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Short and medium run effects of the
minimum wage reform in Germany using a
Diff-in-Diff approach

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Abstract

The aim of this dissertation is to evaluate the impact of the minimum wage reform established in 2015 in Germany in the short and medium run. The causal effects are particularly interesting from an economic and a social point of view. Indeed, minimum wage policies can impact income distribution, employment level, and social welfare status, improving living and work conditions. Also, in the European Union there is an ongoing debate about minimum wage, after the proposal for a Directive of the European Parliament and the Council on adequate minimum wages in October 2020.

From a theoretical perspective, the effects of a minimum wage reform are ambiguous, thus it is important to analyse the effects from an empirical point of view. For this purpose, I use the German Socio-Economic Panel (GSOEP) to analyse the effects of the reform.

The thesis is organized as follow: in the first part I examine the relationship between minimum wage and labour economics, then I analyse the minimum wage reform in Germany, from its introduction in 2015 with a statutory minimum wage of 8.50 euros per hour, to its implementation across the years. Further, I study the literature about minimum wage.

In the second part I analyse the panel dataset and the implications of the reform on employment, and marginal employment. The empirical strategy consists in using a Diff-in-Diff approach, taking into consideration the differences in gender, birth cohorts, education levels and regional differences.

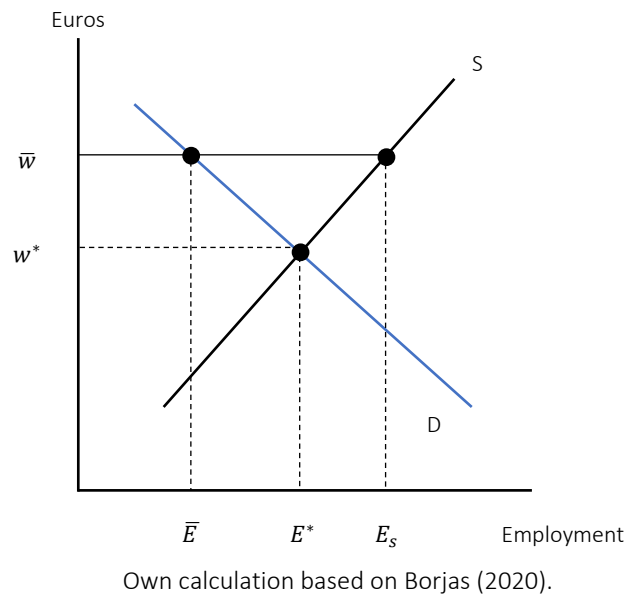
1. Introduction

1.1. Minimum wage and its effects on the labour market

According to the International Labour Organization (ILO), minimum wage can be defined as “the minimum amount of remuneration that an employer is required to pay wage earners for the work performed during a given period, which cannot be reduced by collective agreement or an individual contract”. The purpose of the minimum wage is to guarantee workers suitable working and living conditions, and to protect them against low pay. It can be a social economic policy instrument to achieve more equality, to reduce the gender-wage gap and the in-work poverty. Indeed, ILO states that “minimum wage fixing should constitute one element in a policy designed to overcome poverty and to ensure the satisfaction of the needs of all workers and their families”.

From a theoretical perspective, the effect of the introduction of a minimum wage is ambiguous. The standard model to analyse the impact of a minimum wage reform was first derived by Stigler (1946). The competitive labour market is showed by the Figure 1.1 below.

Figure 1.1: the Impact of the Minimum Wage on Employment



The competitive market equilibrium is at wage w^* and employment E^* . The new minimum wage \bar{w} set to the government leads to a decrease of employment to \bar{E} , because firms rise the labour demand curve. Therefore, some workers ($E^* - \bar{E}$) are dismissed from their jobs and move to unemployment.

In addition, other workers ($E_S - E^*$) who wants to enter the labour market, attracted by higher wages, cannot do it, and become part of the unemployed population.

Thus, according to this model, the new minimum wage \bar{w} leads to an increase of unemployment, both because some workers lose their jobs and because some persons who did not find it valuable to work at the previous competitive wage w^* , they find it now worthy to work at the new minimum wage and enter the labour force. As long as the demand curve for labour is down sloping, an increase of the minimum wage reduces employment, the size of the effect depends on the elasticity of the labour demand, as well as on the level of the minimum wage. On the other hand, the minimum wage is supposed to increase the income of low-skilled workers, whose competitive wage is lower than high-skilled workers. The neoclassical model predicts a reduction in demand for the factor that becomes relatively more costly. Therefore, the implementation of minimum wages implies employment losses. According to Manning (2011), when labour markets are imperfectly competitive, market may be inefficient, and there is the possibility to improve efficiency through regulation. On the contrary, if labour market is perfectly competitive, the equilibrium is Pareto efficient. In the latter case, the implementation of a minimum wage policy leads to a reduction of employment because the cost of labour raises. The same doesn't necessarily apply in the former case. Extending the monopsony model, it can be show that wage elasticity and the relationship between average and marginal costs of hiring don't influence minimum wages' potential benefits. In addition, when considering the impact of minimum wage on aggregate employment, one should take into account the heterogeneity of the labour force, because the minimum wage has different employment effects for different groups of workers.

Some "search models" predict a positive effect of minimum wages (Brown, Merkl, and Snower, 2014). As a matter of fact, according to their dynamic incentive model, higher wages reduce firm job offer rates, but raise workers' acceptance rates. The latter effect may dominate the former if minimum wages are sufficiently low. The two-side search model developed by Ahn, Arcidiacono, and Wessels (2005) shows positive employment effects when increasing the minimum wage. In this more general search model, the number of searching workers increase as well as the number of matches. Thus, a higher minimum wage may induce individuals to search for a job, and this process can lead to a growth of the employment rate. This model leads to a zero or positive employment growth. In the model developed by Burdett and Mortensen (1998), a continuum of workers and employers participate to the labour market. Workers are heterogeneous because the value leisure and unemployment differently. Minimum wage decreases inefficient unemployment and increases workers' earnings. Moreover, the probability that unemployed workers receive an offer w above their reservation wage is raised by the minimum wage. In the competitive labour market model elaborated by Dickens, Machin, and Manning

(1999), firms have monopsony power. Minimum wage can raise employment initially, but the effect can change, and it remains an empirical question. Furthermore, the impact of the minimum wage is likely to be different across the wage distribution.

From a Keynesian perspective, the upturn in labour costs leads to an increase in prices. Thus, in closed economy higher wages imply higher price levels (Herr, 2009). There is no direct relationship between changes in wage levels and employment, the relationship is between wage costs and price level. Moreover, the functional income distribution between wages and profits isn't influenced by changes in wage levels. The distribution is affected by the discrepancy between demand and supply of goods.

Minimum wage policies can also affect the investments in human capital and the acquisition of skills and thus earnings among employees. Skill acquisitions manifest over long term and earnings are likely to be influenced by training over a long period (Neumark and Wascher, 2010). In fact, decisions of individuals and firms to invest in human capital may be affected by changes in the minimum wages (Belman and Wolfson, 2014). The effects are complex and different among different types of employees. A teen may be induced to leave school and look for a job if the minimum wage raises, while retired workers may invest in training that would allow them to be more qualified and re-enter in the labour market. Thus, it is important to analyse whether minimum wage policies influence training or schooling decisions and how it affects future earnings and wages. From the human capital theory, individuals' productivity is related to their skills, knowledge, and innate ability. Skills and knowledge can be increased by education, training, and experience. This investment demands time and money, and the development of human capital has both a direct and an indirect cost for the individual, who must take a decision comparing them in the present with the discounted raise in future income. Direct costs deal with money spend in education and training, whereas indirect costs have to do with forgone earnings and output while the individuals are attending school, university, or a course.

The literature has focused on schooling and on training decisions of firms when evaluating the impact of the minimum wage policies. As regard schooling, the economic effects of increase of minimum wage on school enrolment are not clear from an economics point of view. Neumark and Wascher (2010) consider a model in which a teen has only two options: full-time schooling or full-time labour market participation. Individuals who leave school early to start working earn the minimum wage. The effects of an increase in the minimum wage are determined by the effects on expected earnings, and individuals may remain in school for two reasons. First, individuals may choose to become more qualified and thus remain enrolled, second, the opportunity cost of schooling is lower because the minimum wage has risen. This happens if unemployment effects are high. If instead unemployment effects are small and thus expected earnings increase, the opportunity cost of schooling rises, and

enrolment might fall. Educational decisions of teenagers might be different and depending on the family's income as studied by Ehrenberg and Marcus (1982), they use a multinomial logit model to show that minimum wage legislation cause asymmetrical decisions across family income classes. Teenagers from low-income families are induced to leave school or reduce their level of schooling, whereas teenagers from higher-income families increase their educational level. The effects of the legislation are heterogeneous, and as point out by Welch (1974), for those youths in low-income families who must work part-time to finance their education, the choice of leaving school for a full-time job depends clearly by the family income. As a matter of fact, part-time work is more threatened by minimum wage legislation, and thus if a higher minimum wage reduces job opportunities in the part-time sector, youths in the low-income groups may leave school to work full-time.

As concern training decisions of firms, minimum wage policies may have potentially adverse effects on in-the-job training (Feldstein, 1973, & Welch, 1978). According to Feldstein (1973), those young workers who have low level of education must produce enough to earn the minimum wage and thus they cannot have the opportunity of an adequate on-the-job-learning. The lack of additional training lowers their discounted future earnings, following the fundamental hypothesis that individuals learn also from their working experience and the acquired skills increase their earnings. Welch (1978) points out that an indirect effect of minimum wage is the change in fringe benefits that comprise also on-the-job training. Firms can offer less opportunities of in-the-job training because of wage increases. Acemoglu and Pischke (1999) develop a model in which in the presence of non-competitive labour market and market frictions, minimum wages may increase training and training investments by the firms, because it is less profitable to employ unskilled workers after a minimum wage reform. More in detail, a distinction must be made among workers. Those employees who were unable to finance their training can increase the training and they earn close to the minimum wage threshold, on the contrary, those employees who were financing their own training reduce the training because firms have no interest to provide in-job-training and earn above the minimum wage threshold. The model produces offsetting results, and the implications must be analysed empirically.

The relationship between minimum wage and unemployment and accumulation of human capital are not clear from a theoretical point of view. Thus, the causal impact of a minimum wage policy remains an empirical question. This argument is interesting and important from an economic, social, and political point of view. Indeed, minimum wage policies can impact income distribution, employment level, present and future earnings, education decisions and can improve social conditions of low-paid workers. The remainder of this chapter proceeds as follows: paragraph 1.2 introduces the social implications and purpose of minimum wages with an historical background to frame the reasons and

the development of the policy, paragraph 1.3 shows the European Union context and implementation of minimum wage, and finally paragraph 1.4 introduces the legal framework of the German minimum wage legislation.

1.2. Minimum wage policies and social implications

1.2.1. Historical background

The Minimum wage originated in 1894 in New Zealand, and it has been an important policy tool for over a century. In 1896 was implemented in Australia, followed in 1909 by the United Kingdom. In 1938 the U.S. Congress adopted the minimum wage law as part of the Fair Labour Standards Act. In its early implementation, minimum wage was an instrument to protect homeworkers or women. As a matter of fact, minimum wages were needed initially to overcome the problem of the widespread of “sweatshops” in manufacturing industries, especially in the United States (Neumark and Wascher, 2010). Most of the employees were youth and women, with low bargaining power with respect to other workers. Initially, minimum wage was implemented to ensure fair wage to these categories of workers but over time it became clearer that the policy was a tool to reach self-sufficiency. Thus, the minimum wage laws were implemented also for men and low-paid occupations.

In general, minimum wage laws remain limited and rarely used as economic policy tool before the II World War, in both industrialized and developing countries (Starr, 1981). Minimum wage policies applied only to some categories of workers, but during the 1930s and 1940s, many countries began to implement minimum wage laws and extend them to a larger number of workers. We can distinguish different forms of minimum wage policies among countries. Indeed, although the enforcement of minimum wage is observable around the World, its development is different. In some European countries, like Austria, Denmark, Finland, the Federal Republic of Germany, Italy, Norway, Sweden, and Switzerland, some form of minimum wage law existed after the II World War. The regulation was limited to certain categories of workers, moreover, in these countries, a high percentage of employees were covered by statutory collective bargaining systems. In the United Kingdom and Ireland, on the contrary, minimum wage regulations were implemented in selected industries. Overall, in that period, a lot of European countries adopted minimum wages policies, like Luxemburg and France. Statutory minimum wage of general application was introduced in The Netherlands in 1969, in Portugal in 1974, in Spain in 1963 and in Belgium in 1975. As regard the United States, the Fair Labour Standards Act of 1938 first established a nationally uniform minimum wage for interstate or foreign commerce workers.

Across time, there has been the enlargement to a much wider labour force range, whose extension enlarged from 43% in 1938 to 84% of all non-supervisory employees in private, non-agricultural employment. Canada experienced a similar incremental extension, whereas Japan implemented a minimum wage law only in 1959. Minimum wage policies in these countries are important because they fix supplementary methods of wage regulation, mainly through collective bargaining.

As concern developing countries, some distinctions must be made. To begin with in most of Latin America during 1930s and 1940s minimum wage laws were introduced. The regulations have never completely fulfilled the goals established by the initial purpose, but today almost all countries have a minimum wage program, only in a few less developed countries minimum wages are fixed haphazard. In 1940s and 1950s, minimum wage laws were implemented in Africa. The colonial binds had influenced the form of the regulations in most countries. In many cases, minimum wage laws were not regularly practised, although they have been implemented, with differences between West and East Africa. As regard French colonies, the adoption of the Labour Code for Overseas Territories of 1952 allowed to have a more comprehensive and homogenized approach to minimum wage regulations in those countries. In other African countries, which were characterized by other influences, minimum wage regulation has been developed after the II World War period. The British colonies of the Caribbean adopted the same scheme as in the African colonies, but in most of the countries the regulation was applied regularly to only a few industries. Finally, in Asia, the minimum wage regulations are not as extensive as in the rest of the World. In several Asian countries there isn't any regulation of this kind, some exceptions are some countries of Western Asia like Afghanistan, Iran, Iraq, Lebanon, Syria, and Turkey. The scope of the minimum wage regulation in other Asian countries like Nepal, Pakistan and Thailand has been limited, whereas the regulation has developed in the Philippines.

1.2.2 Purpose of minimum wages

The minimum wage is a policy instrument and as such has some costs and benefits: the challenge facing policy makers is to implement the minimum wage in an efficient way, as to obtain acceptable trade-offs. Indeed, as Gramlich in 1976 wrote "minimum wages do, of course, distort relative prices, and hence compromise economic efficiency, but so do all other attempts to redistribute income through the tax-and-transfer system. The important question is not whether minimum wages distort, but whether the benefits of any income redistribution they bring about are in some political sense sufficient to outweigh the efficiency costs".

The debate on minimum wage is ongoing, and it represents indeed a controversial policy intervention on labour markets. Increases of minimum wage can lead to a redistribution of income across social classes, but it can have implications on labour costs, price and profits, employment and unemployment,

savings, and investment decisions and on economic growth. An increase in the minimum wage has a direct impact on two types of workers: those who were earning the former minimum wage, and those who were earning less than the new minimum but more than the former (Card and Krueger, 1995). However, it is difficult to evaluate the impact of minimum wage when there are other confounding policies and other economic variables to be considered. Further, the impact can be different across countries, with different coverage and enforcement, and it depends on the characteristics of the labour market and on the economic condition of the country considered. The issues regarding the implementation of minimum wage are diverse. When evaluating the impact of the policy, it is essential to analyse how minimum wages have affected wages and labour cost. Secondly, the extent of the impact of minimum wage on employment, especially for those workers who have low-skilled occupations. Then, an analysis on the consequences of the distribution of income must be done. Finally, it is crucial to identify how macroeconomic variables may change after the introduction of the policy. As concern wage distribution, if we assume noncompliance and suitable application, the effect is to truncate or thin out the lower tail of the distribution (Neumark and Wascher, 2010). There are, however, “spillovers” effects because employers can substitute low-skilled workers with high-skilled workers, alternatively, minimum wage can create behavioural incentives for higher-skilled workers and thus their wage can raise. The effect of minimum wage on earnings is not straightforward to analyse, both for workers and for individuals who are unemployed, and requires empirical evidence.

1.3 The minimum wage in the European Union

According to the European Commission¹, adequate minimum wage ensures fair competition and promotes economic and social progress. The policy can also help to reduce the gender-pay gap and its role is fundamental during economic slowdown. As a matter of fact, Principle 6 of the European Pillar of Social Rights states “Workers have the right to fair wages that provide for a decent standard of living. Adequate minimum wages shall be ensured, in a way that provides for the satisfaction of the needs of the worker and his / her family in the light of national economic and social conditions, whilst safeguarding access to employment and incentives to seek work. In-work poverty shall be prevented. All wages shall be set in a transparent and predictable way according to national practices and respecting the autonomy of the social partners.” Consequently, the European Commission adopted a Proposal for a Directive² on adequate minimum wages on 28 October 2020. The aim of the Proposal

¹ Employment, social affairs, and inclusion. <https://ec.europa.eu/social/main.jsp?catId=1539&langId=en>

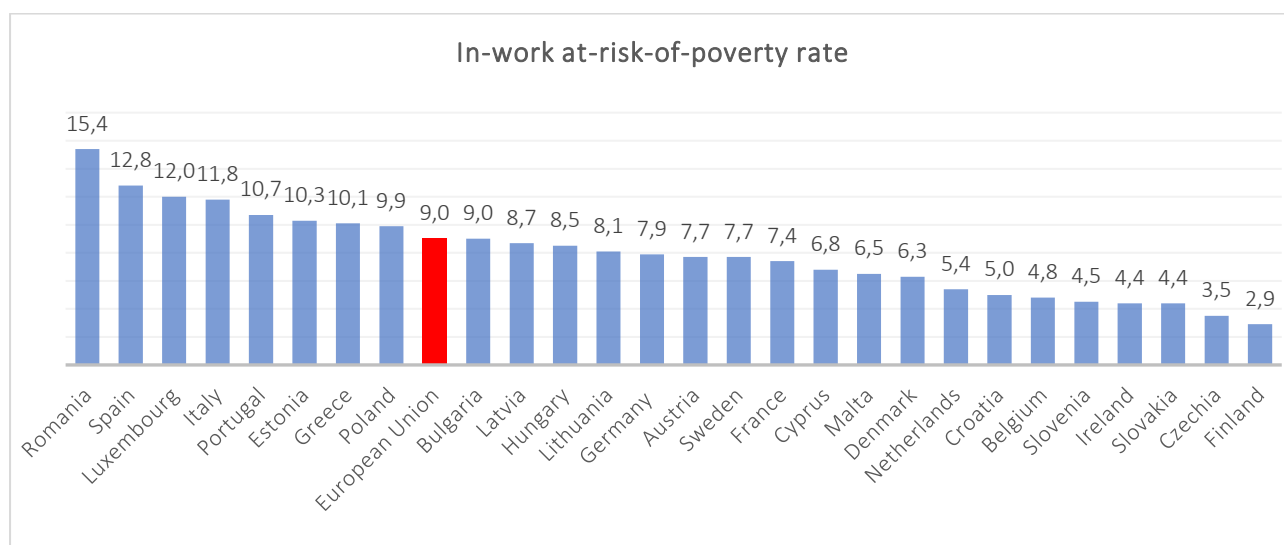
² Proposal for a Directive of the European Parliament and of the Council on adequate minimum wages in the European Union. <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020PC0682&from=EN>

is to guarantee adequate working and living conditions, this purpose is in line with the United Nations 2030 Agenda for Sustainable Development and its Sustainable Development Goals. The Commission aims at promoting collective bargaining on wages because the share of low-wage workers and wage inequality are lower in Member States where the collective bargaining scope is higher, at improving the enforcement and at monitoring the minimum wages across all European countries. Monitoring the policy through collecting data is important for noncompliance. The Commission aims also at setting fair and appropriate minimum wages, thus Member States must consider cost of living, the distribution and level of the rate of wages, as well as national productivity, at ensuring the involvement of social partners. The Proposal is based on Article 153 (1) (b) of the Treaty of Functioning of the EU (TFEU)³ on working conditions. President of the European Commission Ursula von der Leyen said: *“Today’s proposal for adequate minimum wages is an important signal that also in crisis times, the dignity of work must be sacred. We have seen that for too many people, work no longer pays. Workers should have access to adequate minimum wages and a decent standard of living. What we propose today is a framework for minimum wages, in full respect of national traditions and the freedom of social partners. Improving working and living conditions will not only protect our workers, but also employers that pay decent wages, and create the basis for a fair, inclusive, and resilient recovery.”* The European Parliament and the EU Member States have reached an agreement on the Directive proposed in October 2020. The political agreement aims at improving adequate minimum wage protection and at strengthening social fairness. The European Parliament Committee on Employment and Social Affairs adopted the Directive in July 2022.⁴ In most of the Member States workers aren’t adequately covered by minimum wage protection and in-work-poverty is a social and economic issue, as we can see from Figure 1.2 below.

³ Consolidated version of the Treaty on the Functioning of the European Union - PART THREE: UNION POLICIES AND INTERNAL ACTIONS - TITLE X: SOCIAL POLICY - Article 153 (ex-Article 137 TEC) <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A12008E153>

⁴ EMPL Committee Press on Twitter <https://twitter.com/EPsocialAffairs/status/1546758169250222080>

Figure 1.2: Individuals (18-64) in EU who are classified as employed according to their most frequent activity status and are at risk of poverty in 2019.



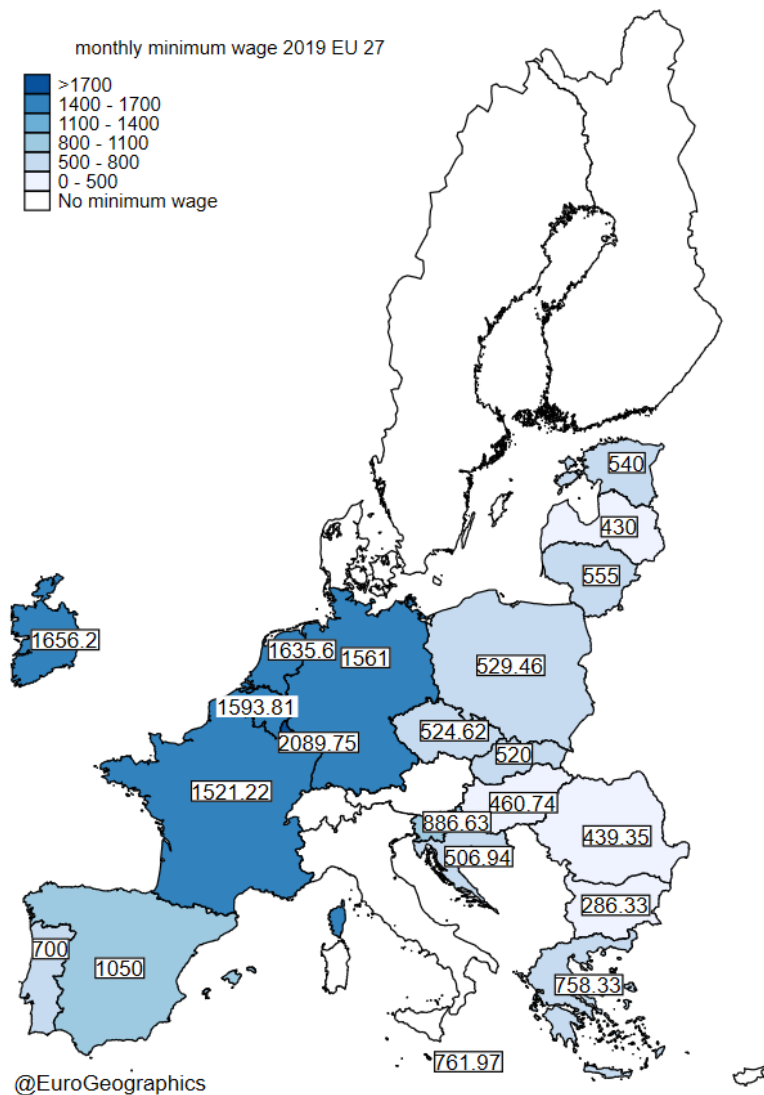
Source: own elaboration from Eurostat ⁵ https://ec.europa.eu/eurostat/databrowser/product/view/ILC_IW01

In 2019 the European average of employed individuals at risk of poverty was 9%, Romania, Spain, and Luxemburg are the Member States with the highest percentage, of 15,4%, 12,8% and 12% respectively. Slovakia, Czechia, and Finland have the lowest percentage with 4,4%, 3,5% and 2,9% respectively. The percentage for Germany is 7,9% in 2019 and it was 9,6% in 2015.

In the European Union, most of countries have minimum wage laws, except for six Member States that have collective agreements: Denmark, Italy, Cyprus, Austria, Finland, and Sweden. Thus, the Commission’s proposal is to set a framework for minimum wage standards, that respect and follow the competences and autonomy of each Member States in matter of wages, following the subsidiary principle. Figure 1.3 below shows the monthly minimum wage in euros in the 27 European Countries in 2019.

⁵ In-work-at-risk-of-poverty rate by age and sex-EU-SILC survey

Figure 1.3: Monthly minimum wage in European Union



Source: own elaboration from Eurostat:

https://ec.europa.eu/eurostat/databrowser/view/earn_mw_cur/default/table?lang=en

Map elaborated from Gisco- the Geographic Information System of the Commission - *localise, analyse, visualise*

<https://ec.europa.eu/eurostat/web/gisco/geodata/reference-data/administrative-units-statistical-units/countries>

The data for monthly minimum wage are calculated semesterly by Eurostat, I use the second semester of 2019, whereas the map represents NUTS 0 as statistical units⁶. Among Member States there are a lot of differences in the minimum wage amount. In Bulgaria monthly minimum wage is very low and

⁶ Countries, 2016 - Administrative Units – Dataset. The dataset contains the administrative boundaries at country level of the world, and it consists of 2 feature classes (regions, boundaries) per scale level and there are 6 different scale levels (100K, 1M, 3M, 10M, 20M and 60M). The dataset is based on the geometry from EBM v12.x. of EuroGeographics.

equal to 286.33 euros, Luxembourg has the highest minimum wage equal to 2089.75 euros. Germany has a monthly minimum wage of 1561 euros, corresponding to 9.19 euros per hour.

1.4 The minimum wage in Germany

1.4.1 Minimum-wage law and its implementations

The minimum wage reform in Germany has been established on 1 January 2015 (“Mindestlohngesetz⁷”), the statutory gross minimum wage was initially set at 8.50 euros per hour. Until 2015, wages were set by collective and voluntary agreements within sectors. The decisions of adjustment to the minimum wage are to be taken by the German Minimum Wage Commission (“Mindestlohnkommission⁸”). One of the most important aims of the reform was to improve the situation of the low-wage workers. According to the German Minimum Wage Commission around four million individuals earned less than 8.50 euros gross per hour before the introduction of the policy, the workers were mostly from East Germany, employees in marginal part-time work (“mini-jobs”⁹), individuals without vocational training, women and workers employed in small businesses. In April 2015 the number decreases to around 1 to 1.4 million (Mindestlohnkommission, 2016b).

On 1 January 2017 it raised to 8.84 euros per hour, on 1 January 2019 it further raised to 9.19 euro per hour, in January 2020 it raised to 9.35 euros per hour and in January 2022 the minimum wage increased to 9.82 euros per hour.

With the Mindestlohngesetz almost any employee in Germany is eligible for the minimum wage, there are, however, some restrictions. Some groups are excluded: self-employed, trainees, individuals who are doing a compulsory internship (“Pflichtpraktikum”), a voluntary orientation internship (“freiwilliges Orientierungspraktikum” or “freiwilliges ausbildungsbegleitendes Praktikum”), an entry-level qualification (“Einstiegsqualifizierung”), volunteers and long-term unemployed (Mindestlohngesetz, 2014). Individuals that earned less than the initial minimum wage of 8.50 euros per hour in 2014 were about 5.5 million, the number of exceptions reduces the number of eligible individuals to about 4 million (Destatis, 2016).

Table 1.1 below summarises employees eligible for the minimum wage in 2014. According to Destatis (2020), the total number of employed individuals in 2014 in Germany was 37.148 million, and workers

⁷ Gesetz zur Regelung eines allgemeinen Mindestlohns (MiLoG) <https://www.gesetze-im-internet.de/milog/BJNR134810014.html>

⁸ Mindestlohnkommission <https://www.mindestlohn-kommission.de/EN/Report/pdf/summary.html?nn=805b5da2-42f0-4d1d-ad95-011c84124975>

⁹ Marginal employment is defined by a monthly income below €450

eligible for minimum wage were 3.974 million, corresponding to 10.7% of the employed population. 61.73% of the eligible workers were women (2.453 million), corresponding to 6.6% of the total employed population, whereas the percentage for men was lower and equal to 38.27% (1.521 million), corresponding to 4.1% of the entire employed population. Most of individuals lived in West-Germany territory (2879 million), and 1.094 million individuals lived in East-Germany regions. Most of workers affected by the policy was employed in “mini-jobs” (2209 million), equivalent to 5.95% of the entire employed population, whereas the percentage of full-time and part-time employees who earned less than the minimum wage is lower and equal, respectively, to 2.38% and 2.37%.

Table 1.1: Minimum wage beneficiaries in 2014

	Units (in thousands)	Share of	
		Employed	Affected
Employed in 2014	37148	100%	-
Wage < €8.50	5500	14.81%	-
Wage < €8.50 and eligible	3974	10.7%	
thereof			
Women	2453	6.60%	61.73%
Men	1521	4.1%	38.27%
West-German residents	2879	7.75%	72.44%
East-German residents	1094	2.95%	27.52%
Full-time employment	884	2.38%	22.25%
Part-time employment	880	2.37%	22.14%
Mini-jobs	2209	5.95%	55.59%

Source: own elaboration from Destatis (2020). Total of West-German residents and East-German residents and total of Full-Time, Part-time, and mini-jobs is 3973.

Destatis (2020) also compares the average gross monthly earnings and average gross earnings per hour. Table 1.2 below shows the differences across types of employment. Mini-jobs employees had an hourly wage of 6.78 euros per hour, and it is the lowest amount compared to full-time and regular part-time employment.

Table 1.2: Average gross earnings across types of employment

	average gross monthly earnings (in euros)	average gross earnings per hour (in euros)
Full-time employment	1283	7.20
Part-time employment	758	7.37
Mini-jobs	264	6.78

Source: own elaboration from Destatis (2020)

Across years, the number of eligible individuals has been reduced. In 2015 affected workers were 1.907 million, 1.754 million in 2016, 1.371 in 2016, 926 thousand in 2018 and 1.421 million in 2019. Most of affected individuals remains women and mini-jobs employees. In 2019, average gross monthly earnings have increased up to 1528 euros for full-employment workers, 892 euros for part-time workers, and 328 euros for mini-jobs workers. Average gross earnings per hour was 9.19 euros for all the employment categories (Destatis, 2020).

According to Bruttel (2019), industries in 2014 with the highest share of jobs paying less than 8.50 euros per hour are taxis with a share of 69.6%, gambling and lottery with a share of low-paid jobs equal to 56.7%, food and services where workers who earned less than the minimum wage were 51.5% of the total workers of that industry, followed by postal services (40.1%), and entertainment and recreation. (33.6%). Industries with the lowest share of jobs paying less than 8.50 euros per hour were in 2014 facility management services with a percentage of 23.1%, followed by repair services for durables (22.1%), publishing of books and magazines (21.9%), retail (21.8%), and rental services (16.6%). Bruttel, Baumann and Duetsch (2018) show that among the 3.974 million individuals that earned less than the minimum wage in 2014, most of them (21.9%) worked in a company with less than 10 employees, whereas the percentage of affected individuals in companies with more than 250 employees is 5%. Moreover, affected individuals with higher education level (university degree) are 152.000 (2.4%), affected individuals with no vocational training are instead 1.126 million (24.3%). Minimum wage beneficiaries in 2014 are in prevalence women, individuals with low education level and workers in marginal part-time employment.

1.4.2 Political background and anticipation effects

The debate about the minimum wage in Germany relates to the roots of post-war German political reconstruction (Kitagawa and Uemura, 2013). There are three main issues to consider. First, we need to consider Article 9 of the Basic Law for the Federal Republic of Germany (Grundgesetz, Article 9¹⁰; BverfGE,14, 96) which advocates institutions of collective bargaining autonomy by mean of which working conditions are decided by agreements between employers' associations and trade unions. In this context, State intervention in collective bargaining autonomy through minimum wage policies plays an important role. Second, the statutory minimum wage became a political issue against the background of "social movement unionism" (Kitagawa and Uemura, 2013). Finally, trade unions with less economic bargaining power than industrial unions have led the debate.

¹⁰ Article 9 "Freedom of Association" https://www.gesetze-im-internet.de/englisch_gg/englisch_gg.html#p0054

In 2013, year of the German parliamentary elections (“Bundestagswahl”), there was a trade unions’ campaign over 80% of the public was in favour of the minimum wage (DGB). All German parties proposed the introduction of a minimum wage in their electoral proposal except for the economically liberal party of FDP. In September 2013 the German Parliament (“Bundestag”) was elected, and the centre-right-wing parties Christian Democratic Union (CDU)/Christian Social Union (CSU) obtained 255 seats, the left-wing party Social Democratic Party (SDP) obtained 193 seats. They formed together the Great Coalition (“Große Koalition”) and they agreed to include in their coalition contract the minimum wage policy, that passed in July 2014 (Mindestlohnengesetz, 2014), and came into force on January 1, 2015. Thus, there could be anticipation effects to be analyse in the pre-treatment period, and there are potential changes in employers’ behaviour before the introduction of the law. As a matter of fact, Bossler (2017), shows that employers who were affected by the minimum wage reported employment uncertainty during summer 2014.

1.4.3 Non-compliance

As we saw in paragraph 1.4.1, in 2019 the number of affected individuals has decreased to 1.421 million, but it is still high. Indeed, a crucial point in the implementation of the minimum wage is monitoring and enforcing its application. A second source of non-compliance is represented by possible measurement errors in employee surveys, that reduce the precision of the information.

According to § 14 MiLoG, the monitoring of the implementation of the statutory minimum wage is a responsibility of the Generalzolldirektion (Custom Authority), the FKS (*Finanzkontrolle Schwarzarbeit*, Financial Monitoring Unit for Illicit Employment) inspect the activity in the shadow economy, undeclared work, and illegal employment. (Mindestlohnkommission, 2016a). In addition, the DGB¹¹ has a “minimum wage hotline”, to hear how employers raise the minimum wage trough illegal circumvent practises (Mindestlohnkommission, 2016c). Examples of illegal practises to bypass the minimum wage introduction are new contracts for mini-jobbers which provide shorter working hours so that the 450 euro threshold is not exceeded, holidays, public holidays and sick days are no longer paid, insufficient or fraudulent documentation of working hours, exclusion from working time of stand-by times (e.g. for taxi drivers) or loading times (for truck drivers) or empty loads and the unlawful compensation of working hours with vouchers or benefits in kind. Therefore, the controls at the FSK need to be increased to better monitor the implementation of the minimum wage law.

¹¹ German Trade Union Confederation
<https://en.dgb.de/#:~:text=The%20German%20Trade%20Union%20Confederation%20%28DGB%29%20is%20a%20n,in%20the%20world%20of%20work%20and%20in%20society>

In chapter 4 I will empirically analyse the impact of the legislation, we will notice that non-compliance is present. As a matter of fact, treatment individuals affected by the policy are slightly decreasing across the years, but the share of workers who earn less than the minimum wage threshold remain high, even after the introduction of the law.

2. Literature Review

The literature on minimum wage policies has focused mainly on two economic outcomes: wage inequality and employment (Caliendo et Al., 2017). As we saw in paragraph 1.1, economic theory shows ambiguous results when modelling the impact of the reform. Thus, it is important to show the empirical conclusions on minimum wage policies. First, we will see studies on minimum wage in the United States and in the United Kingdom, and then we will focus on the impacts of the reform in Germany.

2.1 Minimum wage empirical results in US and UK

Card (1992) studies the effects of the increase on minimum wage in California. In 1988 the minimum wage increased from 3.35\$ to 4.25\$ per hour. In the previous year workers who earned between 3.35\$ and 4.35\$ were 11%, whereas the percentage of the teenagers with low wage was 50%. The scholar uses the Current Population Survey (CPS) to measure the effects of the policy, and he makes a comparison of the demographic characteristics of the individuals. He finds out that the affected groups of workers are likely to be younger, female, Hispanic, and enrolled in school. He finds no significant negative effects on employment, even if the rise of the minimum wage in California raised the earnings of low-income individuals. This effect is particularly evident in teenage workers, who raise their earnings by 10%. Card and Krueger (1994) study the effect of the increasing of minimum wage in New Jersey in 1992 from 4.25\$ to 5.05\$ per hour. They surveyed 410 fast-food restaurants in New Jersey and eastern Pennsylvania, when the minimum wage remains constant, before and after the reform. In addition, they study the change in employment in restaurants that in New Jersey were paying higher wages (above 5\$) and compare them to restaurants that were paying lower wages. It is important to underline some features of New Jersey to better analyse their findings. New Jersey was in recession when the minimum wage law was implemented, second, it is a small State, and its economy is linked with the nearby States. For this reason, the authors use eastern Pennsylvania as a control group of fast-food restaurants and test the validity of the choice. Another important aspect is that the authors conduct interviews of stores before the implementation of the policy (in February and March 1992), and nearly 100% of the restaurants answers after the reform hits (November and December 1992), measuring the overall effect of the minimum wage on employment. They use a diff-in-diff approach to evaluate the difference in employment level in Pennsylvania and New Jersey from the first wave of the interview to the second wave. They find no significant negative effects of

minimum wage on employment at fast-food restaurants in New Jersey, on the contrary, increasing the minimum wage has relatively increased employment for low-wage workers, regardless of the initial wage. Finally, prices in fast-food in New Jersey increase in comparison to Pennsylvania, suggesting that consumers pay part of the rising of the minimum wage. Dolton, Bondibene, and Stops (2015), evaluate the impact of the National Minimum Wage on employment in UK in the period 1999-2010, considering a pre-treatment period of two years using an incremental D-i-D estimator. The scholars also analyse the 2008-2010 recession period. One of the main purposes of the paper is to see if geographic variation in the bite of the minimum wage is relate to geographic variation in employment level. They also analyse the interconnectedness of local labour markets through a spatial econometric method and demonstrated that non considering spatial dependence and endogeneity of the minimum wage could lead to have positive or negative results with underestimated standard errors. The authors conclude that the introduction of the minimum wage in UK and its implementation has no distinguishable effect on employment. Contrary to other findings they use a GMM approach concluding that naïve estimation may have caused the widely different positive and negative effects of the minimum wage introduction.

2.2 Minimum wage empirical results in Germany

Caliendo et Al. (2018) use a diff-in-diff approach to evaluate the employment effects after the minimum wage reform in Germany. They combine data from the Structure of Earnings Survey (SES) 2014, which is available every four years, with administrative information on regional employment. Moreover, they used the Socio-Economic Panel (SOEP) for the pre-treatment period (2012-2014) because it gives information about individual hourly wages, employment, and earnings calculated every year, even if the sample size is smaller than in SES. The authors follow Card (1992) and propose an identification approach using regional variation that doesn't depend on difference in legislation, given that minimum wage policy was implemented in all the 16 German federal States. They use the following structural model:

$$\Delta W_{j,2015} = \alpha + \beta Bite_{j,2014} + \mu_{1,j} \quad (2.1)$$

$$\Delta E_{j,2015} = \gamma + \eta \beta W_{j,2015} + \mu_{2,j} \quad (2.2)$$

where $\Delta W_{j,2015}$ represents the changes in aggregated region j between 2014 and 2015, α is the average change, $Bite_{j,2014}$ is the lagged minimum wage in area j , and $\mu_{1,j}$ is the error term. β is the average effect of the minimum wage on wages, and as we see from the equations 2.1 and 2.2 $Bite_{j,2014}$ doesn't affect employment E_j directly. Substituting equation 2.1 in 2.2 the new equation is as follow:

$$\Delta E_{j,2015} = \gamma_0 + \eta\beta Bite_{j,2014} + \varepsilon_j \quad (2.3)$$

where $\varepsilon_j = \mu_{1,j} + \mu_{2,j}$, and $\gamma_0 = \alpha + \gamma$. The product $\eta\beta$ represents the causal effect of the minimum wage on employment. In addition, they use the logarithm of employment as a dependent variable, and the population level as one of the control variables. The definition of the variable "Bite" is crucial in their analysis, they use the Kaitz index that measures the ratio between the minimum wage and the regional mean wage. The higher the index, the higher the values of "bites" related to the minimum wage. The authors rely on the 141 regional labour markets districts (RLMs) defined by Kosfeld and Werner (2012) and analyse the regional variation of employment level. The authors find that there were no relevant anticipation effects in wages before the introduction of the policy and find a significant negative effect of the minimum wage on employment. As a matter of fact, overall employment reduced by 0.4%, and it is mainly due to the reduction of marginal employment. Moreover, the effects on "mini-jobs" are robust, whereas the same doesn't apply to the estimation of regular employment. Marginal employment workers could have transferred to regular employment. Finally, the authors identify only short run effects of the policy, and the lack of effect on regular employment could be explained by non-compliance and thus it could be early to derive policy conclusions.

Caliendo, Wittbrodt, and Schroeder (2019) emphasize that different estimations of minimum wage impacts across different studies can derive from the differences in datasets, their responders, and the computation of hourly wage. In addition, they identify in the literature a variety of identification approach to evaluate the causal effects of minimum wage policies. As concern Germany, three approaches have been identified. The first one follows Card (1992) using regional variation to analyse the degree to which an area is affected by the wage floor, considering regional heterogeneity in wage levels. The empirical strategy is the Diff-in-Diff, and the causal effect of the reform is represented by the interaction term between a post-policy dummy and the bite measure. The approach can be used on individual level, as well as on regional level. The second method consists in defining a treatment

and a control group. As regard German minimum wage policy, treatment individuals are those workers with an hourly wage below 8.50 euros per hour in the year before the reform, whereas control group is made of those workers whose earnings are above the threshold of 8.50 euros per hour. The problem with this procedure is that there could be spill-over effects between treatment and control groups. The third strategy is obtained by applying the D-i-D on firm level, in which treated group is those with a high share of employees who earn below 8.50 before the policy, and control group is composed by those firms with a small share of affected workers or not at all. Also, in this approach the causal effects are to be found in the interaction term between the post-treatment dummy and the treated one. After having analysed the different data sources for the evaluation of minimum wage effects in Germany across studies and the most striking results, the authors point out the short-term results in the German case. First, one or two years after the introduction of the minimum wage reform wages at the bottom of the distribution have increased. Most of beneficiaries are women, low educated individuals, marginally employed and people with a migration background. However, non-compliance must be considered as we saw in paragraph 1.4.3, and eligible employees earned less than the minimum after the introduction of the reform. Secondly, the purpose of poverty and inequality reduction was not achieved in the short run as the livelihood of affected workers hasn't a significant positive effect. As we saw in paragraph 1.4.3 some employers have reduced the working hours of affected workers, and thus their earnings didn't rise. Finally, there is a small and significant negative effect on overall employment. This effect is mainly caused by marginal employment. They stated that future research can tell us more about the medium and long run effects of the policy, including also better instruments to analyse hourly wages to improve the evaluation of the reform. Bonin (2019) use an extended D-i-D approach to evaluate the short and medium run effects of minimum wage in Germany. They calculate a worker's hourly wage by dividing the monthly income (net of overtime and bonus payments) by the number of paid monthly hours (excluding overtime hours) using the Structure of Earnings Survey with data from 2013 to 2016. They compute the regional wage gap to measure the minimum wage gap, the control group correspond to the wage gap below the median, those regions above the median are the treatment group. The estimation equation is as follow:

$$\ln Y_{i,t} = LMR_i + Time_t + \beta(WageGap_{i,2014}^{high} x I_{t>06/2014}) + \sigma_{it} + \varepsilon_{it} \quad (2.4)$$

where $Y_{i,t}$ is the logarithmic outcome in labour market i at time t , LMR_i represents the labour markets fixed effects, and $Time_t$ is the time fixed effects. $WageGap_{i,2014}^{high} x I_{t>06/2014}$ is the variable of interest

that indicates the treatment group, labour market regions with a high minimum wage bite, after June 2014. The coefficient β is the average treatment effect of the minimum wage introduction. The extended D-i-D strategy allows to consider pre-trend estimates, by considering the bite prior to the introduction of the minimum wage in 2015. The authors find a significant reduction in marginal employment in the short run (2015 and 2016). The effect on regular employment is, however, non-significant and they find no evidence that minimum wage policy has caused higher level of unemployment.

Ahlfeldt, Roth, and Seidel (2018) analyse the regional effects of the introduction of the minimum wage in Germany, using Employment Histories (BeH) and the Integrated Employment Biographies (IEB) provided by the Institute of Employment Research (IAB). To evaluate the impact, they use a D-i-D approach in which the outcome Y in county c in region g and at time t , to identify the treatment effects on both the level and the trend of the outcome. The introduction of minimum wage led to a spatial wage convergence, and wage-low counties increased more rapidly than high-wage counties, especially for workers in the bottom of the wage distribution. Regions with a higher share of low-wages workers had lower unemployment rate in 2015 and 2016. Gregory and Zierahn (2022) study the impact of minimum wage in a quasi-experimental setting, identifying treatment effects along different wage groups. They find positive spill-overs effects for medium-skilled workers whose earnings were just above the threshold of the minimum wage. However, according to their estimates, earnings of high-skilled workers can be reduced after the implementation of the minimum wage. Indeed, for the highest quantile of wage distribution a reduction of 5% in East Germany is noticeable.

Holtemoeller and Pohle (2020) estimate the effects of minimum wage on employment in Germany using panel regressions on the state-industry level, obtained from the Federal Employment Agency. The authors' estimate panel models don't rely on the parallel trend assumption, because they assume that the minimum wage introduction is exogenous with respect to the cross section. They find robust negative effects on marginal employment and robust positive effect on regular employment. In addition, there are industry-specific differences in the effects of the policy, the positive effect on regular employment has been smaller in East Germany, and the negative effects on marginal employment has been bigger in East Germany than in West Germany. Thus, it is important to consider regional differences when implementing minimum wage policies.

Burauel et Al. (2020) study the impact of the minimum wage on monthly earnings using data from 2010 to 2016 of the German Socio-Economic Panel (SOEP). Using a D-i-D approach, they causally identify the effects of the policy on the wage distribution. Between 2014 and 2015, wages in the bottom 10th percentile of the wage distribution increased by 15%. Moreover, between 2014 and 2016, hourly wages of low-wages workers grew above-average with respect to previous period and with respect to non-

affected workers. There is also a positive and marginally significant treatment effect on monthly earnings of 6.6%, and this positive effect is higher for marginal employed workers (15.5%).

Guelal and Ayaita (2020) study the effects of minimum wage in Germany on well-being, as for example satisfaction with life, job and pay, on affected workers. They use a D-i-D strategy for the period 2015-2016 using the German Socio-Economic Panel (SOEP). Minimum wage has a positive and significant effect on well-being dimensions, but the results differ between East and West Germany. As a matter of fact, the positive effects on well-being are more pronounced in East Germany, even if the minimum wage amount is the same in all the 16 German States.

Most of the empirical findings on German minimum wage study the short-run results, thus it is interesting to also analyse the medium run effects to better evaluate the policy. In chapter 3 we will see the research methodology used, the structure of the dataset, and the employment-to-population ratio from 2000 to 2019. The results give us a first understanding of the impact of the policy on total employment, marginal employment, also considering the gender, regional and age differences, and different education level.

3. Research Methodology

3.1 Data Sources

In order to evaluate the impact of the minimum wage reform in Germany, I used the SOEP Dataset: the German Socio-Economic Panel (SOEP) is an annual longitudinal survey of approximately 32.000 individuals and 18.000 private households in the Federal Republic of Germany from 1984 to 2020 and the eastern German Länder from 1990 to 2020. The database is produced by the Deutsches Institut für Wirtschaftsforschung (DIW), Berlin¹².

The aim of the SOEP dataset is to collect representative micro-data on persons, households, and families to measure stability and change in living conditions, its main topics are population and demography, education, training and qualification, labour market and occupational dynamics, earnings, income and social security, housing, health, household production, basic orientation (preferences, values, etc.) and satisfaction with life in general and certain aspects of life. The chapter proceeds as follow: paragraph 3.2 shows the target population and sampling, SOEP is a panel datasets organized with different samples added across the years and thus it is essential to analyse its structure, paragraph 3.3 analyses the development of the sample size that I consider, the follow-up and the reason for exit the panel to see if the sample is representative, paragraph 3.4 investigates the sample and weighting procedure that is important to obtain not biased results, paragraph 3.5 examines the data structure of the panel consider, and finally paragraph 3.6 evaluates the employment-to-population ratio before and after the reform.

3.2 Target Population and Sampling

The Survey started in 1984, since then it was carried out regularly and in June 1990 it was expanded to include the German Democratic Republic. It is structured on the basis of different samples/modules.

- Sample A "Residents in the Federal Republic of Germany" represents one of the two initial samples and consists in individuals in private households with a household head who does not belong to one of the main groups of "guest workers". In 1984 it covered 4528 households with a sampling probability of about 0.0002.
- Sample B "Foreigners in the Federal Republic of Germany" is part, together with sample A, of the initial sample and represents individuals in private households whose household head has

¹² https://www.diw.de/en/diw_01.c.615551.en/research_infrastructure_socio-economic_panel_soep.html

a Turkish, Greek, Yugoslavian, Spanish, or Italian nationality. The initial sample included 1393 households with a sampling probability of 0.002.

- Sample C “German Residents in the German Democratic Republic (GDR)” covers individuals whose household head was a citizen of the GDR. The sample started in 1990 with 2179 households with a sampling probability of about 0.0005.
- Sample D “Immigrants” was first drawn in 1994/95 with two different samples. In 1994, the first sample, D1, had 236 households and in 1995, the second sample, D2, had 295 households, with a total of 531 households in 1995. This sample consisted of households in which at least one member had moved from abroad to West Germany after 1984. The sampling probability is about 0.0002.
- Sample E “Refreshment I/Refresher” was added in 1998, selected from the entire population of private households in Germany. The sample was designed with the aim of being representative of the population of former West and East Germany, and to increase the overall sample size of the dataset, compensating panel attrition and population sample changes. The initial number of households was 1060 with a sampling probability of about 0.00005.
- Sample F “Refreshment/Refresher” was added in 2000, covers private households and increased the sample size of the dataset. “German” households have a sampling probability of 0.00028, whereas the “non-German” households have a sampling probability of 0.0005. The total number of households in this subsample is 6043.
- Sample G “High-Income” was first drawn in 2002 and covers private households whose monthly income is of at least DM 7500 (EUR 3835). The total subsample consists in 1224 households and the sampling probability is about 0.0014. Since 2003 households with a minimum monthly net income of 4500 have been interviewed further.
- Sample H “Refresher” was added in 2006, covers 1506 residential households in Germany, with a sampling probability of 0.0001.
- Sample I “Incentive Sample” was added in 2009, and covers private households in Germany, the total number of households of 1531 and a sampling probability of 0.00013.
- Sample J “Refresher” was added in 2011 as a random sample, and covers residential households in Germany, the total number of households is 3136 with a sampling probability of 0.0002.
- Sample K “Refresher” was added in 2012 as a random sample. The drawn covers 1526 residential households in Germany, with a sampling probability of 0.0001.
- Sample L1 “Cohort Sample”, identifies private households in Germany, in which at least one household member is a child born between January 2007 and March 2010.

- Sample L2 “Family Types I” identifies private households that satisfy at least one of these criteria: single parents, low-income families, and large families with three or more children.
- Sample L3 “Family Types II” is conducted similarly to Sample L2 to increase the initial sample size of these sub-samples.
- Sample M1 “Migration Sample” was drawn in 2013 with 2723 households using register information from the German Federal Employment Agency. It involves persons who immigrated to Germany after 1995 or second-generation immigrants.
- Sample M2 “Migration Sample” was added in 2015 with 1096 households, it includes individuals who immigrated to Germany between 2010 and 2013.
- Samples M3/M4 “Refugee Family Sample” were added in 2016 for the IAB-BAMF-SOEP Refugee Survey. Approximately 1769 refugee households were interviewed. The target population consists in individuals aged 18 and older who entered in Germany between January 2013 and December 2015 and who had completed the asylum application by April 2016.
- Sample M4 “Refugee Family Sample”
- Sample M5 “Refugee Sample” is a refreshment and enlargement for the sub-samples M3 and M4, the first wave was drawn in 2017. M5 added another 1519 households of refugees who have migrated to Germany since 2013.
- Sample M6 “Refugee Sample” is a refreshment and an enlargement of former Refugee Samples
- Sample M7 “Migration Sample” is a top-up sample of the previous samples, that has a focus in the EU migration.
- Sample M8a “Migration Sample” is a boost of the previous samples that was drawn to evaluate the skilled worked immigration law
- Sample N “Refresher Sample” adds 2314 households of former participants in the Program for the International Assessment of Adult Competencies (PIAAC and PIAAC-L) in 2017.
- Sample O “Social City Sample” includes 935 households that live in bigger cities.
- Sample P “Top Shareholder Sample” consists in highly affluent households in Germany
- Sample Q “LGB*” covers LGBTQ+ people that was too scarcely represented in the SOEP. The total number of initial households is 835.

Questionnaires for sample A-D were conducted entirely using Paper-and-Pencil-Interviews (PAPI), from sample E, also Computer-Assisted Personal Interview (CAPI) was used, and the two methods are randomly chosen to study more effects of the sampling methodology (Rainer, Steinhauser, and Schuett, 2022).

3.3 Follow-Up, Reason for Exit the Panel and Development of Sample Size

When dealing with surveys, one of the problems is to cope with problem of representativeness of the sample, in accordance to how and if the respondents are traced across time.

In SOEP all households' members with 16 years old and older are eligible for an interview and they are to be surveyed in the next years. If a new individual is born into a SOEP households, she will become part of the survey when the year of 16 is reached, as well as an individual who results from a residential mobility. Individuals can exit the survey for several reasons: deaths, moving abroad, declined to reply, and there are also temporary dropouts, individuals that cannot be interviewed in a year and are followed until there are two consecutive waves of missing interviews or until the entire households refuses to participate to the survey further. Indeed, there are both demographic reasons and fieldwork-related factors for exit the panel, the latter differentiates from death and moving abroad because these factors relate to the interaction between the interviewer and the responding household.

The variable "netto" in the SOEP PPATHL-Person-Related Meta-Dataset¹³ indicates the current survey status. According with the different codes, I identify 7 groups as in SOEP: "Moved abroad", "Deceased", "Under age 16", "With interview", "Temporary drop out", "Declined to reply", and "Non completed interview".

Firstly, I consider an unbalanced panel dataset from 2000 to 2019 that comprises individuals with 15–65-year range, remaining with 574636 observations as in Table 3.1 below.

The period consider allows to have a long pre-treatment period of fourteen years, in addition, the sample doesn't comprise year 2020 and following in which COVID-19 pandemic hit, and whose effects could have biased the results.

Table 3.1: frequency of current survey status

Current survey status	Freq.	Percent	Cum.
[10] Interviews With Successful Interview (_P)	300626	52.32	52.32
[12] Individual Questionnaire And Person Biography	82949	14.44	66.75
[13] Individual Questionnaire And Youth Biography	318	0.06	66.81
[14] Individual Questionnaire And Other Questionnaires	24	0.00	66.81
[15] Individual Questionnaire And Experiments, Test	33141	5.77	72.58
[16] Individual Questionnaire, First Time Surveyed, Age 17	2265	0.39	72.97
[17] Youth Biography First Time Surveyed, Age 17	6556	1.14	74.11
[19] Individual Questionnaire Without Household Interview	757	0.13	74.24

¹³ Path Files indicate the total population at the household and individual level (over time) and provide all IDs necessary to access further files at different levels.

https://www.diw.de/documents/publikationen/73/diw_01.c.676083.de/diw_ssp0762.pdf

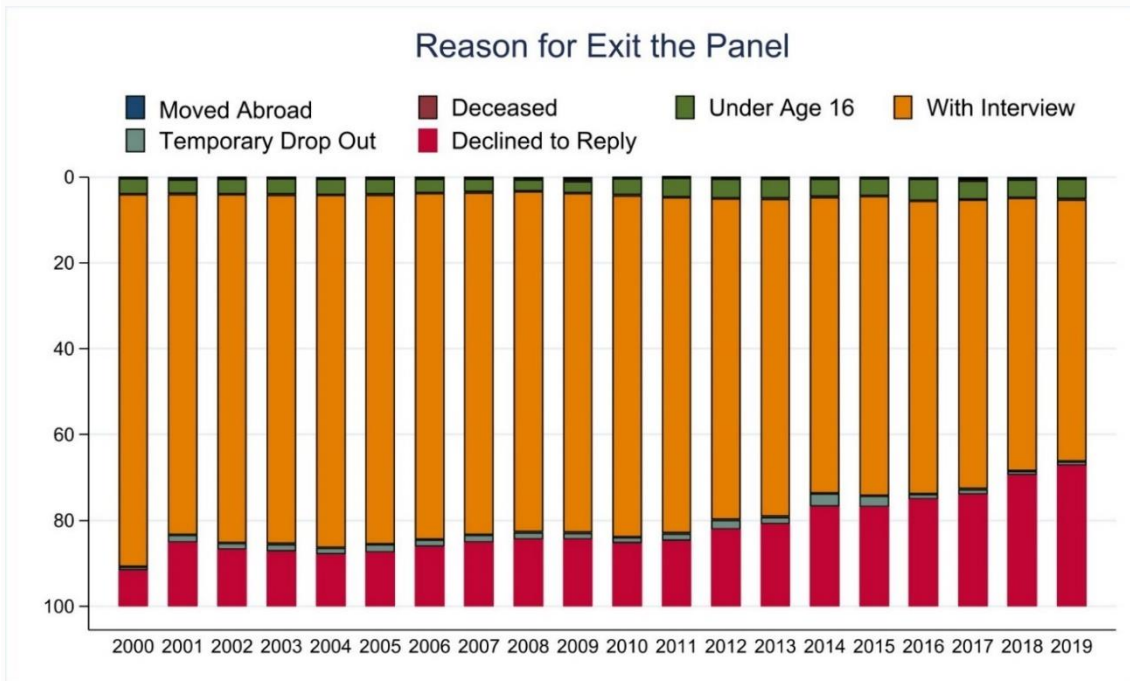
[20] Children in Successfully Interviewed Households (_Kind)	22988	4.00	78.25
[28] Youth questionnaire, Age 13-14	2	0.00	78.25
[29] Youth from refugee sample, age 16-17	483	0.08	78.33
[30] Persons In Successfully Interviewed HH Without Individual Interview	111707	19.44	97.77
[31] Successful Gap Interview (_LUECKE)	6461	1.12	98.89
[32] Successfully Completed Biography Questionnaires	25	0.00	98.90
[33] Successful Youth Questionnaire	22	0.00	98.90
[34] Successful Tests and Experiments	100	0.02	98.92
[35] Part. Success, without HH interview	458	0.08	99.00
[61] Gap Interview without HH reference	9	0.00	99.00
[62] Gap Interview with drop out	3	0.00	99.00
[80] Individual Without Any Current Information	273	0.05	99.05
[81] Prior Interviewee Without Any Current Information	210	0.04	99.08
[88] Repatriate - (moved abroad before [91])	32	0.01	99.09
[89] Repatriate - (was drop out [90])	83	0.01	99.10
[90] Individual Dropouts PBR_EXIT	2285	0.40	99.50
[91] Moved abroad	1492	0.26	99.76
[92] Moved abroad (abroad)	148	0.03	99.79
[93] Moved abroad (exit)	20	0.00	99.79
[94] Person Gap with advices	230	0.04	99.83
[97] advice to dead person (exit)	62	0.01	99.84
[98] advice to dead person (_VP)	84	0.01	99.86
[99] Has Died	823	0.14	100.00
Total	574636	100.00	

The development of the sample population across the 20 years is given by the Figure 3.1 below. From the Figure 3.1, we can notice that the percentage of individuals with successful interview are reducing across the years, starting from 20917 individuals in 2000 and reaching 25117 in 2019. Indeed, the percentage who decides not to reply has grown over the years, there were 2003 individuals who declined to reply in 2000 with a sample size of 21192, with an incidence of non-respondents of 9.45%, and 13482 in 2019 with a sample size of 41125, with an incidence of non-responders of 32.78%. In the sample considered is not present the “Non completed interview” group. Among the 147517 observations that exit the panel, 34707 observations were employed¹⁴ the year before the exit corresponding to 54.04% of the total, whereas 22583 were unemployed (35.11%). Observations with successful interview and employed¹⁵ are 59.14% of the total, whereas unemployed individuals are 31.09%. 43.15% of non-responders are younger than 30 years old, while the percentage of individuals younger than 30 years old in the remaining sample with successful interview is less and equal to 24.37%.

¹⁴ Full-Time Employment and Regular Part Time Employment, non-responders employed in Irregular and Marginal Part-Time Employment are 6.17% of the total.

¹⁵ Responders employed in Irregular and Marginal Part-Time Employment are 5.98% of the total.

Figure 3.1: Development of Sample Size from 2000 to 2019 (in percentage)



Individuals with successful interview are 427119, after having dropped all other survey status, I construct the cross-sectional development of the sample considered, to understand how many individuals per samples are present in the analysis. Paragraph 3.5 analyses more in detail the sample composition of the 427119 observations remained. Table 3.2 represents the development of the samples across the years.

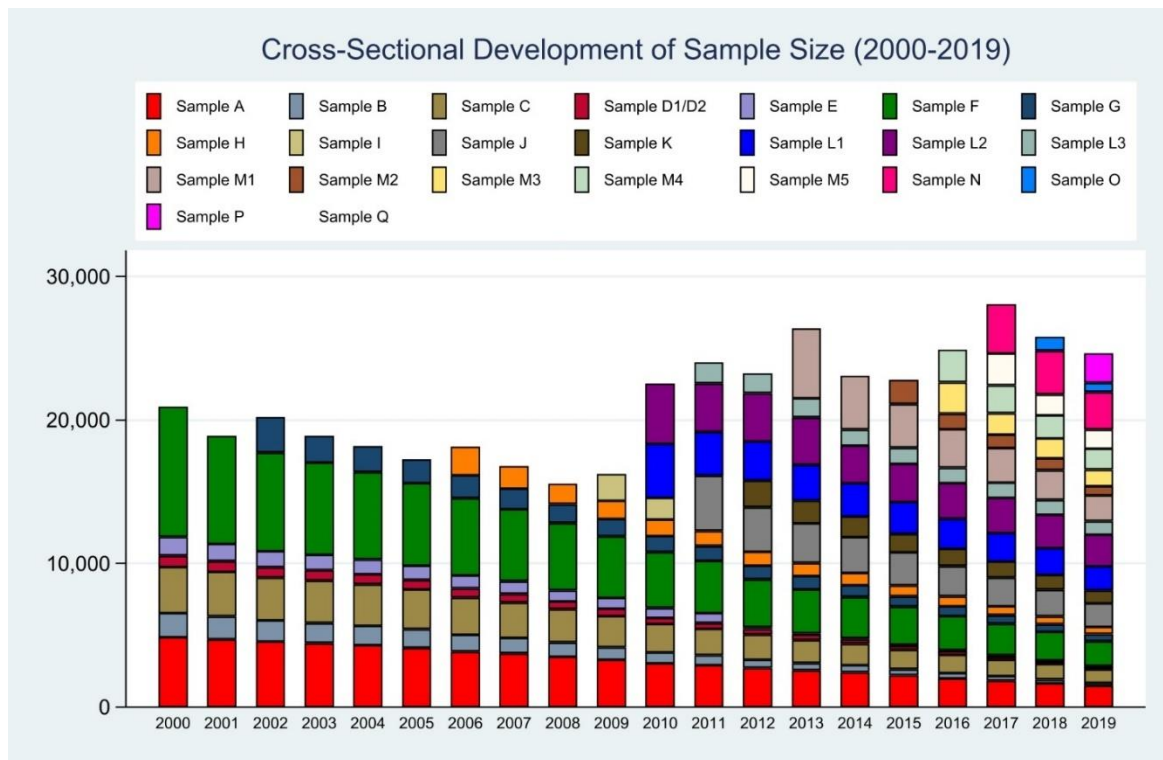
Table 3.2: Development of samples across the years 2000-2019

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
F	9075	7518	6870	6433	6095	5748	5380	5017	4683	4309	3891	3636	3338	3080	2848	2624	2382	2201	1971	1732	88831
E	1299	1216	1125	1079	1040	992	929	875	793	752	702	692	132	107	99	85	77	79	65	58	12196
D	781	730	717	721	690	665	616	592	534	503	429	405	381	345	313	284	248	226	204	180	9564
C	3223	3111	2977	2947	2901	2772	2605	2481	2320	2187	1992	1855	1741	1605	1499	1347	1268	1155	1081	929	41996
B	1678	1609	1493	1411	1354	1306	1170	1075	987	860	751	681	585	519	485	437	370	313	257	216	17557
A	4861	4709	4550	4448	4296	4115	3857	3739	3508	3293	3038	2918	2709	2547	2417	2204	1990	1828	1649	1468	64144

Total	Q	P	O	N	M5	M4	M3	M2	M1	L3	L2	L1	K	J	I	H	G
20917	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18893	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20213	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2481
18895	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1856
18180	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1804
17265	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1667
18153	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2011	1585
16806	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1587	1440
15556	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1430	1301
16250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1889	1268	1189
22554	0	0	0	0	0	0	0	0	0	0	4205	3770	0	0	1514	1146	1116
24033	0	0	0	0	0	0	0	0	0	1480	3384	3049	0	3839	0	1059	1035
23240	0	0	0	0	0	0	0	0	0	1377	3361	2712	1861	3108	0	976	959
26391	0	0	0	0	0	0	0	0	4878	1334	3294	2506	1576	2773	0	908	919
23079	0	0	0	0	0	0	0	0	3748	1111	2630	2314	1436	2505	0	849	825
22811	0	0	0	0	0	0	0	1698	3041	1133	2664	2212	1296	2295	0	761	730
24892	0	0	0	0	0	2252	2197	1091	2690	1072	2478	2091	1193	2129	0	686	678
28062	0	0	0	3415	2221	1948	1493	934	2422	1058	2445	1986	1122	2004	0	616	596
25812	0	0	988	3045	1447	1613	1392	815	2079	1050	2323	1858	1035	1850	0	548	542
25117	479	2038	650	2606	1332	1470	1151	645	1785	961	2205	1673	905	1648	0	491	495
427119	479	2038	1638	9066	5000	7283	6233	5183	20643	10576	28989	24171	10424	22151	3403	14336	21218

The sample with more observations is F, the refresher sample added in 2000, with a total of 88831 observations, followed by sample A, the initial sample with 64144 observations and sample C representing the former GDR households with 41996 individuals. Sample Q "LGB*" has the smaller number of individuals with 479 individuals in 2019 and in total. Individuals of samples from A to F are represented over the 20 years under analysis. The cross-sectional development of the sample can be seen from Figure 3.2 below.

Figure 3.2: Cross-Sectional Development



3.4 Sampling and Weighting

Refreshment samples added to the SOEP are needed to maintain cross-sectional representativeness and to deal with panel attrition issues (Goebel et Al., 2019). Indeed, almost all surveys based on voluntary participation are affected by nonresponse. As seen in Paragraph 3.2, the enlarged samples are either on the form of a general population sample or an addition sample, that focuses on specific population subgroup that is interesting for policy evaluation or for the research community.

In general, we can distinguish between unit and item nonresponse, where the latter indicates that one individual doesn't answer to all the survey questions, whereas unit nonresponse refers to a situation in which individuals are not observed at all. In panel datasets, attrition is a particular type of unit nonresponse and indicates that an individual previously observed is drop off in the following year.

In SOEP dataset weights are used to compensate for disproportional sampling probabilities, selective nonresponse in the first wave of each sample, and panel attrition (Rainer, Steinhauser, and Schuett, 2022).

SOEP uses random probability samples, and it uses the modelling approach to evaluate weights (Schonlau, Kroh, and Watson, 2013). SOEP uses ordinary least squares regression with $\logit(p)$ as a dependent variable, with p standing for the selection probability in wave 1. The explanatory variable refers to person-level characteristics of individuals for the selected wave for which weights are estimated. The regressions explain 90% of the variation in $\logit(p)$ ($R^2=0.9$) for the first waves and about 50% of the variation for the most recent waves.

A multistep process can describe the selection process for a panel study (Haisken-DeNew, and Frick, 2005). The first step consists in initializing the sample (design selection), the second is analyse the response in the first wave, the third step aims to make successful contact in the second wave, the fourth step consists in analysing the response in the second wave, and the subsequent steps analyse the response in the t -wave. Moreover, in SOEP there is a three-step procedure for weighting:

- 1- Cross-sectional weighting of wave 1
- 2- Weighting of longitudinal population
- 3- Cross-sectional weighting of waves 2 and after

The selection probabilities and the weighting factors for the first wave of the panel are very important because the values are used as a starting point for deriving the subsequent weighting factors. Indeed, when weighting longitudinal samples, it is fundamental to calculate and determine the initial probabilities for the first wave, as well as the conditional probabilities of remaining in the panel in the subsequent waves.

In SOEP the cross-sectional and longitudinal weighting factors are stored in PHRF and HHRF datasets, the former relates to individual weights, whereas the latter corresponds to households' weights.

3.5 Data Structure

To evaluate employment status, I use two different variables available in the SOEP dataset. Firstly, I start with the employment status of the individuals¹⁶. The variable is generated annually from the question on current employment status, which separate employed from unemployed people, and create a first filter for further questions. It provides consistent longitudinal data on employment status

¹⁶ SOEP-IS Group, 2021. SOEP-IS 2019—PGEN: Person-related Status and Generated Variables. Pgemplst variable. SOEP Survey Papers 1034: Series D – Variable Descriptions and Coding. Berlin: DIW Berlin/SOEP https://www.diw.de/documents/publikationen/73/diw_01.c.822172.de/diw_ssp1034.pdf This variable is generated from the annual question on current employment status, which has a central filter function in the questionnaire to separate employed people from non-employed people for further questions. It is designed to provide consistent longitudinal data on employment status across all waves. The variable is a self-reported answer to the question: are you currently employed? Which one of the following applies best to your status?

across the waves. It is general in the sense that the category “not employed” encompasses non-working individuals, as well as those in military or community service, those in maternity leave and employed persons in a phased retirement scheme (Altersteilzeit), with 0 working hours. There are six different values: 1 Full-Time Employment, 2 Regular Part-Time Employment, 3 Vocational Training, 4 Marginal, Irregular Part-Time Employment, 5 Not Employed, and 6 Sheltered workshop.

Another variable is more detailed than the previous one and represents the labour force status of the individuals¹⁷. Indeed, it comprises twelve different values based on different categories. It provides consistent longitudinal data on labour force participation, codes 1-10 define the “non-working” categories, whereas codes 11-12 define the “working” categories. “Non-working” categories are subdivided to apply labour concepts in an efficient way. The values are divided as follow: 1 non-working, 2 non-working-Age 65 and older, 3 non-working -in education/training, 4 non-working-maternity leave, 5 non-working -military-community service, 6 non-working-unemployed, 8 non-working-but sometimes second job, 9 non-working but past 7 days, 10 non-working-but regular second job, 11 working, 12 working but non-working in the past 7 days. The variable that describes the labour force status of the individuals supplements the variable regarding the employment status of the individuals, which differentiates among persons who are employed.

To start an analysis on the data, I first drop the observations in which the variable for employment status and labour force status are missing, not contained in the questionnaire or non-admissible. The remaining observations are 426926. From Table 3.3 we can see the frequency of the individuals in every year under analysis.

Table 3.3: Frequency observations for each year

Survey Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
2000	2636	1776	1278	1209	1142	1244	1061	975	937	872	706	967	587	532	552	474	473	474	779	2243	20917

¹⁷ SOEP-IS Group, 2021. SOEP-IS 2019—PGEN: Person-related Status and Generated Variables. Pglfs Variable. SOEP Survey Papers 1034: Series D – Variable Descriptions and Coding. Berlin: DIW Berlin/SOEP. The variable is a self-reported-employment status, the responders answer to the questions: Have you been engaged in paid work during the last 7 days, even if this work was only for an hour or just a few hours? IF [Woman & age <= 49] Are you currently on maternity leave or legislatively regulated parental leave? IF [Man OR (Woman & age > 49)] Are you currently on legislatively regulated parental leave? Are you currently enrolled in an educational or training program? In other words: are you in school or higher education, working on a doctor’s degree, completing vocational training, or taking part in further training? Are you currently employed? Which one of the following applies best to your status?

Total	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001
18670	3651	949	1687	1449	745	236	1475	491	1097	1838	657	61	87	519	71	69	74	718	160
23306	2070	2954	2532	1388	627	1019	1285	1098	1488	2149	1393	145	343	340	130	156	265	378	1770
29358	4485	4889	5077	1692	950	978	1542	1425	1274	754	173	328	358	349	211	351	442	1494	1308
23756	1849	2069	2199	2499	1164	1166	1756	1358	1229	873	319	342	341	382	378	518	1462	1407	1236
21135	948	1091	1429	1609	1982	1474	1457	1011	900	683	292	323	377	488	555	1436	1395	1366	1177
21972	665	960	1134	1392	1659	1716	1490	974	948	665	330	373	510	613	1535	1526	1499	1461	1278
27496	1588	1810	2054	2220	2262	2272	2348	1107	887	638	353	482	610	1485	1368	1328	1290	1239	1094
25904	1220	1520	1724	1728	1758	1771	1935	1938	1187	752	435	521	1339	1340	1241	1206	1175	1131	1008
34893	2178	2397	2430	2433	2482	2530	2608	2646	2705	1255	574	1356	1353	1337	1227	1209	1159	1102	975
33020	2080	2089	2109	2143	2209	2222	2262	2305	2405	2496	1212	1196	1186	1158	1076	1064	1029	997	910
12364	99	129	153	214	242	260	300	380	521	1091	1085	1021	988	971	885	878	849	836	756
16572	124	151	220	235	267	303	406	491	1352	1355	1368	1361	1278	1237	1142	1134	1106	1091	984
12402	167	218	230	259	279	378	448	922	924	925	935	935	933	828	732	720	700	687	595
15190	415	438	451	483	559	648	1071	1057	1071	1055	1073	1077	1072	1073	685	651	631	610	538
11535	105	126	152	213	306	749	746	754	761	758	762	753	755	760	757	679	653	635	559
11088	136	157	221	292	669	683	674	679	680	682	679	683	680	684	682	684	595	562	492
11764	172	229	317	663	682	682	673	675	678	675	685	687	685	680	675	674	671	603	485
14724	399	481	795	799	803	805	807	810	813	807	807	799	804	804	813	800	806	798	500
16587	480	841	850	857	855	857	855	858	851	849	865	863	850	853	856	852	842	853	821
44860	2243	2243	2243	2243	2243	2243	2243	2243	2243	2243	2243	2243	2243	2243	2243	2243	2243	2243	2243
426596	25074	25741	28007	24811	22743	22992	26381	23222	24014	22543	16240	15549	16792	18144	17262	18178	18886	20211	18889

2243 individuals are observed for the 20 years of analysis, whereas a total of 18670 individuals are observed only in a year.

Table 3.4 shows the number of individuals per gender for every year of the survey. Female observations are 224499 in total, and male observations are 202097.

Table 3.4: Gender division for every year

Survey Year	Gender		
	Male	Female	Total
2000	10259	10658	20917
2001	9226	9663	18889
2002	9910	10301	20211
2003	9201	9685	18886
2004	8824	9354	18178
2005	8333	8929	17262
2006	8702	9442	18144
2007	8053	8739	16792
2008	7441	8108	15549
2009	7788	8452	16240
2010	10229	12314	22543
2011	10777	13237	24014
2012	10406	12816	23222
2013	11914	14467	26381
2014	10432	12560	22992
2015	10342	12401	22743
2016	11972	12839	24811
2017	13581	14426	28007
2018	12381	13360	25741
2019	12326	12748	25074
Total	202097	224499	426596

Table 3.5 shows the number of individuals per gender for two-year period. The last two-year periods have the higher number of observations with 52818 and 50815 individuals.

Table 3.5: Gender division every 2 years

2 years cohort	Gender		
	Male	Female	Total
2000-2001	19485	20321	39806
2002-2003	19111	19986	39097
2004-2005	17157	18283	35440
2006-2007	16755	18181	34936
2008-2009	15229	16560	31789
2010-2011	21006	25551	46557
2012-2013	22320	27283	49603
2014-2015	20774	24961	45735
2016-2017	25553	27265	52818
2018-2019	24707	26108	50815
Total	202097	224499	426596

Table 3.6 shows instead the number of individuals divided by gender in the five-year periods. The periods 2010-2014 and 2015-2019 have respectively 119152 and 126376 observations, higher than the previous decade.

Table 3.6: Gender division in five-year period

5 years cohort	Gender		
	Male	Female	Total
2000-2004	47420	49661	97081
2005-2009	40317	43670	83987
2010-2014	53758	65394	119152
2015-2019	60602	65774	126376
Total	202097	224499	426596

3.6 Analysis of the employment to population ratio

To analyse if a change in the employment to population ratio has changed after the reform hit in 2015, I first analyse the variables regarding employment status and the labour force status, dropping value 13 of the variable that doesn't correspond to any answer in the survey, dropping individuals who aren't working because already retired, those who are in education or trading, and incompatible answers, like answering not employed in the employment status and working in the labour force status.¹⁸ Table 3.7 shows the employment status and the labour force status of the individuals. We can see for example that there are 11004 observations not employed because of maternity leave, so that in the analysis they are comprised in the employed population. The total number of observations is now 403050.

Table 3.7: Employment and Labour Force Status

Labor Force Status	Employment Status						Total
	FE	Regular PT	Vocational Trading	Marginal, Irregular PT	Not Employed	Sheltered Workshop	
Non-Working	0	0	17	0	55477	0	55494
Non-working NW-Age 65 And Older	0	0	0	0	962	0	962
NW-In Education-Training	3	0	34	1	21450	0	21488
NW-maternity leave	0	0	0	0	11004	0	11004
NW-Military-Community Service	0	0	0	0	249	0	249
NW-Unemployed	0	0	0	0	28430	0	28430
NW-But Sometimes Sec.	0	0	0	0	4858	0	4858

¹⁸ To evaluate which categories belong to the employment population, I looked at the Eurostat EU labour force survey – methodology [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=EU labour force survey - methodology](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=EU_labour_force_survey_-_methodology)

Job							
NW-work but past 7 days	0	0	0	0	3914	0	3914
NW-But Reg. Sec. Job	0	0	0	0	3845	0	3845
Working	191707	62076	13445	22717	305	628	290878
Working But NW Past 7 Days	158	86	291	2779	1385	1	4700
13-Not in the questionnaire	0	0	0	0	774	0	774
Total	191868	62162	13787	25497	132653	629	426596

Based on Table 3.7 above, I construct the share of participation to work for full-time employment, regular part-time, vocational training, and marginal, irregular part-time employment and non-working individuals that are on maternity leave, have worked in the past 7 days and have a regular second job, calculate as the ratio between the employed population in a given year and total population.

Table 3.8 below compares the data of the survey with the national account of Germany, retrieved from the Federal Statistical Office of Germany¹⁹.

Table 3.8: A comparison between employment rate from national accounts and survey data

Year	Survey Data	National Account	Observations
2000	74.5	65.4	19967
2001	75.5	65.8	18044
2002	76.0	65.4	19249
2003	75.2	64.9	17940
2004	75.4	64.3	17152
2005	75.9	65.4	16224
2006	75.7	67.1	17109
2007	77.9	68.9	15789
2008	78.9	70.0	14717
2009	79.2	70.2	15376
2010	80.1	71.0	21457
2011	80.0	72.5	22761
2012	80.1	72.8	21972
2013	79.4	73.3	24905
2014	80.7	73.6	21686
2015	80.5	73.8	21487
2016	69.0	74.4	23485
2017	70.5	75.2	26082
2018	74.8	75.9	24009
2019	77.8	76.7	23639
	Total		403050

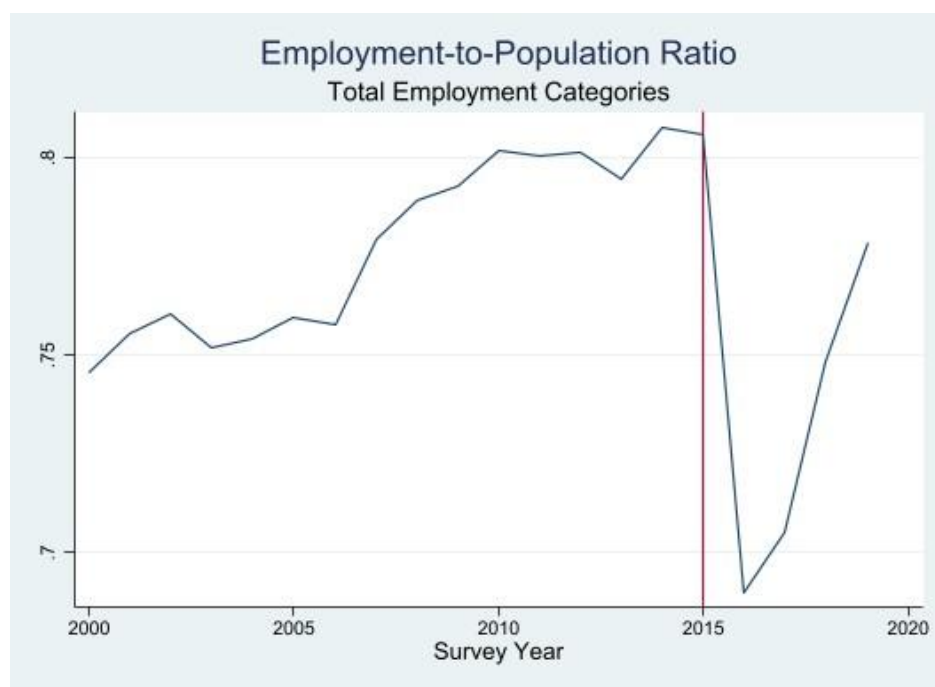
¹⁹ Employment rates 1991 until 2021 - German Federal Statistical Office (destatis.de) <https://www.destatis.de/EN/Themes/Labour/Labour-Market/Employment/Tables/etq-1991-2021.html;jsessionid=9E08CCDA5CAE1065F57851A0753F53DE.live712>

The data differ, and survey data percentage are higher in the first decade of the analysis than the national account. The pattern is similar, except for year 2016, in which the employment-to-population ratio decreases a lot with respect to the previous year in the survey data, differently from the national account data.

Figure 3.3 represents the employment-to-population ratio for all the employment categories. The red line represents the year when the reform was first established, 2015.

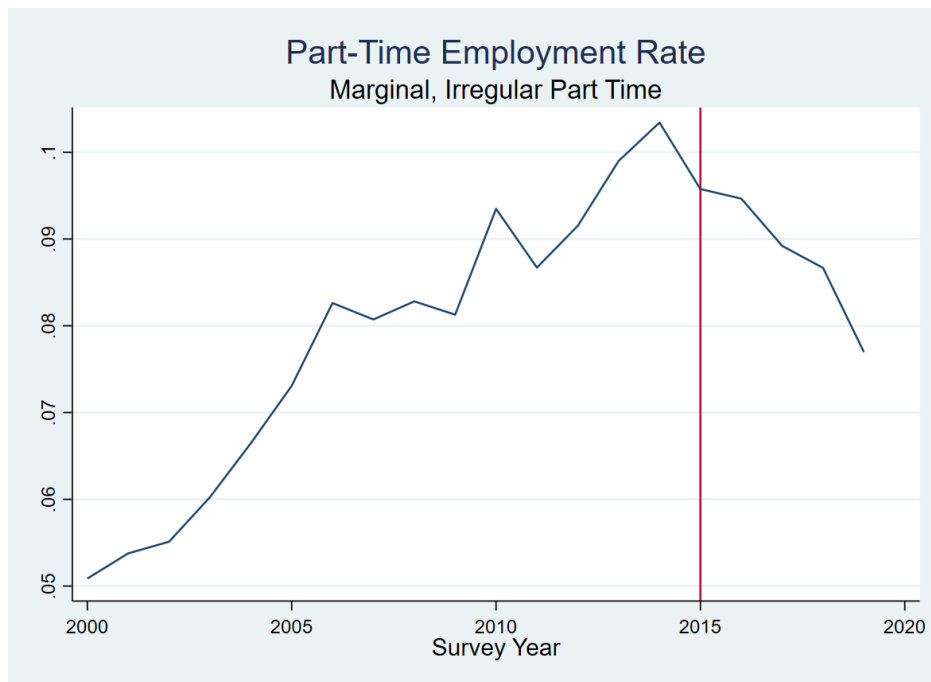
From Figure 3.3, we can see that the ratio is sharply decreasing after the reform was introduced. Some empirical studies argued that there was a negative effect on the employment level after the reform year, mostly driven by the decrease of the marginal employment (Caliendo et Al., 2018). Indeed, the degree to which worker are affected by minimum wage reform depends on their employment type. Marginally employed people are more affected by low wages than those individuals with a full time or a regular part time employment. Figure 3.4 below shows that the marginal and irregular part time employment in percentage of the total employment²⁰ is decreasing up to 2% after the minimum wage reform hit in 2015.

Figure 3.3



²⁰ This indicator, presented as a total and per gender, shows the proportion of persons employed part-time among all employed persons and is also called part-time employment rate. <https://data.oecd.org/emp/part-time-employment-rate.htm>

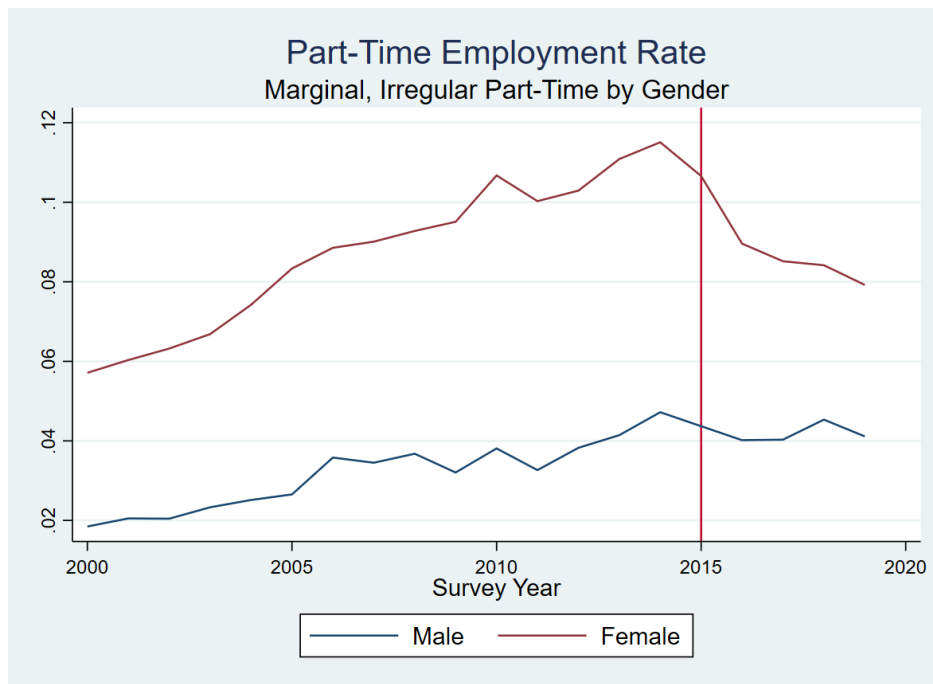
Figure 3.4



Another relevant issue is that the risk of earnings falling below the minimum wage threshold is more significant for women than men, in 2014 19.9% to 22.2% of women were involved in jobs below the threshold, a percentage twice as high as men with 9.7% to 11% . (Amlinger, Bispinck, and Schulten, 2016). Therefore, it is important to identify in the analysis if there are different work participation in marginal jobs for women with respect to men, to recognise gender variations.

Figure 3.5 shows marginal, irregular part-time employment by gender in the 20 years of the analysis. Not surprisingly, the part-time employment rate for women is higher than those for men, and it is decreasing after the minimum wage reform of 2015. As a matter of fact, marginal and irregular part-time employment is closely related to the German social security system and around 60% of mini jobbers in Germany are married women (Konle-Seidl, 2021).

Figure 3.5



Another interesting analysis to perform is to investigate if there are differences in the employment-to-population ratio between West and East Germany. Indeed, following the Kaitz-index, for large part of West Germany it amounts to less than 50%, whereas it lies above for East Germany, with the exclusion of Berlin (Caliendo et Al., 2019). (Moreover, according to Burauel (2017), in 2014 the percentage of earnings in East Germany lower than the initial minimum wage of 8.50 euros per hour were at about 22%, a proportion higher than in West Germany, which was at about 12%. Wages below the minimum wage threshold were common in the ex-GDR region.

The Nuts variable allows to perform analysis at a NUTS1 level²¹, dividing Germany into West and East regions. To the latter belongs Berlin, Brandenburg, Mecklenburg-West Pomerania, Saxony, Saxony-Anhalt, and Thuringia. After having dropped 691 observations with missing hgnuts1_ew variable values, the sample is made of 402359 observations divided as in Table 3.9 below. 76.34% of observations are represented by West-Germany individuals, whereas only 23.66% refers to East-Germany individuals. Indeed, the initial target population in SOEP was represented by the FRG residential households, and only in 1990, after the German reunification, East-Germany households were added to the survey. Thus, the sampling probability for the eastern sample is bigger than the probability in the West Germany sample.

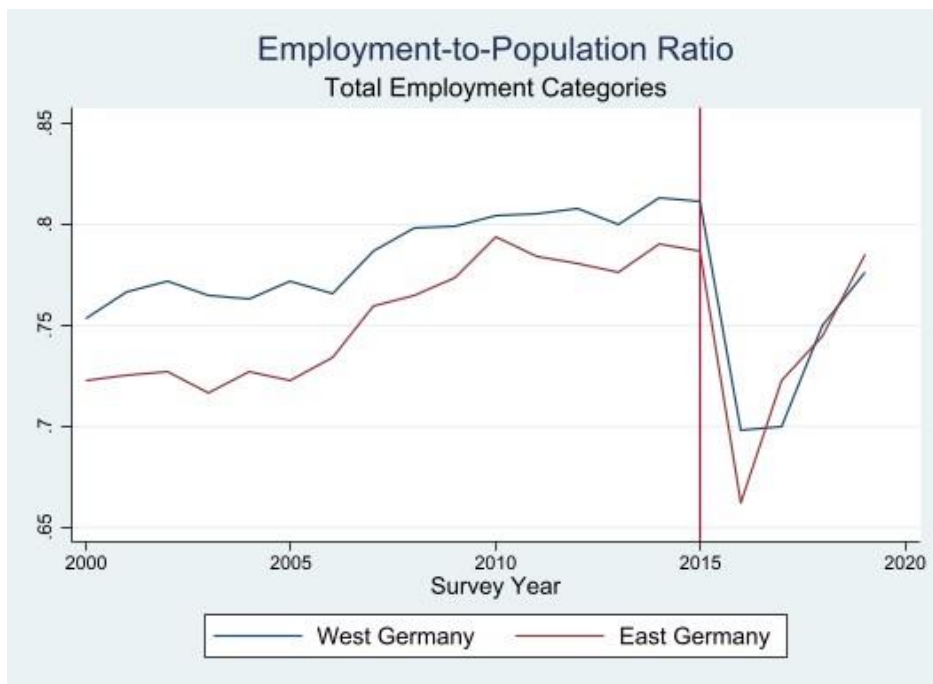
²¹ According to EUROSTAT, NUTS 1 is defined as major socio-economic regions. <https://ec.europa.eu/eurostat/web/nuts/background/>

Table 3.9: Frequency of West-East Germany observations

NUTS-Systematic-1 (East-West Version)	Freq.	Percent	Cum.
West-Germany	307150	76.34	76.34
East-Germany	95209	23.66	100.00
Total	402359	100.00	

Figure 3.6 shows the employment-to-population ratio for total employment divided by West and East Germany, calculate for all the employment categories. The ratio is higher in West Germany, and after the reform hit the decrease is more evident for East Germany regions.

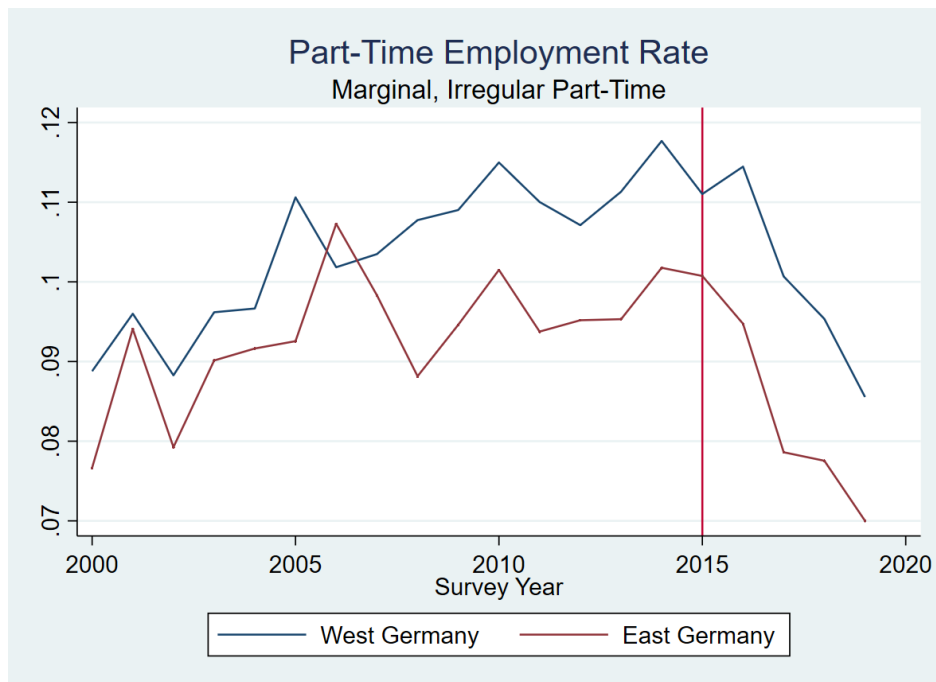
Figure 3.6



Marginal part-time employment ratio in West and East Germany is represented by Figure 3.7 below. From the Figure, we can see that the rate of mini jobs is higher in West Germany than in East Germany. Indeed, according to Fischer et Al. (2015), marginal and part-time employees are more likely to be found in the West, while fixed-term full-time employees are more likely to be found in the East.²² The ratio is decreasing for both West and East Germany after the introduction of the reform in 2015.

²² This result reflects social norms of former GDR, in which it was expected women to work full-time, while former West Germany's social norms were traditionally opposed to maternal employment and childcare use.

Figure 3.7



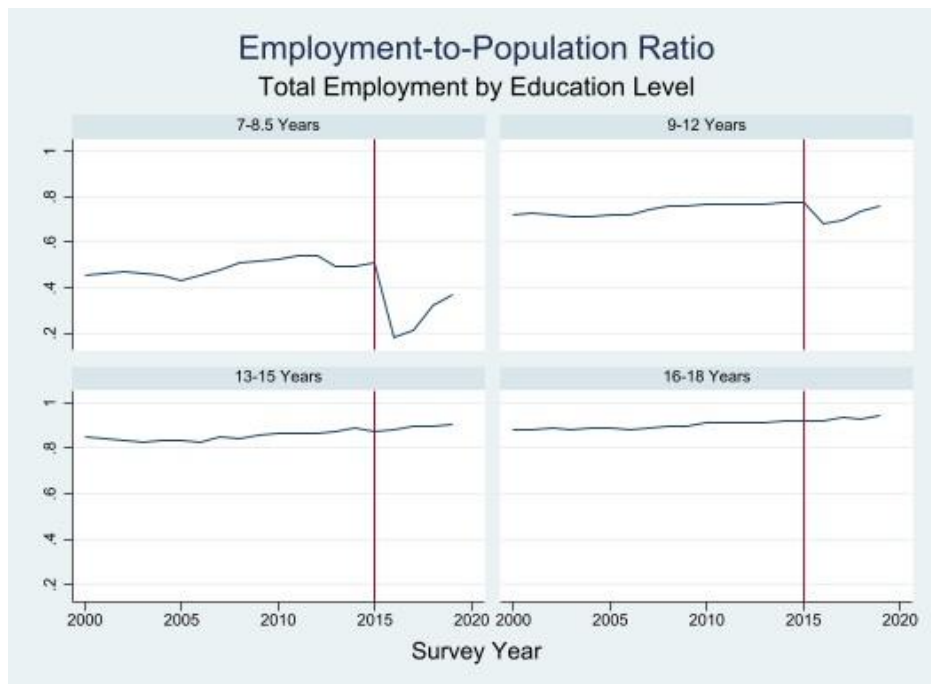
Another graphical analysis interesting to perform is related to the education level of the individuals. According to Caliendo et Al. (2019), the effects of the minimum wage reform on earnings tend to be higher for employees without a completed education, thus also the employment-to-population ratio can be affected by the reform.

In SOEP dataset the value of year of education variable ranges between 7 and 18. The variable that indicates the number of years of education completed at the time survey for all individuals in the household 16 years of age and older is missing for 16358 observations, the total sample is made of 386001 observations. The method used, following the SOEP codebook, is to divide into 4 levels of education: 7-8.5 years, 9-12 years, 13-15 years, and 16-18 years²³ (Grabka, 2019).

Figure 3.8 shows the employment-to-population ratio for all employment categories for the different levels of education. The ratio is higher for those individuals with higher education level (13-15 and 16-18 years), and lower for lower levels of education. In addition, between 2015 and 2016 the ratio in decreasing for the 2 lower level of education (7-8.5 years and 9-12 years), whereas the ratio is more stable for higher level of education.

²³ Individuals with a school leaving degree are assigned a minimum of between 9 and 12 years of education. Individuals with a vocational degree are assigned an additional 2 to 3.5 years of education. Individuals who attended a technical college are assigned an additional 4 years of education. If an individual received a vocational college degree or attended a university outside of the FRG then the individual is assigned a total of 18 or 19 years of education.

Figure 3.8



The last analysis to perform is on birth year cohorts. Minimum wage reform has impacted in different ways among cohorts. Indeed, according to Burauel et Al. (2020), in the group that belongs to the bottom decile of the wage distribution there are young workers with short employment experience and biography, thus employment-to-population ratio can be different among cohorts, after the reform hit. After having looked at the distribution of the birth years, I considered individuals from 1955 as birth year and further, creating 8 different cohorts. Indeed, individuals born in before 1951 are not considered in the sample after 2015, because older than 65 years, and the ratio would stop before 2015.

Table 3.10 shows the frequency distribution of the observations divided into cohorts. Cohorts 1960-1964 and 1965-1969 are oversampled in comparison with the other cohorts, whereas cohorts 1985-1989 and 1990-2002 are those with less observations. The total number of observations is 249053.

Table3.10: frequency distribution of cohorts

Cohorts	Freq.	Percent	Cum.
1955-1959	34545	13.87	13.87
1960-1964	40423	16.23	30.10
1965-1969	44169	17.73	47.84
1970-1974	36541	14.67	62.51
1975-1979	32651	13.11	75.62
1980-1984	25945	10.42	86.04

1985-1989	16137	6.48	92.51
1990-2002	18642	7.49	100.00
Total	249053	100.00	

Figure 3.9 shows the employment to population ratio for all employment categories for the cohorts considered. The ratio is slightly decreasing for the first three cohorts (1955-1959, 1960-1964, 1965-1969) and decreasing for the others. After the reform of 2015, the cohorts 1985-1989 and 1990-2002 represent the most shrinking behaviour.

Figure 3.10 exhibits the incidence of part-time employment divided by cohorts, the percentage is higher for cohorts 1985-1989 and 1990-2002, meaning that younger individuals are marginally employed more than elderly individuals. Moreover, the incidence is diminishing for those individuals after 2015.

Figure 3.9: Employment-to-Population Ratio divided by cohorts

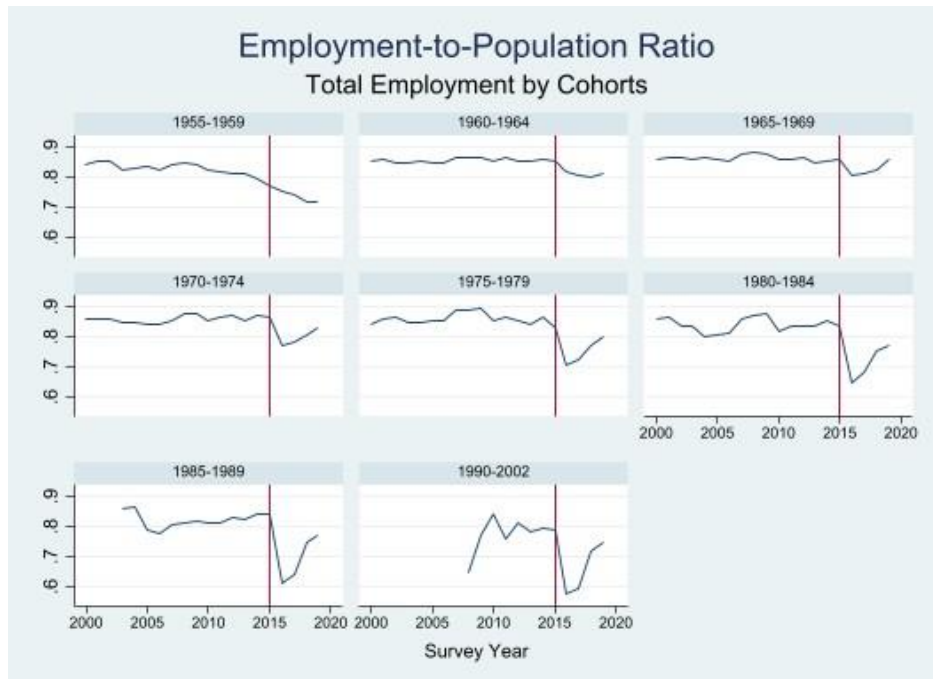
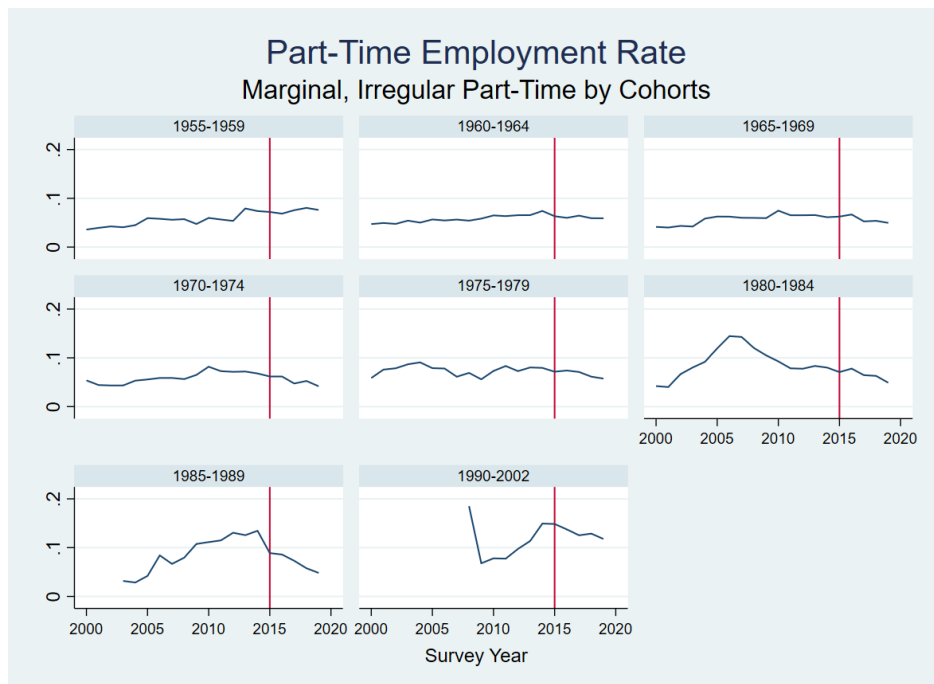


Figure 3.10: Part-time employment ratio divided by cohorts



Throughout this Chapter I analyse the data structure of the SOEP dataset, and the employment-to-population ratio between 2000 and 2019. Chapter 4 will empirically analyse the causal effects of minimum wage policy in Germany, investigating results on employment and on wages.

4. Empirical Analysis

In the previous chapter I analysed the literature about minimum wage policies, hence here I investigate the impact of the minimum wage empirically through a staggered Diff-in-Diff strategy. This procedure is a deviation from the standard Diff-in-Diff setup, and it is a model in which different units receive treatment at different points in time. Treated units act both as controls and treatment depending on the time of the implementation of the policy (the so-called “switchers”). Staggered Difference-in-Difference is used when the treatment effect is heterogeneous among groups or over time, the latter case is applicable to the case of Germany minimum wage policy. As a matter of fact, the minimum wage in Germany has increased during the treatment period from 8.50 euros per hour in 2015, to 8.84 in 2017 and to 9.19 euros per hour in 2019, the treatment is heterogenous across years, and thus we cannot rely on the standard Diff-in-Diff framework. Staggered estimation approaches to evaluate heterogeneous treatment effects have become popular in the recent two decades. Baraldi, Immordino, and Stimolo (2022), for instance, use staggered Diff-in-Diff to evaluate if organized crime discourages qualified people to run for elections. The treatment group comprises municipalities that have had criminal infiltration at different points in time, meaning that the treatment effect of mafia infiltration may change over time.

Difference-in-Differences (D-i-D) exploits variation over time to perform causal effects of policy intervention. This econometric strategy allows the researchers to compare the evolution of observations receiving the policy, the treated group, with similar observations not receiving it, the control group, acting as a counterfactual. In the standard D-i-D framework the control group has not been treated in any of the period, there are two time periods and two groups. The 2x2 Diff-in-Diff estimator (Goodman-Bacon, 2019) is obtained as follow:

$$\hat{\beta} = (\bar{Y}_{T,post} - \bar{Y}_{T,pre}) - (\bar{Y}_{C,post} - \bar{Y}_{C,pre}) \quad (4.1)$$

where $\hat{\beta}$ is the average treatment effect (ATT) for group T (treated), and \bar{Y} is the sample mean for that group in a particular period. $\hat{\beta}$ is also equal to the estimated coefficient in the following regression:

$$Y_{it} = \alpha_0 + \beta_1 T_i + \beta_2 Post_t + \hat{\beta}(T_i Post_t) + \varepsilon_{it} \quad (4.2)$$

where $\hat{\beta}$, is obtained by the interaction term of a treatment group dummy and a post-treatment period dummy. The ATT can be estimate if, in the absence of the treatment, the average outcomes for treated

and control groups would have behaved the same. This is the so-called parallel trend assumption. (Callaway and Sant’Anna, 2021). Redding and Sturm (2008), among others, implement a Diff-in-Diff approach to investigate if market accessibility affect urban development in Germany. The exogenous shock after the splitting of Germany after the Second World War may have caused a disproportionate loss of market access to the West German cities close to the new border relative to other West German cities. To evaluate the impact of the shock, the scholars use West German cities bordering East Germany as treated group, and West German cities not bordering East Germany as control group. The pre-treatment period was from 1920 to 1950, whereas the treatment period was from 1950 to 2000.

When dealing with different implementations of minimum wage across years, if a treated individual begins to earn a salary above the minimum wage once the policy hit, she becomes a control unit from the year in which the minimum wage increases further. This is often the case when evaluating causal effects of policy interventions. In this case, the regression to be estimated has dummies for cross-sectional units, and time periods, and a treatment period:

$$Y_{it} = \alpha_i + \tau_t + \hat{\gamma}T_{it} + \varepsilon_{it} \quad (4.3)$$

Where α_i is the cross-sectional unit, τ_t the time period unit, and T_{it} is the treatment period. The resulting coefficient $\hat{\gamma}$ is called Two-Way-Fixed-Effect (TWFE). Researchers know relatively little about the two-way fixed effects D-i-D when treatment timing varies: it is not clear precisely how it compares mean outcomes across groups.²⁴

4.1 Data methodology and eligible individuals

To analyse employment and wages effects, I first exclude the 1-Euro-Jobs individuals²⁵, and individuals who state to work more than 60 hours per week, because of possible measurement errors. Then, I construct the variable of hourly wage from individual’s monthly earnings and the variable that indicates weekly working hours. In SOEP, responders state their actual weekly hours, as well as their contractual

“It is well known that the standard DiD estimator is numerically equivalent to the linear two-way fixed effects regression estimator if there are two time periods and the treatment is administered to some units only in the second time period. Unfortunately, this equivalence result does not generalize to the multi-period DiD design...Nevertheless, researchers often motivate the use of the two-way fixed effects estimator by referring to the DiD design.” (Imai and Kim, 2021).

²⁵ The German job creation programme for unemployed welfare benefit recipients, known as One-Euro-Jobs (OEJs)

weekly hours. I use the former variable, as potential non-compliance could be an issue. Individuals can earn the minimum wage as contractual hourly working weeks are considered, but only if actual hourly weekly hours don't exceed the actual ones. To construct the variable, I follow Burauel et Al. (2017), according to the following formula:

$$\text{Hourly Wage} = \frac{\text{gross monthly earnings}}{4.3 \times \text{weekly hours worked}} \quad (4.4)$$

After having dropped missing observations on monthly earnings and weekly working hours, the sample is made of 357374 observations.

To construct the treatment group, I create a dummy variable equal one if the individual earns less than the minimum wage before the implementation of the policy, and 0 otherwise. The control group is made of those workers whose earnings are above the threshold. In particular, the affected individuals earn less than 8.50 euros per hour before 2015, the year of the implementation of the policy, and in 2016, because of non-compliance, then individuals whose hourly wages are less than 8.84 euros per hour in 2017 and 2018, and individuals who earn less than 9.19 euros in 2019.

The eligible individuals of the sample are shown in Table 4.1 below.

Table 4.1: Share of employees with hourly wage below the minimum 2015-2019

	Unweighted	Weighted
All Employees	16.14	16.28
Marginal Employment	60.35	61.44

From the Table, we can see that 61.44% of marginal employees are affected by the minimum wage during the period considered. Full-time employees are not affected by the minimum wage since they earn above the minimum threshold. Across the years, the share of affected workers is decreasing, but it is not 0, revealing the non-compliance issue examined in paragraph 1.4.3. As a matter of fact, the percentage of marginal workers earning below the minimum wage is 51.77% in 2015, 47.41% in 2016, 56.31% in 2017, 54.50% in 2018 and 52.76% in 2019.²⁶

²⁶ I considered the weighted share

Table 4.2 below shows the share of employees affected by the policy divide by gender. Women are more affected by the minimum wage policy than men, indeed women tend to earn less than men²⁷. (Destatis, 2022).

Table 4.2: Share of employees with hourly wage below the minimum 2015-2019 by gender

	Unweighted	Weighted
Male	16.14	13.30
Female	19.10	19.43

The share of East-Germany affected individuals is 24.09%, whereas the affected individuals in West-Germany are 14.26% of the total, as showed by Table 4.3 below.

Table 4.3: Share of employees with hourly wage below the minimum 2015-2019 by region

	Unweighted	Weighted
West-Germany	13.89	14.26
East-Germany	23.28	24.09

Eligible individuals with the lowest education level are 16.74%, individuals with nine to twelve years of education are 18.44%, whereas the share of affected individuals with the highest education level is lower and equal to 6.12%, as Table 4.4 below shows.

Table 4.4: Share of employees with hourly wage below the minimum 2015-2019 by education level

	Unweighted	Weighted
7-8.5 Years of Education	11.26	16.74
9-12 Years of Education	18.93	18.44
13-15 Years of Education	15.54	15.77
16-18 Years of Education	5.54	6.12

²⁷ In 2020, the gender pay gap, which measures the percentage difference in average gross hourly earnings between men and women, amounted to 18% in Germany. https://www.destatis.de/Europa/EN/Topic/Population-Labour-Social-Issues/Labour-market/gender_pay_gap.html

4.2 Econometric identification

To evaluate the causal impact of minimum wage in Germany on employment I follow Puhani (2012) and Ai and Norton (2003) since the employment variable is a binary variable which takes value 1 if an individual is employed, and it is 0 otherwise. I will thus identify the response probability to stay in employment if an individual is affected by the minimum wage policy, implementing a probability response diff-in-diff. ϵ_{it} is the employment status of an individual i at time t , ϵ_{it+1} is her employment status in period $t + 1$. The treatment effect²⁸ in this “difference-in-differences” response model is:

$$E[\epsilon_{it+1}^1 | Control = 1, T_{t+1} = 1, X_{it}] - E[\epsilon_{it+1}^0 | Control = 1, T_{t+1} = 1, X_{it}] \quad (4.5)$$

where T is the time period indicator, X_{it} is the vector of covariates, ϵ_{it+1}^1 is the expected outcome with treatment, whereas ϵ_{it+1}^0 is the expected outcome without treatment.

The aim of this specification is to investigate if the implementation of the minimum wage has changed the probability of the transition from employment to unemployment of an affected individual.

In probit model, and in any other nonlinear diff-in-diff model with a strict monotonic transformation function, the treatment effect is not given by the cross difference, but by the difference between two cross differences. The cross difference between the conditional expectation of the observed outcome minus the cross difference of the conditional expectation of the counterfactual outcome, ϵ_{it+1}^0 in this case.

The probit or logit model can be estimated as follow:

$$\Pr[\epsilon_{it+1} = 1 | \epsilon_{it} = 1] = F \{ \eta T_{t+1} + \gamma T_{t+1} * Treat + \alpha * Treat + X_{it} \beta \} \quad (4.6)$$

F is a function that defines the logistic transformation $\Lambda(\cdot)$ for a logit model, or a standard normal $\phi(\cdot)$ for a probit model. γ corresponds to the interaction term of interest.

To evaluate the causal impact of minimum wage in Germany on wages, I create the interaction dummy between the treatment group and the treatment period, a variable that equals 1 for years 2015 and

²⁸ The treatment effect is derived from the idea that in nonlinear models, such as models with limited dependent variables like probit, logit or tobit, the treatment effect cannot be constant across the treated population, because the expectation of the outcome variable is bounded Puhani (2012).

after, 0 otherwise. The dependent variable is the logarithmic transformation of wages, and the regression formula is obtained as in (4.3). The resulting estimate is a TWFE, $\hat{\gamma}$ is capturing the ATT.

4.3 Results

4.3.1 Employment effects

To evaluate the employment effects of minimum wage, I analyse the response probability diff-in-diff model with logit and probit function, as discussed in paragraph 4.2. The results for employed individuals for the probit model and logit models are shown in Table 4.5 and 4.6 below. The only independent variable is γ , the interaction term between the time period indicator and the treated individuals from equation 4.6.

Table 4.5: Probit Model, employment effects, total employment categories

	partial effect at the average (PEA):	p-value	95% Confidence Interval	
Treatment	-0.034*** (.002)	0.000	-0.037	-0.031
Constant	.733*** (.003)	0	.727	.738

357261 observations

Cluster-robust standard errors are in parenthesis

*p<0.1, **p<0.05, ***p<0.01

Table 4.6: Logit Model, employment effects, total employment categories

	partial effect at the average (PEA):	p-value	95% Confidence Interval	
Treatment	-0.034*** (.002)	0.000	-0.037	-0.031
Constant	.733*** (.003)	0	.727	.738

357261 observations

Cluster-robust standard errors are in parenthesis

*p<0.1, **p<0.05, ***p<0.01

Both probit and logistic model estimate a decrease in the percentage of remaining employed after the introduction and the implementation of the minimum wage of 3.4%. The partial effect at the average is negative and significant at 0.01 in both models. In the following logit and probit models, I add gender, education level, region, and cohorts as additional control, as shown by Table 4.7 and Table 4.8 below. The partial effect at the average of the treatment is negative and significant at 0.01, and the other explanatory variables are significant with a p-value of 0.01 as well. Women have 12.8% probability of change from employment to unemployment if eligible for minimum wage policy more than men for the probit model, and 12.6% for the logit model. Education level partial average effect, instead, is positive and significant for both models, meaning that high level of education individuals have less probability to switch from employment to unemployment when treated. The same applies for individuals who live in West-Germany, the partial effect at the average is equal to 6.3% for both models. Finally, treated younger individuals have a probability of change the employment status of 3% and 3.1% for probit and logit model respectively.

Table 4.7: Probit Model, employment effects, total employment categories

	partial effect at the average (PEA):	p-value	95% Confidence Interval	
Treatment	-0.032*** (.002)	0.000	-0.037	-0.031
Gender	-0.128*** (0.002)	0.000	-0.131	-0.125
Education Level	0.159*** (0.001)	0.000	0.156	0.161
Region (West/East)	0.063*** (0.002)	0.000	0.059	0.067
Cohorts	-0.030*** (0.001)	0.000	-0.032	-0.028
Constant	-.278*** (0.014)	0.000	-.306	-.25

357261 observations

Cluster-robust standard errors are in parenthesis

*p<0.1, **p<0.05, ***p<0.01

Table 4.8: Logit Model, employment effects, total employment categories

	partial effect at the average (PEA):	p-value	95% Confidence Interval	
Treatment	-0.032*** (.002)	0.000	-0.035	-0.028
Gender	-0.126*** (0.002)	0.000	-0.129	-0.123
Education	0.172***	0.000	0.170	0.175

Level	(0.001)			
Region (West/East)	0.063*** (0.002)	0.000	0.059	0.067
Cohorts	-0.031*** (0.001)	0.000	-0.032	-0.029
Constant	-.707*** (0.028)	0.000	-.758	-.655

357261 observations

Cluster-robust standard errors are in parenthesis

*p<0.1, **p<0.05, ***p<0.01

According to Caliendo (2018), minimum wage policy has reduced marginal employment of 183000 units in Germany, thus it is important to investigate the response probability of treated marginal employment workers after the reform hit. The results of the estimation for probit model are shown in Table 4.9 below, the results for the logit model are shown in Table 4.10 below.

Table 4.9: Probit Model, employment effects, marginal employment

	partial effect at the average (PEA):	p-value	95% Confidence Interval	
Treatment	0.0012737 (.0008168)	0.119	-.0003272	0.0028746

357261 observations

Cluster-robust standard errors are in parenthesis

*p<0.1, **p<0.05, ***p<0.01

Table 4.10: Logit Model, employment effects, marginal employment

	partial effect at the average (PEA):	p-value	95% Confidence Interval	
Treatment	0.0012728 (0.0008156)	0.119	-0.0003258	0.0028713

357261 observations

Cluster-robust standard errors are in parenthesis

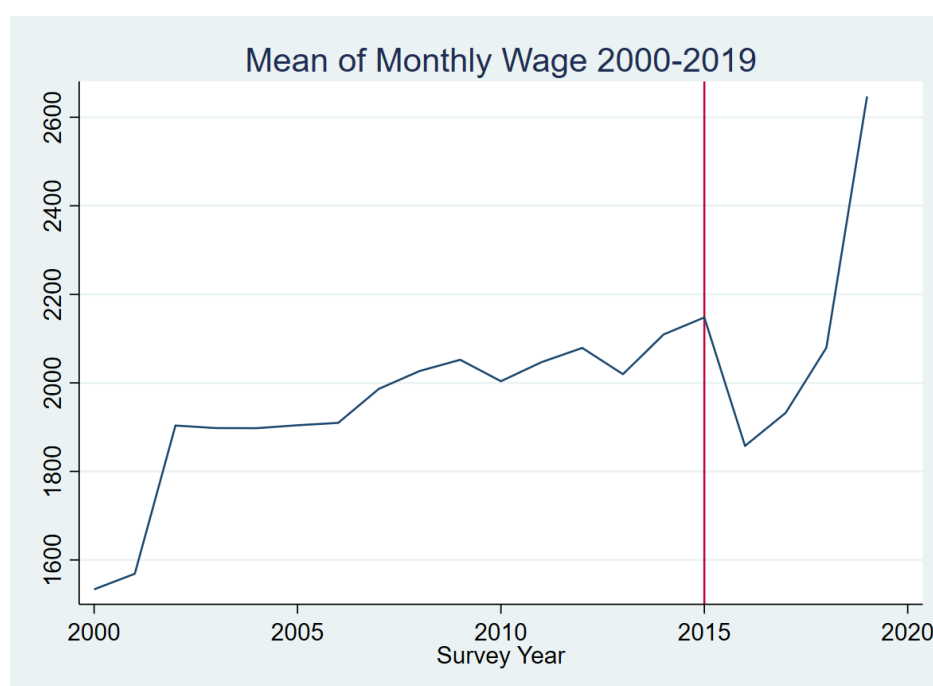
*p<0.1, **p<0.05, ***p<0.01

The partial effect at the average is positive but not statistically significant, it could be that transition from marginal employment to regular employment of a treated individual after the reform has obscured this effect, in addition, also non-compliance may be an issue.

4.3.2 Wage effects

According to Burauel et Al. (2020), the minimum wage reform has increased hourly wages of treated individuals. Thus, it is important to investigate how treated individuals' earnings has changed after the minimum wage implementation. The mean of monthly wage from 2000 to 2019 for all employed individuals is shown in Figure 4.1 below.

Figure 4.1



From the Figure we can see that monthly wage is decreasing in the year after the reform in 2015, but then it is increasing up to around 2600 euros per month. We can expect that the causal effect of minimum wage on wages lead to an increase of the monthly earnings. To do so, I consider the logarithmic transformation of monthly wages, so that the percentage of the change is depicted.

Table 4.11: Diff-in-Diff estimation, wage effects

	Coef.	t-value	p-value	[95% Conf	Interval]
Minwage*Treatperiod	.053*** (.009)	5.73	0	.035	.071
Eligible Individuals	-.646	-103.75	0	-.658	-.634

	(0.006)				
Constant	7.64 (.001)	4996.06	0	7.637	7.643

Cluster-robust standard errors are in parenthesis

*p<0.1, **p<0.05, ***p<0.01

From Table 4.11 we can notice that the average treatment effects coefficient is positive and significant with a p-value of 0.01, meaning that minimum wage policy has increased monthly labour earnings up to 5.3%. This result is in line with the findings of Buraurel et Al. (2020), who find an increase of monthly earnings of 6.6%. When controlling also for gender, the coefficient of the estimate is equal to 4.7%, as shown by Table 4.12 below.

Table 4.12: Diff-in-Diff estimation, wage effects

	Coefficient	t-value	p-value	[95% Conf	Interval]
Minwage*Treatperiod	0.047*** (.009)	5.73	0	.035	.071
Eligible Individuals	-.642 (0.006)	-103.75	0	-.658	-.634
Gender	.094 (.005)	18.35	0	.084	.104
Constant	7.64 (.002)	4996.06	0	7.637	7.643

Cluster-robust standard errors are in parenthesis

*p<0.1, **p<0.05, ***p<0.01

Moreover, the gender coefficient is positive and significant with a p-value of 0.01 and equal to 9.4%, this means that the minimum wage policy has succeed in reducing the gender-pay gap. This result is in line with the findings of Caliendo and Wittbrodt (2022), who find a significant decrease in the gender wage gap in regions in which women were strongly affected by the minimum wage policy, in comparison to regions where women were less affected. When controlling also for region, and education level, the coefficient is still positive and significant equal to 4.8%, as shown by Table 4.13 below.

Table 4.13: Diff-in-Diff estimation, wage effects

	Coefficient	t-value	p-value	[95% Conf	Interval]
Minimum wage*Treatperiod	0.048*** (.001)	5.02	0	.03	.067
Eligible Individuals	-.61 (0.006)	-97.16	0	-.622	-.598
Gender	.09	18.35	17.79	0	.08

	(.005)				
Region (West/East Germany)	.133 (0.025)	5.31	0	.084	.182
Education Level	0.711 (.024)	30.04	0	.665	.757
Constant	5.733 (0.063)	91.26	0	5.61	5.857

Cluster-robust standard errors are in parenthesis

*p<0.1, **p<0.05, ***p<0.01

West German citizens have a 13.3% wage increase bigger than East-German individuals, the coefficient is positive and significant.

5. Conclusions

The minimum wage policy is a turning point in the social and economic structure of Germany. In this thesis we saw the relationship between minimum wage and labour economics, the implementation of the reform in different States, with particular attention to the European Union and Germany. The debate about the minimum wage is still ongoing, and German Parliament aims to increase it up to 12 euros per hours in October 2022.

After reviewing the literature about the minimum wage, I presented the research methodology, pointing out the issues relative to survey datasets as regard measurement errors, missing values, unit non responders and follow-up issues. Further, the employment-to-population gave us a first result of the minimum wage policy in the short and medium run. These findings must be investigated through an econometric analysis that we saw in Chapter 4. Not surprisingly, minimum wage reform has increased the response probability of change the status of the treated individual from employment to unemployment. This result is in line with the findings of Caliendo et Al. (2018), who evaluate a negative effect on employment using the local labour market bites in the two years after the implementation of the policy. Nevertheless, the results of response probability when considering only marginal employment are not significant, this could be a result of non-compliance or misreported answers in the survey.

Moreover, the Difference-in-difference estimate of the monthly wages is positive and significant, as found by Caliendo and Wittbrodt (2022). Minimum wage policy has also led to a decrease in the gender-pay-gap in Germany, as pointed out by the German Federal Statistical Office.²⁹

Further analysis should include local labour markets, to detect the change in the bites of minimum wage regionally in the medium run. In addition, since minimum wage in Germany is increasing, further analysis should focus on the implementation of the policy up to 2022.

²⁹ Between 2006 and 2015, the earnings gap between women and men has been nearly constant. Since then, the pay gap has decreased slightly https://www.destatis.de/EN/Themes/Labour/Labour-Market/Quality-Employment/Dimension1/1_5_GenderPayGap.html

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