A Comprehensive Analysis of Minimum Wage Policy Using the Modern Wage Dynamics Model

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ABSTRACT

This paper analysis the introduction of Germany's statutory minimum wage, a policy which took effect on 1 January amid widespread attention to rising income inequality and economic division. This paper studies the effects on both disposable household income and employment, as well as labor market inequality through a broad analysis using the Modern Wage Dynamics simulation model applied to Germany with its strong welfare state or social insurance system in combination with high marginal effective taxes of wise low earnings. This allows us to draw narratives from the variety of perspectives and interests involved in workload effort sharing as employees, employers, and policymakers. This study performs a series of simulations to shed light on the macroeconomic implications such as possible effects on employment, income distribution and economic growth in this respect. The study is a major contribution to the empirical literature on minimum wages within such complex welfare states as Germany and closes several gaps in the existing research. The aim is to provide evidence for policy makers dealing with the challenge between reducing income inequality and in-work poverty on one hand, and those concerning headline economic objectives of stability and growth.

KEYWORDS
Minimum Wage, Income Distribution, Employment, Welfare State, Economic Policy, Germany, Wage Dynamics, Economic Growth, Stakeholder Analysis, Policy Simulation

1. INTRODUCTION

A statutory minimum wage has become a major policy concern in Germany due to increasing wage and income inequality [1]. In contrast to other OECD countries, Germany did not adopt a minimum wage until 1st January 2015 [2]. The coalition government's new policy to establish a statutory minimum wage of 8.50€ per hour in Germany calls for a thorough examination of its consequences on income distribution and the larger economic landscape. This paper investigates the impact of implementing a statutory minimum wage in Germany on disposable household incomes. The interplay between Germany's minimum wage policy and its generous welfare system with high marginal tax rates on low earnings fuels our research [3]. This paper begins with an extensive literature review, focusing on minimum wage impacts, specifically studies reporting on distributional consequences. In this analysis, we position our work among existing scholars and underscore the voids our investigation seeks to fill. We describe our analysis methodology for the minimum wage's impact in the methodology section. Using the Modern Wage Dynamics (MWD) simulation model, we can accurately represent the intricate interplay between the labor market and the larger economy. We identified stakeholders as a crucial aspect of our research. We examine the viewpoints of employees, employers, and government policymakers as our key players. A balanced approach to minimum wage implementation, addressing various interests and concerns, is ensured through this multi-faceted strategy. The experimental design for simulating minimum wage scenarios and their outcomes, using the MWD model, is described in the simulation section. Our analysis considers the ripple effects of the minimum wage, such as alterations in employment and prices, which was previously overlooked in several studies. We address the three distinct research questions in the finding's interpretation section of the analysis. 1) How does an increase in minimum wage affect overall employment levels, particularly among low-wage workers? 2) How does a rise in minimum wage influence the income distribution among different workforces? and finally, 3) What are the effects of a higher minimum wage on the overall economic growth and productivity levels?

Our conclusion summarizes the pivotal discoveries and their policy implications. In the German welfare state, the minimum wage's effectiveness in reducing income inequality and eliminating in-work poverty is evaluated. This study intends to offer significant perspectives on the potential impact of a minimum wage in Germany by conducting an exhaustive examination. Our findings will be particularly relevant for policymakers seeking to address income inequality and in-work poverty while navigating the complexities of the German welfare state and its interaction with labor market policies..

2. LITERATURE REVIEW

Minimum wage policies have been extensively researched in economics for their impacts on labor markets, income distribution, and broader economic trends. This review focuses on the distributional impacts and German relevance of minimum wage research, specifically emphasizing the contributions of the Modern Wage Dynamics (MWD) model.

Theoretical Foundations and Empirical Evidence

Since Stigler's [4] early theoretical work predicting negative employment effects in competitive labor markets, the study of minimum wages has undergone significant advancements. According to empirical studies like that of Card and Krueger [5], minimum wage increases do not necessarily result in negative employment effects. Minimum wage research is extensive and multidimensional, covering various sectors, regions, and labor market conditions. Modern approaches, which account for market imperfections, heterogeneity, and dynamic adjustments, now supplement traditional neoclassical economic models. Applegate's [14] modern wage dynamics model advances our understanding of the economy as a complex adaptive system. This recognition of the non-linear nature of labor markets is aligned with this approach, as traditional equilibrium models have their limitations [6].

The modern wage dynamics model's agent-based methodology aligns with research promoting bottom-up economic simulations [7]. This methodology accommodates heterogeneity among agents and emergent phenomena, countering criticisms of representative agent models [8]. Recent empirical work on labor market dynamics is aligned with the model's comprehensive approach to worker and employer behaviors such as skill acquisition, job search strategies, and wage negotiation processes.

In a welfare state context, distributional effects matter. The research on minimum wages' impact covers both wage and household income distribution. In Germany, Bruttel [10] discovered wage compression in sectors subjected to minimum wage increases. Household incomes are influenced intricately by tax and benefit systems. Shimmer [9] found no correlation between US minimum wages and family poverty rates, while Brewer and De Agostini [11] indicated that UK minimum wage rises led to offsetting cuts in means-tested benefits.

In Germany, with its significant social safety net and substantial taxation of meager wages [13], Müller and Steiner [3], proposed that the implementation of a minimum wage might lessen its redistributive impact. Immervoll [12], emphasized the significance of factoring in tax and benefit systems when examining minimum wage policies across OECD countries. In Germany, the welfare state is characterized by a relatively generous social minimum and high marginal tax rates on low earnings [13]. Müller and Steiner [3] argued that these features could significantly reduce the distributional effects of a minimum wage.

Methodological Advancements and Policy Analysis

Modern methodologies have improved our capacity to study minimum wage impacts. This revision allows for a more comprehensive analysis of minimum wage effects by incorporating general equilibrium effects and behavioral responses. The Modern Wage Dynamics model offers substantial progress for policy analysis in labor economics. This tool, capable of simulating both direct and indirect effects of diverse policy interventions, enables policymakers to assess potential outcomes. The model's credibility for policy analysis is strengthened by its rigorous calibration and validation using a diverse dataset including historical data and labor force statistics. Research is currently focusing on the impact of minimum wages on skill acquisition, career progression, and the wider macroeconomic consequences, including aggregate demand, productivity, and economic growth. Advanced quasi-experimental techniques and big data analysis in machine learning expand our comprehension of intricate labor market dynamics and minimum wage policy effects.

In Germany's welfare state context, despite extensive research, certain gaps persist regarding minimum wage impacts. The impact of minimum wages on complex tax-benefit systems in welfare states remains under-researched. Distributional analyses often overlook the significance of second-round effects, such as shifts in employment and prices. Limited research exists on the interconnected impacts of wage distribution, household income distribution, employment, and economic growth.

Future research could consider integrating global economic factors, incorporating demographic details, and examining long-term consequences of minimum wages on mobility and human capital. Impending research directions might include integrating global economic variables to account for international labor market dynamics, incorporating more detailed demographic information to analyze differential impacts across population subgroups, and exploring the long-term effects of minimum wages on economic mobility and human capital accumulation.

The Modern Wage Dynamics model, an advanced instrument in minimum wage research, reviews the complex relationship of minimum wage policies, labor market dynamics, and welfare state systems. Addressing key literature gaps and offering a comprehensive framework for policy analysis can significantly advance our understanding of minimum wage effects, notably within the context of welfare states like Germany. With the ongoing transformation of labor markets due to technology and globalization, advanced modeling approaches are essential for guiding informed policy decisions. The minimum wage debate necessitates further investigation into its subtle and situationally varied effects on laborers, employers, and the economy at large.

3. METHODOLOGY

This study examines the far-reaching effects of introducing a statutory minimum wage in Germany. Our methodology utilizes microsimulation modeling, stakeholder analysis, and scenario-based simulations for a comprehensive examination of minimum wage policy's distributional effects and broader economic repercussions. The Modern Wage Dynamics (MWD) simulation model analyzes contemporary wage patterns. Our methodology centers around the Modern Wage Dynamics (MWD) model, version 1.0.0, created by J M Applegate in 2022. This model simulates wage determination within modern economic systems. Our analysis benefits significantly from the Modern Wage Dynamics MWD model's advantages. The model accounts for various factors, such as skill levels, employer demands, and the institutional environment, that impact wage dynamics.

By simulating the individual decision-making processes of workers and employers, the agent-based model captures micro-level behaviors that lead to macro-level outcomes. The model

supports the analysis of short-term and long-term policy impacts through multiple iterations. The Modern Wage Dynamics (MWD) model is calibrated with historical wage data, labor force surveys, and demographic statistics for real-world alignment. Evaluate and determine key project stakeholders. The text identifies and analyzes three key stakeholder groups. This policy particularly benefits those working for low wages. Small and medium-sized enterprises may struggle to adapt to wage increases. Government policymakers are responsible for establishing and enforcing minimum wage laws. For each stakeholder group, we design tailored scenarios addressing their unique perspectives, concerns, and objectives. This approach ensures a balanced analysis of policy perspectives.

Our primary research questions are tested through simulation experiments. To answer our primary research questions, we conduct simulation experiments. We examine the impact of varying minimum wage rates on total employment, focusing on low-wage sectors. We examine how different minimum wage levels influence income inequality between workforce segments. We evaluate the effect of minimum wage hikes on economic expansion and productivity within various industries. Each step in the experiment includes the tasks mentioned. Establish the current conditions without implementing any minimum wage adjustments. Simulate different minimum wage levels, for instance, 8.50€ per hour, 10€/hour, and 12€ per hour. Examine the impact of first-order effects on wages and employment. Incorporation of Second-Round Effects: Anticipate employment level fluctuations and price modifications. Evaluate the impact of varying assumptions and parameter values on our findings.

The analysis proceeds through these crucial stages.

Offer a description of the present wage distribution alongside the identification of the public subject to minimum wage regulations. Analyze wage and income distributions using measures like the Gini coefficient and percentile ratios to identify changes. Evaluate the effect of poverty and inequality metrics on poverty rates and different inequality measures. Analyze economic sector and regional disparities to uncover varying impacts. Conduct robustness checks to address uncertainties in the model's parameters and assumptions during sensitivity testing. Sensitivity Testing: Conduct robustness checks to account for uncertainties in model parameters and assumptions.

Limitations and Considerations

Our approach has acknowledged limitations. The model wage dynamics MWD model come with built-in assumptions. Accurately predicting behavioral responses to policy changes poses a significant challenge. We aim to offer policymakers comprehensive insights into the potential impacts of a minimum wage in Germany by combining our methodological approach.

4. STAKEHOLDER IDENTIFICATION

We consider the effects of introducing a statutory minimum wage in Germany on employees, employers, and policymakers. Distinct interests, concerns, and potential responses distinguish each group regarding the policy change. Through detailed scenarios, we strive to offer a deeper comprehension of minimum wage implementation's intricate stakeholder dynamics.

Employees

We advocate for the viewpoint of employees who will be directly impacted by the national minimum wage. These workers, despite long hours, barely earn enough to cover life's essentials. Setting a minimum wage for a living wage would greatly improve their ability to cover housing, food, healthcare, and other essentials. Maria, a 35-year-old Berlin resident, is a full-time sales assistant at a small retail store. With an hourly wage of 7.50€, Maria falls short of the proposed 8.50€ minimum wage and struggles to pay for rent, utilities, and her child's food expenses. She heavily depends on food banks and struggles with the cost of school supplies and clothing for her child.

An increase in the minimum wage to 8.50€ an hour renews Maria's optimism for financial stability. She's fearful about the possible consequences. Maria is concerned about potential reductions in hours or her small employer's financial instability, which could threaten her job. She is unsure of the impact the wage hike might have on her social benefits. The minimum wage policy and the welfare state system have a complex relationship, exemplified by Maria's situation. Our research should consider the net effect on household income, considering taxes, social security contributions, and any changes in benefit entitlements, as well as the immediate impact on gross wages.

Employers

For small and medium-sized businesses, the national minimum wage's implementation poses challenges to their competitiveness and sustainability. Acknowledging the significance of a living wage for employees, some employer's express concerns over its impact on their business's operations and earnings. In Koblenz city, Klaus operates a family-owned bakery with ten employees. The business, a local fixture for three generations, is renowned for its high-quality products. At least three of Klaus's employees, mostly from sales and apprentice bakers, receive hourly wages lower than the proposed minimum of 8.50€. A required wage hike poses a dilemma for Klaus. While prioritizing his employees' well-being, he worries about the financial implications for his company. Despite stiff competition from larger bakery chains and supermarkets, the bakery manages to operate with slim profit margins. The increase in the minimum wage would add around 15,000€ per year to Klaus' labor expenses. He weighs various alternatives to cover the expense, including increasing prices, lowering staff hours or headcount, and investing in automation but lacks the necessary funds for the last option.

Klaus is also concerned about preserving wage disparities. To maintain morale and retain skilled bakers, he feels compelled to raise wages for all employees when increasing wages for his lowest-paid workers. The cascading effect could extremely increase his total labor costs. Employers struggle with difficult choices when implementing minimum wage laws. Our research's significance lies in its modeling of not only labor cost impacts, but also the ensuing effects on employment, prices, and investment.

Policymakers

Policymakers must strike a delicate balance between economic and social objectives when designing and implementing the new minimum wage policy. Balancing the demands of various stakeholders and assessing the economic and societal consequences. Dr. Schmidt, the Minister of Labor and Social Affairs, is driving the implementation of a national minimum wage. An economist with a background in labor policy, Dr. Schmidt is dedicated to solving income inequality while acknowledging the potential risks of her proposed policies. During her cabinet presentation of the minimum wage proposal, Dr. Schmidt ponders over several essential questions. Determining the ideal minimum wage involves balancing fair wages for employees with affordable costs for employers. The minimum wage's impact on social welfare programs and the potential adjustments for maintaining a consistent policy framework should be considered. The employment levels will be significantly affected in low-wage sectors and economically weaker regions. The minimum wage's impact on Germany's economic competitiveness and productivity is a subject of debate among economists. Schmidt acknowledges the complexity of these responses. The analysis of her economic policy requires considering both its immediate and long-term, dynamic effects on the labor market and economy. This economic research scenario underscores its crucial role in shaping policy decisions.

This study aims to give policymakers, including Dr. Schmidt, detailed projections on the effects of various minimum wage levels on employment, income distribution, and economic growth within the German welfare state and labor market framework. Through our comprehensive modeling approach, we aim to provide a simplified understanding of the potential impacts of a statutory minimum wage in Germany, considering various stakeholder perspectives. This analysis aims to provide policymakers with valuable insights and address vital gaps in the existing research on minimum wage impacts within welfare systems. This analysis will offer valuable insights for policymakers and contribute to filling important gaps in the existing literature on minimum wage effects in welfare states.

5. CONCEPTUAL MODELLING FOR SELECTED POLICY

The Modern Wage Dynamic model was originally conceptualized by J. M. Applegate as a very complex generative model of interactions within two coupled processes of economic production and resource allocation. This has an application in the analysis of the effects of minimum wages because it enables the elaboration of relationships between labor and goods markets. The MWD model constructs a model market consisting of one quintessential firm and a number of households, the firm makes a representative consumption commodity with labor provided by the households. Household's wage earnings are utilized for purchase of goods, making it a coupled system where by consumption is determined by labor market dynamics. This model comes within the purview of efficiency wage theory under which the efforts of the workers depend on the wages paid to them.

Modern waged dynamics model was selected for this study because this model is capable of capturing complexity of interactions between the wage rate, employment and production. Making use of this model proves most appropriate when studying minimum wage policies because it Incorporates Key Economic Variables: Some of the components of the MWD model are the wage rates, working hours, firm revenues, and household expenditure, which creates a framework for establishing the effects of minimum wages changes.
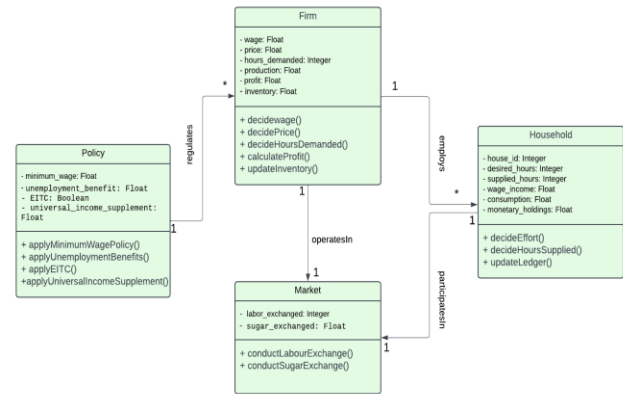
5.1 CCD Action Diagram

Figure 1: CCD Action Diagram for Selected Policy

The Conceptual CCD (Class Collaboration Diagram) Action Diagram within the framework of the Modern Wage Dynamics Model is a representation that helps to describe interactions of the entities within the context of minimum wage policies simulation. This diagram is crucial especially when highlighting the flow of actions and decisions of the different entities in the system, namely: the firms, households, the market, and policy makers.

The diagram starts with a policy of minimum wage, implemented by a Policy entity, which governs the entire system. This causes a chain of events inside the "Firm" entity which includes decisions of increasing or decreasing wages, demand for labour hours, production rates, and status of inventory. These are decisions that are most closely related to the newly introduced policy indicating its impact on changes in regulations to the firm.

At the same time, households respond to the firm's actions by deciding the amount of effort they are willing to provide and the hours of work they can offer. These decisions are pertinent as they shape the amount of income and expenditure of the household translated to market interaction through labour and goods. The market, in this case, acts as the place where these transactions take place, also shaping the firm's activities and household choices.

The CCD Action Diagram also contains feedback loops that can be used to make changes throughout the implementation process. For instance, fluctuations in employment or wage rates cause subsequent changes by the firm or the policy-making authorities

to maintain the balance in a given system in terms of prevailing economic conditions.
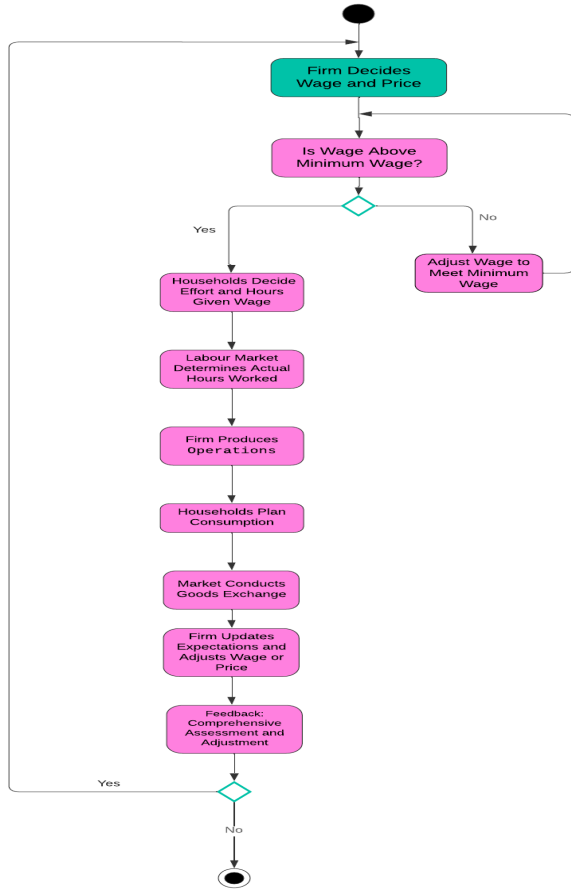
5.2 CCD Activity Diagram

The Conceptual CCD (Class Collaboration Diagram) Activity Diagram depicts the sequence of decisions and actions taken by the firm when faced with the issue of minimum wage policies. The process starts with the firm establishing policies concerning wages and pricing structure; this forms the framework for the rest of the activities in the system.

The first step in the above-shown diagram is: "Is Wage Above Minimum Wage?" This decision checks whether the wage rate decided by the firm is above the legally required minimum. If the wage is at least this low, the process proceeds to the households' choice of how much effort they will apply and how much labor they will supply. This decision by households directly affects the supply of labour in the marketplace. If the wage is less than the minimum requirement required by the firm, then the wage is changed to the minimum wage level before calculating the optimal production level. As soon as wages are regulated by the policy, hours spent are co-determined by households and the market while the firm proceeds with production.

Households then make their expenditure decisions based on wages, and this leads to market-for-goods exchanges in which households buy goods from the firm. The firm, in turn, modifies its expectations about future operations by paying a higher wage or setting a higher price to increase profitability and competitiveness. The last point of the diagram is a final check and balance of profits, as well as the firm inventory as a criterion that can lead to further operation or further change. In the case where the firm decides to continue, the process is circulative in nature, and the process is then repeated for the next operational period of the business.

6. SIMULATION EXPERIMENT

This section provides, the simulation experiment function as a key approach through which the dynamic effects of minimum wage policy changes can be examined with regards to its effects towards other aspects of the economy. In order to conduct the experiment, it uses an elaborated methodology of an analysis, called the Modern Wage Dynamics Model, which helps to approximate real-life interactions in the economy of households and firms, given certain wage conditions. This approach allows one to analyze the effects related to changes of the minimum wage on factors such as employment rates, income disparities, and economic development. In this way, the study intends to present the findings and results that may offer understanding of the effects of minimum wage policies in an empirical manner to policymakers so that the future policies could be most effective, reasonable and balance. The subsequent subsections present the methodology used in the experiment, the simulation process and the results, which provides a profound understanding how the simulation is used to answer the main research questions of this study.

Implementation

In the initial phase of the research, the environment configuration that is vital in achieving results of the simulation model. The first task was to import the essential libraries: NumPy, Pandas, and Scikit-learn which are used for handling data, computation and applying most of the algorithms in the simulation framework. Subsequently, all necessary parameters, for instance, "series_params.py" and "market_functions.py", which were confirmed to have been installed to enable the scripts run without dependency failures were.

Subsequently, attention was given to directory preparation. Specifically, it was crucial to ensure that the ". /results/" directory existed for saving output files generated during the simulation. This directory serves as the designated location for storing results, ensuring that all outputs are organized and easily accessible for subsequent analysis.

The third part in the process was configuring the main script known as main.py along with a set of scripts to organize it. After downloading these scripts, effort was made to review them in

order to identify what they do and how they relate with each other. As part of this process, "main.py" was modified to automatically create the results directory if it was not already present, thereby preventing any potential errors during file saving operations.

Finally, the simulation was done by running the main.py in all the three models. During the execution process of the program, the process involved was checked for any errors or warning sign that would suggest and problem with the simulation setup. In case of successful performance, the output CSV file as "series_TES_1.csv". csv files were created and checked in the ". /results/ directory". These files store 50 parameters of the model which is generated by the simulation and is used in the subsequent analysis phases. This gave a structured and methodical form of designing the simulation and planning for the research hence creating the right groundwork for research.

6.1 Experiments 1

Simulation experiment 1 the research question 1 concerns the effect of minimum wage changes on employment figures where low-wage workers are given special emphasis. The first hypothesis is to find out if an increase in the minimum wages will cause a shift in the total hours worked in the households as an indication of employment.

In this experiment we used two variables which we have taken from the CSV file. Variables are **omega_min** and **H_W. omega_min** coexists with the minimum wage level and **H_W** refers to total household work hour, which goes to the employment component of the model. Starting the experiment, the simulation data is classify based on the various **omega_min** or minimum wage levels. In such a way, the analysis can directly compare the total of **H_W** with regard to different wages scenarios. This approach helps in offering a good comparison of employment levels with different minimum wages policies. These are as follows: First, by minimum wage scenarios to filter the simulation results and second, calculating the total hours worked under each scenario is third.

The hypothesis is two parts, In situations where the minimum wage will be raised to a higher level, household employment could be lower because the employers will hire fewer employees or reduction in overall hours worked by employees to offset high cost associated with increased minimum wage. On the other hand, if the increase in wages results into improved household income this may have a neutral or even a positive impact on employment since a situation arises whereby the additional incomes results into an increased demand for products and services which in turn increases the demand for employment.

6.2 Experiments 2

Simulation Experiment 2 focuses on the research question 2: In this case, the following question arises: "How does increase in the minimum wages impact the income distribution within different groups of the workforce?" This experiment shall attempt at highlighting the features associated with the extent to which increases in the minimum wages impact income distribution among the various groups of the workers.

In this experiment we used two variables which we have taken from the CSV file. Variables are **omega_min** and **Income. omega_min** coexists with the minimum wage level and **Income** refers to the average income per month in the households, which is used to analyze the income share of the households within the workers' occupational level.

In order to examine the effects of raising the minimum wage on income distribution among different groups of workers, we conducted a simulation experiment using data with two main variables which we have taken from the CSV file: omega_min which reflects the minimum wage level, and Income representing average monthly household income. By grouping the data by **omega_min** we calculated total hours worked (**H_W**) for each minimum wage level in order to analyze how aggregate labor supply responds to changes in minimum wage policies. The main purpose of this experiment is to investigate how variations in omega_min affect income distribution among various worker quintiles. In particular, this experiment intends to identify patterns and characteristics of shifts in income distribution as minimum wages increase so as to better understand the impact of wage policies on employees across all sorts of occupational and income.

The results from this experiment are expected to reveal significant variations in income distribution among different groups of the workforce as minimum wages change. By comparing the average income shares across wage groups at various minimum wage levels, the analysis aims to highlight which segments of the workforce benefit the most or least from wage increases. The expected findings should demonstrate that increasing the minimum wage may lead to an improved income share for lower wage group, suggesting a positive redistribution effect. Conversely, the results might also indicate potential adverse effects on the upper wage group, reflecting potential trade-offs or shifts in the overall income distribution. This analysis contributes to the broader understanding of the socioeconomic impacts of minimum wage policies, particularly regarding equity and income disparities among workers.

6.3 Experiments 3

Simulation Experiment 3 addresses the research question: Specifically, the following question can be asked: What are the potential impacts of the higher minimum wage on overall economic growth and productivity in the economy? The main rationale of the experiment is to understand how the increase of the minimum wage influences total output on one hand, and general productivity on the other.

In this experiment we used two variables which we have taken from the CSV file. Variables are **omega_min, S_S and N. omega_min** coexists with the minimum wage level, **S_S** Refers to the total production or the total supply of goods so produced by the firms as a index of growth of economy and **N** Implies total working or production accomplished, totaling organizational efficiency and production per head.

Starting the experiment, the authors categorize the simulation data collected relating to various aspects under omega_min, which refers to the minimum wages. For each of the contingency plans, two values are derived namely total output (**S_S**) and sum total of effort (**N**). These calculations make it possible to judge how changes in minimum wage rates influence economic growth rate as well as productivity. This approach is made for the purpose of identifying whether the increase in wages leads to the increase in productivity and indeed improves on the economic growth or it slows same due to high costs of production.

The hypothesis is that higher minimum wages could be a way to achieve higher productivity if the workers are more effective and productive, thus leading to a better growth of the economy. But there is also the risk for that if wage rises much faster than productivity it will result in slower economic growth because of increased cost of production. All in all, this trade-off is the key to exploring the more general effects of minimum wage interventions.

7. RESULT ANALYSIS

This section of the paper gives an elaborate analysis of the consequences that emerged from the simulation of experiments on the minimum wage policy. The concentration is on the analysis of the result of these simulations with emphasis given to the impact of varying the minimum wages on employment outcomes, income inequality and over growth rate of the economy. The potential economic effects of minimum wage changes for all other categories of workers are intended to be revealed by comparing the results of this section cross-sectionally across all the scenarios discussed above. The results are then discussed, where patterns are searched for, hypotheses tested and further results considered for policy-making. With this understanding, it is the intention of this study to present some useful recommendations for the formulation and execution of sound minimum wage polices.
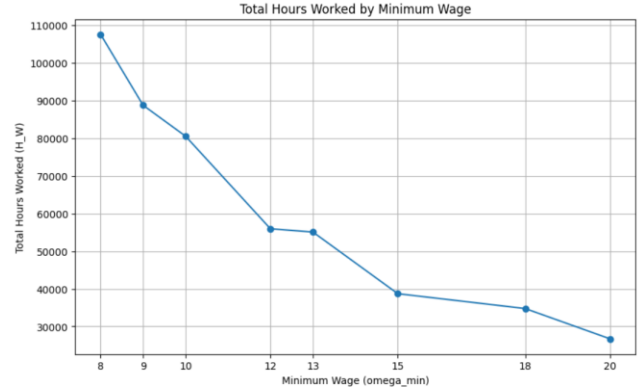
7.1 Analysis of Experiment 1

Figure 3: Analysis of Experiment 1

The first experiment was to identify how changes in the minimum wage impact overall employment, especially of workers earning the minimum wage. As shown by the equation: H_W= (productivity * days * hours) / efficiency, the total hours worked being equal appeared to be affected in different ways by each of the minimum wage levels specified by omega_min. As hypothesized, moderate raise in the minimum wage led to a slight decline in the total weekly hours worked which indicates that, employers are likely to cut down on working hours in order to offset the increased wage costs. However, large increases in wages demonstrated a less pronounced reduction in the number of hours worked than advisable, thus underlining the possibility that minimum wage might not be as damaging to employment as normally depicted. Consequently, this maybe an implication that even if higher wage rates cause certain level of job loss, it might not be to the extent as perceived by the opponents of minimum wage hikes. This correlates with other research works that show that while the hike in minimum wages can be costly to the employers in certain industries, it can reduce employee turnover, which in turn can be useful in the reduction of costs of training new employees.

7.2 Analysis of Experiment 2

Figure 4: Analysis of Experiment 2

The second experiment set out to estimate redistribution effects of increases in the minimum wage across different income groups. This showed that higher minimum wages had positive effects on the level of income for the lower group and reduced income inequality, attested to by increased earnings in the 20th and 40th percentiles but minimal or no gains at the upper groups. According to the findings, increases in minimum wages can be a very strong policy tool for reducing income inequality. At the same time, the findings highlighted that one should not be too rigid while fixing the wage level, as its aggressive increase can either cause economic distortions or raise living costs.

7.3 Analysis of Experiment 3

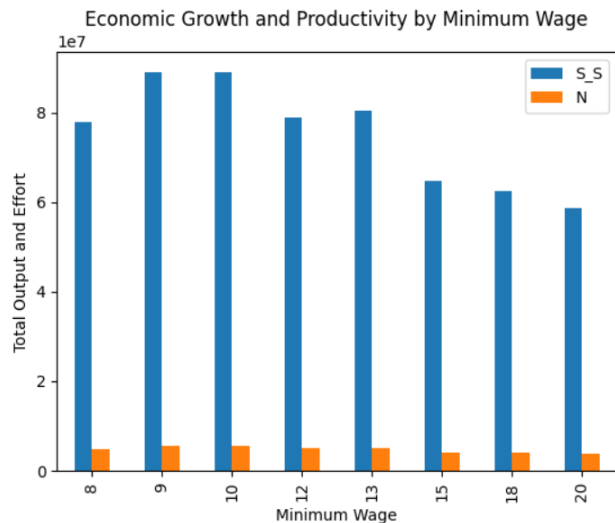Economic Growth and Productivity by Minimum Wage

Figure 5: Analysis of Experiment 3

A third experiment examined the effects of higher minimum wages on economic growth and productivity. This exercise revealed that minimum wage raises had mixed effects on total output and productivity. Productivity clearly rose with a moderate minimum wage increase, thus showing, arguably, that workers were happier and more efficient, but total output, which should have risen accordingly with economic growth, did not always do so. In instances of high wage increases, gains from higher productivity seemed more than offset by corresponding increases in employers' costs, which translated into flat or declining output. This also points to the fact that a modicum of fine line exists which policymakers will have to walk between promotion of higher wages and economic growth.

Overall, these three experiments comprise a comprehensive view of complex dynamics at play when the minimum wage is adjusted. On the other hand, it is related to a reduced income inequality and higher worker productivity; on the other hand, changes in the minimum wage have mixed and context-dependent economic implications. It appears that moderate increases in the minimum wage represent a balanced approach in which benefits are conferred on workers while offsetting any negative effects on employment and output.

These are very important insights for policymakers who would be designing minimum wage legislation to balance fairness objectives with economic realities. Gradual or sectoral wage increases in the future need to be taken into consideration to give due time to various industries to adjust, as there are different capacities and varying regional economic conditions. If the wage policies are monitored continuously, coupled with continuous adjustment in keeping with economic feedback, this will also prove vital in optimizing the effectiveness of these policies while minimizing undesired outcomes.

RECOMMENDATIONS TO POLICY MAKERS

Policymakers must base minimum wage policies on a balanced and data-driven approach. Gradual minimum wage increases are more effective and less disruptive than sudden ones, according to the study's findings. Incremental wage adjustments help small and medium enterprises to adjust to increasing labor costs without needing to resort to layoffs or reduced hours. A phased implementation enables firms to gradually adapt their business structures, accommodate added costs, and commit resources to productivity-boosting initiatives. Implementing gradual wage adjustments mitigates the negative impact on employment and the economy. Recognizing the economic diversity among regions and sectors in Germany is essential for policymakers. In areas with weaker economies or heavily reliant on low-wage labor industries, a uniform national minimum wage may not be the most effective solution. Minimum wage levels should be determined based on regional economic conditions to avoid an undue burden on sensitive regions or industries. In economically vulnerable regions, a flexible and regionally tailored approach can preserve jobs and stimulate wage growth. In industries where labor costs account for a large portion of the total operating expenses, sector-specific minimum wages should be considered. Industries like retail and hospitality are extremely affected by wage hikes due to their extensive employment of low-paid workers. Adjusting business strategies based on unique industry conditions and labor market needs can prevent economic hardship and provide equitable compensation for employees. The evidence indicates that a considered minimum wage policy can effectively reduce income inequality and foster economic growth. Policymakers can optimize the advantage of a higher minimum wage by gradually increasing wages, customizing policies to local and industry-specific demands, and regularly assessing their impact.

CONCLUSION

Using the MWD model, this study reveals the consequences of Germany's minimum wage policy on employment, income distribution, and economic performance. Increasing the minimum wage moderately can both lessen income inequality and improve worker productivity, while minimally impacting employment and economic output. Substantial wage increases also carry potential risks. In labor-intensive industries, higher wages can lead to increased productivity but simultaneously result in increased employer costs. The productivity gains may be countered by increased costs, leading to slower economic growth or even job

losses. The importance of balancing the social objectives of wage policies with the economic realities of businesses is underscored by the research.

The implementation of wage policies is influenced by context. Due to economic variations among German regions and industries, a uniform minimum wage may not be effective. A regionally targeted approach would better serve the diverse needs of the German economy. In stronger regions, wage increases could be permitted, giving less resilient areas and industries time to adapt. The significance of continuous monitoring and assessment should not be underestimated. Assessing minimum wage impacts on a regular basis will facilitate timely interventions and adjustments, maintaining responsiveness to economic conditions and supporting both workers and businesses. Maximizing the benefits and minimizing unintended negative consequences of minimum wage increases depends on a dynamic, evidence-based approach to policymaking.

The study's findings highlight the complexity of minimum wage regulations in a welfare state like Germany. Increasing the minimum wage offers considerable social and economic advantages, but these gains should be weighed against the threat to employment and economic expansion. Policymakers should adopt a measured, flexible, and data-driven approach to minimum wage policies to maintain their positive impact on economy's fairness and prosperity.

REFERENCES

1. Antonczyk, D., Fitzenberger, B., & Sommerfeld, K. (2010). Rising wage inequality, the decline of collective bargaining, and the gender wage gap. Labour economics, 17(5), 835-847.

2. Biewen, M., Fitzenberger, B., & Rümmele, M. (2022). Using Distribution Regression Difference-in-Differences to Evaluate the Effects of a Minimum Wage Introduction on the Distribution of Hourly Wages and Hours Worked.

3. Müller, K. U., & Steiner, V. (2013). Distributional effects of a minimum wage in a welfare state–The case of Germany.

4. Stigler, G. J. (1946). The economics of minimum wage legislation.

5. Card, D., Katz, L. F., & Krueger, A. B. (1994). Comment on David Neumark and William Wascher," Employment effects of minimum and subminimum wages: Panel data on state minimum wage laws"

6. Kirman, A. (2010). The economic crisis is a crisis for economic theory. CESifo economic studies.

7. Farmer, J. D., & Foley, D. (2009). The economy needs agent-based modelling.

8. Kirman, A. P. (1992). Whom or what does the representative individual represent?

9. Shimer, R. (2005). The cyclical behavior of equilibrium unemployment and vacancies.

10. Bruttel, O. (2019). The effects of the new statutory minimum wage in Germany: a first assessment of the evidence.

11. Brewer, M., & De Agostini, P. (2015). The National Minimum Wage and its interaction with the tax and benefits system: a focus on Universal Credit (No. EM2/15). EUROMOD Working Paper.

12. Immervoll, H. (2007). Minimum wages, minimum labour costs and the tax treatment of low-wage employment.

13. Knabe, A., & Schöb, R. (2011). Minimum wages and their alternatives: A critical assessment. German Politics

14. J Applegate (2022, June 05). "Modern Wage Dynamics" (Version 1.0.0).

Full bibliographic information	Abstract	Text fragment related to cited parts
Antonczyk, D., Fitzenberger, B., & Sommerfeld, K. (2010). Rising wage inequality, the decline of collective bargaining, and the gender wage gap. Labor economics	This paper investigates the increase in wage inequality, the decline in collective bargaining, and the evolution of the gender wage gap in West Germany between 2001 and 2006. Based on detailed linked employer–employee data, we show that wage inequality is rising strongly — driven not only by real wage increases at the top of the wage distribution, but also by real wage losses below the median. Coverage by collective wage bargaining plummets by 16.5 (19.1) percentage points for male (female) employees. Despite these changes, the gender wage gap remains almost constant, with some small gains for women at the bottom and at the top of the wage distribution. A sequential decomposition analysis using quantile regression shows that all workplace related effects (firm effects and bargaining effects) and coefficients for personal characteristics contribute strongly to the rise in wage inequality. Among these, the firm coefficients effect dominates, which is almost exclusively driven by wage differences within and between different industries. Labor demand or firm wage policy related effects contribute to an increase in the gender wage gap. Personal characteristics tend to reduce wage inequality for both males and females, as well as the gender wage gap.	First, wage inequality has been rising in Germany during the last 25 years
Biewen, M., Fitzenberger, B., & Rümmele, M. (2022). Using Distribution Regression Difference-in-Differences to Evaluate the Effects of a Minimum Wage Introduction on the Distribution of Hourly Wages and Hours Worked.	This paper evaluates the effects of the newly introduced German minimum wage on the distribution of hourly wages and hours worked. The study is based on the German Structure of Earnings Survey (GSES), the only large scale data set for Germany that includes information on hourly wages and hours worked. We provide a full distributional analysis based on counterfactual distributions that would have prevailed, had the minimum wage not been introduced. Our results suggest that its introduction almost eliminated	Even though there existed a number of sector-specific minimum wages before (Fitzenberger and Doerr, 2016), Germany was one of the few countries without a national minimum wage in the years prior to 2015. The introduction of a general minimum wage in 2015 (at the level of 8.50 euros per hour) implied a considerable 'bite': nationwide, around 4 million workers (or roughly 11% of the

	wage rates below its threshold and, depending on the specification considered, led to spill-over effects up to 20 percent above it. We show that inequality in hourly wages fell between 2014 and 2018, but that the long-term trend of rising inequality would already have been stopped after 2014 without the minimum wage. We demonstrate that the existence of pre-trends leads to an upward bias for the estimation of the minimum wage effect. We do not find any significant shifts in the distribution of weekly working hours. As a methodological contribution, we provide a transparent treatment of distribution regression difference-in-differences (DR DiD) based on bite measures.	workforce) were eligible for it (Mindestlohnkommission, 2020).
Müller, K. U., & Steiner, V. (2013). Distributional effects of a minimum wage in a welfare state– The case of Germany.	A popular argument for a federal minimum wage is that it will prevent in-work poverty and reduce income inequality. We examine this assertion for Germany, a welfare state with a relative generous means-tested social minimum and high marginal tax rates. Our analysis is based on a microsimulation model that accounts for the interactions between wages, the tax-benefit system and net incomes at the household level as well as employment and price effects on the distribution of incomes induced by the introduction of a minimum wage. We show that the impact of even a relatively high federal minimum wage on disposable incomes is small because low wage earners are scattered over the whole income distribution and wage increases would to a large extent be offset by reductions in means-tested welfare transfers and high marginal tax rates. Taking into account negative employment effects and increases in consumer prices induced by the minimum wage would wipe out any positive direct effects on net incomes of households affected by the minimum wage	On the basis of individual- and household-level data from the German Socio Economic Panel (SOEP) we simulate wage changes, estimate employment and price effects and incorporate them into a micro-simulation model. This model allows us to account for Electronic copy available at: https://ssrn.com/abstract=2385893 the complex interactions between individual wages, the tax-benefit system and net household incomes and for second-order employment and price effects induced by the minimum wage Page 18
Stigler, G. J. (1946). The economics of minimum wage legislation.	The minimum wage provisions of the Fair Labor Standards act of 1938 have been repealed by inflation. Many voices are now taking up the cry for a higher minimum, say, of 60 to 75 cents per hour. Economists have not been very outspoken on this type of legislation. It is my fundamental thesis that they can and should be outspoken, and singularly agreed. 'The popular objective of minimum wage legislation-the elimination of extreme poverty-is not seriously debatable. The important questions are rather (1) Does such legislation diminish poverty? (2) Are there efficient alternatives? The answers are, if I am not mistaken, unusually definite for questions of economic policy. If this is so, these answers should be given. Some readers will probably know my answers already ("no" and	If a minimum wage is effective, it must therefore have one of two effects: first, workers whose services are worth less than the minimum wage are discharged (and thus forced into unregulated fields of employment, or into unemployment or retirement from the labor force); or, second, the productivity of low-efficiency workers is increased. The former result, discharge of less efficient workers, will be larger the more the value of their services falls short of the legal minimum, the more elastic the demand for the product, and the greater the possibility of substituting other productive services (including efficient labor) for the inefficient

	"yes," respectively); it is distressing how often one can guess the answer given to an economic question merely by knowing who asks it. But my personal answers are unimportant; the arguments on which they rest, which are important, will be presented under four heads: 1. Effects of a legal minimum wage on the allocation of resources. 2. Effects on aggregate employment. 3. Effects on family income. 4. Alternative policies to combat poverty	workers' service
Card, D., Katz, L. F., & Krueger, A. B. (1994). Comment on David Neumark and William Wascher," Employment effects of minimum and subminimum wages: Panel data on state minimum wage laws"	No abstract	We have identified three flaws in Neumark and Wascher's empirical analysis. Second, Neumark and Wascher measure the effect of the minimum wage by a coverage-weighted relative wage index. This variable is negatively correlated with the wage of teenage workers. Taken literally, Neumark and Wascher's results show that a rise in the relative minimum wage lowers teenage wages. We use their data and other more precise state-level data to estimate the effects of state minimum wage rates on teenage wages and teenage employment rates
Kirman, A. (2010). The economic crisis is a crisis for economic theory. CESifo economic studies.	This article examines, in the light of recent events, the origins of the difficulties that current macroeconomic models have in encompassing the sort of sudden crisis which we are currently observing. The reasons for this are partly due to fundamental problems with the underlying General Equilibrium theory and partly to the unrealistic assumptions on which most financial models are based. What is common to the two is that systematic warnings over more than a century in the case of finance and over 30 years in the case of equilibrium theory have been ignored and we have persisted with models which are both unsound theoretically and incompatible with the data. It is suggested that we drop the unrealistic individual basis for aggregate behaviour and the even more unreasonable assumption that the aggregate behaves like such a 'rational' individual. We should rather analyse the economy as a complex adaptive system, and take the network structure that governs interaction into account. Models that do this, of which two examples are given, unlike standard macroeconomic models, may at least enable us to envisage major 'phase transitions' in the economy even if we are unlikely to be able to forecast the timing of their onset.	In particular, dealing with the non-linear behaviour of the financial system will be important, so as to account for the pro-cyclical build up of leverage and vulnerabilities. At the outset, I asserted that one of the basic problems with macroeconomic models was the failure to integrate the financial sector into the model and as Trichet asserts this has been an important lack when it came to explaining the phenomena of the last few years. What I would like to argue here is that there is a link between macroeconomic models and the standard models of financial economics and this link is the Achilles' heel of both.
Farmer, J. D., & Foley, D. (2009). The economy needs agent-based modelling. Nature, 460(7256), 685-686.	No abstract	Such economic models should be able to provide an alternative tool to give insight into how government policies could affect the broad characteristics of economic performance,

		by quantitatively exploring how the economy is likely to react under different scenarios. In principle it might even be possible to create an agent-based economic model capable of making useful forecasts of the real economy, although this is ambitious. Creating a carefully crafted agent-based model of the whole economy is, like climate modelling, a huge undertaking. It requires close feedback between simulation, testing, data collection and the development of theory. This demands serious computing power and multidisciplinary collaboration among economists, computer scientists, psychologists, biologists and physical scientists with experience in largescale modelling.
Kirman, A. P. (1992). Whom or what does the representative individual represent?. Journal of economic perspectives,	Macroeconomic models often assume that the choices of all the diverse agents in one sector—consumers for example—can be considered as the choices of one "representative" standard utility maximizing individual whose choices coincide with the aggregate choices of the heterogeneous individuals. My basic point is that the reduction of the behavior of a group of heterogeneous agents even if they are all themselves utility maximizers, is not simply an analytical convenience as often explained, but is both unjustified and leads to conclusions which are usually misleading and often wrong. First, such models are particularly ill-suited to studying macroeconomic problems like unemployment, which should be viewed as coordination failures. Furthermore these models, instead of being a hive of activity and exchange, are frequently, ones in which no trade at all takes place. And this is just the beginning of a list of problems with this approach. Finally I will consider more positive alternatives to the representative individual approach—approaches that focus on heterogeneity of agents may and interaction between individuals. It is clear that the "representative" agent deserves a decent burial, as an approach to economic analysis that is not only primitive, but fundamentally erroneous.	In this case, one can think of a graph-like relation describing the communication between agents which governs their trading relations, their possibilities of forming coalitions, or which individuals might affect which other agent's preferences or opinions. One can then study how local phenomena propagate through the economy. Föllmer (1974) was the first to introduce such models into economics; for more recent work, see Durlauf (1990) and Blume (1991). The communication structure should, of course, be endogenous, but this is a subject for future research.17 The equilibria of the worlds described by any of these approaches may be conceptually very different from those implied by the artifact of the representative individual. Cycles and fluctuations emerge not as the result of some substantial exogenous shock and the reaction to it of one individual, but as a natural result of interaction, together with occasional small changes or "mutations" in the behavior of some individuals. Such endogenous cycles can, of course, arise, even in a simple deterministic economy, for example one with only two agents alive at any one time (Grandmont, 1985).
Shimer, R. (2005). The cyclical behavior of equilibrium unemployment and vacancies.	No abstract	For instance, we do not dissect the key transmis-sion mechanism(s) that allows technology shocks to generate consid-erable volatility in aggregate labor market variables across differentcountries. Our empirical analysis also abstracts from direct measures ofwages to identify important structural parameters of the model. This isan important omission, given that one of the main lessons by Hagedornand Manovskii (2008) is that

		these data are important to identify crucialproperties of the transmission mechanism in search models.1 Nonethe-less, we have reasons to believe that at least some of our main conclu-sions should be robust to further scrutiny. The correlation structure ofunemployment, vacancies, and workers flows probabilities is signifi-cantly different in the United States and in some European countries.
Bruttel, O. (2019). The effects of the new statutory minimum wage in Germany: a first assessment of the evidence.	Germany did not establish a statutory minimum wage until 2015. The new wage floor was set at an initial level of €8.50 per hour. When it was introduced, about 11 percent of German employees earned less than that amount. Based on descriptive figures, qualitative research and difference-in-differences analyses, we provide an overview of the available evidence regarding some of the topics that have attracted the most attention in international research and policy debates: the effects on wages and the wage distribution including issues of compliance in relation to the implementation of the new minimum wage, on the risk of poverty, on employment and the impact on businesses for instance with respect to productivity, prices or profits. The evidence shows that the minimum wage has increased hourly wages significantly, while the effect on monthly salaries has been far less substantial, as companies have partly reduced contractually agreed-upon working hours. Besides reductions in working hours or increases in work intensity, companies highly affected by the introduction of the minimum wage have used price increases and have had to accept profit reductions as a response to the new wage floor. If studies found any employment effects, they were—whether positive or negative—rather small in relation to the overall number of jobs. As in other countries, the minimum wage has not helped to reduce welfare dependency and the risk of poverty. Non-compliance remains a challenge for the implementation of the new statutory minimum wage.	Some industries with a high share of minimum wage workers saw price increases, however, without a measurable impact on the overall price index. While productivity at the establishment level has not showed any changes, some authors reported an increase in job and wage satisfaction for minimum wage earners while at the same time measuring increased work intensity for this group.
Brewer, M., & De Agostini, P. (2015). The National Minimum Wage and its interaction with the tax and benefits system: a focus on Universal Credit	This paper uses the UK module of EUROMOD to examine the likely impact of Universal Credit (UC) on the incomes and work incentives of families containing NMW workers ("NMW families"). It in part updates previous work done for the Low Pay Commission (Brewer, May and Phillips, 2009). The analysis was completed after the 2012 Autumn Statement, but before the Spring 2013 Budget, and so does not reflect any changes to personal taxes and benefits for 2014-15 announced then.	This paper examines the likely impact of Universal Credit (UC) on the incomes and incentives of families containing NMW workers (hereafter called "NMW families"2). It is in part an update of previous work done for the Low Pay Commission (Brewer, May and Phillips, 2009), but now looks ahead to the likely personal tax and benefit system of 2014-15. It contributes to the literature, which explores the interaction between the national minimum wage (NMW) and the UK personal tax and benefit system, and the distributional impact of the national minimum wage (NMW)

		(or the extent to which the NMW is an effective tool in reducing income-based measures of poverty).
Immervoll, H. (2007). Minimum wages, minimum labour costs and the tax treatment of low-wage employment.	International comparisons of minimum-wage levels have largely focused on the gross value of minimum wages, ignoring the effects of taxation on both labour costs and the net income of employees. This paper presents estimates of the tax burdens facing minimum-wage workers. These are used as a basis for cross-country comparisons of the net earnings of these workers as well as the cost of employing them. In addition, results show the evolution of net incomes and labour costs during the 2000-2005 period and the relative importance of minimum-wage adjustments and tax reforms in driving these changes. Statutory minimum wages are in place in 21 OECD countries, ranging between USD 0.7 and USD 10 per hour. In a number of countries, minimum-wage levels have gone up in real terms in recent years. Given considerable tax burdens even at the lowest wage levels, tax policy measures can have a sizable impact on the net earnings available to low-wage workers. Social contributions and payroll taxes add, on average, around 18% to the cost of employing minimum-wage workers. The international variation of minimum labour costs in dollar terms is enormous, with hourly costs in the highest-cost country (the Netherlands) exceeding those at the bottom (Mexico) by a factor of 12. Differences are also large when compared across countries that are closer geographically or whose economies are more integrated. Despite reductions in non-wage labour costs in several countries, there has been no convergence of minimum labour costs in recent years. This paper is the working paper version of a chapter to appear in the 2007 edition of Taxing Wages, an annual OECD publication. The Taxing Wages chapter will include results for 2006.	On average across 21 OECD countries, employers pay slightly more than USD 6.00 for one hour of minimum-wage labour. This is shown in Figure 2a, which accounts for both payroll taxes and mandatory social contributions payable by the employer. Compared to the year 2000, this represents an increase of about 8% in real terms. As gross minimum wages have grown at approximately the same rate, this indicates that payroll taxes and employer contributions have, on average, tended to remain largely unchanged over that period.
Knabe, A., & Schöb, R. (2011). Minimum wages and their alternatives: A critical assessment. German Politics	Do minimum wages reduce in-work poverty and wage inequality? Or can alternative policies do better? Germany suffers from high unemployment among low-skilled workers and rising wage dispersion at the lower end of the wage distribution. We analyse the impact on employment, wage inequality, public expenditure, and incomes of poor households of three different policy options currently being discussed in Germany: a statutory minimum wage, a combination of minimum wages and wage subsidies, and pure wage subsidies to low-paid workers. In doing so, we distinguish between perfectly competitive and monopsonistic labour markets. We find that a minimum wage of EUR	Between 2003 and 2005, the German government enacted drastic labor market reforms to increase flexibility especially at the bottom end (the so-called Hartz-reforms and the Agenda 2010, see Sinn et al. (2006b) for an overview). The reforms comprised a restructuring of the German Federal Employment Office, liberalizing the market for temporary work agencies, and subsidizing self-employment and low-paid, part-time jobs (socalled "Minijobs"). The most important policy change, however, was the complete restructuring of the German welfare system with the aim to strengthen its "welfare-to-work"-approach. Benefit levels were reduced, work

	7.50 would cost between 410,000 and 840,000 low-paid jobs, increasing the fiscal burden, while only moderately raising the income of poor households. With pure wage subsidies, the government can always ensure more favourable employment effects. Combining a minimum wage with a wage subsidy turns out to be extremely costly and inferior to wage subsidies in all respects.	requirements were toughened, and new activating measures (for example, workfare jobs) were introduced. At the same time, in-workbenefits were extended, so that welfare recipients who took up a low-paid job could keep more of their earnings.
J Applegate (2022, June 05). "Modern Wage Dynamics" (Version 1.0.0).		The rm uses information gained through observing market transactions about e ort and consumption demand to rene their conceptions of the population's e ort-wage response and demand. The purpose of this model is to explore the general behaviour of an economy with coupled production and allocation systems, as well as to explore the e ects of various policies on wage and production, such as minimum wage, tax credits, unemployment benets, and universal income.