The determinants of part-time employment in the European Union – Econometric analysis on NUTS 2 regional data

by

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Abstract

In my thesis, I examine the determinants of part-time employment rate focusing on the impact of transport infrastructure and the wage rate. I perform the econometric analysis using First Differences and Fixed Effects models on NUTS 2 regional level panel data from the last two decades for all the EU regions. Results show that road density has positive and significant impact on the part-time employment rate. In contrast, there seems to be no significant effect in case of motorway and railway line density. Hourly wage also does not impact part-time rate; however, the effect of gender pay gap is negative. I find negative impact in case of usual male working hours as well. Furthermore, an extensive childcare system seems to contribute positively to the development of part-time employment rate.

Acknowledgements

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Introduction

Part-time employment is an increasing phenomenon in Europe. In 2016, around 19% of employed people worked on a part-time basis which means a four percentage points increase since 2012. Its importance is further pronounced by its contribution to the female work-life balance. This social aspect also makes it a relevant issue for policy makers. Evidence in the literature shows a rise in the share of involuntary part-time workers during the recent economic crisis. So, this form of employment acts as a means for firms to adjust their labor force to changing economic conditions.

Cross-country comparison shows that the incidence of part-time work is spread very unevenly across European Union member states. The Netherlands has outstandingly high share of part-time employees which is almost half of total employment. In Switzerland, Austria and Germany, over a quarter of the workers are employed in this form. By contrast, part-time work was relatively infrequent (around 5 %) in Bulgaria, Hungary, the Czech Republic, Croatia, and Slovakia in 2016. So, the countries lagging behind the most in this regard are all former socialist countries.

This observation motivated my research interest as I wanted to find out which factors could explain these large cross-country differences. Labor economics literature studies the determinants of part-time employment rate. As a contribution to this literature, I examined some hypotheses which were not tested according to my knowledge. In my thesis, I studied the impact of transport infrastructure and wage rate on the development of part-time employment rate. My hypothesis is that with the development of transport infrastructure, part-time employment rate increases. Better infrastructure decreases commuting time which is a fixed cost for workers regardless of hours of work. So, this factor might be more important for part-timers as they work fewer hours to amortize this fixed cost. Also, time is crucial for part-timers; parents

choose it for example because they want to be at home when kindergarten finishes and not sitting in a traffic jam. My second hypothesis is that as wages increase, part-time rate increases. There are several channels for this. As wage rate rises, it might worth for more and more people to face the fixed costs of employment and enter the labor market as part-timer. Or there is high labor demand so firms employ even part-timers. A third channel can be that if people have high wages and incomes, they can afford to work only part-time.

For my analysis, I have collected NUTS 2 level data for all the EU regions between 1999 and 2017. I have used regional level data because it gives more information than analysis only at the country level. Furthermore, I could find the main variables of interest and many interesting explanatory variables at regional level in the Eurostat database. On this panel dataset, I performed econometric analysis using the First Differences and Fixed Effects models.

The results of the analysis might be relevant for policy makers. In Hungary, the government endeavors to increase the part-time employment rate. For example in 2015, a certain tax benefit for employers who employ mothers was equalized for full-time and part-time workers. The issue is important for current Hungarian government as well. One of their main social policy goals is to tackle the decreasing fertility rate. The growing incidence of part-time employment could help women to achieve work-life balance and result in increasing fertility.

The plan of my thesis is as follows. Chapter 1 is a review of the literature. The second chapter discusses labor economics theory related to part-time employment. Chapter 3 describes the data, the various variables used in the paper and the results of the econometric models. The thesis ends with the concluding remarks and policy recommendations.

1. Literature review

In the literature, extensive research can be found about the determinants and trends of part-time employment rate. A paper from 1995 (Houseman, 1995) explains the increase in part-time employment rate in Europe and Japan with three factors. First, there was a sectoral employment shift from industry to services where the share of part-time workers is high. Second, these workers typically receive less fringe benefits than full-time employees, so firms try to lower labor costs by hiring part-timers. Third, European governments wanted to alleviate high unemployment by encouraging part-time employment and in some countries, these workers have less legal protection against layoffs than full-time employees. Another old paper from 1991 (Tilly, 1991) found that involuntary part-timers account for most of the increase in part-time employment since 1970. These workers would prefer full-time jobs, but this labor supply doesn't fit the employers' demand for scheduling flexibility. According to a more recent paper from 2005 (Buddelmeyer et al., 2005), there is great variation in part-time rate by gender and age groups. This form of employment is an important opportunity to enter the labor market for young, older and female workers. Here, authors find that for most workers, the decision to work part-time is voluntary.

Trends in part-time employment seem to have changed since then, as an article about Denmark illustrates (Lind and Rasmussen, 2008). It shows that the traditional age and gender division has become less pronounced: part-time employment became a youth phenomenon and the gender patterns were disappearing. Furthermore, the negative implications such as using part-timers as cheap labor have become less pronounced. A paper from 2012 (Bettio et al., 2012) shows that the economic crisis again changed the trends. Working conditions worsened and the involuntary share of part-time work increased to 38.1%, up 5.8 points between 2007 and 2010. In 2011, however, involuntary part-time work started to decrease.

The impact of the business cycle on the development of part-time employment is investigated in two papers by Buddelmeyer et al. for the EU-15 countries (Buddelmeyer et al., 2004; Buddelmeyer et al., 2008). The authors found that the business cycle exerts a negative effect on it. This is consistent with employers using part-time employment to adjust their labor force to changing economic conditions. Their investigation by age and gender groups revealed that the business cycle has a very significant effect on the part-time rate for young and male prime-age workers. Conversely, the effect is quite weak for women and insignificant for older workers. They also examined the contribution of structural factors to the part-time employment. Changes in legislation to part-time employment seem to have a strong and positive effect on the development of part-time work. And employment protection legislation was found to have positive correlation with part-time rate. This is because part-time employment can be used to increase flexibility in rigid labor markets.

This is not the only reason why part-time employees are beneficial for firms. Relationship between firm productivity and part-time employment was examined on Dutch pharmacies by Künn-Nelen et al. (2013). They found that firms with a 10% larger part-time employment share are 4.8% more productive. They show that this difference in firm productivity can be explained by allocation efficiencies. Data on the timing of labor demand show that part-time employees are allocated differently from full-time employees e.g. the fraction of part-time workers is especially large during lunchtimes. Moreover, part-time employment is used to fill the gap between the full-time workweek and the number of hours a firm is open. The service sector seems to provide good conditions for exploiting the allocation efficiencies offered by part-time labor.

Despite some evidence of increasing firm productivity, part-time employees often face wage penalties. A study (Bardasi and Gornick, 2000) analyzed part-time employment among women in five industrialized countries and found unadjusted part-time wage penalties everywhere.

When the authors examined the sources of wage gaps, they found clear discrimination against part-time workers only in Germany. Another paper studied (Connolly and Gregory, 2008) the earning trajectories of part-time working British women. They found that work experience gained during part-time work has very low return in future earnings and changing back to full-time employment means only a partial recovery in the earning trajectory. Fouarge and Muffels (2009) also examined the long-term effect of part-time work on the wage trajectory in three countries and in each case, they found the "scarring effect" on future wages up to ten years later in the career. Longer duration of being part-timer has stronger negative wage effects. In the UK, the scarring effect is found to persist even after a lasting transition to full-time employment which is consistent with the findings of Connolly and Gregory. This issue was studied on Spanish part-time working women as well distinguishing by their type of contract: permanent or fixed-term (Fernández-Kranz and Rodríguez-Planas, 2011). Their results show that workers on fixed-term contracts can be classified as secondary and part-time pay penalty is larger and more persistent among these workers.

For women, another disadvantage of part-time employment besides the wage penalty is that the majority of them are working "below their potential" based on a study by Grant et al. (2005). In part-time jobs, they are not using all of their skills, experience and qualifications which is a waste of the training and education invested in women and bad for the economy. The article shows that there are simply too few part-time jobs available which could utilize their skills, and there is resistance to create such because managers believe that higher level jobs need to be full-time. Two studies examining the situation of Dutch women (Bosch et al., 2010; Nagy, 2014) also show that high female part-time employment rate can be accounted for the high female labor force participation rate but at the same time, this also means that few women are in full-time positions. This system contributes to the continuing role of women as mothers staying at home with children, which might not be optimal for them.

Looking at the Hungarian situation, one can see that there is large room for expansion in part-time employment. The rate is among the lowest ones in the European Union and this plays a significant role in the low employment rate (Seres, 2010). In particular, Hungarian women would benefit much from the increase in part-time employment (Frey, 2001). Before the regime change, female activity rate was outstandingly high and there was no incidence of part-time work. This dramatically collapsed with the labor market developments after the regime change. Part-time employment is not a panacea, but its increase could help expand the employment by calling females back into the workforce. Fazekas and Kézdi (2011) examined the development of Hungarian part-time employment rate during the crisis and they found great gender differences. For men, this form of employment is rather a means of adaptation to the economic situation on the short-run. Conversely, for women, there is an increasing trend of part-time work on the longer run. As I mentioned in the introduction, current Hungarian government wishes to tackle the decreasing fertility rate. A study from 2011 (Adsera, 2011) found that second births occur sooner in countries with good access to part-time work.

2. The theory of part-time employment

2.1. The hours of work decision

When making decision about the hours of work, people try to choose the combination of goods and leisure which maximizes their utility while they are facing a budget constraint (Borjas, 2013). Figure 1 shows this problem. The worker has V nonlabor income per week and 100 hours to divide between leisure time and working time. The optimal combination of goods and leisure is indicated by point P which gives the worker U* units of utility. Working time will be 40 hours per week and leisure time will be 60 hours. Point A would give higher utility U_1 where the worker works the same 40 hours but consumes more goods. However, it is not affordable given the wage and nonlabor income. For example, Point B on the budget line would be available but it gives less utility than point P. This optimal solution point is where the budget line is tangent to the indifference curve. It is an interior solution because not all hours are spent working or with leisure.

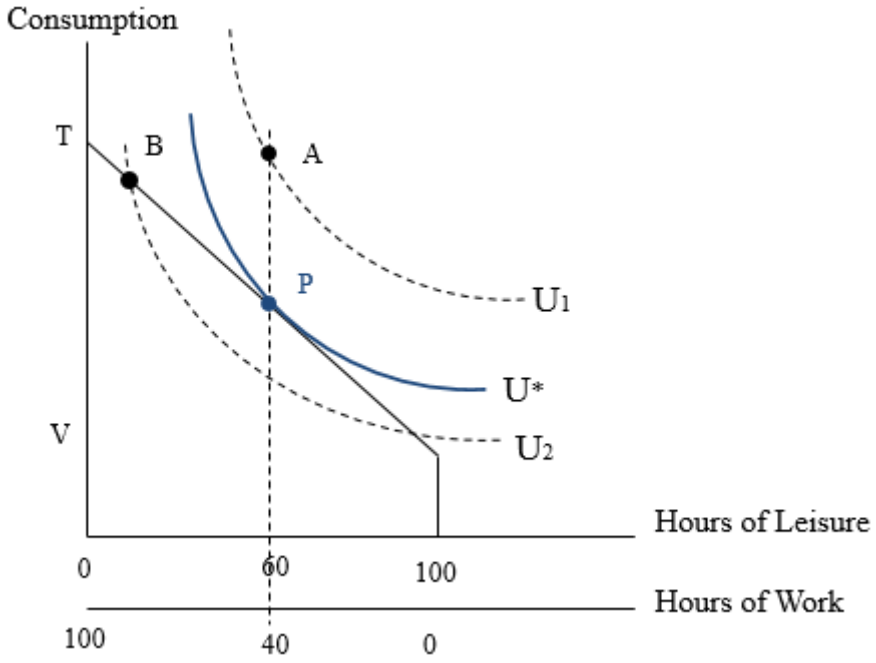

Figure 1. Illustration of the hours of work decision. Source: own edit, based on Borjas (2013)

The decision about the hours of work will change when nonlabor income changes. This is called the income effect. If wage rate is held constant, the slope of the new budget line will be the

same as the slope of the original budget line. So, increasing the nonlabor income results in a parallel shift of the budget line which expands the opportunity set for the worker. Optimal solution will be on a higher indifference curve, so the worker is better off. As leisure is a normal good, an increase in nonlabor income raises the demand for leisure. So, income effect means that hours of work is reduced when nonlabor income increases.

We can also consider the case when wage rate changes. An increase of wage rate rotates the budget line and the opportunity set of the worker expands. The increase in income increases the demand for leisure which is a normal good. So, increase in the wage rate should reduce hours of work through the income effect. But at the same time, leisure becomes more expensive as wage increases. This substitution effect would mean that increase in the wage rate increases working hours and consumption of goods. Because of these two effects of the opposite direction, it is ambiguous how a change in the wage rate changes hours of work decision.

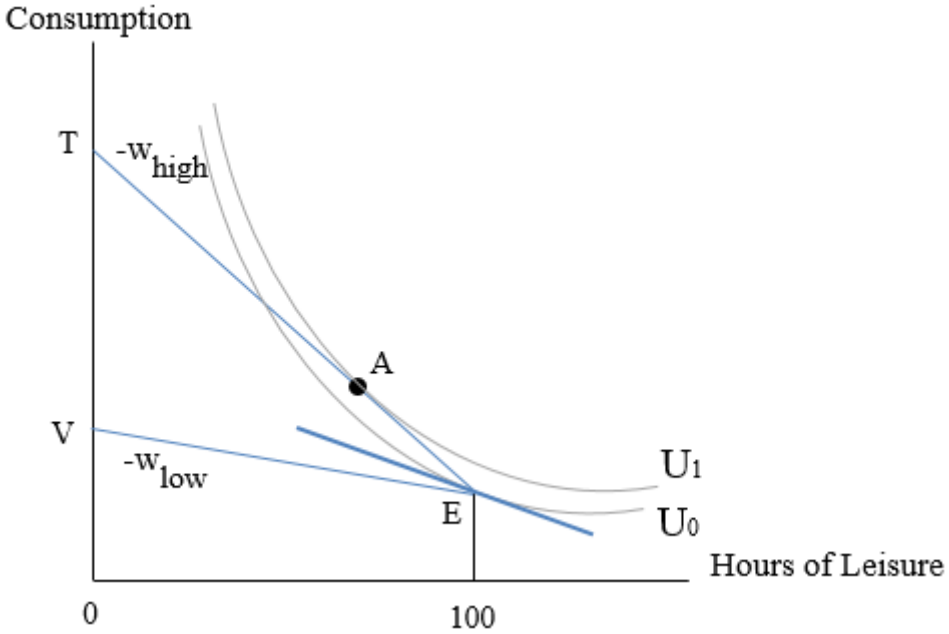

Figure 2. Illustration of the reservation wage. Source: own edit, based on Borjas (2013)

In the above cases, the worker was employed both before and after the change in nonlabor income or wage. If the woman is not in the labor force, U_0 units of utility is received as shown on Figure 2. If the initial wage rate is w_{low}, the budget line is VE and there is no point on this

line which would give higher utility than U_0. So, at this wage she chooses not to work. But if the wage is w_{high}, the new budget line TE will be steeper. Any point on this line gives higher utility than U_0. At point A, her utility will be U_1 which belongs to a higher indifference curve, so the woman is better off if she works. As the budget line is rotated, there is a wage rate w' between w_{low} and w_{high} where she is indifferent between working and not working. This w' is called the reservation wage. She will not enter the labor force if the wage is below the reservation wage, but she will work if wage exceeds it.

This relationship between wage rates and labor force participation helps explain partly the fast increase of female labor force participation rate observed during the past century in the US and many other countries (Borjas, 2013). As wage increases, nonworking women are likely to spend less time in the household sector by entering the labor market. But rising female labor force participation rate might also be explained by a fall in their reservation wages. For example, having children is likely to increase the reservation wage. So, falling fertility rates might also contributed to the rising female labor force participation.

2.2. Decision between workers and hours

From the labor demand side, employers also make decision about the hours of work when they make employment choices. As they want to change the size of the workforce, it is often costly to make quick changes. The adjustment costs influence their decision between hours per worker and number of workers (Hamermesh and Rees, 1988). For example, a firm which expands employment, incurs hiring costs because job applications are processed by the personnel office and new workers need training. And an example for firing costs is the severance pay which firms need to pay for laid-off workers.

Employers take these costs into account. When they face an increase in demand, they can change hours of work rather than employment to avoid adjustment cost of hiring a new

employee. If firms expect the increase in demand to last longer, fixed hiring costs will be less important. So first, employers might just change hours of work before they change the number of workers. Similarly, during a recession, employers might hoard labor by decreasing hours per worker to avoid the fixed costs of firing (Hamermesh and Rees, 1988). When recession is over, they don't have to incur again the hiring and training costs. As a result, adjustment costs reduce the fluctuation in employment.

Employment protection legislations, which increase job security by large costs on firms that fire workers, influence the employment decisions by increasing adjustment costs. They can prevent layoffs, but they also discourage firms during an economic expansion from hiring new workers (Borjas, 2013). As a result, firms might employ more part-time workers instead of full-time workers. However, if employment protection legislations are expanded to protect part-time workers as well, employers might change back to full-timers. This is because when the fixed adjustment costs are substantial, firms prefer to employ full-time workers so that amortization of the fixed costs is faster. So, stricter legislation about part-time work might protect those part-timers who can keep their jobs, but it will also reduce the employment opportunities for this group.

3. Empirical analysis of part-time employment

3.1. Variables of the models

3.1.1. The data

In my thesis, I am studying the impact of transport infrastructure and salary on part-time employment rate. My analysis is performed on NUTS 2 regional level data. According to the current classification, there are 281 regions at the NUTS 2 level. The NUTS (Nomenclature of territorial units for statistics) classification is a hierarchical system which divides up the economic area of the European Union for the following purposes: collecting and harmonizing regional statistics, analyzing the regions socio-economically and framing of regional policies in the European Union (source of definition: Eurostat). For example, EU cohesion policy defines eligibility for support at NUTS 2 regional level.

I have chosen this level because it gives more information than analysis only at the country level. Furthermore, I could find the main variables of interest and many interesting, good quality explanatory variables at NUTS 2 regional level in the Eurostat database. Table 1 shows the variables that I have used during my analysis. All data are in yearly frequency and the last column shows the availability of the variable (the specific period for which I could download it from Eurostat). Some important variables (for example gender pay gap) were not available on the regional level. However, I decided to gather these data on the country level. The second half of the table shows these variables.

The data was downloaded from Eurostat into separate files. With the help of Excel functions, I merged them together into a large panel dataset. Before this step, some of the variables needed to be modified. The "stock of vehicles" variables were proportioned to the population, so that I got the number per inhabitant for a meaningful comparison between regions. For the same reason, length of roads and rails ("transport" variable) were proportioned to the size of the region. I calculated a new variable "compensation" by dividing compensation of employees for

the whole region (which includes wages and salaries as well as employers' social contributions) by the total number of hours worked by all employees in the region. GDP per capita at NUTS 2 level was also not available so it was calculated by dividing gross domestic product in the region by total population in the region.

The employment in service sector as a percentage of total employment was created from two separate variables. This can be explained by the NACE classification (abbreviated from the French version of Statistical classification of economic activities in the European Community) changing in 2007. This is a framework for collecting statistical data according to economic activity in the fields of economic statistics like production and employment statistics (source of definition: Eurostat). So, between 1999 and 2007 I have employment data for "services" category but after that there is no such separate NACE category. To solve this, I combined employment data from different categories such as "Information and communication" and "Financial and insurance activities" to imitate the "services" category present in the older classification.

Variable	**Description**	**Availability**
parttime	Part-time employment rate	NUTS 2, 1999-2017
transport…	Road and rail networks. Length in kilometers by category (motorways, other roads, total railway lines)	NUTS 2, 1990-2016
vehicle…	Stock of vehicles by category (all, passenger cars, buses)	NUTS 2, 1990-2016
compensation_empl	Compensation of employees (in million euro)	NUTS 2, 2000-2016
employment_hours	Employment in thousand hours worked	NUTS 2, 2000-2016
GDP_total	Gross domestic product at current market prices (in million euro)	NUTS 2, 2000-2016
householdinc	Income of households (in euro per inhabitant)	NUTS 2, 2000-2016
childcare	Pupils enrolled (0 to 3 years old) /Population (0 to 3 years old)	NUTS 2, 2013-2016
maleworkinghours	Average number of usual weekly hours of work in main job	NUTS 2, 1999-2017
fertility_rate	Total fertility rate	NUTS 2, 1990-2016
fertility_age	Mean age of women at childbirth	NUTS 2, 1990-2016

activityrate…	Activity rates by sex (%)	NUTS 2, 1999-2017
highed…	Employment with tertiary educational attainment by sex (% of total)	NUTS 2, 1999-2017
higher_ed_now	Participation rates in education (for 20 to 24 years old)	NUTS 2, 2013-2016
youngemployment	Employment from 15 to 24 years /Population 15-24 years old	NUTS 2, 1999-2017
service_share	Employment in service sector (% of total employment)	NUTS 2, 1999-2017
c_commuting…	Mean duration of commuting time one-way between work and home by sex	country, 2005, 2010 and 2015
c_childcare	Children aged less than 3 years in formal childcare (% of total)	country, 2005-2016
c_genderpaygap	Gender pay gap in unadjusted form (%)	country, 2007-2016
c_reason…	Main reason for part-time employment by sex (% by category e.g. family reason)	country, 1983-2017
c_discrimination…	Employed persons discriminated at work during the last 12 months by sex, % of total	country, 2005, 2010 and 2015
c_womenmanagers	Percentage of women in the occupational group of managerial positions as a share of all employed persons in that group	country, 2006-2017
c_workmotivation…	Employed persons being able to influence decisions that affect their work by sex (% of total)	country, 2010 and 2015

Table 1. Description and availability of variables, Source: own.

Next, in Stata I created a table of summary statistics with "tabstat". This contains statistics like mean, median and some other percentiles for the variables. The length of roads and rails ("transport" variables) and the stock of vehicle (for buses) shows skewness based on this summary table. For these four variables, the mean values exceed the median values which shows positive skewness.

To gain more insight, I also examined the distributions of these variables on histograms for the year 2010. Figure 3 shows the distribution of "tr_other_per" variable which is the length of roads other than motorways in kilometers per thousand square kilometers. As it was suggested above, the distribution is positively skewed with a long right tail. The median value for the variable is 783 while the mean is 1239. Similarly, the plots for motorways, railways and number

of buses (Figure 4 to Figure 6) show positive skewness. Based on the results of the summary statistics and the distribution plots, I take the natural logarithm of these variables.

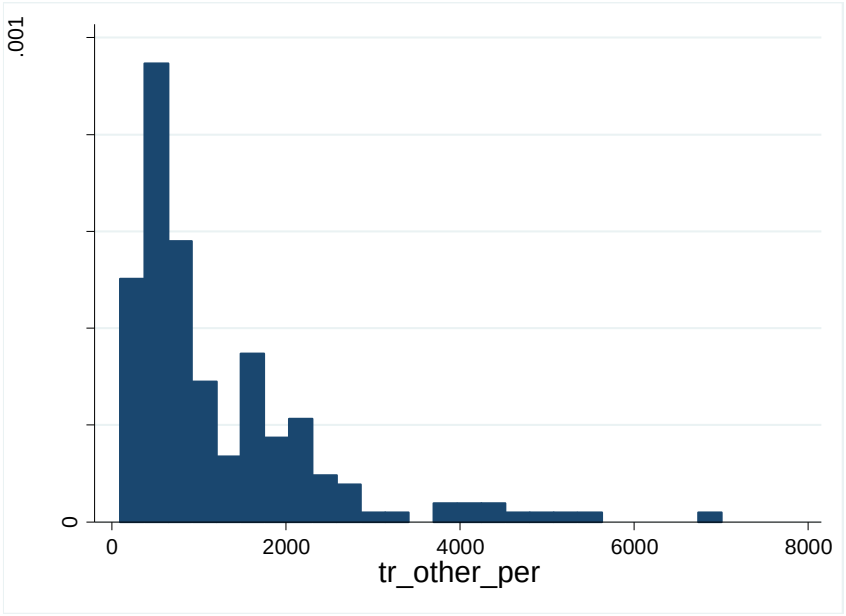

Figure 3. Histogram of the „other roads" variable, Source: own (Stata).

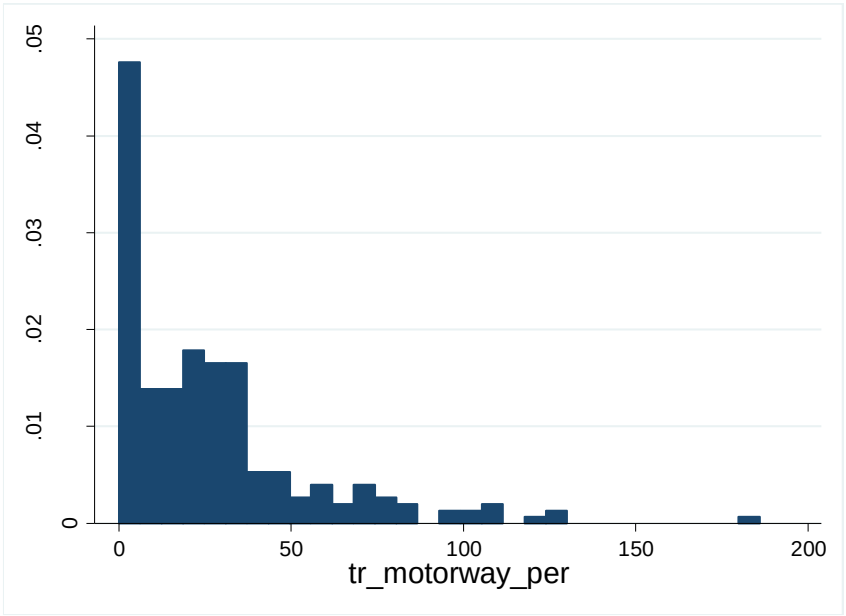

Figure 4. Histogram of the „motorways" variable, Source: own (Stata).

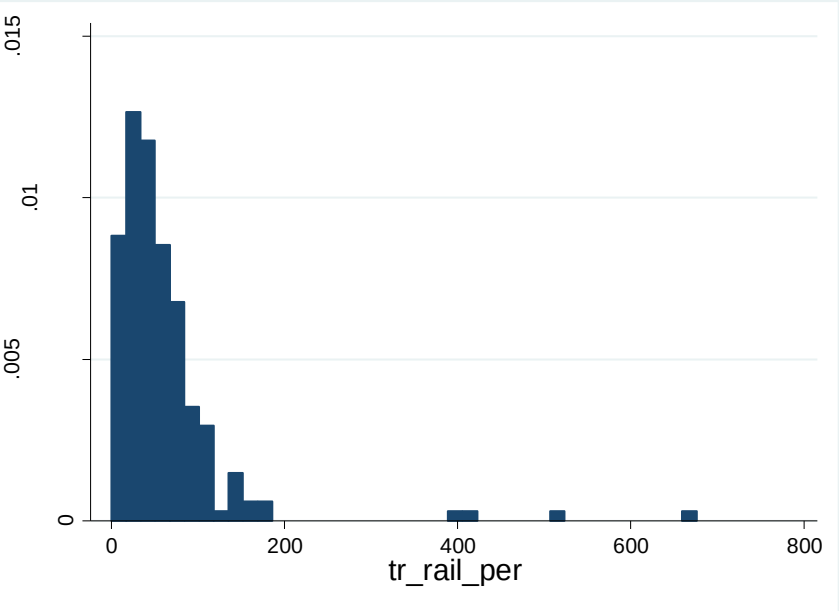

Figure 5. Histogram of the „railways" variable, Source: own (Stata).

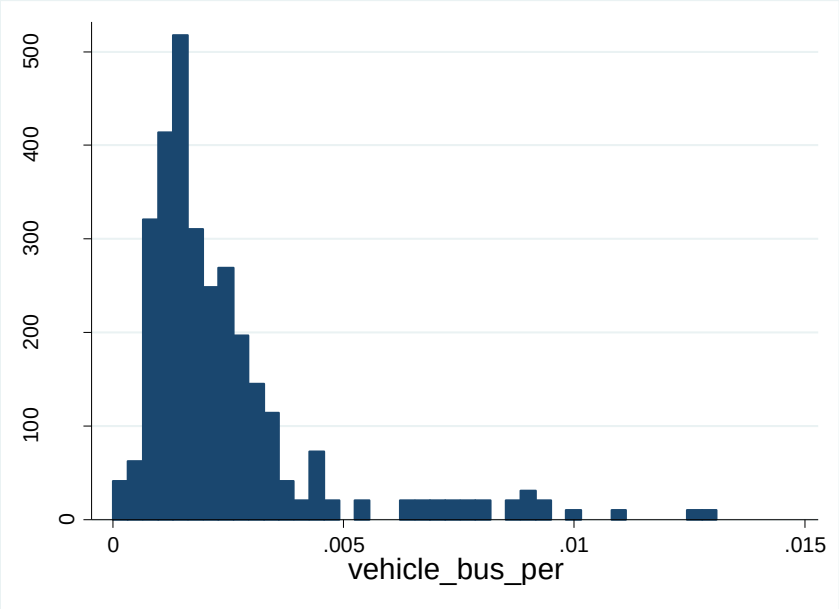

Figure 6. Histogram of the „stock of buses" variable, Source: own (Stata).

In Stata, I calculated a correlation matrix of the variables as well to check whether I should care about multicollinearity. Here, I describe some of its results. The variables showing the stock of vehicles ("vehicle_all" and "vehicle_car") were highly correlated with the correlation coefficient being 0.98. I choose to delete the variable showing all vehicles. The "% of employed persons discriminated at work" variable, the "% of employed persons being able to influence

decisions that affect their work" variable, the "% of employment with tertiary educational attainment" and "mean duration of commuting time" variables were available by sex (male, female, total) and they seemed to be very highly correlated, so I kept only one of the three categories in each case.

3.1.2. Description of the variables

To examine the importance of transport infrastructure and salary on part-time employment in an econometric analysis, one also needs to control for other factors that might have an influence. In this section, I explain why I have chosen the various institutional, sociological, demographic and economic factors introduced in the previous section. Many of these variables are also present in the literature on determinants of part-time employment (e.g. Buddelmeyer et al., 2008).

The *share of employment in service sector* is an important factor of part-time work. The reason for employers to hire part-timers might be to deal with rush hours when there is not enough full-time staff for the customers or to extend opening hours beyond the regular shift of full-time employees. This situation is typically found and part-time employment is frequent in service sectors such as restaurants or retail trade.

The *participation rate of 20 to 24 years old population in education* is also likely to positively influence part-time employment rate. The employers consider students as a relatively flexible and cheap workforce. And from the labor supply side, students are searching mainly for part-time jobs to gain work experience besides university studies or to finance their studies. This variable was only available from 2013 to 2016 at the NUTS 2 regional level so I downloaded the *employment rate of young population* which imperfectly reflects the share of those not working but in school. Imperfectly, exactly because of those who study and work at once.

The *fertility rate* and number of children per family is expected to have a positive relationship with part-time employment rate. Especially for women, more children mean increased need to work part-time because full-time employment is hard to reconcile with family life. In line with this, the *childcare system* (% of children aged less than 3 years in formal childcare) makes work-life balance easier, so its development is expected to allow more women back to work and increase part-time employment rate. At regional level, this data was available only for four years, however, I considered it to be an important factor, so I decided to collect country level data of the same variable.

Similarly, the *usual weekly hours of work for men* is expected to negatively influence part-time employment rate. Even at present, males are the typical breadwinners in families. The high average working hours might show an evidence for this. Also, if the husbands spend a lot of time on the workplace, the task of raising children is solely on the mothers' shoulder and their time wouldn't allow to take a part-time job. Relating to the male breadwinner family model, *household income* is likely to have positive impact on part-time employment rate. The reason for this is that in high income households, women can allow themselves to work only part-time instead of full-time employment.

In my analysis, I also wanted to include some variable which captures the situation of women in society or views of people on gender issues. At regional level, I could not find any. However, I added % of female employment with *tertiary educational attainment* to capture how important career and work is for women. I expect this variable to have positive relationship with part-time employment rate because women who participated in higher education might be more likely to reenter the labor market after having children. On the country level, I have found some good variables reflecting the situation of females. *Gender pay gap* and *discrimination of women* at work might have negative relationship with part-time employment rate. Adverse labor market situation might discourage women with children from taking part-time jobs. On the contrary,

share of female managers (and share of women being able to influence decisions that affect their work) might have positive effect because women motivated in their work are more likely to reenter the labor market.

Employment protection legislation could also have been a good control variable. Data on the strictness of EPL can be downloaded from OECD database. Strict legislation would have ambiguous effect. On the one hand, as an indirect effect, strict legislation affecting full-time jobs can encourage the use of part-time work to avoid this. On the other hand, in some countries there are employment protection legislations affecting part-time work as well which can strictly limit its use. However, this data is available only at country level and for most countries, its value is quite constant over the examined period which makes it unsuitable in a panel analysis.

3.1.3. Descriptive statistics

Non-standard employment and part-time work has been growing in Europe over the last two decades. The part-time employment rate is defined as the percentage of workers working part-time relative to total employment. The part-time employment rate is derived for each European country from the annual European Community Labour Force Survey, which is repeated every year since 1983 and compiled by Eurostat.

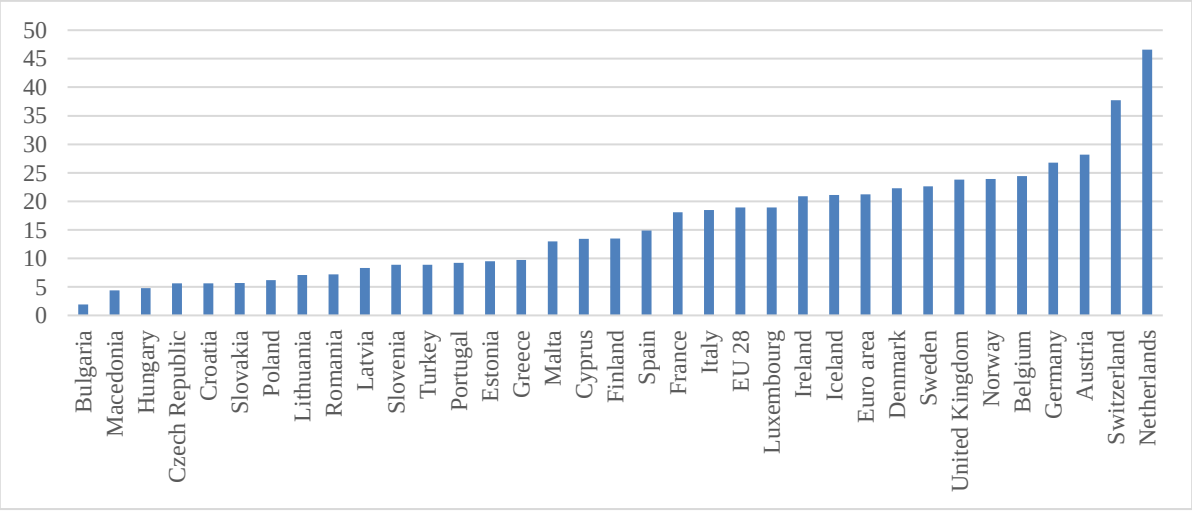

Figure 7. Part-time employment as percentage of the total employment (%) in Europe, 2016. Source: own.

On Figure 7, Eurostat data shows that part-time work is spread very unevenly across European Union Member States. This might reflect differences in legislation, infrastructure or culture. By far the highest proportion of part-time workers in 2016 was found in the Netherlands (46.6%), followed by Switzerland, Austria, Germany, Belgium, Norway, the United Kingdom, Sweden, Denmark and Ireland, where part-time employment was more than a fifth of those in employment.

By contrast, part-time work was relatively infrequent (around 5 %) in Bulgaria, Hungary, the Czech Republic, Croatia, and Slovakia. It is interesting to note that the countries lagging behind the most in this regard are all former socialist countries. As I mentioned in the literature review, outstandingly high share of women was employed during socialism and there was no incidence of part-time work. This collapsed, however, when labor market changed following the regime change. So, this difference might indicate that a large part of the variation between countries in part-time employment rate can be explained by culture and tradition. However, these aspects of life are difficult to grasp, even more at the regional level. Including variables relating to the situation of females at the country level might help capture some of this.

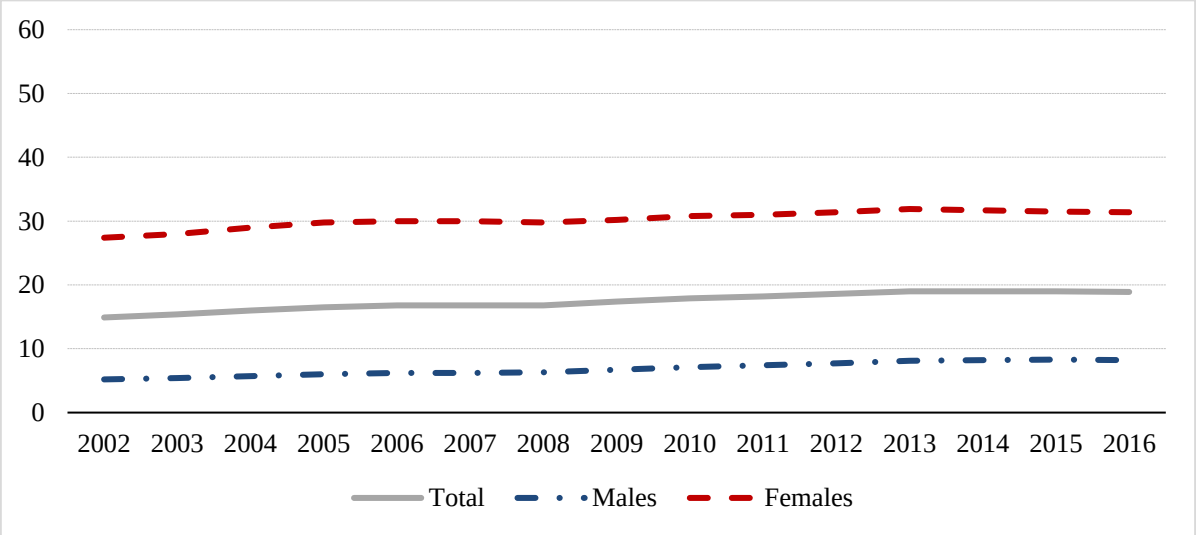

Figure 8. Part-time employment by gender as percentage of the total employment (%) in the European Union, 2002-2016. Source: own.

A breakdown of part-time work by gender on Figure 8 reveals that part-time workers are more likely to be women. 31 % of women aged 20 to 64 years old who were employed in the European Union worked on a part-time basis in 2016, a much higher proportion than the corresponding rate for men (8.2 %). Both numbers have increased since 2002. Back then, part-time employment rate was 27.4% for females and 5.2% of men worked on a part-time basis.

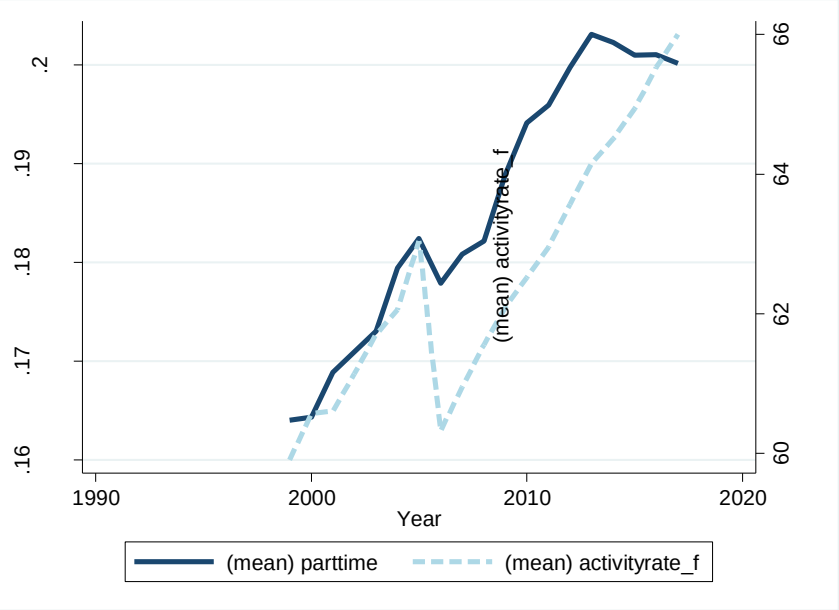

Figure 9. Trends in female activity rate and part-time employment rate. Source: own.

The development of part-time employment rate and activity rate for females for the period 1999 to 2017 is shown on Figure 9. Activity rate is the percentage of active persons compared to the total population. The economically active population comprises the employed and unemployed persons as well (source of definition: Eurostat). The figure was created in Stata by collapsing the dataset to these two variables by year, so yearly averages from the regional values were calculated for the chart. Part-time employment rate increased from 16.4% to 20% and female activity rate increased from 60% to 66% between 1999 and 2017. So, the two variables follow similar increasing trend in the examined period and the chart suggests that the rise in female activity rate can account for the increase in part-time employment rate.

Figure 10 and 11 show on scatterplots the relation between part-time employment rate and the main explanatory variables. The blue points correspond to one NUTS 2 region and the label next to them shows the code of the country which they belong to. Based on Figure 10, there is a positive relation between part-time employment and hourly compensation (which includes wages and salaries as well as employers' social contributions). The fitted red regression line also has a positive slope coefficient. It is interesting to note that the regions of Netherlands are all outliers far above the regression line.

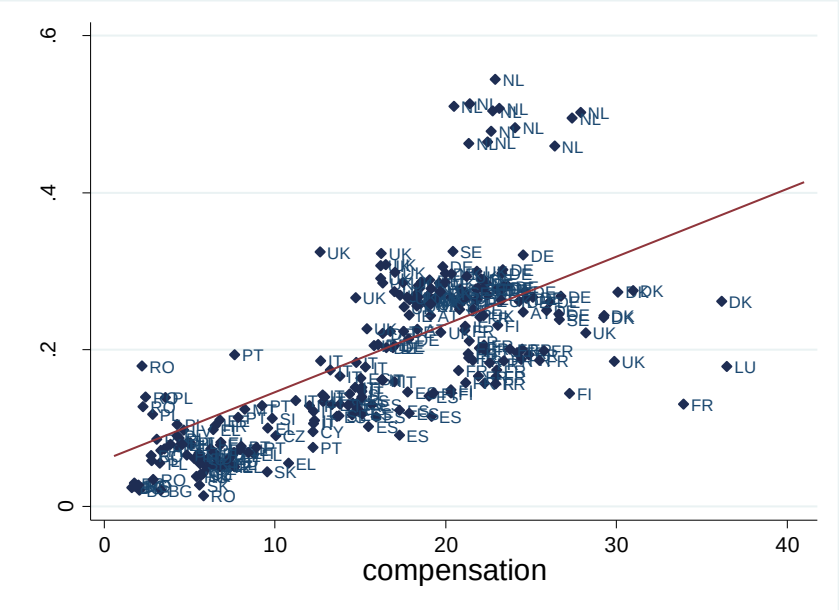

Figure 10. Scatterplot of part-time employment rate and hourly wage. Source: own.

From the variables indicating transport infrastructure, I have chosen the one showing motorway length. Figure 11 shows a scatterplot between this variable and part-time employment rate. In this case we can also see a positive relationship indicated by the upward sloping regression line. However, variation around the regression line is greater than on the previous chart. Similarly to the first scatterplot, regions of the Netherlands are outliers here as well.

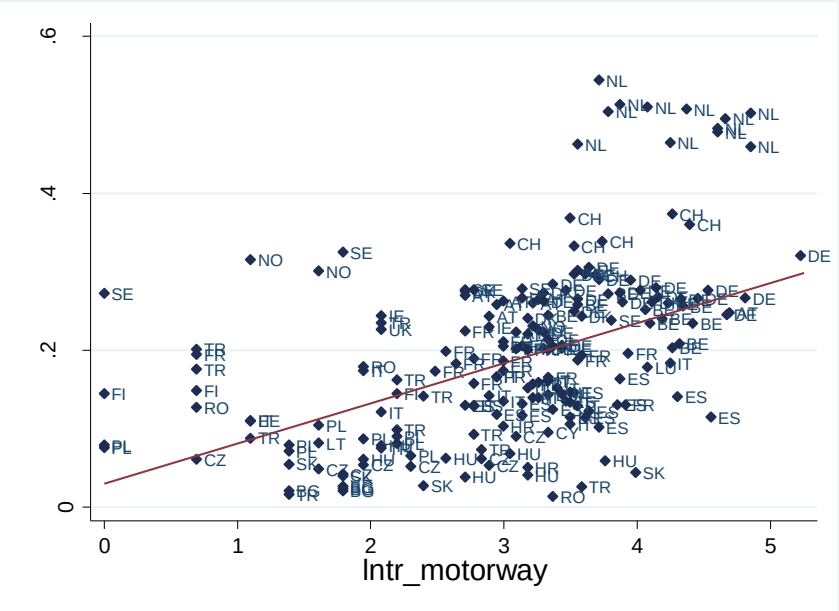

Figure 11. Scatterplot of part-time employment rate and motorway length. Source: own.

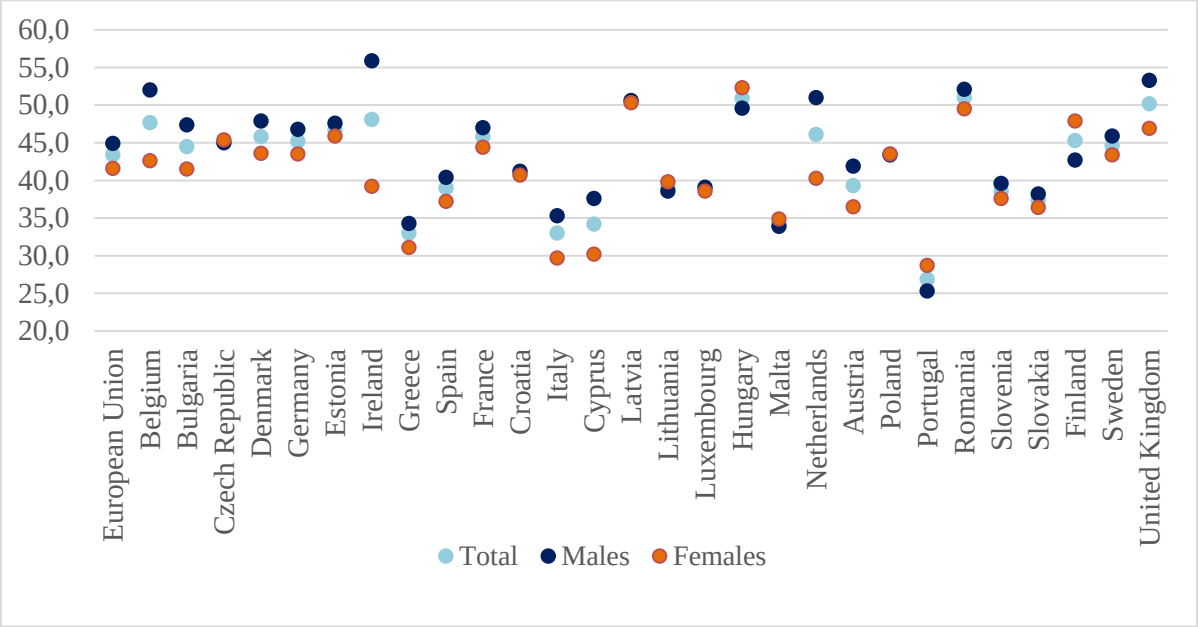

Figure 12. Mean duration of commuting time one-way between work and home by gender, 2010. Source: own.

Country level data on commuting time between work and home is available for the years 2005, 2010 and 2015 on Eurostat. Figure 12 illustrates this variable for both gender in 2010. There are large differences in the values across European Union member states. In Portugal, it takes less than half an hour to reach the workplace, while in Hungary, the United Kingdom, Romania and Latvia it takes more than 50 minutes. It is also interesting to note that in most countries,

average female commuting time is below the value for males. As women are part-time workers in a higher share, this pattern might indicate that time is indeed an important factor for part-time employees. Furthermore, one of the countries with the highest gap between males and females is the Netherlands, where the incidence of part-time work is outstandingly high in Europe.

3.2. Methodology

3.2.1. The advantages of panel data

In my thesis, I would like to examine the impact of transport infrastructure development and wage rate on part-time employment rate using econometric analysis. The dataset I have collected contains data from X to X for NUTS 2 regions of the European Union. This allows me to apply the methods of panel econometrics in my analysis.

In panel data or longitudinal data, we record the behavior of a group of cross-sectional units (e.g. people, households, firms or countries) over a specific time period (Carter, 2011). Panel data has several advantages. One is that we can filter out the unobserved differences, heterogeneity between the individuals.

Time-series or cross-sectional analyses that don't control for this kind of heterogeneity are likely to have biased estimates as a result. There can be a lot of variables influencing the dependent variable which are constant for an individual over time e.g. cultural differences between countries. Several of these variables are difficult to observe and measure, thus our model doesn't contain them. Leaving these variables out can lead to bias in our estimates. In a panel analysis we can control for these constant effects, while cross-sectional analyses are inadequate in this regard.

Furthermore, panel data are more suitable for studying the dynamics of adaptation. Some changes in economic policy have their effects in the economy only on the longer run. For example, if we want to examine the effects of a labor market regulation, cross-sectional data can show the unemployment rate for a given year. If the data collection is repeated in consecutive years, change in the rate can be observed. However, with a panel analysis we can also answer questions such as what share of unemployed people in one period will be employed in a specific later period (Baltagi, 2008). So panel econometrics provides various tools for examining economic policy regulations.

One method of panel econometrics is the Pooled OLS model. I describe the disadvantages of this method to show why I have chosen other methods for analyzing my dataset. In this model, observations about different individuals are just pooled together. So, it has no regard for heterogeneity between individuals which could result in different coefficients. The Pooled model can be written with the following equation:

$$y_{it} = \beta_0 + \beta_1 \cdot x_{1it} + e_{it}$$

In the above equation, indexation of the coefficients (β_0 és β_1) do not contain i or t. They are constant for each individual and each period and don't allow heterogeneity between individuals. Figure 13 illustrates why this is problematic and leads to biased estimates.

The figure illustrates the hypothetical relationship between transport infrastructure and part-time employment rate. The chart shows observations for three regions (A, B and C) for two different periods. My initial hypothesis is that the more developed transport infrastructure a region has, the higher the part-time employment rate is in the region. In the above equation, β_1 should have a value higher than 0 in this case.

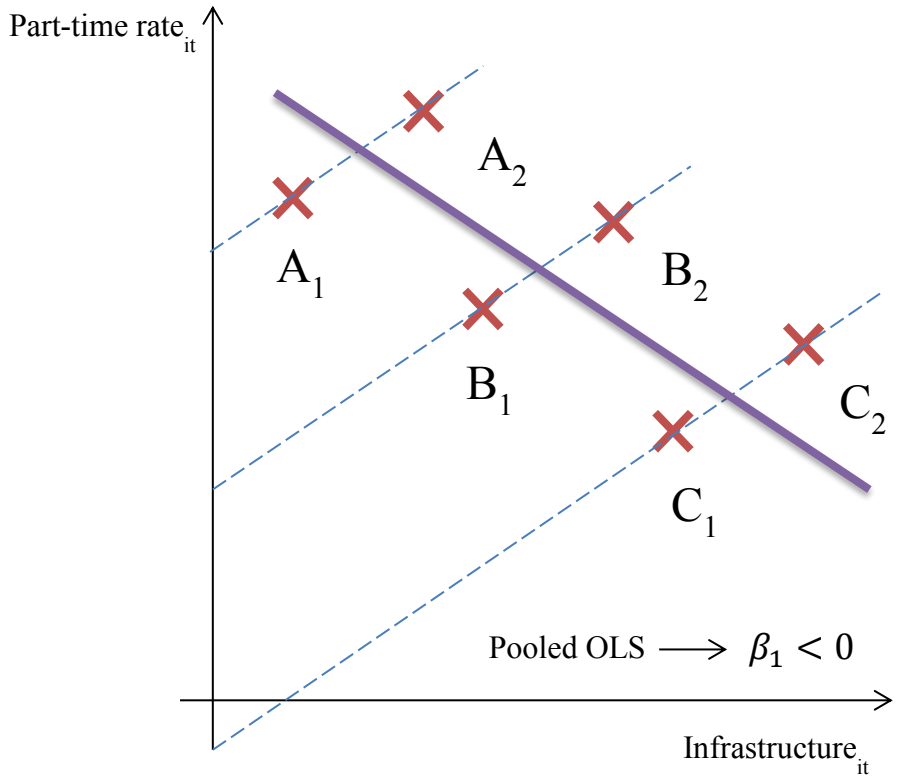

Figure 13. Estimations in Pooled OLS model, Source: own edit.

In the Pooled OLS (Ordinary Least Squares) model, these observations are just pooled together, and we try to find the line which fits these data points the most. On the above figure, this line is the downward sloping solid line. Because of its slope, the value of β_1 would be negative which suggests that the more developed transport infrastructure a region has, the lower the part-time employment rate is in the region. This contradicts the initial hypothesis.

The Fixed Effects and First Differences model treats unobserved heterogeneity between individuals by treating observations for different individuals separately. On the above figure, the dashed lines show that we can fit lines with β_1 positive slopes on the two observations of the same country (e.g. A1 and A2). These show it correctly with the positive β_1 coefficient that if transport infrastructure develops in a region, part-time employment rate increases. These dashed lines intercept the y axis at different places and the different intercepts reflect unobserved heterogeneity between regions which are constant over time and explain partly the dependent variable.

These intercepts can be other than "fixed" parameters. In the Random Effects model, we also presume that intercept contains unobserved heterogeneity, but in this case individuals in the sample are randomly chosen (e.g. household panels) so intercepts here are "random" parameters. In cases when individuals in a model are geographic units such as states or countries, the intercepts are more "fixed" (Carter, 2011). In my analysis, this is the case, since my panel contains observations for regions in the European Union.

3.2.2. The Fixed Effects model

One method in panel econometrics to treat unobserved heterogeneity is the Fixed Effects estimate. In my analysis, I applied this method. Let's suppose that we want to estimate the following equation with Ordinary Least Squares:

$$y_{it} = \beta_1 \cdot x_{1it} + \beta_2 \cdot x_{2it} + \alpha_i + u_{it}$$

In the above equation, α_i stands for unobserved heterogeneity and u_{it} for idiosyncratic error which changes over individuals and time. The indexation of α_i does not contain t which indicates that unobserved heterogeneity is constant over time. For example, unobserved and difficult to measure cultural differences between countries can be included in this.

The α_i and u_{it} together constitute the error term. Unobserved heterogeneity is correlated with the explanatory variables ($Cov(\alpha_i, x_{it}) \neq 0$) so the error term is correlated with them as well. This endogeneity violates the condition for a consistent Least Squares estimate. To handle this, we take the averages of both sides of the equation:

$$\overline{y_i} = \beta_1 \cdot \overline{x_{1i}} + \beta_2 \cdot \overline{x_{2i}} + \alpha_i + \overline{u_i}$$

Here, $\overline{y_i} = \frac{1}{T} * \sum_{t=1}^{T} y_{it}$, so we took the average of the y_{it} dependent variables for each individual over time. It can be seen that the unobserved heterogeneity indicated by α_i is constant

over time so by averaging it, we get back the same α_i. Then we subtract the second equation from the first equation:

$$y_{it} - \overline{y_i} = \beta_1 \cdot (x_{1it} - \overline{x_{1i}}) + \beta_2 \cdot (x_{2it} - \overline{x_{2i}}) + \alpha_i - \alpha_i + (u_{it} - \overline{u_i})$$

The α_i term will disappear so unobserved heterogeneity is taken care of. The OLS estimate on this equation will be consistent now because the error term and the explanatory variables are not correlated: $Cov(x_{it}, u_{it}) = 0$.

One disadvantage of the Fixed Effects estimate is that it removes everything which is constant over time. This is because the main goal was to remove α_i which is constant over time. As a result, we cannot examine the impact of any constant variable on the dependent variable. For example, the proxy for employment protection legislation is constant in most countries so its effect on part-time employment rate cannot be examined with the Fixed Effects model.

3.2.3. The First Differences model

Another method in panel econometrics for treating unobserved heterogeneity is the First Differences model. In the case of only two time periods, it gives the same results as the Fixed Effects method. The starting point is again the following equation:

$$y_{it} = \beta_1 \cdot x_{1it} + \beta_2 \cdot x_{2it} + \alpha_i + u_{it}$$

The α_i and u_{it} constitute the error term which is correlated with the explanatory variables. Endogeneity is treated by the following:

$$\Delta y_{it} = \beta_1 \cdot \Delta x_{1it} + \beta_2 \cdot \Delta x_{2it} + \alpha_i - \alpha_i + \Delta u_{it}$$

Here $\Delta y_{it} = y_{it} - y_{it-1}$. So we subtract the equation for time t-1 from the equation for time t which is the first difference. The unobserved heterogeneity indicated by α_i is constant over time

so its value for time t is the same as its value for time t-1. The term disappears as we subtract them from each other and as a result, unobserved heterogeneity is removed by this method as well. The Pooled OLS estimate on this equation will be consistent since there is no correlation between the new error term and new explanatory variables: $Cov(\Delta x_{it}, \Delta u_{it}) = 0$, which ensures consistency similarly as in Fixed Effects method.

The method has its disadvantage similarly to Fixed Effects method that besides removing α_i which is constant over time, it removes every effect which is constant over time. So the impact of these variables cannot be examined with this method. A further disadvantage is that while the level of explanatory variables may show greater variation across different individuals and times, the Δx_{it} terms may show smaller variation. As a result, standard errors will be greater. A third disadvantage is that for time series with few observations, the First Differences method further decreases the sample. This is because there may be some gaps in the time series and first differences can only be calculated if observations are available for consecutive years.

3.3. Empirical results

In this section I present the econometric models I specified in my analysis and the empirical findings. My initial hypothesis was that the development of transport infrastructure and wages have positive effect on part-time employment rate. First, I will show the results of a cross-sectional analysis, second I present the estimates from the First Differences and Fixed Effects models. Lastly, I perform robustness checks. The analysis was carried out with version 12 of Stata statistical software.

To gain some insight before applying the panel econometrics methods, I ran various cross-sectional OLS regressions. Table 2 shows the results for the year 2010. Among the main explanatory variables, "lntr_motorway" has positive coefficients significant at the 5% level and "lntr_other" has positive coefficients significant at the 1% level in all specifications. These are

consistent with my former expectations. However, the sign for "compensation" is not unequivocal so hourly wage might not have an effect on part-time employment rate based on this result. The "workmotivation" (share of women being able to influence decisions that affect their work) and "maleworkinghours" (usual weekly hours of work for men) variables have significant coefficients of the expected sign. In one specification, coefficient for fertility rate and childcare is positive which is in line with expectation. Looking at the "R-squared" line, regression 5 has the highest value with 82%.

Cross-sectional	(1)	(2)	(3)	(4)	(5)
compensation	0.006**	0.005**	-0.012***	0.002	0.001
	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)
lntr_motorway	0.022**	0.021**	0.020**	0.019**	0.016**
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)
lntr_other	0.042***	0.034***	0.055***	0.052***	0.015***
	(0.011)	(0.009)	(0.008)	(0.009)	(0.005)
GDP	0.000	0.000			0.000
	(0.000)	(0.000)			(0.000)
fertility_rate		0.004	0.059**		0.016
		(0.033)	(0.029)		(0.021)
c_childcare		0.001	0.003***		
		(0.001)	(0.001)		
vehicle_car		0.000			
		(0.000)			
lntr_rail	-0.011				
	(0.013)				
hhinc_capita			0.000***	0.000***	
			(0.000)	(0.000)	
c_workmotivation_f			0.005***	0.005***	
			(0.001)	(0.001)	
maleworkinghours			-0.012**		-0.018***
			(0.005)		(0.004)
c_genderpaygap				-0.001	
				(0.001)	
service_share					-0.102
					(0.067)
youngemployment					0.463***
					(0.039)
Constant	-0.249***	-0.245***	-0.115	-0.505***	0.612***
	(0.077)	(0.088)	(0.251)	(0.086)	(0.172)
Observations	129	163	136	136	156
R-squared	0.563	0.564	0.719	0.625	0.820

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2. Results of the cross-sectional regressions. Source: own (Stata).

First Differences	(1)	(2)	(3)	(4)	(5)
D.compensation	-0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
D.lntr_motorway	-0.003	-0.000			
	(0.002)	(0.002)			
D.lntr_other	0.000	0.010***	0.012***	0.010***	0.009**
	(0.002)	(0.003)	(0.003)	(0.003)	(0.004)
D.lntr_rail	-0.003				
	(0.003)				
LD.lntr_motorway		-0.003			
		(0.003)			
LD.lntr_other		-0.002		-0.003	
		(0.004)		(0.004)	
D.fertility_rate		0.010	0.008	0.005	-0.006
		(0.007)	(0.007)	(0.007)	(0.007)
LD.fertility_rate		-0.009	-0.008		
		(0.006)	(0.006)		
D.maleworkinghours		-0.005***	-0.005***	-0.005***	-0.005***
		(0.001)	(0.001)	(0.001)	(0.001)
D.c_childcare		-0.000	-0.000	-0.000	-0.000
		(0.000)	(0.000)	(0.000)	(0.000)
D.c_genderpaygap		-0.000	-0.000	-0.000	-0.000
		(0.000)	(0.000)	(0.000)	(0.000)
D.GDP		-0.000**	-0.000**		
		(0.000)	(0.000)		
D.service_share		0.023	0.019	0.022	
		(0.028)	(0.028)	(0.028)	
D.c_womenmanagers		-0.000	-0.000*	-0.000*	-0.000*
		(0.000)	(0.000)	(0.000)	(0.000)
D.youngemployment		-0.015	-0.015	-0.009	
		(0.015)	(0.014)	(0.015)	
D.hhinc_capita				-0.000***	-0.000***
				(0.000)	(0.000)
D.highed_f				-0.017	-0.025
				(0.019)	(0.018)
LD.maleworkinghours					-0.001*
					(0.001)
Constant	0.003***	0.003***	0.003***	0.003***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	1,471	1,078	1,108	1,061	1,178
R-squared	0.099	0.150	0.150	0.164	0.149

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

Table 3. Results of the First Differences regressions. Source: own (Stata).

Regression results for different specifications of the First Differences model are shown in Table 3. In these regressions, I estimated clustered standard errors. Cross-sectional standard error estimation would be wrong here because it assumes that observations are independent from each other. But, in panel data, observations for the same individual in different periods are

usually related because of serial correlation. So, robust standard errors are wrong for multi-period panel regressions and instead, clustered standard errors should be estimated. It takes care of heteroskedasticity as well as serial correlation. Some specifications contain lagged differences. Changes in economic policy might need some time to have their effects and this can be captured by the lagged versions of first differences.

Among the main explanatory variables, only "lntr_other" is statistically significant now. With control variables included, it was significant at the 1% level in three specifications. In the cross-sectional analysis, "lntr_motorway" had positive and significant coefficient and here it is statistically insignificant. As First Differences model is better at establishing causality than simple cross-sectional regression, motorway density seems not to have a causal effect on part-time employment rate. This finding might be explained by women searching for nearby workplaces so that commuting time is smaller. Figure 12 shows empirical evidence for that in most European countries. As a result, motorways might be less important for part-time workers than roads because of women working within cities or villages and not in remote cities.

The share of women managers and household income have negative coefficients which contradicts my former expectations. My intuition was that share of women managers reflects esteem of women in a society which might affect whether they can reenter the labor market after having children. However, higher share of female managers can also indicate that career is important for women in that region. I have controlled for fertility rate and still got significant negative coefficient which might mean that women reenter the labor market in full-time jobs.

Similarly to the cross-sectional analysis, the negative coefficient for "maleworkinghours" is statistically significant at 1% level in each specification. In regression 5, I also included the lagged difference of this variable which is statistically significant as well with the same sign. This means that a change in the usual weekly hours of work for men brings change to the part-

time employment rate not only in the same period but also in the following year. However, the coefficient of the lagged variable is somewhat smaller. As I discussed it in one previous section, the high average working hours might show that males are still the typical breadwinners in families. And if the husbands spend a lot of time on the workplace, the task of raising children is solely on the mothers' shoulder and their time won't allow to take a part-time job.

R-squared was highest for regression model specification 4. Interpreting the results, we can say that part-time employment rate is expected to increase by 0.3 percentage points in a year (value of the constant) when hourly wage ("compensation"), road density ("lntr_other") and the other variables remain the same. And interpreting the coefficient of "lntr_other", we can say that if we compare two units or two time periods with different changes in road density from the previous year ("D.lntr_other") but the same changes in road density from t-2 to t-1 ("LD.lntr_other") and the same changes in other variables from the previous year, part-time employment rate is expected to increase by 0.1 percentage points more where or when road density increases by 10% (because it is in log) more.

Fixed Effects	(1)	(2)	(3)	(4)
compensation	-0.000	-0.000	-0.000**	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
lntr_motorway	-0.002	-0.003	-0.009***	-0.007***
	(0.003)	(0.002)	(0.002)	(0.003)
lntr_other	0.038***	0.024***	0.021***	0.015***
	(0.006)	(0.005)	(0.006)	(0.005)
lntr_rail	0.006		-0.005	
	(0.004)		(0.003)	
fertility_rate	-0.005	0.001	-0.028***	-0.005
	(0.008)	(0.008)	(0.008)	(0.008)
maleworkinghours	-0.015***	-0.008***	-0.004***	-0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
c_childcare	0.001***	0.001***	0.000	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
GDP	0.000*		-0.000***	
	(0.000)		(0.000)	
hhinc_capita		-0.000		-0.000***
		(0.000)		(0.000)
service_share		0.034		-0.012
		(0.030)		(0.028)
c_genderpaygap		-0.001**		-0.001*
		(0.000)		(0.000)

c_womenmanagers		-0.000**		-0.000*
		(0.000)		(0.000)
highed_f		0.054***		-0.026
		(0.019)		(0.026)
youngemployment		-0.119***		-0.073***
		(0.013)		(0.014)
2006.year			0.007***	
			(0.001)	
2007.year			0.011***	
			(0.002)	
2008.year			0.019***	0.004***
			(0.002)	(0.001)
2009.year			0.022***	0.007***
			(0.002)	(0.001)
2010.year			0.028***	0.011***
			(0.002)	(0.002)
2011.year			0.029***	0.012***
			(0.002)	(0.002)
2012.year			0.033***	0.017***
			(0.002)	(0.002)
2013.year			0.037***	0.021***
			(0.002)	(0.002)
2014.year			0.039***	0.023***
			(0.003)	(0.003)
2015.year			0.039***	0.022***
			(0.003)	(0.003)
2016.year			0.041***	0.030***
			(0.004)	(0.004)
Constant	0.510***	0.402***	0.299***	0.409***
	(0.084)	(0.072)	(0.055)	(0.062)
Observations	1,319	1,293	1,319	1,293
R-squared	0.480	0.634	0.651	0.692
Number of region	135	179	135	179

Table 4. Results of the Fixed Effects regressions. Source: own (Stata).

Table 4 shows the regression results for different specifications of the Fixed Effects model. In these regressions, I also estimated clustered standard errors. Among the main explanatory variables, road density ("lntr_other") has positive and statistically significant coefficient at the 1% level. This is in line with the results of the cross-sectional regressions and the First Differences models. The other main variables are significant only in some specifications and with the opposite sign than expected. So, hourly wage ("compensation") seems not to have a causal effect on part-time employment rate based on the results from First Differences and Fixed Effects models. However, gender pay gap has negative and statistically significant

coefficient which is consistent with my former expectation that adverse labor market situation for females might discourage women with children from taking part-time jobs.

The coefficient for "maleworkinghours" is negative and statistically significant at the 1% level in each specification. This is in line with the results of cross-sectional and First Differences regressions. The "childcare" variable is positive and statistically significant in most specifications which is consistent with my former expectation that if the childcare system is more developed, it makes work-life balance easier and allows more women back to work after having children. The coefficient on the share of female managers is negative and statistically significant as in First Differences regressions. Among the different specifications, regression 4 has the highest R-squared with a value of 0.69.

Some of the specifications contain also time fixed effects. As Figure 9 in the descriptive statistics section showed, part-time employment rate follows a rising trend and it increased from 16.4% to 20% between 1999 and 2017. In First Differences models, this non-stationarity is handled by taking the differences. But in Fixed Effects models, one needs to take care of it. By adding time dummies in Stata with "i.year", I controlled for this time trend. In the last two columns of Table 4, coefficients of the year dummies are presented at the end of the regression table. These coefficients are continuously increasing compared to the benchmark year, which reflects the trend in part-time employment rate.

Besides the various specifications for First Differences and Fixed Effects models presented in the previous tables, I performed some additional robustness checks. Figure 7 in the section with descriptive statistics showed the part-time employment rates of European countries and we could see that the countries lagging behind the most in this regard are all former socialist countries. So, I was interested whether the empirical findings presented above would hold for both group of countries. First, I have created a dummy variable which is 1 if the country (the

region belongs to) is a former socialist state and separated my sample based on the value of this variable. I have chosen some specifications from the previous ones and rerun them on the two subsamples.

Robustness check FD	post_comm (2)	other (2)	post_comm (4)	other (4)
D.compensation	-0.001***	0.000	-0.001***	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
D.lntr_motorway	0.000	0.001		
	(0.001)	(0.007)		
D.lntr_other	-0.000	0.012***	0.003	0.010***
	(0.005)	(0.004)	(0.005)	(0.004)
LD.lntr_motorway	-0.003	0.005		
	(0.003)	(0.010)		
LD.lntr_other	-0.013	0.002	-0.014	0.002
	(0.009)	(0.004)	(0.009)	(0.004)
D.fertility_rate	0.013	0.019*	0.011	0.014
	(0.010)	(0.010)	(0.009)	(0.009)
LD.fertility_rate	-0.027***	0.007		
	(0.007)	(0.009)		
D.maleworkinghours	-0.004**	-0.005***	-0.005**	-0.004***
	(0.002)	(0.001)	(0.002)	(0.001)
D.c_childcare	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
D.c_genderpaygap	0.000	0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
D.GDP	-0.000	-0.000**		
	(0.000)	(0.000)		
D.service_share	-0.119**	0.078**	-0.129***	0.081***
	(0.045)	(0.030)	(0.047)	(0.030)
D.c_womenmanagers	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
D.youngemployment	-0.010	0.006	-0.009	0.012
	(0.029)	(0.017)	(0.030)	(0.017)
D.hhinc_capita			-0.000	-0.000***
			(0.000)	(0.000)
D.highed_f			0.044	-0.018
			(0.033)	(0.021)
Constant	0.002***	0.003***	0.001*	0.004***
	(0.001)	(0.000)	(0.001)	(0.000)
Observations	278	800	278	783
R-squared	0.289	0.156	0.259	0.193

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

Table 5. Results of the robustness checks for First Differences regressions. Source: own.

Among the First Differences regressions, I have rerun specification 2 and 4 and the results are shown in Table 5. Comparing these to the results on the whole sample, "lntr_other" variable is statistically significant and has same positive sign for the not post-communist countries, but it is insignificant for the post-communist ones. The reason for this might be that the number of observations (which is indicated at the end of the regression table) is quite small for the post-communist group. The "compensation" variable is statistically significant for this sample but has a negative sign which contradicts my expectations. The first difference of the fertility rate is statistically significant and positive for the not post-communist countries which is in line with expectation. As in all previous specifications, "maleworkinghours" is negative and significant for both groups. It is interesting that for the not post-communist countries, share of service sector variable is significant and positive as expected, however, it is also significant but with the opposite sign for the post-communist group.

I have chosen specifications 1 and 4 among the Fixed Effects regressions and rerun them on the two subsamples. Again, "compensation" variable has negative coefficient for the post-communist group as Table 6 shows. In all specifications, motorway density is insignificant. However, road density ("lntr_other") is significant with positive coefficient which is consistent with former results. The "maleworkinghours" is significant with negative coefficient which is also consistent. For the not post-communist countries, the childcare system variable has positive significant coefficient as in the regression for the whole sample. The coefficients of the year dummies show similar positive trend as in case of the original regressions. However, for post-communist countries, there are small decreases in 2014 and 2015. In the last column of the regression table we can see that the R-squared is quite high for that specification with a value of 0.77.

Robustness check FE	post_comm (1)	other (1)	post_comm (4)	other (4)
compensation	0.000	-0.000	-0.001***	0.000
	(0.001)	(0.000)	(0.000)	(0.000)
lntr_motorway	0.004	0.009	-0.000	-0.001
	(0.003)	(0.011)	(0.002)	(0.006)
lntr_other	0.019**	0.042***	0.006	0.015**
	(0.008)	(0.008)	(0.007)	(0.006)
lntr_rail	0.007	-0.001		
	(0.016)	(0.005)		
fertility_rate	0.010	0.001	0.006	0.019*
	(0.008)	(0.012)	(0.010)	(0.009)
maleworkinghours	-0.006***	-0.018***	-0.001	-0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
c_childcare	0.000	0.001***	-0.000	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
GDP	0.000	0.000		
	(0.000)	(0.000)		
hhinc_capita			-0.000	-0.000***
			(0.000)	(0.000)
service_share			-0.054	0.035
			(0.051)	(0.030)
c_genderpaygap			0.000	-0.001***
			(0.000)	(0.000)
c_womenmanagers			-0.000	-0.000
			(0.000)	(0.000)
highed_f			0.024	-0.027
			(0.035)	(0.027)
youngemployment			0.013	-0.037**
			(0.025)	(0.018)
2008.year			0.001	0.003***
			(0.002)	(0.001)
2009.year			0.010***	0.005***
			(0.003)	(0.001)
2010.year			0.017***	0.010***
			(0.004)	(0.002)
2011.year			0.017***	0.013***
			(0.004)	(0.002)
2012.year			0.018***	0.020***
			(0.004)	(0.002)
2013.year			0.021***	0.025***
			(0.004)	(0.003)
2014.year			0.020***	0.026***
			(0.005)	(0.003)
2015.year			0.017***	0.027***
			(0.005)	(0.003)
2016.year			0.022***	0.042***
			(0.006)	(0.004)
Constant	0.123	0.622***	0.081	0.383***
	(0.107)	(0.117)	(0.078)	(0.066)
Observations	411	908	334	959
R-squared	0.262	0.572	0.471	0.765
Number of region	45	90	44	135

Table 6. Results of the robustness checks for Fixed Effects regressions. Source: own.

Conclusion and policy relevance

In my thesis, I examined the determinants of part-time employment rate. In particular, I focused on testing two hypotheses. I expect part-time employment rate to increase with the development of transport infrastructure. My second hypothesis is that as wage rate rises, part-time employment rate also increases.

I have performed my analysis on NUTS 2 regional level data for all the EU regions between 1999 and 2017. For the econometric analysis of this panel data, I used the First Differences and Fixed Effects models. Access to micro data could have enriched the study, but no such database was available for me.

The results of both First Differences and Fixed Effects regressions show that among the main variables of interest, only road density had positive and statistically significant coefficient. Motorway and railway line density seems not to have a causal effect on part-time employment rate. This finding might be explained by women searching for nearby workplaces with shorter commuting time. Figure 12 showed supporting evidence in most European countries. So, motorways might be less important than roads for the development of part-time employment because of women working within cities or villages and not in remote cities. Results also show that hourly wage does not impact the part-time rate. However, gender pay gap has negative and statistically significant coefficient in the Fixed Effects regressions. So, adverse labor market situation of females and gender inequality in society might discourage them from emancipation and taking part-time jobs.

Another robust finding from the empirical analysis was the negative impact of the usual male working hours on part-time employment rate. The high working hours might indicate that males are still the typical breadwinners in families. Furthermore, if the husbands spend a lot of time on their workplace, the task of raising children is solely on the mothers' shoulder and their time

won't allow to take a part-time job. Childcare institutions can help mothers to free up time for work and leisure. Based on the Fixed Effects regressions, this factor has positive effect on part-time rate. So, a developed childcare system makes work-life balance easier for mothers and allows women back to work after having children.

Empirical results of my analysis have high policy relevance. Based on these findings, policy-makers such as the Hungarian government could achieve a growing incidence of part-time employment by developing transport (in particular road) infrastructure to reduce the fixed time cost of commuting for the workers. Introducing new legislations to somehow tackle gender discrimination in the labor market and the wage gap could also help in the emancipation of women. Changing societal preferences about parental roles is a much slower process, but governments could also support dads to stay at home with children instead of women or in more equalized way if it reflects better the preferences of household members. Furthermore, the expansion of affordable childcare services would impact part-time employment rate positively.

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