n^j + S_n = \sum_{j=1}^{J} \sum_{i=1}^{N} \frac{\pi_{in}^j}{(1 + \tau_{in}^j)} X_i^j \tag{3.18}$$

Equilibrium in Relative Changes

To solve the equilibrium model, the steps below have to be followed, which are based on Caliendo and Parro (2015).

Step 1: Calculate π_{in}^j, $\gamma_n^{j,k}$, β_n^j, α_n^j, for all j and n

Bilateral trade share: $\pi_{in}^j = (Z_{in}^j)/(Y_n^j - S_i^j)$

Share that sector k spends on goods of sector j: $\gamma_n^{j,k} = h_n^{j,k} / \sum_j h_n^{j,k}$

Share of the value added: $\beta_n^j = VA_n^j / Y_n^j$

Share of the final demand good in sector j: $\alpha_n^j = \frac{Y_n^j - S_n^j - \sum_k^J \gamma_n^{j,k}(1-\beta_n^j)\gamma_n^k}{I_n}$

Step 2: Estimate productivity θ^j and the parameters $\delta_{shallow}$ and δ_{deep}.

Step 3: Construct $\hat{k}_n^j$:

For the model of Caliendo and Parro (2012) use $\hat{k}_{in}^j = \frac{1+\tau_{in}^{j'}}{1+\tau_{in}^j}$, with tariff structures

τ and $\hat{\tau}'$.

For the model of Aichele et al. (2014) use τ and $\hat{\tau}'$ and $\delta_{shallow}$ and δ_{deep} to get $\hat{k}^j_{in} = \hat{\tau}^j_{in} e^{\delta^j_{shallow}(PTA'_{(shallow,in)} - PTA_{(shallow,in)}) + \delta^j_{deep}(PTA'_{(deep,in)} - PTA_{(deep,in)})}$.

Step 4: Guess a vector of wage changes $\hat{w} = (\hat{w}_1, \therefore, \hat{w}_n)$.

Step 5: Use $\hat{w}$, $\hat{k}^j_n$, π^j_{in}, $\gamma^{j,k}_n$, β^j_n, δ^j to solve for equilibrium input costs $\hat{c}^j_n(\hat{w})$ and prices $\hat{P}^j_n(\hat{w})$ for each sector and each country, which are coherent with the vector of wages $\hat{w}$.

Step 6: Use $\hat{c}^j_n(\hat{w})$ and prices $\hat{P}^j_n(\hat{w})$, together with $\hat{k}^j_{in}$ and θ^j to calculate the bilateral trade shares $\pi^{j'}_{ni}(\hat{w})$ under the trade policy of τ', this is done by using $\hat{\pi}^j_{ni}$.

Step 7: Given $\pi^{j'}_{ni}(\hat{w})$ from step 6, and the tariff vector τ' the value of weighted tariffs $F^{j'}_n = \sum_{i=1}^N \frac{\pi^{j'}_{ni}(\hat{w})}{(1+\tau^{j'}_{ni})}$ can be calculated. Further, $X^{j'}_n(\hat{w})$ consists with the vector of wages $(\hat{w})$ in the following way:

$$X^j_n = \sum_{k=1}^{J} \gamma^{j,k}_n (1-\beta^j_n) \left(\sum_{i=1} \frac{\pi^k_{in}(\hat{w})}{(1+\tau^k_{in})} X^k_i \right) + \alpha^j_n \left[w_n L_n + \sum_{n=1}^{J} X^j_n \left[1 - F^j_n\right] - S_n \right] \tag{3.19}$$

From equation 3.19, the counterfactual equation can be derived:

$$X^{j'}_n = \sum_{k=1}^{J} \gamma^{j,k}_n (1-\beta^j_n) \left(\sum_{i=1} \frac{\pi^{k'}_{in}(\hat{w})}{(1+\tau^{k'}_{in})} X^{k'}_i \right) + \alpha^j_n \left[\hat{w}_n w_n L_n + \sum_{n=1}^{J} X^{j'}_n \left[1 - F^{j'}_n\right] - S_n \right] \tag{3.20}$$

The equation can also be expressed in a matrix form, because it consists as a system of $J \times N$ in $J \times N$.

$$\boldsymbol{\Omega(\hat{w})X = \Delta(\hat{w})} \tag{3.21}$$

Here, $\Delta(\hat{w})$ is a vector which involves the shares for each sector and country of the sum of nominal income minus the surplus for each country. Vector X includes the expenditure levels for each sector and country. Those vectors are defined in the following way:

$$\Delta(\hat{w}) = \begin{bmatrix} \alpha_1^1\left(\hat{w}_n w_n L_n - S_n^{'}\right) \\ \vdots \\ \alpha_1^J\left(\hat{w}_n w_n L_n - S_n^{'}\right) \\ \vdots \\ \alpha_N^1\left(\hat{w}_n w_n L_n - S_n^{'}\right) \\ \vdots \\ \alpha_N^J\left(\hat{w}_n w_n L_n - S_n^{'}\right) \end{bmatrix}_{JN\times 1} \quad ; \quad X = \begin{bmatrix} X_1^{1'} \\ \vdots \\ X_1^{J'} \\ \vdots \\ X_n^{1'} \\ \vdots \\ X_N^{J'} \end{bmatrix}_{JN\times 1} \tag{3.22}$$

$\Omega(\hat{w})$ is a matrix which consists out of three parts, $\Omega(\hat{w}) = I - F(\hat{w}) - \hat{H}(\hat{w})$. Hereby, I is the identity matrix and $F(\hat{w})$ is characterized as:

$$F(\hat{w}) = \begin{bmatrix} A_1 \bigotimes \tilde{F}_1'(\hat{w}) & \dots & 0_{J\times J} & \dots & 0_{J\times J} & \dots & 0_{J\times J} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ 0_{J\times J} & \dots & A_2 \bigotimes \tilde{F}_2'(\hat{w}) & \dots & 0_{J\times J} & \dots & 0_{J\times J} \\ \vdots & \vdots & \vdots & \ddots & \vdots & \vdots & \vdots \\ 0_{J\times J} & \dots & 0_{J\times J} & \dots & A_{N-1} \bigotimes \tilde{F}_{N-1}'(\hat{w}) & \dots & 0_{J\times J} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ 0_{J\times J} & \dots & 0_{J\times J} & \dots & 0_{J\times J} & \dots & A_N \bigotimes \tilde{F}_N'(\hat{w}) \end{bmatrix}_{JN\times JN} \tag{3.23}$$

Note that $F(\hat{w})$ involves the vectors:

$$A_n = \begin{bmatrix} \alpha_n^1 \\ \vdots \\ \alpha_n^J \end{bmatrix}_{JN\times 1} , \tilde{F}_n'(\hat{w}) = \Big((1 - F_n^{1'}(\hat{w}))\dots(1 - F_n^{1'}(\hat{w}))\Big)_{1\times J} \tag{3.24}$$

with $F_n^{j'}(\hat{w}) = \sum_{i=1}^{N} \frac{\pi_{ni}^{j'}(\hat{w})}{(1+\tau_{ni}^{j'})}$.

$\tilde{H}(\hat{w})$ is defined in the following way, which includes $\tilde{\pi}_{in}^{k'}(\hat{w}) = \frac{\pi_{in}^{k'}(\hat{w})}{1+\tau_{in}^{k'}}$:

$$H(\hat{w}) = \begin{bmatrix} \gamma_1^{1,1}(1-\beta_1^1)\tilde{\pi}_{1,1}^{1'}(\hat{w}) & \dots & \gamma_1^{1,J}(1-\beta_1^J)\tilde{\pi}_{1,1}^{J'}(\hat{w}) & \dots & \gamma_1^{1,1}(1-\beta_1^1)\tilde{\pi}_{N,1}^{1'}(\hat{w}) & \dots & \gamma_1^{1,J}(1-\beta_1^J)\tilde{\pi}_{N,1}^{J'}(\hat{w}) \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ \gamma_1^{J,1}(1-\beta_1^1)\tilde{\pi}_{1,1}^{1'}(\hat{w}) & \dots & \gamma_1^{J,J}(1-\beta_1^J)\tilde{\pi}_{1,1}^{J'}(\hat{w}) & \dots & \gamma_1^{J,1}(1-\beta_1^1)\tilde{\pi}_{N,1}^{1'}(\hat{w}) & \dots & \gamma_1^{J,J}(1-\beta_1^J)\tilde{\pi}_{N,1}^{J'}(\hat{w}) \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ \gamma_N^{1,1}(1-\beta_N^1)\tilde{\pi}_{1,N}^{1'}(\hat{w}) & \dots & \gamma_N^{1,J}(1-\beta_N^J)\tilde{\pi}_{1,N}^{J'}(\hat{w}) & \dots & \gamma_N^{1,1}(1-\beta_N^1)\tilde{\pi}_{N,N}^{1'}(\hat{w}) & \dots & \gamma_N^{1,J}(1-\beta_N^J)\tilde{\pi}_{N,N}^{J'}(\hat{w}) \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ \gamma_N^{J,1}(1-\beta_N^1)\tilde{\pi}_{1,N}^{1'}(\hat{w}) & \dots & \gamma_N^{J,J}(1-\beta_N^J)\tilde{\pi}_{1,N}^{J'}(\hat{w}) & \dots & \gamma_N^{J,1}(1-\beta_N^1)\tilde{\pi}_{N,N}^{1'}(\hat{w}) & \dots & \gamma_N^{J,J}(1-\beta_N^J)\tilde{\pi}_{N,N}^{J'}(\hat{w}) \end{bmatrix}_{JN\times JN} \tag{3.25}$$

$\Omega_n(\hat{w})$ is important, because it describes how a change of tariffs in a particular sector is affecting all other sectors. Let there be no tariffs and no other composite goods from other sectors, $\gamma_n^{j,j} = 1$, then there is no linkage between sectors, and the matrix $\Omega_n(\hat{w})$ is a diagonal. Solving the system of equation for $X(\hat{w})$ (total expenditure of country n) leads to the following solution if $\Omega_n(\hat{w})$ is invertible:

$$\boldsymbol{X(\hat{w}) = \Omega^{-1}(\hat{w})\Delta(\hat{w})} \tag{3.26}$$

Let $X_n^{j'}(\hat{w})$ be the total expenditure of the material in sector j of country n. Combining the trade balance condition with the good market clearing condition, the trade balance condition can be re-conducted, now including the wage vector of unknowns, $\hat{w}$.

Step 8: Insert $\pi_{in}^{j'}(\hat{w})$, $X(\hat{w})$, τ' and S_n' to obtain:

$$\sum_{j=1}^{J} F_n^{j\prime} X_n^{j\prime} + S_n = \sum_{j=1}^{J}\sum_{i=1}^{N} \frac{\pi_{in}^{j'}(\hat{w})}{(1+\tau_{in}^{j'})} X_i^{j\prime} \tag{3.27}$$

Which leads to:

$$\boldsymbol{\sum_{j=1}^{J}\sum_{i=1}^{N} \frac{\pi_{ni}^{j'}(\hat{w})}{(1+\tau_{ni}^{j'})} X_n^{j'}(\hat{w}) + S_n = \sum_{j=1}^{J}\sum_{i=1}^{N} \frac{\pi_{in}^{j'}(\hat{w})}{(1+\tau_{in}^{j'})} X_i^{j'}(\hat{w})} \tag{3.28}$$

The last step is to identify the correct vector of wage changes $\hat{w} = (\hat{w}_1, \ldots, \hat{w}_n)$. The correct vector is found if the equilibrium equation 3.28 is in balance. If the equation does not hold, the vector of wage changes has to be guessed again, and the algorithm is repeated. The process continues until the correct vector in wage changes $\hat{w}$ is found.

Table 3.A.9: Sectoral Overview on Delta

Merged sectors & ISIC Rev.4 sector description	Delta Shallow	Delta Deep	Merged sectors & ISIC Rev.4 sector description	Delta Shallow	Delta Deep
Crops & Animals A01	-0.0004	-0.0520	Construction F	-0.0284	-0.0507
Forestry & Logging A02	0.0071	-0.0254	Trade & Repair of Motor Vehicles G45	-0.0216	-0.0973
Fishing & Aquaculture A03	0.0577	-0.0241	Wholesale Trade G46	-0.0216	-0.0973
Mining & Quarrying B	-0.0011	-0.0254	Retail Trade G47	-0.0216	-0.0973
Food, Beverages & Tobacco C10-C12	-0.0753	-0.1157	Land Transport H49	-0.0305	-0.0670
Textiles, Apparel, Leather C13-C15	-0.0242	-0.1959	Water Transport H50	-0.0040	-0.0693
Wood & Cork C16	-0.0263	-0.1716	Air Transport H51	-0.0294	-0.0206
Paper C17	-0.0311	-0.1120	Aux. Transportation Services H52	-0.0216	-0.0973
Recorded Media Reproduction C18	-0.0311	-0.1120	Postal and Courier H53	-0.0371	-0.0493
Coke, Refined Petroleum C19	-0.1477	-0.1230	Accomodation and Food I	-0.0448	-0.0938
Chemicals C20	-0.0424	-0.0668	Publishing J58	-0.0371	-0.0493
Pharmaceuticals C21	-0.0424	-0.0668	Media Services J59_J60	-0.0371	-0.0493
Rubber & Plastics C22	-0.0424	-0.0668	Telecommunications J61	-0.0371	-0.0493
Other non-Metallic Mineral C23	-0.0289	-0.0560	Computer & Information Services J62_J63	-0.0371	-0,0493
Basic Metals C24	-0.0289	-0.0560	Financial Services K64	-0.0269	-0.0822
Fabricated Metal C25	-0.1655	-0.2037	Insurance K65_K66	-0.0255	-0.0567
Electronics & Optical Products C26	-0.1140	-0.1417	Real Estate L68	-0.0448	-0.0938
Electrical Equipment C27	-0.2138	-0.1108	Legal and Accounting M69_M70	-0.0448	-0.0938
Machinery & Equipment C28,C33	-0.0616	-0.0550	Business Services M71,M73-M75	-0.0448	-0.0938
Motor Vehicles C29	-0.0807	-0.2441	Research and Development M72	-0.0448	-0.0938
Other Transport Equipment C30	-0.0587	-0.1767	Admin. & Support Services N	-0.0238	-0.0399
Furniture & Other Manufacturing C31_C32	-0.0743	-0.1103	Public & Social Services O84	-0.0299	-0.0616
Electricity & Gas D35	-0.0237	-0.0653	Education P85	-0.0299	-0.0616
Water Supply E36	-0.0384	-0.0634	Human Health and Social Work Q	-0.0299	-0.0616
Sewerage & Waste E37-E39	-0.0384	-0.0634	Other Services, Households R-U	-0.0299	-0.0616

Source: Aichele et al. (2014)

Table 3.A.10: Sectoral Contribution to Welfare Change - Tariff Reduction

	JP ToT	JP VoT	U.S. ToT	U.S. VoT		JP ToT	JP VoT	U.S. ToT	U.S. VoT
Crops & Animals A01	-0.13%	19.70%	1.08%	8.38%	Construction F	-0.03%	0%	0.07%	0%
Forestry & Logging A02	0.00%	1.30%	0.39%	0.66%	Trade & Repair of Motor Vehicles G45	-0.01%	0%	0.29%	0%
Fishing & Aquaculture A03	0.02%	-0.03%	0.22%	0.54%	Wholesale Trade G46	-0.19%	0%	14.50%	0%
Mining & Quarrying B	-4.22%	2.40%	5.24%	1.82%	Retail Trade G47	-0.06%	0%	0.45%	0%
Food, Beverages & Tobacco C10-C12	0.19%	13.40%	-0.03%	37.80%	Land Transport H49	-0.06%	3.43%	2.30%	0.07%
Textiles, Apparel, Leather C13-C15	-0.70%	2.03%	4.76%	5.54%	Water Transport H50	2.66%	-0.09%	0.51%	0.00%
Wood & Cork C16	-0.14%	0.31%	0.17%	0.06%	Air Transport H51	0.04%	0.04%	3.70%	0.15%
Paper C17	0.24%	0.01%	-0.03%	0.04%	Aux. Transportation Services H52	0.07%	0%	0.79%	0%
Recorded Media Reproduction C18	-0.01%	0.00%	0.04%	0.00%	Postal and Courier H53	0.00%	0%	0.52%	0%
Coke, Refined Petroleum C19	-0.38%	1.11%	6.47%	0.39%	Accomodation and Food I	0.61%	0%	0.07%	0%
Chemicals C20	19.90%	14.90%	3.72%	10.40%	Publishing J58	0.00%	0%	2.90%	0%
Pharmaceuticals C21	-0.03%	-0.09%	-0.66%	0.04%	Media Services J59_J60	0.02%	3.27%	1.45%	0.04%
Rubber & Plastics C22	6.38%	0.99%	-0.80%	0.84%	Telecommunications J61	0.01%	0%	0.76%	0%
Other non-Metallic Mineral C23	0.40%	0.95%	0.66%	0.15%	Computer & Information Services J62_J63	-0.04%	0%	1.84%	0%
Basic Metals C24	3.57%	4.95%	0.16%	1.03%	Financial Services K64	-0.02%	0%	4.19%	0%
Fabricated Metal C25	2.81%	2.94%	-2.71%	30.10%	Insurance K65_K66	-0.04%	0%	5.64%	0%
Electronics & Optical Products C26	31.50%	26.40%	20.50%	2.06%	Real Estate L68	0.00%	0%	0.22%	0%
Electrical Equipment C27	9.95%	-0.95%	2.53%	0.08%	Legal and Accounting M69_M70	-0.05%	0%	2.65%	0%
Machinery & Equipment C28,C33	7.14%	0.19%	-2.26%	0.03%	Business Services M71,M73-M75	0.02%	0%	4.05%	0%
Motor Vehicles C29	18.30%	1%	5.80%	-0.77%	Research and Development M72	0.00%	0%	1.16%	0%
Other Transport Equipment C30	1.45%	0%	-3.91%	0%	Admin. & Support Services N	0.02%	0%	6.23%	0%
Furniture & Other Manufacturing C31_C32	0.87%	1.79%	1.79%	0%	Public & Social Services O84	0.00%	0%	1.05%	0%
Electricity & Gas D35	-0.01%	0%	0.22%	0%	Education P85	-0.01%	0%	0.33%	0%
Water Supply E36	0.00%	0%	0.02%	0%	Human Health and Social Work Q	0.00%	0.01%	0.20%	0.03%
Sewerage & Waste E37-E39	-0.01%	0%	0.50%	0%	Other Services, Households R-U	-0.09%	0.00%	0.27%	0.05%

The first ToT and VoT corresponds to Japan, while the second ToT and VoT corresponds to the U.S.

Source: World Input Output Database, Release 2016; TRAINS; Author's own calculations.

Table 3.A.11: Sectoral Contribution to Welfare Change - Shallow FTA

	JP	**JP**	**U.S.**	**U.S.**		**JP**	**JP**	**U.S.**	**U.S.**
	ToT	**VoT**	**ToT**	**VoT**		**ToT**	**VoT**	**ToT**	**VoT**
Crops & Animals A01	0.588%	18.8%	2.76%	43.4%	Construction F	0.02%	0%	-0.0287%	0%
Forestry & Logging A02	0.046%	0.284%	0.038%	0.124%	Trade & Repair of Motor Vehicles G45	0.02%	0%	-0.0532%	0%
Fishing & Aquaculture A03	0.057%	0.065%	0.044%	0.272%	Wholesale Trade G46	19.6%	0%	5.55%	0%
Mining & Quarrying B	3.21%	1.93%	3.97%	-0.814%	Retail Trade G47	1.1%	0%	0.713%	0%
Food, Beverages & Tobacco C10-C12	1.72%	17.1%	3.55%	25.7%	Land Transport H49	2.85%	2.28%	2.13%	-0.0237%
Textiles, Apparel, Leather C13-C15	1.7%	2.9%	0.055%	2.65%	Water Transport H50	2.99%	0.31%	0.579%	0.0117%
Wood & Cork C16	0.236%	0.48%	0.17%	0.0432%	Air Transport H51	0.69%	0.16%	0.994%	-0.026%
Paper C17	0.905%	0.0666%	1.16%	-0.0246%	Aux. Transportation Services H52	0.94%	0%	0.431%	0%
Recorded Media Reproduction C18	0.0837%	0.0184%	0.149%	0.00248%	Postal and Courier H53	0.05%	0%	0.325%	0%
Coke, Refined Petroleum C19	2.32%	0.965%	2.65%	0.184%	Accomodation and Food I	0.84%	0%	-0.0309%	0%
Chemicals C20	-1.15%	5.76%	4.43%	2.78%	Publishing J58	0.03%	0%	1.1%	0%
Pharmaceuticals C21	1.28%	0.998%	1.44%	1.2%	Media Services J59_J60	0.05%	1.1%	0.678%	-0.0284%
Rubber & Plastics C22	2.41%	1.8%	1.85%	0.403%	Telecommunications J61	0.19%	0%	0.688%	0%
Other non-Metallic Mineral C23	1.7%	0.811%	0.721%	0.393%	Computer & Information Services J62_J63	0.45%	0%	0.47%	0%
Basic Metals C24	7.59%	4.96%	2.29%	-0.131%	Financial Services K64	0.72%	0%	1.26%	0%
Fabricated Metal C25	5.38%	3.44%	3.85%	17.1%	Insurance K65_K66	0.33%	0%	1.41%	0%
Electronics & Optical Products C26	5.56%	22.7%	4.89%	-9.31%	Real Estate L68	0.04%	0%	0.06%	0%
Electrical Equipment C27	4.14%	0.24%	3.81%	-5.99%	Legal and Accounting M69_M70	0.03%	0%	0.719%	0%
Machinery & Equipment C28,C33	8.92%	1.3%	10.6%	-0.873%	Business Services M71,M73-M75	1.87%	0%	1.27%	0%
Motor Vehicles C29	16.9%	5.94%	18.7%	17.9%	Research and Development M72	0.03%	0%	0.431%	0%
Other Transport Equipment C30	0.711%	0%	9.69%	0%	Admin. & Support Services N	0.58%	0%	1.02%	0%
Furniture & Other Manufacturing C31_C32	1.36%	1.94%	2.09%	5.07%	Public & Social Services O84	0.16%	0%	0.469%	0%
Electricity & Gas D35	0.0428%	0%	0%	0%	Education P85	0.08%	0%	0.0864%	0%
Water Supply E36	0.0467%	0%	0%	0%	Human Health and Social Work Q	0.01%	0.02%	0.008%	-0.0161%
Sewerage & Waste E37-E39	0.017%	0%	0.83%	0%	Other Services, Households R-U	0.44%	0.55%	0.0775%	-0.0172%

The first ToT and VoT corresponds to Japan, while the second ToT and VoT corresponds to the U.S.

Source: World Input Output Database, Release 2016; NTMs by Aichele et al. (2014); TRAINS; Author's own calculations.

Table 3.A.12: The Impact of TPP on Exports (in million U.S.$)

BASE	**AUS**	**CAN**	**CHE**	**JPN**	**MEX**	**U.S.**
AUS	$0	$2.703	$3.088	$15.081	$1.655	$27.015
CAN	$1.818	$0	$5.858	$11.700	***$19.944***	***$296.399***
CHE	$1.097	$1.253	$0	$2.537	$1.141	$13.598
JPN	$47.690	*$14.205*	$7.167	$0	$4.500	**$63.610**
MEX	*$483*	***$8.384***	$1.648	$15.420	$0	***$182.353***
U.S.	$10.168	***$351.981***	$33.228	**$122.070**	***$268.283***	$0

Simulation	**AUS**	**CAN**	**CHE**	**JPN**	**MEX**	**U.S.**
AUS	$0	$4.123	$4.735	$21.371	$2.318	$37.788
CAN	$2.941	$0	$8.694	$14.922	***$28.750***	***$413.207***
CHE	$1.645	$1.834	$0	$3.582	$1.682	$19.043
JPN	$77.409	*$24.133*	$11.272	$0	$6.978	**$97.192**
MEX	*$1.223*	***$15.495***	$2.721	$23.228	$0	***$275.452***
U.S.	$14.289	***$475.640***	$48.052	**$164.556**	***$400.463***	$0

Abs. Change	**AUS**	**CAN**	**CHE**	**JPN**	**MEX**	**U.S.**
AUS	$0	$1.420	$1.647	$6.290	$663	$10.774
CAN	$1.124	$0	$2.837	$3.222	***$8.805***	***$116.807***
CHE	$548	$580	$0	$1.045	$541	$5.445
JPN	$29.719	*$9.928*	$4.105	$0	$2.478	**$33.582**
MEX	*$740*	***$7.112***	$1.073	$7.807	$0	***$93.099***
U.S.	$4.121	***$123.658***	$14.824	**$42.486**	***$132.180***	$0

The first ToT and VoT corresponds to Japan, while the second ToT and VoT corresponds to the U.S.

Source: World Input Output Database, Release 2016; NTMs by Aichele et al. (2014); TRAINS; Author's own calculations.

Table 3.A.13: Bilateral Welfare Effects of TPP

	ToT		VoT	
Country	TPP	ROW	TPP	ROW
Japan	-0.011%	-0.001%	0.063%	-0.008%
U.S.	-0.029%	-0.009%	0.11%	-0.024%
Australia	0.029%	0.09%	0.020%	-0.018%
Canada	0.071%	0.1%	0.066%	-0.036%
Chile	0.032%	0.307%	0.008%	0.004%
Mexico	0.310%	0.15%	0.053%	0.046%

Source: World Input Output Database, Release 2016; NTMs by Aichele et al. (2014); TRAINS; Author's own calculations.

Chapter 4

Trade and Welfare Effects of a "Zero Tariff Solution": Elimination of EU and U.S. Import Tariffs in the Automotive Sector[1]

For the last two years, the U.S. government has been using an increasingly aggressive rhetoric in trade policy talks. On March 23rd, 2018, the U.S. government carried out the threat and introduced import tariffs on steel and aluminum products. Therefore, the exemptions for the NAFTA trading partners, Mexico and Canada, as well as for the EU ended on June 1st 2018. In order to avoid a possible counterstrike in this so-called "trade war", the U.S. government threatened the European Union to increase the import tariffs in the automotive sector from 2.5% to 25%.[2] Thus, it was surprising that U.S. Ambassador Richard Grenell suggested on July 4th, 2018 in front of the boards of directors of the leading German car companies the possibility to completely eliminate tariffs on all types of cars.[3] This would

[1]Based on Jung and Walter (2018).
[2]The effects of a trade war have been discussed in *Ifo Schnelldienst* 11/2018.
[3]Richard Grenell had previously been commissioned by the U.S. government, to search for

mean the elimination of a German tariff by 10% and a tariff reduction for the U.S. by 5%. However, the wind can change fast in recent trade policy talks: At a meeting on July 25$^{\text{th}}$, 2018, U.S. President Trump and the President of the European Commission Junker agreed to reduce the tariffs and non-tariff barriers of different products to zero, though the automotive industry was explicitly excluded from the reduction.

In this context, we will take a closer look on possible trade policy scenarios: What would be the concrete trade policy implication for Germany and the U.S. of the "Zero Tariff Solution" in the automotive sector? The realization of this bilateral tariff reduction would, nevertheless, require the agreement of the EU Commission as the European Union is responsible for European trade policy issues. Furthermore, a possible trade policy scenario would be the Pan-European solution, in which both the U.S. and the EU reduce their tariffs in the automotive sector to zero. Alternatively, the U.S. and the EU could reduce import tariffs, according to the WTO rule of the "most favored nation" (MFN), also for all other WTO member states. In this case, no consent of the other WTO member countries would be needed. It would further be possible, that under WTO rules the U.S. and the EU reduce their tariffs to zero in a bilateral agreement. However, this trade agreement must contain more than 90% of all product groups. Despite the successful trade talk between EU Commission President Jean-Claude Juncker and U.S. President Donald Trump, it is questionable, whether such an extended trade agreement would ultimately be signed. As the Transatlantic Free Trade Agreement (TTIP) as such an extended trade agreement was previously canceled.

Even though the U.S. trade policy is currently unpredictable, the trade and welfare effects of the "Zero Tariff Solution" are presented for the following three scenarios: In Scenario 1, we assume that Germany can set the tariffs independently, so that the bilateral zero solution in the automotive sector between Germany and the

alternative solutions in the trade dispute with Europe (cf. Afhüppe et al. (2018)).

U.S. can take place. In Scenario 2, the automobile tariffs are cut to zero between the U.S. and all EU member states. In the third scenario ("grand solution"), the EU and the United States eliminate the tariffs in the automotive sector for all WTO members. The methodical framework for the analysis relies heavily on the New Quantitative Trade Models (cf. Costinot and Rodriguez-Clare (2014)). Starting point for the simulations is the model of Caliendo and Parro (2015), which builds on the Ricardian model of Eaton and Kortum (2002). It takes the input-output links between tradable and non-tradable sectors into account and allows the quantification of the trade and welfare effects.[4]

The most recent World Input-Output Database (WIOD, Release 2016) for the year 2014 is the main data source for the analysis. The database comprises 56 sectors and includes 43 countries, which together account for more than 90% of the world's gross domestic product.[5] The tariff data are obtained from the UNCTAD Trade Analysis Information System (TRAINS). For the substitution elasticities in the primary and industrial sectors we rely on Aichele et al. (2014), for the service sectors the estimates of Egger et al. (2012) are used.

Table 4.1: Change of the Export Shares in the Automotive Sector (in %)

	Germany	U.S.	EU*
Status quo	17.10	5.35	6.45
Bilateral Zero Solution (Scenario 1)	17.70	5.35	6.46
Zero Solution between EU & U.S. (Scenario 2)	17.70	5.39	6.54
MFN-Principle of WTO (Scenario 3)	18.50	5.42	6.77
* Simple unweighted average (without Germany)			

Source: World Input Output Database, Release 2016; TRAINS; Authors' own calculations.

For Germany, the U.S. and the remaining EU countries Table 4.1 shows the export shares of the automotive sector for the status quo and the three scenarios.

[4] Caliendo and Parro (2015) use the model to quantify the effects of NAFTA ex-post; in our study the effects of the "Zero Tariff Solution" is ex-ante, similar to the one used in Walter (2018), which describes the trade and welfare effects of a possible trade agreement between the U.S. and Japan. The *Matlab-Code* of Caliendo and Parro (2015) is freely available and has been adjusted accordingly.

[5] In order to avoid calculation difficulties we compile those sectors with zero output in the style of Felbermayr et al. (2017b), which leads to 50 sectors in total.

Through a bilateral tariff reduction (Scenario 1) the export share of the automotive sector increases in Germany from 17.1% to 17.7%, whereas the EU export share increases only minimally by 0.01 percentage points. For the U.S. a bilateral elimination of tariffs will not change the export share of 5.35%, since the automotive sector is smaller and the tariff reduction is lower. A Pan-European solution (Scenario 2) would not increase the export share of Germany in the automotive sector. This is due to the fact, that Germany profits in both cases from the reduction of U.S. tariffs, whereas the tariff reductions between the U.S. and the other European countries have no additional impact on the change of the German export share. By contrast the export share grows for the European automotive sector from 6.45% to 6.54%. In Scenario 2, the export share of the U.S. also increases from 5.35% to 5.39%. The greatest impact on the automobile exports occurs in Scenario 3, where the tariffs are cut according to the MFN-principle of the WTO. In this scenario the EU and the U.S. reduce the import tariffs to zero for all WTO member states.[6] The export share of the automotive sector increases for Germany to 18.5%, for the EU to 6.77%, and for the U.S. to 5.42%.

Table 4.2: Bilateral Automobile Imports between Germany and the USA (in mil. U.S.$)

		Germany	U.S.
Status quo	Bilateral Imports	5 177	41 360
Bilateral Zero Solution	Bilateral Imports	5 667	53 727
(Scenario 1)	Absolute Change	+490	+12 367
	Relative Change	9.46%	29.90%
Zero Solution between EU & U.S.	Bilateral imports	5 681	53 239
(Scenario 2)	Absolute Change	+505	+11 879
	Relative Change	9.75%	28.72%
MFN-Principle of WTO	Bilateral Imports	5 971	53 049
(Scenario 3)	Absolute Change	+615	+11 689
	Relative Change	11.88%	28.26%

Source: World Input Output Database, Release 2016; TRAINS; Authors' own calculations.

[6] Although the WIOD data contain only 43 countries, the remaining countries are covered by the aggregate "Rest of the world".

Table 4.2 shows for the status quo and the three scenarios the absolute values of bilateral imports between Germany and the U.S. in the automotive industry. In the base year of 2014 the U.S. has imported German cars worth 41.3 billion U.S. dollars, Germany on the other side has imported U.S. vehicles worth $ 5.2 billion. For the U.S. this corresponds to a sectoral trade deficit of 36.1 billion U.S. dollars. Through the bilateral tariff reduction (Scenario 1) the sectoral deficit would grow to 48 billion U.S. dollars: Germany would export 12.3 billion U.S. dollars (due to the larger U.S. market), while the U.S. would additionally export cars to Germany worth 490 million U.S. dollars. In the other two scenarios the import growth of German cars to the U.S. would be lower (28.72% in Scenario 2 and 28.26% in Scenario 3). In these two cases the U.S. demand for automobiles would increasingly shift to other countries due to the wide-ranging U.S. import tariff reductions in the automotive sector. The imports of U.S. vehicles to Germany are growing with the tariff reduction in Scenario 2 and Scenario 3. The increase of 11.9% in the third scenario would even be the highest amongst all scenarios.

Table 4.3: Share of total Demand in the Automotive Sector served by Imports (in %)

	Germany	U.S.	EU*
Status quo	41.43	34.77	36.95
Bilateral Zero Solution (Scenario 1)	41.54	35.81	36.95
Zero Solution between EU & U.S. (Scenario 2)	41.54	36.79	36.99
MFN-Principle of WTO (Scenario 3)	41.60	36.81	37.01
* Simple unweighted average (without Germany)			

Source: World Input Output Database, Release 2016; TRAINS; Authors' own calculations.

Eventually imports are related to the total demand. Table 4.3 shows the share of the total demand, which is related to imports (the rest of the demand occurs from domestic production). For a given total demand, the measure rises when imports rise. In the initial situation, the German share of demand is greater than the share of the EU and the U.S.. Therefore, the automotive sector in the EU and the U.S. is less open than in Germany.

As expected, the elimination of tariffs leads to a larger import share. For Germany this change in Scenario 1 is about 0.1 percentage points, for the U.S. it is about 1 percentage point. The EU would not be affected by the trade policy in Scenario 1 which is why the share remains unchanged. Scenario 2 would have no further impact on the German share; whereas for the EU the share would increase by 0.04%. However, the share of the U.S. would rise by one percentage point compared to Scenario 1. In Scenario 3 the import shares of Germany and the EU would only slightly increase, also for the U.S. the result would have no significant change relatively to Scenario 2. The increase in the degree of openness, however, is only one channel through which the impact of the trade policy on the real per capita income of a country (measure of welfare) works. Other factors rely on changes which result from other sectors.

Table 4.4: Impact of Trade Scenarios on Welfare (in %)

		Germany	U.S.	EU*
Bilateral Zero Solution	Welfare Effects	0.0566	–0.0005	0.0009
(Scenario 1)	Terms of Trade	0.0538	–0.0055	0.0003
	Volume of Trade	0.0028	0.0050	0.0006
Zero Solution between	Welfare Effects	0.0577	– 0.0033	0.0049
EU & U.S.	Terms of Trade	0.0545	–0.0108	0.0039
(Scenario 2)	Volume of Trade	0.0032	0.0075	0.0010
MFN-Principle of WTO	Welfare Effects	0.1354	0.0016	0.0224
(Scenario 3)	Terms of Trade	0.1268	–0.0090	0.0185
	Volume of Trade	0.0080	0.0106	0.0039

∗ Simple unweighted average (without Germany)
Source: World Input Output Database, Release 2016; TRAINS; Authors' own calculations.

The welfare effects of the three trade policy scenarios are shown in Table 4.4. Hereby, the welfare change can be decomposed into two parts: The change of the international exchange ratio, the so-called terms of trade, and the change of the trading volume, the volumes of trade. The international exchange ratio is the purchasing power of a country and depends on the weighted trade surplus and the change in export- and import prices. The change in trading volume is in turn dependent on the original tariffs and imports, as well as on the new imports weighted by the change of import prices. Germany benefits in all three scenarios from the increase in trading volumes, however, predominant is the improvement of the terms of trade. On the one hand, this is due to the trade surplus. On the other hand, the increased export prices have a positive effect on the international exchange ratio, due to higher German real wages relative to the import prices. Especially in the third scenario, the reduction in import tariffs would raise the demand for German cars, which leads to an increase in real wages, and this has in turn a positive effect on the terms of trade. The EU would benefit slightly in the first scenario, which will lead to an increase in welfare of 0.0009%. A greater effect can be shown in Scenario 2, in which all EU countries reduce the import tariffs on U.S. cars, hereby, the welfare would increase by 0.0049%. The EU would have the greatest welfare effect in Scenario 3 with 0.0224%, similar to Germany, this effect can be traced back to the change in the terms of trade and the increase in demand for European cars. Somewhat surprisingly, the U.S. would lose in the first and second scenario, although the import tariff of the EU would be reduced from 10% to 0%. Compared to Scenario 1 (-0.0005%) the negative welfare effect would be a bit more pronounced in Scenario 2 (-0.0033%). The reason for these negative welfare effects is due to the negative international exchange relationship of the U.S., which in turn is based on the large trade deficit of the U.S.. But it is also related to the fact that in all three scenarios the export prices fall more sharply than the import prices. The negative impact of the terms of trade in the first two scenarios would be greater than the positive effect of the trading volume, so that the welfare effects would be negative. In the third scenario the increase in imports, caused by the WTO member states, would lead to a change in trading volume of 0.0106% and thus would be the main reason for the positive welfare effect.

Based on the simulations, the following conclusion can be made: Germany, the EU and the U.S. benefit the most in the third scenario ("grand solution") in which the EU and the U.S. reduce the tariffs on cars for all WTO member states according to the MFN-principle. A bilateral effort by Germany and the U.S. or between the EU and the U.S. would be economically less beneficial. It can be assumed that the deal between the EU and the U.S., when the tariffs of all sectors except of the automotive sector are eliminated, would not be desirable either.

Chapter 5

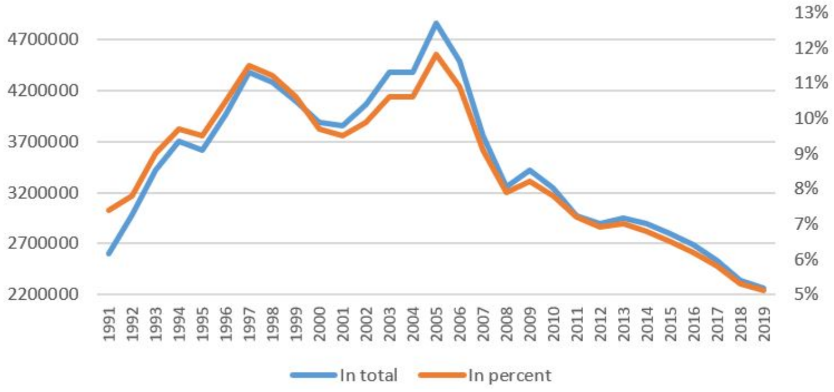
The Rise of Eastern Europe and the German Labor Market Reform: Dissecting their Effects on Employment[1]

5.1 Introduction

A pivotal year in the German labor market development was 2005: After the German reunification the unemployment rate grew from 7.3% 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 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 5.1 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.

[1] Appeared as Walter (2021).

Figure 5.1: Development of Unemployment in Germany



Source: Statistik der Bundesagentur für Arbeit (2020); Author's own calculations.

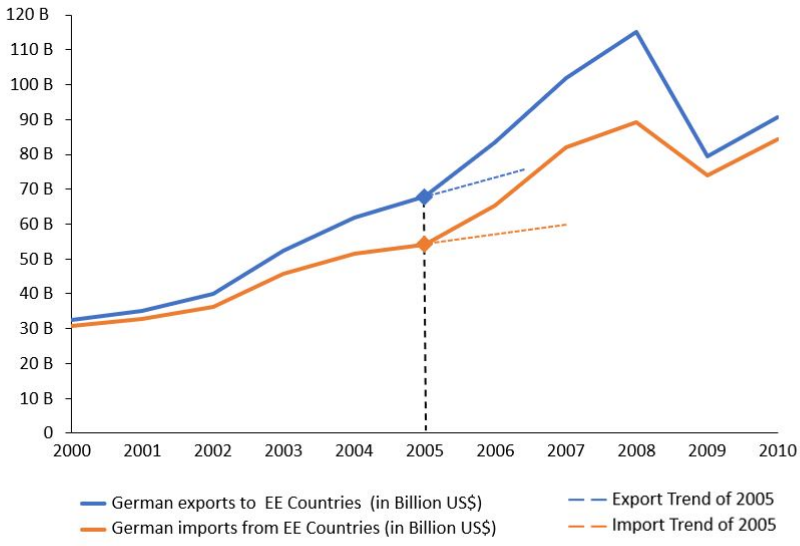
To shed more light on this matter, I show in Figure 5.2 that the German imports from Eastern Europe and the German exports to Eastern Europe grew stronger since 2005 (up to the financial crisis in 2008/09), compared to the previous years. This is indicated by the fact that the actual German imports from and exports to Eastern Europe are lager 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) refer to the rise in trade as the "rise of the East". They 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.[2] Dauth et al. (2016) suggest the rising productivity in Eastern Europe as a driving force behind the increasing trade flows.[3] Especially through the economic transformation the

[2]In addition to the "rise of the East", the rising trade with China could also have impacted the labor market in Germany. Dauth et al. (2014) investigate in their paper the employment effect of the so-called "China Shock" and the "rise of the East". Their findings indicate that the impact of the increasing trade flows of the "China Shock" was less significant than the effects of the "rise of the East". 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.

[3]Several other factors could also play major roles behind the rising trade flows between Ger-

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. This paper tries to explore the German and Eastern European productivity effects on the German labor market via the export and import channel.

Figure 5.2: 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.

Furthermore, the German labor market "Hartz-Reforms" impose themselves as a potential channel for the reversal of unemployment.[4] They had their focus on

many 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).

[4]Other factors could also have contributed to the rapid fall of unemployment, e.g. wage

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.[5] 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.[6]

My paper investigates and disentangles the impact of the German labor market

moderation, economic improvement or the increasing flexibility of the labor market institution, see Dustmann et al. (2014).

[5]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.

[6]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.

reform (Hartz IV) and the "rise of the East" (caused by the productivity shocks in Eastern Europe and Germany) 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). The advantage of the model is that it includes a dynamic set-up, which considers the adjustments of the labor market, as the economic and policy effects on employment differ for each sector and need time to adapt. Further, the trade 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. 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.

The analysis includes a counterfactual part. Thereby, I answer the question: How would German employment have evolved, if the "Hartz IV-Reform" and the "rise of the East" 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 each case: For the “Hartz IV-Reform”, the Eastern European and the German productivity shock. By taking the difference between the baseline and the counterfactual economy (for each case) I am able to identify the employment impact of the “Hartz IV-Reform” and the two productivity shocks.

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, and the Eastern European countries experienced a rapid productivity growth. 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. As the impact of the labor market reform (Hartz IV) and the “rise of the East” varies across regions I am interested in the economic and labor effects on the German county level (NUTS 3 Level). Therefore my analysis includes 402 counties. 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”). It includes seven sectors, which are the sectors of interest in my analysis.[7] Regarding the trade flow data, I make use of 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.

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 (“Bundeshaus

[7]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). 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”).

halt"). 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, 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. The "rise of the East" contributes to the fall in short-term unemployment by 0.03 percentage points. Hereby, the German productivity shock contributes positively to the decline of short-term unemployment, whereas the Eastern European productivity shock is responsible for a minor increase in short-term unemployment. On the county level I find that the rise in Eastern European productivity primarily impacts the east of Germany and counties geographically closer to Eastern Europe. Further, I find a "push effect" at the sectoral level due to the rise of Eastern European productivity: The employment of the import penetrated manufacturing sector declines and short-term unemployment increases, at the same time I discover an employment shift into service sectors. This "push effect" is in line with the findings of Dauth et al. (2016). Regarding the impact of the "Hartz IV-Reform" counties in the eastern part of Germany are benefiting the most as the short-term unemployment declines more than in the west, which corresponds to the results of Launov and Wälde (2013).

Concerning the effect of the "Hartz Reforms" several major studies have been conducted. Most notably by Hochmuth et al. (2019), Krause and Uhlig (2012) and Hartung et al. (2018) with varying results. Many of these studies cover the entire impact of the "Hartz" reforms (Hartz I – Hartz IV). Krebs and Scheffel (2014) find a decline of unemployment by the "Hartz" reforms of 3% and traces about 1% particularly to the effect of Hartz IV.

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, 2016, 2017). However, they do not explore the underlying fundamentals of the rising trade flows, e.g. a rise in productivity and fall of trade costs. My paper contributes to this literature in showing the impact of the rise in productivity of Germany and Eastern Europe on the German labor market. 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.

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 Artuc and McLaren (2010) and Dix-Carneiro (2014).

The structure of this paper is as follows: In section 5.2, I introduce a long-term unemployment state into an otherwise standard dynamic trade model à la Caliendo et al. (2019). Section 5.3 provides a description of the calibration of the data necessary to numerically solve the model. In section 5.4 I present my findings of the economic impact of the German labor market reform (Hartz IV) and the "rise of the East". In section 5.5 I conclude.

5.2 Model

I incorporate a long-term unemployment benefit into the version of the Caliendo et al. (2019) model with Social Security Disability Insurance (SSDI). Caliendo et al. (2019) is a dynamic version of a multi-sector, multi-country Ricardian trade model à la Eaton and Kortum (2002). It is a spatial general equilibrium trade model and allows for labor market dynamics via labor mobility.

The model features the following ingredients: Households are forward looking and decide, depending on their expected utility, in which region and "sector" to work and where to move in the next period, whilst taking transition costs into account. In each region, there is a short-term unemployment sector ("sector 0") and a long-term unemployment sector ("sector A"). With some probabilities households change the "sector" e.g. getting into another sector, becoming short-term unemployed or even long-term unemployed. 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 consists out of many exogenous factors (*fundamentals*), that are constant or time-varying. The model applies the equilibrium conditions in relative changes to avoid the need of solving for the *fundamentals*. Thus, the model embeds the *"hat algebra"* approach of Dekle et al. (2008) in a time-varying setting, labeled as the *"dynamic hat algebra"* method by Caliendo et al. (2019). I introduce the long-term unemployment benefit to the SSDI extended model.

5.2.1 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 of Caliendo et al. (2019). 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. 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 ϵ_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.

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

$$\begin{aligned} V_t^{nj} = U(C_t^{nj}) + \upsilon \log\left(\sum_{i=1}^{N} \exp(\beta V_{t+1}^{i0} - \tau^{nj,i0})^{1/v}\right) + \\ \upsilon(1-\alpha_{t+1}^{nj}) \log\left(\sum_{i=1}^{N}\sum_{k=1}^{J} \exp(\beta V_{t+1}^{ik} - \tau^{nj,ik})^{1/v}\right) + \alpha_{t+1}^{nj}\beta V_{t+1}^{nA} \end{aligned} \tag{5.1}$$

The second term on the right-hand side represents the expected value of being short-term unemployed in the next period. Where $\tau^{nj,i0}$ is the transition cost of moving from region n in sector j into short-term unemployment in region i, as subscript 0 denotes the short-term unemployment sector. The discount factor is given by β and the scale variance of the idiosyncratic shock is denoted by υ. The third 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 fourth 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". In that case the income of the households are not high enough, and the households need to be supported via the long-term unemployment benefit. Vice versa $(1-\alpha_{t+1}^{nj})$ is the probability that the households working in region n and sector j receive in that particular region-sector combination an income which is above the ALG II threshold.

The utility value for short-term unemployed households is

$$V_t^{n0} = \log b^n + \upsilon(1-\delta_{t+1}) \log \left(\sum_{i=1}^{N} \sum_{k=0}^{J} \exp\left(\beta V_{t+1}^{ik} - \tau^{nj,ik}\right)^{1/\upsilon} \right) + \delta_{t+1} \beta V_{t+1}^{nA} \quad (5.2)$$

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,[8] 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.

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

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

$$V_t^{nA} = \log(b_t^A/P_t^n) + (1-\rho_{t+1}^{nA})\beta V_{t+1}^{nj} + \rho_{t+1}^{nA}\beta V_{t+1}^{nA} \tag{5.3}$$

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.

5.2.2 Migration Share and Labor Mobility

The share of moving households is given by

$$\mu_t^{nj,ik} = \frac{\exp(\beta V_{t+1}^{ik} - \tau^{nj,ik})^{1/v}}{\sum_{m=1}^{N}\sum_{h=0}^{J}\exp(\beta V_{t+1}^{mh} - \tau^{nj,mh})^{1/v}} \tag{5.4}$$

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.[9]

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:

$$L_{t+1}^{nj} = \sum_{i=1}^{N}\sum_{k\neq 0}^{J}\mu_t^{ik,nj}(1-\alpha_t^{ik})L_t^{ik} + \sum_{i=1}^{N}\mu_t^{i0,nj}(1-\delta_t)L_t^{i0} + (1-\rho_t^{nA})L_t^{nA}/J \tag{5.5}$$

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

[9]According to Caliendo et al. (2019), $1/v$ can in this context be understood as a migration elasticity.

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.[10] Further, the mass of households which are short-term unemployed is:

$$L_{t+1}^{n0} = \sum_{i=1}^{N} \sum_{k\neq 0}^{J} \mu_t^{ik,n0}(1-\alpha_t^{ik})L_t^{ik} + \sum_{i=1}^{N} \mu_t^{i0,n0}(1-\delta_t)L_t^{i0} \tag{5.6}$$

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:

$$L_{t+1}^{nA} = \rho_t^{nA} L_t^{nA} + \delta_t L_t^{n0} + \sum_{j\neq 0}^{J} \alpha_t^{nj} L_t^{nj} \tag{5.7}$$

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.[11]

5.2.3 Production

Intermediate goods are produced in each region-sector combination by a continuum of perfectly competitive firms. Inputs for the production of intermediate goods are labor and materials (they can come from any sector of the same region) as well as structures. The structures are composite local factors and rented by firms from rentiers.[12] The rentier structure is necessary in order to have the feature of trade

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

[11]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 unemployment 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 payed by the local council for costs like housing since the focus of my study lies on the federal payments.

[12]According to the model those rentiers are located in each region, however, cannot move and shift from a region. They transfer their rents to a global portfolio $\chi_t = \sum_{i=1}^{N}\sum_{k=1}^{J} r_t^{ik} H^{ik}$, which they have stake ι^n in (with $\sum_{n=1}^{N} \iota^n = 1$.). The rentiers can use their shares of the global

unbalances, which becomes essential in section 5.2.5. Further the intermediate good is produced with the total factor productivity (TFP) which consists of a productivity unique for each good and a time-varying sectoral-regional component A_t^{nj}. After solving for optimization, the price of the intermediate good can be written as

$$x_t^{nj} = B^{nj}((r_t^{nj})^{\xi^n}(\omega_t^{nj})^{1-\xi^n})^{\gamma^{nj}} \prod_{k=1}^{J}(P_t^{nj,nk})^{\gamma^{nj,nk}} \tag{5.8}$$

where B^{nj} is a constant, r_t^{nj} is the factor price of the structure (rental) and ω_t^{nj} is the factor price of labor (wages). $P_t^{nj,nk}$ is the price index of the intermediate good which comes from sector k into sector j of the same region n. Further, ξ^n is the value added share of the structure. The equation adds to unity $\sum_{k=1}^{J}\gamma^{nj,nk} = 1-\gamma^{nj}$, where $\gamma^{nj,nk}$ is the share of intermediates from sector k that goes into the production of sector j of the same region j. The share of value added of the intermediate goods produced in the same sector j of the same region n is given by γ^{nj}. Shipping an intermediate good from one region to another is costly and requires iceberg trade costs $\kappa_t^{nj,ij} \geq 1$. It needs the production of $\kappa_t^{nj,ij}$ in region i in order that one unit of the intermediate good arrives in region n.

The local sectoral aggregate good, also labeled as material, is a bundle of intermediate goods acquired from different regions. Thereby the intermediate goods come from different regions of the same sector. The intermediate goods are purchased from the lowest-cost supplier. The local sectoral aggregate good is used to produce either intermediate- or final goods. The model then gives rise to the optimal local sectoral aggregate good price:

$$P_t^{nj} = \Gamma^{nj}\left(\sum_{i=1}^{N}(x_t^{ij}\kappa_t^{nj,ij})^{-\theta^j}(A_t^{ij})^{\theta^j\gamma^{ij}}\right)^{-1/\theta^j} \tag{5.9}$$

Thus, the local sectoral aggregate good price depends on the time-varying sectoral-regional component of the total factor productivity (TFP) A_t^{ij} as well as on the prices of the intermediate goods and iceberg costs, while taking γ^{ij} and θ^j into

portfolio to purchase and consume final goods in region n.

account.[13] As the productivities are Fréchet distributed, θ^j is defined as the parameter of the Fréchet distribution which captures the productivity dispersion. Moreover, Γ^{nj} is a constant. By making use of the local sectoral aggregate good price the model then determines the share of total expenditure:

$$\pi_t^{nj,ij} = \frac{(x_t^{ij}\kappa_t^{nj,ij})^{-\theta^j}(A_t^{ij})^{\theta^j\gamma^{ij}}}{\sum_{m=1}^{N}(x_t^{mj}\kappa_t^{nj,mj})^{-\theta^j}(A_t^{mj})^{\theta^j\gamma^{mj}}} \tag{5.10}$$

The share of total expenditure is region n's spending on imports of sector j from region i relative to region n's total expenditure on imports of sector j.

5.2.4 Government Budget Constraint

In Germany, the long-term unemployed benefit is mainly financed by the federal government.[14] This is reflected by the budget constraint:

$$\sum_{n=1}^{N}\sum_{k=1}^{J}\tau_t^T\omega_t^{nk}L_t^{nk} + G_t = \sum_{n=1}^{N} b_t^A L_t^{nA}$$

The government income comes on the one hand from the revenue of the labor income tax (labor income tax is denoted by τ_t^T) and on the other hand from lump-sum taxes or transfers G_t which are charged from rentiers.[15] The government budget is then spent to finance the long-term unemployed benefit (see the right side of equation 5.2.4). The short-term unemployed households receive income in terms of home production, but no government support takes place for the short-term unemployed households in this model. Hence, expenses for short-term unemployment do not show up in the government budget constraint.

[13] Thus, γ^{ij} is the share of value added of the intermediate goods produced in region i of sector j.

[14] According to § 46 SGB II "the Federation shall bear the costs of basic needs for jobseekers, including administrative costs, insofar the services are provided by the Federal Agency." Only housing and other smaller costs are paid by the municipalities.

[15] This is consistent with the German federal budget, as 96% of the budget is financed by taxes. Out of the total tax revenue, 24.09% is contributed by income tax. Sales tax makes about 24.40%.

5.2.5 Good-, Labor- and Structure Market Clearing

The total supply of good j in region n has to match up with the demand of the good. The good market clearing condition (in value terms) is given by:

$$X_t^{jn} = \sum_{k=1}^{J} \gamma^{nk,nj} \sum_{i=1}^{N} \pi_t^{ik,nk} X_t^{ik} + \eta^j \left((1-\tau_t^T) \sum_{k=1}^{J} \omega_t^{nk} L_t^{nk} + b_t^A L_t^A + \iota^n \chi_t - G_t/N \right) \tag{5.11}$$

The good is used as an intermediate input into production (first term on the right-hand side) and for the final demand. The term in brackets represents the aggregate expenditure.[16]

Labor market clearing is given by:

$$L_t^{nj} = \frac{\gamma^{nj}(1-\xi^n)}{\omega_t^{nj}} \sum_{i=1}^{N} \pi_t^{ij,nj} X_t^{ij} \tag{5.12}$$

The labor market clearing condition implies that labor L_t^{nj} is required to produce goods for all regions of the same sector j, depending on the wages of sector j in region n.

In addition, market clearing of structures commands:

$$H^{nj} = \frac{\gamma^{nj}\xi^n}{r_t^{nj}} \sum_{i=1}^{N} \pi_t^{ij,nj} X_t^{ij} \tag{5.13}$$

Similar to the labor market clearing condition, the structures serve as inputs of the production of goods for all regions n of the same sector (conditional on the specific sector-region rent r_t^{nj}).

[16] Hereby $(1-\tau_t^T)\sum_{k=1}^{J} \omega_t^{nk} L_t^{nk}$ is the effective total labor income revenue, $b_t^A L_t^A$ represents the total long-term unemployment benefit and $(\iota^n \chi_t - G_t/N)$ is the effective income revenue of the rentiers in Germany. N is here the total number of counties in Germany, which is assigned to spread the lump-sum tax/transfer for each rentier uniformly across counties.

5.2.6 Solving the Dynamic Equilibrium Model

The model considers two types of equilibria: The first is the *temporary equilibrium* and involves the equilibrium equations (5.8) - (5.13). Thereby so-called *fundamentals* are introduced to make the exogenous state parameters more operable. The *constant fundamentals* $\tilde{\Theta} = (\Upsilon, H, b)$ include home production across regions $b = \{b^n\}_{n=1}^{N}$, structures across markets $H = \{H^{nj}\}_{n=1,j=1}^{N,J}$ and labor relocation costs $\Upsilon = \{\tau^{nj,ik}\}_{n=1,j=0,i=1,k=0}^{N,J,J,N}$. Whereas the *time-varying fundamentals* $\Theta = (A_t, \kappa_t)$ involve the sectoral-regional productivities $A_t = \{A_t^{nj}\}_{n=1,j=1}^{N,J}$ and bilateral trade costs $\kappa_t = \{\kappa_t^{nj,ij}\}_{n=1,i=1,j=1}^{N,N,J}$. Given the *constant fundamentals* and *time-varying fundamentals* as well as the total number of labor in the economy L_t, the temporary equilibrium can be solved via a vector of equilibrium wages $\omega(L_t, \Theta_t, \bar{\Theta})$.

The second equilibrium is the *sequential competitive equilibrium.* It solves for the equilibrium conditions (5.1) - (5.7) by the application of across time vectors $\{L_t, \mu_t, V_t, \omega(L_t, \Theta_t, \bar{\Theta})\}_{t=0}^{\infty}$, as well as relying on the solution of the temporary equilibrium at any time t and given $L_0, \{\Theta_t\}_{t=0}^{\infty}, \bar{\Theta}$.
In order to be able to conduct the counterfactual equilibrium Caliendo et al. (2019) introduce a *baseline economy.* Hereby the *baseline economy* is defined as an allocation $\{L_t, \mu_{t-1}, \pi_t, X_t\}_{t=0}^{\infty}$ across time, which relies on $\{\Theta_t\}_{t=0}^{\infty}$ and $\bar{\Theta}$. However, as with each time period t the number of necessary parameters increase the empirical estimation becomes more challenging. Therefore, the well-known *"hat algebra"* approach of Dekle et al. (2008) is applied to solve the baseline economy in relative time differences, which reduces the need to estimate certain parameters (in particular the level of fundamentals). Caliendo et al. (2019) sets the Dekle et al. (2008) method in a *"dynamic hat algebra"* time-varying setting to solve the baseline economy in relative time differences. Thereby a vector $\dot{y}_{t+1} \equiv \left(\frac{y_{t+1}^1}{y_t^1}, \frac{y_{t+1}^2}{y_t^2}, \ldots\right)$ can be seen as the relative change of a vector's value y between two periods. To solve the baseline economy at period $t+1$ I apply *Proposition 1* suggested by Caliendo et al. (2019):

"*Given the allocation of the temporary equilibrium at t: $\{L_t, \pi_t, X_t\}$. The solution to the temporary equilibrium at $t+1$ for a given change in $\dot{L}_{t+1}$ and $\dot{\Theta}_{t+1}$ does not require information on the level of fundamentals at t, Θ_t or $\bar{\Theta}$.*" (Caliendo et al., 2019, p. 754)

$$\dot{x}_{t+1}^{nj} = (\dot{L}_{t+1}^{nj})^{\gamma^{nj}\xi^n} (\dot{\omega}_{t+1}^{nj})^{\gamma^{nj}} \prod_{k=1}^{J} (\dot{P}_{t+1}^{nj})^{\gamma^{nj,nk}} \tag{5.14}$$

$$\dot{P}_{t+1}^{nj} = \left(\sum_{i=1}^{N} \pi_t^{nj,ij} (\dot{x}_{t+1}^{ij} \dot{\kappa}_{t+1}^{nj,ij})^{-\theta^j} (\dot{A}_{t+1}^{ij})^{\theta^j \gamma^{ij}} \right)^{-1/\theta^j} \tag{5.15}$$

$$\pi_{t+1}^{nj,ij} = \pi_t^{nj,ij} \left(\frac{\dot{x}_{t+1}^{ij} \dot{\kappa}_{t+1}^{nj,ij}}{\dot{P}_{t+1}^{nj}} \right)^{-\theta^j} (\dot{A}_{t+1}^{ij})^{\theta^j \gamma^{ij}} \tag{5.16}$$

$$\begin{aligned} X_{t+1}^{nj} = \sum_{k=1}^{J} \gamma^{nk,nj} \sum_{i=1}^{N} \pi_{t+1}^{ik,nk} X_{t+1}^{ik} + \eta^j \Bigg(& \sum_{k=1}^{J} \dot{\omega}_{t+1}^{nk} \dot{L}_{t+1}^{nk} \omega_t^{nk} L_t^{nk} + \\ & b_{t+1}^{A} L_{t+1}^{A} + \iota^n \chi_{t+1} - G_{t+1}/N \Bigg) \end{aligned} \tag{5.17}$$

$$\dot{\omega}_{t+1}^{nj} \dot{L}_{t+1}^{nj} \omega_t^{nj} L_t^{nj} = \gamma^{nj}(1-\xi^n) \sum_{i=1}^{N} \pi_{t+1}^{ij,nj} X_{t+1}^{ij} \tag{5.18}$$

Where the vector of the real wage equilibrium in time differences $\dot{\omega}_{t+1}^{nj}(\dot{L}_{t+1}, \dot{\Theta}_{t+1})$ solves the equilibrium equations above. The model further defines the *sequential competitive equilibrium* in relative time differences. Thus, in order to solve for the baseline economy in time differences I make use of *Proposition 2*:

"*Conditional on an initial allocation of the economy, $\{L_0, \pi_0, X_0\, \mu_{-1}\}$, given an anticipated convergent sequence of changes in fundamentals, $\{\Theta_t\}_{t=1}^{\infty}$, the solution to the sequential equilibrium in time differences does not require information on the level of the fundamentals $\{\Theta_t\}_{t=0}^{\infty}$ or $\bar{\Theta}$*" (Caliendo et al., 2019, p. 755). Hence, the *sequential competitive equilibrium* in relative time differences solves for the equilibrium conditions below, in addition $\{\dot{\omega}^{nj}(\dot{L}_t, \dot{\Theta}_t)\}_{n=1,j=0,t=1}^{N,J,\infty}$ and $\{\dot{L}_t, \dot{\Theta}_t)\}_{t=1}^{\infty}$

have to hold:[17]

$$\mu_{t+1}^{nj,ik} = \frac{\mu_t^{nj,ik}(\dot{u}_{t+2}^{ik})^{\beta/v}}{\sum_{m=1}^{N}\sum_{h=0}^{J}\mu_t^{nj,mh}(\dot{u}_{t+2}^{mh})^{\beta/v}} \tag{5.19}$$

$$\begin{aligned}\dot{u}_{t+1}^{nj} = [\dot{\omega}^{nj}(\dot{L}_{t+1}, \dot{\Theta}_{t+1})]\left[\sum_{i=1}^{N}\mu_t^{nj,i0}(\dot{u}_{t+2}^{i0})^{\beta/v}\right]^{v} * \\ \left[\sum_{i=1}^{N}\sum_{k=0}^{J}\mu_t^{nj,ik}(\dot{u}_{t+2}^{ik})^{\beta/v}\right]^{v(1-\alpha^{nj})}(\dot{u}_{t+2}^{nA})^{\alpha^{nj}\beta}\end{aligned} \tag{5.20}$$

$$\dot{u}_{t+1}^{n0} = \dot{b}^{n}\left[\sum_{i=1}^{N}\sum_{k=0}^{J}\mu_t^{nj,ik}(\dot{u}_{t+2}^{ik})^{\beta/v}\right]^{v(1-\delta)}(\dot{u}_{t+2}^{nA})^{\delta\beta} \tag{5.21}$$

$$\dot{u}_{t+1}^{nA} = \frac{\dot{b}^{A}}{\dot{P}_{t+1}^{n}}(\dot{u}_{t+2}^{nj})^{(1-\rho)\beta}(\dot{u}_{t+2}^{nA})^{\rho\beta} \tag{5.22}$$

$$L_{t+1}^{nj} = \sum_{i=1}^{N}\sum_{k\neq 0}^{J}\mu_t^{ik,nj}(1-\alpha_t^{k})L_t^{ik} + \sum_{i=1}^{N}\mu_t^{i0,nj}(1-\delta)L_t^{i0} + (1-\rho_t^{nA})L_t^{nA}/J \tag{5.23}$$

$$L_{t+1}^{n0} = \sum_{i=1}^{N}\sum_{k\neq 0}^{J}\mu_t^{ik,n0}(1-\alpha_t^{k})L_t^{ik} + \sum_{i=1}^{N}\mu_t^{i0,n0}(1-\delta_t)L_t^{i0} \tag{5.24}$$

$$L_{t+1}^{nA} = \rho_t^{nA}L_t^{nA} + \delta_t L_t^{n0} + \sum_{j\neq 0}^{J}\alpha_t^{j}L_t^{nj} \tag{5.25}$$

5.2.7 Counterfactual Equilibrium

After having conducted the *baseline economy* in relative time differences, let us turn our attention to the counterfactual equilibrium in relative time changes to be able to execute the empirical analysis.[18] In this counterfactual equilibrium the counterfactual allocations are set in comparison to the allocation of the *baseline economy*. Like that the ratio of time changes between the counterfactual vari-

[17] The equilibrium conditions contain the extension of the German labor market reform. The calculation to derive the *sequential competitive equilibrium* conditions are displayed in 5.A.

[18] As in the *baseline economy* scenario, it follows that the relative time changes are in particular helpful as the *fundamentals* of the counterfactual economy $\{\Theta_t'\}_{t=0}^{\infty}$ do not have to be estimated.

able $\dot{y}'_{t+1}$ and the baseline economy variable $\dot{y}_{t+1}$ is given by $\hat{y}_{t+1} = \frac{\dot{y}'_{t+1}}{\dot{y}_{t+1}}$, where $\dot{y}'_{t+1} = \frac{y'_{t+1}}{y'_t}$ and $\dot{y}_{t+1} = \frac{y_{t+1}}{y_t}$.[19] In order to boil down the solutions of the counterfactual equilibrium conditions, the forward-looking household is a key feature in the model: In Caliendo et al. (2019) it is assumed that the households do not anticipate the counterfactual fundamentals in the first period $t = 0$ as only the initial fundamentals are known. However, the households gain perfect knowledge of the rest of the entire counterfactual allocations $t \geq 1$, through which the counterfactual equilibrium in relative time changes can be determined. To disentangle the impact of the German Labor market reform and the "rise of the East" counterfactually I follow *Proposition 3*:

"Given a baseline economy, $\{L_t, \mu_{t-1}, \pi_t, X_t\}_{t=0}^{\infty}$*, and a counterfactual convergent sequence of changes in fundamentals (relative to the baseline change),* $\{\hat{\Theta}_t\}_{t=1}^{\infty}$*, solving for the counterfactual sequential equilibrium* $\{L'_t, \mu'_{t-1}, \pi'_t, X'_t\}_{t=1}^{\infty}$ *does not require information on the baseline fundamentals* $(\{\Theta_t\}_{t=0}^{\infty}, \bar{\Theta})$ *and solves the following system of nonlinear equations:"*[20] (Caliendo et al., 2019, p. 757)

$$\mu_t'^{nj,ik} = \frac{\mu_{t-1}'^{nj,ik}\, \dot{\mu}_t^{nj,ik} (\hat{u}_{t+1}^{ik})^{\beta/v}}{\sum_{m=1}^{N}\sum_{h=0}^{J} \mu_{t-1}'^{nj,mh}\, \dot{\mu}_t^{nj,ik} (\hat{u}_{t+1}^{mh})^{\beta/v}} \tag{5.26}$$

$$\begin{aligned} \hat{u}_{t+1}^{nj} = \hat{\omega}^{nj}(\hat{L}_{t+1}, \hat{\Theta}_{t+1}) \left[\sum_{i=1}^{N} \mu_t'^{nj,i0}\, \dot{\mu}_{t+1}^{nj,i0} (\hat{u}_{t+2}^{i0})^{\beta/v} \right]^{v} \\ \left[\sum_{i=1}^{N}\sum_{k=0}^{J} \mu_t'^{nj,ik}\, \dot{\mu}_{t+1}^{nj,ik} (\hat{u}_{t+2}^{ik})^{\beta/v} \right]^{v(1-\alpha^{nj})} (\hat{u}_{t+2}^{nA})^{\alpha^{nj}\beta} \end{aligned} \tag{5.27}$$

$$\hat{u}_{t+1}^{n0} = \hat{b}^{n} \left(\sum_{i=1}^{N}\sum_{k=0}^{J} \mu_t'^{nj,ik}\, \dot{\mu}_{t+1}^{nj,ik} (\hat{u}_{t+2}^{ik})^{\beta/v}) \right)^{v(1-\delta)} (\hat{u}_{t+2}^{nA})^{\delta\beta} \tag{5.28}$$

[19]Here $\dot{y}'_{t+1} = \frac{y'_{t+1}}{y'_t}$ and $\dot{y}_{t+1} = \frac{y_{t+1}}{y_t}$ are the changes in between time periods for the counterfactual and the baseline economy respectively.

[20]The following equations correspondingly include the extension of the *long-term unemployed* benefit. For derivation details, see 5.A.

$$\hat{u}^{nA}_{t+1} = \frac{\hat{b}^A}{\hat{P}^n_{t+1}}(\hat{u}^{nj}_{t+2})^{(1-\rho)\beta}(\hat{u}^{nA}_{t+2})^{\rho\beta} \tag{5.29}$$

$$L'^{nj}_{t+1} = \sum_{i=1}^{N}\sum_{k\neq 0}^{J}\mu'^{ik,nj}_t(1-\alpha^k_t)L'^{ik}_t + \sum_{i=1}^{N}\mu'^{i0,nj}_t(1-\delta)L'^{i0}_t + (1-\rho^{nA}_t)L'^{nA}_t/J \tag{5.30}$$

$$L'^{n0}_{t+1} = \sum_{i=1}^{N}\sum_{k\neq 0}^{J}\mu'^{ik,n0}_t(1-\alpha^k_t)L'^{ik}_t + \sum_{i=1}^{N}\mu'^{i0,n0}_t(1-\delta_t)L'^{i0}_t \tag{5.31}$$

$$L'^{nA}_{t+1} = \rho^{nA}_t L'^{nA}_t + \delta_t L'^{n0}_t + \sum_{j\neq 0}^{J}\alpha^j_t L'^{nj}_t \tag{5.32}$$

In addition, for the *counterfactual sequential equilibrium* to hold, the solution of the *counterfactual temporary equilibrium* $\{\hat{\omega}^{nj}(\hat{L}_t,\hat{\Theta}_t)\}^{N,J,\infty}_{n=1,j=0,t=1}$ and $\{\hat{L}_t,\hat{\Theta}_t)\}^{\infty}_{t=1}$ needs to satisfy the following equations for each time period t:

$$\hat{x}^{nj}_{t+1} = (\hat{L}^{nj}_{t+1})^{\gamma^{nj}\xi^n}(\hat{\omega}^{nj}_{t+1})^{\gamma^{nj}}\prod_{k=1}^{J}(\hat{P}^{nk}_{t+1})^{\gamma^{nj,nk}} \tag{5.33}$$

$$\hat{P}^{nj}_{t+1} = \left(\sum_{i=1}^{N}\pi'^{nj,ij}_t\dot{\pi}^{nj,ij}_{t+1}(\hat{x}^{ij}_{t+1},\hat{\kappa}^{nj,ij}_{t+1})^{-\theta^j}(\hat{A}^{ij}_{t+1})^{\theta^j\gamma^{ij}}\right)^{-1/\theta^j} \tag{5.34}$$

$$\pi'^{nj,ij}_{t+1} = \pi'^{nj,ij}_t\dot{\pi}^{nj,ij}_{t+1}\left(\frac{\hat{x}^{ij}_{t+1}\hat{\kappa}^{nj,ij}_{t+1}}{\hat{P}^{nj}_{t+1}}\right)^{-\theta^j}(\hat{A}^{ij}_{t+1})^{\theta^j\gamma^{ij}} \tag{5.35}$$

$$\begin{aligned} X'^{nj}_{t+1} = \sum_{k=1}^{J}\gamma^{nk,nj}\sum_{i=1}^{N}\pi'^{ik,nk}_{t+1}X'^{ik}_{t+1} + \\ \eta^j\left(\sum_{k=1}^{J}\hat{\omega}^{nk}_{t+1}\hat{L}^{nk}_{t+1}\dot{\omega}^{nk}_{t+1}\dot{L}^{nk}_{t+1}\omega'^{nk}_t L'^{nk}_t + \iota^n\chi'_{t+1} + b'^{A}_{t+1}L'^{A}_{t+1} - G'_{t+1}/N\right) \end{aligned} \tag{5.36}$$

$$\hat{\omega}^{nk}_{t+1}\hat{L}^{nk}_{t+1} = \frac{\gamma^{nj}(1-\xi^n)}{\omega'^{nk}_t L'^{nk}_t\dot{\omega}^{nj}_{t+1}\dot{L}^{nj}_{t+1}}\sum_{i=1}^{N}\pi'^{ij,nj}_{t+1}X'^{ij}_{t+1} \tag{5.37}$$

5.3 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 and the "rise of the East" on employment in Germany. The strategy for the empirical simulation is provided in Appendix 5.A, which involves the algorithm to solve the *sequential competitive equilibrium* (5.A) and the algorithm for *counterfactuals* (5.A).[21] 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 section I describe the data calibration of those parameters used in the simulation that have to be empirically determined.[22]

5.3.1 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 con-

[21] I am thankful for the *Matlab-Code* provided by Caliendo et al. (2019) which my simulation builds on. I further extend the code to be able to simulate the impact of the long-term unemployment benefit and the "rise of the East".

[22] The other parameters resolute endogenously by the modification of the model.

struct 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 ("Statistische Ämter des Bundes und der Länder"). 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 "Regionalstatistik" 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 of data preparation, I follow the approach of Costinot and Rodriguez-Clare (2014) and eliminate negative inventories. 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 output[23] for the 43 countries plus the 402 German counties.

5.3.2 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. 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 Fed-

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

eral Employment Agency as well.[24] 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, ungeförderter 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 Employment Agency.[25] In Table 5.1 I provide an overview of the development of the population composition in Germany.

[24]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.

[25]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.

Table 5.1: Overview Unemployment, Long-term Unemployment and Employment Shares in Germany

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%

Source: Statistik der Bundesagentur für Arbeit (2020); Author's own calculations.

5.3.3 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.[26] 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. 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

[26]The group consists mainly of self-employed, mini-jobbers, part-time employees, but also full-time employees are applicable for the "ALG II" benefit.

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.[27] However, the county data is only available for the years 2009 to 2014. For 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.

5.3.4 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

[27] In a one minus relationship.

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:

$$\Delta M_{GER,j} = a_1 + a_2 \Delta M_{other,j} + u_j \tag{5.38}$$

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.[28] The regressions for each of the eleven Eastern European countries are similar:

$$\Delta M_{EE_i,j} = a_1 + a_2 \Delta M_{other,j} + u_j \tag{5.39}$$

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 5.2, most countries, besides Estonia and Latvia, have high R-squared values that indicate respectable prediction power.

[28]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.

Table 5.2: Coefficient Results for a_2 (for Eastern European Countries)

	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

Source: World Input Output Database, Release 2016;

Author's own calculations.

After having estimated the coefficients I use the baseline economy and the counterfactual economy[29] 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 appendix 5.A.5.

[29]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 $a_2 \Delta M_{other,j}$.

5.3.5 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 various 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 5.3. 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.[30] Having identified the labor income tax and the long-term unemployment benefit I can endogenously determine the lump sum tax/transfer G_t charged by the German rentiers by applying equation 5.2.4 of the model.

Table 5.3: Development of Labor Income Tax responsible for financing ALG II

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

Source: Bundesministerium der Finanzen (2020); Author's own calculations.

5.3.6 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

[30] 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.

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 ("Regionalstatistik") and of the German Federal and State Statistics Office ("Statistische Ämter des Bundes und der Länder"). 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 ("Regionalstatistik").[31] 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.[32]

5.3.7 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

[31] 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.

[32] A similar approach is used in Caliendo et al. (2019).

of the regional statistics ("Regionalstatistik") data of the German Federal and State Statistics Office ("Statistische Ämter des Bundes und der Länder"). 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.

5.3.8 Dispersion of Sector Productivity

In my analysis θ reflects the dispersion of productivity of each sector.[33] I rely on the values for Germany on the sector-specific productivity dispersion parameter of Aichele et al. (2014), 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).[34] Regarding the service sectors: Trade, transport, hotels and restaurants, communication (Sector 5); financial, insurance services (Sector 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 (2018). 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 5.4 summarizes all dispersion productivity parameters

[33]The dispersion of productivity θ can take on values between 0 and 1, a low θ indicates that the productivity levels are highly concentrated on a few varieties.

[34]In Aichele et al. (2014) the values are defined as $-1/\theta$ therefore to identify θ I take the negative inverse of each sector.

used in my paper.

Table 5.4: Dispersion of German Sector Productivity

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

Source: Aichele et al. (2014); Egger et al. (2012); Author's own calculations.

5.3.9 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. (2016), 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. 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.[35] 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. (2016) 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. (2016). In order to construct the mobility for short-term unemployed and long-term unemployed people I rely on the regional statistics data "Regionalstatistik" of the German Federal and Regional Statistical Offices 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).

5.3.10 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 for the years 2005 to 2014. I find an average discount factor of annually 0.9687 and apply this value in my analysis.

[35]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.

5.4 Simulation

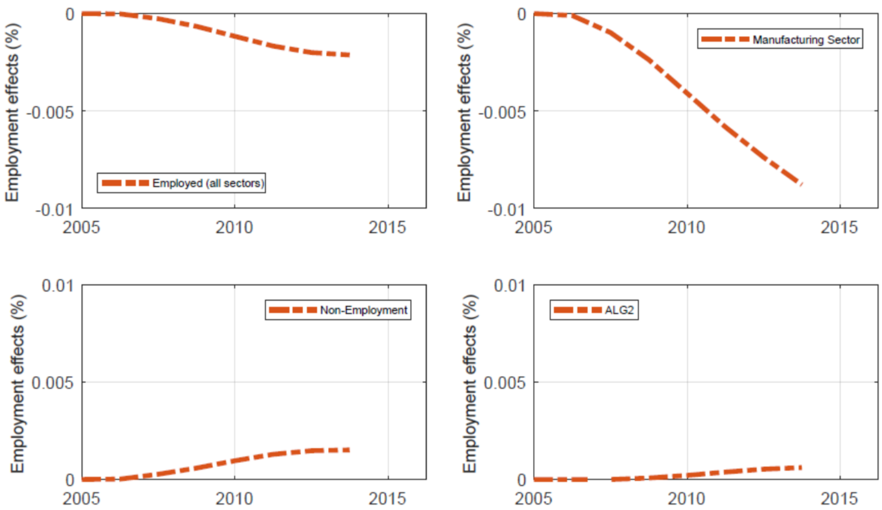
After having derived the key variables let us turn our attention to the analysis. In the following I present a short outline of the approach to conduct the simulation. Hereby the simulations build on the Caliendo et al. (2019) extension of the Social Security Disability Insurance (SSDI) program. I construct the baseline economy for the years 2005 and 2014 which consist of the development of the actual fundamentals. The baseline economy is needed to apply *Proposition 3* to solve for the counterfactual equilibrium. In my counterfactual analysis I simulate the impact of the "rise of the East" and the German labor market reform. As regards the scenario of the "rise of the East", I test changes on the German labor market caused by the rising productivities in Eastern European countries as well as the productivity growth in Germany, which triggered the import competition in the Eastern European countries. As in Caliendo et al. (2019) I am doing this by letting the fundamentals in the counterfactual economies develop as they did in the data, except for the calibrated sectoral changes in productivities. This holds true for the two scenarios of the eleven Eastern European productivities and the German productivity. 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.

5.4.1 Eastern European Productivity Effect

I start by focusing on the Eastern European productivity rise, associated with the export growth of the eleven Eastern European countries to Germany. Figure 5.3 displays the impact of the rise in Eastern European productivity on the German labor market between 2005 and 2014. I primarily observe two effects: On the one hand there is a direct effect, as the Eastern European productivity leads to a short-term unemployment growth by 0.001% and a rise in long-term unemployment by 0.0005%. On the other hand, I find a severe change in the sectoral composition.

Most notably the employment of the manufacturing sector is decreasing by around 0.01%. Out of the manufacturing sector a certain number gets unemployed. However, there is also a movement into other sectors as construction, but especially into the service sectors trade and commerce, finance and the public sector.

Figure 5.3: Eastern European 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 5.3.

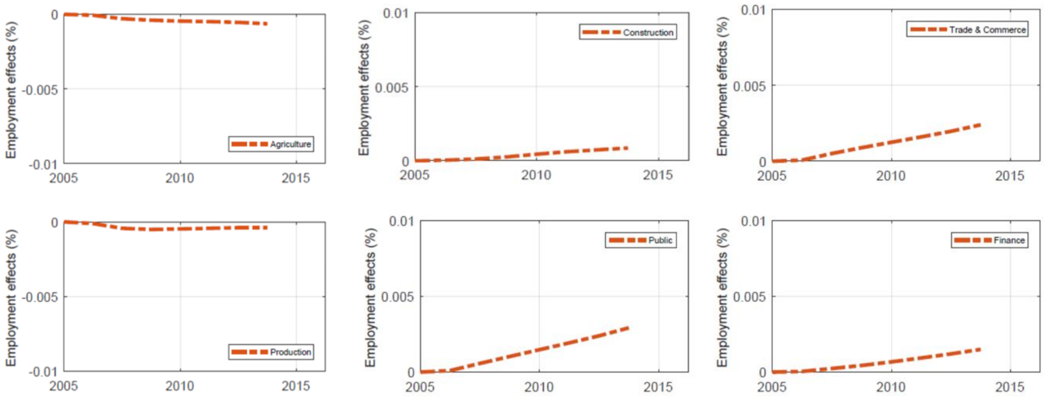
This can be seen in Figure 5.4 as the employment in the construction sector, trade and commerce, finance and the public sector increases. Whereas the agriculture and the production sector are declining in employment by only a margin. My findings are in line with Dauth et al. (2016) who call this employment adjustment from the import penetrated sectors to the service sectors "push effect".

Now turning to the employment changes on the German county level.[36] Figure 5.5 presents the changes of the regional short-term unemployment share relative to the total employment of a county.[37] I find that the regional short-term unemployment shares remain merely constant in the west, however, the regional short-term unemployment shares increase in counties particularly in the Eastern part of Germany more strongly. Predominantly counties as "Nordwest-Mecklenburg", "Oberhavel"

[36] I am thankful to Oliver Krebs for his helpful graphical assistance. I built on the basic *R-Code* he provided me with to illustrate my simulation results on the German county level.

[37] In this context regional refers to the county level.

Figure 5.4: Eastern European Productivity Effect on Sectoral Employment (between 2005 and 2014)



The figures are based on the Author's own calculations and rely on the data explained in chapter 5.3.

and "Tetlow Fläming" experience a larger increase in the share of regional unemployment. This is due to an employment decline in the agriculture sector, caused by the import penetration of Eastern Europe.

Further Figure 5.6 displays the fact that the highest contribution to the increase of unemployment (in share of total unemployment change) is coming from the counties of the Eastern part of Germany. In addition, I find that larger cities such as Berlin, Leipzig, Munich or Nuremberg, which are geographically closer to Eastern Europe than other major German cities contribute severely to the increase of short-term unemployment.

Next let us turn our attention in Figure 5.7 to the regional long-term unemployment results. I discover that counties, especially in Mecklenburg-Western Pomerania, Berlin and Brandenburg experience the largest increase in the regional long-term unemployment shares. Interesting are the findings that in other parts of Eastern Germany specifically in Saxony-Anhalt, Thuringia and Saxony the county-share composition of the regional long-term unemployment shares decreases. Even as there is a positive contribution of those areas to the total long-term unemployment growth in Germany, as Figure 5.8 demonstrates. The difference can be explained by the fact that the long-term unemployment grows due to the "rise of the East" and at the same time the total working population of those counties

Figure 5.5: Changes in Regional Unemployment Shares

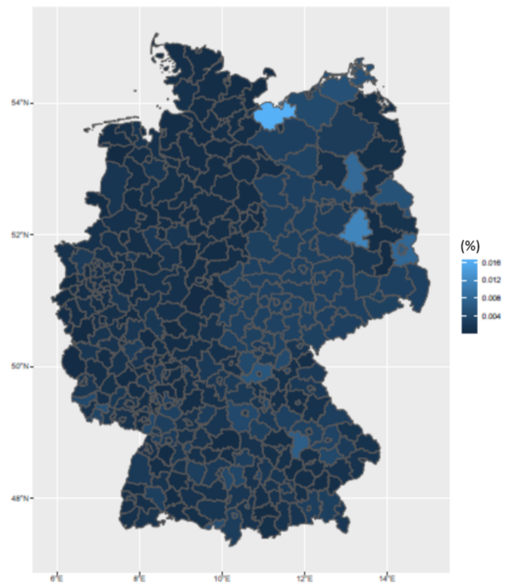
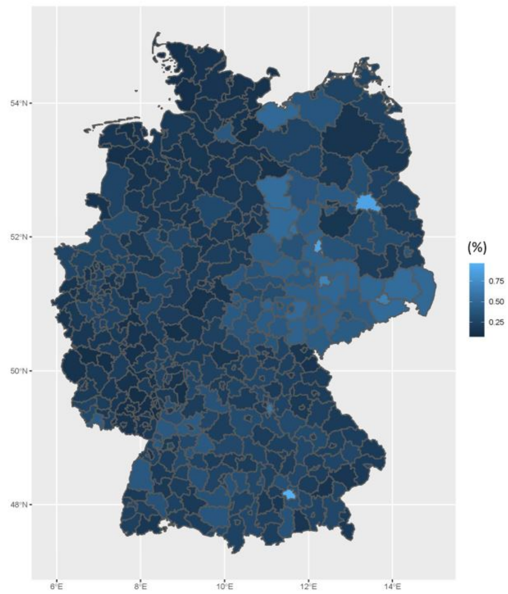


Figure 5.6: Regional Contribution to total Short-Term Unemployment Increase



The figures are based on the Author's own calculations and rely on the data explained in chapter 5.3.

declines. This is caused by retirements and the move of portions of the working population into other counties, e.g. mostly to Western Germany. Furthermore, Figure 5.8 displays that Berlin is contributing strongly to the increase of the aggregate long-term unemployment rise, whilst Munich experiences a fall in long-term unemployment and contributes negatively to the total long-term unemployment growth in Germany.

As seen in Figure 5.3 the manufacturing sector is the most impacted by the Eastern European productivity growth. Figure 5.9 displays the changes of the regional manufacturing shares at the county level. Predominately counties in Lower Saxony, but also in North Rhine Westphalia and Hessen as well as in some counties of Baden Württemberg and in the Munich and Nuremberg area see a decline in regional manufacturing shares. On the other side, most counties of Eastern Germany experience a slight growth of the regional manufacturing shares. Figure 5.10 shows that those counties, in which the regional manufacturing shares decline, are responsible for the aggregated manufacturing decrease. Particularly Munich contributes the highest to the aggregated decline of the manufacturing sector.

Figure 5.7: Changes in Regional Long-Term Unemployment Shares

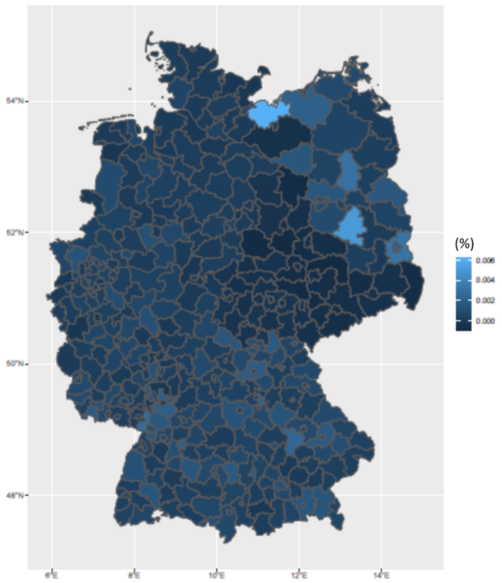
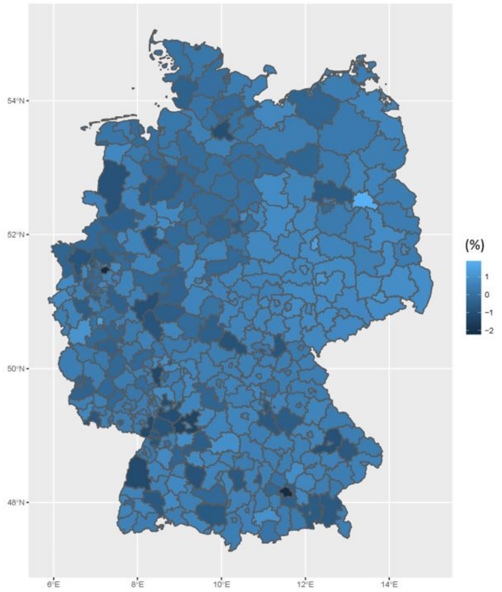


Figure 5.8: Regional Contribution to total Long-Term Unemployment Increase



The figures are based on the Author's own calculations and rely on the data explained in chapter 5.3.

Figure 5.9: Changes in Regional Manufacturing Shares

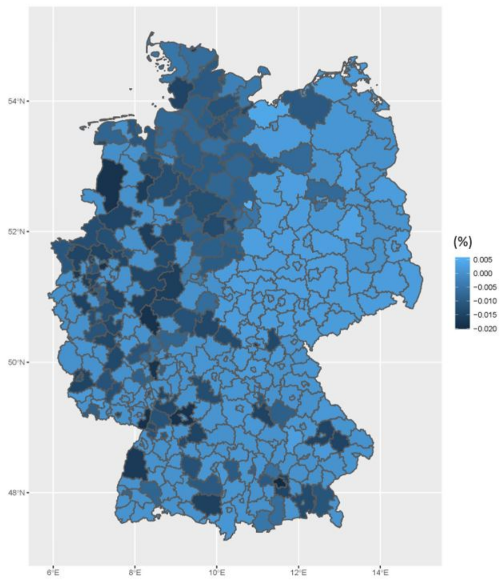
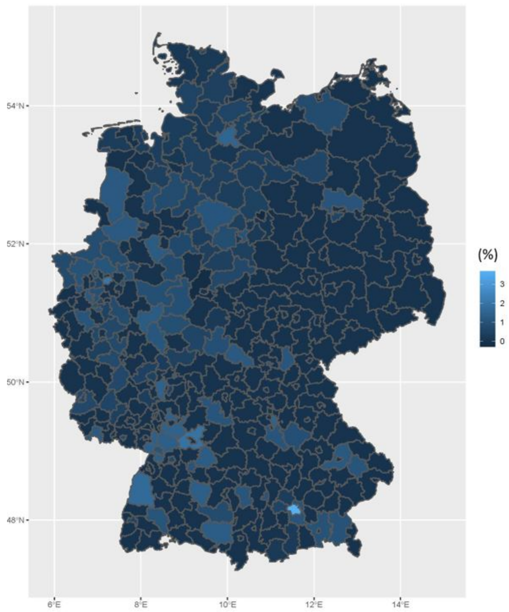


Figure 5.10: Regional Contribution to total Manufacturing Decrease

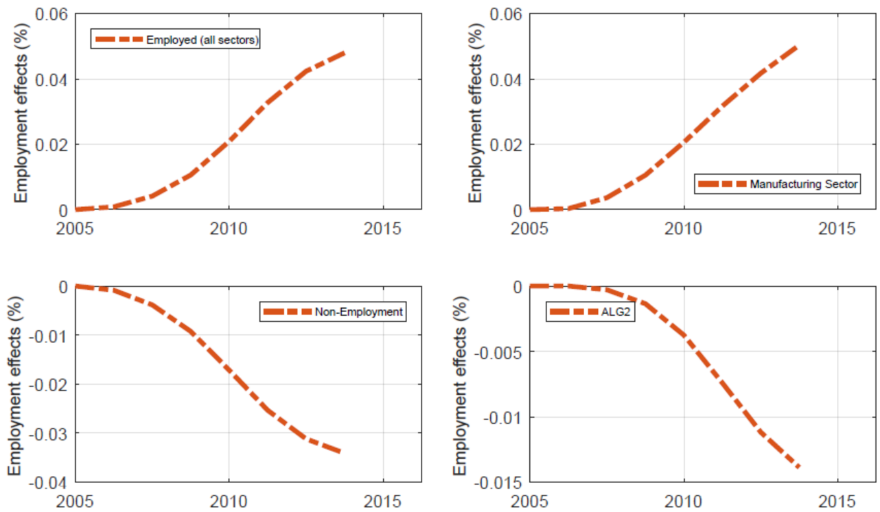


The figures are based on the Author's own calculations and rely on the data explained in chapter 5.3.

5.4.2 German Productivity Effect

In this section let us turn to the increase of the German productivity, which is responsible for the export growth to Eastern Europe between 2005 and 2014. Figure 5.11 provides a contour of the labor market effects in Germany. Compared to the rise of the Eastern European productivity I find that the impact on the German labor market is stronger. Germany experiences a decline in short-term unemployment by -0.034% and a reduction of long-term unemployment by around -0.015%. The employment change is driven to a large extent by the manufacturing sector, as the sector sees an increase of 0.05%. Other sectors are varying just slightly, as it can be noticed in appendix 5.A.

Figure 5.11: 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 5.3.

In Figure 5.12 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. 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, Figure

5.13. Cities with a larger population as Berlin and Munich, but also Magdeburg and Dresden are the highest contributors in the reduction of unemployment.

Figure 5.12: Changes in Regional Unemployment Shares

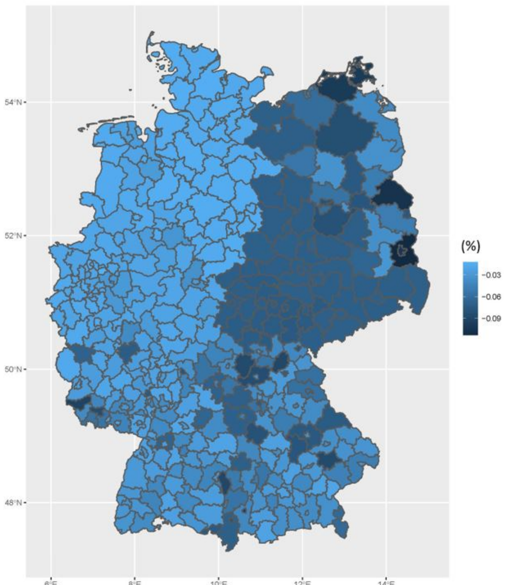
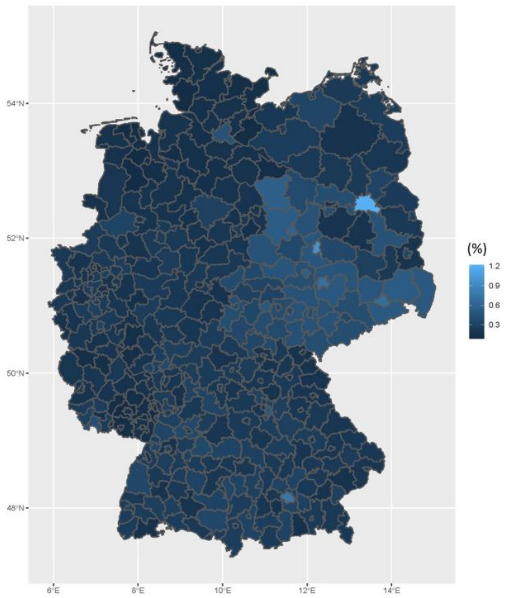


Figure 5.13: Regional Contribution to total Short-Term Unemployment Decrease



The figures are based on the Author's own calculations and rely on the data explained in chapter 5.3.

Focusing on the changes of the regional long-term unemployment shares I find a similar pattern as in the Eastern European productivity scenario, as Figure 5.14 displays. Due to the decrease of the working population in Saxony-Anhalt, Thuringia and Saxony the share of the long-term unemployment grows in those areas.[38] 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, Figure 5.15.

[38]To illustrate why the regional long-term unemployment shares increase in those areas, I provide an example of the county "Altenburger Land" in Thuringia: In 2005 the regional share of long-term unemployment was 0.20%, which is derived from 0.0002 long-term unemployed share to 0.0011 total employment in the region (0.0011 is here the share of the total employment in that region compared with the total employment in Germany). From 2005 to 2014 the long-term unemployment share would rise in the counterfactual scenario to 0.25%, holding the German productivity constant at the 2005 level. However, in the baseline scenario when all fundamentals develop as they did, the long-term unemployment declines to 0.00019 and at the same time the total working population of the county decreases to 0.0007. Hence, there is an increase of long-term unemployment share in the region by 0.26%. Therefore, the share of the county's long-term unemployment rises by 0.01%.

Figure 5.14: Changes in Regional Long-Term Unemployment Shares

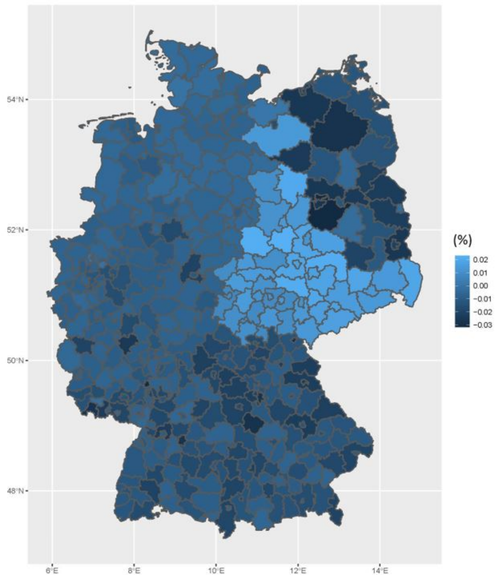
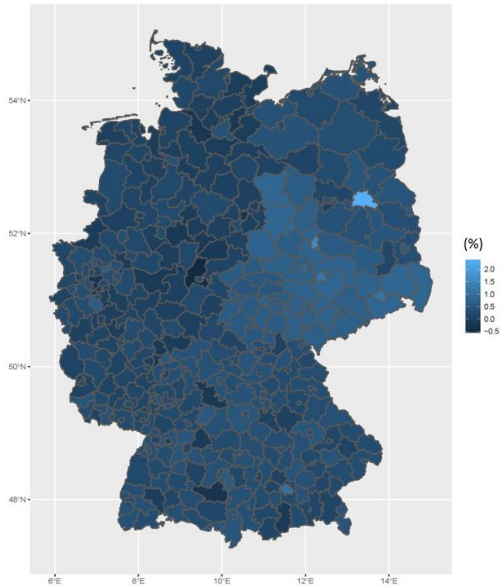


Figure 5.15: Regional Contribution to total Long-term Unemployment Decrease



The figures are based on the Author's own calculations and rely on the data explained in chapter 5.3.

The manufacturing sector is highly impacted by the German productivity gain. Figure 5.16 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 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 Figure 5.17.

Summing up the impact of the "rise of the East", I can conclude that the productivity rise of Eastern Europe has a small negative impact on the German labor market, while the German productivity - responsible for the exports to Eastern Europe - has a positive effect. Taking both "productivity rises" together, I find

Figure 5.16: Changes in Regional Manufacturing Shares

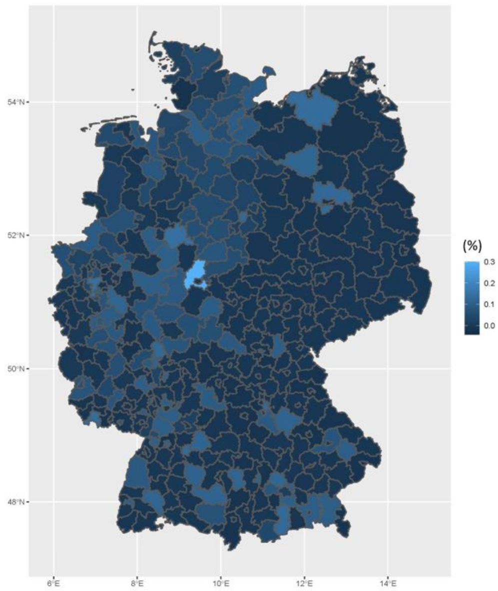
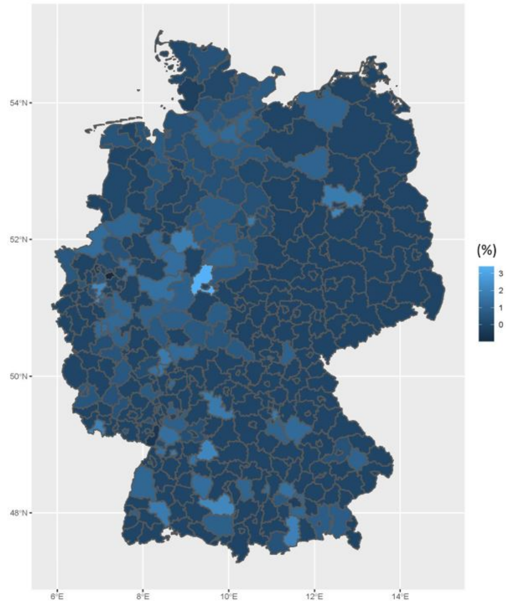


Figure 5.17: Regional Contribution to total Manufacturing Increase



The figures are based on the Author's own calculations and rely on the data explained in chapter 5.3.

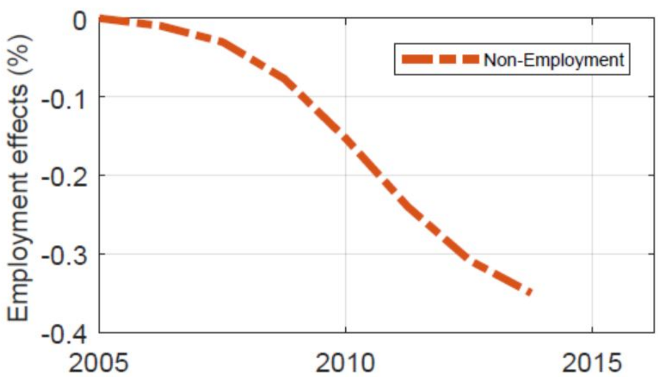
a decrease in total net-unemployment of 49.000.[39] Compared to the findings of Dauth et al. (2014) which identify an increase of the "rise of the East" by 442.000 additional jobs, one might think the result to be small. However, Dauth et al. (2014) included in their analysis 21 Eastern European countries. For my counterfactual analysis I use the convenient World Input-Output Database (WIOD), which is limited to 11 Eastern European countries. Due to the time of interest I test for the "rise of the East" between 2005 and 2014, while Dauth et al. (2014) analyze a much longer time period of 20 years between 1988 and 2008. None the less, the differences provide a hint, that besides the rise in productivities the eastward enlargement of the European Union (2004 and 2007) and the resulting reduction in trade costs could play a main role in the trade flow gains between Germany and Eastern Europe.

[39]This summarizes the effect of short-term unemployment and long-term unemployment while taking the rise of the Eastern European productivity and also the increase of the German productivity into account.

5.4.3 Long-Term Unemployment Benefit

In this section I investigate the impact of the long-term unemployment benefit which was introduced during the labor market reforms. I focus especially on the fourth phase of the reform also known as Hartz IV and in particular on the long-term unemployment benefit "Arbeitslosengeld II". My counterfactual question to answer is: How would the German labor market have been affected if long-term unemployment benefits had been eliminated?[40] Through this question I can examine the labor market changes due to Hartz IV. Figure 5.18 shows the effect of the long-term unemployment benefits on the German unemployment between 2005 and 2014.

Figure 5.18: 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 5.3.

Thus, the long-term unemployment benefit would account for an around 0.4% decrease in short-term unemployment.[41] That would correspond to an approximated reduction of unemployed people by 385.000 over time. My finding is in line with the literature. The results vary from an unemployment decrease of 0.1%

[40] 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.

[41] 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".

estimated by Launov and Wälde (2013) to 2% by Hochmuth et al. (2019) 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.[42] 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%. Thus, I 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.

Next, I present the findings for the impact of the long-term unemployment benefit introduction on the German county level. Figure 5.19 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 Figure 5.20 shows, the counties in the East contribute more to the decline of aggregate unemployment in Germany, corresponding to the finding of Launov and Wälde (2013). 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 manu-

[42] It is argued that the "Hartz IV-Reform" has two main mechanisms which lead to the 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 my model I focus on the effect of the "Arbeitslosengeld II" and not explicitly count for the time of the first mechanism. I therefore would assume that my findings would be closer to 1 once the impact of the shorter "Arbeitslosengeld II" is accounted for.

Figure 5.19: Change in Regional Unemployment Shares

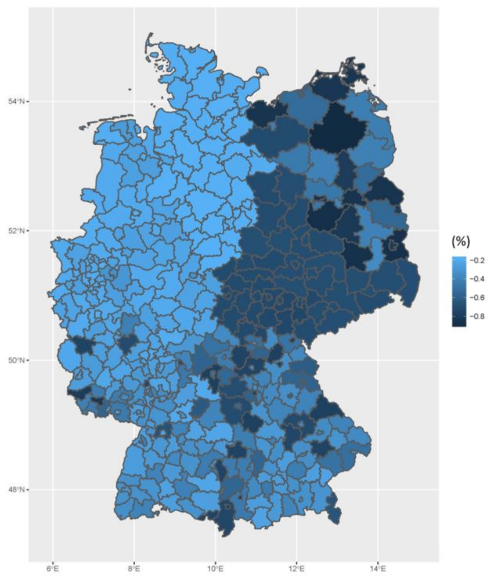
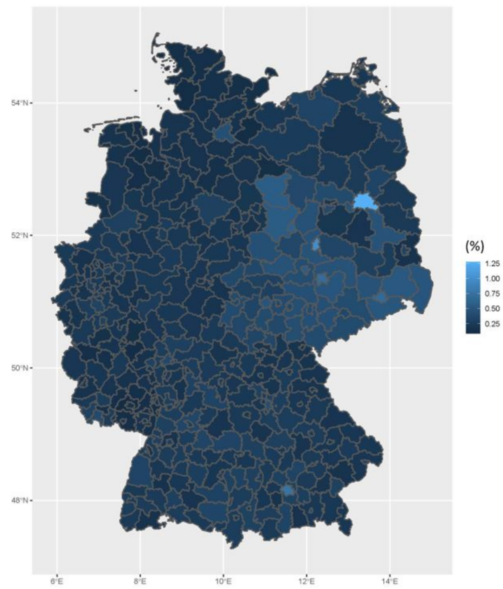


Figure 5.20: Regional Contribution to total Short-Term Unemployment Decrease



The figures are based on the Author's own calculations and rely on the data explained in chapter 5.3.

facturing 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 in Germany, see Figure 5.21 and 5.22. Further, I discover a shift into the trade and commerce sector as well as into the public sector, see appendix 5.A. 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.

Figure 5.21: Changes in Regional Manufacturing Shares

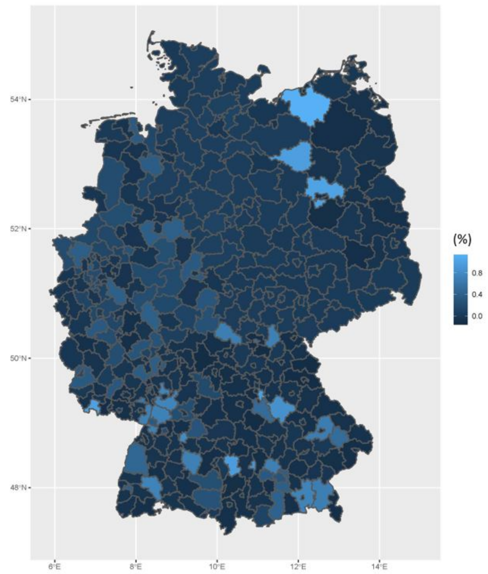
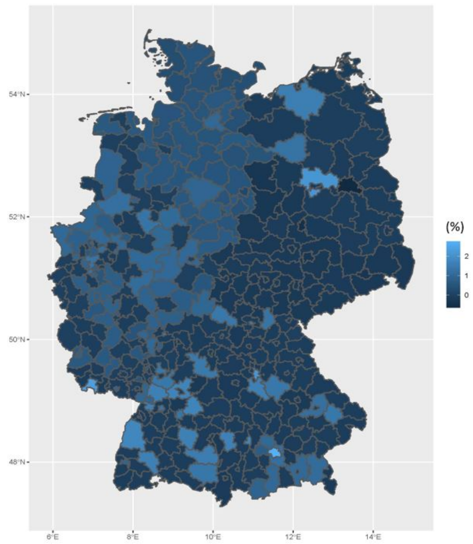


Figure 5.22: Regional Contribution to total Manufacturing Increase



The figures are based on the Author's own calculations and rely on the data explained in chapter 5.3.

5.5 Conclusion

Germany has seen a rapid decline in unemployment after 2005. This paper tries to shed more light on the cause of this development focusing on the employment impact of the "Hartz IV-Reform" (specifically the long-term unemployment benefit effect) and the "rise of the East", which both happened during the same time period. Hereby, my work builds on the dynamic spatial multi-country and multi-sector equilibrium Caliendo et al. (2019) model. I extend the model by including the structure of the long-term unemployment benefit to simulate the effects of the "Hartz IV-Reform". My analysis contains 402 German counties and 43 countries with 7 sectors plus a sector for unemployment and a long-term unemployment sector. To conduct 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.

My findings show that the "Hartz IV-Reform" reduces the short-term unemployment by 0.4%, particularly in the east of Germany. The finding is in line with literature, however, those studies which test for all stages of the labor market reform (Hartz I - Hartz IV) find larger effects. Therefore, my result suggests 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. As I further tested for the impact of the increasing productivities as a possible cause of the "rise of the East" I find a modest impact. Without the "rise of the East" the short-term unemployment would have been 0.03% 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. The moderate result in terms of productivity effects can be traced back to the limited number of Eastern European countries available in the World Input-Output Database (WIOD) as well as the short time period of nine years. For a potential further study, it would be interesting to test for the reduction of trade costs (due to the eastward enlargement of the European Union in 2004 and 2007) as another possible cause of the rising trade flows.

5.A Appendix

Equilibrium in Relative Time Differences

In this section I show how the equilibrium conditions of the three different lifetime utilities in relative time differences are determined.

Starting with the *employment lifetime utility*, the conditions for period t and $t+1$ are given by:

$$V_t^{nj} = U(C_t^{nj}) + \upsilon \log \left(\sum_{i=1}^{N} \exp(\beta V_{t+1}^{i0} - \tau^{nj,i0})^{1/v} \right) + \\ \upsilon(1-\alpha^{nj}) \log \left(\sum_{i=1}^{N} \sum_{k=0}^{J} \exp(\beta V_{t+1}^{ik} - \tau^{nj,ik})^{1/v} \right) + \alpha^{nj} \beta V_{t+1}^{nA}$$

$$V_{t+1}^{nj} = U(C_{t+1}^{nj}) + \upsilon \log \left(\sum_{i=1}^{N} \exp(\beta V_{t+2}^{i0} - \tau^{nj,i0})^{1/v} \right) + \\ \upsilon(1-\alpha^{nj}) \log \left(\sum_{i=1}^{N} \sum_{k=0}^{J} \exp(\beta V_{t+2}^{ik} - \tau^{nj,ik})^{1/v} \right) + \alpha^{nj} \beta V_{t+2}^{nA}$$

Putting these equations together in terms of time differences:

$$V_{t+1}^{nj} - V_t^{nj} = U(C_{t+1}^{nj}) - U(C_t^{nj}) + \upsilon \log \left[\frac{\sum_{i=1}^{N} \exp(\beta V_{t+2}^{i0} - \tau^{nj,i0})^{1/v}}{\sum_{i=1}^{N} \exp(\beta V_{t+1}^{i0} - \tau^{nj,i0})^{1/v}} \right] + \\ \upsilon(1-\alpha^{nj}) \log \left[\frac{\sum_{i=1}^{N} \sum_{k=0}^{J} \exp(\beta V_{t+2}^{ik} - \tau^{nj,ik})^{1/v}}{\sum_{i=1}^{N} \sum_{k=0}^{J} \exp(\beta V_{t+1}^{ik} - \tau^{nj,ik})^{1/v}} \right] + \alpha^{nj} \beta (V_{t+2}^{nA} - V_{t+1}^{nA})$$

The equation can be simplified by the application of $\exp(\beta V_{t+1}^{i0} - \tau^{nj,i0})^{1/v}$ and $\mu_t^{nj,i0}$ for the third term, and by the application of $\exp(\beta V_{t+1}^{ik} - \tau^{nj,ik})^{1/v}$ and $\mu_t^{nj,ik}$ for the fourth term:

$$V_{t+1}^{nj} - V_t^{nj} = U(C_{t+1}^{nj}) - U(C_t^{nj}) + \upsilon \log \left[\sum_{i=1}^{N} \mu_t^{nj,i0} \exp\left(V_{t+2}^{i0} - V_{t+1}^{i0}\right)^{\beta/v} \right] + \\ \upsilon(1-\alpha^{nj}) \log \left[\sum_{i=1}^{N} \sum_{k=0}^{J} \mu_t^{nj,ik} \exp\left(V_{t+2}^{ik} - V_{t+1}^{ik}\right)^{\beta/v} \right] + \alpha^{nj} \beta (V_{t+2}^{nA} - V_{t+1}^{nA})$$

I further apply the assumption of Caliendo et al. (2019) that agents have logarithmic preferences, as well as $u_{t+1}^{i,0}$ and $u_{t+1}^{i,k}$. With the help of the exponential transformation I get an expression of the *employment lifetime utility* in relative time differences:

$$\dot{u}_{t+1}^{nj} = [\dot{\omega}^{nj}(\dot{L}_{t+1}, \dot{\Theta}_{t+1})] \left[\sum_{i=1}^{N} \mu_t^{nj,i0} (\dot{u}_{t+2}^{i0})^{\beta/v} \right]^{v} \left[\sum_{i=1}^{N} \sum_{k=0}^{J} \mu_t^{nj,ik} (\dot{u}_{t+2}^{ik})^{\beta/v} \right]^{v(1-\alpha^{nj})} (\dot{u}_{t+2}^{nA})^{\alpha^{nj}\beta}$$

The approach to identify the *short-term unemployment lifetime utility* in relative time differences follows in a similar fashion:

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

$$V_{t+1}^{n0} = \log b^n + v(1-\delta) \log \left[\sum_{i=1}^{N} \sum_{k=0}^{J} \exp\left(\beta V_{t+2}^{ik} - \tau^{nj,ik}\right)^{1/v} \right] + \delta\beta V_{t+2}^{nA}$$

$$V_{t+1}^{n0} - V_t^{n0} = \log \dot{b}^n + v(1-\delta) \log \left[\frac{\exp\left(\beta V_{t+2}^{ik} - \tau^{nj,ik}\right)^{1/v}}{\exp\left(\beta V_{t+1}^{ik} - \tau^{nj,ik}\right)^{1/v}} \right] + \delta\beta(V_{t+2}^{nA} - V_{t+1}^{nA})$$

$$V_{t+1}^{n0} - V_t^{n0} = \log \dot{b}^n + v(1-\delta) \log \left[\sum_{i=1}^{N} \sum_{k=0}^{J} \mu_t^{nj,ik} \exp\left(V_{t+2}^{ik} - V_{t+1}^{ik}\right)^{\beta/v} \right] + \delta\beta(V_{t+2}^{nA} - V_{t+1}^{nA})$$

Making use of the logarithmic preferences and $u_{t+1}^{i,k}$ as well as applying the exponentials, I can rearrange the equation in terms of relative time differences:

$$\dot{u}_{t+1}^{n0} = \dot{b}^n \left[\sum_{i=1}^{N} \sum_{k=0}^{J} \mu_t^{nj,ik} (\dot{u}_{t+2}^{ik})^{\beta/v} \right]^{v(1-\delta)} (\dot{u}_{t+2}^{nA})^{\delta\beta}$$

The *long-term unemployed lifetime utility* can also be expressed in relative time differences:

$$V_t^{nA} = \log(b_t^A / P_t^n) + (1-\rho^A)\beta V_{t+1}^{nj} + \rho^A \beta [V_{t+1}^{nA}]$$

$$V_{t+1}^{nA} = \log(b_{t+1}^A / P_{t+1}^n) + (1-\rho^A)\beta V_{t+2}^{nj} + \rho^A \beta [V_{t+2}^{nA}]$$

$$V_{t+1}^{nA} - V_t^{nA} = \log(\dot{b}^A / \dot{P}_{t+1^n}) + (1-\rho^A)\beta(V_{t+2}^{nj} - V_{t+1}^{nA}) + \rho^A \beta (V_{t+2}^{nA} - V_{t+1}^{nA})$$

Transforming and rearranging by taking the exponential I get the *long-term un-*

employed lifetime utility in relative time differences:

$$\dot{u}_{t+1}^{nA} = \frac{\dot{b}^A}{\dot{P}_{t+1}^n}(\dot{u}_{t+2}^{nj})^{(1-\rho^A)\beta}(\dot{u}_{t+2}^{nA})^{\rho^A\beta}$$

Counterfactual Equilibrium in Relative Time Differences

Next, the counterfactual equilibrium of the *employment lifetime utility* is derived:

$$\dot{u}_{t+1}^{\prime nj} = \dot{\omega}^{nj}(\dot{L}_{t+1}, \dot{\Theta}_{t+1})' \left[\sum_{i=1}^{N} \mu_t^{\prime nj,i0}(\dot{u}_{t+2}^{\prime i0})^{\beta/v}\right]^v \left[\sum_{i=1}^{N}\sum_{k=0}^{J} \mu_t^{\prime nj,ik}(\dot{u}_{t+2}^{\prime ik})^{\beta/v}\right]^{v(1-\alpha^{nj})} (\dot{u}_{t+2}^{\prime nA})^{\alpha^{nj}\beta}$$

$$\dot{u}_{t+1}^{nj} = [\dot{\omega}^{nj}(\dot{L}_{t+1}, \dot{\Theta}_{t+1})] \left[\sum_{i=1}^{N} \mu_t^{nj,i0}(\dot{u}_{t+2}^{i0})^{\beta/v}\right]^v \left[\sum_{i=1}^{N}\sum_{k=0}^{J} \mu_t^{nj,ik}(\dot{u}_{t+2}^{ik})^{\beta/v}\right]^{v(1-\alpha^{nj})} (\dot{u}_{t+2}^{nA})^{\alpha^{nj}\beta}$$

Rewrite the equations in relative terms:

$$\frac{\dot{u}_{t+1}^{\prime nj}}{\dot{u}_{t+1}^{nj}} = \frac{\dot{\omega}^{nj}(\dot{L}_{t+1}, \dot{\Theta}_{t+1})'}{\dot{\omega}^{nj}(\dot{L}_{t+1}, \dot{\Theta}_{t+1})} \left[\frac{\sum_{i=1}^{N} \mu_t^{\prime nj,i0}(\dot{u}_{t+2}^{\prime i0})^{\beta/v}}{\sum_{i=1}^{N} \mu_t^{nj,ik}(\dot{u}_{t+2}^{ik})^{\beta/v}}\right]^v *$$
$$\left[\frac{\sum_{i=1}^{N}\sum_{k=0}^{J} \mu_t^{\prime nj,ik}(\dot{u}_{t+2}^{\prime ik})^{\beta/v}}{\sum_{i=1}^{N}\sum_{k=0}^{J} \mu_t^{nj,ik}(\dot{u}_{t+2}^{ik})^{\beta/v}}\right]^{v(1-\alpha^{nj})} \left(\frac{\dot{u}_{t+2}^{\prime nA}}{\dot{u}_{t+2}^{nA}}\right)^{\alpha^{nj}\beta}$$

By the application of $\frac{\mu_t^{nj,i0}(\dot{u}_{t+2}^{i0})^{\beta/v}}{\mu_t^{nj,i0}(\dot{u}_{t+2}^{i0})^{\beta/v}}$ and $\frac{\mu_t^{nj,ik}(\dot{u}_{t+2}^{ik})^{\beta/v}}{\mu_t^{nj,ik}(\dot{u}_{t+2}^{ik})^{\beta/v}}$ the equation can be rearranged:

$$\hat{u}_{t+1}^{nj} = \hat{\omega}^{nj}(\hat{L}_{t+1}, \hat{\Theta}_{t+1}) \left[\sum_{i=1}^{N} \frac{\mu_t^{\prime nj,i0}(\dot{u}_{t+2}^{\prime i0})^{\beta/v}}{\sum_{m=1}^{N} \mu_t^{nj,m0}(\dot{u}_{t+2}^{m0})^{\beta/v}}\right]^v *$$
$$\left[\sum_{i=1}^{N}\sum_{k=0}^{J} \frac{\mu_t^{\prime nj,ik}(\dot{u}_{t+2}^{\prime ik})^{\beta/v}}{\sum_{m=1}^{N}\sum_{h=0}^{J} \mu_t^{nj,mh}(\dot{u}_{t+2}^{mh})^{\beta/v}}\right]^{v(1-\alpha^{nj})} (\hat{u}_{t+2}^{nA})^{\alpha^{nj}\beta}$$

$$\hat{u}_{t+1}^{nj} = \hat{\omega}^{nj}(\hat{L}_{t+1}, \hat{\Theta}_{t+1}) \left[\sum_{i=1}^{N} \left(\frac{\mu_t^{\prime nj,i0}}{\mu_t^{nj,i0}}\right) \frac{\mu_t^{nj,i0}(\dot{u}_{t+2}^{\prime i0})^{\beta/v}}{\sum_{m=1}^{N} \mu_t^{nj,m0}(\dot{u}_{t+2}^{m0})^{\beta/v}} \left(\frac{\dot{u}_{t+2}^{\prime nj,i0}}{\dot{u}_{t+2}^{nj,i0}}\right)^{\beta/v}\right]^v *$$
$$\left[\sum_{i=1}^{N}\sum_{k=0}^{J} \left(\frac{\mu_t^{\prime nj,ik}}{\mu_t^{nj,ik}}\right) \frac{\mu_t^{nj,ik}(\dot{u}_{t+2}^{\prime ik})^{\beta/v}}{\sum_{m=1}^{N}\sum_{h=0}^{J} \mu_t^{nj,mh}(\dot{u}_{t+2}^{mh})^{\beta/v}} \left(\frac{\dot{u}_{t+2}^{\prime nj,ik}}{\dot{u}_{t+2}^{nj,ik}}\right)^{\beta/v}\right]^{v(1-\alpha^{nj})} (\hat{u}_{t+2}^{nA})^{\alpha^{nj}\beta}$$

Make use of $\mu_{t+1}^{nj,i0}$, $\mu_{t+1}^{nj,ik}$ to write the equation as the following:

$$\hat{u}_{t+1}^{nj} = \hat{\omega}^{nj}(\hat{L}_{t+1}, \hat{\Theta}_{t+1}) \left[\sum_{i=1}^{N} \left(\frac{\mu_t^{\prime nj,i0}}{\mu_t^{nj,i0}} \right) \mu_{t+1}^{nj,i0} (\hat{u}_{t+2}^{i0})^{\beta/v} \right]^{v} *$$

$$\left[\sum_{i=1}^{N} \sum_{k=0}^{J} \left(\frac{\mu_t^{\prime nj,ik}}{\mu_t^{nj,ik}} \right) \mu_{t+1}^{nj,ik} (\hat{u}_{t+2}^{ik})^{\beta/v} \right]^{v(1-\alpha^{nj})} (\hat{u}_{t+2}^{nA})^{\alpha^{nj}\beta}$$

This leads to the value of the *employment lifetime utility* in counterfactual equilibrium:

$$\hat{u}_{t+1}^{nj} = \hat{\omega}^{nj}(\hat{L}_{t+1}, \hat{\Theta}_{t+1}) \left[\sum_{i=1}^{N} \mu_t^{\prime nj,i0} \dot{\mu}_{t+1}^{nj,i0} (\hat{u}_{t+2}^{i0})^{\beta/v} \right]^{v} *$$

$$\left[\sum_{i=1}^{N} \sum_{k=0}^{J} \mu_t^{\prime nj,ik} \dot{\mu}_{t+1}^{nj,ik} (\hat{u}_{t+2}^{ik})^{\beta/v} \right]^{v(1-\alpha^{nj})} (\hat{u}_{t+2}^{nA})^{\alpha^{nj}\beta}$$

The *short-term unemployment lifetime utility* in the counterfactual equilibrium is calculated in the following:

$$\dot{u}_{t+1}^{\prime n0} = \dot{b}^{\prime n} \left[\sum_{i=1}^{N} \sum_{k=0}^{J} \mu_t^{\prime nj,ik} (\dot{u}_{t+2}^{\prime ik})^{\beta/v} \right]^{v(1-\delta)} (\dot{u}_{t+2}^{\prime nA})^{\delta\beta}$$

$$\dot{u}_{t+1}^{n0} = \dot{b}^{n} \left[\sum_{i=1}^{N} \sum_{k=0}^{J} \mu_t^{nj,ik} (\dot{u}_{t+2}^{ik})^{\beta/v} \right]^{v(1-\delta)} (\dot{u}_{t+2}^{nA})^{\delta\beta}$$

Rewrite the equations in relative terms:

$$\hat{u}_{t+1}^{n0} = \hat{b}^{n} \left[\frac{\sum_{i=1}^{N} \sum_{k=0}^{J} \mu_t^{\prime nj,ik} (\dot{u}_{t+2}^{\prime ik})^{\beta/v}}{\sum_{i=1}^{N} \sum_{k=0}^{J} \mu_t^{nj,ik} (\dot{u}_{t+2}^{ik})^{\beta/v}} \right]^{v(1-\delta)} (\hat{u}_{t+2}^{nA})^{\delta\beta}$$

As before, apply $\frac{\mu_t^{nj,ik} (\dot{u}_{t+2}^{ik})^{\beta/v}}{\mu_t^{nj,ik} (\dot{u}_{t+2}^{ik})^{\beta/v}}$:

$$\hat{u}_{t+1}^{n0} = \hat{b}^{n} \left[\sum_{i=1}^{N} \sum_{k=0}^{J} \frac{\mu_t^{\prime nj,ik} (\dot{u}_{t+2}^{\prime ik})^{\beta/v}}{\sum_{m=1}^{N} \sum_{h=0}^{J} \mu_t^{nj,mh} (\dot{u}_{t+2}^{mh})^{\beta/v}} \right]^{v(1-\delta)} (\hat{u}_{t+2}^{nA})^{\delta\beta}$$

$$\hat{u}^{n0}_{t+1} = \hat{b}^n \left[\sum_{i=1}^{N} \sum_{k=0}^{J} \left(\frac{\mu'^{nj,ik}_t}{\mu^{nj,ik}_t} \right) \frac{\mu^{nj,ik}_t (\dot{u}'^{ik}_{t+2})^{\beta/v}}{\sum_{m=1}^{N} \sum_{h=0}^{J} \mu^{nj,mh}_t (\dot{u}^{mh}_{t+2})^{\beta/v}} \left(\frac{\dot{u}'^{nj,ik}_{t+2}}{\dot{u}^{nj,ik}_{t+2}} \right)^{\beta/v} \right]^{v(1-\delta)} (\hat{u}^{nA}_{t+2})^{\delta\beta}$$

Use $\mu^{nj,ik}_{t+1}$ and rewrite:

$$\hat{u}^{n0}_{t+1} = \hat{b}^n \left[\sum_{i=1}^{N} \sum_{k=0}^{J} \left(\frac{\mu'^{nj,ik}_t}{\mu^{nj,ik}_t} \right) \mu^{nj,ik}_{t+1} (\hat{u}^{ik}_{t+2})^{\beta/v} \right]^{v(1-\delta)} (\hat{u}^{nA}_{t+2})^{\delta\beta}$$

The *short-term unemployment lifetime utility* in the counterfactual equilibrium is given by:

$$\hat{u}^{n0}_{t+1} = \hat{b}^n \left(\sum_{i=1}^{N} \sum_{k=0}^{J} \mu'^{nj,ik}_t \mu^{nj,ik}_{t+1} (\hat{u}^{ik}_{t+2})^{\beta/v}) \right)^{v(1-\delta)} (\hat{u}^{nA}_{t+2})^{\delta\beta}$$

Lastly, I derive the *long-term unemployed lifetime utility* in the counterfactual equilibrium:

Starting with the counterfactual and baseline scenario:

$$\dot{u}'^{nA}_{t+1} = \frac{\dot{b}'^A}{\dot{P}'^{\,n}_{t+1}} (\dot{u}'^{nj}_{t+2})^{(1-\rho^A)\beta} (\dot{u}'^{nA}_{t+2})^{\rho^A \beta}$$

$$\dot{u}^{nA}_{t+1} = \frac{\dot{b}^A}{\dot{P}^n_{t+1}} (\dot{u}^{nj}_{t+2})^{(1-\rho^A)\beta} (\dot{u}^{nA}_{t+2})^{\rho^A \beta}$$

I then derive the equations in relative terms of the counterfactual equilibrium:

$$\hat{u}^{nA}_{t+1} = \frac{\hat{b}^A}{\hat{P}^n_{t+1}} (\hat{u}^{nj}_{t+2})^{(1-\rho^A)\beta} (\hat{u}^{nA}_{t+2})^{\rho^A \beta}$$

Extended Version - Punishment

In this section let us introduce sanctions on the lifetime utility of a long-term unemployed household. As mentioned in the introduction, in the case of a breach of duty the long-term unemployment benefit is cut by 30%. I introduce ψ^A, which is the probability that a long-term unemployed recipient will not take up an offered job and is therefore punished by receiving 30% less benefit in the next period. The value of the long-term unemployed households at time t is then given by:

$$V_t^{nA} = \log\left(\frac{b_t^A}{P_t^n}\right) + (1-\rho^A)\beta V_{t+1}^{nj} + \rho^A\beta\Bigg[(1-\psi^A)\log\left(\frac{[b_{t+1}^A]}{P_{t+1}^n}\right) + (\psi^A)\log\left(\frac{[b_{t+1}^A * 0.3]}{P_{t+1}^n}\right) + (1-\rho^A)\beta V_{t+2}^{nj} + \rho^A\beta[V_{t+2}^{nA}]\Bigg]$$

Strategy to solve the Model

To analyze the effects of the German labor market reform and the "rise of the East" my simulations are based on the code and the algorithms provided by Caliendo et al. (2019). The strategy to conduct the simulation involves first the construction of the *Base Economy*, which solves for the equilibrium conditions of the base year of 2005 (when the German labor market reform (in particular Hartz IV) was introduced). In a second step the so called *Baseline Economy* for the time span of 2005 to 2014 is composed. This is done by the calibration of the time series data for each year.[43] Using the results of the *Base Economy* and the time series data the equilibrium allocations of the *Baseline Economy* for all the years are constructed by the application of *Algorithm I*. After having identified the *Baseline Economy* I can then turn to the *Counterfactual Economy*, which is solved by the use of *Algorithm II*[44]. Herewith, I simulate the scenarios were on the one hand the German labor market reform is eliminated and on the other hand

[43] Following Caliendo et al. (2019) in this step, time series data of the bilateral trade flows, bilateral trade shares, expenditure levels, labor allocations and the gross output flows for each year are identified.

[44] For the temporary equilibrium to be solved, which is necessary to help solve the *Algorithm II*, the *Algorithm I* is also applied.

the productivity rise of the Eastern European countries (or Germany) do not occur. Taking the difference between the *Base Economy* and the *Counterfactual Economy* provides the results of the effect.

Algorithm I: Sequential Competitive Equilibrium

I rely on the algorithms of Caliendo et al. (2019) and further extend it to fit my analysis. The Algorithm I has the allocations $\{L_0^{nj}, L_0^{n0}, L_0^{nA}, \pi_0, X_0\, \mu_{-1}\}$ and $\{\dot{\Theta}_t\}_{t=1}^{\infty}$ as input requirements.[45] In the following the superscript (0) denotes to the number of rounds of guesses, starting with zero. The Algorithm I starts in the following way:

1. **Guess a path of $\{\dot{u}_{t+1}^{nA(0)}\}_{t=0}^{T}$**
2. **Guess a path of $\{\dot{u}_{t+1}^{n0(0)}\}_{t=0}^{T}$**
   (a) **Solve for the path of migration flows $\{\mu_t^{i0,nj}\}_{t=0}^{T}$**
3. **Guess a path of $\{\dot{u}_{t+1}^{nj(0)}\}_{t=0}^{T}$**
   (a) **Solve for the path of $\{\mu_t^{nj,ik}\}_{t=0}^{T}$ by the application of $\{\dot{u}_{t+1}^{nj(0)}\}_{t=0}^{T}$ and $\mu_{-1}^{nj,ik}$ for $t \geq 0$.**
4. **Get the path for $\{L_{t+1}^{nj}\}_{t=0}^{T}$**
   By relying on $\{\mu_t^{nj,ik}\}_{t=0}^{T}$, $\{\mu_t^{i0,nj}\}_{t=0}^{T}$ and $L_0^{nj}, L_0^{n0}, L_0^{nA}$, as well as $\alpha^{ik}, \delta, \rho^A$ and solving with:

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

5. **Get the path for $\{L_{t+1}^{nA}\}_{t=0}^{T}$**
   By using $L_0^{nj}, L_0^{n0}, L_0^{nA}$, as well as $\alpha^{ik}, \delta, \rho^A$ and insert it in $L_{t+1}^{nA} = \rho^A L_t^{nA} + \delta L_t^{n0} + \alpha^{nj} L_t^{nj}$
6. **Determination of the temporary equilibrium:**
   (a) With $\dot{L}_{t+1}^{nj}$, take a guess for $\dot{\omega}_{t+1}^{nj}$ $(t \geq 0)$
   (b) Solve for $\dot{x}_{t+1}^{nj}$, $\dot{P}_{t+1}^{nj}$, and $\dot{\pi}_{t+1}^{nj}$ by applying the following equilibrium

[45] In addition, $\gamma^{nk,nj}, L_0^{nj}, L_0^{n0}, L_0^{nA}, \mu_{-1}^{nj,ik}, \pi_0^{ni,nj}, w_0^{nj} L_0^{nj}, r_0^{nj} H_0^{nj}, \alpha^{ik}, \delta, \rho^A, \eta^j, b^A, G, \iota^n$ needs to be provided.

equations:
$\dot{x}^{nj}_{t+1} = (\dot{L}^{nj}_{t+1})^{\gamma^{nj}\xi^n}(\dot{\omega}^{nj}_{t+1})^{\gamma^{nj}} \prod_{k=1}^{J}(\dot{P}^{nj}_{t+1})^{\gamma^{nj,nk}}$,
$\dot{P}^{nj}_{t+1} = \left(\sum_{i=1}^{N} \pi^{nj,ij}_t (\dot{x}^{ij}_{t+1}, \dot{\kappa}^{nj,ij}_{t+1})^{-\theta^j} (\dot{A}^{ij}_{t+1})^{\theta^j \gamma^{ij}}\right)^{-1/\theta^j}$,
$\pi^{nj,ij}_{t+1} = \pi^{nj,ij}_t \left(\frac{\dot{x}^{ij}_{t+1}\dot{\kappa}^{nj,ij}_{t+1}}{\dot{P}^{nj}_{t+1}}\right)^{-\theta^j} (\dot{A}^{ij}_{t+1})^{\theta^j\gamma^{ij}}$

(c) Solve for X^{nj}_{t+1} by relying on $\pi^{nj,ij}_{t+1}$, $\dot{\omega}^{nj}_{t+1}$, $\dot{L}^{nj}_{t+1}$ and

$$X^{nj}_{t+1} = \sum_{k=1}^{J} \gamma^{nk,nj} \sum_{i=1}^{N} \pi^{ik,nk}_{t+1} X^{ik}_{t+1} + \eta^j \left(\sum_{k=1}^{J} \dot{\omega}^{nk}_{t+1} \dot{L}^{nk}_{t+1} \omega^{nk}_t L^{nk}_t + b^A_{t+1} L'^A_{t+1} + \iota^n \chi'_{t+1} - G_{t+1}/N\right)$$

(d) The following equation needs to hold
$\dot{\omega}^{nj}_{t+1}\dot{L}^{nj}_{t+1}\omega^{nj}_t L^{nj}_t = \gamma^{nj}(1-\xi^n)\sum_{i=1}^{N} \pi^{ij,nj}_{t+1} X^{ij}_{t+1}$,
otherwise, return to (a) until the temporary equilibrium conditions hold.

(e) Get the path $\{\dot{\omega}^{nj}_{t+1}, \dot{P}^{nj}_{t+1}\}^T_{t=0}$ by conducting the temporary equilibrium for each period t.

7. **Solve for $\dot{u}^{nj(1)}_{t+1}$**
By inserting $\mu^{nj,i0}_t$, $\mu^{nj,ik}_t$, $\dot{\omega}^{nj}_{t+1}$ and the guesses of $\dot{u}^{n0(0)}_{t+2}$, $\dot{u}^{nj(0)}_{t+2}$, $\dot{u}^{nA(0)}_{t+2}$ for each period t into the equation:

$$\dot{u}^{nj}_{t+1} = [\dot{\omega}^{nj}(\dot{L}_{t+1}, \dot{\Theta}_{t+1})]\left[\sum_{i=1}^{N} \mu^{nj,i0}_t (\dot{u}^{i0}_{t+2})^{\beta/v}\right]^v \left[\sum_{i=1}^{N}\sum_{k=0}^{J} \mu^{nj,ik}_t (\dot{u}^{ik}_{t+2})^{\beta/v}\right]^{v(1-\alpha^{nj})} (\dot{u}^{nA}_{t+2})^{\alpha^{nj}\beta}$$

(a) **This gives a new result for $\{\dot{u}^{nj(1)}_{t+1}\}^T_{t=0}$**

(b) **Check if $\{\dot{u}^{nj(1)}_{t+1}\}^T_{t=0} \simeq \{\dot{u}^{nj(0)}_{t+1}\}^T_{t=0}$ holds, otherwise start guessing at step 3 again.**

8. **Solve for $\dot{u}^{n0(1)}_{t+1}$**
By inserting $\dot{b}^n$, $\mu^{nj,ik}_t$ and the guesses of $\dot{u}^{nj(1)}_{t+2}$, $\dot{u}^{nA(0)}_{t+2}$ for each period t into the equation:

$$\dot{u}^{n0}_{t+1} = \dot{b}^n \left[\sum_{i=1}^{N}\sum_{k=0}^{J} \mu^{nj,ik}_t (\dot{u}^{ik}_{t+2})^{\beta/v}\right]^{v(1-\delta)} (\dot{u}^{nA}_{t+2})^{\delta\beta} \tag{5.40}$$

(a) **This gives a new result for $\{\dot{u}^{n0(1)}_{t+1}\}^T_{t=0}$**

(b) **Check if $\{\dot{u}^{n0(1)}_{t+1}\}^T_{t=0} \simeq \{\dot{u}^{n0(0)}_{t+1}\}^T_{t=0}$ holds, otherwise start guessing**

at step 2 again.

9. **Solve for** $\dot{u}^{nA}_{t+1}$

   By inserting $\dot{b}^{A}$, $\dot{P}^{n}_{t+1}$ and the guesses of$\dot{u}^{nj(1)}_{t+2}$, $\dot{u}^{nA(0)}_{t+2}$ for each period t into the equation:

$$\dot{u}^{nA}_{t+1} = \frac{\dot{b}^{A}}{\dot{P}^{n}_{t+1}}(\dot{u}^{nj}_{t+2})^{(1-\rho)\beta}(\dot{u}^{nA}_{t+2})^{\rho\beta} \tag{5.41}$$

   (a) **This gives a new result for** $\{\dot{u}^{nA(1)}_{t+1}\}^{T}_{t=0}$

   (b) **Check if** $\{\dot{u}^{nA(1)}_{t+1}\}^{T}_{t=0} \simeq \{\dot{u}^{nA(0)}_{t+1}\}^{T}_{t=0}$ **holds, otherwise start guessing at step 1 again.**

Algorithm II: Solving for Counterfactuals

Algorithm II requires the baseline economy $\{L_t, \pi_t, \mu_{t-1}, X_t\}_{t=0}^{\infty}$ as well as the sequential competitive equilibrium allocations of the baseline economy $\{\dot{L}_t, \dot{\pi}_t, \dot{\mu}_{t-1}, \dot{X}_t\}_{t=0}^{\infty}$ and $\{\hat{\Theta}_t\}_{t=1}^{\infty}$ as inputs.[46] In the following the superscript (0) denotes to the number of rounds of guesses, starting with zero. The Algorithm II begins as follows:

1. **Guess a path of** $\{\hat{u}_{t+1}^{nA(0)}\}_{t=0}^{T}$
2. **Guess a path of** $\{\hat{u}_{t+1}^{n0(0)}\}_{t=0}^{T}$
   (a) **Solve for the path of migration flows** $\{\mu_t'^{i0,nj}\}_{t=0}^{T}$ **for** $t \geq 0$.
3. **Guess a path of** $\{\hat{u}_{t+1}^{n,j(0)}\}_{t=0}^{T}$
   (a) **Solve for the path of** $\{u_t'^{nj}\}_{t=0}^{T}$ **by the application of** $\{\hat{u}_{t+1}^{nj(0)}\}_{t=0}^{T}$ **and** $\{\dot{\mu}_{t-1}\}_{t=0}^{\infty}$ **for** $t \geq 0$.
4. **Get the path for** $\{L_{t+1}'^{nj}\}_{t=0}^{T}$
   By relying on $\{\mu_t'^{nj,ik}\}_{t=0}^{T}$, $\{\mu_t'^{i0,nj}\}_{t=0}^{T}$ and $L_0'^{nj}, L_0'^{n0}, L_0'^{nA}$, as well as $\alpha^{ik}, \delta, \rho^A$ and solving with:

$$L_{t+1}'^{nj} = \sum_{i=1}^{N}\sum_{k\neq 0}^{J} \mu_t'^{ik,nj}(1-\alpha^{ik})L_t'^{ik} + \sum_{i=1}^{N} \mu_t'^{i0,nj}(1-\delta)L_t'^{i0} + (1-\rho^A)L_t'^{nA}/J$$

5. **Get the path for** $\{L_{t+1}'^{nA}\}_{t=0}^{T}$
   By using $L_0'^{nj}, L_0'^{n0}, L_0'^{nA}$, as well as $\alpha^{ik}, \delta, \rho^A$ to insert in $L_{t+1}'^{nA} = \rho^A L_t'^{nA} + \delta L_t'^{n0} + \alpha^{nj} L_t'^{nj}$
6. **Determination of the temporary equilibrium:**
   (a) With $\hat{L}_{t+1}^{nj}$, take a guess for $\{\hat{\omega}_{t+1}^{nj}\}_{n=1,j=0}^{N,J}$
   (b) Solve for $\hat{x}_{t+1}^{nj}$, $\hat{P}_{t+1}^{nj}$, and $\hat{\pi}_{t+1}^{nj,ij}$ by applying following equilibrium equations:
   $\hat{x}_{t+1}^{nj} = (\hat{L}_{t+1}^{nj})^{\gamma^{nj}\xi^n}(\hat{\omega}_{t+1}^{nj})^{\gamma^{nj}} \prod_{k=1}^{J}(\hat{P}_{t+1}^{nk})^{\gamma^{nj,nk}}$,
   $\hat{P}_{t+1}^{nj} = \left(\sum_{i=1}^{N} \pi_t'^{nj,ij} \dot{\pi}_{t+1}^{nj,ij} (\hat{x}_{t+1}^{ij}, \hat{\kappa}_{t+1}^{nj,ij})^{-\theta^j} (\hat{A}_{t+1}^{ij})^{\theta^j\gamma^{ij}} \right)^{-1/\theta^j}$,

[46] In addition $\gamma^{nk,nj}, L_0^{nj}, L_0^{n0}, L_0^{nA}, \mu_{-1}^{nj,ik}, \pi_0^{ni,nj}, w_0^{nj} L_0^{nj}, r_0^{nj} H_0^{nj}, \alpha^{ik}, \delta, \rho^A, \eta^j, b^A, G, \iota^n$ needs to be provided.

$$\pi'^{nj,ij}_{t+1} = \pi'^{nj,ij}_{t}\pi^{nj,ij}_{t+1}\left(\frac{\hat{x}^{ij}_{t+1}\hat{\kappa}^{nj,ij}_{t+1}}{\hat{P}^{nj}_{t+1}}\right)^{-\theta^j}(\hat{A}^{ij}_{t+1})^{\theta^j\gamma^{ij}}$$

(c) Solve for X'^{nj}_{t+1} by relying on $\pi'^{nj,ij}_{t+1}$, $\omega'^{nk}_{t}\mathrm{L}'^{nk}_{t}$, $\dot{\omega}^{nk}_{t+1}\dot{L}^{nk}_{t+1}$, $\hat{L}^{nj}_{t+1}$ and

$$X'^{nj}_{t+1} = \sum_{k=1}^{J}\gamma^{nk,nj}\sum_{i=1}^{N}\pi'^{ik,nk}_{t+1}X'^{ik}_{t+1} +$$
$$\eta^j\left(\sum_{k=1}^{J}\hat{\omega}^{nk}_{t+1}\hat{L}^{nk}_{t+1}\dot{\omega}^{nk}_{t+1}\dot{L}^{nk}_{t+1}\omega'^{nk}_{t}L'^{nk}_{t} + b^{A}_{t+1}L^{A}_{t+1} + \iota^n\chi_{t+1} - G_{t+1}/N\right)$$

(d) The following equation needs to hold
$\hat{\omega}^{nk}_{t+1}\hat{L}^{nk}_{t+1} = \frac{\gamma^{nj}(1-\xi^n)}{\omega'^{nk}_{t}L'^{nk}_{t}\dot{\omega}^{nj}_{t+1}\dot{L}^{nj}_{t+1}}\sum_{i=1}^{N}\pi'^{ij,nj}_{t+1}X'^{ij}_{t+1}$,
otherwise return to (a) until the temporary equilibrium conditions holds.

(e) Get the path $\{\hat{\omega}^{nj}_{t+1}\hat{P}^{nj}_{t+1}\}^{N,J,T}_{n=1,j=0,t=0}$ by conducting the temporary equilibrium for each period t.

7. **Solve for $\hat{u}^{nj(1)}_{t+1}$**
   (a) **This gives a new result for $\{\hat{u}^{nj(1)}_{t+1}\}^{T}_{t=0}$**
   (b) **Check if $\{\hat{u}^{nj(1)}_{t+1}\}^{T}_{t=0} \simeq \{\hat{u}^{nj(0)}_{t+1}\}^{T}_{t=0}$ holds, otherwise start guessing at step 3 again.**
8. **Solve for $\hat{u}^{n0(1)}_{t+1}$**
   (a) **Check if $\{\hat{u}^{n0(1)}_{t+1}\}^{T}_{t=0} \simeq \{\hat{u}^{n0(0)}_{t+1}\}^{T}_{t=0}$ holds, otherwise start guessing at step 2 again.**
9. **Solve for $\hat{u}^{nA}_{t+1}$**
   (a) **Check if $\{\hat{u}^{nA(1)}_{t+1}\}^{T}_{t=0} \simeq \{\hat{u}^{nA(0)}_{t+1}\}^{T}_{t=0}$ holds, otherwise start guessing at step 1 again.**

Additional Results

Productivity Change

Table 5.A.5: Sectoral Productivity Changes for Eastern European Countries (between 2005 and 2014)

	Sector 1	**Sector 2**	**Sector 3**	**Sector 4**
CZE	16.90%	7.28%	8.32%	2.21%
HUN	21.50%	7.69%	10.98%	2.18%
POL	24.80%	10.47%	16.14%	5.87%
SVK	26.69%	0.01%	7.58%	20.50%
EST	8.47%	8.26%	16.56%	0.01%
LVA	12.16%	16.17%	13.09%	18.93%
LTU	6.88%	0.09%	19.60%	19.53%
SVN	28.88%	2.53%	13.07%	5.91%
BGR	5.98%	17.26%	9.02%	0.10%
HRV	16.26%	2.60%	5.49%	0.30%
ROU	18.81%	27.46%	15.38%	0.03%

Agriculture and forestry, fisheries (Sector 1), Manufacturing without construction (Sector 2), Manufacturing (Sector 3), Construction (Sector 4)

Source: World Input Output Database, Release 2016; Author's own calculations.

Productivity Effect of Eastern Europe

Figure 5.A.23: Changes in Regional Agriculture Shares

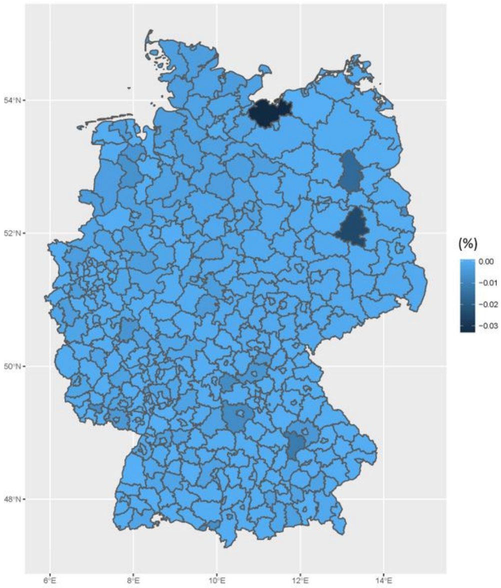
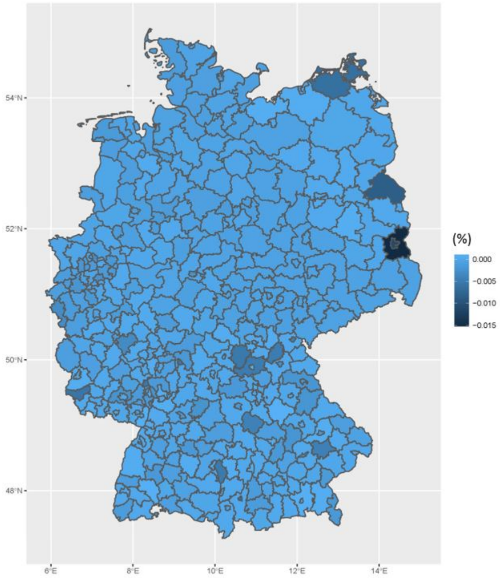


Figure 5.A.24: Changes in Regional Production Shares



The figures are based on the Author's own calculations and rely on the data explained in chapter 5.3.

Figure 5.A.25: Changes in Regional Public Sector Shares

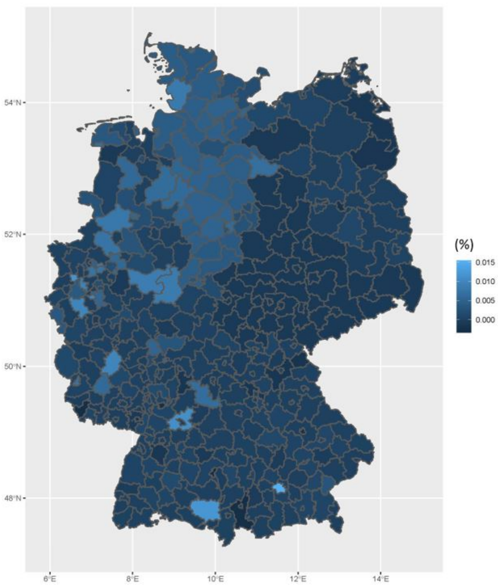
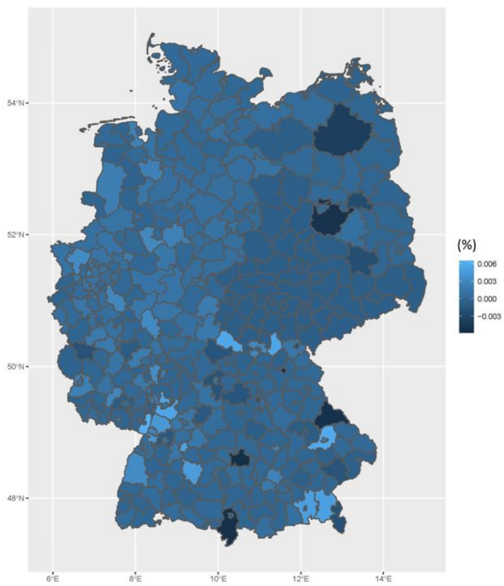


Figure 5.A.26: Changes in Regional Construction Shares



The figures are based on the Author's own calculations and rely on the data explained in chapter 5.3.

Figure 5.A.27: Changes in Regional Trade and Commerce Shares

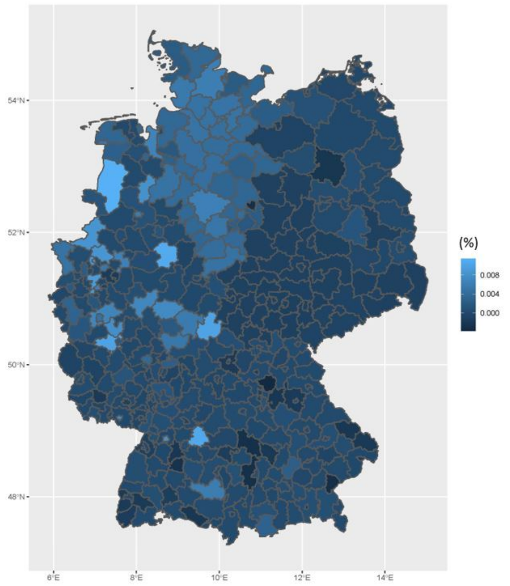
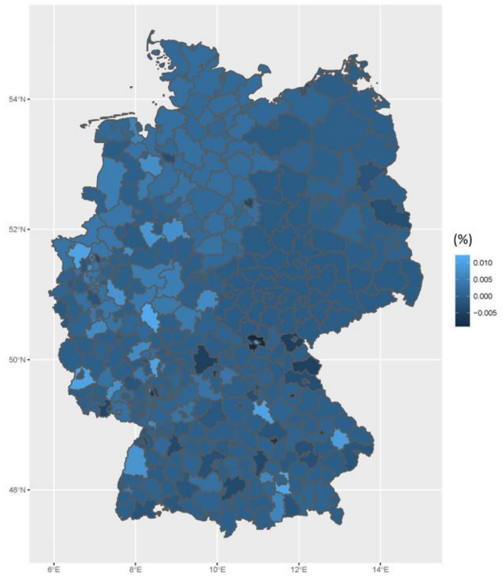


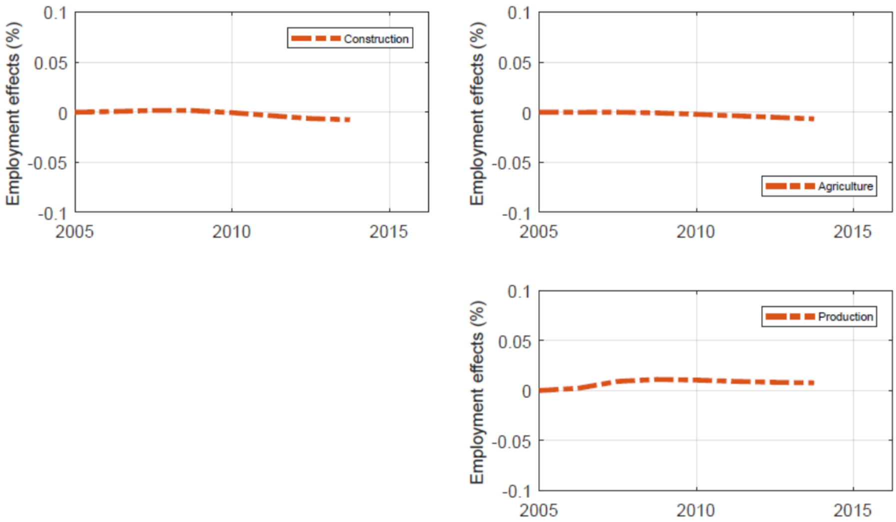
Figure 5.A.28: Changes in Regional Finance Sector Shares



The figures are based on the Author's own calculations and rely on the data explained in chapter 5.3.

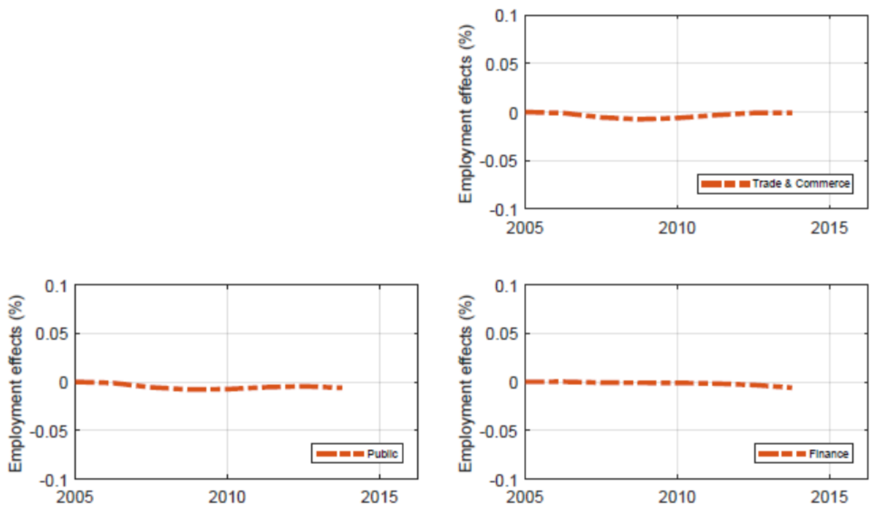
German Productivity Effect

Figure 5.A.29: Overview of the German Productivity Impact on the Agriculture-, Production- and Construction Sector



The figures are based on the Author's own calculations and rely on the data explained in chapter 5.3.

Figure 5.A.30: Overview of the German Productivity Impact on the Trade-, Commerce-, Finance- and Public Sector



The figures are based on the Author's own calculations and rely on the data explained in chapter 5.3.

Figure 5.A.31: Changes in Regional Agriculture Shares

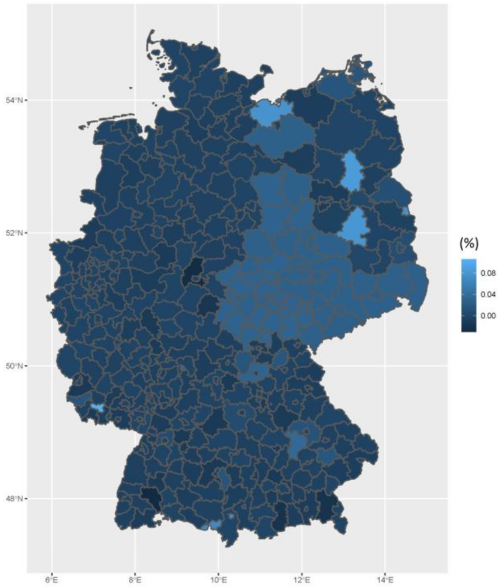
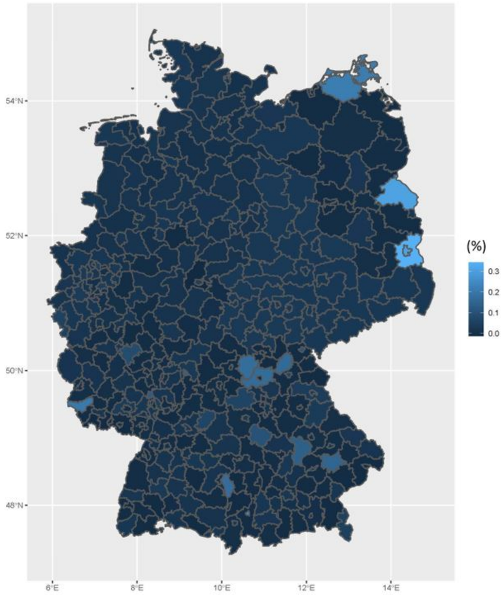


Figure 5.A.32: Changes in Regional Production Shares



The figures are based on the Author's own calculations and rely on the data explained in chapter 5.3.

Figure 5.A.33: Changes in Regional Public Sector Shares

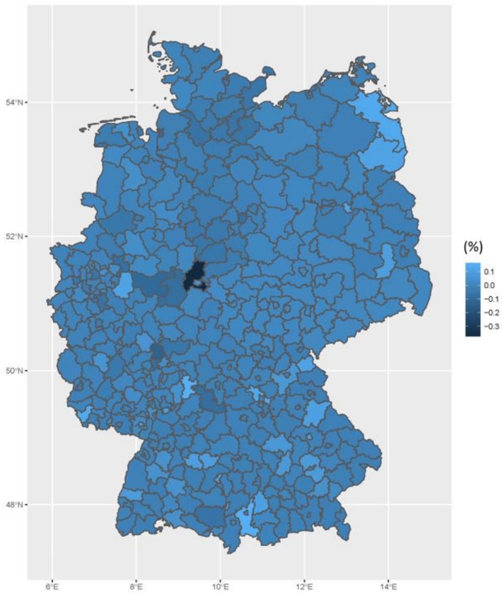
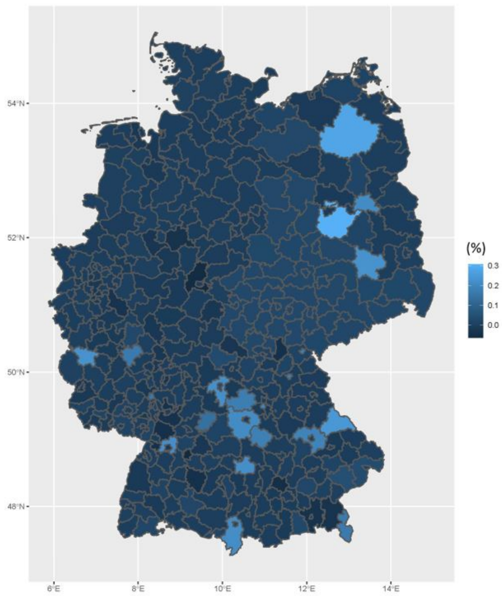


Figure 5.A.34: Changes in Regional Construction Shares



The figures are based on the Author's own calculations and rely on the data explained in chapter 5.3.

Figure 5.A.35: Changes in Regional Trade and Commerce Shares

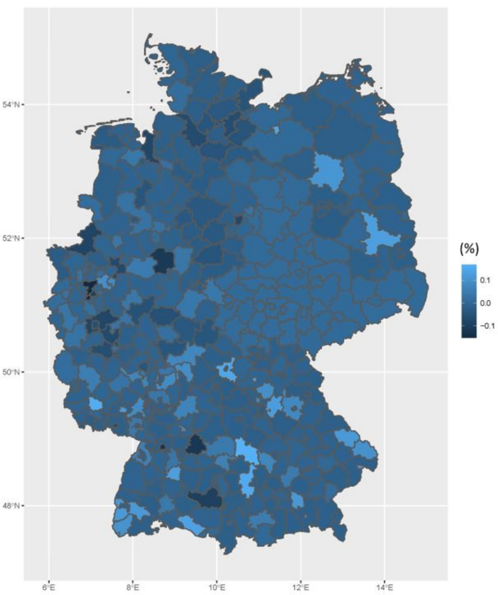
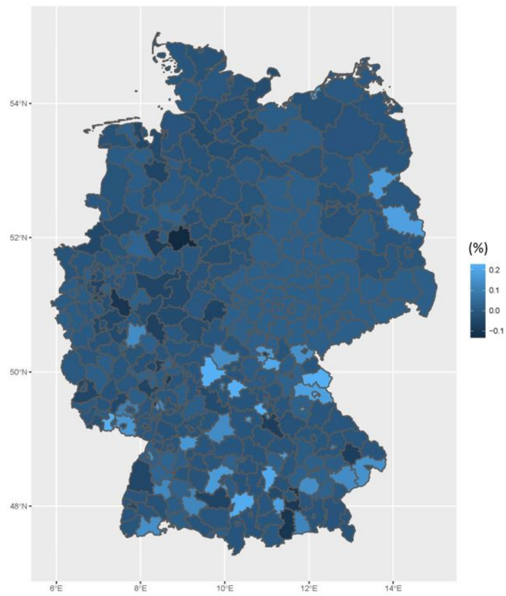


Figure 5.A.36: Changes in Regional Finance Sector Shares



The figures are based on the Author's own calculations and rely on the data explained in chapter 5.3.

Long-Term Unemployment Benefit Effect

Figure 5.A.37: Changes in Regional Trade and Commerce Shares

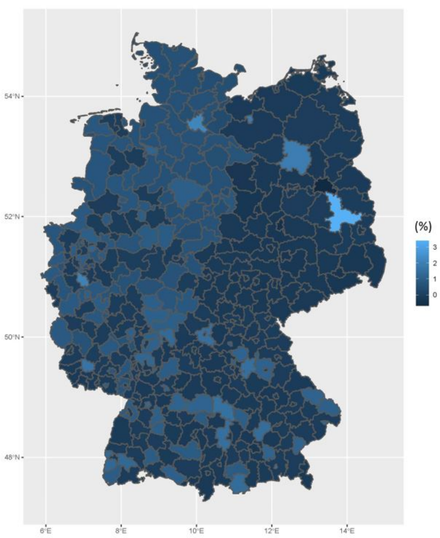
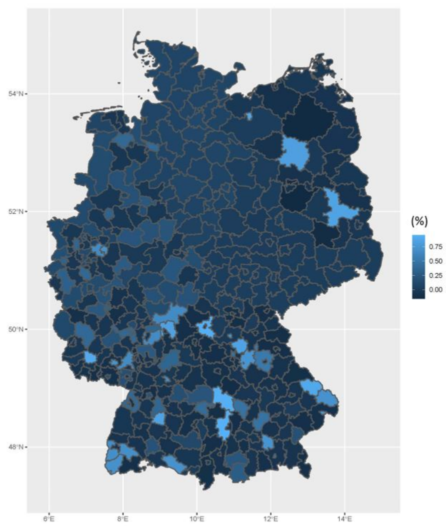


Figure 5.A.38: Regional Contribution to total Trade and Commerce Increase



The figures are based on the Author's own calculations and rely on the data explained in chapter 5.3.

Figure 5.A.39: Changes in Regional Public Sector Shares

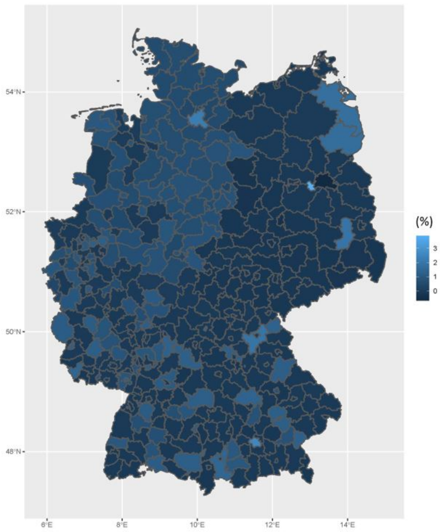
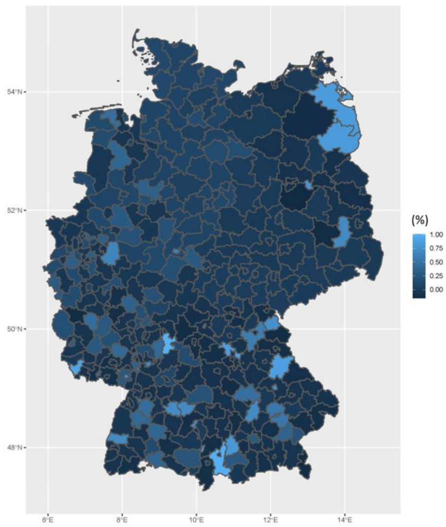


Figure 5.A.40: Regional Contribution to total Public Sector Increase



The figures are based on the Author's own calculations and rely on the data explained in chapter 5.3.

Chapter 6

Social Welfare and Income Inequality in Germany

6.1 Introduction

In the year 2000, Germany had the largest average income tax rate of all OECD countries with 43.2% (OECD (2020a)). In order to reduce the high tax rate, the German government introduced the "Tax-Reform 2000".[1] A key element of the tax-reform was to improve the income tax system. From 2001 to 2005 the German government reduced the top income tax from 53% to 42% and the lowest income tax rate from 25.9% to 15%. Additionally, the basic tax allowance was raised from 6322 Euro to 7664 Euro (Bundesministerium der Finanzen (2004)). In the following years of 2005, the income tax system was further improved.

For most households the German tax-reform led to an income increase, however, higher income households benefited more from the tax-reform than lower income households. This could have led to a rise in income inequality, as the German Gini coefficient, a measure of income dispersion after taxes and transfers, indicates. The Gini coefficient increased from 0.25 to 0.305 over the period from 1998 to 2007. Though, as the OECD reports the income inequality has risen in Germany

[1] The income tax rate was even higher before 2000. Starting in 1998 measures were taken by the German government to reduce the income tax rate (e.g. reduction of the top income tax rate and increase of the basic tax allowance).

and many other countries over the last decades, Cingano (2014).

In this study we are interested in the effects of the "Tax-Reform 2000" on income inequality. In particular, we want to examine the contribution of the tax-reform to the increase of income inequality in Germany. But even more importantly, we are interested in the growth of the social welfare rising from the German tax-reform. The social welfare growth is typically determined by taking the growth of (aggregated) income into consideration. However, how does income inequality impact the social welfare growth? And what would have been the optimal tax progressivity in the context of the "Tax-Reform 2000", when taking income inequality into account?

In order to tackle these questions, we apply the new social welfare model by Antràs et al. (2017).[2] The model builds on the Kaldor-Hicks compensation principle, developed by Kaldor (1939) and Hicks (1939). The Kaldor-Hicks compensation principle is commonly used to analyze social welfare by taking a utilitarian approach and by concentrating on the growth of (aggregated) income. In a Kaldor-Hicks economy the aggregated surpluses of those agents benefiting from the policy change have the potential to compensate the agents being negatively impacted by the policy change via the costless lump-sum transfers.
Antràs et al. (2017) extend the Kaldor-Hicks approach by accounting for inequality aversion of the society which gives rise to the *welfarist-correction term* in the social welfare formula. Hereby, the model incorporates the constant degree of inequality-aversion relying on the concept of risk aversion.[3] On top of

[2]Hereby, we are thankful for the *Matlab-Code* provided by Antràs et al. (2017) on which this paper is built on. We extend the code to fit the German economic environment and to derive the optimal tax rate, that maximizes the German social welfare for each year of the period.

[3]In general, the concept of risk aversion states how a decision is made under uncertainty, when one or more alternatives are available, which shapes the utility function of an individual or of the social planner, as in the case of this paper. According to the literature, it is arguable how to measure inequality- (or risk-) aversion, because on the one hand it relies on personal preferences and there are many approaches that try to capture risk aversion. On the other hand, it is debatable if the inequality- (or risk-) aversion can even be considered as a constant (see Thomas (2016)).

inequality aversion, the authors consider a progressive (distortionary) tax system designed to redistribute income from the rich to the poor. In doing so, they account for the fact that distortion-free redistribution by means of lump-sum transfers is typically infeasible.[4] Thus, with the use of redistribution tax-systems costs might occur (e.g. costly distribution effects through the deadweight loss). To capture the costly distortion effect of the redistribution system, the model includes a *costly-redistribution correction term* in the social welfare formula as well.

As the Antràs et al. (2017) model is written in a rather complicated way, making it harder to follow for the interested reader, we present the model in a comprehensible and clearly structured form. We conduct the analysis on the "Tax-Reform 2000" in a closed economy setting, which represents the main part of this paper. We concentrate on the time between 1998 and 2007, as this was the time of the tax-reform.[5] The new social welfare approach can be used to study the welfare effects for different kinds of policies. We examine additionally, in the context of the open economy, the impact of trade liberalization which affected Germany between 1995 and 2014. This is interesting as after the fall of the Iron Curtain several rounds of WTO-Accessions occurred, most notably with China joining the WTO in 2001. Moreover, the eastern enlargement of the European Union also happened during the same time period. Hence, the trade liberalization led to a fall in trading costs and a rise in income inequality impacting the social welfare in Germany.

In order to conduct the welfare analysis, certain parameters are essential: The tax progressivity and the distribution of market- and disposable income in Germany are identified by applying the German Socio-Economic Panel (SOEP) as our main data source. We set the German benchmark for the inequality aversion

[4]The tax literature points out that lump-sum taxes usually require a lot of detailed information and are not feasible, e.g. Mirrlees (1971).

[5]Note, that the major tax-reform occurred between 2001 and 2005. However, before and after that time further reformation of the taxation system took place, which is why we choose the years between 1998 and 2007 (prior to the financial crisis) as the time of interest.

parameter equal to one which is in line with Chetty (2006) and Gandelman and Hernández-Murillo (2013). For the German Frisch elasticity of labor supply, we rely on the findings of Kneip et al. (ming) and further use the estimation result by Chetty (2012) for the elasticity of taxable income. In addition, we conduct our simulations for various values of inequality aversions, Frisch elasticities and elasticities of taxable income as robustness checks. Moreover, to conduct the open economy analysis, we derive the necessary trade parameters by the use of trade moments that represent the German economy.

Our findings show that the average annual income growth between 1998 and 2007 is 2.34% and the German “Tax-Reform 2000” is hereby responsible for an average annual income growth of 0.62%. We demonstrate that the “Tax-Reform 2000” is furthermore responsible for the rise in income inequality. Through the tax-reform the Gini coefficient increases on average by 0.32% each year. A key finding is that the average annual welfare growth would roughly grow at the same welfare level as when the “Tax-Reform 2000” would not have taken place and the tax progressivity would have stayed constant at the level of 1998. The welfare growth would just be 0.07% larger with the tax-reform. This is due to the fact that the model takes income inequality into consideration. In the benchmark case, with an inequality aversion of $\rho = 1$, the changes of the correction terms offset each other. In our analysis we determine the optimal tax progressivity that maximizes the welfare of each year of the period. Our findings indicate that for the German benchmark case the reduction of the tax progressivity, driven by the “Tax-Reform 2000”, approximates in 2007 the optimal welfare maximizing tax progressivity. We further show that the inequality aversion by the social planner plays an important role for the determination of the optimal tax progressivity. The lower the inequality aversion of the social planner is the lower the optimal tax progressivity has to be to maximize the social welfare. In the extreme case of no inequality aversion ($\rho = 0$) the level of the optimal tax progressivity would be zero. In the open economy analysis, we show the welfare effects of moving the

German economy of 2014 counterfactually to the level of trade openness of the year 1995 and to a situation of autarky. Our results demonstrate that with the higher variable trade cost of 1995 the welfare would be reduced by 3.69%, and with the move to autarky the welfare would decline by 8.37%.

The Antràs et al. (2017) model relies for the methodological framework on Itskhoki et al. (2008) and with regard to the open economy on Melitz (2003) with heterogeneous agents. The welfarist correction term is similar to the Atkinson et al. (1970) inequality index. Regarding the concept of the costly-redistribution correction term, the model builds on Kaplow (2004) and in particular on the inequality deflator of Hendren (2014). The concept of the non-linear tax system is taken from Heathcote et al. (2017) which relies on Benabou (2002). On the empirical side, the impact of the German tax-reform on welfare is estimated by Wagenhals (2000), Haan et al. (2005) and Ochmann (2016). Our findings are in line with the mentioned taxation literature, as they all find an increase of household income levels, which is also supported by Merz and Zwick (2002). The center of attention differs, however, as Wagenhals (2000) and Haan et al. (2005) put their focus on different labor supply effects, while Ochmann (2016) considers household savings decision. Ochmann (2016) finds that the impact on social welfare per household is lower than the income gains, as they account for the relative asset price effect due to a change in saving patterns. Concerning the trade liberalization and its impact on income inequality and social welfare in Germany, there is, to our knowledge, no study which covers the income inequality effects of trade liberalization on social welfare for Germany. Several studies were done on the German trade liberalization (between 1988 and 2008) as for example Dauth et al. (2014) and Dauth et al. (2016), yet with different focuses (e.g. effects on the German labor market). Others study the trade liberalization and welfare in Germany, though do not take inequality into account or focus on other trade agreements (e.g. Aichele et al. (2014) on TTIP). Therefore, this paper tries to shed more light on the impact of trade liberalization on German social welfare by taking income inequality into consideration.

The structure of the paper is as follows. Section 2 presents the model of the closed economy. Section 3 displays the strategy to determine the necessary parameters. Section 4 presents the research findings on the social welfare effects of the German “Tax-Reform 2000”. In addition, section 5 analyzes the open economy and the trade cost reduction caused by trade liberalization. Section 6 concludes.

6.2 Model

In the following chapter, we present the Antràs et al. (2017) model in a coherent form. Our focus lies thereby on the closed economy. Thus, we derive the social welfare function of the Kaldor-Hicks economy and identify the new social welfare function, including the two correction terms in a comprehensible way.

6.2.1 Set-up

On the demand side, there is a continuum of agents[6] with Greenwood–Hercowitz–Huffman (GHH) preferences. Hereby, a consumption-leisure trade-off occurs, as the utility function depends on the choice between after-tax consumption c and labor ℓ (see Greenwood et al. (1988) for more details):

$$u(c, \ell) = c - \frac{1}{\gamma}\ell^{\gamma} \tag{6.1}$$

Labor ℓ is used in the production process and $\gamma \geq 1$ governs the Frisch elasticity of labor supply $\frac{1}{\gamma-1}$. The Frisch elasticity is the responsiveness of labor supply given a wage rate change and is declining in γ.

The agents produce specific tasks according to their individual ability and labor supply $y_{\varphi} = \varphi\ell$. The agents are heterogeneous regarding their individual ability levels φ, which are distributed by the cumulative function H_{φ}.[7]

[6] The total number of the continuum of individuals is measured in the model to one.

[7] The cumulative distribution function H_{φ} can take on different forms, e.g. the Pareto- or

Using a Constant Elasticity of Substitution (CES) aggregator the imperfectly substitutable tasks are used to produce the final good Q:

$$Q = \Big(\int_{\varphi} y_{\varphi}^{\beta} dH_{\varphi} \Big)^{1/\beta} \tag{6.2}$$

The parameter $0 < \beta \leq 1$ impacts the elasticity of substitution across different tasks.[8] Thus, the final good is produced more efficiently with a greater variety. The CES structure of the model implies that the conditional demand for a variety produced by agent φ is:

$$q_{\varphi} = Q \bigg(\frac{p_{\varphi}}{P} \bigg)^{-\frac{1}{1-\beta}} \tag{6.3}$$

where p_{φ} is the price of the task produced by the agent and $P = \Big(\int_{\varphi} p_{\varphi}^{-\frac{\beta}{1-\beta}} dH_{\varphi} \Big)^{-\frac{(1-\beta)}{\beta}}$ is the standard aggregate price index of the CES function.

We set the final good as a numéraire, such that $P = 1$. Thus, the optimal demand implies $p_{\varphi} = q_{\varphi}^{-(1-\beta)} Q^{1-\beta}$, the revenue of the individual task then becomes:

$$r_{\varphi} = p_{\varphi} q_{\varphi} = Q^{1-\beta} q_{\varphi}^{\beta} = Q^{1-\beta} y_{\varphi}^{\beta} = Q^{1-\beta} (\varphi \ell)^{\beta} \tag{6.4}$$

which follows from the market clearing condition for tasks $q_{\varphi} = y_{\varphi}$.[9]

6.2.2 Disposable Income and Consumption

The applied non-linear tax system is similar to the tax-rule used in Heathcote et al. (2017):

$$r_{\varphi}^{d} = r_{\varphi} - \tau(r_{\varphi}) r_{\varphi} = k r_{\varphi}^{1-\phi} \tag{6.5}$$

Lognormal distribution. In our empirical analysis we use the Lognormal distribution as it fits the German data, see section 6.3.1 for more details.

[8] The elasticity of substitution can be expressed as $(1/(1-\beta))$. In the special case $\beta = 1$ the tasks are perfect substitutes.

[9] Note that in the case of $\beta = 1$ the individual revenue is equal to its output $r_{\varphi} = y_{\varphi}$. In this case the aggregate (average) income becomes $Q = R = \int_{\varphi} r_{\varphi} dH_{\varphi}$.

as equation (6.5) shows, the disposable income r_φ^d depends on the tax rate $\tau(r_\varphi)$. It includes the tax progressivity ϕ and a constant average tax parameter k.[10] In the case of low tax progressivity ϕ, taxes are more proportionate for all, however, when ϕ is high, higher moments of income are taxed more heavily. In the extreme case of $\phi = 1$ no inequality occurs. Empirically, the tax-rule fits not only the U.S. tax system, but as we find in our analysis in section 6.3.2, it also represents the German tax system quite well. This might be a bit of a surprise as the German tax-system can in general be seen as rather complex, with many exceptions and specialties.

The government uses all the net tax revenue to acquire the final good. The aggregate income of the economy is expressed as:

$$Q = \int_\varphi r_\varphi^d dH_\varphi + gQ \tag{6.6}$$

the government spends gQ on the final good, g is a constant and represents an exogenous fraction of the GDP spend by the government. Equation (6.6) can be rewritten as the balanced budget of the government:

$$(1-g)Q = k \int_\varphi r_\varphi^{1-\phi} dH_\varphi \tag{6.7}$$

as the government expenditure share g is exogenously given, there is for each tax progressivity ϕ a unique k that adjusts the government budget. The shape of the income distribution is not altered by g. In the case that all government spending goes into the provision of public goods, we would assume $g = 0$. This would lead to the equation of $Q = k \int r_\varphi^{1-\phi} dH_\varphi$.

Further, the disposable income of the agent with the ability φ is equal to his consumption $c_\varphi = r_\varphi^d = k r_\varphi^{(1-\phi)}$. Using equation (6.4) we can express consumption as a function depending on labor ℓ:

$$c_\varphi = k[Q^{(1-\beta)}(\varphi\ell)^\beta]^{(1-\phi)} \tag{6.8}$$

[10]This constant k is chosen to balance the government budget.

6.2.3 Optimal Utility

After having identified the individual consumption c_φ in the last section, we derive the optimal utility function, through which we are able to reduce the model's dimensionality.

The agent faces the following optimization problem:

$$u_\varphi = \max_{\ell_\varphi} \left[k[Q^{(1-\beta)}(\varphi \ell)^\beta]^{(1-\phi)} - \frac{1}{\gamma}\ell^\gamma \right] \tag{6.9}$$

By taking the first-order condition (FOC) of the utility function with respect to labor, we derive the optimal labor supply:

$$\ell_\varphi = \left[kQ^{(1-\beta)(1-\phi)}(\varphi)^{\beta(1-\phi)}\beta(1-\phi) \right]^{\frac{1}{\gamma-\beta(1-\phi)}} \tag{6.10}$$

Through inserting the optimal labor supply condition into equation (6.4), we determine the revenue function:

$$r_\varphi = Q^{(1-\beta)}\varphi^\beta [kQ^{(1-\beta)(1-\phi)}(\varphi)^{\beta(1-\phi)}\beta(1-\phi)]^{\frac{\beta}{\gamma-\beta(1-\phi)}} \tag{6.11}$$

Let $\epsilon \equiv \frac{\beta}{\gamma-\beta}$ define the elasticity of taxable income, including the Frisch elasticity of labor supply $\frac{1}{\gamma-1}$ and the parameter β, that represents the impact of imperfect suitable tasks.[11] This leads to the solution of the optimal revenue:

$$r_\varphi = [k\beta(1-\phi)]^{\frac{\epsilon}{1+\epsilon\phi}} [Q^{(1-\beta)}\varphi^\beta]^{\frac{1+\epsilon}{1+\epsilon\phi}} \tag{6.12}$$

Using the individual utility (6.1) and the optimal labor supply as well as the consumption function (6.8), the optimal utility function of an agent can be expressed as follows:[12]

$$u_\varphi = \frac{1+\epsilon\phi}{1+\epsilon} k r_\varphi^{1-\phi} \tag{6.13}$$

[11] The elasticity of taxable income can also be expressed as $\epsilon = \frac{d \ln r_\varphi}{d \ln 1-\tau^m(r_\varphi)}$. This means that for the case of the agent facing a higher marginal tax rate the reported income is going down.

[12] The derivation of the optimal utility function is displayed in appendix 6.A.

The utility function depends on the disposable income as well as on the term $1+\epsilon\phi$, which takes the disutility of work into account.

6.2.4 Aggregate Output

To identify the new social welfare function the model needs to be solved for the endogenous variables k and Q. This is done in two steps: In a first step, we derive the equilibrium conditions under the counterfactual assumption of the tax progressivity set to zero ($\phi = 0$). Therefore, no distortion through taxes takes place (in section 6.2.4). This assumption is necessary to obtain the welfare function of the Kaldor-Hicks economy and to be able to express the correction terms. In the second step, the equilibrium condition of Q is identified for the case of $\phi > 0$ (in section 6.2.4). Thus, the model is solved for both endogenous parameters, by inserting the two endogenous parameters into the new social welfare function (in section 6.2.6).

Equilibrium with $\phi = 0$

We define $\tilde{Q}$ as the potential final good under the assumption of no tax progressivity ($\phi = 0$). The assumption gives rise to the governmental balance condition:

$$(1-g)\tilde{Q} = \tilde{k}\int_{\varphi} \tilde{r}_{\varphi} dH_{\varphi} = \tilde{k}\tilde{Q} \tag{6.14}$$

The potential final good $\tilde{Q}$ can be expressed as:[13]

$$\tilde{Q} = \int_{\varphi} \tilde{r}_{\varphi} dH_{\varphi} \tag{6.15}$$

[13]The potential final good $\tilde{Q}$ can be identified as $\tilde{k} = 1 - g$ and $\tau(r_{\varphi}) = \tau^{m}(r_{\varphi}) = 1 - \tilde{k} = g$.

Equilibrium with $\phi > 0$

In the next step, we derive the equilibrium condition of the endogenous final good (output) Q under the assumption of existing tax progressivity ($\phi > 0$).[14]

$$Q = \left[(1-\phi)^{\epsilon} \frac{\left(\int_{\varphi} \tilde{r}_{\varphi}^{\frac{1}{1+\epsilon\phi}} dH_{\varphi} \right)^{\epsilon+1}}{\left(\int_{\varphi} \tilde{r}_{\varphi}^{\frac{1-\phi}{1+\epsilon\phi}} dH_{\varphi} \right)^{\epsilon} \int_{\varphi} \tilde{r}_{\varphi} dH_{\varphi}} \right]^{\kappa} \times \tilde{Q} \tag{6.16}$$

The final good depends on the potential revenue $\tilde{r}$ and the potential good $\tilde{Q}$. The equilibrium condition of the final good is important as equation (6.16) is one part of the new social welfare function (section 6.2.6). Note that $\kappa \equiv \frac{1}{1-(1-\beta)(1+\epsilon)} > 1$ defines the love of variety effect. It occurs when the model involves agents that produce differentiated varieties.

6.2.5 Kaldor-Hicks Welfare

The welfare in a hypothetical Kaldor-Hicks economy is the integral over utilities distributed according to the abilities φ. In particular, the premises hold that there is no tax progressivity ($\phi = 0$) and the social planner faces no inequality aversion ($\rho = 0$). The Kaldor-Hicks economy can be expressed in terms of revenue (using equation 6.13):

$$\tilde{W} = \int_{\varphi} u_{\varphi} dH_{\varphi} = \frac{k}{1+\epsilon} \int_{\varphi} r_{\varphi} dH_{\varphi}$$

By assumption the Kaldor-Hicks economy does not involve tax progressivity. With the use of equation (6.14) the welfare in a hypothetical Kaldor-Hicks economy can be written as:

$$\tilde{W} = \frac{\tilde{k}}{1+\epsilon} \int_{\varphi} \tilde{r}_{\varphi} dH_{\varphi} = \frac{1-g}{1+\epsilon} \tilde{Q} \tag{6.17}$$

The Kaldor-Hicks welfare function depends on the potential final good $\tilde{Q}$, as well as the government spending share g and the elasticity of taxable income ϵ. This means, if the government spending share is large, the social welfare is reduced.

[14] Find the detailed derivations in appendix 6.A.

Likewise, if the elasticity of taxable income is high, it reduces the welfare in the Kaldor-Hicks economy as well.

6.2.6 New Social Welfare

In contrast to the Kaldor-Hicks welfare function, the new social welfare function by Antràs et al. (2017) includes tax progressivity $\phi \neq 0$ and inequality aversion $\rho \neq 0$.

$$W = \left(\int_{\varphi} u_{\varphi}^{1-\rho} dH_{\varphi} \right)^{\frac{1}{1-\rho}} \tag{6.18}$$

The new social welfare function is similar to the one used in Atkinson et al. (1970), involving a constant elasticity parameter. In the new social welfare function the social planner's constant degree of inequality $\rho \geq 0$ plays an important role. In the special case of $\rho = 0$ the social welfare is the aggregate of utilities across agents. Alternatively, ρ can be defined as the constant-degree of relative risk aversion (CRRA).[15] In order to identify the correction terms of the new social welfare function, we insert as a first step equation (6.13) into the social welfare function (6.18) and use equation (6.5):

$$W = \frac{1+\epsilon\phi}{1+\epsilon} \left(\int (r_{\varphi}^{d})^{1-\rho} dH_{\varphi} \right)^{\frac{1}{1-\rho}} \tag{6.19}$$

By extending equation (6.19) with $\int r_{\varphi}^{d} dH_{\varphi} = (1-g)Q$ and together with equation (6.16) we solve for the endogenous parameter Q and derive the new social welfare function of Antràs et al. (2017):

$$W = \frac{1+\epsilon\phi}{1+\epsilon} \underbrace{\frac{\left(\int_{\varphi} (r_{\varphi}^{d})^{1-\rho} dH_{\varphi} \right)^{\frac{1}{1-\rho}}}{\int_{\varphi} r_{\varphi}^{d} dH_{\varphi}}}_{\Delta} (1-g) \underbrace{\left[(1-\phi)^{\epsilon} \frac{\left(\int \tilde{r}_{\varphi}^{\frac{1}{1+\epsilon\phi}} dH_{\varphi} \right)^{\epsilon+1}}{\left(\int_{\varphi} \tilde{r}_{\varphi}^{\frac{1-\phi}{1+\epsilon\phi}} dH_{\varphi} \right)^{\epsilon} \int_{\varphi} \tilde{r}_{\varphi} dH_{\varphi}} \right]^{\kappa}}_{\Theta^{\kappa}} \tilde{Q} \tag{6.20}$$

[15] We will discuss the implications of the inequality- (risk-) aversion in section 6.3.3 in more detail.

where Δ is the welfarist correction term[16] and Θ^{κ} is defined as the costly-redistribution correction term.[17] Moreover, we simplify the equation by adapting the welfare function of the Kaldor-Hicks economy (6.17):

$$W = \Delta \times (1 + \epsilon\phi)\Theta^{\kappa} \times \tilde{W} \tag{6.21}$$

The new social welfare function W indicates that a society faces lower welfare, the higher the income inequality in a population. The mechanism can be shown by the welfarist correction term Δ. In particular, the welfarist correction term depends on the disposable income distribution, and in the case of a large distribution of disposable income (inequality) the social welfare diminishes. Additionally, the welfarist correction term is governed by the inequality aversion parameter (ρ). In the case of a high ρ, the inequality aversion penalizes a large distribution of disposable income, which in turn decreases welfare. The other terms $(1 + \epsilon\phi)\Theta^{\kappa}$ and $\tilde{W}$ are independent of ρ. Focusing on the policy measure and the social welfare impact of tax progressivity ϕ several effects can be identified: First, a lower level of tax progressivity ϕ leads to a decrease of the welfarist correction term Δ, as the tax progressivity ϕ increases the disposable income distribution and rises inequality. The negative impact on Δ decreases social welfare in turn. However, the impact of tax progressivity ϕ on the correction terms $(1 + \epsilon\phi)\Theta^{\kappa}$ is ambiguous. On the one hand, less costly redistribution takes place (which increases the costly-redistribution term Θ^{κ}) due to the lower marginal tax rate and enhances social welfare. On the other hand, as lower tax progressivity increases output. Agents have to work in order to receive that income and more work effort generates disutility for them. Therefore, lower tax progressivity decreases the disutility of the labor effort term $(1 + \epsilon\phi)$ and has a diminishing impact on social welfare.

[16] Δ is equal to one minus the Atkinson inequality index (Atkinson et al. (1970)), which is a well-known inequality measure, based on a social welfare approach. Note that by Jensen's inequality $\Delta \leq 1$.

[17] The value of Θ^{κ} is between 0 and 1. It decreases in ϕ as well as in ϵ. The larger the income distribution the smaller Θ^{κ}.

Further, the change in social welfare can be presented in the following way:

$$\frac{W'}{W} = \frac{\Delta'}{\Delta} \times \frac{(1+\epsilon\phi)'}{(1+\epsilon\phi)} \frac{\Theta'^{\kappa}}{\Theta^{\kappa}} \times \frac{\tilde{W}'}{\tilde{W}} \tag{6.22}$$

where the prime notations indicate the parameters under a new situation and therefore allow to express the equation in relative terms. Due to the relationship of $\Theta^{\kappa}\tilde{W} = \frac{1-g}{1+\epsilon}\Theta^{\kappa}\tilde{Q} = \frac{1-g}{1+\epsilon}Q$, equation (6.22) can be stated as a function of aggregate output Q (instead of $\tilde{W}$ of the Kaldor-Hicks economy):

$$\frac{W'}{W} = \frac{\Delta'}{\Delta} \frac{(1+\epsilon\phi)'}{(1+\epsilon\phi)} \frac{\Theta'^{\kappa}}{\Theta^{\kappa}} \frac{\tilde{W}'}{\tilde{W}} = \frac{\Delta'}{\Delta} \times \frac{(1+\epsilon\phi)'}{(1+\epsilon\phi)} \times \frac{Q'}{Q} \tag{6.23}$$

On the one hand, the equation can be utilized to examine the impact of taxation policies on the welfare change. One the other hand, the equation allows to explore the impact of other exogenous shocks that impact the distribution of disposable income or output, and hence lead to a shift in welfare.

6.3 Parameter Identification

Next, we bring the data to the model. Our focus is on the German "Tax-Reform 2000". In order to conduct the empirical analysis certain key parameters have to be identified (section 6.3.2 to 6.3.5). Hereby, we rely on the German Socio-Economic Panel (SOEP) as the main data source. The SOEP is a yearly survey on the economic situation of households in Germany. We are especially interested in the years of the German "Tax-Reform 2000" ranging from 1998 to 2007. The SOEP dataset is conducted on the household level, however, by the use of OECD equivalence weights, we are able to transform the household dataset to the individual levels.[18] This allows to identify the market- and disposable income, through which

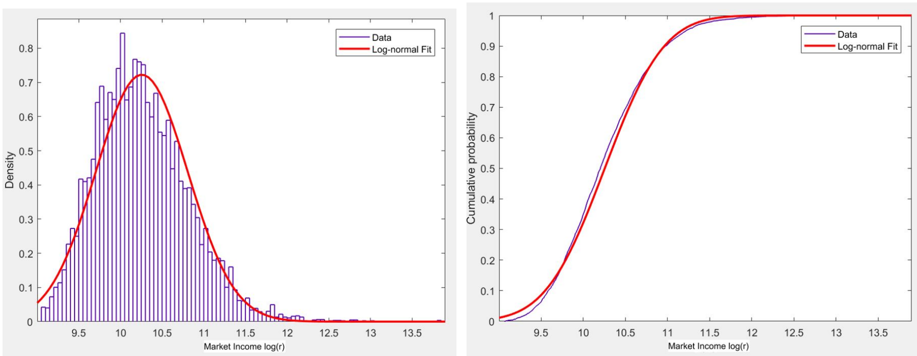
[18] The prices are in "Euro" of the current year. Therefore we adjust the prices to the constant prices of the base year of 2014, via the consumer price index. The consumer price index of the SOEP relies here on the Statistisches Bundesamt (Destatis) (2014). For the years 1998 to 2000 two consumer price indices, for West Germany and East Germany are provided. In order to get the consumer price index for Germany as a whole, we take the average of the two consumer price indices.

we can estimate the level of tax progressivity in Germany. As regards the parameter selection of the open economy, in section 6.5 we present the key parameters for the trade liberalization analysis.

6.3.1 Income Distributions

The SOEP data show an annual increase of the average market income by 4.16% for the time between 1998 and 2007. Considering the pre-government income distribution, the SOEP data display that the market income distribution of the population can be represented by the log-normal distribution. As we demonstrate for the year 2007 in Figure 6.1(a), the income levels for the percentile $0-99$ are log-normal distributed in a probability density function (PDF) (the results are robust for the other years as well). Note, that the SOEP has its advantage in covering the distribution up to the 99th percentile. However, the top levels of income earners are less represented in the survey, due to data limitations, as data for the highest top earners are usually difficult to collect. Findings as in Clementi et al. (2006) suggest, however, that the very top income earners in Germany are Pareto distributed. Diamond and Saez (2011) and Antràs et al. (2017) find similar patterns for the United States. Furthermore, a good overview on income distributions is given by Atkinson et al. (2011). To conduct a robustness check, we show in Figure 6.1(b) that the log-data represents the curve of the log-normal fit as a cumulative density function (CDF) quite well. Moreover, we conduct for the log-normality assumption the goodness-of-fit normality test by Gel and Gastwirth (2008). The test is a robust version of the Jarque and Bera (1980) normality test, widely used in economics.

Figure 6.1: Income Levels (percentile 0 - 99), Log-normal Distributed (2007)



(a) Log-normal distribution (PDF) (b) Log-income distribution (CDF)

Source: SOEP 2016; Authors' own calculations.

6.3.2 Tax Progressivity

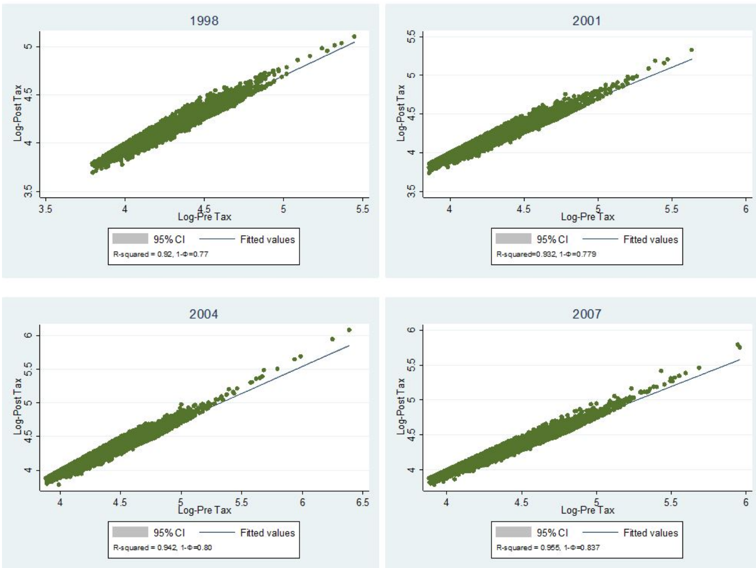
We make use of the non-linear progressive tax system by Heathcote et al. (2017) that is based on Benabou (2002), as this tax system fits for Germany exceptionally well. This is especially interesting for comparison reasons, since Antràs et al. (2017) rely on the same tax-rule for the United States. In order to estimate the tax progressivity we rely on the before-tax and after-tax personal income distribution in Germany, which are taken from the SOEP dataset. For the tax system we plot the pre-government income data for each year ($1998 - 2007$) and exclude the observations falling under a certain personal exemption level ("Grundfreibetrag"). In our estimation we focus only on the effect of income taxes and neglect public transfers of the post-government income data. Moreover, we do not take those observations into account, which have reported negative income levels. After the data preparation the tax progressivity ϕ can be calibrated by applying the log-linear relationship of equation (6.5):

$$\ln r^d = \ln k + (1 - \phi) \ln r(\phi) \tag{6.24}$$

We estimate this regression on an annual basis and find high R^2 values, indicating a high compatibility of the applied tax rule with the German tax system.

Figure 6.2 gives an overview for some selected years[19] and shows that R^2 ranges from 0.92 in 1998 up to 0.96 in 2007 (with the average of 0.94 over the years). The constant k, which makes sure that the government budget is adjusted and regulates the average tax rate across individuals is on average around 0.73. Even more importantly, Figure 6.2 shows the results of the regression's coefficient $(1-\phi)$. Hereby, the coefficient includes the tax progressivity ϕ, identified for each year separately.

Figure 6.2: Tax Progressivity in Germany



Source: SOEP 2016; Authors' own calculations.

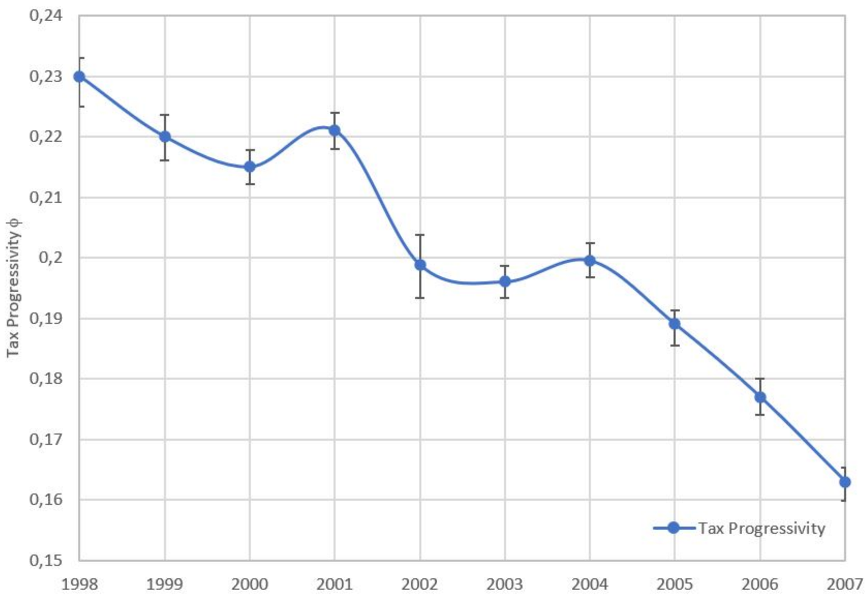
In Figure 6.3 the development of the tax progressivity for each year is displayed. The tax progressivity was the highest in 1998 ($\phi = 0.23$) and was reduced slightly through tax-policy measures taken by the German government. The main tax-reform occurred in 2001 and decreased the tax-progressivity to $\phi = 0.198$ in 2002 and to $\phi = 0.196$ in 2003. The tax progressivity was further reduced in 2004 and in the following years to $\phi = 0.163$ in 2007. For the observation period the average tax progressivity is $\phi_{avr} = 0.20$.

Our results are in line with the literature, e.g. for a wider range of years Rostam-Afschar and Yao (2017) find a tax progressivity of $\phi = 0.22$. Compared to the findings for the United States the tax progressivity in Germany is higher, hence in

[19] The tax progressivity for all years is displayed in the appendix 6.A.10.

Germany higher earnings are taxed more strongly: Antràs et al. (2017) find for the United States a ϕ of 0.15 in 2007, Heathcote et al. (2017) a ϕ of 0.181. Rostam-Afschar and Yao (2017) observe a ϕ of 0.11 and trace this lower tax progressivity back to a lower elasticity of labor supply in the United States.

Figure 6.3: Tax Progressivity Development in Germany



Tax Progressivity around a 95% Conf. Interval

Source: SOEP 2016; Authors' own calculations.

6.3.3 Inequality Aversion Parameter

Inequality- (or risk-) aversion draws on personal preferences. The personal preferences are of a complex nature, as they strongly depend on the individual decision-making behavior, which can be impacted by economic, social, cultural, and other circumstances. In the public finance literature, there are several empirical methods how to estimate personal preferences, e.g., through studies on incentivized games or via self-reported surveys. Due to the various empirical approaches, the range of empirical findings on the constant degree of inequality- (or risk-) aversion differs from 0 to 3 (see Gandelman and Hernández-Murillo (2015)), up to the extreme point of 10, Gordon and St-Amour (2004). Empirical evidence suggests, however, that the mean of constant degree of inequality- (or risk-) aversion might be around one, Chetty (2006) and Gandelman and Hernández-Murillo (2013). Gandelman and Hernández-Murillo (2015) make the case in their study, covering 75 countries, that the mean value is associated to one. A constant degree of inequality- (or risk-) aversion of one is an interesting case, as it represents the logarithmic utility function. In particular, the concavity of the logarithmic utility function is useful as it involves diminishing marginal utility.[20] Focusing on the inequality aversion in Germany Rostam-Afschar and Yao (2017) estimate a ρ of 1.29, while Gandelman and Hernández-Murillo (2015) find a ρ of 0.77. In addition, Schwarze and Härpfer (2007) find only weak evidence for inequality aversion in Germany.[21] As the findings of inequality aversion in Germany seems to lie between 0.77 and 1.29, we set $\rho = 1$ in the baseline simulation exercises. Moreover, we conduct the analysis with various parameters for ρ as robustness checks.

6.3.4 Frisch Elasticity of Labor Supply

The Frisch elasticity of labor supply can be expressed for a consistent welfare as "a measure of people's willingness to trade work for consumption over time" (Whalen and Reichling (2015, p.1)). As noted in chapter 6.2.1 the elasticity of the Frisch labor supply is defined as $1/(\gamma - 1)$, where γ effects the Frisch elasticity of labor supply. The Frisch elasticity of labor supply varies depending on different economic approaches. An overview of this matter is given by Chetty (2012) and a good review is presented by Whalen and Reichling (2017). A distinction can be made between micro and macro elasticities. The micro elasticity covers the changes of individual's hours of work, while the macro elasticity takes the total hours worked in account. In addition, there are different results for age, gender and other characteristics: Whalen and Reichling (2017) summarize the results of various labor supply elasticity studies. They report that labor supply elasticity for

[20]Suppose the inequality averse utility function is defined by $U(r^d) = \frac{(r^d)^{1-\rho}-1}{1-\rho}$ for $\rho \geq 0$. The FOC is given by $U'(r^d) = r^{d(-\rho)}$. For the case $\rho = 1$ it is $U'(r^d) = [\ln(r^d)]'$.

[21]The findings for the inequality aversion of the United States are higher. Gandelman and Hernández-Murillo (2015) identify a ρ of 1.39 and Rostam-Afschar and Yao (2017) estimate a ρ of 2.47.

men of the age between 25 and 54 ranges from 0 to 0.8. Furthermore, they find a labor supply elasticity for men in their prime age of working (20 - 30) of 0.2. This means that especially younger working men are less elastic in their behavior and they change less often their labor supply. Women have slightly greater Frisch elasticities (0.5 to 1), for married women it is even larger (1.1 to 2.2). This means that married women are very elastic in their labor supply, they more often leave their workplace to raise their kids. Further distinctions can be made for example of rich and poor, where rich people are having higher labor supply elasticities than poorer individuals.[22]

For Germany there are very few estimates of the Frisch elasticity.[23] Rostam-Afschar and Yao (2017) identify a Frisch elasticity of 0.304 ($\gamma = 4.28$), only including men from the age of 26 to 65. We rely on the findings of Kneip et al. (ming) as they use the SOEP dataset and include the intensive and extensive margin in their estimation. Hereby, their findings indicate that the Frisch elasticity varies between 0.57 and 0.67 (with the mean of 0.61) for the years 2000 to 2013. To conduct the simulation, we apply the Frisch elasticity of labor supply of 0.61. In addition, we test in our simulation for the average Frisch elasticity found in the literature of 0.85 by Keane (2011) and for extreme cases. The results are displayed in the appendix 6.A.

6.3.5 Task Substitutability Parameter

In order to identify the task substitutability parameter β, we use the elasticity of taxable income, given by $\epsilon = \beta/(\gamma - \beta)$. The elasticity of taxable income depends on the Frisch elasticity parameter γ, as well as on the task-substitutability β parameter. There is an academic debate on the value of the elasticity of taxable income, in the survey of fifteen studies Chetty (2012) estimates a $\epsilon = 0.5$. The

[22]In addition, Whalen and Reichling (2017) distinguishes between intensive margin, which is "changes in after-tax consumption affects worker's decision about how many hours they work", and extensive margin, which is the decision if they work or not.

[23]More research is done for the United States: Antràs et al. (2017) estimate for the United States a Frisch elasticity of 0.71, and hence identifies $\gamma = 2.4$. In the literature this is similar to other findings, as the one in Chetty (2012) with a Frisch elasticity of 0.75.

range varies widely from $\epsilon = 0.1$ in Kleven and Schultz (2014) and $\epsilon = 0.858$ found by Weber (2014) up to an elasticity of taxable income ranging from 1 to 2 in Keane and Rogerson (2012). However, Keane and Rogerson (2012) findings are rejected by Jäntti et al. (2014). For Germany Doerrenberg et al. (2017) find a taxable income elasticity between $\epsilon = 0.548$ and $\epsilon = 0.675$. We follow the survey result of Chetty (2012) and set $\epsilon = 0.5$. To check for the different elasticities found in the literature we conduct the analysis for various values of taxable income elasticities. Further, we take the aggregate mean of the Frisch elasticity of labor supply (0.61) for Germany from Kneip et al. (ming), which leads to a γ of 2.639. Thus, we estimate a German specific task substitutability parameter of $\beta = 0.873$. The elasticity of task substitutability is then $\frac{1}{1-\beta} = 7.894$. Compared to the United States and Antràs et al. (2017) findings this is slightly higher. In Table 6.1 we display a summary of our parameter selection.

Table 6.1: Choice of Parameters

Parameter	**Values**
Tax Progressivity ϕ	differs yearly ($\phi_{avr} = 0.20$)
Inequality Aversion ρ	1
Frisch Elasticity of Labor Supply $\frac{1}{\gamma-1}$	0.61
Frisch Elasticity Parameter γ	2.639
Task Substitutability β	0.873
Elasticity of Taxable Income ϵ	0.5

6.4 Tax-Reform 2000

6.4.1 Social Welfare Growth

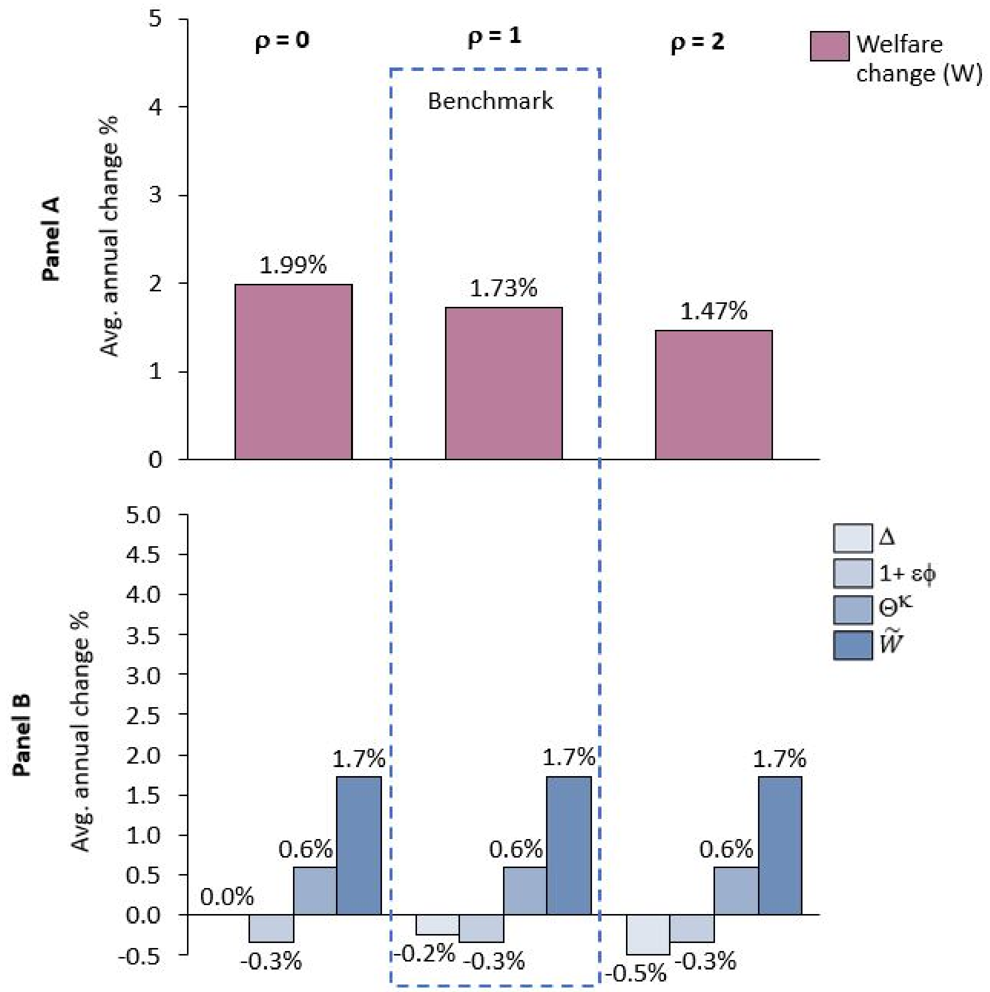
In the following section we explore the social welfare growth in the time of the German “Tax-Reform 2000”. As the new social welfare function (6.20) depends on the constant degree of inequality (ρ) of the social planner, as well as on the elasticity of taxable income (ϵ), we will study the impact those parameters. Specifically, we use the parameters for Germany projected in section 6.3, $\rho = 1$ and $\epsilon = 0.5$, as the benchmarks. To deepen the analysis, we also apply other potential values as robustness checks in our simulations.

Figure 6.4 shows the average annual welfare growth for different values of inequality aversion.[24] In Panel A the German benchmark case with $\rho = 1$ leads to an average annual welfare growth of 1.73% over the period. In the case of no inequality aversion $\rho = 0$ the average annual welfare growth is the highest with 1.99%, while in the case of high inequality aversion $\rho = 2$ the change in average yearly welfare is 1.47%. Panel B displays the average annual growth of each term of the new social welfare function, which gives an indication of the welfare drivers. The average growth of the Kaldor-Hicks economy ($\tilde{W}$) is 1.7% and constant for each value of inequality aversion, as ρ does not effect the Kaldor-Hicks economy by design. The adjustments for the disutility of work ($1 + \varepsilon\phi$) and the costly-redistribution correction term (Θ^{κ}) are constant for various values of ρ (not impacted by the inequality aversion). Hereby, the adjustments of both terms are not overwhelming, but also not trivial. The only term which is affected by inequality aversion is the welfarist correction term (Δ). In the case of $\rho = 0$, there is no inequality aversion by the social planner and therefore the growth of the welfarist correction term is zero. However, with higher values of inequality aversion the welfarist correction term is impacted more strongly, and the welfarist correction term decreases by -0.2% and -0.5% for $\rho = 1$ and $\rho = 2$ respectively. This in turn leads to lower social welfare growth.

The elasticity of taxable income is important to capture the behavioral response of an agent to the tax progressivity change. In Figure 6.5 we present for various taxable income elasticities the average annual welfare growth W and the changes of the components of the new social welfare function. In order to compute the

[24]To determine the average annual social welfare growth, we take, amongst others, the observed income distribution of each year into account.

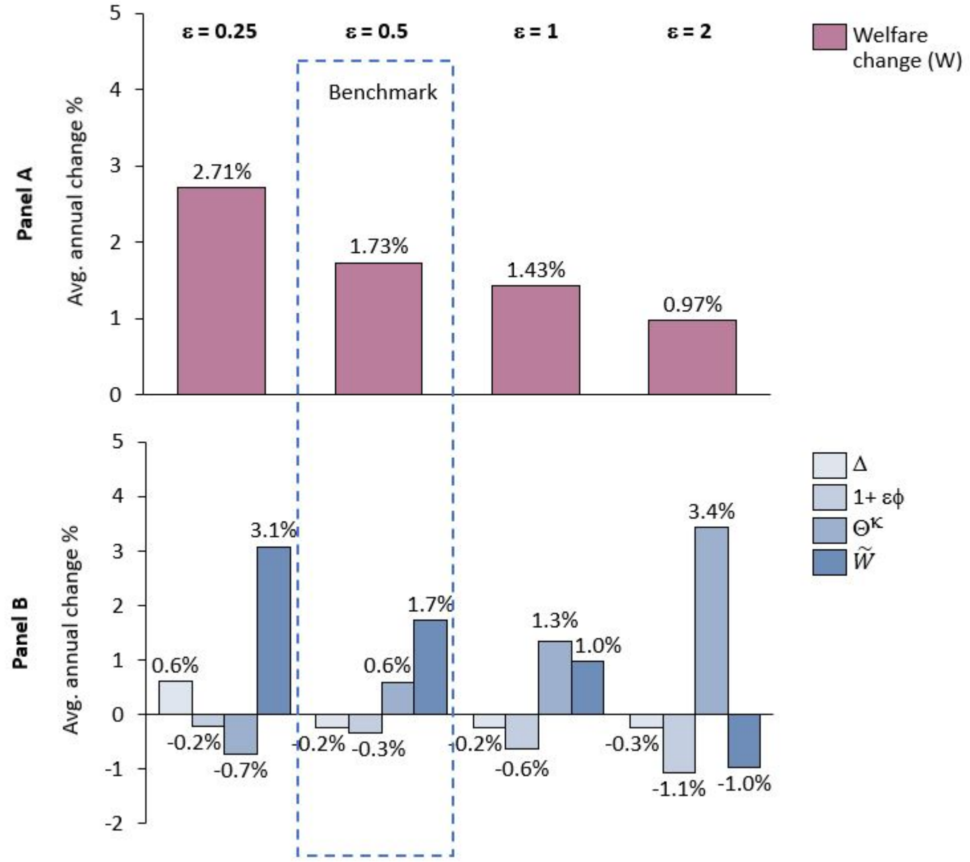
Figure 6.4: Social Welfare Growth (for various ρ)



Δ represents the welfarist correction term, $(1+\epsilon\phi)$ is the disutility of labor effort term, Θ^{κ} is the costly-redistribution correction term and $\tilde{W}$ is the welfare in a hypothetical Kaldor-Hicks economy.

Source: SOEP 2016; Authors' own calculations.

Figure 6.5: Social Welfare Growth (for various ϵ)



Δ represents the welfarist correction term, $(1+\epsilon\phi)$ is the disutility of labor effort term, Θ^{κ} is the costly-redistribution correction term and $\tilde{W}$ is the welfare in a hypothetical Kaldor-Hicks economy.

Source: SOEP 2016; Authors' own calculations.

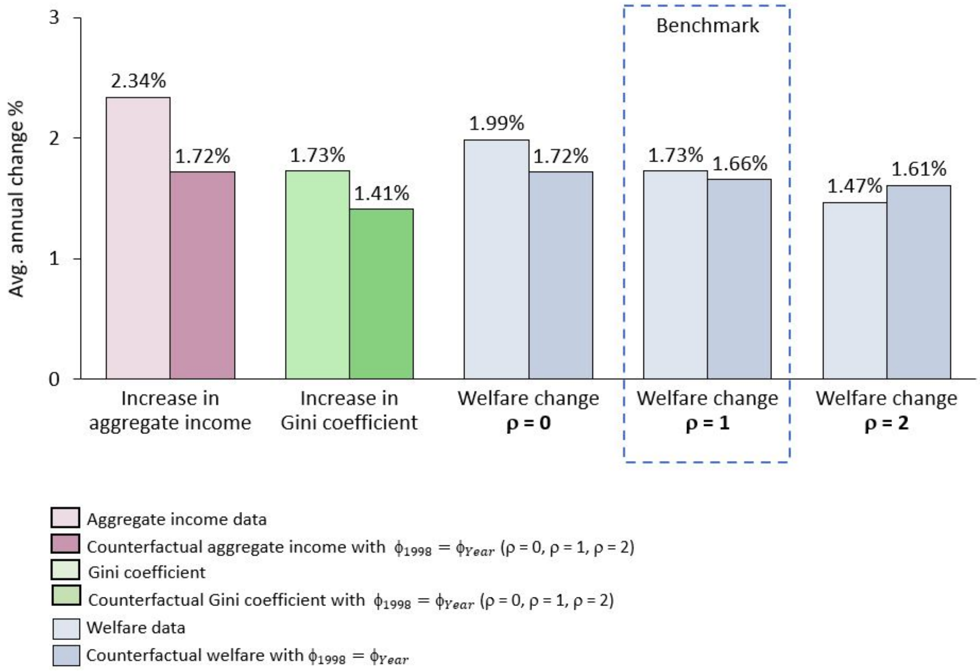
different elasticities, we set $\rho = 1$ and $\beta = 0.873$ and let γ change accordingly. In Panel A the benchmark case for Germany has an elasticity of taxable income of $\epsilon = 0.5$, which leads, as we have seen before, to a welfare growth (W) of 1.73%. A low elasticity of taxable income ($\epsilon = 0.25$) causes a high welfare growth, while for the case of higher elasticities of taxable income ($\epsilon = 1$ and $\epsilon = 2$) the welfare growth is smaller, with 1.43% and 0.97% respectively. Panel B shows the change of the different terms of the social welfare function. The case of ($\epsilon = 0.25$) leads to a high welfare growth and is mainly driven by the growth of the Kaldor-Hicks economy $\tilde{W}$ (3.1%) as well as to a minor extent by the welfarist correction term (Δ) (0.6%). With higher elasticities of taxable income, the growth rates of the Kaldor-Hicks economy term decreases,[25] while the growth rates of the costly-redistribution correction term (Θ^{κ}) are increasing in ϵ (as the distortions through the costly-redistribution are rising in ϵ). The change rates of the correction term of the disutility of work ($1 + \varepsilon\phi$) is negatively impacted for every elasticity of taxable income and is decreasing in ϵ.

6.4.2 Tax-Reform Implications

After having explored the social welfare growth, the next section dissects the social welfare impact of the German "Tax-Reform 2000". Figure 6.6 plots the actual average annual growth and the average annual growth of a counterfactual scenario for the aggregate income, the Gini coefficient of disposable income and welfare. In the counterfactual scenario the tax progressivity is kept constant for every year in the time period at the level of 1998 ($\phi = 0.23$). Like this, we are able to determine the impact of the tax-reform through comparison of the growth rates with the actual data.

[25] A small elasticity of taxable income leads to a low response to the tax rate change, while with a high elasticity agents are sensitive to the tax rate change and react much stronger. Hence, the welfare growth of the Kaldor-Hicks economy is smaller, as it can be seen in section 6.2.5.

Figure 6.6: Tax-Reform Implications



Source: SOEP 2016; Authors' own calculations.

Figure 6.6 reports that the actual average income growth (between 1998 and 2007) lies by 2.34%, while when holding the tax progressivity constant ($\phi = 0.23$), the average income growth (1.72%) is smaller. Hence, the reduction of the tax progressivity is responsible for an average income growth of 0.62%. Focusing on the change of the Gini coefficient of disposable income, the data show that the Gini coefficient increases on average by 1.73%, while when keeping the tax progressivity constant over the years, the Gini coefficient would grow by 1.41%.[26] Therefore the "Tax-Reform 2000" leads to a rise in inequality (the Gini coefficient increases by 0.32%).

Exploring the welfare impact of the tax-reform for various levels of inequality aversions, we find that if the social planner has no inequality aversion ($\rho = 0$) the actual welfare growth is 1.99%. In the case that the tax progressivity is kept at the 1998 level, the average annual welfare growth is 1.72%. That corresponds to

[26]The income growth and the change of the Gini coefficient is not impacted by inequality aversion and therefore stays the same for different values of inequality aversions ($\rho = 0$, $\rho = 1$, $\rho = 2$).

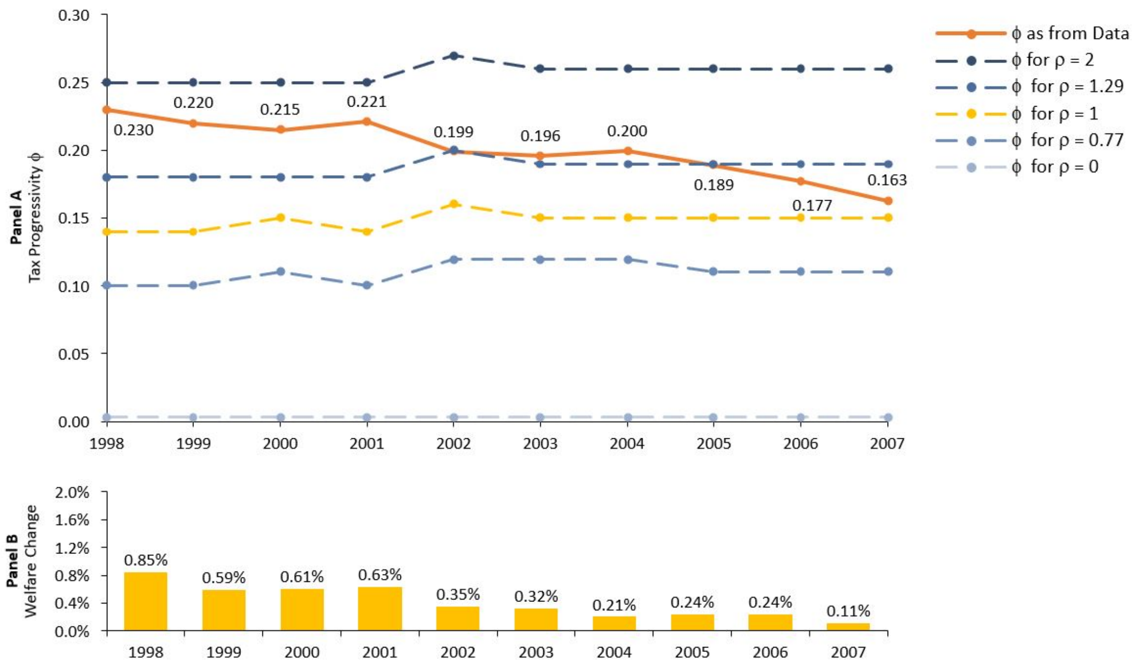
a welfare rise by the tax-reform of 0.27%. For the benchmark case with $\rho = 1$ the actual average welfare growth is 1.73%, whereas the counterfactual welfare growth is slightly lower with 1.66%. Thus, without the tax-reform (and having let the tax progressivity stay for all years at the 1998 level) the average welfare growth would be 0.07% lower. A $\rho = 2$ leads to an actual welfare increase by 1.47%, while the welfare of the counterfactual scenario grows by 1.61%. Accordingly, the welfare growth would be 0.14% higher without the tax-reform.

To see the reason why the average welfare growth is decreasing in ρ in the counterfactual scenarios, it is necessary to look at the main driver, which is the welfarist correction term (Δ). The increase of inequality aversion reduces the growth rate of the welfarist correction term. A higher level of inequality aversion leads to a stronger decline of the welfare correction term. This in turn leads to a stronger decrease in welfare compared to the cases with lower inequality aversion.

6.4.3 Optimal Tax Progressivity

Next, we are interested in the tax progressivity maximizing the new social welfare function (6.20). Thus, we identify the optimal tax progressivity for each year that maximizes the annual social welfare. As the optimal taxation varies with the degree of inequality aversion, we offer a visualization of the optimal taxation for various levels of inequality aversion in Panel A of Figure 6.7.

Figure 6.7: Optimal Tax Progressivity



Panel B demonstrates the welfare change between the welfare of the optimal tax progressivity of the benchmark case $\rho = 1$ and the welfare of the actual tax progressivity.

Source: SOEP 2016; Authors' own calculations.

In the graph the orange line represents the actual tax progressivity as it occurs from the data (also seen in Figure 6.3). Due to the "Tax-Reform 2000" the German tax progressivity has declined over the period from 1998 to 2007. The dark blue line illustrates the optimal tax progressivity as it would occur with a high level of inequality aversion ($\rho = 2$). The higher the inequality aversion the higher the optimal tax progressivity must be in order to achieve the maximized welfare. In the case of no inequality aversion the highest welfare growth would be achieved, if the tax progressivity is zero (characterized by the light blue line at the bottom of the graph). For the German benchmark case of $\rho = 1$ (yellow line) the tax progressivity reported from the data for 1998 is $\phi = 0.25$, which is at distant from the optimum level of $\phi = 0.14$. As through the "Tax-Reform 2000" the tax progressivity decreases over the years, it approximates the optimal tax progressivity level. In 2007 the actual tax progressivity reaches $\phi = 0.163$, which is close to the optimal level of tax progressivity of $\phi = 0.15$.

In addition, we test for the German inequality aversion found in literature by Gandelman and Hernández-Murillo (2015) ($\rho = 0.77$) and Rostam-Afschar and Yao (2017) ($\rho = 1.29$). Hereby, the optimal levels of tax progressivity revolve around the yellow line: The navy blue line above the benchmark represents the optimal tax progressivity with higher inequality aversion ($\rho = 1.29$), whilst the light blue line below the benchmark is the tax progressivity with lower inequality aversion ($\rho = 0.77$). In the case of $\rho = 1.29$, the actual tax progressivity is close to the navy-blue line (for the years 2002 to 2005). This would mean, if we would assume an inequality aversion of $\rho = 1.29$ for Germany, the tax progressivity would have been at the welfare optimizing level, at least for some years.

In Panel B of Figure 6.7 we display, for a given year, the difference between the welfare of the optimal tax progressivity and the welfare of the actual tax progressivity. Panel B shows, for the year 1998, that the welfare would increase by 0.85% (compared to the welfare with the actual tax progressivity) if the optimal tax progressivity would have been applied. As the actual tax progressivity approximates the optimal tax progressivity over the years, the differences between the two welfare level shrinks. In 2007 the actual tax progressivity got close to the optimal tax progressivity of $\phi = 0.15$. Therefore, the optimum welfare would just be 0.11% higher than the actual welfare.

6.5 Trade Liberalization

After the fall of the Iron Curtain as well as in the 2000s Germany experienced a period shaped by trade liberalization: In 1995 the World Trade Organization (WTO) emerged from its predecessor, the General Agreement on Tariffs and Trade (GATT). During a number of accession rounds several Eastern European countries joined the WTO. A major step occurred when China joined the WTO through the Doha Round in 2001, as well as the accession of Vietnam in 2007 and Russia in 2014. In addition, the EU eastern enlargement in the early 2000s led to a development opening the trade in Germany even more. The trade openness index

(Exports and Imports as a share of GDP) indicates the effect of trade liberalization. For Germany the index almost doubled from 43.6% in 1995 to 84.6% in 2014 (World Bank (2020)). The trade liberalization was driven by a reduction of trade costs and led to a rise in trade-induced income inequality. In the following, we will explore the impact of trade liberalization on the new social welfare, that takes income inequality into account. To investigate the distributional consequences of trade we follow the theoretical and empirical open economy approach by Antràs et al. (2017).

6.5.1 Open Economy Model

The open economy model is strongly related to the closed economy but includes additional assumptions: There are $N + 1$ symmetric countries. Hereby, the intermediate inputs are imperfect substitutes and tradable across countries. The intermediate inputs are assembled to final goods in each country. Final goods are assumed to be perfect substitutes and due to the symmetry of countries the final goods can be seen as non-tradable. The agents can sell their task without costs at the home market. However, variable trade costs and additional fixed costs occur when selling the task to another country. Through the fixed costs only agents with high abilities are able to export to another market: $f(n) = f_x n^{\alpha}$, with $\alpha \geq 0$ and $n \geq 1$. Consequently, f_x is responsible for the average fixed cost level and α impacts the bend of the fixed cost function depending on the market serviced. Additionally, iceberg trade costs are introduced, implying that in order to move one unit from one country to another country, it is required to produce $d \geq 1$ units of the good.

In the open economy model trade liberalization increases trade-induced income inequality in the following way: Only those agents with the highest abilities are able to export their tasks and therefore can serve the domestic and foreign markets. This rises the agent´s income. However, those agents with low ability levels, who can only serve the domestic market, face additional import competition in an open economy, which decreases their income and leads in turn to a rise in inequality.

6.5.2 Trade Parameters

Additionally to the previous parameters of section 6.3, the fixed costs, iceberg trade costs and α have to be identified to solve the open economy model.[27] Based on Antràs et al. (2017) the three trade parameters are calibrated in such a way (together with the ability distribution, as the income distribution strongly depends on exporters) that they are analogue to three trade moments representing the German economy of the year 2014.

The first trade moment (M1) is the aggregate export over aggregate output in Germany. From the World Input-Output Database (Release 2016) by Timmer et al. (2015) we estimate the share of aggregate export over aggregate output to be 33.2% for Germany. The second moment (M2) is the aggregate output of exporters as a share of aggregate output, corresponding to the ratio of sales of exporting firms to the sales of all firms (55.44%).[28] The third moment (M3) is the share of aggregate exports that are produced by households exporting to more than five locations (91.72%).[29] The model is calibrated by identifying the set of parameters (d, f_x and α) that minimize the difference between simulated moments in the model and those of the data (M1=33.2%, M2=55.44%, M3=91.72%). The optimization problem is thereby defined as the objective function, subject to the equilibrium equations of the model. This allows us to calibrate the iceberg trade cost of $d = 1.83$ and the fixed costs of $f_x = \$851$, as well as $\alpha = 0.21$. Those parameters minimize the difference between the equilibrium equations and the three empirical moments.

The variable trade cost is computed for the 1995 economy as well: With 17% for the first moment and keeping all others equal, this leads us to variable trade costs of $d_{1995} = 1.92$. As the German share of world GDP is 5.03% for the year 2014, we set the number of symmetric countries to $N = 19$.[30]

[27] Note, that the parameter findings of section 6.3 are robust and hold also for the years 1995 to 2014.

[28] EFIGE cross-country report (2009) of manufacturing sector by Altomonte et al. (2017). For the year of 2008, the survey covers 15.000 firms with over 10 employees of the manufacturing industry.

[29] EFIGE cross-country report (2009) of the manufacturing sector by Altomonte et al. (2017).

[30] Our findings are in line with the literature. For the United States Melitz and Redding (2015)

6.5.3 Simulation Results

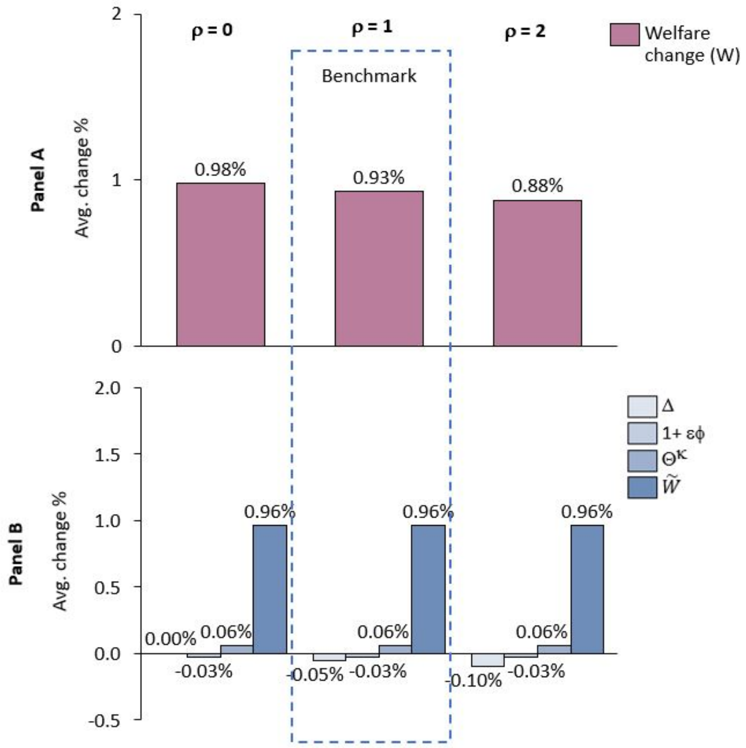
As shown in the last subsection, the variable trade costs in Germany decreased from $d_{1995} = 1.92$ in 1995 to $d_{2014} = 1.83$ in 2014, driven by the trade liberalization. Panel A of Figure 6.8 plots the average welfare change for the years 1995 to 2014 for different inequality aversion levels (while keeping $\epsilon = 0.5$ as a constant). For the German benchmark case of $\rho = 1$ the welfare grew on average by 0.93%. For the case of no inequality aversion of the social planner the average welfare growth would be a bit higher (0.95%), while with an inequality aversion of $\rho = 2$ the average welfare growth would be slightly lower (0.88%). Panel B of Figure 6.8 displays that the welfare growth is primarily driven by the growth of the Kaldor-Hicks economy ($\tilde{W}$). The welfare of the Kaldor-Hicks economy grows with 0.96%, independently of the level of inequality aversion. Further, the adjustments for the disutility of work $(1 + \varepsilon\phi)$ and the costly-redistribution correction term (Θ^{κ}) stay constant, irrespectively of the level of ρ. The welfarist correction term (Δ) decreases with the level of inequality aversion, and thus gives rise to the differences in welfare for the different levels of inequality aversion in Panel A.

For the next part, we conduct two counterfactual scenarios. In the first scenario, we shift the German economy of the year 2014 to the trade openness level of 1995. Thereby we let all parameters of the economy of 2014 remain equal, except that we incorporate the variable trade costs of the year 1995. In the second counterfactual scenario, we move the German economy to a situation under autarky, where the German economy of 2014 experiences exceptionally high levels of variable trade costs.

In Figure 6.9 we present the changes between the German economy of 2014 and the two counterfactual scenarios. The Figure shows that when the variable trade costs would rise to the level of 1995, the aggregate income of the economy would decrease by -4.5%. However, the society would become more equal in terms of post-government income distribution, indicated by a fall of the Gini-Index by -3.43%.

find variable trade costs of $d = 1.83$. Antràs et al. (2017) obtain for the United States variable trade costs of $d = 2.147$, fixed costs of $f_x = \$675$ and $\alpha = 0.554$.

Figure 6.8: Social Welfare Growth in an Open Economy

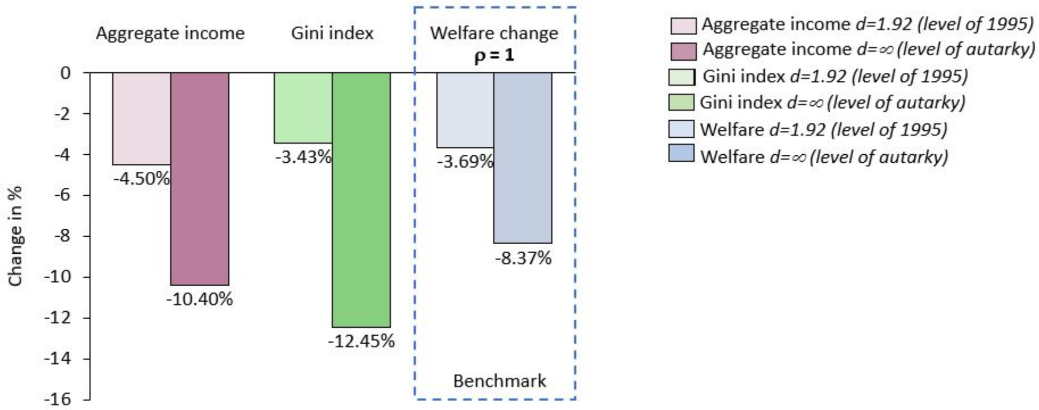


The figure displays the German social welfare growth in an open economy between the years 1995 and 2014. Δ represents the welfarist correction term, $(1+\epsilon\phi)$ is the disutility of labor effort term, Θ^{κ} is the costly-redistribution correction term and $\tilde{W}$ is the welfare in a hypothetical Kaldor-Hicks economy.

Source: World Input Output Database, Release 2016; SOEP 2016; Authors' own calculations.

Under the situation of autarky, the fall in aggregate income is with -10.40% even more severe. Through the situation under autarky the trade-induced inequality would diminish, pointed out by the Gini index decrease by -12.45%. Regarding the change in welfare, for the benchmark case with an inequality aversion of $\rho = 1$, the welfare would decrease by -3.69%, when the German economy would move to the level of trade openness of 1995. In the case of the move to autarky, the decline of welfare would be even more profound with -8.37%.

Figure 6.9: A move to Trade Openness of 1995 and to Autarky



The Figure displays the changes, when moving from the German economy of the year 2014 to (i) the German economy of 2014 with the trade openness of the year 1995 and (ii) the German economy of 2014 under autarky.

Source: World Input Output Database, Release 2016; SOEP 2016; Authors' own calculations.

6.6 Conclusion

Most OECD countries saw a rise in income inequality over the last decades (see Cingano (2014)), therefore, income inequality became an important policy issue. A common approach for welfare models is the use of the Kaldor-Hicks compensation principle, which, however, ignores the impact of income inequality and the fact that redistribution is costly. Against this background, Antràs et al. (2017) correct the shortcomings of the Kaldor-Hicks compensation principle by taking the aspect of income inequality into consideration, as well as account for the costs of progressive taxation arising through the redistribution scheme.

To shed more light on the impact of inequality on social welfare in Germany, this paper applies the new approach of Antràs et al. (2017) and examines two policy measures: The center of attention lies on the welfare impact of the German "Tax-Reform 2000" in the closed economy. Additionally, the welfare effect of trade liberalization in Germany is analyzed for the open economy. By making use of the rich dataset of the German Socio-Economic Panel (SOEP) we find that the tax-reform leads to an additional average annual income growth of 0.62%. However, considering the welfare growth we can show that the average annual welfare growth would have been just 0.07% larger with the "Tax-Reform 2000", due to the rising income inequality, triggered by lower tax progressivity.

We identify for each year between 1998 and 2007 the optimal tax progressivity in Germany. The optimal level of tax progression depends to a large extent on the inequality aversion of the social planner and varies with the level of inequality aversion. A key takeaway is that the "Tax-Reform 2000" can be seen as a success, as over the investigated period the actual tax progressivities approximate the optimal tax progressivity levels (for the German benchmark case). In addition, we present the welfare effects of the trade liberalization and show that the welfare of the German economy (of the year 2014) would be reduce by -3.69% when moving to the trade openness level of 1995, and by -8.37% when moving to an autarky situation.

6.A Appendix

Utility Function

The utility function can be expressed in the following way:

$$u(c,\ell) = c - \frac{1}{\gamma}\ell^{\gamma}$$

$$u_{\varphi} = kr_{\varphi}^{1-\phi} - \frac{1}{\gamma}[kQ^{(1-\beta)(1-\phi)}(\varphi)^{\beta(1-\phi)}\beta(1-\phi)]^{\frac{\gamma}{\gamma-\beta(1-\phi)}}$$

$$u_{\varphi} = kr_{\varphi}^{1-\phi} - \frac{1}{\gamma}[k\beta(1-\phi)]^{\frac{1+\epsilon}{1+\epsilon\phi}}[Q^{(1-\beta)}\varphi^{\beta}]^{(1-\phi)\frac{1+\epsilon}{1+\epsilon\phi}}$$

Drawing on: $kr_{\varphi}^{1-\phi} = k[[Q^{(1-\beta)}\varphi^{\beta}]^{\frac{1-\phi(1+\epsilon)}{1+\epsilon\phi}}[k\beta(1-\phi)]^{\frac{(1-\phi)\epsilon}{1+\epsilon\phi}}]$

Leads to:

$$u_{\varphi} = kr_{\varphi}^{1-\phi} - \frac{1}{\gamma}\frac{[k\beta(1-\phi]^{\frac{1+\epsilon}{1+\epsilon\phi}}}{k[k\beta(1-\phi]^{\frac{\epsilon(1-\phi)}{1+\epsilon\phi}}}kr_{\varphi}^{1-\phi}$$

$$u_{\varphi} = \left(1 - \frac{1}{\gamma}\frac{1}{k}[k\beta(1-\phi]^{\frac{1+\epsilon\phi}{1+\epsilon\phi}}\right)kr_{\varphi}^{1-\phi}$$

$$u_{\varphi} = \left(1 - \frac{\gamma-\beta(1-\phi)}{\gamma}\right)kr_{\varphi}^{1-\phi}$$

$$u_{\varphi} = \frac{1+\epsilon\phi}{1+\epsilon}kr_{\varphi}^{1-\phi}$$

Equilibria

Equilibrium under $\phi = 0$

Recall governmental balances for $\phi = 0$:

$$(1-g)\tilde{Q} = \tilde{k}\int r_{\varphi}dH_{\varphi} = \tilde{k}\tilde{Q}$$

Hence, we have $\tilde{k} = 1-g$ and $\tau(r_{\varphi}) = \tau^{m}(r_{\varphi}) = 1-\tilde{k} = g$.

Next, identify the aggregate consumption (final) good $\tilde{Q}$ under that new assumption:

$$\tilde{Q} = \int \tilde{r}_\varphi dH_\varphi$$

Insert $\tilde{r}_\varphi$:

$$\tilde{Q} = \int [\tilde{Q}^{(1-\beta)}\varphi^\beta]^{1+\epsilon}[\tilde{k}\beta]^\epsilon dH_\varphi$$

Simplify the equation:

$$\tilde{Q} = [\tilde{Q}^{(1-\beta)(1+\epsilon)}[(1-g)\beta]^\epsilon \int \varphi^{\beta(1+\epsilon)} dH_\varphi$$

Summing up for $\tilde{Q}$:

$$\tilde{Q} = \left([(1-g)\beta]^\epsilon \int \varphi^{\beta(1+\epsilon)} dH_\varphi\right)^{\frac{1}{1-(1-\beta)(1+\epsilon)}}$$

$$[(1-g)\beta]^\epsilon = \frac{\tilde{Q}^{1-(1-\beta)(1+\epsilon)}}{\int \varphi^{\beta(1+\epsilon)} dH_\varphi}$$

The individual revenue $\tilde{r}$ becomes:[31]

$$\tilde{r}_\varphi = [\tilde{Q}^{(1-\beta)}\varphi^\beta]^{1+\epsilon}[\tilde{k}\beta]^\epsilon$$

$$\tilde{r}_\varphi = \tilde{Q}^{(1-\beta)(1+\epsilon)}[\varphi^\beta]^{1+\epsilon}[(1-g)\beta]^\epsilon$$

$$\tilde{r}_\varphi = \frac{\tilde{Q}^{1-(1-\beta)(1+\epsilon)}}{\int \varphi^{\beta(1+\epsilon)} dH_\varphi}[\varphi^{\beta 1+\epsilon}]\tilde{Q}^{(1-\beta)(1+\epsilon)}$$

$$\tilde{r}_\varphi = \frac{\varphi^{\beta(1+\epsilon)}}{\int \varphi^{\beta(1+\epsilon)} dH_\varphi}\tilde{Q}$$

Equilibrium under $\phi > 0$

Next, consider the equilibrium with $\phi > 0$.

[31]Starting point:

$$r_\varphi = [Q^{(1-\beta)}\varphi^\beta]^{\frac{1+\epsilon}{1+\epsilon\phi}}[k\beta(1-\phi)]^{\frac{\epsilon}{1+\epsilon\phi}}$$

Take the optimal revenue of equation 6.12

$$r_\varphi = [Q^{(1-\beta)}\varphi^\beta]^{\frac{1+\epsilon}{1+\epsilon\phi}}[k\beta(1-\phi)]^{\frac{\epsilon}{1+\epsilon\phi}} \tag{6.25}$$

Rearrange the equation to insert it in the counterfactual revenue equation:

$$r_\varphi = (1-\phi)^{\frac{\epsilon}{1+\epsilon\phi}} k^{\frac{\epsilon}{1+\epsilon\phi}} \left[\beta^\epsilon \varphi^{\beta(1+\epsilon)}\right]^{\frac{1}{1+\epsilon\phi}} Q^{\frac{(1-\beta)(1+\epsilon)}{1+\epsilon\phi}} \tag{6.26}$$

$$r_\varphi = (1-\phi)^{\frac{\epsilon}{1+\epsilon\phi}} k^{\frac{\epsilon}{1+\epsilon\phi}} \left[\frac{\tilde{r}_\varphi}{(1-g)^\epsilon \tilde{Q}^{(1-\beta)(1+\epsilon)}}\right]^{\frac{1}{1+\epsilon\phi}} Q^{\frac{(1-\beta)(1+\epsilon)}{1+\epsilon\phi}} \tag{6.27}$$

Rearrange to obtain $(k/(1-g))$ and extend equation 6.15 with $\tilde{Q}$:

$$r_\varphi = (1-\phi)^{\frac{\epsilon}{1+\epsilon\phi}} \left(\frac{k}{1-g}\right)^{\frac{\epsilon}{1+\epsilon\phi}} \left(\frac{Q}{\tilde{Q}}\right)^{\frac{(1-\beta)(1+\epsilon)}{1+\epsilon\phi}} \tilde{r}_\phi^{\frac{1}{1+\epsilon\phi}} \tag{6.28}$$

It is defined: $(1-g)Q = k\int r_\varphi^{1-\phi} dH_\varphi$, where $Q = R = \int r_\varphi^{1-\phi} dH_\varphi$

Then it can be written:

$$\frac{k}{1-g} = \frac{\int r_\varphi dH_\varphi}{\int r_\varphi^{1-\phi} dH_\varphi}$$

Insert r_φ:

$$\frac{k}{1-g} = \frac{\int r_\varphi dH_\varphi}{\int r_\varphi^{1-\phi} dH_\varphi} = (1-\phi)^{\frac{\epsilon\phi}{1+\epsilon\phi}} \left(\frac{k}{1-g}\right)^{\frac{\epsilon\phi}{1+\epsilon\phi}} \left(\frac{Q}{\tilde{Q}}\right)^{\frac{(1-\beta)(1+\epsilon)\phi}{1+\epsilon\phi}} \frac{\int \tilde{r}_\varphi^{\frac{1}{1+\epsilon\phi}} dH_\varphi}{\int \tilde{r}_\varphi^{\frac{1-\phi}{1+\epsilon\phi}} dH_\varphi} \tag{6.29}$$

Get $(k/(1-g))$ on the left-hand side:

$$\frac{k}{1-g} = (1-\phi)^{\epsilon\phi} \left(\frac{Q}{\tilde{Q}}\right)^{(1-\beta)(1+\epsilon)\phi} \left(\frac{\int \tilde{r}_\varphi^{\frac{1}{1+\epsilon\phi}} dH_\varphi}{\int \tilde{r}_\varphi^{\frac{1-\phi}{1+\epsilon\phi}} dH_\varphi}\right)^{1+\epsilon\phi} \tag{6.30}$$

Note that $Q = \int r_\varphi dH_\varphi$ and insert r_φ

$$Q = \int r_\varphi dH_\varphi = (1-\phi)^{\frac{\epsilon}{1+\epsilon\phi}} \left(\frac{k}{1-g}\right)^{\frac{\epsilon}{1+\epsilon\phi}} \left(\frac{Q}{\tilde{Q}}\right)^{\frac{(1-\beta)(1+\epsilon)}{1+\epsilon\phi}} \int \tilde{r}_\varphi^{\frac{1}{1+\epsilon\phi}} dH_\varphi \tag{6.31}$$

Extend with $\tilde{Q} = \int \tilde{r}_\varphi dH_\varphi$:

$$\frac{Q}{\tilde{Q}} = (1-\phi)^{\frac{\epsilon}{1+\epsilon\phi}} \left(\frac{k}{1-g}\right)^{\frac{\epsilon}{1+\epsilon\phi}} \left(\frac{Q}{\tilde{Q}}\right)^{\frac{(1-\beta)(1+\epsilon)}{1+\epsilon\phi}} \frac{\int \tilde{r}_\varphi^{\frac{1}{1+\epsilon\phi}} dH_\varphi}{\int \tilde{r}_\varphi dH_\varphi} \tag{6.32}$$

Insert the equation of $(k/(1-g))$ from above:

$$\frac{Q}{\tilde{Q}} = (1-\phi)^{\frac{\epsilon}{1+\epsilon\phi}} \left((1-\phi)^{\epsilon\phi} \left(\frac{Q}{\tilde{Q}}\right)^{(1-\beta)(1+\epsilon)\phi} \left(\frac{\int \tilde{r}_\varphi^{\frac{1}{1+\epsilon\phi}} dH_\varphi}{\int \tilde{r}_\varphi^{\frac{1-\phi}{1+\epsilon\phi}} dH_\varphi} \right)^{1+\epsilon\phi} \right)^{\frac{\epsilon}{1+\epsilon\phi}} * \\ \left(\frac{Q}{\tilde{Q}}\right)^{\frac{(1-\beta)(1+\epsilon)}{1+\epsilon\phi}} \frac{\int \tilde{r}_\varphi^{\frac{1}{1+\epsilon\phi}} dH_\varphi}{\int \tilde{r}_\varphi dH_\varphi}$$

Rearrange the equation:

$$\frac{Q}{\tilde{Q}} = (1-\phi)^{\epsilon} \left(\frac{Q}{\tilde{Q}}\right)^{(1-\beta)(1+\epsilon)} \frac{\left(\int \tilde{r}_\varphi^{\frac{1}{1+\epsilon\phi}} dH_\varphi \right)^{\epsilon+1}}{\left(\int \tilde{r}_\varphi^{\frac{1-\phi}{1+\epsilon\phi}} dH_\varphi \right)^{\epsilon} \int \tilde{r}_\varphi dH_\varphi} \tag{6.33}$$

Bring $\frac{Q}{\tilde{Q}}$ on left-hand side:

$$\frac{Q}{\tilde{Q}} = \left[(1-\phi)^{\epsilon} \frac{\left(\int \tilde{r}_\varphi^{\frac{1}{1+\epsilon\phi}} dH_\varphi \right)^{\epsilon+1}}{\left(\int \tilde{r}_\varphi^{\frac{1-\phi}{1+\epsilon\phi}} dH_\varphi \right)^{\epsilon} \int \tilde{r}_\varphi dH_\varphi} \right]^{\frac{1}{1-(1-\beta)(1+\epsilon)}} \tag{6.34}$$

Note that $\frac{Q}{\tilde{Q}} = \frac{R}{\tilde{R}}$, hence, $R = \frac{Q}{\tilde{Q}} \times \tilde{R}$. Thus, aggregate income is:

$$R = \left[(1-\phi)^{\epsilon} \frac{\left(\int \tilde{r}_\varphi^{\frac{1}{1+\epsilon\phi}} dH_\varphi \right)^{\epsilon+1}}{\left(\int \tilde{r}_\varphi^{\frac{1-\phi}{1+\epsilon\phi}} dH_\varphi \right)^{\epsilon} \int \tilde{r}_\varphi dH_\varphi} \right]^{\frac{1}{1-(1-\beta)(1+\epsilon)}} \times \tilde{R} \tag{6.35}$$

KH-Welfare if $\phi = \rho = 0$

$$\tilde{W} = \int u_\varphi dH_\varphi = \frac{k}{1+\epsilon} \int r_\varphi dH_\varphi = \frac{1-g}{1+\epsilon} \tilde{Q} \tag{6.36}$$

Welfare if $\phi \neq 0$ and $\rho \neq 0$

$$W = \left(\int u_\varphi dH_\varphi \right)^{\frac{1}{1-\rho}} \tag{6.37}$$

$$W = \frac{1+\epsilon\phi}{1+\epsilon} \left(\int (k r_\varphi^{1-\phi})^{1-\rho} dH_\varphi \right)^{\frac{1}{1-\rho}} \tag{6.38}$$

$$W = \frac{1+\epsilon\phi}{1+\epsilon} \left(\int (r_\varphi^d)^{1-\rho} dH_\varphi \right)^{\frac{1}{1-\rho}} \tag{6.39}$$

$$W = \frac{1+\epsilon\phi}{1+\epsilon} \frac{\left(\int (r_\varphi^d)^{1-\rho} dH_\varphi \right)^{\frac{1}{1-\rho}}}{\int r_\varphi^d dH_\varphi} (1-g)Q \tag{6.40}$$

$$W = \frac{1+\epsilon\phi}{1+\epsilon} \underbrace{\frac{\left(\int (r_\varphi^d)^{1-\rho} dH_\varphi \right)^{\frac{1}{1-\rho}}}{\int r_\varphi^d dH_\varphi}}_{\Delta} (1-g)\Theta^\kappa \tilde{Q} \tag{6.41}$$

$$W = \Delta \times (1+\epsilon\phi)\Theta^\kappa \times \frac{1-g}{1+\epsilon}\tilde{Q} \tag{6.42}$$

$$W = \Delta \times (1+\epsilon\phi)\Theta^\kappa \times \tilde{W} \tag{6.43}$$

Change in social welfare is defined as:

$$\frac{W'}{W} = \frac{\Delta'}{\Delta} \frac{\Theta'^\kappa}{\Theta^\kappa} \frac{\tilde{W}'}{\tilde{W}} \tag{6.44}$$

$$\frac{W'}{W} = \frac{\Delta'}{\Delta} \times \frac{(1+\epsilon\phi)'}{(1+\epsilon\phi)} \times \frac{Q'}{Q} \tag{6.45}$$

Robustness Checks

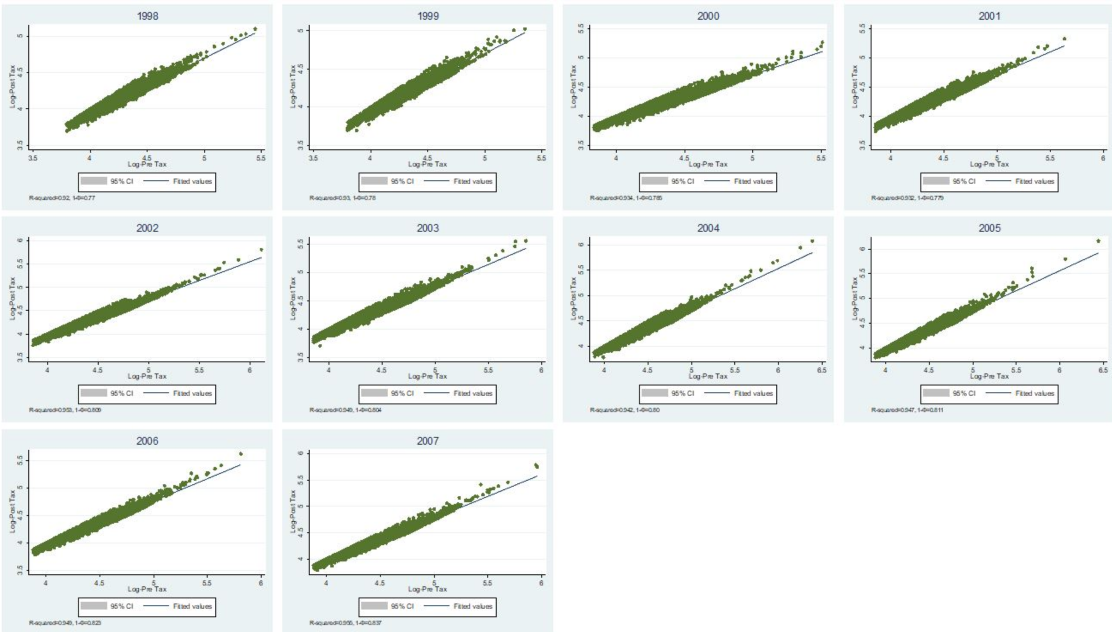
Table 6.A.2: Robustness checks (for various γ with $\epsilon = 0.5$ and $\rho = 1$)

Frisch Elasticity	Δ	$1 + \varepsilon\phi$	Θ^{κ}	$\tilde{W}$	W
0.55	-0.25%	-0.34%	0.54%	1.77%	1.71%
0.85	-0.25%	-0.33%	0.83%	1.59%	1.82%
2	-0.26%	-0.34%	1.97%	0.38%	1.72%

Source: SOEP 2016; Authors' own calculations.

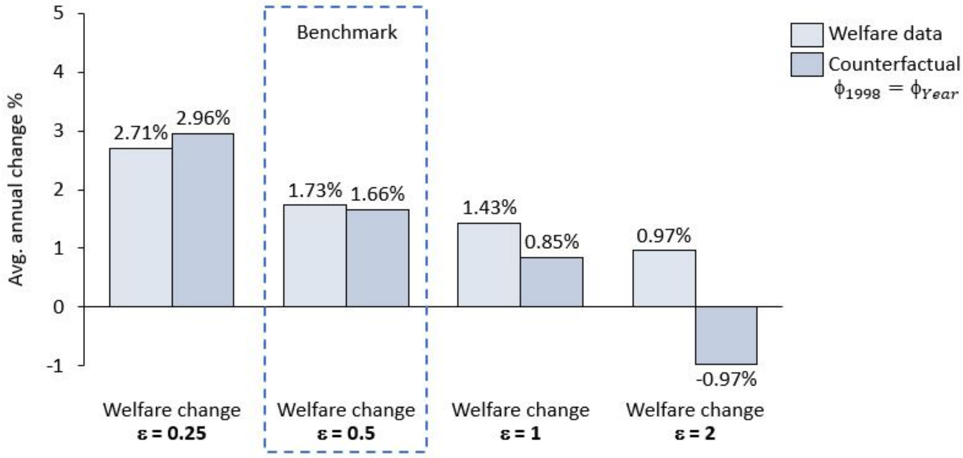
Graphs

Figure 6.A.10: Tax Progressivity in Germany (annually)



Source: SOEP 2016; Authors' own calculations.

Figure 6.A.11: Counterfactual Scenarios (for various levels of ϵ)



Source: SOEP 2016; Authors' own calculations.

Chapter 7

Conclusion

7.1 Summary

"Globalization is not something that can be hold off or turn off, it is the equivalent of a force – like wind or water."

Former U.S. President Bill Clinton (2000)

Over 20 years ago, former U.S. President Bill Clinton made this statement in a speech. The statement might still be true today as the world has become even more connected. In this context, trade policy plays a crucial role for countries to boost their economy. If trade policies are set right, they can be like sails allowing countries to cruise in the wind of globalization. To shed more light on policy implications I explore a broad variety of relevant trade policy issues in my dissertation. I conduct the policy research in two ways: First, by investigating the effects of potential trade policies that are not yet implemented. To conduct the policy analysis, I compare the actual status with a counterfactual situation. Second, I evaluate various policy reforms and assess the effects after the reforms were executed. I carry out the research on policies through the application of state-of-the art quantitative trade models. Especially, I rely on "New Quantitative Trade Models" as my main workhorses. In chapter 2, I give a short outline on NQTMs and put the models into the broader context of trade literature with a focus on quantitative trade analysis.

Chapter 3 is devoted to the examination of a potential free trade agreement between the United States and Japan. To investigate the potential free trade agreement and its impact on trade and welfare, I apply the multi-country, multi-sector Ricardian trade model of Caliendo and Parro (2015). I contribute by analyzing three possible scenarios of the potential free trade agreement: Ranging from the scenario of bilateral tariffs being eliminated to a "Shallow FTA" and to a "Deep FTA". The last cases both include the adoption of bilateral standards and regulations. In addition, I compare the "Deep FTA" scenario to the impact which the Trans-Pacific Partnership would have had.
My findings highlight the importance of adopting regulations and standards through trade agreements. With my analysis I demonstrate that the reduction of non-tariff barriers has the largest impact on trade flows. Whereas the elimination of tariffs plays only a minor role. Furthermore, the results suggest that it makes a difference what type of trade agreement countries adopt. Thus, Japan would prefer the bilateral (deep) free trade agreement, whereas the United States would benefit more by being part of the Trans-Pacific Partnership. Especially for Japan this might be surprising. But this can be explained by looking at the composition of the welfare effects which depend on the volume of trade and the terms of trade (change of the international exchange ratio). The volume of trade is higher in the case of the Trans-Pacific Partnership (compared to a "Deep FTA"). However, the negative terms of trade decrease the welfare growth. Hence, the welfare growth would be lower for Japan in the case of the TPP than in the case of a "Deep FTA".

Chapter 4 deals with a potential "Zero Tariff Solution" in the automotive sector as another current trade policy topic. Under the Trump administration a potential trade war hung over Europe like a sword of Damocles. To calm the situation the "Zero Tariff Solution" was proposed as an alternative trade strategy. The "Zero Tariff Solution" would have involved the removal of EU and U.S. import tariffs in the car sector. In this chapter we study three possible trade scenarios of the "Zero Tariff Solution" and its impact on trade and welfare. We rely on the theoretical and empirical approach presented in chapter 3. The study comprises the scenario of a bilateral "Zero Tariff Solution" between Germany and the U.S. as well as the scenario of a "Zero Tariff Solution" between the EU and the U.S.. The third scenario is the large "Zero Tariff Solution" that involves the elimination of import tariffs in the car sector between the EU, the U.S. and the WTO member states. We find that Germany will have the highest import increase of American cars in the third scenario, as the German import of U.S. cars would increase by 11.9 percent. While for the U.S. the import of German cars would be the highest in the first scenario with an increase of 29.9 percent. In the other two scenarios the demand for German cars would slightly shift to other countries, due to the fall in U.S. import tariffs. The key takeaway from this trade policy analysis regarding welfare effects is that Germany, the EU and the U.S. would benefit the most in the third scenario. Hereby, the welfare effects are the highest in Germany and in the EU. The U.S. benefits primarily from the volume of trade and is negatively affected by the terms of trade. The negative terms of trade are caused by the larger U.S. trade deficit as well as the sharper decline in export prices compared to the import prices.[1]

In the fifth chapter, my interest lies in the potential causes of the rapid decline in German unemployment after 2005. For this reason, I examine the German labor market reform, which was implemented during that time. In particular, I put my focus on the "Hartz IV-Reform". Moreover, the rising trade flows between Germany and Eastern Europe known as the "rise of the East" could have contributed to the decline in German unemployment as well. It is argued that the increase in German and Eastern European productivity could have steered the rising trade flows. Therefore, I investigate the labor market impact of the so-called German

[1] The European Union has higher import tariffs on U.S. automobiles than the United States on cars from the European Union. The bilateral elimination of tariffs on automobiles leads therefore to a sharper decline in export prices compared to the import prices for the United States, which in turn affects the terms of trade.

and Eastern European productivity shock. In order to examine the labor market effects I extend the dynamic New Quantitative Trade Model of Caliendo et al. (2019) by including the “Hartz IV-Reform” into the model. The findings indicate that the largest impact on short-term unemployment is driven by the “Hartz IV-Reform”. For further research it would be interesting to study the entire “Hartz Reform” in a dynamic setting. In addition, it became evident through my analysis that the “rise of the East”, triggered by the productivity shocks, decreased the German short-term unemployment by 0.03 percent. Dissecting the effects shows a positive contribution of the German rise in productivity and a minor negative impact caused by the Eastern European productivity shock. On the county level, my results show that counties in East Germany, close to Eastern Europe, are more strongly affected by the Eastern European productivity shock. Concerning the sectoral dynamics of employment, my findings display a “push effect” away from the import penetrated manufacturing sector into the service sectors.

In chapter 6 we evaluate policies and their impact on social welfare and income inequality. As described in chapter 2, the NQTMs are mostly silent on distribution issues. Therefore, we apply the methodology of Antràs et al. (2017), that builds on public finance literature as well as on concepts of the “New New Trade Theory”. Antràs et al. (2017) correct the Kaldor-Hicks approach for its shortcomings on income distribution. We apply this approach in a closed economy and an open economy setting and rely hereby on the rich German Socio-Economic Panel (SOEP) data set. For the closed economy we investigate the “Tax-Reform 2000”. We find support that the “Tax-Reform 2000” has a positive impact on the average annual income growth. However, our findings also suggest that the average annual welfare growth would be just 0.07 percent larger with the “Tax-Reform 2000”. This can be explained as a lower tax progressivity leads to more inequality lowering in turn the social welfare growth. We contribute to the literature by identifying the optimal tax progressivity that maximizes social welfare while taking inequality into account. For the case of the open economy, we study the trade liberalization between 1995 and 2014 in Germany. The results demonstrate that a counterfactual move of the German economy of the year 2014 to the trade openness of 1995 would severely reduce the social welfare. Another aspect, worth mentioning is that the open economy uses a basic trade framework. The Antràs et al. (2017) approach would benefit if the methodology would be set into a richer methodological environment of NQTMs. However, we leave this for further research.

7.2 Concluding Remarks

The goal of my thesis was to offer new insights on various trade policy issues. Through this exploration I hope to offer some policy advice how to set the sails right (at least a bit more) in order to navigate smoothly through the winds of globalization.

The wind of globalization seems to have slowed down in recent years, as Antràs (2020) points out. This study provides an excellent overview and outlook on the development of globalization. Antràs (2020) indicates that compared to the rapid growth between the late 1980s and the early 2000s ("hyperglobalization") the growth rate of globalization slowed down since the financial crisis in 2008-2009. Thereby he argues that the recent development of globalization can be seen as a "slowbalization". Though the "slowbalization" might even shift into a deglobalization with a persistent COVID-19 pandemic and an ongoing geopolitical U.S. – China trade war.

In the case of the wind of globalization turning into the direction of a deglobalization it will severely (re)shape the landscape of the global economy. Under those new economic circumstances, the focus will be more on the resilience of the national supply systems with an increase in protectionism and with firms rewiring their current supply chains. These developments will lead to the rise of new research questions on the consequences of a more de-globalized world. In order to answer such research questions and to identify the appropriate policy approaches the alignment of theoretical concepts as well as further expansion of the empirical methods will be required.

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