**Charles University in Prague**

Faculty of Social Sciences
Institute of Economic Studies

MASTER'S THESIS

# Effect of the Flat Tax Reform on Labour Supply Elasticity at the Intensive and Extensive Margins: Evidence from the Czech Republic

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Prague, 3rd August 2015

Signature

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# Abstract

The thesis deals with the estimation of labour supply responses to the personal income tax reform in the Czech Republic adopted in 2008 by applying quasi experimental design known as "difference-in-differences". By exploiting the different change in the effective tax rates for various population subgroups as a natural experiment and using microdata from European Labour Force Survey we constructed the treatment and control groups according to the highest attained level of education serving as a proxy for an income range that assigns an individual to the particular tax bracket before and after policy change. Analysing one-person households we found significant negative effect on the labour force participation and significant positive effect on the hours work of the treated by comparing these outcomes for the treatment and control groups in the baseline and follow up periods before and after the reform.



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| **JEL Classification** | C21, D04, H24, H31, I38, J22 |
| **Keywords** | tax reform, labour supply, natural experiment, difference-in-differences |



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# Abstrakt

Práce se zabývá odhadem reakcí nabídky práce na reformu daně z příjmu zavedenou v České republice v roce 2008 aplikováním kvazi experimentální metody známé jako "rozdíl-v-rozdílech". Využitím rozdílných změn v efektivních daňových sazbách pro různé skupiny společnosti jako přirozeného experimentu a s použitím dat z Evropského průzkumu pracovní síly jsme zkonstruovali experimentální a kontrolní skupiny na základě nejvyššího dosaženého vzdělání, sloužícího jako aproximace rozmezí příjmu, který jednotlivce přirazuje do konkrétního daňového pásma před a po reformě. Analýzou jednočlenných domácností jsme nalezli signifikantní negativní efekt na participaci na trhu práce a signifikantní pozitivní efekt na pracovní dobu experimentální skupiny srovnáním těchto hodnot pro experimentální a kontrolní skupiny ve výchozím a následujícím období před a po reformě.

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| **Klasifikace JEL** | C21, D04, H24, H31, I38, J22 |
| **Klíčová slova** | daňová reforma, nabídka práce, přirozený experiment |

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# Acronyms

**ATE** Average Treatment Effect

**ATR** Average Tax Rate

**ATT** Average Treatment Effect on the Treated

**CIT** Corporate Income Tax

**CZSO** Czech Statistical Office

**DiD** Difference-in-Differences

**EATR** Effective Average Tax Rate

**EITC** Earned Income Tax Credit

**EMTR** Effective Marginal Tax Rate

**ETR** Effective Tax Rate

**ILO** International Labour Organization

**ISCED** International Standard Classification of Education

**ISCO** International Standard Classification of Occupations

**LFS** Labour Force Survey

**MLS** Minimum Living Standard

**MTR** Marginal Tax Rate

**NUTS 2** Nomenclature of Territorial Units for Statistics

**PIT** Personal Income Tax

**SSC** Social Security Contributions

**VAT** Value-Added Tax

**WFTC** Working Families' Tax Credit

# Master's Thesis Proposal

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|---|---|
| **Author** | Bc. Ján Tomo |
| **Supervisor** | Mgr. Barbara Pertold-Gebicka, M.A. Ph.D. |
| **Proposed topic** | Effect of the Flat Tax Reform on Labour Supply Elasticity at the Intensive and Extensive Margins: Evidence from the Czech Republic |

**Topic characteristics** Last 20 years have brought a worldwide effort to improve tax collection, prevent tax evasions and possibly also increase labour force participation and employment. Since the fall of the Soviet Union, many European countries, especially the former communist ones in Central and Eastern Europe, have adopted various forms of flat rate income tax reform, inspired by optimal tax theory and practice in different countries. Since the introduction in the Baltic States of Estonia, Lithuania and Latvia in the mid-1990s, several countries followed suit, including Russia (2001), Serbia and Ukraine (2003), Slovakia (2004), Georgia and Romania (2005), Iceland, Macedonia and Albania (2007), the Czech Republic and Bulgaria (2008), Bosnia (2009), Hungary (2011) and Poland (2013) (Peichl, 2013).

Since January 1st, 2008, the Czech Republic has adopted a new tax system that may be at best characterized as a "modified flat tax" compared to the flat tax as defined by Hall & Rabushka (1995). It has some features of a broad-based income tax, and some features of neutral or consumed-income tax (Hrbek 2012). It is not a true flat tax for a number of reasons: several exemptions, double taxation of corporate and individual income, and tax bias against income saved as opposed to income used for consumption. The new personal income tax rate has been set at 15%, replacing the old system of four rates (12%, 19%, 25%, and 32%). However, the amount of income subject to tax has increased to include social security contributions (SSC) that were

formerly deductible. This makes the 15% tax rate equivalent to a rate of 22.4% on the net wage that was taxable under the old system (Hrbek 2012).

In the proposed research we plan to exploit the exogenous change in effective marginal and average tax rates created by above described tax reform as a form of natural experiment and identify its effect on labour supply elasticity of various population subgroups at the intensive and extensive margin. We will try to compare our findings with the outcomes from similar studies on other countries, with focus on labour force participation across countries with different tax rates.

Along the intensive margin, a tax reform which changes the marginal net wage induces employees to adjust their working hours. At the same time, it may create extensive responses by affecting the incentive to participate in the labour market. This effect is likely to be particularly relevant for certain subgroups of the population such as married females, single mothers, low-educated individuals, the young and the elderly. For these individuals, higher tax burdens may make it worthwhile to leave the labour market entirely (Eissa *et al.* 2008). A central finding of the modern empirical labour literature is that labour supply responses tend to be concentrated more along the extensive margin - labour force participation than along the intensive margin - working hours (Eissa & Liebman 1996; Meyer & Rosenbaum 2001). We will focus on confirming these findings by our own analysis using the data and evidence from the Czech Republic.

### Hypotheses

1. Hypothesis #1: Marginal tax rates changed significantly and differently for various population subgroups

2. Hypothesis #2: Employment rates of low-income workers has changed significantly due to the reform

3. Hypothesis #3: Workers across population subgroups adjusted their working hours

**Methodology** First, we will analyse the data statistically to identify the prevailing patterns. Specifically, we are interested in basic indicators of different labour force groups' attachment in the selected European countries such as participation rates, employment rates, hours worked and occupational allocation. While this type of aggregate information is available on the Eurostat

webpage, we will need individual level data to produce more detailed statistics – separately for men and women without and with children, differentiated by age, education and income level. This will supplement the available aggregate statistics.

Next, we will turn to the econometric analysis to formally determine the relationship between effective tax rates change and labour supply responses of workers in the Czech Republic and other countries of interest. The approach proposed to be used in this paper is based on the standard econometric methods for panel data and identification strategies frequently used in related studies, more specifically difference-in-differences and regression discontinuity design (Eissa & Liebman (1996); Duncan & Peter (2010); Saez *et al.* (2012)). As the baseline the basic panel data methods such as pooled regression, fixed/random effects model (for labour market status) might be used. To obtain robust results we will apply difference-in-differences analysis (to compare hours worked and employment status before and after the reform) and regression discontinuity design (to compare individuals from different subgroups around certain arbitrarily given marginal tax rate threshold).

We will try to identify the control and treatment groups needed to employ these methods based on after-reform reported hours because a taxpayer experiencing no or negligible change in the marginal tax rate should not have behavioural response to the pre-reform tax rate threshold. Since the design of the Czech reform does not provide a clean comparison group by keeping the same marginal tax rate for the lowest tax brackets we plan to calculate the effective tax rate in order to be able to sort households into treatment and comparison groups. This analysis will identify potential labour supply responses along its intensive and extensive margins.

Microdata in which we observe labour supply for individuals in households are necessary to conduct this study, as we want to compare various population subgroups. We need to observe individual labour force status (employed, unemployed, out of labour force), occupation if employed, demographic characteristics (age, gender), family status (married, single, children), education level and the labour force status and occupation in the previous year. To get this sensitive and publicly unavailable data, we have already sent the proposal to the Eurostat and are currently waiting for the reply.

**Expected Contribution** The main goal of the thesis is to estimate individual and households responses to Czech 2008 flat rate personal income tax reform, as measured by labour supply elasticity and thus contribute to ongoing public debate about optimal tax policy. In contrast with most of the previously published studies on the topic in the Czech Republic, that are predominantly of descriptive character and deal mostly with the changes in income, our aim is to quantify the effects of the exogenous change in marginal tax rates on different population subgroups, more specifically their labour market participation and hours of work. Employing various econometric methods suitable for microeconomic panel data, namely difference-in-differences approach, fixed effects model and/or regression discontinuity design, we hope to get consistent and efficient estimates to appropriately evaluate the success and impacts of the chosen fiscal policy compared to its objectives regarding the labour supply.

## Outline

1. Introduction and Motivation: although the flat tax reforms are adopted mainly to simplify the framework and reduce tax evasions of high-income earners, they have also considerable impact on overall employment and time spent at work.
2. Related studies: we will briefly discuss how others estimate the effect of change in personal income taxation on labour supply elasticity.
3. Data: we will explain what kind of micro-data we use, describe the statistical properties and discuss their appropriation.
4. Methods: we will introduce the suitable micro-econometric panel data methods, such as difference-in-differences approach, regression discontinuity design, and other possible identification strategies and estimation procedures using the exogenous change in marginal tax rates as a natural experiment.
5. Results: we will discuss the outcomes of our baseline regressions and robustness checks.
6. Concluding Remarks: we will summarize our findings and their implications for economic policy and future research.

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Author Supervisor

# Chapter 1

# Introduction

One of the commonly studied questions many economists all over the world are trying to answer is how the interaction between changes in taxes and social benefits is affecting households' decisions regarding their labour supply. Because of many factors, which can affect the labour force preferences in several possible ways, to isolate the effect of interest as causal, the rigorous research design has to be implemented.

One can conclude that economic agents in the Czech Republic has already accustomed to the frequent legislative tax and welfare system changes. The relevant laws are changing at least partially almost every year. Optimists may believe the objectives of these revisions are not only due to political affiliation or raising the election potential, but also in order to simultaneously increase tax revenues and standard of living, to achieve redistributive goals, and to promote economic growth.

In the years 2007 and 2008 the former Czech right-wing government adopted the most extensive reforms in both social welfare system and particularly in tax schedule since the Velvet Revolution in 1989 and establishing the independent Czech Republic after the division of Czechoslovakia in 1993. Beside numerous changes in eligibility for social benefits based on new definitions of minimum living standard and material need in 2007, as the major part of the reform should be considered the comprehensive revision of the whole taxation scheme coming into effect at the beginning of 2008, which included adoption of flat personal income tax rate together with substantial change in the respective tax base, increase of value-added tax rate and other consumption-based taxes, or reduction of corporate income tax rate.

The objective of this thesis is to appropriately analyse especially the impact

of changes induced by personal income tax reform, which is exploited as a natural experiment, on labour supply elasticity along the intensive and extensive margins. Hence social welfare system is indeed usually focusing on the bottom end of the income distribution in general, it can create various unemployment traps and disincentives regarding the labour force participation and possible working hours readjustment. As many authors previously pointed out, the Czech social benefits system is targeting mainly families with children rather than poor per se (Dušek *et al.* 2013a). Therefore one can expect the greatest effect on low-income households, single mothers, low-skilled workers, and similar population subgroups. Nevertheless, we have decided to focus our analysis on single-member households, because of more straightforward approach and less distortions caused by other household members income or family oriented social benefits.

In order to isolate the outcome of interest, we are applying a widely used econometric approach known as "difference-in-differences". To use this technique, the appropriate treatment and control groups has to be identified. For the approach to be valid, two identification assumptions are required. First, in the absence of any treatment (without changes in tax-benefits policy), the trends in the labour supply of treatment and control groups would have been the same. The second assumption demands no substantial difference in the treatment and control groups compositions before and after policy adoption. Since we consider a significant change in effective tax rates as a treatment here, our control group is a part of population with no or negligible change in these rates.

Data used for identifying both groups, computing effective tax rates and conducting difference-in-differences based regression analysis itself are taken from European Labour Force Survey (LFS) and provided by Eurostat. The relevant period for estimating the treatment effect is set to 2006-2009, because of variety of underlying policy changes reasons and to better capture the trend path for both treatment and comparison groups.

The rest of the paper is organized as follows. chapter 2 provides a broad review of relevant studies on more or less related topics. chapter 3 familiarizes reader with the Czech tax and benefits reforms between 2006-2009, conduct a brief descriptive analysis and carries out a simple microsimulation of newly adopted tax reform and its consequence for change in effective tax rates for the selected model household. chapter 4 concisely introduces microeconomic theory of individual labour supply with focus on the net wage rate change

influence on budget set, utility, and optimal labour supply decisions of economic agents. Data description, together with descriptive statistics, and overview of methods to be used, including their underlying assumptions, association to economic theory with possible advantages, drawbacks and weaknesses, and offering of additional approaches for robustness check can be found in chapter 5. In chapter 6 we present the results of the research with in-depth analysis and interpretation. The last section, chapter 7, summarizes our findings about significance of tax reform on labour supply elasticity and answers whether the particular economic policy met its intended objectives as examined in this work.

# Chapter 2

# Literature Review

## 2.1 Taxes and Labour Supply: Emprical Approach

### 2.1.1 In-Work Benefits in Work

There is wide scope of literature trying to evaluate effects of tax and transfers on the welfare and labour force responses. Probably the most cited and recognised papers are those from Eissa, N. and Blundell, R.. Dozens of them are focused on empirical analysis of adopted tax reforms on labour supply of various population subgroups.

The labour supply of married women is examined in Eissa (1995) using Tax Reform Act of 1986 in the US as a natural experiment. The main finding is a substantial increase of working hours of high-income married women. Several other both authors' works look at the in-work-benefits encouraging the low-income households to participate in the labour market, such as Earned Income Tax Credit (Earned Income Tax Credit (EITC)) in the US (Eissa) or Working Families' Tax Credit (Working Families' Tax Credit (WFTC)) in the UK (Blundell).

The impact of the former mentioned welfare program was a number of times analysed and reviewed in Eissa & Hoynes (1998; 2004; 2006) concentrating mostly on the labour supply of married couples, while Eissa & Liebman (1996) tried to find a significant difference between labour supply of single women with children and single women without children. Eissa (1996) reviews the lessons that emerged from the 1980s changes in the U.S. tax code and income distribution, focusing primarily on the labour supply response and examining whether the dramatic responses in taxable income over the 1980s are due to an increase in males' labour market participation.

More recently, in Eissa *et al.* (2006; 2008) there are four tax reforms in the US, and more generally tax policy and labour market performance studied, respectively. Both works possess complex theoretical specification of the labour supply while pointing out several weaknesses in approaches of earlier studies stressing distinguishing between intensive and extensive margin of labour supply elasticity.

On the other side of the Atlantic Ocean, R. Blundell has been focusing on similar topics based on the tax and welfare programs changes in the UK, while developing and reviewing various evaluation methods of policy interventions; for the recent work, see e.g. Blundell & Dias (2009).

Some of the earlier works were trying to look at alternative and flexible labour supply specifications from different angles (Blundell & Meghir 1986; Blundell *et al.* 1998) in order to satisfy both theoretical and statistical assumptions for reasonable policy analysis assessment.

Later on, he published articles addressing econometric methods suitable for estimating labour supply using tax reforms (Blundell *et al.* 1998; Blundell & Macurdy 1999), examining various social policy reforms mostly in the UK (Blundell *et al.* 2000; 2005; Blundell 2006) as well as trying to bring coherent picture underlying the evolution of labour supply at the extensive and intensive margins in the last forty years in three countries: United-States, United-Kingdom and France (Blundell *et al.* 2011).

More recent work "Employment, Hours of Work and the Optimal Taxation of Low-Income Families" (Blundell & Shephard 2012) analyses the optimal design of low-income support using a structural labour supply model.

Laroque (2005) studies the optimal tax-subsidy schedules in an economy where the only decision of the agents is to work, or not, with an application to the case of France.

Other influential papers are the two by Meyer & Rosenbaum (2001) and Saez (2002). In the first work, the authors show that a large share of the increase in work by single mothers can be attributed to the EITC and other tax changes. The latter paper analyses optimal income transfers for low incomes along the intensive margin and along the extensive margin with carefully calibrated numerical simulations provided.

There is a bulk of other papers regarding the above described taxes/benefits and labour supply participation/hours of work responses. Notable and often cited is Brewer *et al.* (2006) estimating statistically significant effect of the

UK in-work benefits program (WFTC) particularly on labour supply of single mothers.

### 2.1.2 Looking for Optimal Tax-Benefits Balance

Domeij & Flodén (2006) argue that assumptions underlying previous econometric estimates of the labour supply elasticity are inconsistent and downward biased with incomplete-markets economies, especially due to ignoring the borrowing constraints. Similar findings are described also in Keane & Rogerson (2012), where they claim that conventional wisdom of quite low labour supply elasticity does not hold up to empirically reasonable and relevant extensions of simple life-cycle models.

Other works of Keane include survey on labour supply and taxes 2011 and estimating elasticity when participating in multiple welfare programs (Keane & Moffitt 1998). Moffitt (2002) alone also reviews the economic research on this topic, covering both the theoretical models that have been developed as well as the empirical findings from econometric studies on the effects of existing welfare programs on labour supply.

Kleven & Kreiner (2006) try to measure the marginal cost of public funds to account for labour force participation responses, motivated by the consensus in the empirical literature that extensive (participation) responses are more important than intensive (hours of work) responses. On the contrary Rogerson & Wallenius (2009) find that changes in taxes have large aggregate effects on hours of work and assume no inconsistency between this result and the empirical finding of small labour elasticities for prime age workers.

Kumar (2008; 2012) applies non-parametric estimation with non-linear budget sets to estimate female labour supply elasticities using data on married women from the 1985 and 1989 waves of the Panel Study of Income Dynamics, exploiting the substantial variation in budget sets caused by the Tax Reform Act of 1986 in the US as a source of identification.

Slemrod (2001) generalizes the standard model of how taxes affect the labour-leisure choice by allowing individuals to change both their labour supply and avoidance effort in response to tax changes.

Two very recent papers from Kalíšková (2014) and Kabátek *et al.* (2014) examine joint taxation of the families on labour supply and houseworks simultaneously in the Czech Republic and France, respectively. Former work is exploiting introducing of joint taxation of married couples using difference-in-

differences method, while the latter is more oriented on estimating complex structural equations.

## 2.2 Flat Tax: From Theory to Reality

### 2.2.1 Microsimulations and Theoretical Studies

Next part of this overview is dedicated to a number flat tax reforms analysing papers with rather broad range of topics. A large portion of works is focusing on "what if" scenarios, i.e. simulations of flat tax reform adoption and its impact on various economic variables, including items such as labour market, income distribution or inequality.

Ventura (1999) quantitatively explores the general equilibrium implications of a revenue neutral tax reform in which tax structure in the U.S. is replaced by a flat tax, concluding an equity-efficiency trade-off.

Aaberge *et al.* (2000) employ a microeconometric framework to examine the labour supply responses and the welfare effects from replacing the then tax systems in Italy, Norway and Sweden by a flat tax on total income. The flat tax rates are determined so that the tax revenues are equal to the revenues as of 1992.

Fuest *et al.* (2008) use a simulation model to analyse the effects of revenue neutral flat rate tax reforms on equity and efficiency for the case of Germany and find that a flat rate tax with a low tax rate and a low basic allowance yields positive static welfare effects amounting to approximately 1.8% of income tax revenue but increases income inequality.

Similarly, Paulus & Peichl (2009) estimate the potential distributional impact of various flat taxes for selected Western European countries and show that the specific flat tax design and the welfare state regime play a key role.

Jacobs *et al.* (2007) assess the attractiveness of such a flat tax in achieving redistributive objectives with the least cost to labour market performance by applying general equilibrium model for the Netherlands and find it less efficient regarding these goals.

### 2.2.2 How Flat is Actually "Flat Tax?": Descriptive Evidence

Other part of the sample rather deals with empirical analysis, stylized facts and descriptive evidence. This is the case particularly for Central and Eastern European countries, which adopted more or less similar "flat tax" reform to the one proposed by Hall & Rabushka (1995).

Several of the recent analyses focus on Russia. Ivanova *et al.* (2005) as well as Gorodnichenko *et al.* (2008) examine the effects of Russia's 2001 flat rate income tax reform on consumption, income, and tax evasion. Both collectives find that large and significant increase in personal income tax revenue, hence changes in tax evasion following the flat tax reform are associated with changes in voluntary compliance and cannot be explained by changes in tax enforcement policies.

Work similar to Gorodnichenko's was written by Hrbek (2012) trying to evaluate these effects for the Czech flat tax reform.

Duncan & Peter (2010) exploit the exogenous change in marginal tax rates created by the Russian flat tax reform of 2001 to identify the effect of taxes on the labour supply of men and women. The main regression results indicate that the tax reform led to a statistically significant increase in hours of work for men but had no effect on work hours for women, however, with a positive response to tax changes in both tails of the female working hours distribution.

The study of Easterbrook (2008) examines how flat taxes have affected labour supply in eight Central and Eastern European countries, where they have been adopted by analysing a structural relationship among key variables, with results varying throughout the sample.

Staehr (2008) presents estimates of the employment and welfare effects of personal labour income taxation in Estonia. Economic incentives are found to affect the participation decisions of individuals, but not the number of hours worked of individuals already working. Surprisingly, the participation elasticities are higher for individuals in the middle income groups than for individuals in the low and high income groups.

The rest of the studies has more descriptive and observational nature, see e.g. Brook & Leibfritz (2005) for Slovakia, Duncan (2012) for Russia, and Keen *et al.* (2008) or Peter *et al.* (2009) for large international comparison. Interestingly, majority of authors mentioned in this section are considering the tax schemes in most of the studied countries at best as "modified flat tax".

# Chapter 3

# Tax-Benefits System in the Czech Republic

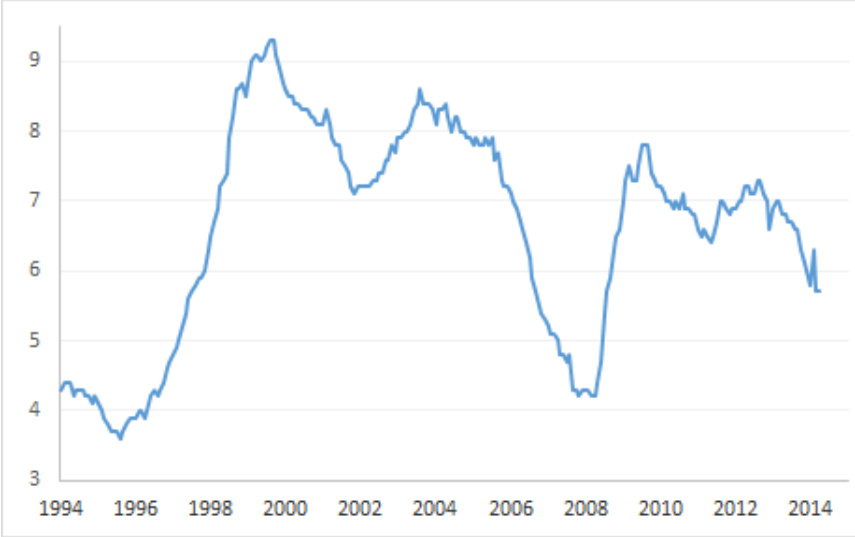
The Czech economy provides a unique opportunity to study the impact of various fiscal and social policies on labour market dynamics. The unemployment rate have been extraordinarily low not only in regional comparison, but also regarding the most European and OECD member countries. This figure, however, has been fluctuating from 4.3% (1994, 2008) to around 8% (2003, 2010) (see Figure 3.1), thus there occurred a considerable change within our period of interest (2006-2010). It is interesting to investigate, to what extent it might be a consequence of interaction of changes in effective tax rates due to complex tax reform with "generous" social welfare system increasing the reservation wages of the particular population subgroups (Galuščák & Pavel 2012).

## 3.1 The Czech Modified Flat Tax

Since January 1st, 2008, the Czech Republic implemented substantial reform of taxation system, and the one of social benefits a year earlier. One of the crucial steps within this process was an adoption of the flat personal income tax rate that may be at best described as a "modified flat tax" compared to the flat tax as defined by Hall & Rabushka (1995) as it is not a classical flat expenditure tax with one marginal rate, but a one-rate tax on personal income.

In practice, however, multiple marginal effective tax rates still remained due to the substantially extended tax credits, the social security contributions and the means-tested social benefits (Dalsgaard 2008). As Hrbek (2012) states, the tax "[h]as some features of a broad-based personal income tax (PIT), and some

Figure 3.1: Unemployment Rate in Percentage (1994-2014)




Source: Eurostat (2014)

features of neutral or consumed-income tax" (p. 16). It is not a true flat tax due to number of reasons: several exemptions and allowances, double taxation of corporate and individual income, and tax bias against income saved as opposed to income used for consumption.

### 3.1.1 Personal Income Tax Reform

The personal income tax rate has been set at 15%, replacing the old progressive system of four rates (12%, 19%, 25%, and 32%) with low effective tax rates based on a lower level of redistribution than in all neighbouring countries (Jarass & Obermair 2000). The statutory figures can be found in Table 3.1. The most important difference to previous taxation scheme was the introduction of flat tax rate at direct labour costs, i.e. adding employer's social security contributions (SSCs) (which are equivalent to 35% of gross salary) to the gross salary itself, giving final amount of income subject to tax.[1] This makes the 15% tax rate roughly equivalent to a rate slightly below 23% on the net wage that was taxable prior to the reform adoption (Hrdlička *et al.* 2010).

In order to compensate low-income individuals for increasing their marginal tax rate, the reform extensively broadened tax credits, including the personal tax credit, the tax credit for non-earning spouse and the tax credit for children among others. These changes effectively avoided increase in tax burden on those

[1] This is sometimes referred to as super-gross salary.

Table 3.1: Statutory PIT Rates in 2007 and 2008 for Incomes in CZK

| ***2007 Base over*** | ***But not over*** | ***Tax Liability*** | ***Of the Amount over*** |
|---|---|---|---|
| 0 | 121,200 | 12% | - |
| 121,200 | 218,400 | 14,544 + 19% | 121,200 |
| 218,400 | 331,200 | 33,012 + 25% | 218,400 |
| 331,200 | and more | 61,212 + 35% | 331,200 |
| ***2008 Base over*** | ***But not over*** | ***Tax Liability*** | ***Of the Amount over*** |
| 0 | and more | 15% | - |

previously taxed at rates below 23%, cut the average tax rates significantly for most of the tax payers, hence resulting in relatively high tax-exempt threshold so even the single earner without children enters the PIT net when earning about 45% of average wage. An example of much more vulnerable single payer with 2 children is a no tax liability until at about 130% of national average wage (Hrdlička *et al.* 2010). For better notion we indicate the size of main tax credits in both pre-reform and after-reform periods in Table 3.2.

Table 3.2: Tax Credits in 2007 and 2008 in CZK

| ***Type*** | ***2007*** | ***2008*** |
|---|---|---|
| Personal | 7,200 | 24,840 |
| Child | 6,000 | 10,680 |
| Child, disabled | 18,000 | 32,040 |
| Spouse, non-earning | 4,200 | 24,840 |
| Spouse, disabled | 8,400 | 49,680 |
| Partial disability pension | 1,500 | 2,520 |
| Full disability pension | 3,000 | 5,040 |
| Disabled | 9,600 | 16,140 |
| Student | 2,400 | 4,020 |

We find also suitable to mention here that if after subtracting applied corresponding credits the computed income tax was negative, the actual tax liability was zero. The only exception were the children credits, when earner effectively paid negative income tax, if applicable. The previously widely used joint taxation of couples with children introduced in 2005 was abolished (Kalíšková 2014); there is little advantage of it under a flat-rate PIT, and as already mentioned, the tax credit for non- or little earning spouse was markedly elevated.

### 3.1.2 Social Security Contributions

Another important feature of the newly adopted tax system was introduction of a cap on income subject to SSCs at four times the average wage, which was about CZK 1,089,168 per year in 2008, thus only relevant to those with monthly earnings above CZK 90,000, which constituted only around 1.8% of the Czech dependent earners at the time. The already existing ceiling for the self-employed was raised to the same level (Dalsgaard 2008). Any excessive income on top of mentioned yearly amount was subject only to 15% tax rate without applying the "super-gross" method and therefore substantially reducing the effective average tax rates for the very right tail of earnings distribution. Since it affects only a negligible part of earners, it is unlikely to have much impact on labour supply decisions (Hrdlička *et al.* 2010).

The SSCs themselves were constituted from two parts for full-time employed people. Their rates did not change from 2007 to 2008, however they negligibly changed in 2009 (decrease by 1% for employer and 1.5% for employee): social insurance contributions (paid as 8% from gross wage by employee and as 26% by employer) and health insurance contributions (paid as 4.5% from gross wage by employee and as 9% by employer). For people with declarable taxable income less than the minimum wage the mandatory health insurance contributions were based on the full-time workers' minimum-wage payments, unless they were taking care of children, receiving living allowance or actively looking for a job, if unemployed. This could be effectively considered as a disincentive for part-time employment, while availability of such jobs is limited in the Czech Republic (Tang & Cousins 2005).

### 3.1.3 Changes in Other Tax Rates

Another part of tax reform was also a cut in the statutory corporate income tax (CIT) rate from 24% in 2007 to 21% in 2008. All withholding taxes on capital returns were unified at a 15% rate, the lowest possible under EU regulations (Hrdlička *et al.* 2010). The lower rate of value added tax (VAT) applied to a range of basic goods and services rose from 5 to 9% in order to offset the revenue losses resulting of the changes to the PIT and CIT. The second standard 19 percent rate was maintained.

### 3.1.4 Effect of the Reform on Effective Tax Rates

Hrdlička *et al.* (2010) and Dalsgaard (2008) agree that the reform intended to promote growth and employment by simplifying the tax system, cutting tax rates while expanding tax bases, and partially shifting the tax burden from income to consumption. I addition to that, government argued the changes would strengthen the incentives for labour-market activation. Nevertheless, since there was simultaneously adopted another extensive reform of social benefits, this claim is rather disputable. More generous tax and benefits system can be viewed as more equitable, on the other hand, it can create substantial unemployment traps and disincentives to increase earnings (Hrdlička *et al.* 2010).

Dušek *et al.* (2013b) computed that "some low-income taxpayers face effective marginal tax rates between 50% and 90%. About 2% of taxpayers are exposed to effective MTRs exceeding 60%. These taxpayers face positive withdrawals of benefits if their earnings increase" (p. 489). Similar conclusions can be found also in Hrdlička *et al.* (2010) or in Dalsgaard (2008). These credits and social benefits are meant to induce progressive elements into the flat-tax scheme but they aim primarily at households with children rather than poor per se (Dušek *et al.* 2013b) and act as a barrier to labour supply of single parents and low-income families (Dalsgaard 2008).

## 3.2 Social Welfare Reform

The change in social welfare began already in 2007, when so called "minimum living standard" (MLS) measure stopped being automatically indexed to living costs. The lower "subsistence minimum" as a sanction for people inactive in employment searching was introduced. Beside significantly extended tax credits that were already mentioned, there was instituted a new form of housing allowance, based on "common housing costs", together with another type of living allowance, housing supplement, and broadened support in material need. The process further continued in 2008 by revisions of both parental and child allowances. The former one introduced optional period of drawing down up to full amount in the range 2-4 years, while the latter unified the eligibility threshold from previous three rates to the single level of 2.4 time MLS, thus reducing a number of drawing households.

To summarize the above written, both the tax liability and the average tax

rate deteriorates considerably with increasing number of children in a household. This is primarily because of relatively large tax credit per child. Let us recall this is the only tax credit that can actually become tax bonus, i.e. if it is greater than tax liability, applying parent effectively pays negative taxes. Furthermore, the payments such as child allowance, parental allowance, birth grant, and maternity benefit are linked to the children in a family, so other households obtain transfers only in case of need (very low income or perhaps low income in combination with higher housing costs than affordable).

As Dušek *et al.* (2013a) computed, over 50 percent of families with children receive some benefits contrary to only quarter of childless households. In terms of household income, for the former group, on average 34 percent of it come from social transfers, while this figure is only about 5 percent for the latter group. Therefore it is reasonable to expect that low- to moderate-income households with several children will have excessively high effective marginal tax rates at the points of social benefits withdrawal, operating as disincentives for active labour market participation mostly in the case of non-working spouses.

### 3.2.1 The Main Changes in Tax-Benefits System (2006-2009)

- Since 2008, Personal Income Tax (PIT) rates unified from previous four rates (12%, 19%, 25%, and 35%) to a single rate of 15%.
- Social Security Contributions (SSC) stayed at the same levels for both employees and employers (12.5% and 35% respectively) until 2009, when they negligibly decreased (to 11% and 34%).
- In 2008 subject to a PIT changed from gross income to super-gross income, hence making effective tax wedge considerably higher than the statutory rate of 15%.
- The ceiling on SSCs was introduced, decreasing both effective marginal and average tax rates for 1.8% of the top earners.
- Tax credits were extensively enlarged together with PIT reform; joint taxation of married couples was abolished.
- Corporate Income Tax (CIT) rate was lowered from 24% to 21%, while lower Value-Added Tax (VAT) rate increased from 5% to 9%.

- Definition of Minimum Living Standard (MLS) was substantially changed in 2007 and became just a simple sum of household members MLSs. It stopped to consist of two parts and ceased to be automatically indexed to living costs, for example excluding accommodation expenditures.
- Housing allowance was largely expanded since 2007, it was, however, no more related to MLS, rather it regarded the "normative" housing costs associated with the urbanization level of the living place and a number of household members.
- Child allowance eligibility incomes increased from 1.1; 1.8; and 3.0 times MLS in 2006 to 1.5; 2.4; and 4.0 times MLS, to be unified at 2.4 times MLS in 2008 and further slightly increased to 2.5 times MLS in 2009.
- Parental allowance sharply grew from 3,696 CZK per month in 2006 to 7,582 CZK per month in 2007, with an option to choose the overall period of drawing in 2008.

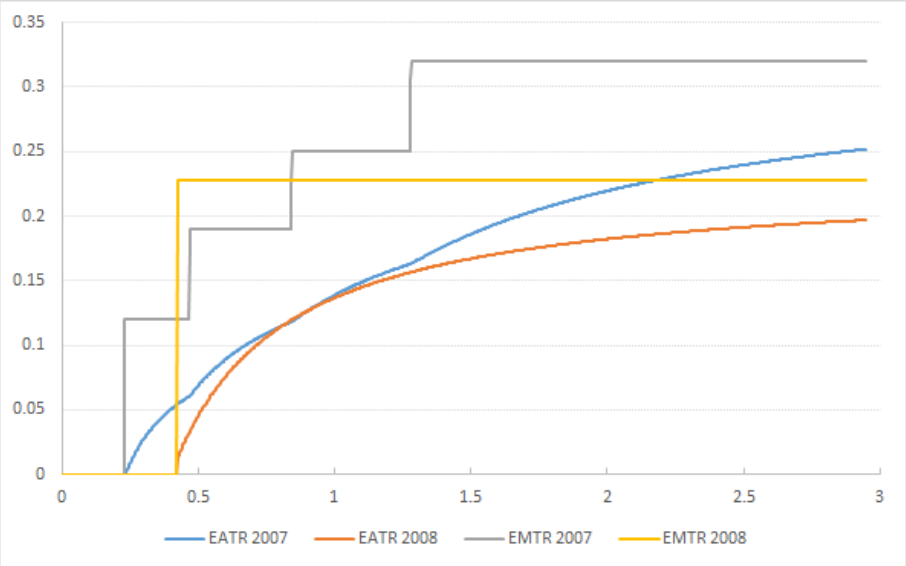
## 3.3 Simulated Impact of PIT reform on ETRs

In this part of the paper we try to quantitatively and graphically show the effect of changes in effective marginal and average tax rates induced by adopted tax and social welfare reforms by carrying out a simple microsimulation for a particular type of households.

The simplest household consists of a single person without children, thus not eligible for almost any social benefits unless with very low income. Comparison of average and marginal income tax rates for such a household before and after the reform can be observed in Figure 3.2.

Units of X axis are multiples of average wage in particular year, while on Y axis are tax rates measured in percentage points. X axis is restricted by triple of average wage to avoid mixing up individuals affected by SSC ceiling. Moreover, as Hrdlička *et al.* (2010) points out people earning more than 4 times average wage constitute only about 1.8% of all employees. Since SSC didn't change except for the mentioned case of a very few top earners, who are not in the figure, only PIT rates are considered here. The similar figure for overall tax wedge with social security contribution incorporated can be found in the Appendix A.

Figure 3.2: Marginal and Average Income Tax Rates for a One-Person Household




Source: Author's computations (2015)

From the figure it is obvious that elevated personal tax credit substantially increased tax-exempt income threshold, at which the single earner without children enters into PIT net, from 24 to around 43% of the average wage.[2] Marginal tax rates important for labour supply decision decreased by 12% for this part of the income distribution. The similar case occurred at the opposite end in an income range of around 1.3 to 4 times average wage, where marginal income tax rates decreased by about 9.2%. Only relatively minor changes come about in ranges of 0.45 to 0.85 and 0.85 to 1.3 times average wage, where MTRs rose by 3.8% and decreased by 2.2% respectively. The previous paragraph is summarized in Table 3.3.

Table 3.3: Changes in Marginal Tax Rates

| Income Range | Change in MTR |
|---|---|
| 0.00 - 0.23 | 0% |
| 0.23 - 0.45 | -12% |
| 0.45 - 0.85 | +3.8% |
| 0.85 - 1.30 | -2.2% |
| 1.30 - 4.00 | -9.2% |

[2]For other types of households this threshold is shifted more to the right, due to substantially broadened child and non-working spouse tax credits, nonetheless, the marginal tax rate of 22.8% (as it would be under the old tax system) remains the same once entering the PIT net.

Since the most of the social benefits are targeted on the families with children (Dušek *et al.* 2013a), we further focus our analysis on the single-member households, whose labour supply decisions shouldn't be distorted by other household members income and family-based social benefits.

# Chapter 4

# Individual Labour Supply Theory

Each healthy and able adult person must decide whether to work and once employed, how many hours to spend at job. This part of the paper describes basic framework usually used in various labour supply studies – the *neoclassical model of labour supply choice*.

## 4.1 The Utility Function

The model is based on microeconomic worker's preference theory. It assumes that both leisure and consumption are goods, so the consumer prefers more of each. Individual preferences are usually represented by utility function in the form

$$U = f(C, L), \tag{4.1}$$

where $C$ denotes consumption and $L$ denotes leisure. This function transforms various combinations of both goods into an index that measures the level of satisfaction – utility. It is generally accepted that different combinations of leisure and consumption can lead to the same level of utility. An aggregation of such points forms indifference curves illustrating the same level of utility with well defined properties:

1. Indifference curves are downward sloping. As both consumption and leisure are goods, if we get more of one, we must lower the other to keep the level of utility constant.

2. Higher indifference curves represent combinations of more leisure and more consumption, thus indicating higher levels of utility.

3. Indifference curves do not intersect in order to keep preferences rational.

4. If we are ever to observe the allocation of time between work and leisure, the indifference curves must be convex to origin. This is equivalent to decreasing marginal utility property.

## 4.2 The Budget Constraint

The consumption and leisure are bounded by person's time and income. Fraction of the income may be independent of hours worked. It is known as "non-labour" or "unearned income", say $V$. Denote $h$ the hours of work and $w$ the hourly wage rate. The budget constraint can be then written as:

$$C = wh + V, \tag{4.2}$$

thus the aggregate consumption must be equal to the sum of earned plus non-labour incomes. A worker has two options how to use their time: work or leisure. Let be $T$ a total number of hours available in a period. Then $T = h+L$, and we can rewrite the budget set:

$$C = w(T - L) + V = (wT + V) - wL, \tag{4.3}$$

where the last form of the equation is in fact a line representation with the slope of the negative wage rate. The budget line is easy to graph (see Figure 4.1), since in this static model we assume a constant wage rate for every hour worked and no savings. Even if the person decides not to work at all, such that $T = L$, she can still afford to consume $V$ amount of goods. The combination of consumption and leisure, when person doesn't work is called *endowment point*.

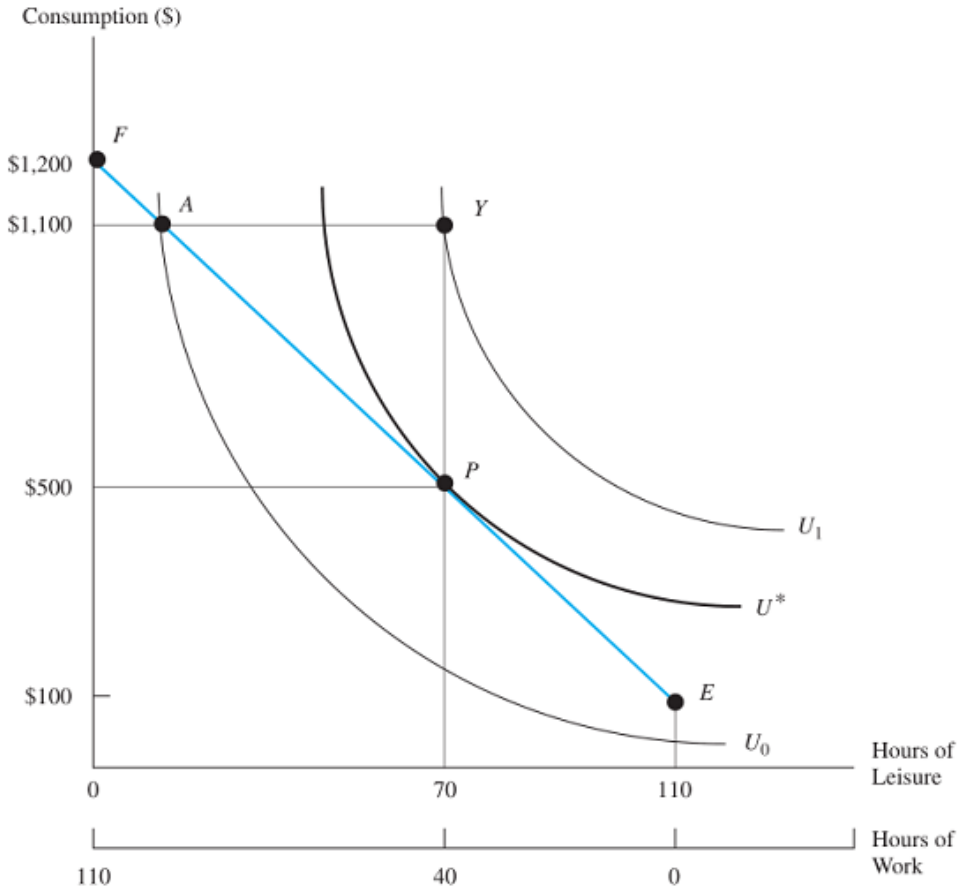
## 4.3 The Hours of Work Decision

Workers choose such a combination of leisure–consumption that maximizes their utility $U$ given their budget constraint. Because the person can always achieve the higher indifference curve, if the current one is crossing the budget line, and simultaneously, the indifference curves above the budget line are not affordable, this utility maximization is gained at the point, where the budget line is tangent to the indifference curve, hence their slopes are equal, i.e. the

ratio of marginal utilities—marginal rate of substitution—of leisure and consumption is equal to the wage rate as depicted at the Figure 4.1:

$$-\frac{MU_L}{MU_C} = -w \tag{4.4}$$

Figure 4.1: The Labour-Leisure Decision




Source: Borjas (2005)

### 4.3.1 The Impact of Change in Income

If only the non-labour income changes, while keeping the wage rate constant, the budget line shifts parallel to the original one. For example after an increase worker can achieve higher indifference curve, and thus is necessarily better off. The new combination of consumption and leisure depends, whether they are normal or inferior goods[1]. If we reasonably assume they are normal, then the *income effect*—as the impact of this change is called—increases consumption

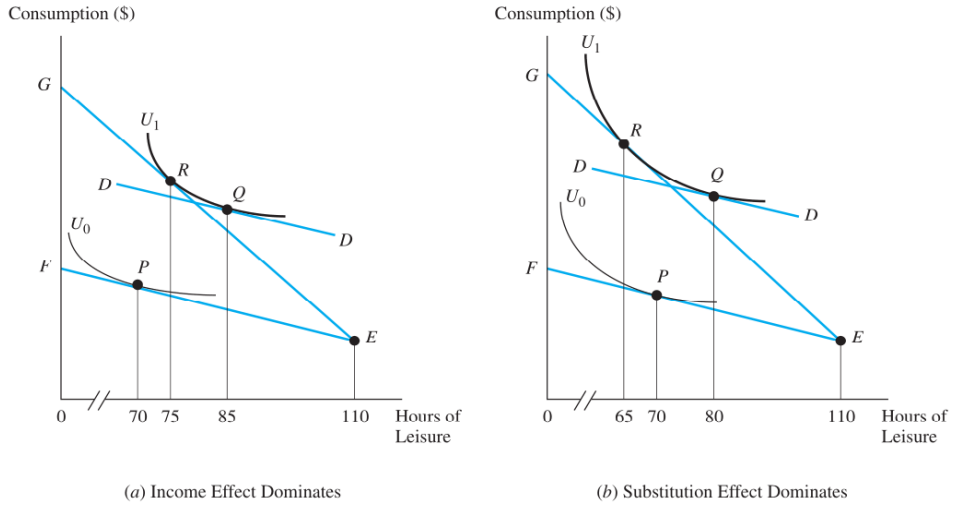
[1] Assumptions we made so far imply only one can be possibly inferior—it depends on the utility function—both can, however, be normal and they empirically usually are.

and reduces hours of work. In other words, substantial change in non-labour income (along with changes in preferences) may cause a shift in an individual labour supply curve (McConnell *et al.* 2003), see section 4.5.

If the wage rate changes, the situation is, however, more complicated. The budget line rotates around endowment point, but the net impact of the wage rate change is ambiguous. If wage increase, the budget set expands and worker has more opportunities. This should increase demand for all normal goods, including leisure. On the other hand, it also makes leisure more expensive. These two contradicting forces are crucial in determining what will be the final combination of factors. One is an already discussed *income effect*.

The latter opposite force with the negative sign is known as *substitution effect*, when after the wage growth the first leg of income effect impact takes place, the economic agent "moves" along the new indifference curve and reduces hours of leisure in favour of work, to compensate for more expensive leisure, keeping the income constant. The net outcome depends on the relative strengths of the effects as illustrated at Figure 4.2 and implicitly is defining wage elasticity of labour supply, see section 4.6.

Figure 4.2: Decomposition of Wage Change into Income and Substitution Effects




Source: Borjas (2005)

## 4.4 The Labour Force Participation Decision

The decision of work depends on so called *reservation wage*. It gives the wage rate that would make a person indifferent between remaining at the endowment

point and starting to work. Individual will not work if the offered wage is less than the reservation wage (she cannot get more utility than when not working under such a wage) and vice versa, the person will enter the labour market if the offered wage exceeds the reservation wage.

The reservation wage level depends on many factors, such as taste for work or if the leisure is a normal good. Holding the reservation wage constant, increase in the market wage rate increases the labour force participation. The difference to subsection 4.3.1 is that income effect is generated only if the person is already working. If not, the rise of the wage rate has no effect on their real income, but simply makes leisure more expensive, thus making them more likely to start working.

## 4.5 The Labour Supply Curve

The *labour supply curve* represents relation between hours of work and the wage rate. Figure 4.3 shows how individual labour supply curve can be obtained from the utility-maximization problem previously discussed.

The left panel illustrates optimal consumption-leisure bundles under several wage rates. At first, when the wage rate is lower than reservation wage, the person does not work. After market wage exceeds this threshold, person starts to work. From the right part of the figure it is obvious that substitution effect dominates at lower wage rates, while income effect dominates at higher ones. Because of this, the curve displayed at Figure 4.3 is usually referred to as *backward bending labour supply curve.*

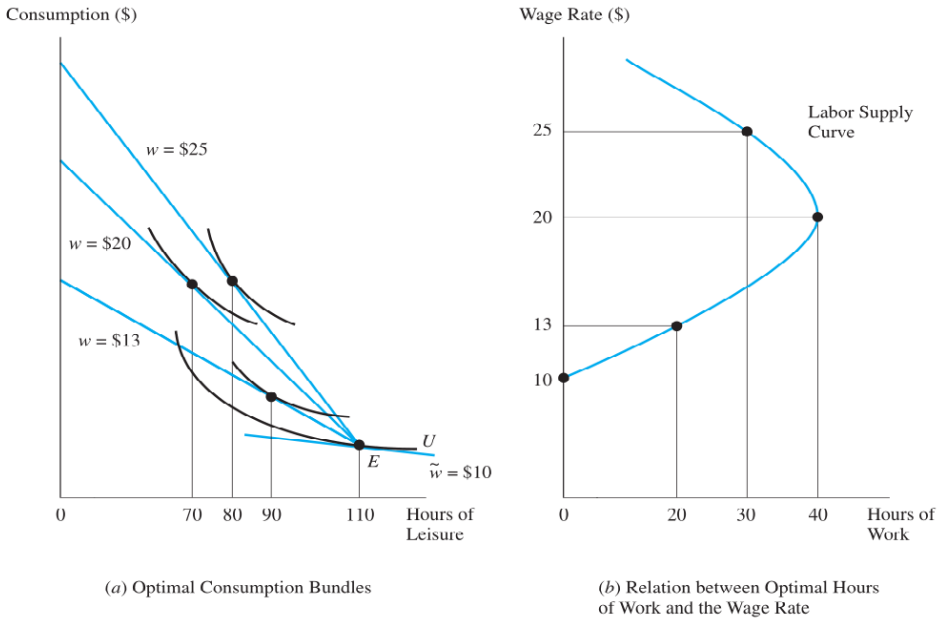
## 4.6 The Labour Supply Elasticity

Responsiveness of hours of work to changes in the wage rate is measured by the *labour supply elasticity* defined as:

$$\sigma = \frac{\text{percent change in hours of work}}{\text{percent change in wage rate}} = \frac{\Delta h/h}{\Delta w/w} = \frac{\Delta h}{\Delta w} \cdot \frac{w}{h} \tag{4.5}$$

The labour supply elasticity represents the percentage change in hours worked with a one percent change in the wage rate. The sign depends on the labour supply curve slope. It is positive when substitution effect dominates and negative when income effect dominates. The greater the absolute value of the labour

Figure 4.3: Derivation of Individual Labour Supply Curve




Source: Borjas (2005)

supply elasticity, the more the hours of work respond to changes in the wage rate.

### 4.6.1 Estimates of The Labour Supply Elasticity

Empirical responses of hours of work have been extensively researched like few other topics in economics. A typical study in the past was trying to estimate a model in the form:

$$h_i = \beta w_i + \gamma V_i + \text{covariates}, \tag{4.6}$$

with $h_i$ being i-th person's hours of work, $w_i$ their wage rate, and $V_i$ non-labour income. $w_i$ and often also $h_i$ are usually logarithmically transformed. Coefficient $\beta$ represents labour supply elasticity and its sign depends on already discussed "clash" of income and substitution effects. If *beta* is negative, income effects dominate, and vice versa, if positive, substitution effect dominate. There is almost as many estimates of elasticity as empirical studies, nevertheless, for men the average is often reported around -0.1, while for women around 0.2, thus women are more responsive to change in wages and for their labour supply the substitution effect seem to dominate contrary to the men's responses (Borjas 2005).

Nowadays, there are many other approaches of estimating labour supply responses to the change in the wage rates. They may be structural, static, dynamic, dealing with many types of obstacles. Many of the related works using various of these methods are reviewed in chapter 2. One of the popular methods in the labour economics field used also in this study is referred to as "natural experiment approach" that often uses "difference-in-differences" estimator. The approach is exploiting variation in incomes induced by changes in tax and welfare systems that had impact only on a part of population and it is discussed in detail in chapter 5. Perhaps it is important to mention that parameters estimated by this method measure the total response of a policy change, rather than elasticity per se (Blundell & Macurdy 1999).

# Chapter 5

# Data Description and Methodology

## 5.1 Data Description

The data used come from yearly European Labour Force Survey (LFS) for the Czech Republic for four consecutive years 2006-2009. The years 2006 and 2007 are defined as the pre-reform period here, while 2008 and 2009 are treated as the post-reform years.

The EU Labour Force Survey is the largest European household sample survey conducted in the 28 Member States of the European Union, 2 candidate countries and 3 countries of the European Free Trade Association. At the moment, the LFS anonymized microdata for scientific purposes contain data for all Member States in addition to Iceland, Norway and Switzerland. In general, data for individual countries are available depending on their accession date.

LFS provides quarterly and annual data on labour participation of people aged 15 and over and on persons outside the labour force. It covers residents in private households according to labour status. The data can be broken down according to multiple dimensions including age, sex, educational attainment, and distinctions between permanent/temporary and full-time/part-time employment. The significant drawback of the survey is unavailability of some income information. Only since 2009 the income decile for every surveyed working employee is provided.

For our data private households were sampled annually under the responsibility of the Czech Statistical Office (CZSO), which selected the sample, prepared the questionnaires, conducted the direct interviews among households, and forwarded the outcomes to Eurostat in accordance with the common coding scheme.

### 5.1.1 Sample Description and Summary Statistics

To keep the analysis straightforward and to avoid further identification difficulties and possible distortions the sample is restricted to one-person households only. The objects of our interests are people aged 20-60 years reporting living alone[1]. Magnitude of impact of the PIT reform on labour supply of these households is, however, questionable mainly due to well-known issues such as frictions, hours of work rigidity or inter-temporal substitution.

Despite other subgroups such as single mothers or married women reportedly respond more to exogenous changes in disposable income, their analysis would be much more complex and would demand a model on the household level, where other members incomes and labour decisions together with family oriented social benefits are involved.

Table 5.1: Estimation Sample Summary Statistics: Men

| | 2006 | | 2007 | | 2008 | | 2009 | |
|---|---|---|---|---|---|---|---|---|
| Variable | Mean | Std. Dev. | Mean | Std. Dev. | Mean | Std. Dev. | Mean | Std. Dev. |
| Participation | 0.88 | 0.32 | 0.89 | 0.31 | 0.90 | 0.30 | 0.89 | 0.31 |
| Unemployed | 0.08 | 0.27 | 0.05 | 0.23 | 0.05 | 0.21 | 0.07 | 0.25 |
| Income | 20,476 | 6,877 | 21,753 | 7,448 | 23,612 | 8,368 | 23,571 | 8,074 |
| Age | 41.10 | 11.10 | 40.81 | 11.15 | 40.66 | 11.20 | 40.54 | 11.20 |
| University | 0.15 | 0.35 | 0.15 | 0.36 | 0.16 | 0.37 | 0.18 | 0.38 |
| Married | 0.07 | 0.25 | 0.09 | 0.28 | 0.08 | 0.27 | 0.08 | 0.27 |
| Sample size | 5,764 | | 5,624 | | 5,765 | | 5,854 | |

Table 5.2: Estimation Sample Summary Statistics: Women

| | 2006 | | 2007 | | 2008 | | 2009 | |
|---|---|---|---|---|---|---|---|---|
| Variable | Mean | Std. Dev. | Mean | Std. Dev. | Mean | Std. Dev. | Mean | Std. Dev. |
| Participation | 0.76 | 0.43 | 0.79 | 0.41 | 0.77 | 0.42 | 0.79 | 0.41 |
| Unemployed | 0.06 | 0.24 | 0.04 | 0.21 | 0.04 | 0.20 | 0.06 | 0.23 |
| Income | 20,344 | 7,662 | 21,319 | 7,691 | 23,325 | 8,320 | 23,587 | 8,564 |
| Age | 44.83 | 12.34 | 43.99 | 12.48 | 43.57 | 12.56 | 43.40 | 12.65 |
| University | 0.14 | 0.35 | 0.16 | 0.36 | 0.17 | 0.37 | 0.18 | 0.38 |
| Married | 0.05 | 0.21 | 0.06 | 0.24 | 0.06 | 0.24 | 0.06 | 0.24 |
| Sample size | 4,513 | | 4,602 | | 4,492 | | 4,292 | |

[1]Although in many studies the prime age starts at 25 years, the reason to start at age 20 is that many workers of this age with (lower) secondary education are already participating in the labour market in the Czech Republic.

Basic summary statistics for the whole sample of single households can be found in Table 5.1 and Table 5.2. Interesting fact is that around 6% of these people are married despite they claim to live alone. One can also observe significantly higher labour force participation for single men than for their female counterparts, slightly growing share of people with higher education over the years, and decreasing average age, whereas men tend to be younger.

## 5.2 Defining Treatment and Control Groups

The data used in the paper is "just" anonymised `repeated cross-sections` and not true panel with no income in the data reported, i.e. we cannot track the same individuals over time (and neither estimate e.g. fixed effect model), thus it is not possible to divide individuals to treatment and control groups according to their incomes, which were not part of the survey and secondly, they were subjects to the tax reform and thus the composition of the groups created on this basis might change in a non-random way (Duncan & Peter 2010). In addition, incomes are not even observed for individuals out of labour force and very difficult to approximate in a reasonable way.

Therefore we have to find some other criterion for such an assignment. In this case the highest attained level of education is used as a proxy for income and thus approximate belonging of an individual to the particular income range and associated pre-reform marginal tax rate bracket. As a second grouping variable is considered cohort, this disaggregation, however, markedly lowers the sample sizes of the groups, see Table 6.3. As previously analysed, the marginal tax rates fell considerably especially for the low and high income earners and changed only negligibly around the mean of the income distribution.

The people with primary and lower secondary education, usually low-skilled and working in rather low-paid jobs, are taken as the first treatment group. The labour supply elasticity response, if any, is expected to occur at the extensive margin (labour force status change).

Nevertheless, given the minimum wage setting at the time, most of the employees working full time in analysed period had income greater than 0.45 times average Czech wage regardless of their occupation, implying a considerable part of the single lower educated experienced only minor change in their marginal tax rates due to the PIT reform and thus was effectively excluded from the treatment.

The highly educated individuals with college or university diploma are

serving as the second treatment group, since most of them are working as a highly-qualified professionals with above average earnings. On the contrary, these highly-skilled workers are expected to possibly adjust their labour supply at the intensive margin (hours of work change) if they can and if their net wage elasticity is sufficiently high.

Workers with completed upper secondary education are defined as the control group here. Although they are the largest and most variegated group from the three, we can assume that on average they are earning income around the Czech Republic mean or slightly below, due to typical right-skewed earnings distribution with outliers at the top incomes.

The shares of workers with particular education levels as defined by ISCED classification are summarized in Table 5.3.

Table 5.3: Highest Attained Level of Education

| Education | Men (%) | Women (%) | Total (%) |
|---|---|---|---|
| No Formal Education | 0.05 | 0.07 | 0.06 |
| Primary | 0.08 | 0.02 | 0.05 |
| Lower Secondary | 7.13 | 13.83 | 10.48 |
| Upper Secondary [1] | 43.51 | 28.16 | 35.84 |
| Upper Secondary [2] | 31.8 | 39.31 | 35.56 |
| Post-Secondary | 1.25 | 2.44 | 1.85 |
| Tertiary [3] | 0.75 | 1.75 | 1.25 |
| Tertiary [4] | 14.77 | 13.73 | 14.25 |
| Post-Tertiary | 0.66 | 0.69 | 0.68 |
| Observations | 23,004 | 17,898 | 40,902 |

[1] vocational, not designed to lead directly to next stage of education
[2] general, designed to provide direct access to further education or labour market
[3] practically oriented tertiary education (college)
[4] theoretically based/research preparatory (university)

Due to lack of observations for some educational levels, to finally construct the groups of interest we aggregate together people with *no formal education, primary education* and *lower secondary education*; both categories of *upper secondary education* plus *post-secondary non-tertiary education*; and finally *both levels of tertiary education* plus *post-tertiary education*. This way we obtain three broader levels of education: *low, medium* and *high* summarized in Table 5.4, which are actually our treatment/control groups as described above.

Table 5.4: Groups According to the Education Level

| Education Level | Men (%) | Women (%) | Total (%) | Observations |
|---|---|---|---|---|
| Low | 7.26 | 13.92 | 10.02 | 4,677 |
| Medium | 76.56 | 69.91 | 73.80 | 30,579 |
| High | 16.18 | 16.17 | 16.18 | 5,646 |
| Observations | 23,004 | 17,898 | 40,902 | |

### 5.2.1 Occupational Choices and Distribution of Income by Levels of Education

To effectively assess the basic labour market decomposition according to the levels of education, we present the cross-table of shares of individuals with certain education levels in rather broad defined occupation groups based on 1-digit ISCO classification codes. In the last column the absolute numbers of people in every occupation group are stated[2].

For example the most common workers in the sample are technicians and associate professionals, followed by craftsmen, and operators. Table 5.5 also shows that almost half of low educated in the sample is either inactive or unemployed according to ILO labour status definition. On the contrary, just 20.5% and 8.7% respectively are not employed among those with medium and high levels of education.

If the non-working individuals are omitted (the table on the right side), it is clear that less skilled workers with low level of education largely work as plant/machine operators or in some of the elementary occupations. A smaller but still considerable part operates in service & sales, and craft & related trades. People with attained upper secondary education are mostly technicians/associated professionals, craftsmen, plant/machine operators, or work in service & sales. The most educated group is conclusively dominated by professionals, followed by technicians and managers.

One can relatively easily assume, which occupations should be highly rewarded in monetary terms and vice versa. For better notion we provide an overview of incomes by reporting averages of medians of gross wages in business sector for concrete occupation groups over the examined years in Table 5.6. One can notice that for many of the occupation groups wages fell in 2009, probably because of the intensifying economic crisis.

[2]The figures are different after omitting unemployed and inactive persons because of using analytical weights.

Table 5.5: Share of Individuals in Occupation Groups According to Their Education Level

| | Education Level | | | | Education Level | | | |
|---|---|---|---|---|---|---|---|---|
| Occupation | Low (%) | Middle (%) | High (%) | Total | Low (%) | Middle (%) | High (%) | Total |
| armed forces | 0.00 | 0.27 | 0.29 | 132 | 0.00 | 0.34 | 0.32 | 128 |
| managers | 0.67 | 3.63 | 10.44 | 2,420 | 1.31 | 4.57 | 11.44 | 2,358 |
| professionals | 0.28 | 3.34 | 47.51 | 5,727 | 0.54 | 4.21 | 52.05 | 5,579 |
| technicians | 1.24 | 18.57 | 25.40 | 9,666 | 2.44 | 23.35 | 27.83 | 9,416 |
| clerical support | 1.76 | 6.37 | 3.17 | 2,868 | 3.45 | 8.01 | 3.47 | 2,793 |
| service and sales | 8.09 | 11.56 | 2.15 | 5,114 | 15.88 | 14.54 | 2.36 | 4,982 |
| agriculture | 2.24 | 0.98 | 0.40 | 532 | 4.40 | 1.24 | 0.44 | 519 |
| craft and related | 6.88 | 17.43 | 1.09 | 7,245 | 13.49 | 21.92 | 1.19 | 7,057 |
| machine operators | 14.66 | 13.22 | 0.69 | 5,953 | 28.76 | 16.63 | 0.76 | 5,799 |
| elementary | 15.15 | 4.14 | 0.13 | 2,380 | 29.72 | 5.21 | 0.14 | 2,319 |
| not employed | 49.04 | 20.47 | 8.72 | 11,232 | - | - | - | - |
| Observations | 4,960 | 39,033 | 9,278 | 53,271 | 2,462 | 30,239 | 8,249 | 40,950 |

These (medians) were imputed from from Information Survey on Average Earnings conducted quarterly under supervision of the Czech Statistical Office and Ministry of Labour and Social Affairs. The break-down level was chosen at 1-digit ISCO codes taking into account NUTS 2 regions, where the individuals live. The drawback of this approach is indeed a great simplification, since the persons within the same occupation group and region have imputed income equal regardless of age, sex or education, but at he moment these statistics were the best available solution.

Table 5.6: Gross Median Wages According to Occupation (in CZK)

| Occupation | 2006 | 2007 | 2008 | 2009 | Observations |
|---|---|---|---|---|---|
| armed forces | 21,067 | 22,925 | 24,606 | 23,084 | 119 |
| managers | 35,033 | 37,166 | 41,392 | 39,921 | 1,977 |
| professionals | 30,664 | 31,515 | 33,898 | 34,908 | 4,111 |
| technicians | 22,851 | 23,811 | 26,066 | 26,355 | 7,252 |
| clerical support | 16,270 | 16,688 | 18,643 | 19,419 | 2,008 |
| service and sales | 12,357 | 12,643 | 13,442 | 13,917 | 3,692 |
| agricultural, forestry | 14,313 | 14,916 | 16,523 | 15,667 | 372 |
| craft and related | 18,004 | 18,955 | 20,402 | 20,175 | 5,368 |
| machine operators | 17,735 | 18,357 | 20,020 | 19,459 | 4,632 |
| elementary | 12,540 | 12,742 | 13,787 | 13,648 | 1,828 |
| Observations | 7,068 | 7,634 | 8,271 | 8,386 | 31,359 |

In addition to the table we show the effect of education on job market position and earnings level in Figure 5.1, where there are plots for every year of the examined period with income deciles of gross median take home pay on the X axis, and percentage of the sample with particular education level within these deciles on the Y axis.

Whilst only a tiny fraction of the low educated employees takes home pay greater than median, the high-skilled workers' earnings above the 7th decile are substantially right-skewed. For both of these subgroups there seem to occur some remarkable shocks to the wages distribution during the reference period. The comparison group of medium education level individuals has relatively consistent distribution of income over the years with fractions of workers more or less evenly divided especially among the first 8 deciles.

Figure 5.1: Monthly Gross Wages Deciles Distribution by Education


Source: Author's computations (2015)

Since reporting income deciles in Labour Force Survey (LFS) started to be mandatory from 2009, the similar figure for the years 2009-2011 based on the income deciles reported directly in the survey can be found in Appendix A. Hence the reader can compare the relative accuracy of imputed aggregate income statistics with the ones reported by the respondents directly at least for 2009.

## 5.3 Difference-in-Differences Estimator

To quantitatively assess the impacts of policies or programs, when randomized trials are impossible to conduct, often only the observational data such as responses to survey questions are available to use. A possible caveats with these studies, however, is that observations are not randomly assigned to treatment. Statistical approaches used to explore these data are often referred to as "treatment effects" (ATE) models.

In this part of the thesis, we consider one of the methods for estimating treatment effects with observational data: the "difference-in-differences" (DiD) estimator, which is just a special case of the well-known fixed effects model (Blundell & Macurdy 1999). We will briefly discuss the DiD model and its underlying assumptions, and then turn to our topic application: Estimating effects of PIT reform on labour supply of single-person households.

Since simple comparison of pre- and post-treatment outcomes for the treated is likely to be contaminated by temporal trends in the outcome variable or by the effect of events, other than the treatment, the essential reasoning behind the DiD technique, or the "natural experiment approach", is to obtain the treatment effect by estimating the difference between outcome measures at two time points for both the treatment and the comparison group, which was not exposed to the treatment and then comparing the difference between the two; hence the difference-in-differences (Buckley & Shang 2003).

The double differencing effectively rules out any (unobserved) variables constant over time correlated with the selection process and the outcome variable from affecting the estimation of interest. To achieve this, DiD procedure involves repeated observations of the units. These may not necessarily have a true panel structure, where data is collected on the same individuals at both periods, as repeated cross-sections, such as two random survey samples like in our case, are sufficient, if other assumptions for using this technique hold.

### 5.3.1 Main Assumptions of the DiD Model

The crucial assumption of the method is that in the absence of treatment the average change in the outcome is expected to be equal for both the controls and, as a counterfactual, for treated if they had not participated, i.e. it is presumed that unmeasured factors, like macroeconomic shocks or other economic policies,

affect both groups in similar manner. This condition is often referred to as "common" or "parallel trends".

Moreover, especially in pseudo-panels like our data, there must not be a systematic change in composition of treatment and comparison groups with respect to the fixed effect term to ensure before-after comparability. For rich and comprehensive discussion of these assumptions see Blundell & Dias (2000; 2002; 2009). Abadie (2005) proposes a more technically complex solution that employs the semi-parametric technique—the propensity score matching, to adjust the sample, when the "parallel trends" assumption is violated.

One should be aware that beside these identifying assumptions, the DiD as described here employs the ordinary least squares estimator and, as such, it is sensitive to the usual violations of the Gauss-Markov theorem (such as homoscedasticity, normality, and no autocorrelation).

### 5.3.2 Derivation of the DiD Model

The conventional DiD model here is defined following Abadie (2005). Let $Y_{it}$ be the outcome of interest for individual $i$ at time $t$. The population is observed before policy change at $t = 0$, and after policy change at $t = 1$. Between the two, a part of the population is subject to the treatment. Denote $D_{it} = 1$ if individual $i$ has been exposed to the treatment before period $t$, $D_{it} = 0$ otherwise. The participants form the `treatment group`, while the latter are `controls`. Since everyone can be possibly only exposed to treatment after the first period, $D_{i0} = 0$ for all $i$.

The estimator is usually derived using a linear parametric model like e.g. in Ashenfelter & Card (1985):

> Suppose the outcome variable is generated by a components of variance process
>
> $$Y_{it} = \delta_t + \gamma D_{it} + \eta_i + \nu_{it}, \tag{5.1}$$
>
> where $\delta_t$ is a time-specific component, $\gamma$ represents the impact of the treatment, $\eta_i$ is an individual-specific component, and $\nu_{it}$ is an individual-transitory shock that has mean zero at each period, $t = 0, 1$, and is possibly correlated in time. Only $Y_{it}$ and $D_{it}$ are observed. The effect of the treatment, $\gamma$, is not identified without further restrictions. A sufficient condition for identification is that

selection for treatment does not depend on the individual-transitory shocks, that is

$$P(D_{i1} = 1|\nu_{it}) = P(D_{i1} = 1) \tag{5.2}$$

for $t = 0, 1$. Adding and subtracting $E[\eta_i|D_{i1}]$ in (5.1) we obtain

$$Y_{it} = \delta_t + \gamma D_{it} + E[\eta_i|D_{i1}] + \epsilon_{it}, \tag{5.3}$$

where $\epsilon_{it} = \eta_i - E[\eta_i|D_{i1}] + \nu_{it}$. Notice that $\delta_t = \delta_0 + (\delta_1 - \delta_0)t$, and $E[\eta_i|D_{i1}] = E[\eta_i|D_{i1} = 0] + (E[\eta_i|D_{i1} = 1] - E[\eta_i|D_{i1} = 0])D_{i1}$. Let $\alpha = E[\eta_i|D_{i1} = 0] + \delta_0$, $\beta = E[\eta_i|D_{i1} = 1] - E[\eta_i|D_{i1} = 0]$ and $\delta = \delta_1 - \delta_0$.

We obtain:

$$Y_{it} = \alpha + \beta D_{i1} + \delta \cdot t + \gamma D_{it} + \epsilon_{it}. \tag{5.4}$$

The restriction in (5.2) for $t = 0, 1$ implies $E[(1, D_{i1}, t, D_{it}) \cdot \epsilon_{it}] = 0$, so all the parameters in equation (5.4), including treatment effect $\gamma$, can be estimated by ordinary least squares[3]. Notice, that the model allows *any* kind of dependence between selection for treatment, $D_{i1} = 1$, and the individual-specific component, $\eta_i$. This model is called "difference-in-differences", because under the identifying condition in equation (5.2) we have

$$\begin{aligned} \gamma = &\{E[Y_{i1}|D_{i1} = 1] - E[Y_{i1}|D_{i1} = 0]\} \\ &- \{E[Y_{i0}|D_{i1} = 1] - E[Y_{i0}|D_{i1} = 0]\}, \end{aligned} \tag{5.5}$$

and the least square estimator of $\gamma$ is the sample counterpart of equation (5.5).

In equation (5.4) estimable by OLS as already mentioned, the $Y_{it}$ is an outcome measure for particular individual in one of two periods, $D_{i1}$ is a dummy variable signalising, whether person received treatment, while $D_{it}$ can be rewritten as interaction term $D_{i1} \cdot t$, which is effectively just a dummy variable equal to 1, if person was exposed to treatment and the period is post-treatment.

[3]If true panel data are available, model is even more straightforward, statistically powerful and greatly simplifies.

Among the parameters estimated $\alpha$ is a common intercept for all observations, $\beta$ shifts this intercept for treated only, $\delta$ is an effect of time on all units and finally $\gamma$ is our main target of interest, Average Treatment Effect on the Treated (ATT) and according to equation (5.5) it can be seen as a causal parameter and excess difference to the common difference between treated and controls, because of exposure to the treatment, if the underlying assumptions are met.

The expected values of parameters of interest of the model above are summarized in a comprehensive Table 5.7.

Table 5.7: Parameters of Interest in Difference-in-Differences Model

| | *Pre-Treatment* | *Post-Treatment* | ***Difference*** |
|---|---|---|---|
| Treated Units | $\alpha + \beta$ | $\alpha + \beta + \delta + \gamma$ | $\delta + \gamma$ |
| Control Units | $\alpha$ | $\alpha + \delta$ | $\delta$ |
| **Difference** | $\beta$ | $\beta + \gamma$ | $\gamma$ |

### 5.3.3 Extending the Difference-in-Differences Model

The basic model for two periods can be easily extended for multiple periods and groups, as well as by adding covariates as control variables that may not only help the model to be more statistically powerful but also control for confounding trends (Angrist & Pischke 2008). The model then looks as following:

$$Y_{igt} = \alpha + \beta D_g + \delta \cdot D_t + \gamma D_{gt} + \pi X_{igt} + \epsilon_{igt}, \tag{5.6}$$

where $D_g$ are group dummy variables, $D_t$ are year dummies[4], $D_{gt}$ is an indicator for treatment group in post-treatment period and $X_{igt}$ is a vector of covariates either on individual or group level.

[4]Both can be thought as individual and time fixed effects.

# Chapter 6

# Results

## 6.1 Model Setup

Summarizing the we have two treatment groups—low and high educated individuals, and one control group—people with middle level of education and we employ a difference-in-differences estimator for two possible margins of the labour supply as dependent variables.

Economic theory suggest that if there are any responses, they should concentrate mostly at the extensive margin, i.e. labour force participation for the low-skilled workers, while it should be more about hours of work response at intensive margin for the high-skilled. For the former case one may expect the rise in employment of low-educated due to increase in the market wage caused by fall in the effective marginal tax rate many of these individuals possibly faced, and thus (for at least some of them) it might become greater than the reservation wage. Sign of hours of work response of already working is ambiguous, as it depends on the relative strengths of income and substitution effects for our groups of interest. Nevertheless, most of the studies agree on greater responsiveness at the extensive margin (Eissa & Liebman 1996; Meyer & Rosenbaum 2001; Blundell *et al.* 2011)

Expressed in mathematical form, the specification of our model looks as follows:

$$Y_{igt} = \alpha + \beta \cdot D_g + \delta \cdot D_t + \gamma \cdot D_{gt} + \pi \cdot X_{igt} + \epsilon_{igt}, \tag{6.1}$$

where $Y_{igt}$ are hours of work or labour force participation, respectively, $D_g$ is low or high educated group indicator, $D_t$ are year dummies, $D_{gt}$ is an indicator of the treated in post-reform period and in fact the interaction effect of the

previous two, if there are only two periods and two groups. $X_{igt}$ are covariates that should lower the variation in the error term, control for some uncaptured differences between groups and may vary across individuals, groups or time.

Unfortunately, there is a lack of continuous variables in our survey data, thus our covariates include regional dummies at Nomenclature of Territorial Units for Statistics (NUTS 2) level, degree of urbanisation indicators, marital status (for single-member households may seem weird, see subsection 5.1.1 though) and gender indicators, and age bands dummies.

The relative heterogeneity across the defined groups by covariates is assessed in Table 6.1. For example low-educated have substantially greater average age and are dominated by females, while people with tertiary education live mostly in the densely populated areas. Even if we deal with one-person households, almost 10% of them claim to be married. Thus it is questionable if the control group would mimic the counterfactual behaviour of the treatment groups in the absence of treatment.

Table 6.1: Sample Characteristics According to Level of Education

| | Low | Middle | High |
|---|---|---|---|
| Age | 49 | 42 | 40 |
| Females | 0.576412 | 0.39304 | 0.414781 |
| Married | 0.048105 | 0.067593 | 0.096047 |
| City | 0.273894 | 0.382943 | 0.591746 |
| Town | 0.251229 | 0.211649 | 0.166135 |

Both models are linear and since labour force participation is a binary choice, its Difference-in-Differences (DiD) estimator is in fact a linear probability model. Despite it is well known that this model is heteroskedastic from definition, it has some preferable properties unless not intended for predictions, like straightforward interpretation without burdensome computing of marginal effects and easy implementation within difference-in-differences framework. Heteroskedasticity can be easily corrected for by using some type of robust standard errors. For suggestion of very sophisticated non-linear DiD models see e.g. Athey & Imbens (2006).

### 6.1.1 Assumptions, Their Validity and Potential Difficulties

Let us recall the two most important assumptions for difference-in-differences estimator to be consistent:

1. Parallel trends assumption: Time effects are assumed to have common effects across treated and controls. If both groups share similar trends with stable difference between them, then DiD procedure recovers ATT. The difficulties might arise when demographic composition of treatment and control groups significantly differ; empirically the trends and business cycles don't have the same impact on single/married, men/women, high-skilled/low-skilled workers, which is essentially also our case.

2. Stable composition assumption: Composition of both groups must remain stable before and after treatment. If the individuals in each group have the same characteristics before and after the change, differencing eliminates averages of unobserved individual effects. Unfortunately, even if the DiD successfully recovers ATT, this is subject to conventional sample selection biases and cannot be used to simulate policy responses (Blundell & Macurdy 1999).

When one or both of these conditions are not fulfilled, Abadie (2005) proposed to use non-parametric approach—namely propensity score matching—together with difference-in-differences. Another famous paper published by Bertrand *et al.* (2004) advises to correct for serial correlation if using multiple periods in order to obtain reliable standard errors and test statistics.

## 6.2 Trends in Employment and Hours of Work

At first, we provide an overview of employment and hours of work development in Table 6.2 according to levels of education. In upper part of the table, there are employment figures in percent, while at the bottom, there are average weekly working hours in a given year for those who were employed.

Table 6.2: Employment and Hours of Work Development

| | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|
| Low (%) | 49.40 | 52.95 | 52.37 | 51.00 |
| Medium (%) | 77.38 | 80.19 | 80.90 | 79.42 |
| High (%) | 91.64 | 94.37 | 91.76 | 89.60 |
| Low | 39.92 | 40.38 | 40.81 | 41.02 |
| Medium | 42.09 | 42.37 | 42.61 | 42.19 |
| High | 43.58 | 43.00 | 44.12 | 44.02 |

Since we have data for two periods before the policy change and two periods after, we cannot sufficiently assess the parallel trends assumption. Yet, at Figure 6.1 and Figure 6.2 are depicted trends for employment and hours of work, respectively. The three lines reflects our treatment and control groups defined according to level of education over the years we have data for.

Figure 6.1: Employment

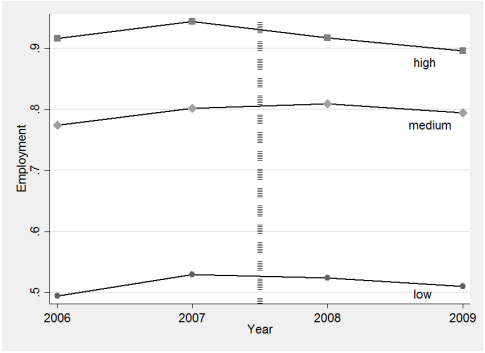
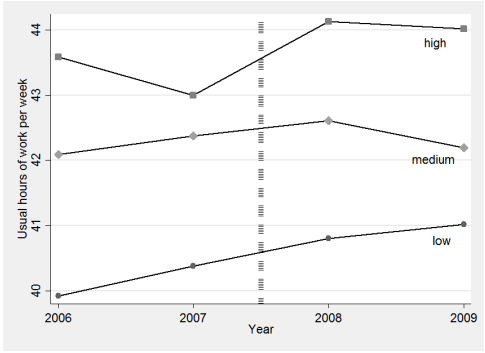


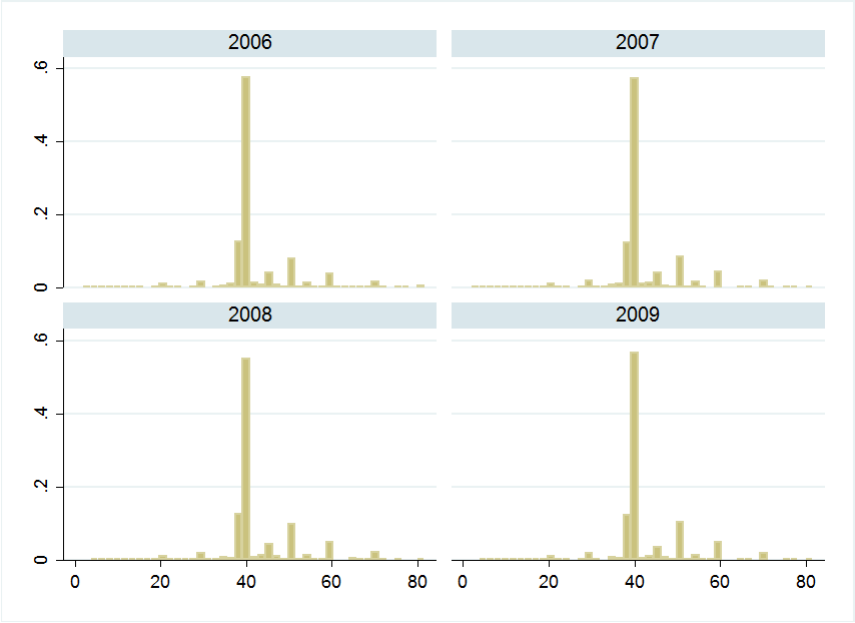

Figure 6.2: Hours of Work




Source: Author's computations (2015)

From the previous graphs it is hard to tell, whether there are some parallel trends, it rather seems there are not. Most probably, the groups are too heterogeneous and their responses to overall macroeconomic shocks are different. For example, one might assume the impact of global economic crisis on employment of low-skilled and high-skilled workers was fairly different.

Figure 6.3: Workers' Usual Weekly Working Hours




Source: Author's computations (2015)

As for hours of work, it is known that there is a substantial measurement error on these values reported in the survey data (Bound *et al.* 1994). Many workers are paid fixed monthly salary and they make a little effort to track how many hours they work in a week. Thus we might expect many of the respondents just report 40 hours a week. Figure 6.3 shows almost 60% of workers reported 40 hours as their usual weekly working time. Moreover, most of the employees have set their working time in the contract and cannot freely decide for number of hours.

To see the patterns in the data in more detail, we further split the education groups according to the age of individuals to 4 subgroups for every education level group. Overall, in the sample we have men and women aged 20–60, divide them by 10-year bands and finally match them according to education level. The trends for employment and working hours can be observed at Figure 6.4 and Figure 6.5.

Figure 6.4: Trends in Employment by Age Groups and Level Of Education


Source: Author's computations (2015)

The figures reveal significant heterogeneity especially within the group of low education level. The younger half seemed to be vulnerable to worsening economic conditions and in 2009 their employment rapidly declined possibly at least partially due to massive layoffs. It is also obvious that the low-skilled in-

dividuals aged over 40 suffer from low labour market participation levels. Similar trend can be observed also for the persons with completed upper secondary education but just in the age category above 50 years, where the difference in employment between the two groups fell approximately by on half. This issue is frequently stressed also by the media and it raises a question, to what extent is this voluntary. Beside this age subgroup, other medium level educated and all high educated maintain relatively high and stable levels of employment with the youngest cohorts working slightly less.

Figure 6.5: Trends in Usual Weekly Working Hours by Age Groups and Level Of Education


Source: Author's computations (2015)

At the first glance, the hours of work exhibit a bit more variation over the groups and cohorts, yet, one should be cautious with making preliminary conclusions, because of hours of work rigidity and measurement error typically present in the survey data, as discussed in previous paragraphs.

When the sample is split into 3 groups of education level times 4 age groups, the subsamples suffer from considerably lowered number of observation, which can make it difficult to meet especially the second assumption of the same groups composition randomly drawn from the same population before and after the policy change if used for possible DiD estimation over these smaller sub-

groups. In the Table 6.3 we provide absolute numbers of individuals of the given age groups within the specific level of education.

Table 6.3: Number of Individuals in the Specific Age-Education Clusters

| | Age group | | | | |
|---|---|---|---|---|---|
| | 20 - 30 | 30 - 40 | 40 - 50 | 50 - 60 | Total |
| Low | 306 | 354 | 803 | 2,637 | 4,100 |
| Middle | 6,576 | 6,940 | 5,794 | 10,874 | 30,184 |
| High | 1,542 | 1,996 | 1,347 | 1,733 | 6,618 |
| Total | 8,424 | 9,290 | 7,944 | 15,244 | 40,902 |

## 6.3 Estimation Results

In this part of the chapter we present the most important estimation results and their possible interpretation. Full table with all estimated parameters including covariates can be found in Appendix A.

First we examined the responses for the first treatment group—individuals living alone with completed primary or lower secondary education. From the Table 6.4 it seems that contrary to our intuition the treatment parameter $\gamma$ is slightly negative and on average it looks that combination of treatment (group) and "post-" period lowered the probability of employment among the low educated by -0.53% and it is significant at 95% level of confidence.

As for covariates, the most significant is parameter on age, which is expressed in 5-year bands between 20-60, with the value almost equal to DiD coefficient. Being female lowers the probability of labour force participation in contrast to being married, even if living alone. Most of the regional dummies beside the two Moravian regions are not different from Prague, which is the base category, the urbanisation degree has no distinct effect to base category city as well.

Estimation results for hours of work of low-skilled workers in Table 6.5 shows significant interaction coefficient, that caused increase in working hours on average by 0.294. In this case, several regional dummies coefficients are significant, estimated impact on female and married indicators are also significant, and have negative and positive sign, respectively. For hours of work, age is, however, not significant.

Table 6.4: DiD Estimation: Labour Force Participation of Low Educated

| | Before | | | After | | | |
|---|---|---|---|---|---|---|---|
| | Control | Treated | Diff | Control | Treated | Diff | DiD |
| Employed | 1.038 | 0.818 | -0.220 | 1.043 | 0.817 | -0.225 | -0.005 |
| Std.Error | (0.019) | (0.023) | (0.005) | (0.019) | (0.024) | (0.006) | (0.001) |
| Sample | 7782 | 1072 | | 7653 | 1137 | | |
| $R^2$: | 0.088 | | | | | | |

Standard errors clustered at group-year level in parentheses

Table 6.5: DiD Estimation: Hours of Work of Low Educated

| | Before | | | After | | | |
|---|---|---|---|---|---|---|---|
| | Control | Treated | Diff | Control | Treated | Diff | DiD |
| Hours | 44.522 | 43.040 | -1.482 | 44.647 | 43.460 | -1.187 | 0.294 |
| Std.Error | (0.499) | (0.578) | (0.080) | (0.483) | (0.547) | (0.066) | (0.019) |
| Sample | 6124 | 556 | | 6079 | 580 | | |
| $R^2$: | 0.050 | | | | | | |

Standard errors clustered at group-year level in parentheses

Surprisingly, for the highly educated the extensive margin seems to be even more significant than for the low educated. The coefficient of interest is negative and can be interpreted as 3.27% decrease in labour force participation probability of high-skilled workers. Most of the covariates have same effect as in the previous case, i.e. increasing age and being female lower probability of working, while being married leads to the opposite. The only region distinct from Prague is Central Moravia and Moravia-Silesia as before.

Table 6.6: DiD Estimation: Labour Force Participation of Highly Educated

| | Before | | | After | | | |
|---|---|---|---|---|---|---|---|
| | Control | Treated | Diff | Control | Treated | Diff | DiD |
| Employed | 1.000 | 1.142 | 0.142 | 1.005 | 1.114 | 0.109 | -0.033 |
| Std.Error | (0.023) | (0.023) | (0.002) | (0.023) | (0.023) | (0.002) | (0.000) |
| Sample | 7782 | 1396 | | 7653 | 1466 | | |
| $R^2$: | 0.055 | | | | | | |

Standard errors clustered at group-year level in parentheses

The intensive margin of labour supply of high-skilled workers is in fact "intensive"—interaction of post-reform period and being in the group of highly

educated caused on average increase in working hours by 0.839. Female indicator plus many regional dummies have highly significant and negative coefficient, indicating that working hours probably increased mostly for highly educated males in Prague, which are the base categories. Age and marriage seem to have no effect in this case.

Table 6.7: DiD Estimation: Hours of Work of Highly Educated

| | Before | | | After | | | |
|---|---|---|---|---|---|---|---|
| | Control | Treated | Diff | Control | Treated | Diff | DiD |
| Employed | 44.298 | 44.703 | 0.404 | 44.414 | 45.657 | 1.243 | 0.839 |
| Std.Error | (0.374) | (0.348) | (0.044) | (0.363) | (0.340) | (0.047) | (0.011) |
| Sample | 6124 | 1280 | | 6079 | 1320 | | |
| $R^2$: | 0.051 | | | | | | |

Standard errors clustered at group-year level in parentheses

Despite all four coefficients on the treatment groups in the post-reform period are significant, it is questionable, whether it is an ATT, what was recovered by the DiD estimator. We believe that due to heterogeneity of the selected groups and their possible distinct reaction to macroeconomic shocks it is probably not, hence it would be very daring to interpret the effects as causal.

Moreover, to perform some robustness checks like *triple differences* or *placebo DiD*, usual for the method employed, is pretty hard due to lack of available control groups for the former method and almost no recent years without any change in tax or welfare policy, that wouldn't have affected at least some part of the population in the Czech Republic. Although empirical studies suggest single mothers or married women respond more to wage rate changes, in the case of Czech Republic e.g. for the latter group the response to markedly broadened non-working spouse and children tax credits might be to the large extent offset by the abolition of joint taxation of married couples (Kalíšková 2014).

The attempt to assess the 2008 tax reform from the labour supply perspective provide a solid basis for further research. It might involve more carefully defined treatment and control groups that might be more responsive to the exogenous changes in disposable income, slightly different methods such as propensity score matching difference-in-differences, instrumental variables combines with some structural approach or the currently very popular synthetic control methods.

# Chapter 7

# Conclusion

In the previous 6 chapters we tried to evaluate the comprehensive tax scheme reform adopted in the 2008 in the Czech Republic based on labour supply responses of one-person households using quasi-experimental method known as difference-in-differences by exploiting the adoption of the single flat personal income tax rate as a natural experiment. The workers' responses were estimated at the intensive (hours of work) and extensive (labour force participation) margins of the labour supply elasticity controlling for several additional factors.

After comprehensive description of the adopted reform and setting theoretical ground for the chosen model we have constructed treatment and control groups using European Labour Force Survey yearly microdata for 2006–2009, with highest attained level of education as a proxy for income, that would assign particular individual to the associated pre- and post-reform tax brackets. Based on the simple microsimulation we estimated the income ranges, for which the effective income tax rates changed considerably and for which the change was rather negligible, thus the people in latter group would mimic the responses of the former in the absence of treatment.

Taking changes in the effective tax rate as an exogenous treatment only part of the population is exposed to, we assumed that assignment to treatment was as good as random, which in the end might not be the case due to very heterogeneous characteristics of the constructed groups. These probably react differently to a aggregate macroeconomic shocks over time, thus not fulfilling the assumption of "parallel trends" crucial for the DiD procedure to recover consistent estimate of ATT.

Despite our results suggest all parameters of interest were found significant, at least some of them are not of expected sign and magnitude, hence cannot be

interpreted as causal owing to the tax reform. Specifically, we found significant negative impact on labour force participation of low-skilled, but especially high-skilled individuals and significant positive impact on hours of work of already employed within both groups.

These results should be approached with caution due to a number of reasons: possible endogeneity of the policy change caused by targeting specific groups in a non-random way, measurement error of hours of work typical for the survey data and their rigidity due to employment contracts, possible impact of the reform in the long-run rather than immediately, and at last but not least the extensive social welfare reform that was adopted the year before and other partial changes in the tax and benefits system occurring almost every year make it harder to isolate the effects of the selected tax reform and compare the outcomes before and after this policy change.

The attempt to assess the 2008 tax reform from the labour supply perspective provide a solid basis for further research. It might involve carefully defined alternative treatment and control groups based on the valid exclusion restriction that might be more comparable and responsive to the exogenous changes in disposable income. This can be achieved by using slightly different methods such as semi-parametric propensity score matching difference-in-differences, instrumental variables combined with a comprehensively defined structural model or the currently very popular synthetic control methods.

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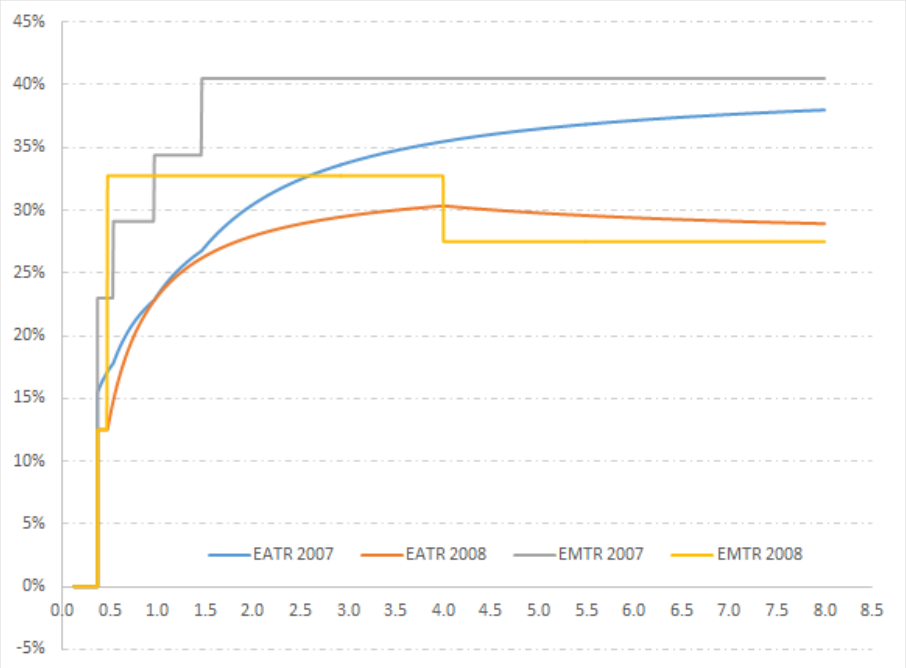
# Appendix A

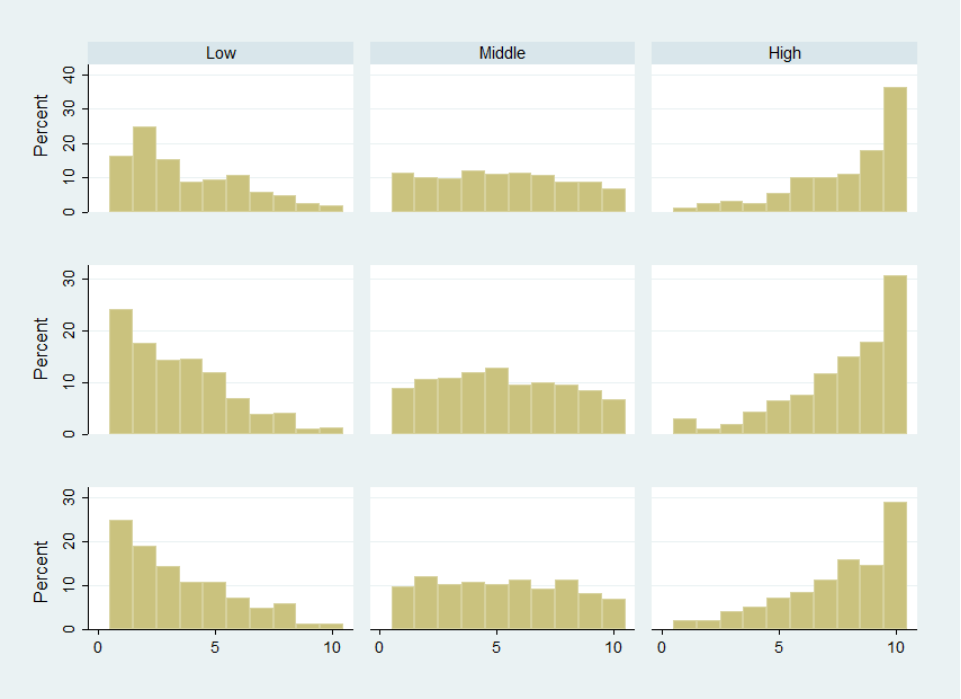
# Appendix

Figure A.1: Overall Tax Wedge for a One-Person Household




Source: Author's computations (2015)

Figure A.2: Monthly Gross Wages Deciles Distribution by Education




Source: European Labour Force Survey & Author's computations (2015)

Table A.1: Difference-in-Differences Estimation Results

| VARIABLES | (1) Employed | (2) Hours of work | (3) Employed | (4) Hours of work |
|---|---|---|---|---|
| Treated | -0.220*** | -1.482*** | 0.142*** | 0.404*** |
| | (0.00466) | (0.0796) | (0.00202) | (0.0440) |
| After | 0.00443*** | 0.125*** | 0.00486*** | 0.116*** |
| | (0.000521) | (0.0172) | (0.000330) | (0.0158) |
| DiD | -0.00527** | 0.294*** | -0.0327*** | 0.839*** |
| | (0.00144) | (0.0188) | (0.000350) | (0.0106) |
| Age | -0.00518*** | 0.00324 | -0.00430*** | 0.0171 |
| | (0.000426) | (0.00741) | (0.000602) | (0.00740) |
| Female | -0.0884** | -2.730*** | -0.0798** | -2.814*** |
| | (0.0155) | (0.136) | (0.0187) | (0.144) |
| Married | 0.0826** | 1.630* | 0.0634*** | 1.328 |
| | (0.0191) | (0.616) | (0.00798) | (0.568) |
| Central Bohemia | 0.0261 | -0.538 | 0.00942 | -1.080 |
| | (0.0168) | (0.659) | (0.0182) | (0.657) |
| Southwest | 0.0180 | -1.928** | -0.0120 | -2.192** |
| | (0.0170) | (0.378) | (0.0256) | (0.400) |
| Northwest | 0.0161 | -2.646*** | 0.0206 | -3.071*** |
| | (0.0149) | (0.391) | (0.0101) | (0.450) |
| Northeast | 0.0142 | -0.841 | -0.0140 | -0.951* |
| | (0.0144) | (0.373) | (0.0145) | (0.376) |
| Southeast | -0.0431 | -2.159*** | -0.0468 | -2.644** |
| | (0.0271) | (0.320) | (0.0237) | (0.548) |
| Central Moravia | -0.0554** | -1.932* | -0.0517*** | -2.537** |
| | (0.0128) | (0.613) | (0.00555) | (0.633) |
| Moravia-Silesia | -0.0392** | -3.056*** | -0.0351** | -3.480*** |
| | (0.0121) | (0.250) | (0.00707) | (0.454) |
| Town | 0.0274 | 0.165 | 0.0332 | 0.340* |
| | (0.0168) | (0.187) | (0.0160) | (0.117) |
| Rural | 0.0292 | 0.425 | 0.0459* | 0.438 |
| | (0.0230) | (0.197) | (0.0158) | (0.191) |
| Constant | 1.038*** | 44.52*** | 1.000*** | 44.30*** |
| | (0.0194) | (0.499) | (0.0230) | (0.374) |
| Observations | 17,644 | 13,339 | 18,270 | 14,803 |
| $R^2$ | 0.088 | 0.050 | 0.055 | 0.051 |
| Treated | Low | Low | High | High |
| Before | 2007 | 2007 | 2007 | 2007 |
| After | 2008 | 2008 | 2008 | 2008 |

Std. errors clustered at group-year level in parentheses
*** p<0.01, ** p<0.05, * p<0.1