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Labour Supply and Marginal Tax Rates

A case study of Belgium, France, Italy, the Netherlands, the United Kingdom and the United States of America

By A.J. de Bruin

Editor's Note: *This CF&P Foundation Prosperitas is adapted from Mr. de Bruin's thesis, submitted as part of the graduate program in Econometrics and Management Science at Erasmus University in Rotterdam, Netherlands.*

Policy Summary

In most nations, the law-abiding, hard-working individual loses a substantial part of his income to a range of taxes connected to his work, consumption and personal life. Taxes on labour income are particularly noteworthy, since they discourage people from working as hard as they would under a less punitive fiscal regime. This diminished labour participation creates a deadweight loss and reduces national income.

The attached research paper by Bram de Bruin (Erasmus University, Rotterdam), originally prepared as a masters' thesis and with assistance from the European Independent Institute (The Hague, The Netherlands) investigates the effect of labour income taxes on the supply of paid labour for several Western countries over the last two decades. De Bruin uses time-series econometrics to determine the macro-economic impact of the labour income tax, adapting the marginal tax rate data from a recent paper by Nobel laureate Edward Prescott (2004). Though limited availability of historical macro-economic data prevents the construction of good models for some countries, all countries that can be modelled using linear time-series methods clearly confirm the damaging effect of excessive income taxes on the supply of paid labour.

In addition to confirming the damaging effect of labour income taxes, the paper also gives specific estimates of its magnitude for several countries and at the same time sheds some light on the amount of time it takes for changes in taxation to affect the labour market. For the countries with the best data, namely France, Italy, the Netherlands and the United States, the statistical estimates imply labour supply elasticities of approximately 0.43, 0.2, 0.15 and 0.18 respectively. In non-economic language, this means that the amount of paid labour would increase between 1.5 percent and 4.3 percent in the selected countries if the tax pressure on labour income was reduced by 10 percent (i.e., a reduction in the marginal tax rate from 40 percent to 36 percent). Moreover, the structure of the models shows that the time required for such an effect to materialize in the respective labour markets would be between one and two years.

Another noteworthy hypothesis that is confirmed in the paper, one already implied by Prescott's analysis of the supply of paid labour (2004), is that the amount of time people spend working is not significantly influenced by union membership or other institutional factors by themselves. In other words, only when they are strongly correlated with tax pressure do institutional factors significantly influence the supply of paid labour. Attempts to add non-fiscal explanatory variables (concerning union strength, technological and demographic development) are largely unsuccessful and, in the few cases that they are successful, tend to have a small and/or ambiguous impact on the supply of paid labour.

Last but not least, an additional confirmation of the negative relationship between labour income tax pressure and the activity on the labour market is provided by a statistical analysis of the pooled data made up of all countries included in the paper. A visual inspection of this data immediately suggests that the negative impact of labour income taxes on paid working hours not only holds within countries, but clearly also across countries. This hypothesis is then statistically confirmed by means of pooled regression, which demonstrates, when it comes to the influence of labour income taxes on aggregate economic performance, there is little difference between countries.

In general, the conclusions of this paper are consistent with the notion commonly known as the Laffer Curve, which holds that a decrease in marginal tax rates on productive activity in high-tax societies will stimulate economic activity, thereby generating at least some additional government revenues that compensate for the revenue loss due to the lower tax rate. The paper focusses on the marginal tax rate of labour, which is a major contributor to the overall tax level, and predicts that lowering this marginal rate will generally boost labour participation. This increase in labour participation will, other things being equal, expand economic output, leading to a Laffer-Curve effect as additional tax revenues flow back to government (though only in rare cases will the additional revenue from stronger economic performance fully offset the revenue losses caused by the lower tax rate).

As already noted by Prescott (2004), from the viewpoint of public policy this is good news, since it implies that the general welfare can be considerably enhanced by cutting both government spending and income tax rates. Such reforms are especially important as a tool to address the aging problem faced by most Western nations in the coming decades. Given the gravity and universal character of the questions investigated in this paper, its research deserves to be expanded on in the future, by for instance increasing the number of countries, refining its statistical methods and gathering more relevant macro-economic data.

Note: *Peter Heemeijer is an economic adviser for the Netherlands' Party of Freedom and a lecturer on quantitative economics at the University of Amsterdam.*

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Report Summary

This report reviews and expands the recent discussions about the relationship between labour income tax rates and weekly worked hours. An important stimulus is the work of Prescott (2004), who argues that the average marginal tax rate on labour income is the most important explanation for the differences in the number of working hours between the United States of America and (continental) Europe.

This report contains the following contributions. First, we construct the average marginal tax rate on labour income, and we investigate whether this tax rate is a variable which explains the number of worked hours. Second, we investigate whether other economic variables that might influence the number of worked hours have additional explaining power. We construct a statistically and economically meaningful model to explain the number of worked hours by the average marginal tax on labour income and the tax on consumption. Our analysis also shows that other variables, which are named in the literature, do not play a significant role. This supports earlier claims that the level of taxes has its influence on the labour market and, therefore, on society.

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Introduction

Everyone who earns money by working in the economy pays tax. Every hour worked can be split up in minutes worked for the government and minutes worked for own income. On a yearly basis, the average number of days worked for government and for own income can be calculated. In the Netherlands, in 2005, one worked from January 1 till June 14 for the government. After June 14 one worked for own income, and therefore that day is called tax freedom day. On June 14 2005, the paper of Heemeijer (2005) was presented. The paper focused on the topic of flat tax in the Netherlands. Heemeijer calculated that, if everyone paid the same tax rate (18.7%) on labour income, this would (under some assumptions) not lead to a decrease in total tax revenues. Another conclusion of the paper was that a tax on labour income with this low and equal marginal rate would be an advantage for everyone and an enormous stimulus for the Dutch economy. The exact results and underlying assumptions can be found in the paper of Heemeijer (2005). This hypothetical realization of the flat tax is just one of the difference ideas of this topic; this and another idea can be found in section I.I.

A purely flat tax system is a system in which the government demands the same percentage of tax on every currency unit earned. This system has no redemptions and no deductible items. If one earns for example € 1,000 or € 10,000 a month and the marginal rate is always 18.7%, one pays € 187 (18.7% of total income) or € 1,870 (also 18.7% of total income) to the government. This is totally different from the progressive system that most countries have today. However, you can make a flat tax system a progressive one. The word flat means that the amount of tax, above a certain level, will be calculated using the same marginal tariff, not the same average tariff. By introducing a total redemption of € 187 a month with the double tax rate, 37.4%, one pays € 374 - € 187 = € 187 (18.7% of total income) in the first case and € 3,740 - € 187 = € 3,553 (35.5% of total income) in the second case. This shows that the flat tax system is changed into a progressive tax system, where people with a higher income contribute a higher percentage of income to the tax system.

The last decades, the topic of taxes and marginal rates receives steadily more attention. Hall and Rabushka (1995), for example, propose a 19% flat tax system for the American society. Their system has no deductions and the same redemption for everyone. It is so easy and simple that in their proposal, the tax forms for both taxes, personal wage tax and business tax, each have the size of a postcard. This highly efficient way of declaring one's income will save a lot of time. By this system one can spend more time on holiday and sending cards instead of filling in one's voluminous and complex forms. Or one could spend more time in the office and earn even more money.

The article of the 2004 Nobel-prize co-winner Prescott (2004) is the inspiring paper of this research. In his paper, Prescott constructs a model for the average marginal tax rate of a country. Further he compares the G-7 countries at two different time intervals to investigate the relation between the hours worked in the (tax paying) economy and the average marginal tax rates. He finds a strong relation between these two variables.

The current paper also presents an international comparative research to obtain a clearer view on the effects of different marginal tax rates. Governments of different countries demand varying levels of labour income tax from their inhabitants. The average marginal tax rate on

income may influence the behaviour of people. When the marginal tax rate changes, labour decisions of people also may change. In this research, different countries are compared with each other to see if this hypothesis is correct.

The first objective of this paper is to replicate and expand Prescott's model, by expanding his analysis by considering other countries and more time observations. The second objective is to expand the analysis with more variables, on which people may make decisions with respect to the number of active hours in the economy.

The focus of this research is primarily a study of the activities on the labour market and associated variables. The six countries involved in this research are (alphabetically classified): Belgium, France, Italy, the Netherlands, the United Kingdom and the United States of America. The G-7 economies are the most dominant in the world; therefore some of the G-7 countries are in this analysis. The Netherlands is in the analysis for comparison (own interest) with some of the G-7 countries, and Belgium because it is the neighbour country of the Netherlands. The condition we imposed was that the countries had at least 20 observations for the yearly average marginal tax rate and for the number of worked hours per year, both very important variables in this research. Because of this 20 year of data restriction, some countries which were initially also included in the analyses are not further investigated. These countries are: Brazil, Czech Republic, Estonia, Germany, Hong Kong, India, Japan, Lithuania, South-Africa and Sweden.

This paper is organised as follows; chapter I gives more information about the (income-) tax and labour discussion. Chapter II discusses the model of Prescott and the construction of average marginal tax rates. Chapter III gives an overview of the other economic indicators, and the econometric method of modelling. Chapter IV contains the results for the different countries, and chapter V contains conclusions and final remarks.

The motivation for writing this paper is that it might contribute to the current discussion on the level of marginal rates. Most of the arguments in this discussion against a flat tax are based on soft analyses or arguments. Therefore, a solid and quantitative argument in this current discussion is quite new (in the Netherlands), and this report tries to give a stimulus to future discussions on the topic. The aim of this study is to present an objective analysis of the relationship between marginal tax rates ad the number of hours worked. Therefore this paper will focus on the following questions:

-How to make a model for the relation between the number of hours worked in the (tax paying) economy and the average marginal tax rate's?

-Do other (labour market based) economic indicators influence the above relation?

-Can we draw clear conclusions on the influence of high marginal tax rates on the labour market and the economy in total?

The research hypothesis based on the three points above and the article of Prescott (2004) is: The number of weekly worked hours is affected by the marginal tax rates; other indicators do not affect this labour decision.

At the end of this introduction, I would like to thank the people who helped me before or during this project. First of all I would thank Eline van den Broek, Peter Heemeijer and Christiaan Heij, for the time and effort they put from before the start until the end of the work I did. Furthermore I would like to thank Daniel Mitchell, who supported this investigation form the

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Other people who I like to mention are my parents, family, Wouter van't Spijker, Pim van Vliet and old colleagues. My parents and family, because they take care of me and form a critical and supporting sounding board, not only during this research, but in the whole (educational) period towards it. Pim van Vliet was the one who supported me to try to do an internship at the Edmund Burke Foundation, so he can be seen as the stimulator towards this research. Wouter van't Spijker, who is also part of the family, I would like to thank because he supported me and joined me to the drinks where I met Eline, and the first idea was created.

During a six months internship I have been working for QN (the Hague). At last I would like to thank the Centre for Freedom and Prosperity Foundation for giving me the opportunity to publish this research paper.

Chapter I: Tax and Labour

This chapter contains more information about tax-systems in general, the discussion about the level of the tariffs, and sensitivity to the rates.

Section I.I: Tax system

In the literature, there are many different conditions for a good tax system. Different people work with different definitions. It is hard to find a clear and complete description of the requirements of a tax system in the literature. However, Stiglitz (2000) presents in his book (on page 457) a description of five characteristics, which are the minimum conditions of any tax system. These five characteristics can be split up in economic and political terms.

The economic driven characteristics are

1. Economic efficiency,

2. Administrative simplicity.

The politically driven characteristics are

3. Flexibility,

4. Political responsibility,

5. Fairness.

A short description and more explanation per characteristic are given below.

1: The idea that a government should not, or least the minimum possible, interfere with the efficient allocation of resources through a tax system, is the basis of this characteristic. One can think of the effects taxes may have on work, education, investment, savings, retirement, marriage, corporations or unincorporated enterprises, etc.

2: The tax system ought to be easy and relatively inexpensive to administer.

3: Changes in economic circumstances requires changes in tax rates. For some tax structures these adjustments are easy, for some others they occur automatically, for some tax structures however, they require extensive political debate.

4: The tax system should be transparent. Therefore the tax system should be designed so that individuals can ascertain what they are paying, and evaluate how accurately the system reflects their preferences.

5: The tax system should be, and should be seen to be, fair in its relative treatment of different individuals.

These characteristics seem to be simple and logical, and almost everyone would agree with them. Reality shows however a different picture. A very nice example of the administrative expenses for the American tax system in 1992 - 1993 is given in Hall and Rabushka (1995). They calculated the following costs: Direct compliance costs, both in filing and in buying expert advice exceeded $ 100 billion. Direct tax-planning costs exceeded $ 35 billion. Revenue lost to the Treasury due to evasion exceeded $ 100 billion. Distortions from pursuing tax-advantaged investments in the form of lost output may have exceeded $ 100 billion. And the lobbyists

probably cost the economy more than $ 50 billion. Furthermore they show figures over the enormous amount of paper and, what they call, the nightmare of complexity.

Another example of tax system costs can be found in the paper of Pitt and Slemrod (1989). In this paper they focus on the compliance costs of itemizing deductions, in order to estimate the costs of itemizing. By analyzing micro data they calculate a burden above which people will use their deductions. Thus they calculate in this way the implicit costs of itemizing deductions. They conclude that they have constructed a method to evaluate the taxpayer's time and other resources used in tax compliance, and there is a relation between the number of itemizers, the costs of itemizing and additional itemizers if costs were zero.

The most difficult characteristic will be the fifth characteristic, which is about fairness. In the Netherlands there are ideas for a flat tax between a marginal rate of 18.7% and no redemption and a marginal rate of 50% and a redemption of € 14,400. Both parties are convinced about their fairness. The term horizontal equity is mostly used, which means that people having similar circumstances should bear equal tax burdens.

Especially in Western Europe people (and therefore governments) associate a kind of equality by fairness, like who earns more has to pay more tax proportional. Redistribution of the income by demanding tax en providing subsidies is one of the governmental tools to reduce the differences in income. The progressive systems used nowadays (see section I.II) is the result of the wish to equalize the incomes of individuals. Therefore one could pretend that a progressive system is the basis of our society. Although this kind of wishes for equality and fairness is not in scope of this research, but it is important to mention it.

There are many more problems with the current tax system, which would be reduced in a flat tax system. One may think of; double taxation (of profits and income), loopholes (government stimulates for example savings and buying a house), tax evasion, tax avoidance and all other tax regulations in which the government influences the economic behaviour of the people (characteristics 1, 4 and 5). The above problems could be dramatically reduced if the system were changed in the right direction, examples can be found in Hall and Rabushka (1995).

Section I.II: Marginal rates, labour and leisure

The marginal rate of tax on labour income can be defined as the percentage of the extra currency unit earned, which is paid in tax. In the Netherlands, in 2005, four possible percentages (34.15, 41.45, 42.00 or 52.00%) could be paid within the tax system on the extra Euro earned[1]. The Dutch tax system is in principle piece-wise linear and depending on ones income the marginal rate increases. Without deductions, redemptions and additions, the number of Euros paid in the Dutch tax system (in 2005) can be calculated by ones income and can be presented as:

$$(1.1)\qquad \begin{cases} 0.3415 \cdot income & \text{if } €0 \le income \le €17{,}046 \\ 0.4145 \cdot (income - 17{,}046) + 5{,}821.21 & \text{if } €17{,}047 \le income \le €30{,}631 \\ 0.4200 \cdot (income - 30{,}631) + 11{,}451.78 & \text{if } €30{,}632 \le income \le €52{,}228 \\ 0.5200 \cdot (income - 52{,}228) + 20{,}522.10 & \text{if } income \ge €52{,}229 \end{cases}$$

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[1] Source: http://www.belastingdienst.nl/particulier/alsugaatwerken/alsugaatwerken-01.html

Because marginal means changes by a very small movement, mathematically seen, the marginal rate corresponds to the derivative of the function. For a linear function, $y = a \cdot x + b$, the derivative of the function to x (and therefore the marginal rate) is constant and equal to a. So it is clear that the earlier mentioned marginal rates, per income group, can be obtained from formula 1.1. In the Netherlands the first part of personal income is free of tax (the so called 'belastingvrije voet') and the level of that tax-free part is depending on personal circumstances.

Points of criticism of the current system are the high marginal rates. Each individual person pays tax. For example tax on consumptions, tax on savings, and sometimes excise duty on special products like alcoholics, cigarettes and fuel. The reason for this is that a government needs to finance its expenditures or thinks it is necessary to influence the behaviour of its people. By demanding higher taxes or by means of giving subsidies to products or services, government influences the behaviour of the consumers. It is quite logical that if taxes on a product are rising, people react to that change through negative price-elasticity (in the case of elemental and luxury goods), by purchasing less of that product. Given that logical phenomenon, it is strange that nowadays most tax systems are as strongly progressive as they are. By this kind of tax system, government discourages people to work more. As with cigarettes, governments punish those who work, and even punish them more if they earn more, because they must pay a higher rate.

Prescott (2004) concludes after a comparative investigation that the high labour supply elasticity to marginal tax rates is good news, because the level of the marginal rate accounts for the variations in labour supply across countries and through time. He has compared the working hours in the G-7 countries with the average marginal tax rates in the same countries. For example over the period 1993 – 1996 in the U.S. average working hours per week per person of 15-64 was 25.9 hours and the average marginal tax rate had an average in the same period of 40%. For Germany these figures are 19.3 hours and 59% respectively. He finds big differences between the United States of America and continental Europe, so he concludes that the height of the average marginal rate explains the number of hours people are willing to work in the economy. More of this article can be found in the next chapter.

Not everyone is convinced by the arguments of Prescott. Alesina, Glaeser and Sacerdote (2005) for example, defend the hypothesis that the cross-sectional relationship between taxed and hours worked is just the result of omitted variables that are correlated with the tax rate and also has an impact on the number of worked hours. In particular, unionization and labour market regulations are strongly correlated with both hours worked and marginal tax rates across countries. They mention furthermore that German and French trade unions pursued a policy of work sharing, demanding a reduction in hours worked as a response to rising unemployment, with slogans like 'work less – work all'. So, they conclude that the marginal tax rate may have also played a role, especially for women's labour force participation, but their view is that in a hypothetical competitive labour market without trade unions and with limited regulation these tax increases would not have affected hours worked as much. This is directly in contradiction with the arguments of Prescott, and assumes that people in Europe should have another preference schedule to their leisure time. So Europeans should be happier by spending time with other people outside rather than inside the office compared with American people. This difference is a strange phenomenon, because the expectation is that people should have the same reaction on this kind of wealth decisions. This is shown below by the experiment of Lucas.

Another point of criticism Alesina, Glaeser and Sacerdote (2005) mention is the elasticity. In their opinion, there are two elements wrong of Prescott's explanation with respect to the elasticity. Because of these elements in his explanation, Prescott finds a high level of elasticity between the tax rates and hours worked.

First, Prescott assumes that the government spending returns completely to the consumers. Therefore government spending is valuated by consumer as much as income. This assumption creates a higher elasticity, because changes in the level of taxation results only to changes in labour, it does not reduce income. Second, Prescott works with macro data, which results in higher elasticity, because there is a 'social multiplier' effect. This effect is that utility from leisure (not working) is increasing by the number of people that do not work. If everyone is working the individual value of leisure is not as large as when there are a more people who has leisure time. This phenomenon of differences in appreciation of leisure means that macro elasticity is greater than micro elasticity. All in all Alesina, Glaeser and Sacerdote conclude that these assumptions of Prescott lead to a high level of elasticity in the analysis of Prescott. Even a higher elasticity than found is most estimates for labour supply studies.

In reaction to the criticism of the high elasticity Prescott wrote an explanation (2004a) for this elasticity by considering a labour supply which is not affected by tax. This idea holds that labour participation would remain the same when tax rates are either raised or lowered. Government can move those tax rates up and down whenever they like and assume that these movements will have no effect on output or labour supply. But, Prescott continues "economic theory and data have come together to prove this notion wrong, and there are many different laboratories – or countries – in which live experiments can be viewed. The most useful comparison is between the United States of America and the countries of Europe, because these economies share traits; but the data also hold when other countries are considered".

A recent study of Schettkat (2003) shows that Americans and Germans spend the same amount of time at work, but the proportion of taxable market time versus non-taxable home work time is different. In other words, Germans work just as much, but more of their work is not captured in the taxable market. Another example can be found in Italy: they aren't necessarily working any less than the Americans; they simply are not being taxed for some of their labour. The Italian government increases its measured output by nearly 25 percent to capture the output of the underground sector. If the tax laws are changed, there will be a change noticed in behaviour: People will not start working more; they will simply engage in more taxable market labour and will produce more per hour worked.

The following example gives a clearer view of the reaction of people towards money and income. 1995 Nobel-prize winner Lucas has set up an experiment in his paper (1972), which is called 'The Lucas Island Experiment'. This experiment is done by (American) students recently in reality. The students were divided on ten different islands, with no communication between the islands. On the island a household existed of workers and shoppers. The workers worked in the islands' factory to produce one kind of product, while the shoppers were able to go to the other islands and purchase products of the other islands. Because there was no communication, prices were unknown until the shopper really visited the island. The experiment ran for some periods and in each period the workers had to decide how many hours they want to work and the shoppers had to buy necessary items of the other islands. At the beginning of each period, the worker knows his nominal wage. He will find out the current price level when the shopper returns

at the end of the day. In the meantime, he must decide how many hours to work, so he estimates his real wage. The worker faces an inter-temporal labour/leisure trade-off.

One of the conclusions of that experiment was that the worker wants to work extra hours when real wages are relatively high, and leisure expensive. He wants to work fewer hours when real wages are relatively low, and leisure cheap. There is no evidence that students in the (continental) European countries should make other decision than these American students. And if students should not make different choices than there is no evidence that the total workforce in the European countries should different choices than these American students by nature. So there are other external effects which influences the potential workforce to decide if and how many hours one wants to work.

Let us return to the discussion about the level of the marginal rates, and the theory behind the Laffer Curve. This Curve supposes that for a given economy there is an optimal tax level to maximize tax revenues. If the current level is below this optimal level, raising tax will increase tax revenue. On the other hand, if the current level is above this optimal level, lowering the tax level will increase tax revenue. For the United States of America (and generally other western countries) Moore (2005) translated this idea in: "lowering the tax rate on production, work, investment, and risk taking will spur more of these activities and thereby will often lead to more tax revenue collections for the government rather than less." Moore (2005) continues by giving two examples. In the two terms President Ronald Reagan was in the office he lowered the highest personal tax income tax rate from 70% to 28%. In the same period, tax receipts almost doubled form $ 517 billion to $ 1,032 billion. A more recent example is from the Bush tax cuts in May 2003. The level of tax rates on dividends were lowered from 39.6% towards 15% and on capital gains from 20% to 15%. In the fiscal year 2004 – 2005 the federal tax receipts rose with 15.4% compared to the fiscal year before. In two year time after the tax cut, individual and corporate income tax receipts have up 30%.

Moore (2005) concludes that "once again, tax rate cuts have crated a virtuous chain reaction of higher economic growth, more jobs, higher corporate profits, and finally more tax receipts." This illustrative conclusion is not in scope of this research, and therefore not checked on the rightness of the causality. More evidences and convincing examples can, for example, be found in the fourth en fifth chapter of Heath (2006).

Chapter II: Prescott's paper: model and forecasts

In this chapter the leading paper for this study of Prescott (2004) is presented. The focus is on the ideas of Prescott and on Prescott's model to construct the average marginal tax rate for different countries. The results of this model are in the last section.

Section II.I: Why do Americans work so much more than Europeans?

In the early 1970's, Western Europeans worked more than Americans. Nowadays, Americans work about 50 percent more than do the people in Germany, France and Italy. This is measured on a basis of weekly hours per person aged 15 – 64. In his article Prescott investigates this remarkable phenomenon and he gives an explanation for this huge difference. First he investigates the current situation, in a representative period, and then he compares that with the situation of a period more than 20 years earlier in the same countries.

For his analysis, Prescott uses the G-7 countries, because for these countries sufficient and comparable data is available to carry out the investigation. The years of investigation consist of two periods, namely the period of 1970 – 1974 and the period of 1993 – 1996. The first period was selected because it is the earliest one for which sufficiently good data was available. The last period was chosen because it is the most recent period before the United States of America telecommunications/dot-com boom of the later 1990's. His argument for the last period is: "that the boom period was a period when the relative size of unmeasured output was probably significantly larger than normal, and there may have been associated problems with the market hour statistics".

One of the most important observations in the paper is that, in the 1993 - 1996 period the labour supply (measured in hours per week per person of 15 – 64) is much higher in Japan and the United States of America than it is in the continental European countries. Canada and the United Kingdom are in the intermediary range. The United States of America per capita output is about 30 to 40 percent higher than in the European countries. And most of the difference can be ascribed to the differences in hours worked per person, not by differences in productivity (output per hour). However, in Japan, the difference of over 20 percent in per capita output is accounted for by lower productivity, not by lower labour supply as compared to the United States of America. The exact figures can be found in table 2.1.

The 1970 – 1974 period however, shows a totally different picture. The European per capita output is in this period also about 70 percent of the level in the United States of America, as it was in 1993 – 1996. However, the reason for the lower output in Europe was not fewer working hours (as it was in 1993 – 1996), but a rather lower productivity. In 1970 – 1974, Europeans worked more than Americans. These figures are also presented in table 2.1.

Table 2.1: Labour Supply, Productivity, GDP, tax rates etc. Major Advanced Countries

country	1970-1974					
	Actual hours per week per person 15-64	GDP per hour (US = 100)	GDP per person15-64 (US = 100)	Average marginal tax rate t_h	Predicted hours per week per person 15-64	Difference of actual - predicted
Germany	24.6	72	75	0.52	24.6	0.0
France	24.4	74	77	0.49	25.4	-1.0
Italy	19.2	65	53	0.41	28.3	-9.1
Canada	22.2	91	86	0.44	25.6	-3.4
United Kingdom	25.9	62	68	0.45	24.0	1.9
Japan	29.8	49	62	0.25	35.8	-6
United States	23.5	100	100	0.40	26.4	-2.9
country	1993-1996					
	Actual hours per week per person 15-64	GDP per hour (US = 100)	GDP per person15-64 (US = 100)	Average marginal tax rate t_h	Predicted hours per week per person 15-64	Difference of actual - predicted
Germany	19.3	99	74	0.59	19.5	-0.2
France	17.5	110	74	0.59	19.5	2.0
Italy	16.5	90	57	0.64	18.8	-1.3
Canada	22.9	89	79	0.52	21.3	1.6
United Kingdom	22.8	76	67	0.44	22.8	0.0
Japan	27.0	74	78	0.37	29.0	-2.0
United States	25.9	100	100	0.40	24.6	1.3

Source: Prescott (2004)

In the next section of this chapter, the construction model of Prescott will be explained in more detail. He uses a model to construct the average marginal tax rates (t_h) of the different countries. With this rate he predicts the number of hours worked and compares the predictions with the actual numbers. The predicted values are surprisingly close to the actual values, Prescott concludes, which can be seen in table 2.1.

Section II.II: Prescott's model of tax rates

How much do people pay to the government? What percentage of the next working hours is contributed to the tax system? This is a rather difficult question because there are different marginal rates in most countries. As has been seen in the introduction and chapter I the marginal tax rate is not the same as the average tax rate (only a flat tax system without redemptions is an exception).

It is not possible to make a model which describes all different inhabitants. The purpose of this paper is to compare different countries (all inhabitants) with each other. A good way of dealing with different marginal rates in one figure is to use the average marginal rate. Prescott constructs a model to obtain a good estimation of the average marginal tax rate of a country by using standard national account statistics. In this section the model from Prescott (2004) is presented and in the next section will be shown how it is interpreted for the Netherlands and the results for the other countries.

Prescott distinguishes two types of taxes on income. First the social security tax with marginal rate t_{ss} and second the income tax with marginal rate t_{inc}. A small example of the marginal rate has been given in the introduction. In this section the model is presented. In the next sections the interpretation of the model is given.

The estimate of the social security tax is:

$$(2.1) \quad t_{ss} = \frac{SocialSecurityTaxes}{(1-q)\cdot(GDP - IT)}$$

IT stands for net indirect taxes and q is the capital cost share parameter, obtained in the Cobb-Douglas production function. Therefore Prescott set the denominator equal to labour income if labour is paid its marginal product. Prescott finds the average number of 0.3224 for the value of q. In his analysis over different countries and in both of the periods he finds that the parameter was close to the average. So the value was set equal for both periods for all countries. In the present analysis some different western countries are taken, including from outside the G-7 region, furthermore Prescott's two periods are at the beginning and somewhere at the end of the timeline used here, and therefore in this analysis the same value for q (= 0.3224) is chosen.

The estimate of the average (not marginal) labour income tax is:

$$(2.2) \quad \bar{t}_{inc} = \frac{DirectTaxes}{GDP - IT - Depriciation}$$

Direct taxes are those paid by households and do not include corporate income taxes.

The estimate of the average marginal tax rate on labour income is:

$$t_h = t_{ss} + 1.6 \cdot \bar{t}_{inc} \quad (2.3)$$

The 1.6 factor reflects the fact that the marginal tax rates on income are higher than the average tax rates on income (this can be caused by redemption). Prescott selected the 1.6 factor because it results in the marginal income tax rate obtained using the Feenberg and Coutts (1993) methodology in his analysis. This methodology uses a representative sample of tax records to compute the marginal tax rate on labour income by determining how much tax revenue increases if every household's labour income is changed by one percent. The total change in tax receipts divided by the total change in labour income is the Feenberg-Coutts estimate of the marginal tax rate on labour income.

In addition to the tax which working people have to pay on their income, people have to pay tax on consumption. Examples of this kind of tax are the VAT and excise duty (on goods like fuel and cigarettes). Prescott assumes that "two-thirds of these indirect taxes net of subsidies fall directly on private consumption and the remaining one-third is distributed evenly over private consumption and private investment". Net indirect tax on consumption is given by:

$$IT_c = \left(2/3 + 1/3 \cdot \frac{C}{C+I} \right) \cdot IT \quad (2.4)$$

Where C stands for private consumption expenditures and I for private investment. Prescott continues: "The motivation for this assignment of indirect taxes is that most indirect taxes fall on consumption whether these taxes are a value-added tax, a sales tax, an excise tax, or a property tax. Some taxes, such as fuel taxes on diesel fuel used by trucks that transport goods, property taxes on office buildings, and sales taxes on equipment purchases by business, fall on all forms of product". The estimation of the consumption tax rate is:

$$t_c = \frac{IT_c}{C - IT_c} \quad (2.5)$$

Section II.III: The average marginal tax rate

In this section the interpretation for the Netherlands of Prescott's the model described above will be given. The above model may be a little abstract and the definitions of the variables not clear, so in this section there will be an explanation. It starts with a description of the data used and ends with the results of the model for the different countries.

Section II.III.I: Collection of the data

Prescott's construction of the tax rates and analyse are both done on a macro economic level. Therefore in this paper also a macro economic analyse is described. Except the fact that Prescott used this kind of data, macro data is more public available and therefore more useful for this analyse. By doing analyses to the decision making of people or households, using micro data is the most logic choice. But as described above in this analyse macro data is used. Therefore it may differ from other papers in this field, but it is in line with the analyse of Prescott (2004).

For the Netherlands the EUROSTAT database provided most of the figures used in the formulae described in the previous part. A complete overview of the definitions of the used parameters is given in appendix A.

Below are the EUROSTAT definitions of the variables used in the model, all with the period of 1960 to 2004 (or as much data as possible). The variable with the * sign has further explanation below the definition.

-*GDP*: 'gross domestic production at market prices', given in national currency (€ or Euro),

-*IT*: 'taxes on production and import less subsidies', current prices in national currency,

-*SocialSecurityTaxes*: 'actual social contributions, receivable', current prices in national currency,

-*DirectTaxes**: 'taxes on income', current prices in national currency,

-*Depreciation**: not defined in EUROSTAT, calculated by 'gross national income at market prices' – 'net national income at market prices', given in national currency,

-*C*: 'final consumption expenditure of households', current prices in national currency,

-*I**: 'net saving', current prices in national currency.

*DirectTaxes**. All the variables have the same period. 'taxes on income' however was available from 2004 backwards to 1980 and not to 1960. Another EUROSTAT variable exists to 1974, this is the 'current taxes on income, wealth, etc.' In figure 2.1 this combined variable is split up for the period in which 'taxes on income' is also known, in a part for tax on income and a part for tax on wealth etc.

During the period from 1980 till 2004 there is not a big difference in the parts of the current tax which counts for tax on income and the part which count for tax on wealth, etc. This justifies the decision to extrapolate the *DirectTaxes* back in time till 1974, with the average of the part which counts for the income (91.4%). It is very possible that other variables may also be unavailable in the first few years. Therefore it is not yet clear if these extrapolated data points will really be used in this analysis in the future.

*Depreciation**. In the EUROSTAT database there is no definition of depreciation. But basic economics tells that depreciation is defined as gross minus net. Therefore depreciation in this model is calculated by subtracting the 'net national income' from the 'gross national income' for the desired period.

*I**. According to Prescott, private investment has to be in the model. In EUROSTAT there is no variable which gives private investment, but basic economics tells that private investments are equal to net savings. And the variable 'net saving' is available in the database for the right period. In an open economy, private investments don't have to be equal to net savings, but we made this assumption for further calculation.

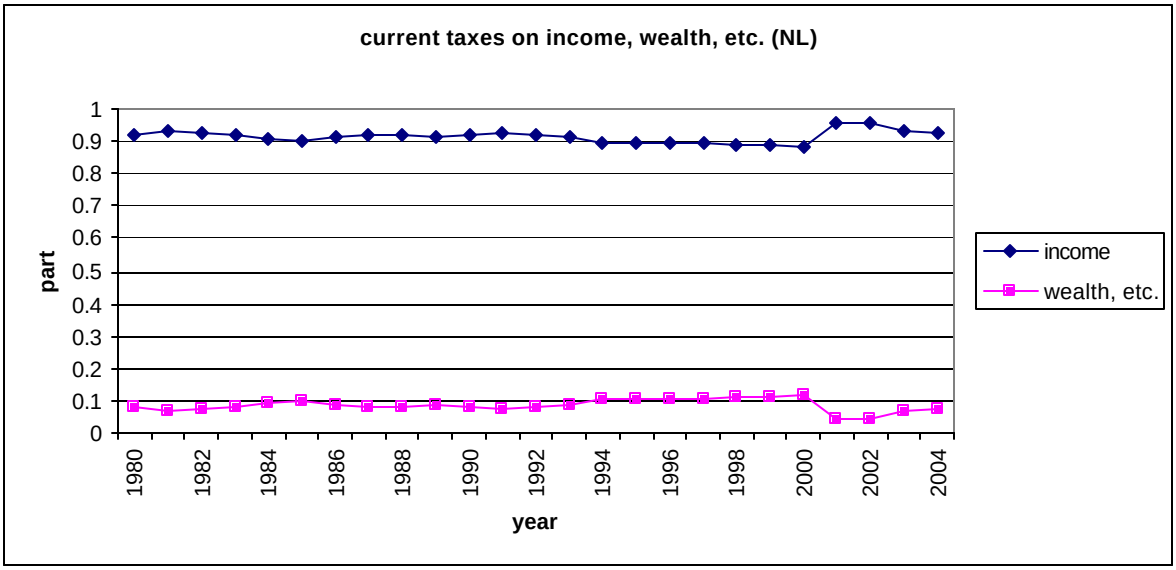


Figure 2.1: current taxes on income, wealth, etc. split up into income and wealth etc.

In the next section there will be the results for the rates of all the countries. Below (table 2.2) however is a brief overview for a few years, in the Netherlands, of the values of the parameters and the corresponding rates. Notice that 1974 is the first year in which all required data are available to calculate the rates for the Netherlands.

Table 2.2: overview of the Prescott model in the Netherlands (in millions of Euros or percentage)

Variable	2004	2000	1990	1980	1974
GDP	€ 488,642.0	€ 402,291.0	€ 232,140.9	€ 128,314.2	€ 66,363.9
IT	€ 55,216.5	€ 45,056.6	€ 19,732.0	€ 10,650.1	€ 5,309.1
SocialSecurityTaxes	€ 68,409.9	€ 64,366.6	€ 35,285.4	€ 20,786.9	€ 10,087.3
DirectTaxes	€ 47,398.3	€ 43,045.1	€ 32,035.4	€ 18,092.3	€ 8,859.6
Depreciation	€ 73,296.3	€ 61,148.2	€ 35,749.6	€ 16,809.2	€ 7,698.2
C	€ 235,936.8	€ 197,927.2	€ 113,981.1	€ 67,108.3	€ 33,447.4
I	€ 52,284.7	€ 47,872.6	€ 24,839.1	€ 12,061.5	€ 11,613.7
IT_c	€ 51,869.3	€ 42,119.9	€ 18,548.1	€ 10,111.2	€ 4,851.2
t_c	**28.3 %**	**27.0 %**	**19.4 %**	**17.7 %**	**17.0 %**
t_{ss}	23.3 %	26.6 %	24.5 %	26.1 %	24.4 %
$\bar{t}_{inc}$	13.1 %	14.5 %	18.1 %	17.9 %	16.6 %
t_h	**44.3 %**	**49.9 %**	**53.5 %**	**54.8 %**	**50.9 %**

Source: EUROSTAT, Prescott (2004)

Section II.III.II: Construction of the rates

Prescott's model has been applied to all the countries for the time periods which were available at the databases. The results of the model can be seen in figure 2.2 for the tax on labour income (average marginal tax rate, t_h) and in figure 2.3 for the tax on consumption (t_c).

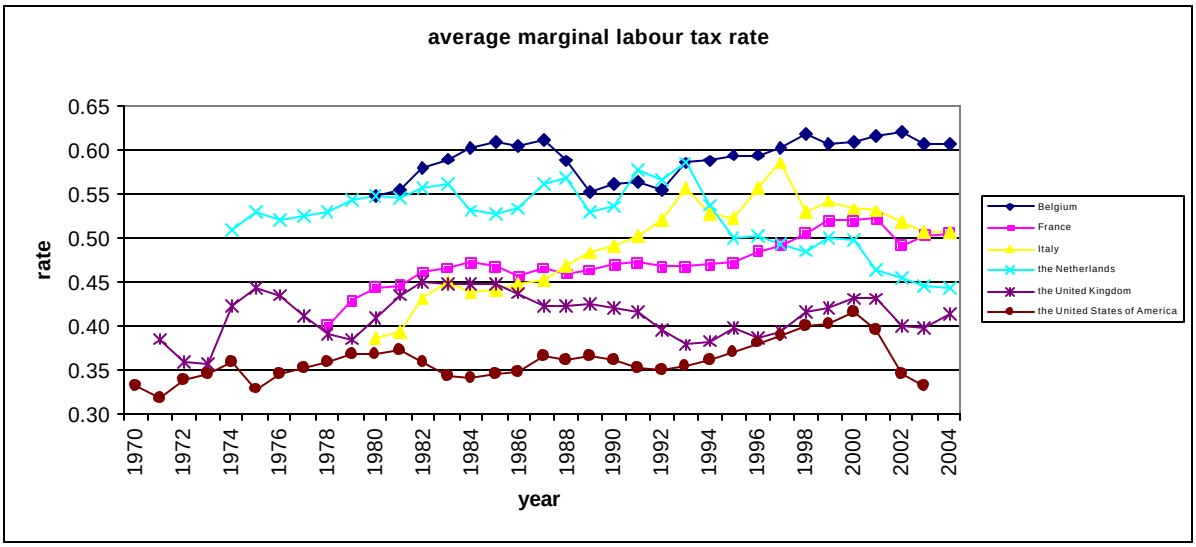


Figure 2.2: average marginal tax rates in different countries

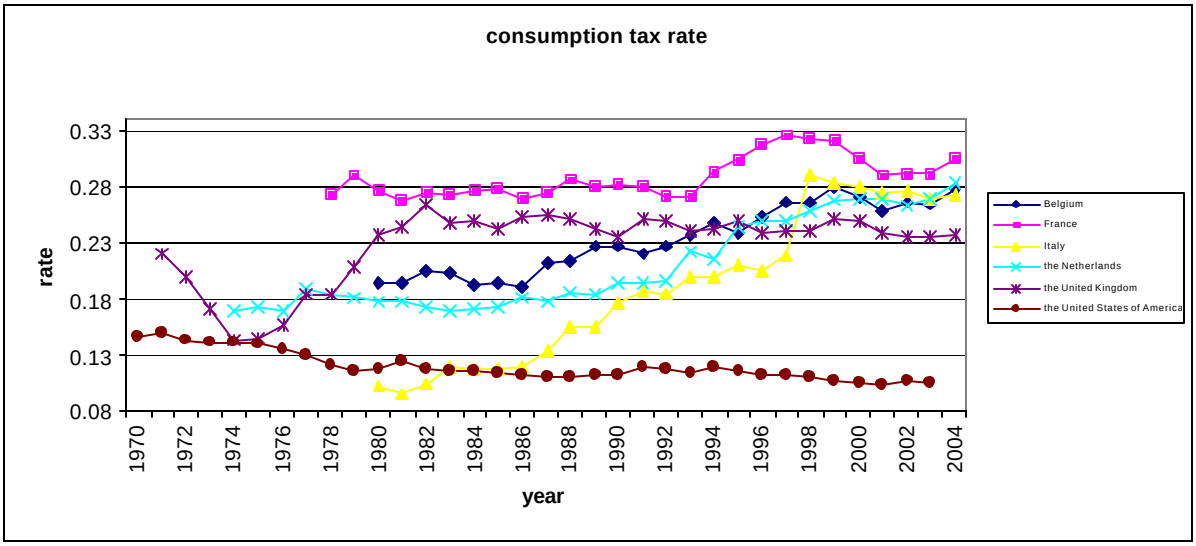


Figure 2.3: consumption tax rates in different countries

Some remarks have to be made. The first remark is that the data used for the United States are not from the EUROSTAT database, but are figures which are available in the OECD database. The precise definitions can be found in appendix A, and are similar to the definitions used in EUROSTAT.

The second remark is that in the OECD database the variable 'taxes on income' for the United States do not have any data points, therefore for the United States the variable 'current taxes on income, wealth etc., receivable' is used for the whole period of 1970 until 2003.

The third remark is that for Belgium in the period of 1980 until 1984 and for Italy in the period of 1980 until 1989 the same backward extrapolation has been made for the 'taxes on income' variable, figures like figure 2.1 can be found in appendix B for Belgium and Italy.

The fourth remark is that the values of the model with the EUROSTAT or OECD figures does not give the same values as Prescott find in his article, see table 2.1. Below in table 2.3 a better comparison is made for the values of Prescott in his article and the average value of countries and periods which are the same.

Table 2.3: comparison with the average marginal tax rates of Prescott

	1993 – 1996		1970 – 1974	
	Prescott	avg. model	Prescott	avg. Model
France	59 %	47.4 %	49 %	:
Italy	64 %	54.0 %	41 %	:
The United Kingdom	44 %	38.6 %	45 %	38.1 % (1971 – 1974)
The United States	40 %	36.6 %	40 %	33.9 %

Source: Prescott (2004), EUROSTAT and OECD

: means no data available

Although the values are not of the same size, the ranking of the countries is still the same. The differences are not as great as they are in Prescott's analysis, but the picture is still clear.

A first glance at the graphs shows that Prescott is right about the differences in the level of taxes on income in the different countries. The average worker in the United States has the lowest marginal tax over the whole period. An average worker in Belgium on the other hand has to pay the highest marginal rates over almost the whole period. The rates of other continental European countries (France, Italy and the Netherlands) are somewhat lower than Belgium, but have still higher rates than the United Kingdom en the United States of America.

Also for the tax on consumption the government of the United States of America demands the lowest level, and the difference with the European countries is clearer than by the marginal tax rate on income. The tariffs in the European countries are coming closer together in the last decades.

Chapter III: Economic Indicators and analysis

This investigation covers the average number of weekly hours worked in the taxpaying economy and other indicators; thus in this chapter the indicators are introduced in the first section. In the second section the focus is on the analysis. Where an example of constructed data is given, the Netherlands is the country used. In the next chapter the results per country are given.

Section III.I: Data

In this section the economic indicators used in the paper are presented. The first indicator is the number of weekly worked hours, since that is the indicator which will be shown to be dependent on the other indicators. These other indicators are presented alphabetically after the number of weekly worked hours, and an overview (for the Netherlands) is at the end of the section in table 3.2.

Section III.I.I: Number of weekly worked hours

In his investigation, Prescott (2004) finds a strong relationship in the different countries between the average number of hours an employee works in the taxpaying economy and the average marginal tax rate on income. The first thing is to calculate the average number of hours people work on a weekly basis, and to make the relationship (with the average marginal tax rate) visual.

The OECD website provides, as an element of the Labour Market Statistics, the variable 'average actual annual hours worked per person in employment'. By dividing that figure by 52 and multiplying it by the number employed out of the population in the age range of 15 to 64, the desired variable is calculated. In table 3.1 the calculation of the weekly figure is replicated for various years in the Netherlands. Notice that the weekly worked hours are not available before 1983 for the Netherlands, so further investigation will only be made for the years 1983 and thereafter.

Table 3.1 calculation of the weekly worked hours by people, in the age of 15 – 64, in the Netherlands

Variable	2004	2000	1990	1983
Average actual annual hours worked per person in employment	1,357.0	1,368.0	1,456.0	1,664.0
*Total employment (15-64, *1000)*	7,889	7,733	6,361	4,907.97
*Total population (15-64, *1000)*	10,958	10,728	10,297	9,702
Weekly worked hours	**18.79**	**18.96**	**17.30**	**16.19**
t_h	44.3 %	49.9 %	53.5 %	56.1 %

Source: OECD, Labour Market Statistics

In this analysis the number of weekly worked hours is the variable which has to be explained by other variables. Regardless of the influence of the marginal tax rate on people's decisions of how many hours to work per week (which is Prescott's assumption), there may be more economic indicators which influence this decision. This is the basis of the criticisms of Prescott. In this section other indicators are briefly introduced, and something is said about the reasoning behind these variables.

Section III.I.II: Age

The idea behind this indicator is that the age of the potential workforce influences the number of hours people want to work. The older one becomes, the fewer hours one wants to work. On the other hand, young and ambitious people work more hours. The expectation therefore is that the average age of people between 15 and 64 can have a negative as well a positive attitude to the number of working hours.

The positive relation can show up in countries with a younger workforce. If one makes a career it is certainly possible that one wants to work more hours. Or one has to work more hours because that is part of the better paid job by a promotion. In countries with an older workforce population and with some issues of obsolescence, the average age may cause a negative relationship. Above a certain age one mostly wishes to work fewer hours, and luxuries such as days off and early retirement are given to older people.

The calculation is as follows: data is available from EUROSTAT (BE, FR, IT, NL and UK) or OECD (US) and is called 'Average population by sex and five-year age groups'. Then by calculating the weighted average, the average age of the population between 15 and 64 is the result.

One thing to bear in mind is that over time (and definitely in the last two decades) the average age of the workforce is slightly increasing. Therefore it may be correlated with all other variables which are slightly increasing or decreasing over time and not part of the model.

Section III.I.III: Tax on consumption

As explained in the previous chapter, Prescott (2004) has also constructed a model for the tax on consumption. This level of tax rate might have its influence on the number of hours one wants to work. Imagine a rise in tax on consumption and a constant salary per hour worked. The expectation is that people will tend to work more if tax on consumption rises, because the price of consumption will increase, and therefore leisure will become more expensive.

Another possibility is that the number of worked hours is not influenced by the more expensive consumption, but people react by consuming less (so that the total amount of money spent on consumption stays the same) or by saving less money (in that case the amount of money spent on consumption rises without working more hours).

Section III.I.IV: Trade union

Before defining data on trade unions, and relating something about the thinking over the influence of trade unions, it is desirable to say something about trade unions in general. Trade

unions see themselves as protectors of their members interests and of employment in general. In Europe the number of members is decreasing, but the (political) power of trade unions still remains mostly the same.

Defenders of the trade unions claim that trade unions are good for the economy, because slogans like 'work less – work all' are examples of their way to reduce temporary unemployment. A reduction in the employment rate benefits the economy of a country. Furthermore, trade unions seem to see the labour market as a market with employers as a big oligopoly and employees as the weak other side. So the employees have to be protected by someone against the power of the employers who would otherwise make the workers drudges or abuse them in their naivety to have to work. The more rules there are to protect the employees from the power of the employers the better, in the view of the trade unions. In this aspect it is not strange that trade unions are by nature against free-market issues. They simply distrust the free-market and almost hate capitalism.

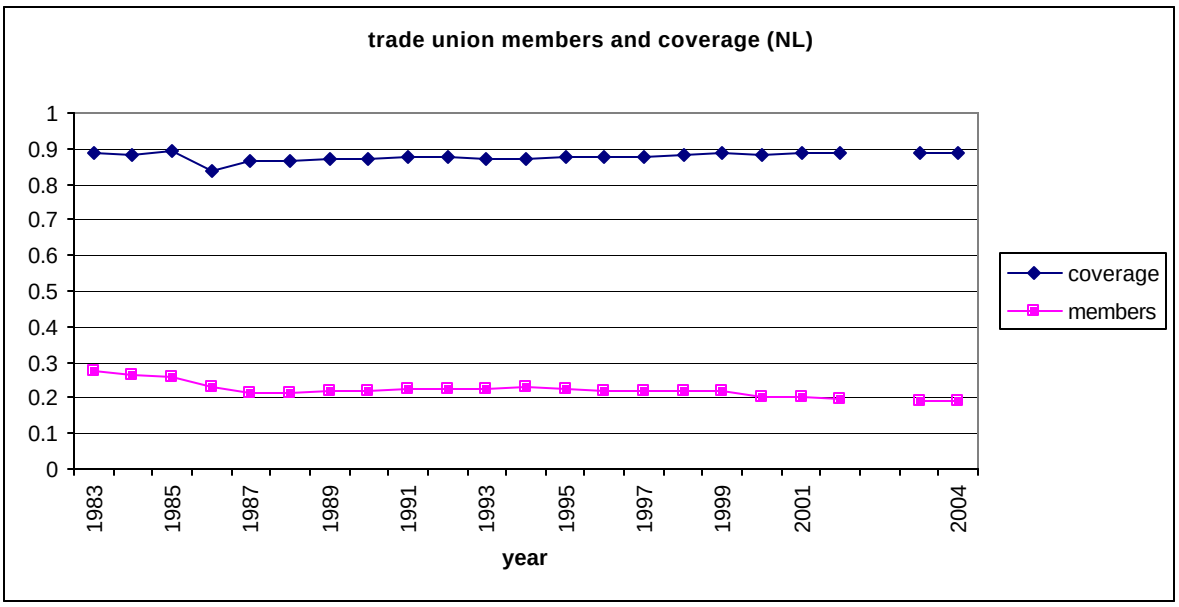
Based on the article of Alesina, Glaeser and Sacerdote (2005), the thinking is that trade unions may have a significant negative influence on the number of worked hours. The more power the trade unions have, the less hours people work per week. This is because most trade union agreements have a negative impact on the number of hours. One can think of the 36 hours workweek and more days off. Prescott focuses on the marginal tax rates, and therefore he implicitly assumes that trade unions do not necessarily have a negative affect, while Alesina (and others with him) maintains that the trade unions (as symbols for the European welfare state) have a significant influence on the number of hours worked. This is because trade unions are one of the cultural differences between Americans and (continental) Europeans, which could be important, next to the marginal tax rates on income.

Trade union power is one of the indicators having a significant impact on the number of hours worked. The assumption is that a trade union is more powerful if it has more members. When a trade union is more powerful, its ideas will have more impact on the labour market. The expectation is that the percentage of employees actually members of a trade union, might have a negative influence on the number of hours worked.

The variable used is from the Labour Market Statistics of the OECD, 'Trade union members and number of employees'. The number of trade union members is divided by the total number of people employed, from the same database, to use the percentage instead of the absolute value. The percentage is used because if more people went to work, and so the average hours of the total potential workforce increased, it is quite logical that the number of members of trade unions will also increase. Therefore the absolute value is not reliable, and the ratio in terms of the total employment will be used.

Another point of interest with trade unions is the coverage rate. Most agreements which trade unions make for their members with other parties (like governments or employers) are binding on all employees working in that sector of industry. Therefore the trade union has not only an influence on the number of hours worked through the number of its members, but also through its coverage rate. If more employees are under the protecting wings of the trade union (regardless of membership), the thinking (and also of Alesina et al) says that the number of hours worked will decline. The variable used is from the Labour Market Statistics of the OECD, 'Trade union members and number of employees'. The number of employees is divided by the total number employed, from the same database.

Unfortunately the variable 'Trade union members and number of employees' was only available till 2001 for Belgium and France, till 2002 for Italy and the Netherlands, and till 2003 for the United Kingdom and the United States of America. The numbers of total employment are known up to 2004 for all countries. Therefore the percentages of trade union members and coverage can be calculated. The next step is to calculate the average growth of the percentage and



then extrapolate up to 2004. Below in figure 3.1 a visualisation of the trends has been done for the Netherlands, and for the other countries this visualisation can be found in appendix C. The known data is from 1983 till 2002 and the data for 2003 and 2004 is calculated by the average growth. In the figure this is visualised by the open spot between the years 2002 and 2003. Years before the open spot are from the database and the years afterwards are extrapolated on basis of the total employment.

Figure 3.1: visualisation of the extrapolation for trade union figures

Section III.I.V: Wages

The reasoning behind this variable is that income may have its influence on the number of working hours. It is not easy to say beforehand whether it is logical to expect a positive or a negative influence on the number of hours worked. If one earns enough income for living, and one's hourly income increases, one might decide to work fewer hours to obtain the same amount of income. Alternatively one might decide to work more hours, because leisure price rises, and it is more attractive to work compared with the situation before the increase in hourly salary.

The variable used is obtained from the EUROSTAT website (for all countries) and is named: 'wages and salaries', measured in PPS per inhabitant. PPS stands for Purchasing Power Standard, which equalises the purchasing power of different countries and national currencies and thus allows meaningful comparison.

Table 3.2: overview of the previous economic indicators for the Netherlands				
Variable	2004	2000	1990	1983
Weekly worked hours	18.79	18.96	17.30	16.19
Age (in years)	39.5	38.8	36.9	36.2
t_c	28.3 %	27.0 %	19.4 %	16.9 %
Trade union members (% employment)	19.0 %	20.5 %	22.2 %	27.8 %
Trade union coverage (% employment	89.0 %	88.2 %	87.1 %	88.9 %
Wages (in PPS per inhabitant)	11,100	9,900	7,200	4,100

Source: EUROSTAT and OECD

Section III.I.VI: Trend

An important thing to bear in mind is that the labour market is constantly in movement and that there may be a many more indicators which change (in a positive way) over time. They may have impact on the number of hours employees work, or they may have influence on the participation ratio. One can think of more machinery in households, so that less time needs to be spent in household work, and therefore more time can be spent in working away from home. Ore one can think for instance of (in Europe) the decreasing number of children. If one has fewer children, or the children can spend a few days at a nearby playgroup, there is more time to work, and so the number of hours may increase.

Thus the trend variable indicate developments which has a positive affect to save hours on time consuming tasks out of the office. If one has more hours to spend, one might easier decide to work more hours.

The above examples are just examples, while the trend captures all the changes over time. The trend is not country dependent, and is simply a rising line in time, since progression is positive. This trend is only added to the 'best' model already selected to check if this development indicator may correct the model.

Section III.II: Analysis

In this section the description of the analysis will be presented.

Section III.II.I: Summary statistics

All countries have country specific variables, so each variable will be presented with an indicator for the right country. BE for Belgium, FR for France, IT for Italy, NL for the Netherlands, UK for the United Kingdom and US for the United States of America.

For the Netherlands the variables used are given by:

NL_W: number of average weekly worked hours per inhabitant, 15 to 64 year, measured in hours.

NL_TAU_H: average marginal tax rate on income (see formula 2.3), measured in percentage.

NL_TAU_C: average tax on consumption (see formula 2.5), measured in percentage.

NL_LFT_WF: average age of the inhabitants between 15 and 64 years, measured in years.

NL_TUM_PT: the members of a trade union, measured as a percentage of total employment.

NL_CAO_PT: the percentage of employees under union coverage, measured as a percentage of total employment.

NL_WGS_PPS: wages defined in purchasing power standard, measured in PPS currency units.

The correlation for the variables in the Netherlands can be found in the table below, while these tables for the other countries can be found in appendix C.

Table 3.3: correlation between the different variables for the Netherlands

Variable	*NL_W*	*NL_TAU_H*	*NL_TAU_C*	*NL_LFT_WF*	*NL_TUM_PT*	*NL_CAO_PT*	*NL_WGS_PPS*
NL_W	1.000	-0.773	0.918	0.941	-0.784	0.463	0.927
NL_TAU_H	-0.773	1.000	-0.809	-0.832	0.564	-0.479	-0.725
NL_TAU_C	0.918	-0.809	1.000	0.980	-0.720	0.447	0.933
NL_LFT_WF	0.941	-0.832	0.980	1.000	-0.752	0.499	0.970
NL_TUM_PT	-0.784	0.564	-0.720	-0.752	1.000	-0.027	-0.810
NL_CAO_PT	0.463	-0.479	0.447	0.499	-0.027	1.000	0.429
NL_WGS_PPS	0.927	-0.725	0.933	0.970	-0.810	0.429	1.000

Source: EUROSTAT, OECD, Prescott (2004)

The high level of correlation between the different variables may indicate the problem of multicollinearity when the model is estimated. This means that an above presented indicator may have not only a direct relationship with the number of worked hours, but also an indirect relationship through one of the other indicators. In this analysis the objective is to find reliable estimates of the partial effects of the different explanatory variables. These high correlations may cause a wrong value for the significance level of the different variables, and this may lead to a wrong conclusion.

Section III.II.II: OLS regression and testing

The first step in the modelling process is to create a model on the basis of an ordinary least squares (OLS) regression, whereby W is explained by t_h (with none, one, or two lags) and t_c (with none, one, or two lags) and eventually W (with one or two lags). The lagged W may be in the model to reduce the presence of serial correlation. The best model created on basis of these two tax variables and a lag will be corrected with the trend to see if time itself has an explaining power. There is no restriction that the models for the different countries should be the same,

because the countries may differ from each other. The best model per country is chosen on basis of:

1. the significance of the variables and the level of the R^2 (see formula 3.7 below),
2. the 'Breusch-Godfrey Serial Correlation LM Test', and
3. the Akaike Information Criterion[2] (see formula 3.9 below).

The first criterion is the most important. So the model with good values for criterion two and three and the best values for criterion one is selected as the 'best' model.

The second step in the process is to add more explanatory factors to the model. All the combinations of W (with one or two lags), t_h (with one or two lags), t_c (with none, one, or two lags) and one of the other indicators (with none, one, or two lags) will be calculated to try to explain the number of worked hours. So per indicator 36 (2 times 2 times 3 times 3) models will be calculated. If there is only one model with significant values for the variables of the 36 models, this is less then a 5%, and therefore this one model is not regarded as significant.

By using OLS, all data points are plotted and a straight line is drawn through these points. The vertical difference between a point and the line is called an error. The slope and the starting point of this special OLS line are chosen in such a way that the total summed errors are minimal. An example of modelling OLS is given below in 2-dimensional form, on the next pages.

In figure 3.2 there is an explanatory graph for the Netherlands where OLS is applied for W and t_h, in time. One sees a straight line drawn in the graph. Every other straight line is less optimal by having larger errors.

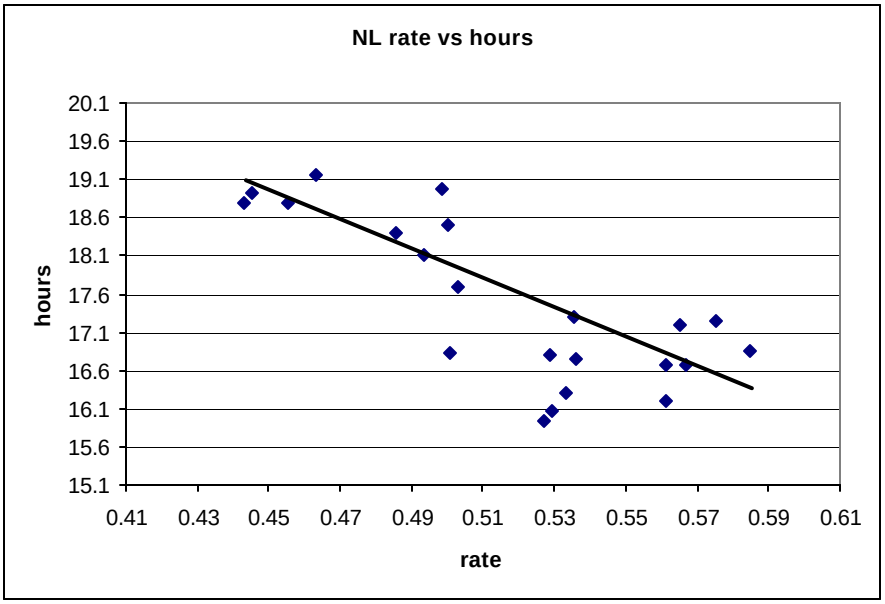


Figure 3.2: example of OLS for the Dutch figures

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[2] In this analyse is chosen for the Akaike information criterion (AIC) and not for Schwarz information criterion (SIC). Heij (2004) tells that SIC imposes a stronger penalty on extra variables than AIC. This investigation is interested in the added value of a variable and therefore the AIC is used to test see if the model is improved.

Creating the OLS line in a formal way can also be found in econometric literature (for example Heij et al (2004)). The idea is to explain the differences in the outcomes of the number of worked hours by means of the differences over the years in the average marginal tax rate. It begins with a set of points in a diagram (like the dots in figure 3.2) corresponding to paired observations $(rate_i , hours_i)$, here i = 1,..,21, and the linear line is given by the formula:

$$hours = a + b \cdot rate \tag{3.1}$$

where a is the intercept and b is the slope. The error is defined as the difference between the value of the number of worked hours and the corresponding (vertical up or down) point at the linear line, given by the formula:

$$error_i = hours_i - a - b \cdot rate_i \tag{3.2}$$

The least squares criterion function, the term which has to be minimal, is defined as:

$$S(a,b) = \sum_i error_i^2 \tag{3.3}$$

By substituting formula 3.2 in 3.3:

$$S(a,b) = \left(hours_i - a - b \cdot rate_i\right)^2 \tag{3.4}$$

by solving both the first order conditions a and b are defined as:

$$a = \overline{hours} - b \cdot \overline{rate} \tag{3.5}$$

and

$$b = \frac{\sum_i \left(rate_i - \overline{rate}\right) \cdot \left(hours_i - \overline{hours}\right)}{\sum_i \left(rate_i - \overline{rate}\right)^2} \tag{3.6}$$

The stripe above the variable is the mathematical symbol that stands for the average of that variable.

Given the formulas 3.5 and 3.6 one can calculate the values for *a* and *b* for the Netherlands, which are 27.438 and -19.268 respectively.

A measurement, which is defined as the relative explained sum of squares, is the R^2. The least squares criterion is equivalent to the maximization of R^2, which is in this case defined as:

$$(3.7) \quad R^2 = \frac{\left(\sum_i \left(rate_i - \overline{rate}\right)\cdot\left(hours_i - \overline{hours}\right)\right)^2}{\sum_i \left(rate_i - \overline{rate}\right)^2 \cdot \sum_i \left(hours_i - \overline{hours}\right)^2}, \qquad 0 \le R^2 \le 1$$

Something which has to be taken into account is that in addition to the statistical part, there is an economic part, which is at least just as important. The models which have a high level of R^2 are not necessarily models which are economically interpretable. One example is that it is quite reasonable that one makes his decision on the level of the previous years tax, or even on the year before. Therefore the earlier mentioned lags are allowed in this model. Even if one wants to react immediately to a changing level of tax, there might be some obstacles which restrict one from changing ones working hours (for instance the hours in the labour-contract or limitations in the work schedule which prevent the immediate raising or reduction of the number of worked hours).

A further point is the problem of serial correlation. As mentioned before, people may react delayed. This delayed reaction towards changes in the marginal rates may be the cause of systematic errors, so serial correlation. In formula the problem is defined as:

Assume:

$$(3.8) \quad \begin{aligned} e_i &= hours_i - a - b \cdot rate_i \\ e_j &= hours_j - a - b \cdot rate_j \end{aligned}, \qquad i \neq j.$$

One of the assumptions of OLS regression is that there is no correlation between the error terms. If the correlation between two different error terms is significantly different from 0, the model has serial correlation. The absence of serial correlation is tested in this analysis by using the F-statistic of the 'Breusch-Godfrey Serial Correlation LM Test'[3]

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[3] It is not in the scope of this research to go deeper into the serial correlation test, so this theory is from Heij et al (2004).

Breusch-Godfrey test for serial correlation of order *p*, which is 2 in this report

This test is done with two lags and at a significance level of 5%.

The effect of serial correlation is that the OLS estimator is not efficient, and mostly underestimates the standard errors of the regression coefficients. Thus serial correlation might give the wrong value of the significance level, and might lead to wrong conclusions. The model can be adjusted to reduce the serial correlations and to calculate the correct numbers with corresponding levels of significance. The easiest way to adjust the model is to expand the number of explaining variables by lags of the variable which has to be explained. Another way is to expend the explaining variables with more lags or other variables.

Therefore the strategy for the different countries is the following: Firstly, create a model with significant values (at the normal level of 5 %) of the tax parameters (t_h and t_c), with the absence of serial correlation (also at 5 % significance). The most ideal is if the lags used are not greater than two years, and the model has to be economically interpretable. Secondly, the hypothesis is tested by adding more variables to the model and indicating if they can have an added value to the existing model with only the two tax variables.

The previously mentioned Akaike Information Criterion (AIC) is in formula given by:

$$(3.9) \qquad AIC(p) = \log\left(s_p^2\right) + \frac{2 \cdot p}{n}$$

Where p is the number of included regressors, s_p^2 is the maximum likelihood estimator[4] of the error variance in the model with p regressors, and where n is the number of observations (in this report the number of years). It is not in the scope of this research to go deeper into the AIC formula, but a lower value of the AIC (with the same p and n values) means a better model.

Step 1: Apply OLS in the model $y = Xb + e$ and compute the errors $e = y - Xb$

Step 2: Apply OLS in the auxiliary regression equation $e_i = x_i'd + g_1 e_{i-1} + \cdots + g_p e_{i-p} + w_i$, $i = p+1, \ldots, n$

Step 3: *F*-test on the joint significance of the parameters $(g_1, \ldots, g_p)$ in the above auxiliary regression. The null hypothesis is that there is no joint significance and therefore no serial correlation.

[4] It is not in the scope of this research to go deeper into the maximum likelihood estimator, so this theory is from Heij et al (2004).

An example is given, in this case: $y = Xb + e$, $e \sim N(0, s^2 I)$, so that $y \sim N(Xb, s^2 I)$. It follows that the log-likelihood is given by: $l(b, s^2) = -\frac{n}{2}\log(2p) - \frac{n}{2}\log(s^2) - \frac{1}{2s^2}(y - Xb)'(y - Xb)$. The maximum likelihood estimates are obtained from the first order conditions and the solutions are given by: $b_{ML} = (X'X)^{-1}X'y = b$ and $s^2_{ML} = \frac{1}{n}(y - Xb)'(y - Xb) = \frac{n-k}{n}s^2$, where s^2 is the (unbiased) least squares estimator of s^2

Chapter IV: Countries

In this section the results for the different countries will be presented. First the graphs with the time series and the regression (OLS) line are given (formula and R^2 are also given, top right). The graphs are purely illustrative, and no conclusions can be drawn from them. Next to the graphs the years of start and end are presented, corresponding the height of the point. The size of the axis is for all the graphs the same, so the changes per country can easily be viewed and compared. Second the model output is presented. The R^2 and significance level can be read out of the model output. The serial correlation test is presented in the lowest line of the model output. For some countries there seems to be a contradiction between the graph and the model. This can happen because of the lags in the model, or other explaining variables. The first model presented is the best (if possible) model with the two tax variables, this does not mean it is the only one, but it is the best given the criteria. If other models are presented it is to show that other indicators may have a contribution to the model for that country.

The implementation of the models is as follows:

To implement the model outputs in a right way, below there are a few remarks which may assist in looking at the models. Most important are the

-Variable: the definition of the variable used to explain the number of worked hours. A negative number between brackets means a lag of that size in years.

-Coefficient: the value of contribution of the explaining variable to the value of the dependent variable. A positive value means that if the value of the explaining variable raises the value of the dependent variable also rises. A negative value means that the value of the dependent variable is getting down if the explaining variable is declining.

-Prob.: the significance level, if this figure is larger than 0.05, the variable has a significant contribution to the model

-R-squared: R^2, see formula 3.7, indicator of the explaining power of the indicators.

-Probability: the significance level of the serial correlation test, if this figure is lager than 0.05 the hypothesis that there is no serial correlation can not be rejected.

Less important, but nice to see are the

-Sample (adjusted): per country can be seen in which period all the variables were available and the total number of observations is given in the line below.

-Method: for each model the Least Squares method is used.

-Dependent variable: for each country must be here the *W* variable. This is the one to be explained by the other variables.

-Akaike Info criterion: the earlier mentioned AIC (see formula 3.9).

Section IV.I: Belgium

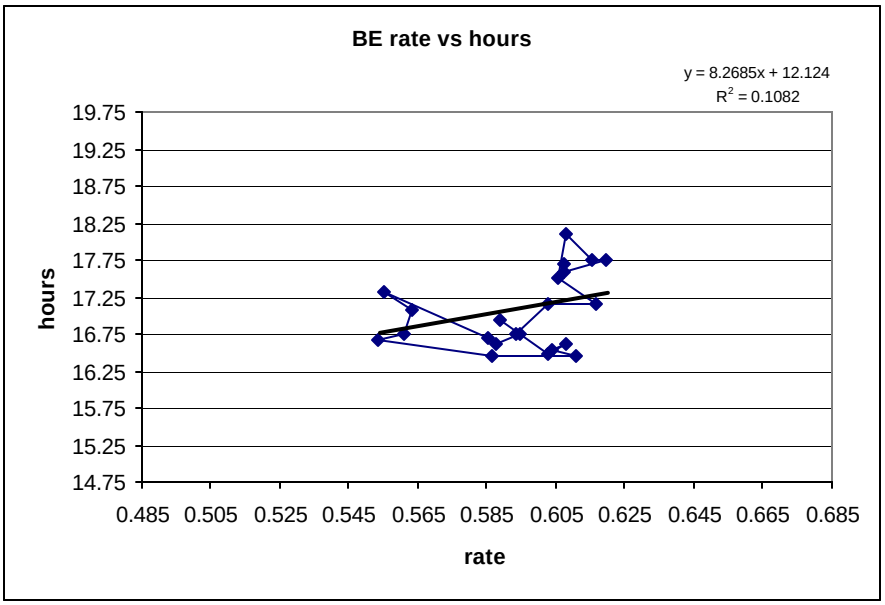

Figure 4.1: relation of hours and rate in Belgium, through time

One can see that from the early '80's to the middle '90's the graph shows overall a climbing line if the rate is decreasing. The first part of the line confirms Prescott's idea about this relationship; the second part definitely does not confirm it. From the end of the '90's both rates en worked hours have gone up. In his analysis, Prescott uses observations till 1996 to avoid data out of the 'dot-com hype'. In Belgium the latest few observations are out of that period around the turn of the millennium. However, both changes in the rate and in hours are rather small, so not a lot happened in Belgium in the period of 1983 till 2004 with either variable.

As expected from figure 4.1, there is some trouble in estimating the model for the Belgian relationship between the level of tax and the number of worked hours. In the model output (model 4.1) it is clear that it is not possible to create a significant model for Belgium on the basis of these two tax parameters. Only if the Belgian t_h variable has a lag of four years, does it have a significant contribution to the model, with a positive sign (see model 4.2).

Other variables (age, trade union figures and wages) and the time trend do not have a significant contribution to the model for Belgium with the two tax variables.

Model 4.1

Dependent Variable: BE_W

Method: Least Squares

Sample(adjusted): 1984 2004

Included observations: 21 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11.48217	2.841713	4.040579	0.0008
BE_W(-1)	0.294048	0.186724	1.574778	0.1337
BE_TAU_H	**-4.264505**	2.714071	-1.571258	**0.1345**
BE_TAU_C(-3)	13.47648	3.321913	4.056842	0.0008
R-squared	**0.851440**	Akaike info criterion		-0.063637
B-G F-statistic	0.869162	Probability		**0.439384**

Model 4.2

Dependent Variable: BE_W

Method: Least Squares

Sample(adjusted): 1984 2004

Included observations: 21 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.985885	2.261697	2.646635	0.0170
BE_W(-1)	0.309234	0.151462	2.041666	0.0570
BE_TAU_H(-4)	**5.834466**	2.107174	2.768858	**0.0131**
BE_TAU_C(-2)	10.20345	2.637982	3.867900	0.0012
R-squared	**0.881665**	Akaike info criterion		-0.291106
B-G F-statistic	0.886472	Probability		**0.432628**

Section IV.II: France

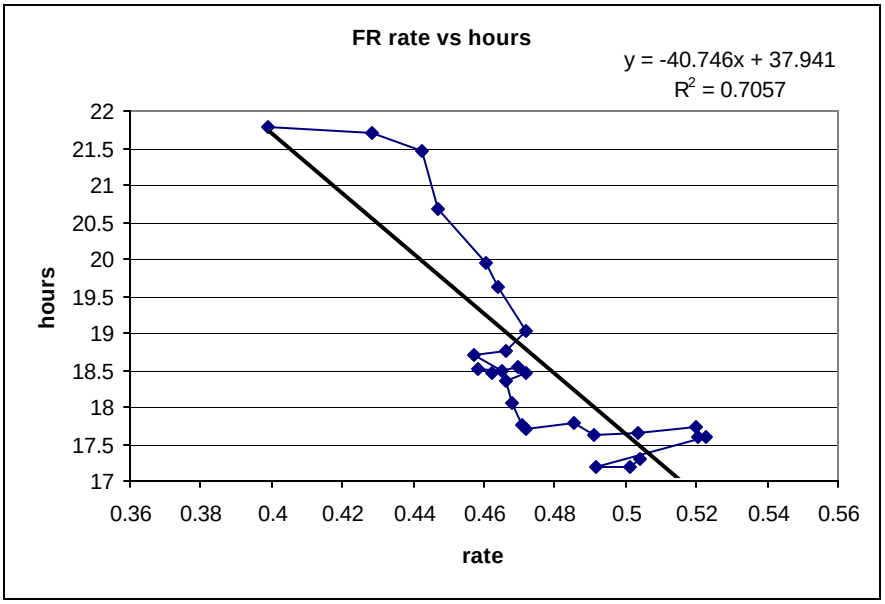

Figure 4.2: relation of hours and rate in France, through time

Except for a small chaotic period, the picture is quite clear. The average marginal tax rate on income has increased in time since 1978 and the average worked hours per week have decreased. Prescott's idea can be read clearly at the figure 4.2.

As can be seen in the figure above there is a strong negative relationship between the number of worked hours and the average marginal tax rate. So it was quite easy to create a good model for France, which can be seen in model 4.3.

Model 4.3

Dependent Variable: FR_W

Method: Least Squares

Sample(adjusted): 1980 2004

Included observations: 25 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.950276	2.523558	3.942955	0.0007
FR_W(-2)	0.644591	0.059220	10.88471	0.0000
FR_TAU_H(-1)	**-14.73660**	4.559507	-3.232060	**0.0040**
FR_TAU_C(-2)	11.66088	4.521682	2.578881	0.0175
R-squared	**0.955358**	Akaike info criterion		0.148516
B-G F-statistic	0.688861	Probability		**0.514258**

The tax variables are highly significant, and there is no presence of serial correlation. The coefficient for the t_h, with a lag of one year, is negative, which underpinned the idea of Prescott. The positive sign of the t_c means that if tax on consumption rises, people, between 15 and 64, react to it (with a lag of two years) by increasing the average number of working hours.

The very high value of the R^2 (of 95.5 %) shows that the three explaining variables have a very good explaining power. As expected the other indicators (age, wages and trade union indicators) and the time trend do not have a positive contribution to the model. If one of these indicators is added to the model has not a significant probability and therefore it is easy to conclude that they do not have any contribution in addition to these two tax variables.

Section IV.III: Italy

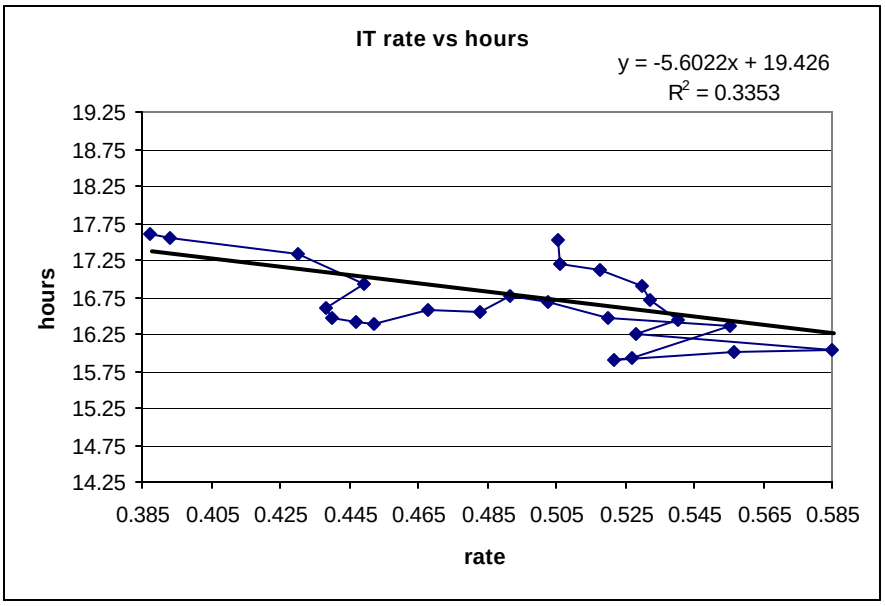

Figure 4.3: relation of hours and rate in Italy, through time

The Italian graph (figure 4.3) seems a little confusing. From 1980 till the middle '90's the trend can simply be seen as rates go up through time, and worked hours go down. After the middle '90's the trend is the same, as rates go down through time and worked hours go up (the effect is even stronger than it was up to the middle '90's). This is (two times) exactly the relationship Prescott assumes to be true. The strong increase of the worked hours in the last decade could be caused by the 'dot-com hype'. Around the turn of the millennium one can see an almost vertical increase in the number of hours.

The slope of the change in hours is rather flat. This may be caused by the fact that large shadow economy of Italy is decreasing slowly over time. Therefore the number of hours worked increases by the shrinking shadow economy, while, at the same time, the number of hours worked decreases by the higher tax rate.

The model with the two tax variables and the lagged *W* is given in model 4.4.

Model 4.4

Dependent Variable: IT_W

Method: Least Squares

Sample(adjusted): 1981 2004

Included observations: 24 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	7.584862	1.649623	4.597937	0.0002
IT_W(-1)	0.681152	0.074620	9.128278	0.0000
IT_TAU_H(-1)	**-7.134071**	1.297912	-5.496574	**0.0000**
IT_TAU_C	6.316291	0.852344	7.410498	0.0000
R-squared	**0.953593**	Akaike info criterion		-1.454204
B-G F-statistic	0.455066	Probability		**0.641507**

The tax variables are highly significant, and there is no presence of serial correlation. The coefficient for the t_h with a lag of one year is negative, which underpinned Prescott's idea. The positive sign of the t_c means that if tax on consumption rises people between 15 and 64 react to it (with a lag of two years) by increasing the average number of weekly working hours. The very high value of the R^2 (of 95.4 %) shows that the three explaining variables have a very good explaining power.

Time trend does not have an added value for the model, even as the wages indicator has no positive contribution to the model. The coverage of the trade unions however has a significant influence (see model 4.5). And the indicator of the average age does have influence on the model (see model 4.6), although it is not very big.

The idea was that if the coverage percentage is increasing, the worked hours are decreasing, thus a negative coefficient. A glance at model 4.5 tells however that this idea is not correct. The positive coefficient of the variable *CAO_PT* means that if the percentage of employees under union coverage increases the number of worked hours also increases. An important point to mention is that Italy is well-known for its large size of the shadow economy. And (by definition) hours worked in the shadow economy are not registered as working hours, and the hours worked in the shadow economy are free of tax on income. A possible economic explanation for the positive sign may be that, if the rates are lowered people may decide to work

in the tax paying economy in stead of the shadow economy. And if more employment moves from the shadow to the tax paying economy in a year (so *W* is increasing), it is quite possible that the percentage of union coverage (*CAO_PT*) also grows that year. This may be an explanation for the positive value.

Model 4.5

Dependent Variable: IT_W

Method: Least Squares

Sample(adjusted): 1982 2004

Included observations: 23 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.851103	3.959623	-0.214946	0.8322
IT_W(-1)	0.557686	0.125016	4.460925	0.0003
IT_TAU_H(-2)	-5.663089	1.957039	-2.893703	0.0097
IT_TAU_C	5.149819	1.496627	3.440951	0.0029
IT_CAO_PT	**13.95779**	6.193459	2.253634	**0.0369**
R-squared	**0.924679**	Akaike info criterion		-1.022005
B-G F-statistic	0.142929	Probability		**0.867910**

A closer look at model 4.5 provides more information about the differences. For example, the R^2 is lower than without the trade union coverage variable. The signs of the other variables (except the constant term) are the same, while their level of significance is slightly lower. The hypothesis of presence of serial correlation can be more strongly rejected. All in all the variable *CAO_PT* has a positive contribution to the model as a variable, but the total model statistics are not really improved.

As presented in model 4.6, the average age of the inhabitants between 15 and 64 years in Italy seems to have a significant influence (with a positive sign). The idea however was that if one gets older one wants to reduce the number of working hours, and not increase them. Here also the famous Italian shadow economy may play its role. It may be possible that as an Italian grows older, he prefers to work in the normal instead of the shadow economy. Another more logical possibility may be that the size of the shadow economy is decreasing slightly over time, so the number of legal worked hours is increasing over time. Just as the average age of the potential workforce is doing.

The explaining power of the explaining variables however is lower than the model without the average age indicator. This variable seem to work quite well to reduce serial

correlation, but that was not a problem in the original model, so *LFT_WF(-2)* does not really make a contribution to the model.

Model 4.6

Dependent Variable: IT_W

Method: Least Squares

Sample(adjusted): 1982 2004

Included observations: 23 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.408226	5.619981	-0.250575	0.8050
IT_W(-2)	0.426380	0.110313	3.865189	0.0011
IT_TAU_H(-2)	-9.519237	1.943015	-4.899209	0.0001
IT_TAU_C	6.479005	2.089524	3.100709	0.0062
IT_LFT_WF(-2)	**0.373654**	0.149466	2.499924	**0.0223**
R-squared	**0.887243**	Akaike info criterion		-0.618535
B-G F-statistic	0.016834	Probability		**0.983324**

Section IV.IV: The Netherlands

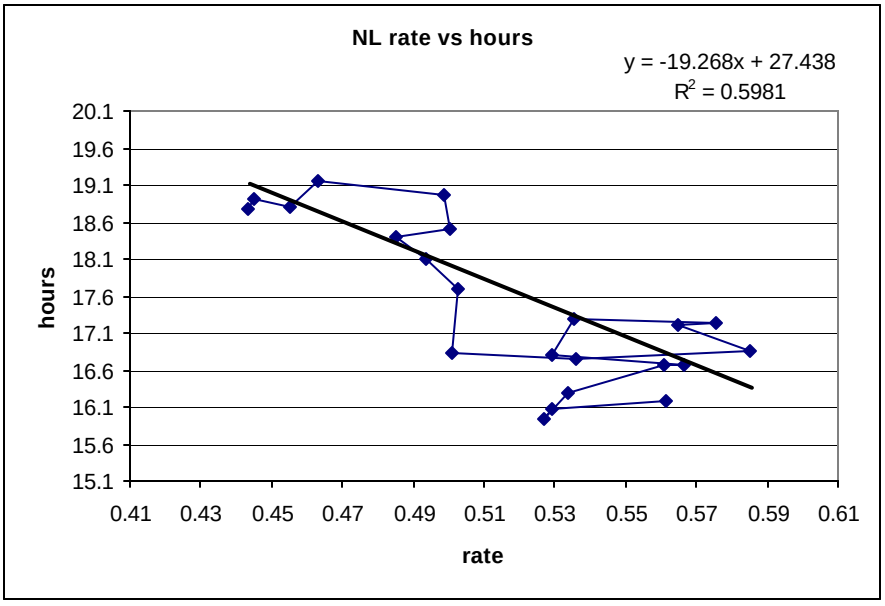

Figure 4.4: relation of hours and rate in the Netherlands, through time

Except a small 'bubble' in the early '90's and in the beginning of the '00's the relation can shortly be given by: if the rate goes down, people start to work more hours per week, exactly in line with Prescott's idea! The hours increased rapidly at the end of the '90's, the time of the 'dot-com hype'. After the turn of the millennium the hours are not increasing that much any more, or decreases slowly.

The basis model for the Netherlands (model 4.7) is in line with that of France. There is negative coefficient for the t_h with two lags. The number of worked hours with a lag does not have a probability level of significance that is low enough, but the variable is in the model to reduce the serial correlation, and in that case *W(-2)* has an added value for the model.

Model 4.7

Dependent Variable: NL_W

Method: Least Squares

Sample(adjusted): 1985 2004

Included observations: 20 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	13.54549	2.858658	4.738409	0.0002
NL_W(-2)	0.245457	0.139606	1.758213	0.0978
NL_TAU_H(-2)	**-6.567759**	2.801732	-2.344178	**0.0323**
NL_TAU_C(-1)	14.62914	3.825447	3.824165	0.0015
R-squared	**0.928051**	Akaike info criterion		0.589100
B-G F-statistic	1.436654	Probability		**0.270704**

Only one of the 36 models which were created with the average age indicator has a significant value for *LFT_WF*, the model is given in model 4.8. Earlier in the chapter was proposed that if only one of the 36 models were to show an improvement it would not be significant. Therefore average age does not explain the average number of worked hours per week in the Netherlands in addition to the tax variables.

Model 4.8

Dependent Variable: NL_W

Method: Least Squares

Sample(adjusted): 1984 2004

Included observations: 21 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	28.56039	9.398865	3.038707	0.0078
NL_W(-1)	0.749988	0.139752	5.366579	0.0001
NL_TAU_H(-1)	-4.700439	2.173651	-2.162463	0.0461
NL_TAU_C(-1)	20.90765	5.890678	3.549278	0.0027
NL_LFT_WF(-2)	**-0.701013**	0.297591	-2.355623	**0.0316**
R-squared	**0.964533**	Akaike info criterion		0.016911
B-G F-statistic	1.311586	Probability		**0.300538**

However to complete the picture, the output of that one model is presented, where it can be seen that there is a negative coefficient for the average age indicator, which could indicate the importance of obsolescence.

The other indicators (wages, trade union figures) and the time trend do not have a contribution to the model.

Section IV.V: United Kingdom

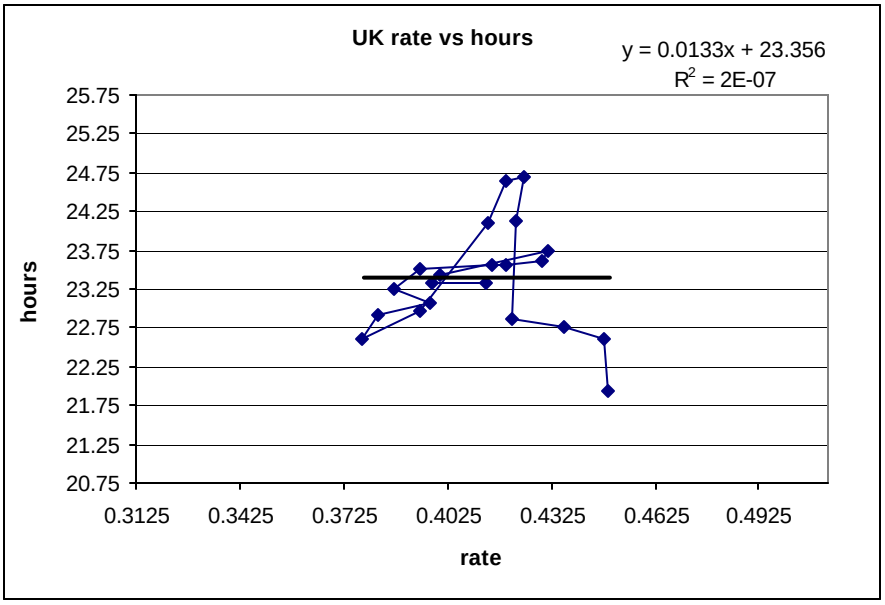

Figure 4.5: relation of hours and rate in the United Kingdom, through time

The United Kingdom graph (figure 4.5) is not quite clear. There seems to be a negative relationship between rate and hours in the middle '80's, but a positive relation in the early '90's. From the end of the '90's the number of hours seems to be rather constant, while the rate is changing up and down. Both changes in hours and in rates are not very big, so it seems not a lot happened in the United Kingdom with respect of these two indicators, although the first few years of the graph looks promising.

The model outputs confirm the idea; for the United Kingdom it is impossible to create a 'normal' model on the basis of the desired tax variables and a lag of the working hours. The less bad model of these explaining variables is given in model 4.9, the t_h has an insignificant contribution (with a positive coefficient) and the model reacts positively on the serial correlation test.

To reduce the serial correlation, an extra lag of the dependent variable is introduced in the model, and the other explaining variables are taken out of the model. Then the absence of serial correlation can be proven statistically (very weak with a probability of 0.082 for the serial correlation test), see model 4.10.

Model 4.9

Dependent Variable: UK_W

Method: Least Squares

Sample(adjusted): 1985 2004

Included observations: 20 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-3.717886	4.835424	-0.768885	0.4532
UK_W(-1)	0.684773	0.117559	5.824940	0.0000
UK_TAU_H	**7.859991**	4.292510	1.831094	**0.0858**
UK_TAU_C(-2)	32.27574	13.98270	2.308263	0.0347
R-squared	**0.714651**	Akaike info criterion		0.923204
B-G F-statistic	5.211562	Probability		**0.020337**

Model 4.10

Dependent Variable: UK_W

Method: Least Squares

Sample(adjusted): 1986 2004

Included observations: 19 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	10.05422	3.181099	3.160612	0.0061
UK_W(-1)	1.114390	0.195510	5.699911	0.0000
UK_W(-2)	-0.543432	0.170557	-3.186224	0.0057
R-squared	**0.683864**	Akaike info criterion		0.880563
B-G F-statistic	3.005957	Probability		**0.082012**

All in all it is not possible to create a model, without the presence of serial correlation, with significant tax variables for the United Kingdom. Also the other possible explaining variables and the time trend do not have a contribution in the explanation. So the number of average working hours per week in the United Kingdom can in this analysis only be explained

with its own lags. This is not in line with Prescott's idea, but at least it is also not the other way around that other indicators can improve the model compared to the model presented in model 4.9. It is possible that if available data goes back to the '70's or even before, the model can be created.

Section IV.VI: United States of America

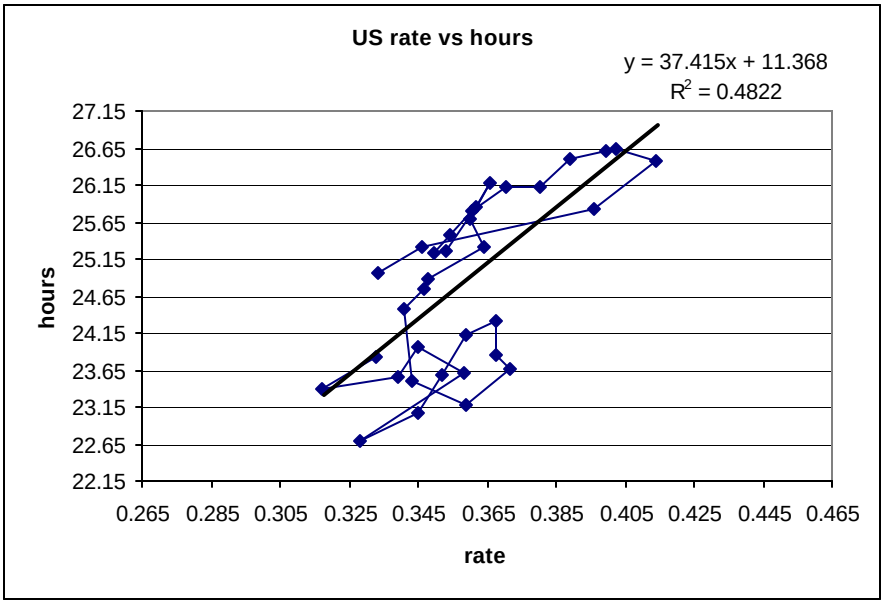

Figure 4.6: relation of hours and rate in the United States of America, through time

The graph for the United States of America (figure 4.6) is not directly in line with the idea of Prescott. Actually it is exactly the opposite. The Americans pay after 33 years the same level of average marginal tax rate on income, while they work an hour more on a weekly basis than 33 years ago. This is in contradiction with Prescott's idea of the relation between the rates en hours. Around the year 2000 the number of hours is at its highest level.

If the average marginal tax rate on income is delayed with two years in comparison with the number of hours, the picture becomes like figure 4.7, where it can be seen that the OLS line does not fit the relation that well. As written above, these graphs are purely illustrative and it is not possible to draw conclusions out of them.

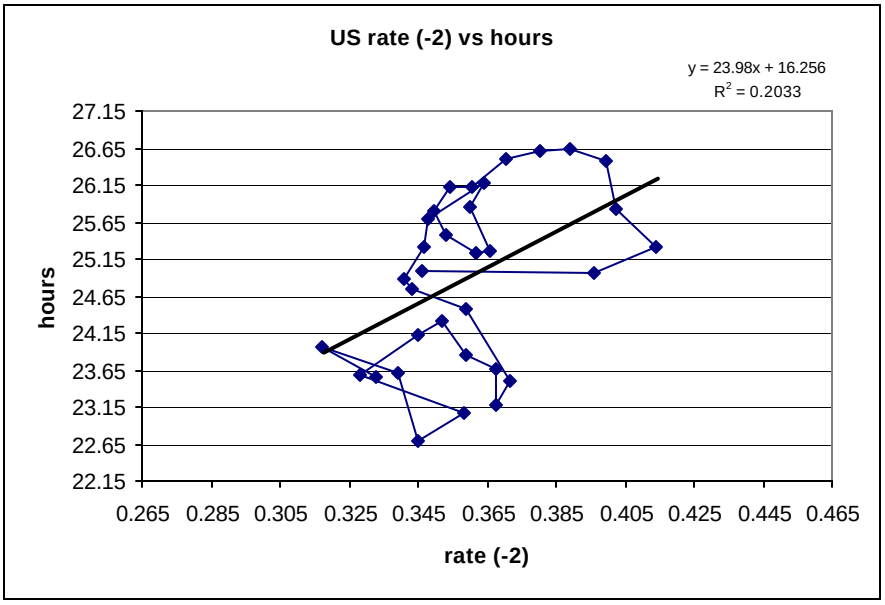

Figure 4.7: relation of hours and rate (with a 2 years lag) in the United States of America, through time

The model output for the United Station of America shows another relation (see model 4.11) between the average marginal tax rate variable and average number of weekly worked hours than the graphs would pretend.

Model 4.11

Dependent Variable: US_W

Method: Least Squares

Sample(adjusted): 1972 2003

Included observations: 32 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11.17689	3.150758	3.547364	0.0014
US_W(-1)	0.885210	0.078428	11.28698	0.0000
US_TAU_H(-2)	**-13.97793**	4.177998	-3.345605	**0.0023**
US_TAU_C	**-27.31592**	9.451496	-2.890116	**0.0074**
R-squared	**0.914123**	Akaike info criterion		0.924476
B-G F-statistic	0.686459	Probability		**0.512247**

The two tax variables are significant and the presence of serial correlation can not be proven. This means model 4.11 is a good model for the relation between tax on labour, consumption and the average number of worked hours and the R^2 is high with a value of 91.4%. It is remarkable that the coefficient of t_c is negative. With all other countries the coefficient for the tax on consumption variable is positive (which means, if tax on consumption rises, people react by working more hours on average).

Wages and trade union figures do not contribute extra to the above presented model. However out of 36 models created for the average age indicators there are two models where the *LFT_WF* has a significant probability (at a 5 %-level). The most significant contribution is presented in model 4.12, where the average age variable has a positive coefficient. As the American workforce grows older on average, they tend to work more hours a week on average. In the Italian model (see model 4.6) the sign was the same, however in the Netherlands the coefficient has the reverse sign (see model 4.8) for the models where age has a significant coefficient.

Model 4.12

Dependent Variable: US_W

Method: Least Squares

Sample(adjusted): 1972 2003

Included observations: 32 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	10.62806	5.589242	1.901520	0.0680
US_W(-2)	0.659804	0.129770	5.084407	0.0000
US_TAU_H(-2)	-35.48572	6.311737	-5.622179	0.0000
US_TAU_C	-61.63981	10.51088	-5.864379	0.0000
US_LFT_WF	**0.485231**	0.210213	2.308278	**0.0289**
R-squared	**0.878222**	Akaike info criterion		1.336260
B-G F-statistic	0.791268	Probability		**0.464296**

A possible explanation of the size of the shadow economy (which may have its effect in Italy) does not fit the picture for the United States of America. There may be another possibility. The United States of America is, compared with the European countries, a young country with no (or less) obsolescence (which may have his effect in the Netherlands). The Americans could have another vision on their career. The positive sign may indicate that when Americans get older (and career advances) they want to work more hours.

A few differences between the model 4.11 and 4.12 are that:

-the R^2 is some lower in the second model,

-the significance of the tax variables has increased, while their coefficient has become more negative.

Although the *LFT_WF* has a positive contribution to the model, it is not possible to conclude that it is a direct improvement of the model, if compared with the model without the age indicator.

As concluded from figure 4.6 in 33 years the workforce in the United States of America works an hour more while paying the same level of tax. This could indicate on a time trend, and the output in model 4.13 confirms this idea, although not very strongly. The probability level is not significant enough, and also the significance level of the t_c is decreased. The R^2 is slightly higher, but in this model the time trend seems nothing more than an indication that the American society is changed over time, which may have some influence on the behaviour of the workforce, but not significant.

Model 4.13

Dependent Variable: US_W

Method: Least Squares

Sample(adjusted): 1972 2003

Included observations: 32 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	14.74662	3.664688	4.023977	0.0004
US_W(-1)	0.723582	0.119582	6.050950	0.0000
US_TAU_H(-2)	-18.57680	4.816874	-3.856610	0.0006
US_TAU_C	-18.84210	10.33398	-1.823315	0.0793
TREND	**0.038622**	0.022119	1.746107	**0.0922**
R-squared	**0.922836**	Akaike info criterion		0.879987
B-G F-statistic	0.560939	Probability		**0.577691**

Section IV.VII: Pool of all countries

If the above country figures (figures 4.1 till 4.6) are plotted in one figure (for the United States of America the relation with no lags is chosen for a better comparison with the other countries), figure 4.8 is obtained. In this figure it is very clear that there are huge differences in the levels of the hours and rate between countries. But also the negative relationship between the rate and the hours is very clear for the different countries. If doubts arise with the graphics and

models per country, figure 4.8 really must be sufficiently convincing to see the negative relationship. Also the relative sizes of differences in rates and hours can be seen. The movements in Belgium and the United Kingdom are really small, while France, Italy and the Netherlands fill more space in the graph.

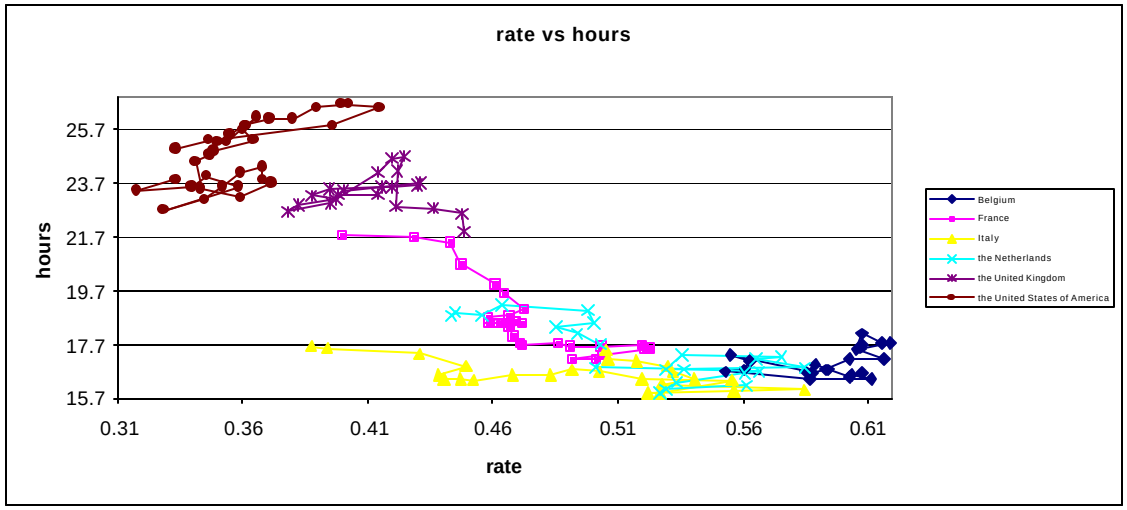

Figure 4.8: overview of the relations of rate and hours in total group

In addition to the differences in level, one can see from the presented (optimal) models that for each country, if it is possible to explain *W* by lagged *W*, t_h and t_c, the lags in the optimal models are different. Therefore the following idea is to create a model which fits for all the countries. Because of the earlier seen differences, the object is to create a model with the same relationship for the tax variables and the number of worked hours, but a different constant factor per country. In formula:

$$(4.1) \quad W_{t,j} = a_j + \sum_{lag=1}^{2} b_{1,lag} \cdot W_{t-lag,j} + \sum_{lag=1}^{2} b_{2,lag} \cdot t_{h\,t-lag,j} + \sum_{lag=0}^{2} b_{3,lag} \cdot t_{h\,t-lag,j} + e_{t,j}$$

Where *t* is time index, *j* is the country indicator and *lag* can be a combination zero (not by *W* and t_h), one and two years.

The values for the coefficients in formula 4.1 can be found in model 4.14. The same strategy as before is applied. So with some lags the best model (with the highest significance levels) has been selected. Notice that in model 4.14 there are two lags of *W*, this was necessary to reduce the serial correlation. With these two lags the Durbin-Watson statistic looks promising.

Model 4.14

Dependent Variable: ?W

Method: Pooled Least Squares

Sample(adjusted): 1971 2004

Included observations: 34 after adjusting endpoints

Number of cross-sections used: 6

Total panel (unbalanced) observations: 142

Variable	Coefficient	Std. Error	t-Statistic	Prob.
?W(-1)	1.250633	0.075665	16.52851	0.0000
?W(-2)	-0.374472	0.073212	-5.114886	0.0000
?TAU_H(-1)	**-1.841538**	0.850248	-2.165883	**0.0321**
?TAU_C()	**1.889133**	0.797931	2.367540	**0.0194**
Fixed Effects				
BE_C	2.791501		NL_C	2.773846
FR_C	2.538138		UK_C	3.209095
IT_C	2.599338		US_C	3.534748
R-squared	**0.993502**	Durbin-Watson statistic		**1.927814**

It is clear that if the differences per country are entered at a constant value (see Fixed Effects, model 4.14), the other relationships assumed to be the same for all countries. The coefficient for the average marginal tax rate is negative, and the value for the average consumption tax rate is positive. This means that if all the countries are treated in the same way the average employee in these countries tend to work less if the average marginal tax rates go up. The constant values, which can be found below 'Fixed Effects', for the countries in (continental) Europe are lower than the constant value for the United States of America.

This model was also expended with the other possible explaining variables (age, trade unions and wages) and the time trend, but not one of these variables does contribute to this model.

Conclusion and remarks

Conclusion

The hypothesis formulated in the introduction of this paper is that the weekly number of hours worked is influenced by the marginal tax rates, while other indicators do not contribute to that explanation. After investigating the data of several countries, the following conclusions can be drawn:

-The number of hours worked weekly is indeed affected by a combination of the average marginal tax rate on labour income and the average tax on consumption.

-We did not find evidence that the other concerned variables do contribute (significantly or constantly) to the explanation of the number of hours worked in these countries.

Remarks

The basis for this research is Prescott's (2004) idea that the labour income tax has a negative influence on the number of hours worked in the tax paying economy. In this thesis, his idea is applied to some additional countries (countries analyzed are Belgium, France, Italy, the Netherlands, the United Kingdom and the United States of America), and instead of taking two time intervals, in this analysis the whole period is taken, or as far back in the past as possible.

Data collecting was difficult, but with some minor extrapolations there are at least 21 years (and up to 33) of reliable data available for each analyzed country. A lot of information is required to construct the tax rates given in Prescott's paper.

On the basis of the models the conclusion is drawn that, in general, the number of hours worked can be explained well by the two tax rates. Except for Belgium and the United Kingdom, the models performed well in the sense of economic interpretation and statistical adequacy. For Belgium and the United Kingdom it was not possible to find a model within the restrictions of the level of significance, the size of the lags and absence of serial correlation.

The other indicators sometimes have a significant contribution to the model, but this contribution never makes an improvement (statistically or economically) compared with the original model (with the two tax variables). The finally selected model, with the same coefficient per variable for all countries, gives a significant negative value for the effect of the average marginal tax rate on labour income.

Thus, all in all, the conclusion can be drawn that it is possible to create a good model for explaining the weekly number of hours worked using the average marginal tax rate on labour income together with the average tax on consumption. Therefore, our conclusion is that people make decisions with respect to how many hours they wish to work on the basis of the level of these two taxes. Hereby the validity of Prescott's idea is supported and other indicators, mentioned in the literature, do not influence their decision significantly.

By the negative coefficient of the average marginal tax rate on labour income (t_h) we can conclude that, if the average marginal level of tax on labour income rises, people tend to work

less hours in tax paying economies. By the positive coefficient of the average tax rate on consumption (t_c) (except the United States of America) we might conclude that as a result of an increase in the level of the average tax rate on consumption people tend to work more hours in tax paying economies.

A better look to the used lags in the selected models may lead to another conclusion: a decreasing of the average marginal tax level on labour income leads to an increase in both the number of worked hours and the average tax on consumption (for instance by consuming more luxury goods). This is also in line with the negative correlation between the two tax variables (of -0.809), which is presented table 3.3. However, the correlation figures are not always negative for the other countries (Appendix C). Therefore the positive effect on the number of worked hours by an increase of the average tax on consumption has become questionable, and more research to the effect of the average tax rate on consumption is needed. Also more research to the relation between the two tax variables (t_h and t_c) could be an addition to this investigation.

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Note: *Mr de Bruin also adds that at "a six months internship at the Quid Novi (QN) institute I worked on this paper. At the same time I was a master student at the Erasmus University Rotterdam (EUR) in Econometrics and Management Science, specialisation within Quantitative Finance. This paper is both used as a working paper for the institute and as a thesis for the study."*

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Appendix A: Data definitions

Definitions of the variables used from the databases of EUROSTAT and the OECD, ranked in order as they are in the paper.

EUROSTAT:

http://epp.eurostat.cec.eu.int/portal/page?_pageid=1090,30070682,1090_30298591&_dad=portal&_schema=PORTAL

-for Belgium, France, Italy, the Netherlands and the United Kingdom:

SocialSecurityTaxes: actual social contributions, receivable

GDP: gross domestic production at market prices

IT: taxes on production and import less subsidies

DirectTaxes: taxes on income

Depreciation: *GNI – NNI*: gross national income at market prices - net national income at market prices

C: final consumption expenditure of households

I: net saving

LFT_WF (average age 15 - 64): Average population by sex and five-year age groups

-for all countries

WGS_PPS: Compensation of employees (defined in PPS per inhabitant)

OECD:

http://www.oecd.org/home/0,2987,en_2649_201185_1_1_1_1_1,00.html or http://lysander.sourceoecd.org/vl=15121092/cl=12/nw=1/rpsv/cgi-bin/jsearch_oecd_stats (only for subscribers)

-for the United States of America

SocialSecurityTaxes: Annual National Accounts - Volume 2, 1970-2003 (2004 prov)- detailed aggregates, GG. Actual social contribution

DGP: „ C. Gross domestic product

IT: „ GG. Taxes on production and imports, receivable - „ GG. Subsidies, payable

DirectTaxes: „ GG. Current taxes on income, wealth etc., receivable

Depreciation: *GNI – NNI*: „ C. Gross national income at market prices - C. Net national income at market prices

C: ,, C. Household final consumption expenditure

I: ,, C. Saving, net

LFT_WF (average age 15 - 64): Labour Market Statistics - DATALFS by sex and age

-for all countries

W: Labour Market Statistics - DATAAverage actual annual hours worked per person in employment, and Labour Market Statistics - DATALFS by sex and age

TUM_PT and *CAO_PT*: Labour Market Statistics - DATATrade union members and number of employees, and Labour Market Statistics - DATALFS by sex and age

Appendix B Taxes on income

In this Appendix the figures like figure 2.1 for Belgium and Italy are presented. The lines correspond with the two parts inside the variable 'current taxes on income, wealth, etc.', because one part counts for the taxes on income and the other part counts for the remains. By splitting the combined variable in these two parts it is possible to obtain the needed variable *DirectTaxes*. The blue flat line justifies the extrapolation backwards as long as the 'current taxes on income, wealth, etc.' is available to create the *DirectTaxes*.

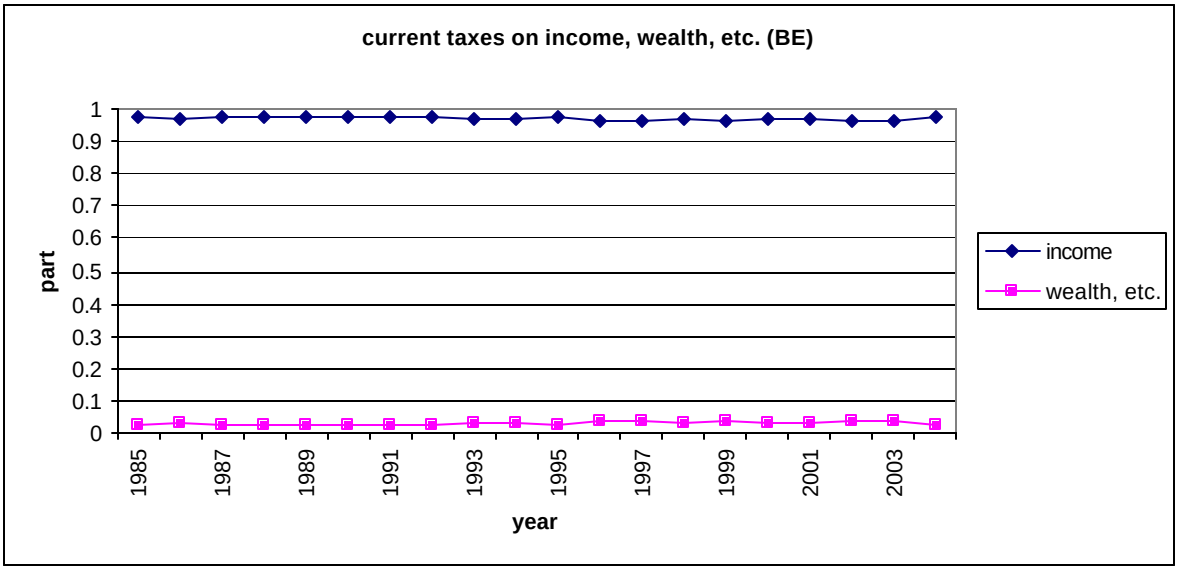

Figure B.1: current taxes on income, wealth, etc. split up into income and wealth, etc.

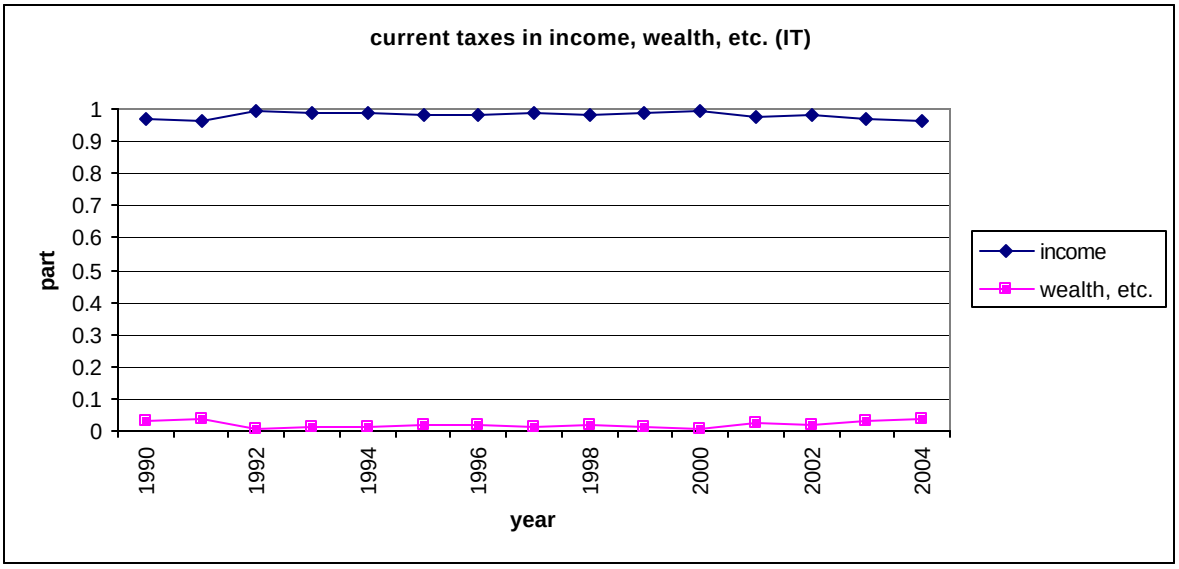

Figure B.2: current taxes on income, wealth, etc. split up into income and wealth, etc.

Appendix C: Country figures

In this Appendix the country figures can be found. The results for the Netherlands are presented in chapter three. In the first table a summary of the used economic indicators is presented. In the figure below the extrapolation of the trade union figures is visualised. The left part of the line is the known data, while the right part is the extrapolated data (with the average trend). The open spot is to indicate which part is left (known) and which part is right (extrapolated). The second table gives the correlations between the variables.

Section C.I Belgium

Table C.1: economic indicators for Belgium

Variable	2004	2000	1990	1983
Weekly worked hours	17.7	18.1	16.8	16.9
Age (in years)	39.2 (2003)	38.9	38.0	37.7
t_c	27.9 %	27.1 %	22.6 %	20.2 %
Trade union members (% employment)	46.4 % *	44.1 %	45.6 %	44.1 %
Trade union coverage (% employment	82.3 % *	79.4 %	84.5 %	84.9 %
Wages (in PPS per inhabitant)	10,100	8,900	3,700	2,700

Source: EUROSTAT and OECD

* extrapolation

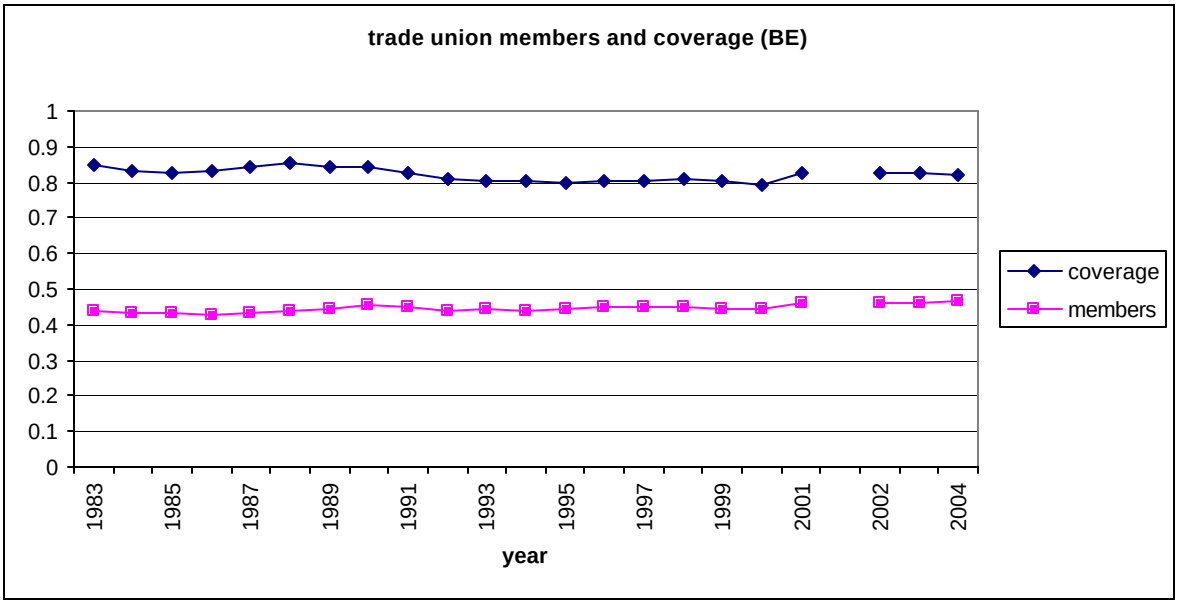

Figure C.1: visualisation of the extrapolation for trade union figures

Table C.2: correlation between the different variables for Belgium							
Variable	*BE_W*	*BE_TAU_H*	*BE_TAU_C*	*BE_LFT_WF*	*BE_TUM_PT*	*BE_CAO_PT*	*BE_WGS_PPS*
BE_W	1.000	0.303	0.736	0.825	0.594	-0.417	0.815
BE_TAU_H	0.303	1.000	0.305	0.469	0.116	-0.212	0.535
BE_TAU_C	0.736	0.305	1.000	0.905	0.658	-0.650	0.890
BE_LFT_WF	0.825	0.469	0.905	1.000	0.737	-0.565	0.969
BE_TUM_PT	0.594	0.116	0.658	0.737	1.000	-0.097	0.729
BE_CAO_PT	-0.417	-0.212	-0.650	-0.565	-0.097	1.000	-0.536
BE_WGS_PPS	0.815	0.535	0.890	0.969	0.729	-0.536	1.000

Source: EUROSTAT, OECD, Prescott 2004

Section C.II France

Table C.3: economic indicators for France				
Variable	2004	2000	1990	1983
Weekly worked hours	17.3	17.6	18.5	19.6
Age (in years)	38.8	38.3	37.3	37.1
t_c	30.6 %	30.6 %	28.2 %	27.4 %
Trade union members (% employment)	8.5 % *	9.1 %	8.9 %	13.3 %
Trade union coverage (% employment	95.3 % *	93.9 %	87.6 %	83.2 %
Wages (in PPS per inhabitant)	9,200 (2002)	8,500	5,900	4,100

Source: EUROSTAT and OECD * extrapolation

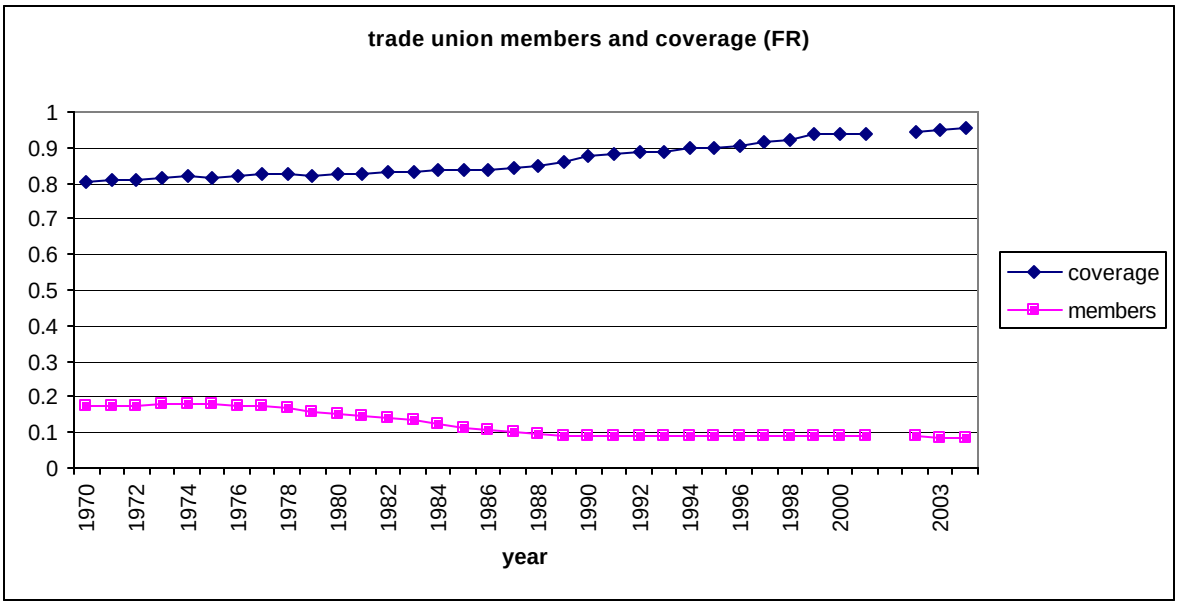

Figure C.2: visualisation of the extrapolation for trade union figures

Table C.4: correlation between the different variables for France

Variable	*FR_W*	*FR_TAU_H*	*FR_TAU_C*	*FR_LFT_WF*	*FR_TUM_PT*	*FR_CAO_PT*	*FR_WGS_PPS*
FR_W	1.000	-0.825	-0.531	-0.905	0.956	-0.820	-0.888
FR_TAU_H	-0.825	1.000	0.639	0.897	-0.735	0.850	0.884
FR_TAU_C	-0.531	0.639	1.000	0.662	-0.467	0.717	0.617
FR_LFT_WF	-0.905	0.897	0.662	1.000	-0.811	0.965	0.981
FR_TUM_PT	0.956	-0.735	-0.467	-0.811	1.000	-0.764	-0.838
FR_CAO_PT	-0.820	0.850	0.717	0.965	-0.764	1.000	0.979
FR_WGS_PPS	-0.888	0.884	0.617	0.981	-0.838	0.979	1.000

Source: EUROSTAT, OECD, Prescott 2004

Section C.III Italy

Table C.5: economic indicators for Italy				
Variable	2004	2000	1990	1983
Weekly worked hours	17.5	16.7	16.8	16.9
Age (in years)	39.6 (2003)	39.2	38.0	37.8
t_c	27.3 %	28.1 %	17.7 %	12.0 %
Trade union members (% employment)	24.6 % *	24.9 %	28.0 %	32.2 %
Trade union coverage (% employment	72.6 % *	71.4 %	71.9 %	70.7 %
Wages (in PPS per inhabitant)	6,900	6,500	5,100	3,300

Source: EUROSTAT and OECD * extrapolation

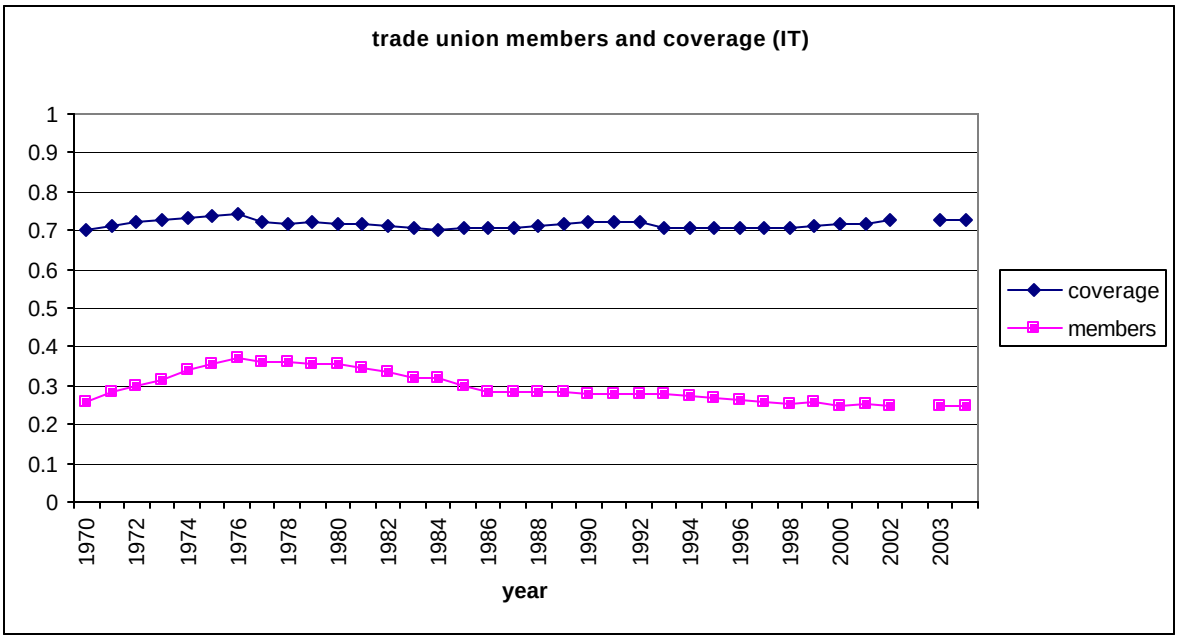

Figure C.3: visualisation of the extrapolation for trade union figures

Table C.6: correlation between the different variables for Italy							
Variable	*IT_W*	*IT_TAU_H*	*IT_TAU_C*	*IT_LFT_WF*	*IT_TUM_PT*	*IT_CAO_PT*	*IT_WGS_PPS*
IT_W	1.000	-0.639	-0.272	-0.127	0.528	0.611	-0.324
IT_TAU_H	-0.639	1.000	0.810	0.681	-0.861	0.013	0.854
IT_TAU_C	-0.272	0.810	1.000	0.928	-0.885	0.304	0.951
IT_LFT_WF	-0.127	0.681	0.928	1.000	-0.837	0.337	0.897
IT_TUM_PT	0.528	-0.861	-0.885	-0.837	1.000	-0.158	-0.939
IT_CAO_PT	0.611	0.013	0.304	0.337	-0.158	1.000	0.380
IT_WGS_PPS	-0.324	0.854	0.951	0.897	-0.939	0.380	1.000

Source: EUROSTAT, OECD, Prescott 2004

Section C.IV The United Kingdom

Table C.7: economic indicators for the United Kingdom				
Variable	2004	2000	1990	1983
Weekly worked hours	23.3	23.6	24.6	21.9 (1984)
Age (in years)	38.9 (2003)	38.7	37.5	37.4
t_c	23.7 %	25.0 %	23.6 %	24.8 %
Trade union members (% employment)	26.6 % *	28.4 %	33.9 %	42.0 % (1984)
Trade union coverage (% employment	92.3 % *	90.9 %	86.3 %	88.3 % (1984)
Wages (in PPS per inhabitant)	12,900	11,000	7,200	4,300

Source: EUROSTAT and OECD

* extrapolation

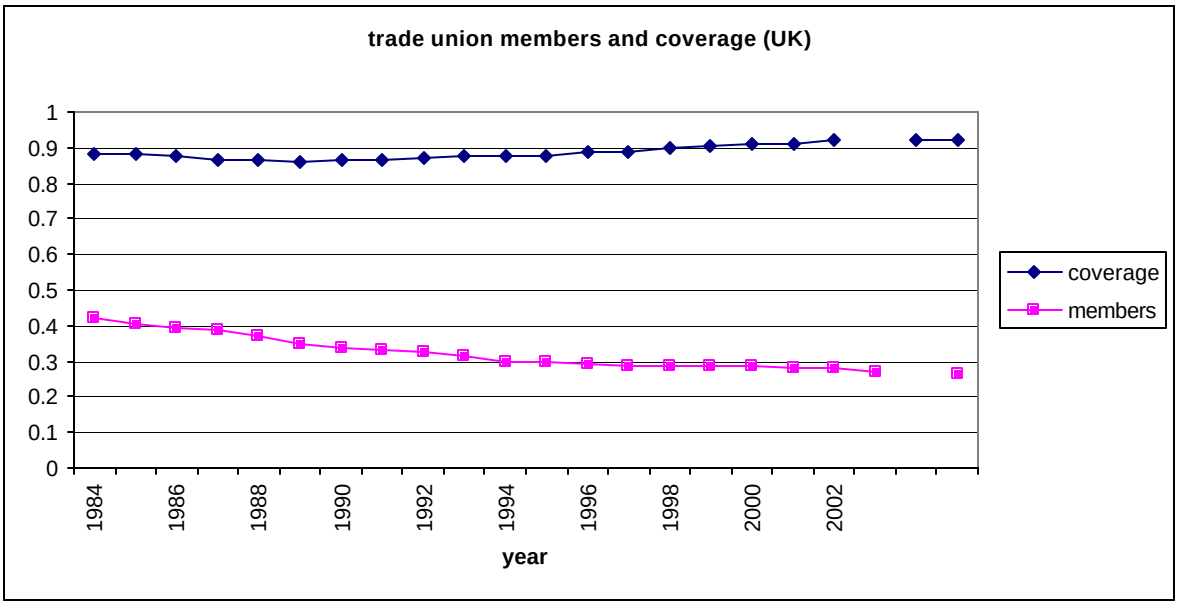

Figure C.4: visualisation of the extrapolation for trade union figures

Table C.8: correlation between the different variables for the United Kingdom

Variable	*UK_W*	*UK_TAU_H*	*UK_TAU_C*	*UK_LFT_WF*	*UK_TUM_PT*	*UK_CAO_PT*	*UK_WGS_PPS*
UK_W	1.000	0.000	-0.221	0.091	-0.319	-0.092	0.292
UK_TAU_H	0.000	1.000	0.380	-0.369	0.625	-0.026	-0.360
UK_TAU_C	-0.221	0.380	1.000	-0.465	0.483	-0.378	-0.485
UK_LFT_WF	0.091	-0.369	-0.465	1.000	-0.905	0.894	0.952
UK_TUM_PT	-0.319	0.625	0.483	-0.905	1.000	-0.631	-0.904
UK_CAO_PT	-0.092	-0.026	-0.378	0.894	-0.631	1.000	0.836
UK_WGS_PPS	0.292	-0.360	-0.485	0.952	-0.904	0.836	1.000

Source: EUROSTAT, OECD, Prescott 2004

Section C.V The United States of America

Table C.9: economic indicators for the United States of America				
Variable	2004	2000	1990	1983
Weekly worked hours	25.0	26.5	25.8	23.5
Age (in years)	38.8	38.3	36.8	36.5
t_c	10.6 % (2003)	10.6 %	11.3 %	11.5 %
Trade union members (% employment)	11.6 % *	12.2 %	14.5 %	18.1 %
Trade union coverage (% employment	96.3 % *	95.5 %	93.8 %	93.0 %
Wages (in PPS per inhabitant)	14,900 (2002)	15,100	9,800	6,000

Source: EUROSTAT and OECD * extrapolation

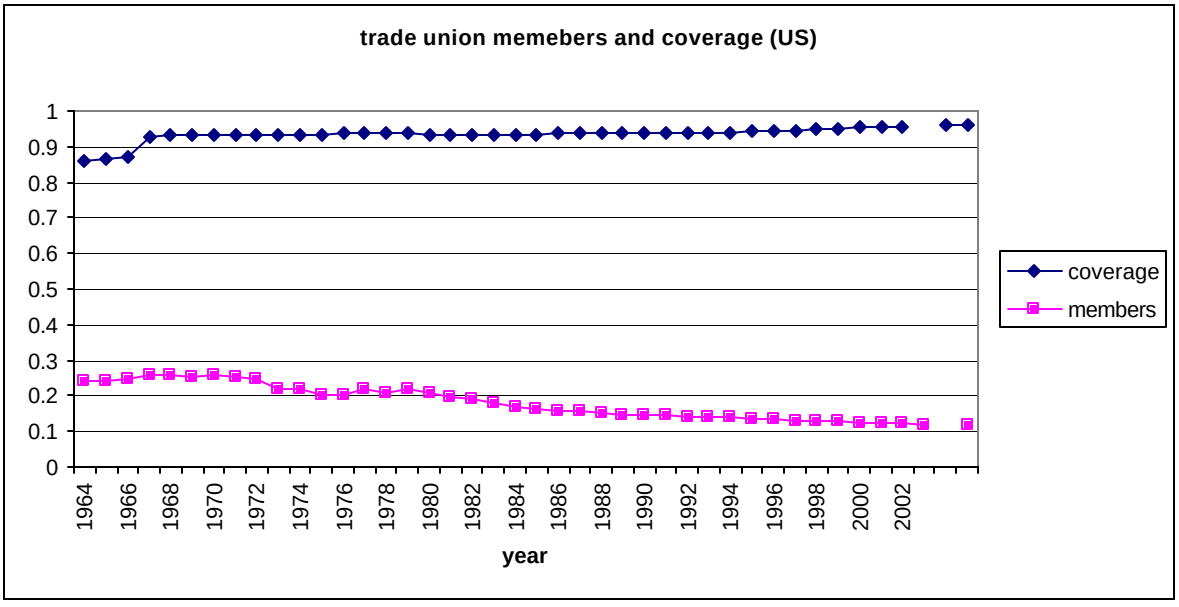

Figure C.5: visualisation of the extrapolation for trade union figures

Table C.10: correlation between the different variables for the United States of America

Variable	*US_W*	*US_TAU_H*	*US_TAU_C*	*US_LFT_WF*	*US_TUM_PT*	*US_CAO_PT*	*US_WGS_PPS*
US_W	1.000	0.715	-0.731	0.688	-0.859	0.687	0.888
US_TAU_H	0.715	1.000	-0.666	0.532	-0.632	0.672	0.710
US_TAU_C	-0.731	-0.666	1.000	-0.361	0.858	-0.519	-0.831
US_LFT_WF	0.688	0.532	-0.361	1.000	-0.607	0.925	0.772
US_TUM_PT	-0.859	-0.632	0.858	-0.607	1.000	-0.664	-0.954
US_CAO_PT	0.687	0.672	-0.519	0.925	-0.664	1.000	0.818
US_WGS_PPS	0.888	0.710	-0.831	0.772	-0.954	0.818	1.000

Source: EUROSTAT, OECD, Prescott 2004

Section C.VI Regression results

In this section an overview of the presented regressions in the paper is given. The 'standard' models with the two tax variables (the average marginal tax rate on labour income (*TAU_H*) and the average tax rate on consumption (*TAU_C*)) as explaining variables for the number of weekly worked hours (*W*). *W* itself may be in the model to reduce the presence of serial correlation. Some test statistics and figures are presented as well.

Table C.11: regressions output overview

Variable	Item	BE	FR	IT	NL	UK	US	all
C	Coefficient	11.482	9.950	7.584	13.545	-3.718	11.177	Country specific
W	Coefficient	0.294	0.645	0.681	0.245	0.685	0.885	1.251 (-0.374)
	Std. Error	0.187	0.059	0.075	0.140	0.118	0.078	0.076 (0.073)
	Prob.	0.134	0.000	0.000	0.098	0.000	0.000	0.000 (0.000)
	Lags	1	2	1	2	1	1	1 (and 2)
TAU_H	Coefficient	-4.265	-14.737	-7.134	-6.568	7.860	-13.978	-1.842
	Std. Error	2.714	4.560	1.298	2.802	4.293	4.178	0.850
	Prob.	0.135	0.004	0.000	0.032	0.086	0.002	0.032
	Lags	0	1	1	2	0	2	1
TAU_C	Coefficient	13.477	11.661	6.316	14.629	32.276	-25.316	1.889
	Std. Error	3.322	4.522	0.852	3.825	13.983	9.451	0.798
	Prob.	0.001	0.018	0.000	0.002	0.035	0.007	0.019
	Lags	3	2	1	1	2	0	0
statistics	R^2	0.851	0.955	0.954	0.928	0.715	0.914	0.994
	AIC	-0.064	0.149	-1.454	0.589	0.923	0.924	
	P(B-G F-stat)	0.439	0.514	0.642	0.271	0.020	0.512	
	Included observations	21	25	24	20	20	32	142
remark				Age and union coverage might contri-bute	Age might contri-bute		Age might contri-bute	In this model *W* was used with one and two lags.

Appendix D: Methodology

This appendix contains information on data collection, creation of the rates given by Prescott (2004), and the analyses done for this paper.

To get better informed, many articles on taxes, marginal rates, workforce, economics etc. were read, to give a clearer view of the topic. Books and articles were suggested by people who work in the field, and were very helpful for the overall picture of this investigation.

The focus of this research was originally on many more countries. In total sixteen very different countries from all over the world (namely Belgium, Brazil, the Czech Republic, Estonia, France, Germany, Hong Kong, India, Italy, Japan, Lithuania, the Netherlands, the United Kingdom, the United States of America, South-Africa and Sweden). This mix of countries, with very different tax systems and rates, would make it a very interesting investigation.

After the countries were chosen, collection of the data which were necessary to create the tax rates (the average marginal tax rate on labour income and the average tax on consumption) could begin. It is hard to find reliable and sufficient data for all the countries. Therefore, at this point a number of countries dropped out through a lack of useful data. The analysis is further on six countries, and even then it was difficult to collect all the necessary data. The EUROSTAT database is rather good, but for the most variables the United States of America is not present, while in the OECD databases the other countries have a lot of blanks, or simply no data available.

For the six countries chosen there were at least 20 years of data available, and the construction of the rates was made with the formulas given by Prescott (2004). It was regrettable that the calculated rates were not the same as the rates shown in Prescott's paper. As already mentioned in chapter 2, the differences are such that they have no negative effect on the investigation.

When the rates were created the investigation could really begin. As written previously (see chapter 4), first a good model was created on the basis of the two tax variables (t_h and t_c) and a lag of the number of hours (*W*). While a few lags were allowed per country (two for the *W* and four for the t_h and t_c), 32 models had to be made. Out of these 32 models, the best was chosen on a basis of:

1. the significance and the R^2,
2. the serial correlation test, and
3. the Akaike information criterion.

Two lags of the same variable were mostly not very helpful. For more consistency between the countries only one (lagged) explaining regressor per variable was chosen.

When the best model was chosen (if possible) the other indicators were treated in the same way. Thus *W* is explained by *W* (with one or two lags), t_h (with one or two lags) t_c (with none, one, or two lags) and the other indicator (with none, one, or two lags). This results in 36 models per indicator per country. And out of these 36 models the best model is chosen, if possible. In addition to the indicators used (*CAO_PT*, *LFT_WF*, *TUM_PT*, *WGS_PPS*) and a trend, some research has been done into the economic differences between men and women (see

appendix E). With some extra analyses, almost 300 models were created (and analyzed) per country.

Some indicators which would be very interesting, are ‘minimum wages’ and ‘Public expenditures on labour market programmes’, both available from the OECD database, but not for all the countries or not for sufficient time periods. Further research, and expansion, with these variables is very recommendable.

Some used indicators, which are assumed to have a linear relation with the number of hours worked, may have another relation. For example LFT_WF may be quadratic related, but to create models for al variables with higher order relations would mean a very rapid increase the number of models. Therefore further research to the precise relation between de indicators and the number of hours worked is also very recommendable.

Appendix E: Gender effects

Another interesting point, which is not within the scope of this paper, is the question whether there is a difference in sensibility to tax between the first and second earner in the household. The assumption is that the second earner should be more sensitive to the rates, by more easily adapting the number of hours than the first earner will do.

Because there was no data available about the first and second earner in the household, the traditional point of view has been applied. Men are seen as first earner and women as second earner. This is of course not true for all households, but this assumption has to be made otherwise no data would be available. The participation ratio, of both men and women, is constructed from data of the OECD database and calculated as employment, by sex and from 15 to 64 years, divided by population, by sex and from 15 to 64 years.

While there was no data which provided information about the number of hours worked by man and women, the assumption is they work both the same number of hours. Therefore the second assumption is that the average number of hours worked is the average of the total population, of men as well as of women. This is a major assumption, which directly weakens the analyses, because it is commonly known that the second earner tends to work more part-time, and therefore less hours.

Given these two assumptions the analyses are made, and the number of hours worked by both men and women were explained by the two tax variables. The results were not very exciting, because for most countries it was not possible to find a good model for both groups. It was possible for Italy, where the few good models suggest that men are more sensitive to the rates than women.

When it was clear that there was no sufficient way to tell something about the differences in sensitivity toward tax rates between the sexes, with the two assumptions, the next step was to find out if it is possible to explain the difference in the participation grade between the two sexes. All necessary figures had already been obtained in the data collection. The participation grade is here defined as the number of people in employment divided by the number of inhabitants between 15 and 64.

In this analysis it was not possible to build a good model to explain the participation grade (for men and for women) by the tax variables. So no conclusions can be drawn here, except the conclusion that with these assumptions, these data and this methodology, it is not possible to tell anything meaningful about the differences between decisions of different gender in the labour market with respect to the tax rates.

When there is better information about the average number of worked hours by sex, or more information about participation grades measured on fulltime basis, this analysis can be meaningful. But the second assumption about the average number of hours worked by man and women, which had to be made, is in our view too far from reality.