# Fiscal incidence and the effect on income inequality

May 14, 2012


Master thesis for the degree Master of Philosophy in Economics

Ragnar Juelsrud
Department of Economics
University of Oslo

## Summary

This thesis aims to answer two questions utilizing Norwegian data for 2007; 1) what is the distribution of taxes and public spending across different income deciles and household types? and 2) taking this into account, how does it affect income inequality and poverty?

The first step in answering the two questions is to estimate the distribution of taxes. While all direct taxes are obtained immideatly from data, indirect taxes requires a different approach. Data from the Consumer Survey's of Statistics Norway is used together with effective tax shares of consumer prices to find indirect taxes paid. When looking at income deciles, consumption expenditures are not known, so these are estimated in an Almost Ideal Demand System. The last tax distributed is the payroll tax, under the assumption of inelastic labor supply. Corporate taxes are left out of the analysis because of no clear consesus regarding the incidence assumptions. Summing the different taxes together, I find the distribution of taxes as share of income for all groups, where the total average tax rate is 46,3%.

Moving on to public expenditures, these are distributed in two steps. First, direct cash transfers are obtained and distributed directly from available data. The value of public services is distributed according to an allocation rule derived from a theoretical framework. All municipal- and county-provided services are covered. In addition to these, I also impute the value of public hospitals. The value of public services is assumed to be equal the cost of providing them. Since the allocation of public spending is likely to reflect the allocation of *needs* in the population, these values are *needs-adjusted* according to estimated equivalence scales drawn from the same model which was used to derive the allocation rule. Finally, the *fiscal incidence* - the incidence of all (covered) taxes and all (covered ) public expenditures is estimated for all household types and income deciles.

I find that there are large variations in the fiscal incidence across groups. Typically "weak" (retiree-abundant groups and lone parents) and poor households recieve large amounts of public expenditures relative to what they pay in taxes. This is a reflection of the redistributional properties of the fiscal budget. There are also relatively large differences in the fiscal incidence for certain groups *before* and *after* needs-adjusting. For households who are not a typical risk-group in terms of poverty but still recieves a large amount of public spending, such as couples with small children, the fiscal incidence changes from being a net recipient of public services to being a net financieer when needs-adjusting.

Knowing the incidence of taxes and public spending, I move on to answering the second question; does this change the degree of economic inequality? For instance, since public expenditures cater to many poor groups, what happens to economic inequality when recieved public goods are added as an income component?

Comparing the Gini-indicies for different income measures I find that the traditional approach (estimating a Gini-coefficient for the distribution of cash income net of direct taxes) produces a higher measured inequality than when accounting for the provision of public services and additional taxes. Accounting

for indirect taxes, the payroll tax and in-kind public services, the Gini-coefficient is reduced from approximately 0.237 to 0.182. I also find that the poverty incidence is reduced by 11 - 13% when taking the fiscal incidence into account.

# Preface

A few persons have been of vital help while writing this thesis. First off, my supervisor Halvor Mehlum deserves credit for being involved at every step. From the original idea to shaping the analysis and helping me tackle challenges along the way, he has been of great help. His door has always been open and he has given me his absolute attention whenever I needed.

Rolf Aaberge at Statistics Norway also deserves a large credit. In many ways, he has acted as a second supervisor for me, always willing to discuss and shape my thoughts on the matter. He also helped me to a large extent with the work on the minimum quantity parameters and all other aspects related to the ABLM-model, even though it was never his task. His enthusiasm and curiosity for the project has been much appreciated.

Family and friends have provided much needed moral support, as well as a mental break in periods where it was needed. And Ella, your comments, questions and support helped me tremendously underway.

I must also thank the ESOP center at UiO for granting me the ESOP Scholarship and an office space which I had the pleasure of sharing with a few great fellow students.

All errors are mine.

# List of Figures

# List of Tables

# Contents

# 1 Introduction

Income inequality and redistribution has always been an important topic within economics, but the recent two decades have funneled the two topics into the limelight of the economics debate. Many OECD countries saw from the early 1990's to the mid 2000's increasing income inequality. Norway is no exception (OECD 2008). Motivated by this fact, this master thesis seeks to look closer at the redistributional properties of the fiscal budget.

The traditional approach to answering such a question is to compare the Gini-index after direct taxes and cash transfers to a (hypothetical) Gini-index before the same taxes and transfers. This approach has three weaknesses.

First, the Gini-index before taxes and transfers (i.e. before the public sector) is not known. Even after "giving" each household/individual back the paid taxes and subtracting the transfers recieved, we fail to account for any behavioral changes caused by the taxes and transfers in the first place. We therefore compare, in a sense, two allocations at the same existing equilibrium, when we instead should have looked at two separate equilibra. Unfortunately, the "pre-government" equilibrium is unkown and a correct general equilibrium comparison is impossible.

Second, when looking at the distribution after direct taxes, we fail to account for other taxes. Indirect taxes, as well as the payroll tax, are likely to have an impact on economic inequality as they are not uniformally distributed among the population.

Third, income inequality measures after taxes and transfers are often interpreted as inequality in economic welfare. However, by excluding the value of in-kind public services, such as public hospitals and education, they fail to account for approximately half of the public sector's expenditures in most western countries (Chamberlain & Prante 2007) . Considering the fact that at least some components of the direct taxes deducted from households are used to finance these services, they should certainly be accounted for. Overall, excluding the value of public services gives a distorted picture of economic well-being.

While little can be done about the first point, this thesis aims to extend the literature by looking at the two latter, using data on the Norwegian economy for 2007. In principle, I aim to answer two questions:

*(1) What is the fiscal incidence across population groups*? The *fiscal incidence* is simply the distribution of taxes and public spending for different parts of the population. In addition to looking at the distribution of cash transfers and direct taxes, it aims to incorporate indirect taxes and the payroll tax, as well as the value of public services imputed to households based on their utilization of these services. This ought to give a more complete picture of the incidence and the redistributional properties of the fiscal budget. Knowing these values, we can also easily answer a second question, namely; *(2) What is the effect on the income distribution when the fiscal incidence is taken into account?* Does including all taxes and the value of public services affect income inequality?

Since answering these questions requires a rather data-rich and vast analysis, it might be worthwile to settle certain methodological issues before embarking on the task.

**Population groups** Grouping the population according to some measure is the most practical approach to such an enquiry. This requires deciding along what dimension we want to compare the population. Of course, when looking at income inequality the obvious choice is by comparing different *income groups.* In order to get a closer description of the distribution of economic welfare, it is common to look at the distribution of income per consumer unit, i.e. *equivalent income*. The concept of equivalent income will be more closely discussed later in the text. Income statistics for Norway is usually reported according to income deciles[1]. This means that the population has been "lined up" in ascending order according to equivalent income net of direct taxes and then divided into ten equally-sized groups. These income deciles are the first grouping of the population used in this thesis.

In addition to income groups, a sensible approach is to look at different *household types.* Since especially transfers and public services are to a large extent distributed according to demographic factors, comparing different household types, is likely to give extra insight when looking at the fiscal incidence across the population. It is also, of course, crucial when looking at the effects on income inequality, as the imputed value to each income decile is likely to depend on the household types within that group.

While an income decile is self explanaining, the respective household types covered in this thesis are listed in table 1.

[1]Students are left out of the analysis when looking at income deciles.

Table 1: Household types and household shares

| Household type (abbreviation) | Share of all households |
|---|---|
| Single, below 30 yrs (A,0-29) | 8% |
| Single, 30-44 yrs (A,30-44) | 8% |
| Single, 45-66 yrs (A,45-66) | 12% |
| Single, 67 → yrs (A,67->) | 11% |
| Couple, without children, oldest person below 30 yr (PUB,0-29) | 1% |
| Couple, without children, oldest person 30-44 yrs (PUB,30-44) | 2% |
| Couple, without children, oldest person 45-66 yrs (PUB,45-66) | 11% |
| Couple, without children, oldest person 67 →yrs (PUB,67->) | 8% |
| Couple, with children, youngest child 0-5 yrs (PB,0-5) | 11% |
| Couple, with children, youngest child 6-17 yrs (PB,6-17) | 12% |
| Couple, with children, youngest child 18 yrs (PB,18->) | 4% |
| Single parent, youngest child 0-5 yrs (S,0-5) | 1% |
| Single parent, youngest child 6-17 yrs (S,6-17) | 4% |
| Single parent, youngest child 18→ yrs (S,18->) | 2% |

Source: Statistics Norway

Note: *One household type, multi-family households, are excluded from the analysis. This is the reason why the population shares do not add up to one.*

Because of the relatively aggregated data, certain assumptions about the underlying distributions have to be made. These are listed in Appendix A.2.

**What is income?** Throughout the thesis, I will frequently mention both "income", "non-cash income" and "extended income". A natural precision is then of course to specify what these income measures mean. "Income" is defined as the sum of factor incomes (labor and capital), net income from self-owned enterprises and cash transfers. It does not account for the value of home-production and "imputed rents" from owning a home. "Non-cash income" is the value of in-kind public services imputed to the household while "Extended income" is simply income plus non-cash income.

**Equivalence scales** Third, as household types vary in size and composition, how can we ensure comparability across them? A sensible approach is to derive so-called *equivalent income*, similar to what is done when creating the income distribution. The logic behind this is illustrated by a simple example. Consider two households, one single-individual household and one consisting of a couple with two children. Clearly, 100'000 NOK in household income is not the same for the first household as the latter in terms of welfare. The latter household would require a higher income to maintain the same standard of living. In addition to that, dividing income on the number of household members is not a sufficient approach, as there are significant economies of scale with respect to intrahousehold consumption. In order to overcome this problem, the standard approach is scaling income according to *equivalence scales* (Lind 2001). An

equivalence scale therefore attempts to quantify how we need to scale the cash income of a certain household in order for it to be able to attain the same welfare level as a reference household. The reference household typically consists of one adult individual. Three of the most common equivalence scales being utilized in the literature are the EU-scale, the OECD scale and the root scale. The EU scale weighs the second adult as 0.5 "consumer units" and each child by 0.3, while the OECD scale weighs the second adult as 0.7 and each child by 0.5. The root-scale weighs household income by the square root of its total number of household members. According to these three equivalence scales then, a household consisting of two adults and one child would require 1.8 (EU), 2.2 (OECD) and $\sqrt{3}$ (root-scale), respectively, times the income of a single adult individual to achieve the same standard of living. In general, there is no consesus on what is the most approriate equivalence scale.

Adding non-cash public services into the analysis calls for a different set of equivalence scales. In principle, the allocation of public services is likely to reflect the allocation of *needs* across the population. Thus, not accounting for this is likely to lead us to *overestimate* the distributional impact of public services. Because of this, needs-adjusted equivalence scales (Aaberge et.al 2010) are estimated in order to weigh extended income. This is more thoroughly discussed in chapter 3.

Two problems with regards to the usage of equivalence scales are commonly cited. The first problem was illustrated above - there is no consesus on which is the "correct" equivalence scale. The choice of equivalence scale is therefore somewhat arbitrary. This is of course unfortunate as the choice of equivalence scale will affect the results.

A second problem, of a more theoretical nature, is the so-called "Pangloss-critique" (Lind 2001). The critique arises from the derivation of equivalence scales and the implicit assumption it makes that households are maximizing a welfare function of *equally weighted individual utilities*. However, it is likely that the households will put different weights on the utility of various household members. I will not focus particularly on this here - for a detailed discussion see Lind (2001). Because of this, there is an underlying assumption here, and in other similar studies such as [14], that the benefits are distributed uniformally across all household members.

All in all, to ensure comparability, I will use the following equivalence scales. Cash income will be equivalized with the household's corresponding EU scale. Non-cash income is scaled using estimated equivalence scales attempting to account for different needs. Extended income is then scaled using a combination of the two. These topics are further discussed in chapter 3.

**The valuation of public goods** The fourth clarification needed to be made is how we value public goods. This is perhaps the most fundamental of all empirical issues in similar studies. In principle, pure public goods should be valued according to the individual's willingness to pay for the good. However, this imposes enormous informational requirements. One possible solution could

be to undertake surveys asking a reprepsentative sample of the population their willingness to pay or willingness to accept for certain public services. This corresponds to finding the *equivalent* or *compensating* variation of the agents. Unfortunately, a vast literature has pointed out and discussed numerous challenges with this approach, see for instance Horowitz & McConnell (2000).

Because of this, virtually all fiscal incidence studies (De Wulf 1975) value public services according to the cost of provision. This is the case here as well.

**Which public goods to include?** Fifth, it should be decided upon which public services to include. In principle, all public services should be included into the analysis, but because of informational requirements this may prove difficult. The provision of public services in Norway occurs at three levels; municipally, countywise and statewise. For 2007, a similar analysis found in Aaberge et.al (2010) provides relevant estimates for all municipally provided services. I utilize these estimates when imputing the value of public services, hence the value of all municipally provided services are included. This is the reason why 2007 is the point of departure for this thesis. More on this in chapter 3. Furthermore, I extend the analysis in Aaberge et.al (2010) to include county-provided public services, enabling me to fully account for public service provision at the county level. When it comes to state-provided goods, I include the value of public hospitals. This is the only good at the state-level covered in this thesis. Most other goods provided by the state, except higher education, are in principle pure public goods, however. Excluding these from the analysis will lower the *levels* of absolute and relative fiscal incidence, but are not likely to have a decisive impact on the variance across groups.

**Inequality measure** Sixth, in order to measure the impact of fiscal incidence on income inequality, an inequality measure has to be chosen. Numerous indicies and ratios exist in the literature. In this thesis, I considered using either of the two most popular; the Gini-index or the Bonferroni measure. As will be discussed in chapter 3, the Gini-index appeared more approriate for the methodology employed. Therefore, inequality is measured by estimated Gini-coefficients.

This thesis is structured as follows[2]. The next chapter is dedicated to the distribution of taxes across the population. Chapter 3 then distributes public expenditures. The value of public services is allocated to population groups according to an allocation rule, derived from a theoretical framework of how a social planner behaves. Chapter 4 merges the results of the two preceeding chapters in order to answer the two key questions of this thesis; *what is the fiscal incidence across groups* and *what happens to income inequality once this is taken into account?* Chapter 5 provides a discussion of the methodology used, as well as possible pathways for future research. Chapter 6 concludes.

[2]All calculations and estimations in this thesis have been done utilizing MS Excel 2007 and OxMetrics 6

# 2 The distribution of taxes

This chapter investigates the distribution of taxes during the fiscal year of 2007. Appendix D contains relevant intermediate results. The purpose of this chapter is to enable me to incorporate other taxes than just the direct taxes when looking at the fiscal incidence and its impact on income inequality. While direct taxes is the most obvious "burden" in terms of economic welfare to most households, indirect taxes should also be accounted for because they, to some extent, imply higher consumption prices. In addition to this, the payroll tax should also be taken into account because it results in a real burden to households in terms of lower net wages. Corporate taxes are not included here. These are excluded because of no clear consesus of incidence assumptions in the literature (Wolff & Ajit 2004). See subsection 5.1.5 for a brief discussion. The other incidence assumptions are presented in table 2.

Table 2: Tax incidence assumptions
The inequality measure of choice

| Tax type | Incidence assumption | Datasource |
|---|---|---|
| Direct taxes | Not shifted | Statistics Norway |
| Payroll tax | Shifted to the worker | Statistics Norway |
| Indirect taxes | See table 3 | Statistics Norway/MSG |

Source: Author

## 2.1 Direct taxes

Direct taxes consist of all taxes that cannot be shifted on towards someone who is not legally liable to pay the tax. These taxes are the labor income tax, capital gains tax, regular wealth tax and the property tax. While the capital gains tax (flat at 28%), the wealth tax (1,1% for values above 700'000 NOK, 1'400'000 NOK for couples) and the property tax (municipally determined) are, once activated, flat, the labor income tax feature progressive components. The tax rate is increased step-wise, twice, as income increases. In addition, there is a deductable amount of up to 87'200 NOK that is exempted for taxation. There are also heterogenous tax rates across the household type dimension - the deductables depend on which tax class (1 or 2) the individual belongs to, which again depends on family type. For instance, single parents with children below the age of 18 belongs to tax class 2 and have higher tax deductables than someone living in a couple with similar aged children. Variation in direct taxes is therefore likely to be caused by three factors; varying income levels, varying composition of income and varying household types. The direct tax rates paid by the different income deciles and household types are calculated with data from Statistics Norway's Income Statistics.

## 2.2 Indirect taxes

Indirect taxes can be divided into two main categories; value-added taxes (MVA/VAT) and excise taxes. A complete list of all indirect taxes in Norway are given at Regjeringen.no (2012).

While direct taxes are unshiftable, the payers of the indirect taxes are not necessarily the ones legally liable to pay the tax. For instance, a tax on the production of a certain commodity, originally meant to be paid by the producers, may be shifted towards the consumers in terms of higher prices. Standard public economics theory predicts that the size of this effect depends on supply and demand elastisities (Rosen & Gayer 2008). In order to investigate how much the various population groups pay in indirect taxes I therefore need to settle two issues.

First, the tax as share of consumer price for a given commodity or commodity group has to be known. This is determined by the imposed tax rate and the tax incidence/elasticity assumption. Second, when budget shares/expenditures for the various commodites cannot be directly obtained from available data, they have to be estimated.

With regards to the first point, these values are obtained for 2006 from the simulations of MSG, a general equilibrium model from Statistics Norway (Heide et.al 2004). Since the 2007 tax shares are not accessible, I have to assume that there is no structural difference between the 2006 and 2007 tax rates. Since the same parliament composition was in place during both these years[3], this is likely to be a plausible assumption, given no large shifts in the relative distribution of market power between producers and consumers.

The MSG estimated tax shares are given in table 3.

Table 3: Effective tax rate as share of consumer price

| Category | Effective tax rate 2006 |
|---|---|
| Food and non-alcoholic beverages | 0,13 |
| Alcohol and tobacco | 0,57 |
| Housing and fuel | 0,07 |
| Car | 0,49 |
| Clothing and shoes | 0,20 |
| Furniture and home-related goods | 0,19 |
| Culture and recreational | 0,21 |
| Health services | 0,09 |
| Transportation | 0,07 |
| Postal- and telecom-services | 0,20 |
| Other | 0,10 |
| Average | 0,16 |

Source: MSG (Heide et.al 2004)

[3]and I am unable to find any reforms/large shifts in the indirect taxation regimes between the two years.

Knowing the effective indirect tax rate, what remains for the allocation of indirect taxes is to know how much, on average, the various population groups spent on the respective consumption categories. When analyzing household types, data are easily obtainable from the Consumer Surveys of Statistics Norway. Consumption expenditures on category X is then multiplied by the effective tax rate of category X in order to determine the amount of indirect taxes paid.

When looking at different income groups, a bit more work is required. Because of lack of directly applicable data[4] the average consumption expenditures on various consumptions goods across different income groups needs to be estimated. The estimations are outlined in appendix B.

Once these are known, the average incomes in each income group have to be estimated as well. They are obtained by taking the nationwide average post-tax equivalent income and applying the formula

$$Net_i = \frac{Average * Dist_i}{10} \tag{1}$$

where $Net_i$ denotes the average post-tax equivalent income in decile i, $Average$ denotes the nationwide average equivalent income and $Dist_i$ denotes the share of total income that decile i holds. $Average$ is obtained from EuroStat and was 246'177 NOK per consumer unit in 2007. The distribution of average equivalized income is obtained from Statistics Norway. Utilizing these values, the estimated average incomes for all income deciles are given in table 4.

Table 4: Estimated post-tax equivalent income

| Decile | Income |
|---|---|
| Decile 1 | 98470 |
| Decile 2 | 150168 |
| Decile 3 | 174785 |
| Decile 4 | 196941 |
| Decile 5 | 214174 |
| Decile 6 | 233868 |
| Decile 7 | 256024 |
| Decile 8 | 283103 |
| Decile 9 | 327415 |
| Decile 10 | 526818 |

Source: Author

The estimated average equivalent incomes are then multiplied with the estimated consumption rates, obtained from Halvorsen (2011), before the predicted *budgets* are used in the estimated demand system to obtain predicted consumption expenditures on the respective categories. Once these are known, the indirect taxes paid are found by multiplying these values with the effective tax rates from table 3.

[4]Consumption expenditures are reported for given income classes, but these classes do not match the ones in the income distribution.

## 2.3 The payroll tax

Finally, the last tax to distribute is the payroll tax. The justification for distributing the payroll tax to the households is inelastic labor supply, something which has been frequently documented. For the Norwegian case, an excellent reference is Sollie & Svendsen (2001). Employers are the ones legally liable of paying the tax, but because of inelastic labor supply, employees end up bearing the burden in terms of lower net wages. The payroll tax varies in the interval 0 - 14,1 %, depending on geographical location. The nationwide average is 13% (Regjeringen.no 2010). Self-employed pay a payroll tax of an average of 11%. From the income statements, the respective labor and net incomes from self-owned enterprises can be derived for each population group. The payroll tax rates are then multiplied with the relevant incomes.

## 2.4 Summing the taxes together

Adding all the different taxes together, the total distribution is given in figure 1,2 and tables 5 and 6.

Table 5: Total taxes as share of income, according to household type.

| Household type | Total taxes as share of income |
|---|---|
| A,0-30 | 0,49 |
| A,30-44 | 0,47 |
| A,45-66 | 0,44 |
| A,67-> | 0,34 |
| PUB,0-29 | 0,48 |
| PUB,30-44 | 0,48 |
| PUB,45-66 | 0,46 |
| PUB,67-> | 0,37 |
| PB,0-5 | 0,46 |
| PB,6-17 | 0,46 |
| PB,18-> | 0,44 |
| S,0-5 | 0,32 |
| S,6-17 | 0,39 |
| S,18-> | 0,40 |

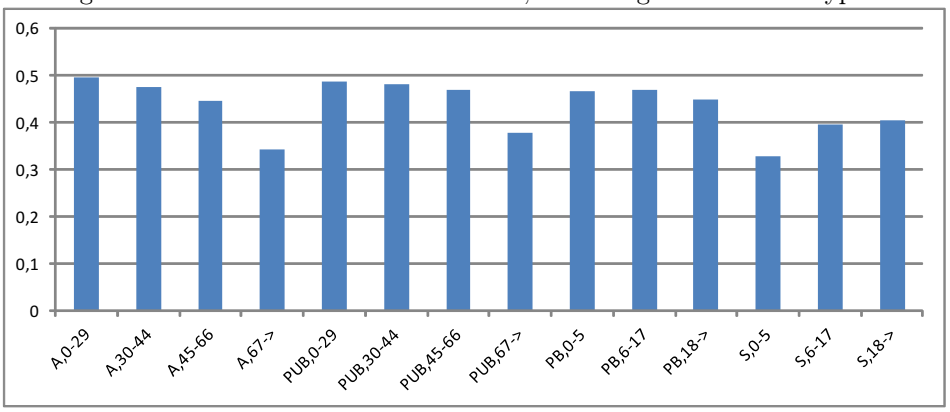
Source: Author

Table 6: Total taxes as share of income, according to income decile.

| Income decile | Total tax rate |
|---|---|
| Decile 1 | 0,34 |
| Decile 2 | 0,35 |
| Decile 3 | 0,40 |
| Decile 4 | 0,43 |
| Decile 5 | 0,46 |
| Decile 6 | 0,48 |
| Decile 7 | 0,50 |
| Decile 8 | 0,52 |
| Decile 9 | 0,55 |
| Decile 10 | 0,60 |

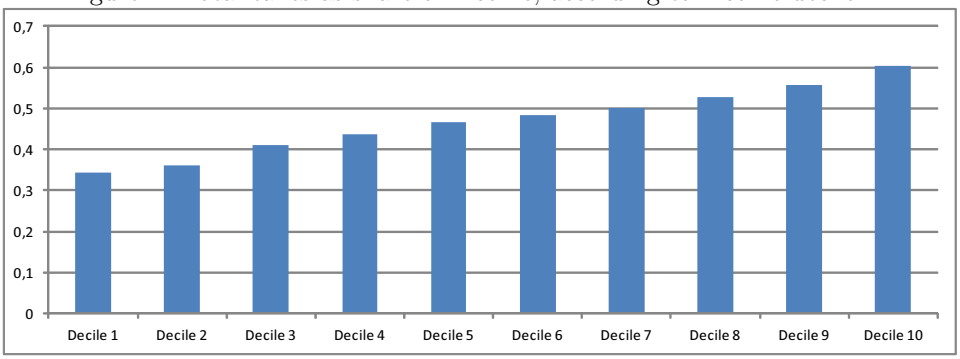
Source: Author

Figure 1: Total taxes as share of income, according to household type




Source: Author

Figure 2: Total taxes as share of income, according to income decile




Source: Author

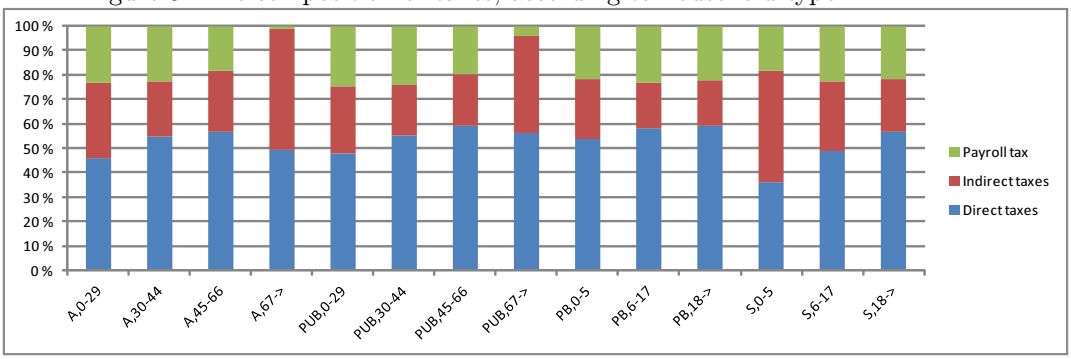
From the estimated distribution of taxes, we can point out a few things.

First off, looking at table 6 and figure 2, we see that the Norwegian tax system is progressive, with total tax rates increasing with equivalent income. The income tax is more progressive than the other type of taxes. Indirect taxes and payroll taxes offset the progressive effect on the tax rate of increased income[5]. Overall, the lowest income decile pays approximately 34% of their total income in taxes, while the richest decile pays approximately 60%. The average tax rate increase as we move up one income decile is 2,8%-points. The nationwide average tax rate is 46,3%. Note that the lowest decile pays a relatively high tax share. This is likely to be caused by the inclusion of many high-wealth individuals who have no taxable *income* but pay high wealth taxes.

Second, there is type-wise heterogeneity as well - see table 5 and figure 1. While some of the variation is likely to be caused by varying income levels, it is still reasonable to believe that there are type-specific variation because of the type 1/type 2 classifications. Typical "weak" groups such as retiree-abundant household types (A,67-> & PUB,67->) and single parents with small children (S,0-5) end up paying a substantially lower tax rate than other groups. Among those who pay the highest tax rate I found young single individuals and couples without children in working age. These groups pay approximately 50% of their income in taxes on average. The weaker groups identified above pay between 30-40% in taxes on average.

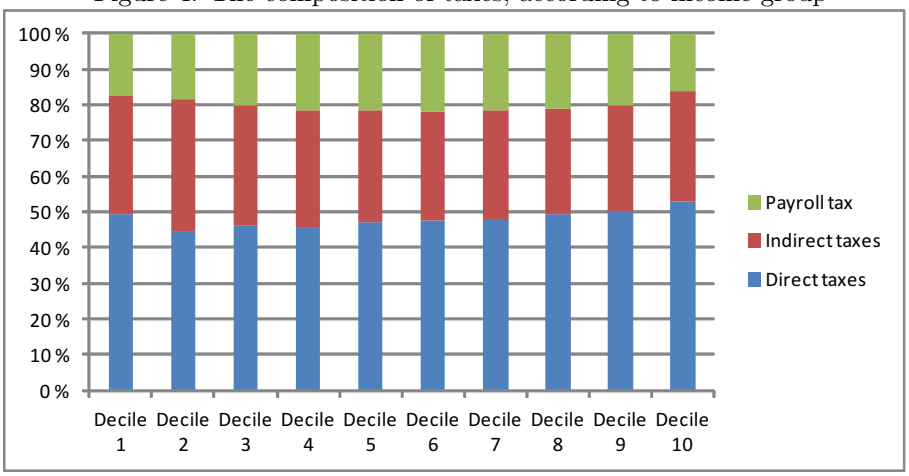
[5]See the results in appendix D for verification.

Figure 3: The composition of taxes, according to household type




Source: Author

Figure 4: The composition of taxes, according to income group




Source: Author

From figure 3 and 4, we see that the composition of taxes varies across the different groups, with predictable patterns emerging. For instance, retiree-abundant groups pay a relatively low amount of payroll taxes. For these groups, as well as lone-parents with young children (S,0-5), indirect taxes are a relatively large share of total taxes compared to other household types.

When looking at the various income deciles (figure 4), the composition of taxes is somewhat more stable. Direct taxes account for about 50% of all taxes for all groups.

# 3 The distribution of public spending

The purpose of this chapter is to distribute public spending across the population. Including the value of this will give a more complete picture of the fiscal incidence. It will also allow me to measure the impact of public services on income inequality.

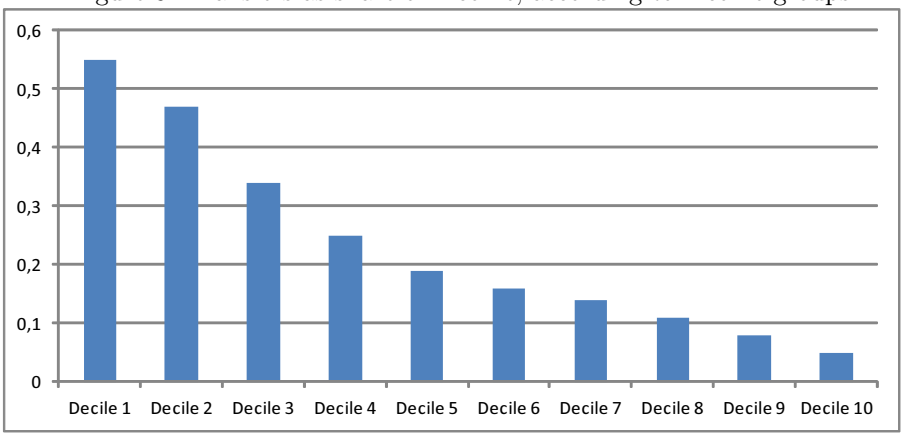
To distribute the value of public services, a theoretical model (referred to as the ABLM-model in the text) will be used to derive an allocation rule. I will first look at the distribution of cash transfers however.

## 3.1 Transfers

Transfers can in general be divided into two categories; tax-free and taxable. Tax-free transfers from the public sector comprises of child-support (*kontantstøtte* and *barnetrygd*), living support, social help, student stipends and various, smaller transfer schemes. The taxable transfers are pensions, both age and disabillity related, contributions in relation to sickness and "day-money" for the unemployed. Transfers form an important component in the overall redistributional role of the public sector.

When looking at income groups, I do not have available data of composition of transfers, only the total amount as share of income. This is presented in figure 5.

Figure 5: Transfers as share of income, according to income groups

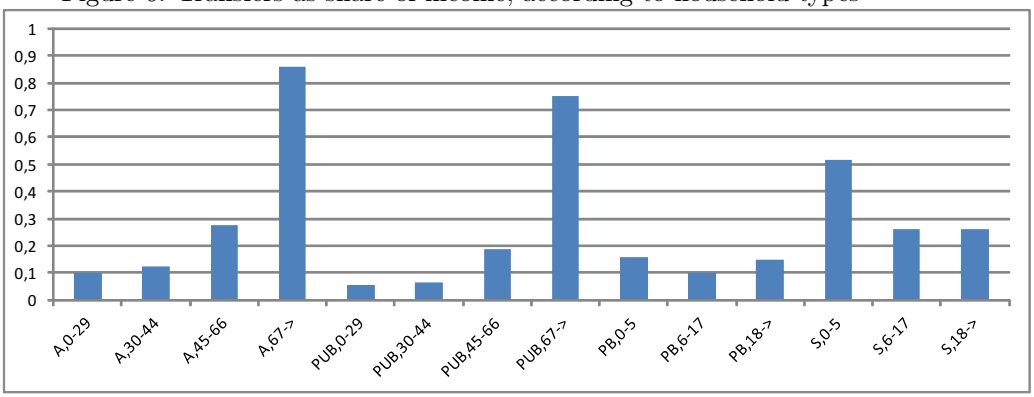



Source: Statistics Norway's Income Statistics

The transfer system appears highly progressive, meaning that transfers as share of income decreases relatively sharp as we move up along the income distribution. For the poorest 10%, transfers account for over 50% of total income, whereas the richest decile have approximately 5% of their total income as transfers from the public sector.

Moving to the different household types, the distribution of transfers is given in figure 6.

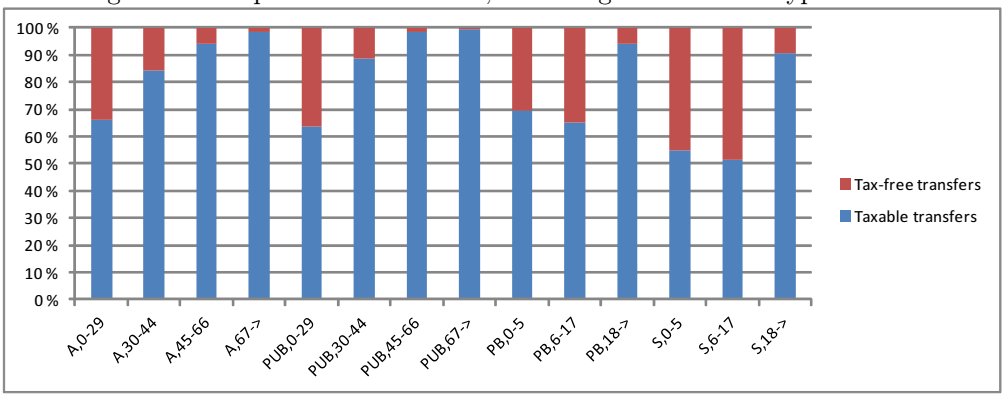
Figure 6: Transfers as share of income, according to household types




Source: Statistics Norway's Income Statistics

The same pattern as when looking at taxes emerge - weak groups such as retirees and lone parents recieve a relatively large share of their income in the form of transfers from the public sector.

Figure 7: Composition of transfers, according to household types




Source: Statistics Norway

Not surprisingly, the majority of transfers are taxable, with the exemption of transfers targeted towards families with children. These families have a larger share of their total transfers in the form of tax-free transfers. A,0-29 and PUB,0-29 also recieve a relatively large amount of tax-free transfers because of a relatively large concentration of students within these household types.

## 3.2 Public services

In this section, the value of public services will be imputed to the household types. This is non-cash income. Non-cash income is important for both the fiscal incidence and the (extended) income distribution. Public services are valued according to the cost of providing them, hence the total benefit is equal the total cost (there is no aggregate externalities). A theoretical framework, the ABLM-model, is used to 1) derive an allocation rule and 2) create equivalence scales for non-cash income which attempts to account for different needs in the population. The model is taken from Aaberge et.al (2010 [2]).

Consider a social planner (i.e. a local government) with a rational preference relation $\succeq$ over the allocation of public expenditures across various sectors and population target groups.

DEFINITION 1. *A target group is defined as a population group who has identical needs for a specific service. If there are k target groups for service i, indexed* $j = 1, 2, ..., k$*, and* $Z_i^j$ *denotes the set of all members of target group j in sector i,* $Z_i^j \cap Z_i^{-j} = \emptyset$*, where* $Z_i^{-j}$ *is any of the other k-1 sets. In words, no individual is a member of more than one target group for each service.*

The preference relation of the social planner can be represented by a general monotonically increasing ($\succeq$ is locally non-satiated) utility function,

$$V = V\left[\sum_{i=1}^{s}\sum_{j=1}^{k}\beta_{ij}(x_{ij} - \gamma_{ij})\right] \tag{2}$$

where $\gamma_{ij}$ can be thought of as the subsistence quantity per person of service i targeted to group j.$\gamma_{ij}$ can also be interpreted as the percieved minimum *need* of target group j on service i. We can think of this parameter as being centrally determined, for instance by expert opinion. $\beta_{ij}$ is the marginal budget share for spending on group j in service sector i and $x_{ij}$ is additional spending in sector i on target group j. Let there be a total of s sectors, $i \in \{1, 2, ....., s\}$ (and k target groups, $j \in \{1, 2, ..., k\}$ as in definition 1).

Resources are scarce. The social planner maximizes $V$ with respect to a budget constraint (where taxes and thus income are treated as exogenous. In the Norwegian case the parliament determines the level of taxes and the distribution of tasks among municipalities and counties.)

$$y = \sum_{i=1}^{s}\pi_i\sum_{j=1}^{k}x_{ij}z_j = \sum_{i=1}^{s}\sum_{j=1}^{k}u_{ij}z_j \tag{3}$$

$\pi_i$ is the cost of providing one unit of "output" in sector i and may vary across districts and sectors. $z_j$ is the population share of target group j. Simply

put, equation (3) tells us that total income has to equal total costs[6][7].

Furthermore, the unobserved unit-cost parameter can be specified in the following way

$$\pi_i = \pi_{i0}\left[1 + \sum_h \pi_{ih}(p_h - \overline{p_h})\right] \tag{4}$$

where h is geographical area h which provides service i. Since the set of services provided by both the municipalities and the counties is empty, I avoid double-counting.

$p_h$ is a variable that affects units costs in *at least* one of the service sectors and $\overline{p_h}$ is the mean of that variable across all $h$. An example of such a variable is population density, which is likely to lead to economies of scale in the provision of at least some services. The parameter $\pi_{i0}$ can be interpreted as the average price level in sector i. In the empirical application of this model, this is normalized to 1.

The optimal allocation of public spending across groups and sectors is found by taking the supremum of (2) with respect to (3).

In order to solve the model, an explicit functional form of $V$ has to be assumed. In Aaberge et.al (2010 [2]),$V$ is assumed to be of the Stone-Geary form

$$V = \sum_{i=1}^{s}\sum_{j=1}^{k} \beta_{ij} log\left(\frac{x_{ij} - \gamma_{ij}}{\gamma_{ij}}\right) \tag{5}$$

Having assumed this functional form, we can solve the model by maximizing (5) with respect to (3).

Combining the necessary first order conditions for maximum we obtain the linear expenditure system

$$u_{ij}z_j = \pi_i\gamma_{ij}z_j + \beta_{ij}\left(y - \sum_{i=1}^{s}\sum_{j=1}^{k}\pi_i\gamma_{ij}z_j\right) \tag{6}$$

$$\sum_{i=1}^{s}\sum_{j=1}^{k}\beta_{ij} = 1 \tag{7}$$

Equation (6) tells us that total expenditure on service i allocated to target group j is equal the subsistence expenditures plus discretionary income (income that is left once all subsistence expenditures are covered) allocated to that group[8].

[6]Prices are unobserved. What we do observe however, is total spending which is equal $\sum_{i=1}^{s}\sum_{j=1}^{k} u_{ij}z_j$, where $u_{ij}$ is spending per capita on service i for target group j.

[7]Note that budget surplus/deficit is treated as a residually determined sector.

[8]Note that $\gamma_{ij} = 0$ for some i,j, as certain target groups are excluded from consuming certain public goods. For instance, one target group is single individuals above the age of 67, however they will not recieve the service "primary education".

If the allocation of spending on i to target group j, $u_{ij}$, is not observable, (6) is not of much help in terms of the empirical application. To work around this problem, Aaberge et.al (2010 [2]) imposes the following multiplicative structure on the marginal budget shares:

$$\beta_{ij} = \beta_i \theta_{ij} \tag{8}$$

$$\sum_{i=1}^{s} \beta_i = 1 \tag{9}$$

$$\sum_{j=1}^{k} \theta_{ij} = 1 \tag{10}$$

where $\beta_i$ is the marginal budget share for service sector i and $\theta_{ij}$ is the share of sector-specific discretionary income in service sector i that is allocated to target group j. Inserting the restrictions above into (6) and summing over target groups yield

$$u_i = \pi_i \sum_{j=1}^{k} \gamma_{ij} z_j + \beta_i \left( y - \sum_{i=1}^{s} \sum_{j=1}^{k} \gamma_{ij} z_j \right) \tag{11}$$

where the left hand side is expenditure per capita in service sector i. The total minimum quantity in sector i is $\sum_{j=1}^{k} \gamma_{ij} z_j$. The monetary value of this, in addition to discretionary spending on sector i, given by $\beta_i \left( y - \sum_{i=1}^{s} \sum_{j=1}^{k} \gamma_{ij} z_j \right)$, adds up to total per capita spending on the respective service sectors. The intuition behind (11) is that per capita spending on sector i is equal to the cost of satisfying the needs of all the target groups plus the total amount of discretionary spending allocated to that sector.

So far, this model can account for differences in spending according to three factors; different needs ($\gamma$), different demographic structure ($z$) and different prices ($\pi$). In addition, we'd like to add the possibility of different "tastes" of the social planners across regions (in reality, different tastes across different local governments). This can arise for numerous reasons, such as different local governing parties and cultural norms. The ABLM-model incorporates this by letting

$$\beta_i = \beta_{i0} + \sum_{h} \beta_{ih} t_h \tag{12}$$

$$\sum_{i=1}^{s} \beta_{i0} = 1 \tag{13}$$

$$\sum_{i=1}^{s} \beta_{ih} = 0 \tag{14}$$

where $t_h$ is a "taste-vector", enabling different municipalities and counties to have different preferences for allocating discretionary income. Examples of variables which might be incorporated into the taste-vector according to Aaberge et.al (2010 [2])is the amount of socialists (defined as social democrats and all parties "left" of them in the political spectrum) in the local council, average education level in the population and so forth. A crucial assumption is that these variables *affect the allocation of discretionary income only, and not subsistence expenditures.*

If we assume that the sector specific discretionary income that is allocated to target groups is proportional to the respective minimum quantities, we can write $\theta_{ij}$ as

$$\theta_{ij} = \frac{\gamma_{ij}}{\sum_{j=1}^{k} \gamma_{ij} z_j} \tag{15}$$

Knowing this, we can finally solve for the spending per individual in the target group j on service i

$$u_{ij} = \frac{\gamma_{ij}}{\sum_{j=1}^{k} \gamma_{ij} z_j} u_i \tag{16}$$

This is the *allocation rule.* The allocation of public services will therefore only require two steps;

1. The identification of target groups
2. The estimation of minimum quantities for each target group across all services.

Both steps are covered in the next subsection.

### 3.2.1 Estimation

In Aaberge et.al (2010 [2]), table 3.4, estimates of minimum quantities are provided for all municipally-provided services. To allocate these services to the different population groups, I directly use these estimates in the allocation rule. The same table also provides an identification of target groups (Table 3.5 and A.1 also provides the estimates for the price- and preference- related variables.). The municipal services imputed to the households are (with target group in paranthesis): *Administrative services* (all), *primary education* (residents aged 6-15), *After-school and adult education* (residents aged 6 - 15 and recentily domiciled refugees 20-59 years), *child care* (all children aged 1- 5, separated according to working status of guardians), *health care* (all), *social services* (poor and unemployed 16 - 59, remaining recently domiciled refugees 0 - 59, remaining divorced or separated 16-59), *child protection* (poor children 0 - 15 with lone parent, poor children 0 - 15 with couple parents, non-poor children 0 - 15 with lone parent and non-poor children 0 - 15 with couple parents), *long term care* (population 0 - 66, population 67 - 79, population 80 - 89, population 90

and above and mentally disabled individuals above 16 years), *culture* (all) and *infrastructure* (all).

In order to extend the coverage of public services, I apply the model above to estimate the minimum quantities of county-provided goods. In principle, I divide county-prodivided goods into four categories; secondary schooling, dentist services, culture and administrative services. The last sector comprises of admistration costs, local support for businesses and infrastructure. This sector is denoted "Administration".

Summary statistics are given below.

Table 7: Summary statistics, per capita spending, county-service sectors.

| Sector | Mean | St.deviation | Min | Max |
|---|---|---|---|---|
| Secondary schooling | 4708 | 674 | 3281 | 6110 |
| Dentist services | 377 | 123 | 192 | 627 |
| Administration | 19 | 14 | 12 | 78 |
| Culture | 49 | 26 | 6 | 103 |

Source: KOSTRA.
Total of 76 observations.

In order to estimate the parameters, I specify the following system of equations, in total 4;

$$u_i = \alpha + \gamma_{ij} z_{ijh} + \delta_i \pi_h + \zeta t_h + error_i \tag{17}$$

where $\alpha, \gamma, \delta, \zeta$ is vectors of constant terms, coefficients measuring the effect of a one-individual increase in target group j on the spending on service i, coefficients measuring the effect of a one-unit increase in factors affecting the price of providing service i and coefficients measuring the effect of a one-unit change in a variable that is postulated to have an effect of local preferences, respectively. To account for differential prices I include the population density of the county. To control for different tastes across regions I include the share of the population with at at least 1 year of higher education and the average per capita wealth tax paid.

The system is estimated simultanouesly by maximum likelihood estimations where the error terms are assumed to have a multinormal distribution with zero mean and unrestricted covariance matrix. It was also estimated by regular OLS. Both techniques produced of course the same parameters, and the standard errors were of largely the same magnitude (no shift in significant/insignificant status). Verification of the latter was the reason why OLS was undertaken in addition to MLE.

The results, as well as the identification of target groups, are presented in table 8. For other coefficients and issues related to the estimation of (17), see appendix C.

The estimated parameters measure how much spending on service i increases when target group j increases with one person. These parameters are used in

Table 8: Estimates of minimum quantity parameters in (17)

| Sector | Function | Target groups | Parameter | t-stat | Sigma |
|---|---|---|---|---|---|
| Secondary schooling | Provide secondary education<br>Enrollment rate used: 91% | Population 16-17 | 112056*** | 23,8 | 63782 |
| Dentist services | Dental health | Population 0 - 17<br>Institutionalized patients | 802***<br>7445*** | 3,58<br>2,1 | 14884 |
| Administration, exclusive culture | Administrative services, business support, infrastructure | All residents | 6183*** | 4,09 | 480282 |
| Culture | Sports, arts, museums, libraries etc. | All residents | 175*** | 3,07 | 17636 |

*** denotes p<0.01

the allocation rule specified by (15) to determine per capita spending on service i and target group j. The allocation of these values are then imputed to the various household types based on a set of probabilities of the different household types being a member of the respective target groups, on an individual basis. These probabilities are based on demographic data from Statistics Norway. For instance, for the group S,0-5, the allocation of public services is based on the minimum quantities as well as probabilities that the adult member is a part of various target groups. Then, the value of child services are imputed according the minimum quantities and the probability of a child in the age 0-5 being a part of various target groups, multiplied with the average amount of children for the household type. Finally, the imputed non-cash income for the adult and the (expected amount of) children is added together to find the household group's, on average, *unscaled* non-cash income.

What is common for the services above is that they are imputed directly to target groups based on their cost of provision. Some goods, such as public hospitals are however commonly imputed by utilizing the "insurance-principle" (Freund & Smeeding 2006). Before I present the total non-cash income for the various household types, these services have to be treated accordingly.

**Insurance services** A justification for the approach above is that the spending of the public sector on providing certain services would closely resemble the hypothetical market prices that agents would pay if they were to obtain them there.

However, some public services might be viewed differently, such as services related to health. If agents were to obtain these goods in the market, they would pay differential prices, depending on their *expected utilization* of the service. Therefore, imputing the same value across all household types when expected utilization rates are heterogenous is not optimal.

Such services are therefore treated as *insurance* goods. In this thesis, these goods are general health care and public hospitals. General health care is covered by the municipalities and its minimum quantities when the entire population is a target group is given in (Aaberge et.al 2010 [2]). It could be argued that other municipal services should be treated as insurance goods as well, such as social services, child protection, long-term care and dentist services. However, because of the relatively large amount of target groups defined in the estimation of the corresponding minimum quantities, heterogenous values are ensured. For health care however, the target group is all residents, creating a homogenous minimum quantity for all individuals.

To overcome this problem, (Freund & Smeeding 2006) suggests an insurance based approach at which health care expenditures per capita is scaled according to an "insurance"-multiplier. These multipliers are derived from empirical work on US data and the allocation of health expenditures. Keeping individuals aged 19-34 as a reference group, health care multipliers are found to increase with age. For the age groups 0-18, 19-34, 35-54, 55-64, 65-74 and 75-> the multipliers are

0.75, 1, 1.25, 1.75, 3 and 4 respectively. These multipliers are derived from the relative spending of each population group compared to the base group. However, relative health care expenditures are found to vary substantially over time. Since the latest estimates are from the US in the early 90's, I feel uncomfortable applying them to data for Norway for 2007.

To overcome this problem, I propose a somewhat different approach, based on available and applicable data.

First, I impute municipal health services to the households based on the following formula

$$cost_h = \overline{cost} \cdot \hat{mgen}_h \tag{18}$$

where $\overline{cost}$ is the average per capita cost of municipal health care services and $\hat{mgen}_h$ is the multiplier

$$\hat{mgen}_h = \frac{Prob_h(user)}{Prob(user)} \cdot \frac{consultations_h}{consultations} \tag{19}$$

where $\frac{Prob_j(user)}{Prob(user)}$ is the probability of household type h being a user (having consulted a general practitioner within the last twelve months) relative to the average probability of being a user, and $\frac{consultations_j}{consultations}$ is the, given $user = 1$, average number of consultations for group h relative to the average number of consultations of the average user. The multiplier is therefore larger for one group relative to another if i) it is more likely that they will end up using the service, ii) given that they actually use it, their frequency of usage is higher or iii) both.

$\hat{mgen}_{jh}$ is used on the assumption that, on average, the service each patient gets from one consultation at a general practitioner is equal across all groups. The defense of this assumption is that , except for different frequency and probability of usage, the service each household type recieves is relatively similar. For instance, general practitioners focus on tasks such as check-ups, recommendation for specialists, etc. These services are fairly equal in terms of the cost of providing them, and scaling health care expenditures according to $\hat{mgen}_h$ is therefore likely to be a suitable way of distributing their costs.

All variables needed to estimate $\hat{mgen}_h$ for the various household types are available from Statistics Norway Health Surveys. For lone parents, there is no differentiation between the age of the children. In these cases, the average for the entire group is used.

For public hospitals however, it is imperative to adopt a more sophisticated approach. The data also allow me to. There are enormous differences in the costs of providing a liver transplant compared to a consultation with a specialist. Therefore, differences between population groups may, for an identical numbers of visits, play out as large differences in costs. As a response to this, hospitals in Norway utilizes *DRG-points*, where 1 DRG represents the "average"-patient and the treatment he/she gets.A relatively simple procedure such as a standard operation on feet is equal to 0.55 DRG-points, while an operation on the thyroidea

is 1,21 DRG-points. More complex procedures, such as a liver-transplants, have far higher DRG-weights.[9].

Accumulated annual DRG-points are known for the age-groups 0-15, 16-49, 50-66 and 80-> for both sexes. If all individuals had been equal, the share of total DRG-points would be equal to the population share of the respective groups. For groups who are more frequent users or users of more expensive services, the share of DRG-points will be larger than their population share. I therefore propose the following insurance multiplier for public hospitals, both somatic and psychological services included

$$\hat{mhos}_j = \frac{DRG, \%_j}{population, \%_j} \tag{20}$$

where the numerator and denominator are shares of total DRG-points and population shares, respectively. The average per capita cost of public hospitals is then allocated to each group j based on

$$costpub_j = \overline{costpub} \cdot \hat{mhos}_j \tag{21}$$

where $\hat{mhos}_j$ is the estimated multiplier for each reported population group and $\overline{costpub}$ is the average per capita cost of public hospitals. The multiplier for each household type $h$, $\hat{mhos}_h$ is then based on the probability that a member of $j$ is a member of $h$ multiplied with the corresponding multiplier for all relevant $j$.

The estimated multipliers, both $\hat{mgen}_h$ and $\hat{mhos}_h$, based on data from Statistics Norway's Health Surveys and the Norwegian Patient Register for 2007 where the DRG-statistics is reported, are given in table 9.

[9]For a precise overview over the different services provided and the corresponding DRG-points, see Helsedirektoratet.

Table 9: Estimated health multipliers

| Household type | $\hat{mgen}_h$ | $\hat{mhos}_h$ |
|---|---|---|
| A,0-29 | 0,9 | 0,49 |
| A,30-44 | 0,92 | 0,54 |
| A,45-66 | 1,12 | 1,08 |
| A,67-> | 1,12 | 3,06 |
| PUB,0-29 | 0,93 | 0,99 |
| PUB,30-44 | 0,93 | 1,09 |
| PUB,45-66 | 0,94 | 2,16 |
| PUB,67-> | 1,05 | 6,12 |
| PB,0-5 | 0,85 | 1,90 |
| PB,6-17 | 0,84 | 1,91 |
| PB,18-> | 0,94 | 2,66 |
| S,0-5 | 1,28 | 1,22 |
| S,6-17 | 1,28 | 1,19 |
| S,18-> | 1,28 | 1,57 |

Source: Author

Note that $\hat{mgen}_h$ is originally estimated on the household level, while $\hat{mhos}_h$ is estimated on an individual level. Therefore, larger households will also have larger $\hat{mhos}_h$. The difference between the ages is most easily observed when comparing single-individual households (A,0-29, A,30-44, A,45-66 and A,67->). From the table above we can see that there is little *relative* variation in the utilization of general practitioners, with elderly groups and single parents being more frequent users. The variation in imputed health care costs will therefore be relatively small. However, when looking at public hospitals there are relatively large differences, with a single individual above the age of 67 having 306% higher imputed costs than the per capita average. Note that factors other than age or sex are assumed to not affect the households' hospital multiplier.

**Total non-cash income** Finally, having imputed health related services according to the insurance principle, total non-cash income is dervied from simply adding the value of all services together for each household type.

The estimated non-cash incomes for the various population groups are presented in table 10.

Table 10: Estimated non-cash income

| Household type | Average non-cash income |
|---|---|
| A,0-29 | 33662 |
| A,30-44 | 33327 |
| A,45-66 | 42618 |
| A,67-> | 110104 |
| PUB,0-29 | 66353 |
| PUB,30-44 | 65639 |
| PUB,45-66 | 83786 |
| PUB,67-> | 218881 |
| PB,0-5 | 204403 |
| PB,6-17 | 255480 |
| PB,18-> | 116444 |
| S,0-5 | 162811 |
| S,6-17 | 185225 |
| S,18-> | 75455 |

The variation in non-cash income reflects that the prioritized groups are retiree-abundant types, as well as parents with children in the age 0-17. These groups recieve a relatively large amount of public services because of long-term care institutions, pre-school, primary school and secondary school. To get a feeling of the magnitude of these services, non-cash income as share of cash-income is given in table 11 for all types.

Table 11: Non-cash income as share of cash income

| Household type | Non-cash/Cash |
|---|---|
| A,0-29 | 0,13 |
| A,30-44 | 0,09 |
| A,45-66 | 0,11 |
| A,67-> | 0,47 |
| PUB,0-29 | 0,11 |
| PUB,30-44 | 0,08 |
| PUB,45-66 | 0,10 |
| PUB,67-> | 0,43 |
| PB,0-5 | 0,25 |
| PB,6-17 | 0,26 |
| PB,18-> | 0,11 |
| S,0-5 | 0,50 |
| S,6-17 | 0,42 |
| S,18-> | 0,13 |

The groups who recieve the largest amount of public services relative to their cash income (where public transfers are included) are groups such as A,67->,

PUB,67-> S,0-5 and S,6-17. For these groups, the value of public services accounts for 47%, 43% , 50% and 42% of their cash income, respectively.

Before these values are combined with the results in chapter 2 to provide estimates of the fiscal incidence and the effect on the Gini-coefficient, the non-cash values have to be *needs-adjusted.*

### 3.2.2 Needs-adjusting the value of public services

**Why needs-adjust?** As Aaberge et.al (2010 [2]) points out, a reason why certain population groups recieve relatively large amounts of public spending is because they *need* a high amount. This is important to take into account, otherwise we would overestimate the redistributional effect of including these services. In the model outlined above, high needs is equivalent with having a high sum of subsistence expenditures across sectors. To account for the different needs, needs-adjusted equivalence scales are estimated.

**Estimating needs-adjusted equivalence scales** In Aaberge et.al (2010 [2]) and Aaberge et.al (2010 [3]) , a methodological framework for the estimation of these scales is outlined. For a derivation, see the original sources.

In principle, because of the non-cash income component, extended income is scaled differently than cash income. The equivalence scale for extended income, as suggested in Aaberge et.al (2010 [3]) , is given by the formula

$$NA_h = \theta_r CI_h + (1 - \theta_r) \sum_j n_{hj} NC_j \tag{22}$$

which is a special case (prices are assumed to be homogenous across municipalities and constant) of the general needs and price adjusted equivalence scale of Aaberge et.al (2010 [2]).$h$ denotes household and $n_{hj}$ is the number of members of household $h$ in target group $j$. We have that

$$\theta_r = \frac{y_{r,med}}{y_{r,med} + \sum_{i=1}^{s} u_{ir}} \tag{23}$$

where $r$ denotes the reference group (in this thesis I use single adults aged 30-44 as reference group because they are the group who are recipients of the least amount of public services), *med* denotes the median observation, CI is the equivalence scale for cash income (I use the EU-scale) and NC is the non-cash equivalence scale for target group j given by

$$NC_j = \frac{\sum_{i=1}^{s} u_{ij}}{\sum_{i=1}^{s} u_{ir}} \tag{24}$$

NC will be bigger for groups who are recipients of many public services relative to the reference group. This is where the needs-adjustment comes into play.

From (22), we see that the equivalence scale for extended income varies across groups because of household composition and the relative amount of public goods recieved. Households recieving more public goods will, all else equal, have a higher equivalence scale. This is because their percieved needs are higher, and non-cash income thus has to be corrected for it.

Applying equations (22), (23) and (24) to the estimated per-capita expenditures and median income I estimate the equivalence scales for all household types. This is reported in table 12.

Table 12: Extended income equivalence scales

| Household type | CI | NC | NA | Needs-index |
|---|---|---|---|---|
| A,0-29 | 1 | 1,07 | 1,01 | 1,01 |
| A,30-44 | 1 | 1 | 1 | 1 |
| A,45-66 | 1 | 1,27 | 1,02 | 1,27 |
| A,67-> | 1 | 3,30 | 1,16 | 3,30 |
| PUB,0-29 | 1,5 | 1,99 | 1,53 | 0,99 |
| PUB,30-44 | 1,5 | 1,96 | 1,53 | 0,98 |
| PUB,45-66 | 1,5 | 2,51 | 1,57 | 1,25 |
| PUB,67-> | 1,5 | 6,56 | 1,86 | 3,28 |
| PB,0-5 | 1,855 | 6,13 | 2,16 | 1,56 |
| PB,6-17 | 2,021 | 7,66 | 2,42 | 2,05 |
| PB,18-> | 2,48 | 3,49 | 2,56 | 1,16 |
| S,0-5 | 1,46 | 4,88 | 1,70 | 1,92 |
| S,6-17 | 1,41 | 5,55 | 1,70 | 4,08 |
| S,18-> | 1,98 | 2,26 | 2 | 1,13 |

Source: Author

*Note: Needs-index is obtained by taking the non-cash equivalence scale of household h divided by the expected amount of household members.*

Applying (23) as well as the value of public services for the reference group,$\theta_r$ is estimated to be approximately 0.87.

Finally, applying these scales on cash income and non-cash income, extended and needs-adjusted extended income for each group are calculated. This is reported in table 13. Needs-adjusted extended income will be the basis for the extended income distribution.

Table 13: Equivalent non-cash and extended income

| Household type | Extended income | Needs-adjusted extended income |
|---|---|---|
| A,0-29 | 289462 | 285690 |
| A,30-44 | 400227 | 400227 |
| A,45-66 | 398118 | 384331 |
| A,67-> | 344104 | 285164 |
| PUB,0-29 | 629853 | 403765 |
| PUB,30-44 | 824139 | 528925 |
| PUB,45-66 | 864986 | 539243 |
| PUB,67-> | 727681 | 373934 |
| PB,0-5 | 1011603 | 451849 |
| PB,6-17 | 1208680 | 479228 |
| PB,18-> | 1131244 | 434349 |
| S,0-5 | 485211 | 274168 |
| S,6-17 | 619625 | 348631 |
| S,18-> | 634755 | 311657 |

Source: Author

Armed with estimates of the value of public services imputed to households, as well as the distribution of taxes, we can finally set out to answer the two questions of this thesis. What is the fiscal incidence across population groups? What happens with income inequality once we take it into account? This is the topic of chapter 4.

# 4 Fiscal incidence and the income distribution

**Definitions** If we index each population group by j, for both the income- and the type-grouping, fiscal incidence can either be measured as *relative fiscal incidence* or *absolute fiscal incidence.*

DEFINITION 2. *Let taxes, as share of income for each group, be denoted $\tau$, and transfers as share of income be denoted $\rho$. Then, the* RELATIVE FISCAL INCIDENCE, $\Psi$, *for group j is given by*

$$\Psi_j = \frac{\rho_j}{\tau_j} \tag{25}$$

In other words, we can think of the relative fiscal incidence as how much each population group gets in transfers per tax-krone. Since $\rho$ and $\tau$ are fractions with the same denominator, this is of course equivalent with taking the absolute value of transfers divided by the absolute value of taxes. A number larger than one means that the respective group gets back more in the form of public expenditures than what they pay in taxes. A number in the interval [0,1)

means that the respective group gets back less in the form of public expenditures relative to what they pay in taxes. A number equal one indicates that expenditures recieved and taxes paid are equal.

DEFINITION 3. *Let total taxes for each group be denoted by $T$, and total transfers be denoted by $P$. Then, the* ABSOLUTE FISCAL INCIDENCE, $\Phi$, *for group $j$ is given by*

$$\Phi_j = P_j - T_j \tag{26}$$

In other words, we can think of the absolute fiscal incidence as how much each population group get in expenditures, net of taxes. A positive number means that the respective population group is a net reciever of public expenditures. A negative number means that the respective population group is a net provider of public expenditures, also referred to as a *net financieer*. Note that, in order to ensure comparability across households, these numbers should be equivalence adjusted, using the equivalence scales estimated in chapter 3.

## 4.1 The fiscal incidence across household types

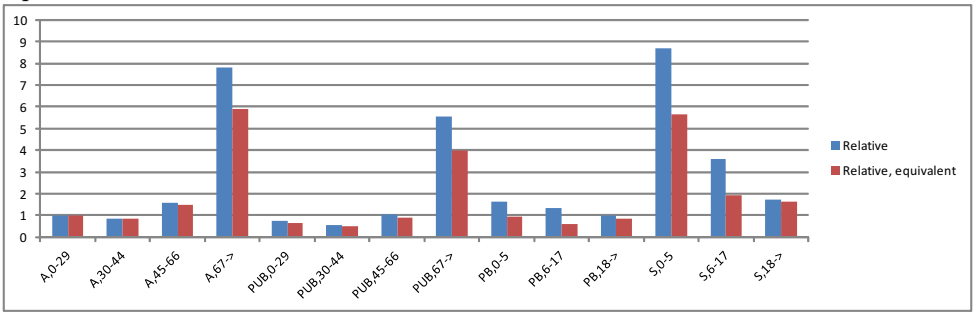
What remains is applying equation (25) and (26) to find the relative and absolute fiscal incidence for each household type. The results are given in table 14, 15 and figure 8&9.

Table 14: Relative fiscal incidence according to household type, non-equivalent income and equivalent (needs-adjusted) income

| Household type | Relative fisc. inc | Relative eq. fisc. inc |
|---|---|---|
| A,0-29 | 1,01 | 1,00 |
| A,30-44 | 0,82 | 0,82 |
| A,45-66 | 1,58 | 1,47 |
| A,67-> | 7,83 | 5,9 |
| PUB,0-29 | 0,75 | 0,62 |
| PUB,30-44 | 0,56 | 0,48 |
| PUB,45-66 | 1,06 | 0,90 |
| PUB,67-> | 5,56 | 4,00 |
| PB,0-5 | 1,65 | 0,94 |
| PB,6-17 | 1,35 | 0,62 |
| PB,18-> | 0,99 | 0,86 |
| S,0-5 | 8,67 | 5,67 |
| S,6-17 | 3,59 | 1,93 |
| S,18-> | 1,72 | 1,63 |

Source: Author

Figure 8: Relative fiscal incidence, equivalent (needs-adjusted) and non-equivalent income




Source: Author

First, according to non-needs-adjusted extended income, the groups who recieve most expenditures relative to taxes paid are S,0-5, A,67-> and PUB,67->. These groups recieved an estimated 8.67, 7.83 and 5.56 per tax krone, respectively, in municipal- and county-provided services, as well as public hospitals. This is a product of being a target group for many transfer schemes such as retiree-benefits and single-parent benefits, as well as recipients of many in-kind services such as long-term care institutions and kindergardens.

Among those who appear to be the worst off are groups who typically are not eligible for any special government programs. They end up as net financeers of the public sector. These are working couples without children and single working individuals.

Adjusting for needs, we see that the change in relative fiscal incidence for all groups is negative for all (except the reference group of course). The biggest change in relative fiscal incidence numbers when needs-adjusting is found for households with children. For couples with children aged 0 - 17, the fiscal incidence is actually reduced from being above 1 to below 1, meaning that they move from net recipients to net financieers once we account for the percieved needs. The groups who appear as winners in the sense that they have a relative fiscal incidence above 1 are lone parents with children, as well as retiree-abundant groups.

Note that, when we needs-adjust, we transform the value of public services to an equivalent value, comparable across all households. When needs are taken into account (and since public expenditures are allocated proportional to needs, by equation (15)) this equivalent value will be equal to the public service value imputed to the reference household[10].

[10]To see this a bit more clearly, consider the total public spending imputed to household $h$. This is given by

$$\sum_{j=1}^{k} n_{hj} \sum_{i=1}^{s} u_{ij} = \sum_{j=1}^{k} n_{hj} \sum_{i=1}^{s} \left( \frac{\gamma_{ij}}{\sum_{j=1}^{k} \gamma_{ij}} u_i \right) \tag{27}$$

Similarily, the total imputed value to the reference household, consisting of one individual,

Because of this, the relative and absolute equivalized fiscal incidence will depend on this size relative to equivalized taxes and cash transfers.

Table 15: Absolute fiscal incideince, equivalent (needs-adjusted) and non-equivalent income

| Household type | Absolute fisc. inc | Absolute eq. fisc. inc |
|---|---|---|
| A,0-29 | 762 | 427 |
| A,30-44 | -16172 | -16172 |
| A,45-66 | 52118 | 42827 |
| A,67-> | 272005 | 195227 |
| PUB,0-29 | -32046 | -32272 |
| PUB,30-44 | -87360 | -68672 |
| PUB,45-66 | 13686 | -13405 |
| PUB,67-> | 494181 | 216861 |
| PB,0-5 | 132103 | -5648 |
| PB,6-17 | 90780 | -48166 |
| PB,18-> | -255 | -14484 |
| S,0-5 | 291712 | 121434 |
| S,6-17 | 215726 | 54958 |
| S,18-> | 92955 | 42126 |

Source: Author

is given by

$$\sum_{i=1}^{s} u_{ir} = \sum_{i=1}^{s} \left( \frac{\gamma_{ir}}{\sum_{j=1}^{k} \gamma_{ij}} u_i \right) \tag{28}$$

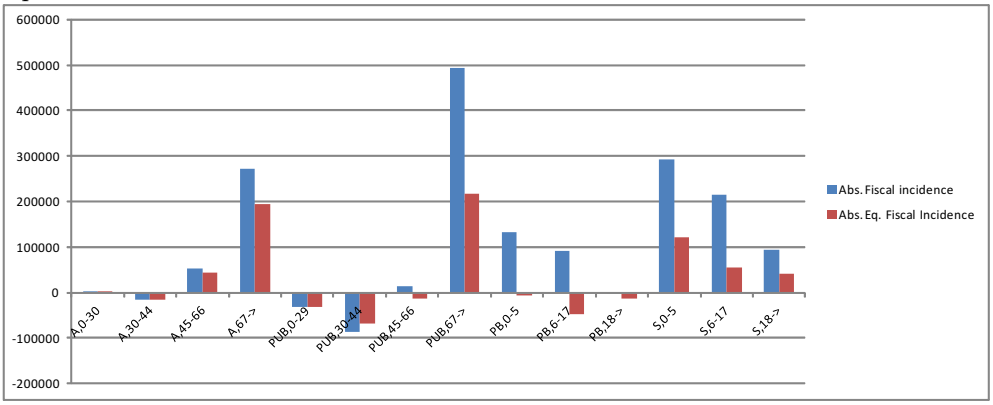
Recall from equation (24) that $NC_j$ is simply the total imputed value to member of target group $j$ relative to the total imputed value to the reference household/group $r$, i.e.

$$NC_j = \frac{\sum_{i=1}^{s} u_{ij}}{\sum_{i=1}^{s} u_{ir}} = \frac{\sum_{i=1}^{s} \left( \frac{\gamma_{ij}}{\sum_{j=1}^{k} \gamma_{ij}} u_i \right)}{\sum_{i=1}^{s} \left( \frac{\gamma_{ir}}{\sum_{j=1}^{k} \gamma_{ij}} u_i \right)} = \frac{\sum_{i=1}^{s} \gamma_{ij}}{\sum_{i=1}^{s} \gamma_{ir}} \tag{29}$$

Thus, the equivalized in-kind income of household j is given by

$$\frac{\sum_{j=1}^{k} n_{hj} \sum_{i=1}^{s} u_{ij}}{\sum_{j=1}^{k} n_{hj} NC_j} = \frac{\sum_{i=1}^{s} \left( \frac{\gamma_{ij}}{\sum_{j=1}^{k} \gamma_{ij}} u_i \right)}{\frac{\sum_{i=1}^{s} \gamma_{ij}}{\sum_{i=1}^{s} \gamma_{ir}}} = \sum_{i=1}^{s} \left( \frac{\gamma_{ir}}{\sum_{j=1}^{k} \gamma_{ij}} u_i \right) = \sum_{i=1}^{s} u_{ir} \tag{30}$$

Figure 9: Absolute fiscal incidence, equivalent (needs-adjusted) and non-equivalent income




Source: Author

The distribution of absolute fiscal incidence mirrors of course the distribution of relative fiscal incidence. When needs-adjusting, the group who recieves the most recources are couples without children, aged 67->, with approximately 216'000 on average. Couples without children aged 45-66 acts as the biggest average financieer, with a net transfer of approximately 68'000 on average[11].

What do these results indicate? First off, there are large variations in fiscal incidence across groups. While some groups recieve less in public spending than their tax payments, other groups recieve substantially more. The pattern appears to be that typical "weak" groups recieve relatively large amounts compared to "stronger" household types. When attempting to adjust for needs, some of the picture changes. Couples with children in the age 0 - 17, who had a relative fiscal incidence above 1 now has a relative fiscal incidence below, indicating that after we control for needs, there is no additional "rents" allocated to these groups. The elderly population's and lone-parents' fiscal incidence declines both in relative and absolute terms as well, but they still appear as the biggest winners of the fiscal sector. Of course, the elderly population has been

[11] When do absolute fiscal incidence increase when we use equivalence scales and when will it decrease? As we see, it decreases for most groups, but for groups such as PUB,30-44 the absolute fiscal incidence actually increase when applying equivalence scales. The reasons for this can be illustrated easily. Let $o$, $s$ and $t$ be the amount of transfers, services and taxes paid or recieved for each group, respectively. Let a superbar denote the equivalized value of the corresponding variable. Then, we have that equivalized absolute fiscal incidence is higher than the non-equivalized fiscal incidence iff $(\bar{o} - o) + (\bar{p} - p) - (\bar{t} - t) > 0$. Each term within the parantheses denotes the change in the respective variable when equivalizing. Notice that all three terms will be nonpositive. If the last term is larger in absolute value than the sum of the two first, the absolute fiscal incidence will actually increase when needs-adjusting. Thus we would expect groups whose absolute fiscal incidence improves once we scale income are groups who pay a large amount of taxes. The effect of scaling this down, in absolute terms, will be bigger for them than the effect of scaling down transfers and thus the absolute fiscal incidence improves. This of course illustrates that we should be careful with interpreting absolute numbers.

young once, and then belonged to households who were likely to be net financieers. We should be very clear of the fact that we are looking at this from a purely static approach.

## 4.2 Fiscal incidence according to income deciles

After needs-adjusting non-cash income, I obtained the equivalized value of public services. This is imputed to the respective income deciles accordingly. Adding this to cash income and taking into account the estimated taxes, the relative and absolute fiscal incidence for each income decile can be calculated[12].

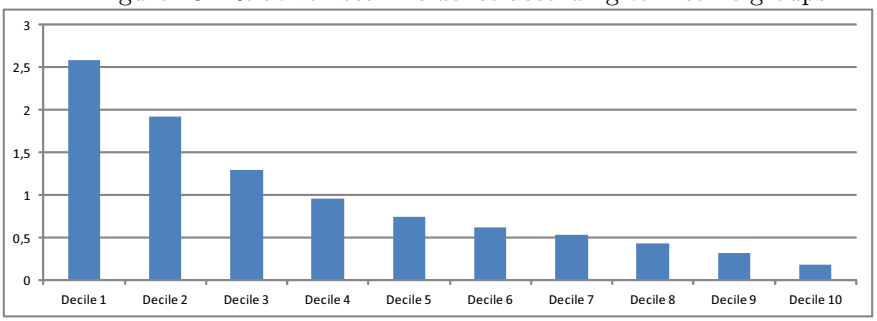
These values are given below.

Table 16: Relative fiscal incidence according to income groups

| Decile | Relative fiscal incidence |
|---|---|
| Decile 1 | 2,58 |
| Decile 2 | 1,92 |
| Decile 3 | 1,29 |
| Decile 4 | 0,95 |
| Decile 5 | 0,74 |
| Decile 6 | 0,62 |
| Decile 7 | 0,53 |
| Decile 8 | 0,43 |
| Decile 9 | 0,32 |
| Decile 10 | 0,18 |

Source: Author

Figure 10: Relative fiscal incidence according to income groups




Source: Author

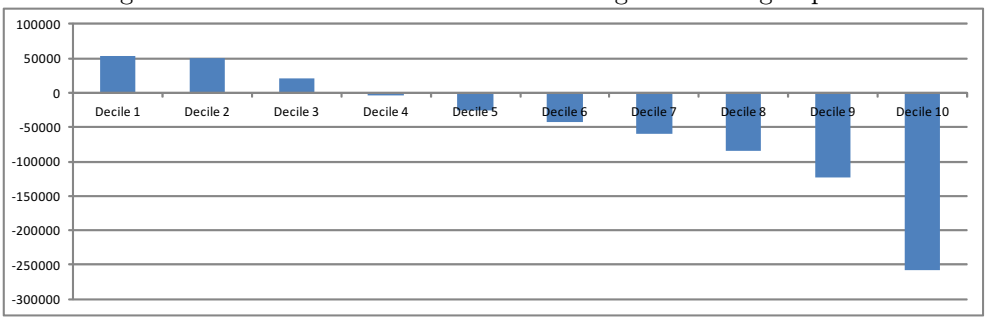
[12]Note that, since cash income already is on the equivalized form and household type is unkown, I cannot utilize equation (22). The result is that cash and non-cash income is weighted equally, i.e. not weighted. Extended income of the household types and extended income of the income deciles is therefore not directly comparable.

Table 17: Absolute fiscal incidence according to income group

| Decile | Absolute equivalized fiscal incidence |
|---|---|
| Decile 1 | 53591 |
| Decile 2 | 49896 |
| Decile 3 | 21121 |
| Decile 4 | -3533 |
| Decile 5 | -25667 |
| Decile 6 | -42620 |
| Decile 7 | -59189 |
| Decile 8 | -85144 |
| Decile 9 | -122835 |
| Decile 10 | -258572 |

Source: Author

Figure 11: Absolute fiscal incidence according to income group




Source: Author

Decile 1 recieves a net transfer of approximately 53'000 equivalent NOK, while decile 10 pays a net transfer of approximately 250'000. There are large differences in absolute fiscal incidence as we move up along the income distribution, with a progressive pattern emerging.

## 4.3 Taxes, public spending and the income distribution

Knowing the fiscal incidence across groups, we can easily see how incorporating this affects inequality.

The choice of inequality measure is the Gini index. Originally, the Bonferroni measure was also considered. However, as demonstrated by Aaberge (2000), the Bonferroni measure is particularly sensitive to changes that concern the lower parts of the income distribution. The Gini-index on the other hand pays more attention to changes that take place in the middle part of the income distribution. Without having the entire income distribution, I have to estimate the inequality measure based on predicted income distributions. In order to

produce these estimates, I assume that income and taxes *within* each decile is uniformally distributed. This is likely to produce biased tails. This is the reason why the Gini-coefficient was chosen as an inequality measure in the first place. A consequence of this assumed distribution is that the Gini-coefficient is likely to be biased, probably downwards, meaning that I underestimate inequality. For the sake of comparability then, I will estimate the corresponding Gini-index before the fiscal incidence (but after direct taxes) is taken into account and use this as a benchmark.

Let $X_k$ be the cumulative population share and $Y_k$ be the corresponding cumulative income share. Since we have 10 income deciles we have 11 data points, i.e. $k = \{0, 1, ....., 10\}$, where $X_0 = Y_0 = 0$ and $X_{10} = Y_{10} = 1$

The Gini-index, $G$ , is then approximated according to

$$G = 1 - \sum_{k=1}^{10} (X_k - X_{k-1})(Y_k + Y_{k-1}) \tag{31}$$

To find this coefficient, the cumulative income shares have to be estimated for each (hypothetical) distribution. By finding the average income in each decile and rewriting (1) to solve for $Dist_i$, these can be identified.

Let I = equivalent income after direct taxes and cash transfers, II = equivalent income after *all* taxes and cash transfers, and III = equivalent *extended* income after all taxes. The distribution of income for each income measure is given in table 18.

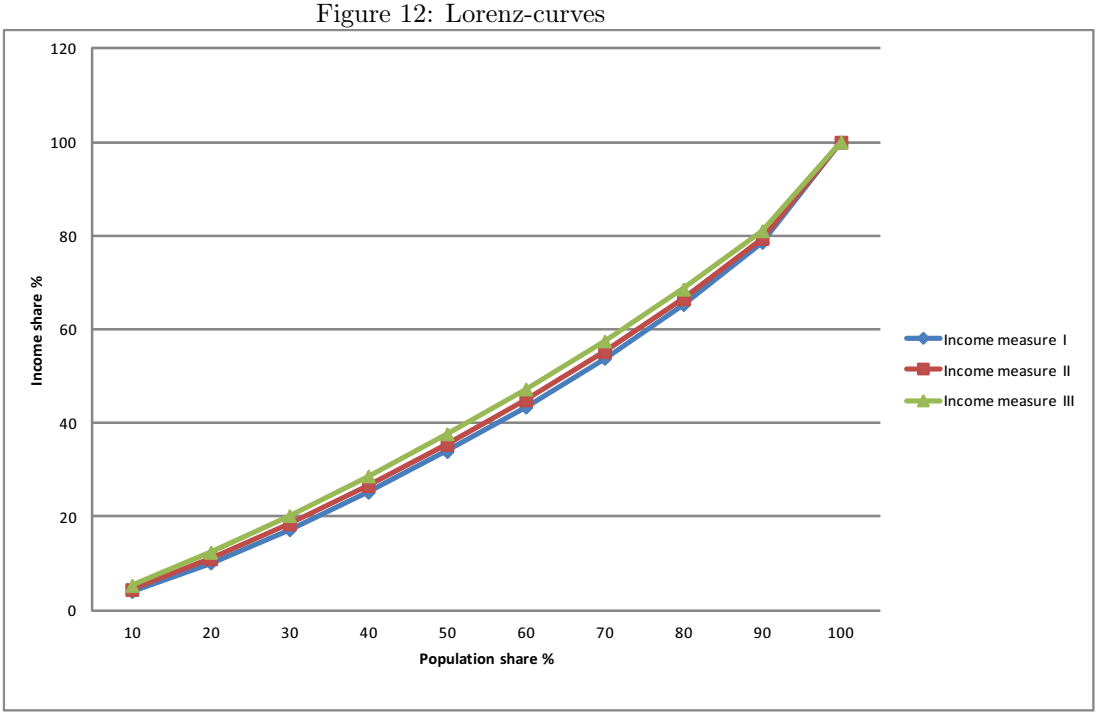
Once these income shares are known, finding the cumulative income shares is trivial. Note that, as we introduce the other taxes and the value of public services, the income share of Decile 1 - 5 increases, while decile 6's is unchanged. For decile 7 - 10 the income share declines. This indicates that inequality is substantially lower once we account for all taxes and public expenditures. The estimated Lorenz curves are shown in figure 12.

Table 18: Income distributions

| Decile | Share of total income acc. to I | Share of total income acc. to II | Share of total income acc. to III |
|---|---|---|---|
| Decile 1 | 4% | 4,4% | 5,2% |
| Decile 2 | 6,1% | 6,5% | 7,1% |
| Decile 3 | 7,1% | 7,4% | 7,8% |
| Decile 4 | 8% | 8,1% | 8,4% |
| Decile 5 | 8,7% | 8,8% | 8,9% |
| Decile 6 | 9,5% | 9,5% | 9,5% |
| Decile 7 | 10,4% | 10,3% | 10,2% |
| Decile 8 | 11,5% | 11,2% | 11,1% |
| Decile 9 | 13,3% | 12,9% | 12,4% |
| Decile 10 | 21,4% | 20,5% | 18,9% |

Source: Author

Figure 12: Lorenz-curves




Source: Author

Utilizing the values in table 18 we can estimate the predicted Gini-coefficients, where the subscripts refer to what income measure is being used. These, as well as percentage changes in the Gini coefficient when moving from $i$ to the $i+1$ income measure, are given in table 19.

Table 19: Gini-coefficients and percentage changes

| Gini | Coefficient | %-change from Gini-coefficient above |
|---|---|---|
| $G_I$ | 0,237 | - |
| $G_{II}$ | 0,215 | -8,8% |
| $G_{III}$ | 0,182 | -15,3% |

Source: Author

*Note: The reported Gini-coefficient from Statistics Norway was for 2007 0.244, indicating, as predicted, that I underestimate inequality in the numbers given above. The difference in benchmark Gini is approximately 2,8%.*

Indirect taxes and the payroll tax reduces inequality. The marginal reduction in Gini-coefficient from including these taxes relative to the benchmark is 8.8%. We see that including the value of public services reduces the inequality measure by an additional 15,3%, indicating that public services is more imortant in terms of reducing inequality than indirect and payroll taxes.

All in all, these results indicate that economic inequality is overestimated with the traditional approach, at least if we believe that public expenditures should be incorporated into an inequality measure. Once we incorporate more than just direct taxes, as well as the value of public services, inequality declines. This is in line with previous literature on the topic such as Aaberge et.al (2010 [2]). It is worth noting however that once we account for indirect taxes, the payroll tax and more public services, inequality is reduced further than what Aaberge et.al (2010 [2]) estimates.

A final issue to assess is the impact on poverty incidence when taking the fiscal incidence into account. Table 20 shows how the poverty incidence changes, for two different poverty thresholds, when I replace income with extended income.

Table 20: Risk-at-poverty

| Threshold (% of median) | Poverty incidence % Income | Extended income |
|---|---|---|
| 50 | 7,89% | 6,82% |
| 60 | 9,22% | 8,18% |

Source: Author

*Note: Income is scaled according to the EU-scale. Extended income is not needs-adjusted according to (22) because of data limitations, instead the equivalized non-cash income is added to equivalized cash income.*

As we see, including the value of public services significantly reduces the poverty incidence by 11 - 13%[13]. These results indicate that, not only is the fiscal incidence important to take into account when measuring inequality, but it is also important for poverty rates.

[13]The reduction in poverty incidence is smaller than that of (Aaberge et.al 2010 [2]). This is likely to be caused by the assumptions invoked on the underlying distribution. A natural sensitivity analysis would be to compare the results given here, found using aggregated data, with a register-data approach. This is left for future research.

# 5 Discussion

The purpose of this chapter is to discuss possible caveats with the methodology, as well as briefly discussing pathways for futher research.

## 5.1 Methodology

### 5.1.1 Estimations

**Estimations in general** This thesis is rather "estimation-intensive". Not only do I estimate expenditures in the case of consumption and minimum quantity parameters, but health multipliers and a large set of probabilities/utilization rates are estimated as well. I have done my best to do everything correct, but studies containing this vast amount of information will always be succeptible to criticism. In hindsight, I feel it is important to approach the results in a specific manner. The purpose of this thesis was to provide a description of the system and certain features of it, given a set of assumptions and imputation rules, rather than an "exact" representation. I hope that I have suceeded in this goal, and that the marginal utility of such a thesis would be, even if the exact kroner values or Gini-changes might differ from those in reality, positive. The importance of trying to characterize the effects of the public sector is too great to be discouraged from doing so.

**Caveats with the insurance principle** The insurance approach is derived from the logic that the value of the relevant services should be scaled according to factors taking into account the probability of a specific group being a user relative to a reference group. The rationale for this is that, if individuals were to aquire similar insurances in the private market, they would pay differential prices based on their age and sex. A correct imputation formula would therefore be consistent with what a private insurance company would charge the respective groups.

In this thesis, I have scaled the costs up and down according to the relative probability of being a user as well as the expected frequency of usage. For public hospitals, a bit more sophisticated approach was possible, namely by accounting for the costs of services recieved as well. In a perfect world, these health multipliers should also take into account the variance of usage within each group, at least if we think of insurance companies as to some extent risk averse. Since I only had access to aggregated data, these variances were not known. A better approach, left for future research, would be to utilize register data to account for different variances as well.

**The Gini-index** The Gini-index reported in this thesis is a mere approximation of the actual. This is because I do not know the exact income distribution, only the income shares of the respective deciles. The bias in my reported Gini-index relative to the true value will thus depend on the validity of assuming a uniform distribution of income within each decile.

### 5.1.2 A general equilibrium solution

As hinted on early in the introduction, this thesis is of a more positive nature. A general equilibrium solution of such a research question is way beyond the scope of this thesis. Any behavioral effects and the corresponding implicit cost of them are excluded from the analysis. Results should be interepreted with care.

### 5.1.3 Multiple datasets

When estimating the consumption expenditures for the various income deciles (see chapter 2 and Appendix B), I combined data from two different sources, namely EuroStat and Statistics Norway, to measure one variable. EuroStat numbers was used to estimate average incomes in each decile and Statistics Norway data was used to estimate consumption expenditures as a function of income for each group. The reason for having to utilize different sources is because average post-tax equivalent income is not available in Statistics Norway's Income Distribution Statistics, only the total distribution of income (the share of total income that each income decile holds). Consumer expenditures are estimated with Statistics Norway's data, and then the estimated average income, found by using EuroStat data, are plugged into the estimated system. If the EuroStat numbers are for some reason lower than the Statistics Norway numbers, indirect taxes are underestimated, and the opposite if Statistics Norway's numbers are lower. Different measurement techniques, classifications and so forth could give rise to differences between the data. I was not able to uncover such discrepansies while undertaking the analysis.

### 5.1.4 Paternalism

When thinking about these services, it is tempting to view them as services the households are exempted from buying in the market and thus the provision of them is a genuine service. If the households wouldn't have purchased it in the market if they had been given a cash transfer similar to the size of the service imputed, is it correct to impute the service in the first place? This question is in a sense of a normative nature - what is the willingness to pay of the households for the various goods and services? From a welfare point of view, these aspects should be taken into consideration. Unfortunately, it requires vast amounts of information. The consequence of not accounting for such aspects is that we have to be extra careful interepreting the results.

### 5.1.5 Corporate income taxes

The corporate income tax was excluded from the analysis, simply because of no clear consensus in the literature on the approriate incidence assumptions. What is the consequence of excluding this? Of course, it depends on what the correct incidence assumptions are. If the corporate income tax is carried by owners of corporations, excluding it from the analysis is likely to make the

distribution of total taxes less progressive than what it actually is. As asset wealth increases with income, the holdings of companies would likely increase as we move up along the income distribution. Distributing the corporate income tax proportionally to this would increase the average tax rate on the richer income groups. The effect on the inequality measure is that excluding the corporate income tax would therefore increase measured inequality since it falls more heavily on richer consumer units, given the incidence assumption above.

### 5.1.6 Externalities and other issues related to public goods

**Externalities** A concept closely related to public goods is externalities, both positive and negative. Externalities are often an important motivation for why public goods are provided, i.e. because private agents fail to incorporate this positive/negative effect into their valuation of the good. For instance, health care and education are likely to generate positive externalities. In this thesis, the total benefit of public goods is assumed to be equal to the total cost of providing them, hence, in total there is no "aggregate externality" of the public sector. This might be an inplausible assumption. However, since I analyze the ex.post distribution of disposable income and extended income, any externalities affecting these values are accounted for.

**Investments vs. outlays** Many public goods are typical investments, such as infrastructure and education. The assumption used in this thesis is that these expenditures generate benefits only within the same year as they are paid. Of course, for education for example, we could in principle include the discounted value of the additional future benefit each individual obtains from having utilized the service. This is not done here.

**Static vs. dynamic approach** Related to the previous paragraph - this thesis is purely static. Dynamic benefits are excluded, such as education. It should be kept in mind that, over the life-cycle, individuals move between household types and thus recieve varying benefits. The numbers presented in the previous chapter measures only the static distribution of taxes and public spending across household types for 2007. A life-cycle analysis of the public sector would require more data than what was available to me.

## 5.2 Future research

### 5.2.1 Adding time

An interesting extension would be to look at how fiscal incidence develops over time. Since the framework outlined can easily be applied to more years, a natural next step would be to estimate the fiscal incidence for the same groups over time and see how it evolves. Interesting research questions such as; who are the prioritizatized groups of different governments? and is the welfare state getting more or less generous? could be answered. We could then also estimate

"incidence-adjusted" Gini-coefficients over time. This is especially relevant in the wake of (OECD 2008). Are inequality actually increasing or is the rising Gini-indicies a consequence of a public sector putting increasingly more emphasis on the provision of public services rather than cash-income preservation?

### 5.2.2 More public goods

More public goods could in principle be added to the analysis. This is left for future research. The justification for excluding most goods here is that they are distributed uniformally across the population and, except for level values, have less descriptive power. There are also time- and data-limitations.

### 5.2.3 Why cross-country comparisons of inequality is dangerous

The results in section 4.3 indicates that one should be careful when undertaking cross country comparisons of inequality measures. Consider two countries who are identical in the distribution of factor income, but differs in the prioritzation between cash transfers and the provision of public services, as redistributional tools. With the standard Gini approach, the first will appear to have less inequality compared to the latter, however this is not necessarily the case, at least not in welfare terms. For a better comparison between countries, a more complete picture of the fiscal incidence should be taken into account. Aaberge et.al (2010 [3]) is an example of work attempting to do this, where the values of health and education are included into an extended income measure. The authors there find that inequality and poverty are significantly reduced once the value of public services is taken into account. Future research should build on the framework used there and here, to account for more taxes and public services in the measure of inequality. By doing this, inequality across borders can be better compared.

### 5.2.4 A wealth-adjusted income distribution

When looking at the distribution of income it is important to recall what we actually observe. An important aspect to keep in mind is that it is by no means a complete description of the *distribution of resources.* For instance, as mentioned in this thesis, income decile 1 contains a set of wealthy individuals with zero taxable income who still pays a substantial (in absolute terms) wealth tax. Therefore, the direct tax rate will be relatively high for that decile. As long as one is aware of this, this is perfectly fine. However, as the income-distribution is an important component in policy-making regarding poverty, conclusions and interpretations will not be as clear as we would perhaps hope. A possible solution to this is to construct a *resource distribution* measure.

For the purpose of creating a resource distribution, a common practice is to create Wealth Adjusted Income, WAI. A typical WAI-measure aims to convert wealth of the stock form to a flow variable. The (hypothetical) returns from the current holdings of a wide array of assets is, in addition to imputed rents

if the household/individual is a *home*-owner[14], added to wage income to form the WAI. While the WAI provides a wider picture than income alone, a few improvements can be made.

First, by looking at the components included in regular WAI we have not defined the entire consumption set. Obviously, in addition to providing annuity, at least some assets can be liquidated at prevailing market prices to provide consumption. From an Arrow-Debreu point of view, liquid assets are merely consumption transferred across different states of the world. The option to liquidate is always there if the realized state requires so, for the purpose of consumption smoothing. It would therefore seem right that at least some discretionary amount of liquid wealth above annuity should be included into an extended WAI.

Similarily, non-fungible stock wealth, such as the market value of houses, is excluded from the WAI concept. The justification is that the transformation from stock to flow is hard, except the imputed rents derived from it. However, households/individuals can use these values as collateral to obtain loans which increases the set of feasible consumption bundles. It should therefore, in some manner, be accounted for.

Obviously, there is an intertemporal aspect here. Liquidating wealth and borrowing today both has the same effect - less consumption is available tomorrow. This should also be taken into account when constructing such a distribution, however it is not clear exactly how this should be done. Working further on the topic is left for future research.

[14]If he/she/they are multiple house-owners, second houses and so forth is considered an non-fungible asset.

# 6 Concluding remarks

The main insights from this thesis can be summarized in four points.

1. Even after adjusting for needs, there are large differences in the relative relationship between taxes and public transfers (both cash and in-kind) across household types and income groups. Groups who benefits the most from the public sector are retiree-abundant groups, as well as households with children (especially lone parents). This is because, not only do they recieve relatively large amounts of cash transfers, but most public services cater to these groups.

2. The Gini-coefficient obtained from the standard approach of looking at post-(direct)tax equivalent income distribution overestimates inequality, at least in the year covered in this thesis. This is most likely a general effect. Accounting for indirect taxes and the payroll tax reduces the Gini-coefficient from 0,237 to approximately 0,215. Incorporating the value of public services into an extended income framework further reduce the coefficient to 0,182. While these coefficients are likely to be biased in the sense that they underestimate inequality, the effects illustrated are believed to be real.

3. From the analysis, it appears that public services are more effective in terms of reducing inequality than indirect taxation, perhaps because they are to a larger extent designed to do just so.

4. When taking more taxes and public services into account, the poverty incidence falls with 11 - 13%, depending on what poverty threshold is used.

These effects indicate that fiscal incidence, even with uncertainty regarding levels, is important, not only for the descriptive power itself but also for its implications on inequality and poverty. Failing to account for the complete incidence will give us less powerful descriptions of one important element in the economy, namely the public sector, as well as a distorted view on the distribution of economic well-being.

# References


[1] Aaberge, R. (2000). "Characterizations of Lorenz curves and income distributions". Social Choice and Welfare 17. pp. 639 - 653.

[2] Aaberge, R, Bhuller, M, Langørgen, A, Mogstad, M (2010). "The distributional impact of public services when needs differ". Journal of Public Economics 94, pp. 549-562.

[3] Aaberge, R. Langørgen, A & Lindgren, P. (2010). "The impact of basic public services on the distribution of income in European Countries". Eurostat. Income and living conditions in Europe.

[4] Aaberge, R. & Langørgen, A. (2003). "Fiscal and spending behavior of local governments: Identification of price effects when prices are not observed". Public Choice 117. pp. 125 - 161

[5] Adler, J. (1951). "The fiscal system, the distribution of income and public welfare". Fiscal Policies and the American Economy. Prentice Hall, pp 359 - 421.

[6] Barna, T. (1945). "Redistribution of incomes through public finance". Oxford University Press.

[7] Bishop, G. (1966). "Income Redistribution in the framework of national income accounts". Tax Journal 19. pp. 378 - 390.

[8] Brennan, G. (1976). "The Distributional Implications of Public Goods". Econometrica 44(2). pp 391 - 399.

[9] Cappelen, Å. Jia, Z. Nesbakken, R., Prestmo, J, Thoresen, T. (2010). "Effekter av dynamisk skattepolitikk". Samfunnsøkonomen nr.4, 2010. pp. 4 - 14.

[10] Cartter, A. (1955). "The redistribution of income in post war Britain". Yale University Press.

[11] Chamberlain, A & Prante, G. (2007) "Who pays taxes and who recieves government spending? An analysis of federal, state and local tax and spending distributions, 1991 - 2004". Tax Foundation Working Paper No. 1.

[12] Conrad, A. (1954). "Redistribution through government budgets in the United States, 1950". Income Redistribution and Social Policy". Jonathan Cape, pp. 178 - 267.

[13] Deaton, A. & Muellbauer, J. (1980). "An Almost Ideal Demand System". The American Economic Review. Vol. 70, No. 3. pp 312 - 326

[14] De Wulf, L. (1975). "Fiscal Incidence Studies in Developing Countries: Survey and Critique". Staff Papers - International Monetary Fund. Vol. 22, No. 1. pp 61-131.

[15] Feldstein, M. (1999). "Tax Avoidance and the deadweight loss of the income tax". Review of Economics and Statistics 81(4). pp 674 - 680.

[16] Freund, D. & Smeeding, T. (2006). "The future costs of health care in aging societies: Is the glass half full or half empty?" In S.Tuljapurkar, N.Ogawa & A. Gauthier (eds) "Riding the age waves: responses to aging in advanced industrial states. Springer Kluwer Press.

[17] Garfinkel, I. Rainwater,L. & Smeeding, T. (2006). "A re-examination of welfare states and inequality in rich nations: How in kind transfers and indirect taxes change the story."

[18] Gemmel, N. (1985). "The incidence of government expenditure and redistribution in the United Kingdom." Econometrica 52(207). pp 335 - 344.

[19] Gillespie, I. (1965). "Effect of public expenditures on the distribution of income". Essays in Fiscal Federalism. The Brookings Institution.

[20] Greene, K. (1975). "Fiscal incidence in the Washington Metropolitan Area". Land Economics 52(1). pp. 13-31.

[21] Harberger. A. (1962). "The incidence of the corporation income tax". Journal of Political Economy 70. pp 215 - 240.

[22] Halvorsen, E. (2011). "Norske husholdningers sparing". Økonomiske analyser 3. pp. 31 - 35.

[23] Heide, K. Holmøy, E. Lerskau, L & Solli, I. (2004). "Macroeconomic Properties of the Norwegian Applied General Equilibrium Model MSG6". Rapporter 2004/18. Statistisk Sentralbyrå.

[24] Horowitz, J. & McConnell, K. (2000), "A Review of WTA/WTP Studies". Available at SSRN: http://ssrn.com/abstract=257336 or doi:10.2139/ssrn.257336

[25] Horowitz, J. & McConnel, K. (2003) "Willingness to accept, willingness to pay and the income effect". Journal of Economic Behavior & Organization, 51, issue 4, pp. 537 - 545.

[26] Immervoll, H. (2005). "Household incomes and redistribution in the European Union: Quantifying the equalising properties of taxes and benefits". EUROMOD Working Paper No. EM9/05. University of Essex Institute for Social & Economic Research.

[27] Kienzle, E (1982). "Post-fiscal distribution of income: Measuring progressivity with application to the United States". Public Finance Quarterly 10(3). pp. 355 - 368.

[28] Lind, J. T (2001). "The Pangloss critique of equivalence scales". Statistics Norway, Discussion paper no. 296.

[29] Maital, S. (1975). "Apportionment of public goods benefits to individuals". Public Finance 30: pp 397 - 416.

[30] Maital, S. (1973). "Public goods and income distribution: Some further results". Econometrica 41(3). pp. 561 - 568.

[31] Martinez-Vazquez, J. (2004). "The impact of fiscal policy on the poor: Fiscal incidence analysis". ISP Working Paper 01-10.

[32] Mas-Collel, A. Whinston & M. Green, J. (1995) "Microeconomic Theory". Oxford University Press

[33] McQuire, M. & Aaron, H. (1970). "Public Goods and Income Distribution". Econometrica 38(6). pp 907 - 920.

[34] OECD (2009). "Dynamic scoring: Attractions, Challenges and Trade-offs." GOV/PGC/SBO (2009)/7

[35] OECD (2008). "Growing unequal? Income Distribution and Poverty in OECD Countries". ISBN: 9789264044180

[36] Papadimitriou, D. (2006). "Government effects on the distribution of income: An Overview". Levy Economics Institute of Bard College Working Paper No. 442. Levy Economics Institute.

[37] Peacock, A. (1954). "Income distribution and social policy". Jonathan Cape.

[38] Persson, T & Tabellini, G. (2000). "Political economics - explaining economic policy". MIT Press.

[39] Regjeringen.no (2012). "http://www.regjeringen.no/en/dep/fin/Selected-topics/taxes-and-duties.html?id=1359". Accessed the 27th of February, 2012.

[40] Regjeringen.no (2010). "http://www.regjeringen.no/nb/dep/fin/dok/andre/brev/brev_stortinget/2010/D
885-S-2009-2010-Representantforslag-fra-Skei-Grande-og-Tenden-
.html?id=600087". Accessed the 06th of May, 2012

[41] Reynolds, M & Smolensky, E. (1977). "Public expenditures, taxes and the distribution of income: The United States, 1950, 1961, 1970". Academic Press.

[42] Rosen, H. & Gayer, T. (2008) "Public Finance". McGraw-Hill.

[43] Sollie, M & Svendsen, I. (2001). "En økonometrisk studie av arbeidstilbudet i Norge". Rapporter 2001/7. Statistisk Sentralbyrå.

[44] Statistics Norway (2012). "Statistikkbanken". All data acessed in the period January - April 2012.

[45] Stigler, George. (1970). "Director's law of public income distribution". The Journal of Law and Economics 13(1). pp 1- 10.

[46] Wolff, E & Ajit, Z. (2004). "An overall assessment of the distributional consequences of government spending and taxation in the U.S, 1989 and 2000". Levy Economics Institute.

[47] Woolridge, J (2009). "Introductory Econometrics. A Modern Approach - Fourth Edition". South-Western, CENGAGE Learning.

# A Data and assumptions

## A.1 Data

All data obtained from Statistics Norway are extracted from "Statistikkbanken", (Statistics Norway 2012) and listed in table 21. Statistics Norway will be throughout the table be referred to as "SSB"

## A.2 Assumptions

Below is an overview over central assumptions utilized in this thesis. Most of them stems from the fact that data used are highly aggregated.

- ASSUMPTION 1[15].

1. *The age distribution of adults within PB,0-5, PB,6-17 and PB,18-> is equal to the age distribution within PUB,0-29, PUB,30-44 and PUB45-66 respectively.*
2. *All children residing in the household is within the assigned age group.*

- ASSUMPTION 2. *There is no structural change in the effective indirect tax rate from 2006 to 2007.*
- ASSUMPTION 3. *If Z is the set of variables affecting subsistence output on all services to all target groups and T is the set of variables affecting the allocation of discretionary spendings across all municipalities and counties, then* $Z \cap T = \emptyset$
- ASSUMPTION 4. *Income, taxes and public spending are uniformally distributed within each income decile.*
- ASSUMPTION 5. *There is no systematic differences between the average quality of consultations across age groups in terms of service recieved.*

[15] What is the consequence of invoking this assumption? Related to the first point, it should be noted than in terms of cash transfers and taxes, we know the exact averages for each group. The bias from invoking the first point in assumption 1 will thus arise if there are large differences in the actual recieved amount of public services and the amount the assumed distribution recieves. Fortunately, adults within all these age groups recieve relatively similar public services. It is therefore likely to believe that the results will not be affected much by assuming this.

With regards to the second point, it will induce biases that increase in size as a larger share of the households within each group have children that "belong" to other categories. This arise for instance when there is a large number of years between siblings. It is worth noting that the age intervals are relatively large. This increases the probability of assumption 1 not leading to systematic bias.

Table 21: Data and datasources

| Datasource | Data |
|---|---|
| SSB, Income Statistics 2007 | Income, composition of income, direct taxes paid, distribution of income |
| SSB, Consumer Survey 1998 - 2008 | Consumption expenditures |
| SSB, Demographic Statistics 2007 | Different population groups as share of total population or sub-sets. |
| SSB, Health Survey 2007 | Utilization of general practitioner services across household types |
| SSB, KOSTRA 2007 | Data on all county-provided services and county-specific features such as size of target groups |
| SSB, Price Statistics 2007 | Price indicies for various consumption good categories |
| Norwegian Patient Register (NPR) 2007 | Distribution of DRG-points, across age- and sex-groups |
| EuroStat | Average equivalized income for Norway, in local currencies |
| SSB, Wealth Statistics for households 2007 | Distribution of taxable, gross finance capital |
| SSB, Education Statistics 2007 | Average education level, countywise |
| SSB, MSG (2006) | Indirect tax rates as share of consumer price |

Source: Author

# B An Almost Ideal Demand System

## B.1 Theory

In order to estimate the average budget shares of the various consumption categories, I estimate an Almost Ideal Demand System (with the unfortunate acronym AIDS) (Deaton & Muellbauer 1980). The model is outlined in more detail in its original paper (Deaton & Muellbauer 1980).

Define the log of an expenditure function which defines the minimium cost of attaining a specific utility level u at a given price vector $\overrightarrow{p}$ as

$$\log c(u, \overrightarrow{p}) = (1-u)log\{a(\overrightarrow{p})\} + ulog\{b(\overrightarrow{p})\} \tag{32}$$

where u normally lies between 0 (subsistence) and 1 (bliss). Assume that $a(\overrightarrow{p})$ and $b(\overrightarrow{p})$ are positive linearly homogenous functions that can be regarded as the cost of subsitence and bliss, respectively. The cost function is assumed to be twice differentiable.

Define k different consumption categories, $i = \{1, 2, ...., k\}$ and

$$\log a(\overrightarrow{p}) = a_0 + \sum_k \alpha_k \log p_k + \frac{1}{2}\sum_k \sum_j \gamma_{jk} \log p_k \log p_j \tag{33}$$

$$\log b(\overrightarrow{p}) = \log a(\overrightarrow{p}) + \beta_o \prod_k p_k^{\beta_k} \tag{34}$$

Inserting (33) and (34) into (32) we get the (log of the) AIDS cost function

$$\log c(u, \overrightarrow{p}) = a_0 + \sum_k \alpha_k \log p_k + \frac{1}{2}\sum_k \sum_j \gamma_{jk} \log p_k \log p_j + u\beta_o \prod_k p_k^{\beta_k} \tag{35}$$

The $\alpha' s$ are the price effect of a change in the price of good k, whereas the $\gamma' s$ denote cross-price effects. The $\beta' s$ are the income effects.

We see that, given that (36) is linearly homogenous, the following "adding-up" restrictions must hold

$$\sum_i \alpha_i = 1, \sum_j \gamma_{jk} = \sum_j \beta_j = 0 \tag{36}$$

Applying Shephard's Lemma, we get the AIDS containing only observable variables

$$w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i log\left(\frac{X}{P}\right) \tag{37}$$

where $w_i$ is the budget share of consumption good category i, X is the total per household budget and P is a general price index.

In addition to the restrictions outlined in (37), three additional restrictions is necessary, formally,

$$\sum_i \gamma_{ij} = 0 \forall i \tag{38}$$

$$\gamma_{ij} = \gamma_{ji} \tag{39}$$

$$Negativity \tag{40}$$

The first restriction is a consequence of the fact that the demand function is homogenous of degree zero, whereas (40) arise from Slutsky symmetry. The last restriction, often referred to as the *negativity condition* (Mas-Colell et.al 1995), implies that the Slutsky matrix is negative semidefinite, i.e. if the matrix is pre- and post- multiplied by the same vector, the result is nonpositive.

Even though theory imposes these restrictions, there are little empirical evidence confirming them. Both the violation of the homogeneity restriction as well as symmetry are somewhat frequently documented, see for instance Deaton & Muellbauer (1980). The negativity condition is more seldom tested for. A possible approach to this problem is to estimate the constrained system of equations. In this thesis however, I am interested in calculating robust expected consumption expenditures instead of estimates conforming with theory. I will therefore abstain from imposing the restrictions ex.ante.

As in Deaton & Muellbauer (1980), the AIDS framework can be extended to an income-equivalence framework so that (38) is written as

$$w_{ih} = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i log \left( \frac{X_h}{e_h P} \right) \tag{41}$$

where $e_h$ is the equivalence scale so that per capita deflated total budget can be thought of as a needs-based per capita budget. In principle, it can also be extended to include household-specific slope-coefficients. This is not done here. The coefficients obtained should therefore be thought of as average price and real equivalent-expenditure effects across *all* household types.

## B.2 Empirics

A possible problem related to the estimation of (42) is that the various price indicies are highly correlated. If the explanatory variables are not independent of each other but correlated to a "large" extent, the estimated coefficients lose predictive power. Variance of the model increase, thus increasing the standard deviations and reducing significance. In addition, coefficients are sensitive to changes in model specification. This is symptoms of a high degree of multicollinearity.

To test whether multicollinearity was a problem, I regressed each explanatory variable $j$ on the $-j$ other variables. The Variance Inflation Factor (VIF), given by $VIF = tolerance^{-1}$ where $tolerance = 1 - R_j^2$ were >100 for all

explanatory variables, indiciating a severe multicollinearity problem. Three possible remedies were considered.

The first-best approach to a multicollinearity problem is always to obtain more and "better" (less correlated) data (Woolridge 2009). Unfortunately, because of different standard (consumption good classifications) for consumer surveys before 1998, this was not possible.

The second option considered was running a Tikhonov regularization, also known as a ridge regression. Ridge regressions will produce estimates with lower variance, however somewhat biased. The rationale for doing a ridge-regression is the bias-variance tradeoff. Unbiased estimators with high variance can be traded off for somewhat biased coefficients with lower variance. I abstained however from doing this estimation here.

The third and chosen method is actually two separate operations. Since the price indicies are highly correlated, performing some sort of standarization could reduce the correlation. By for instance looking at how much prices for consumption good category j has changed, *relative* to the overall price level, correlation could be reduced. Each price variable was therefore deflated by the overall consumer price index $P$. The interpretation of the $\gamma's$ would then be the effect on demand of an increase in the price of good j, *relative to the average good*. Unfortunately, the correlations were reduced but not by much. Performing the same VIF estimations, the problem appeared to persist. The final remedy, since all the price indicies are telling much of the same story, was to drop prices except the one corresponding to the dependent variable. The price effect variable, $\gamma_i$, then measures the effect of a 1% increase in the price of good category $i$ *relative* to the average good, on good category $i's$ budget share. The model estimated will therefore be the one given below, where subscript $ei$ denotes equivalent income.

$$w_i = \alpha_i + \gamma_i \log\left(\frac{P_i}{P}\right) + \beta_i \log\left(\frac{X_{ei}}{P}\right) \tag{42}$$

The interpretation of the coefficients is as follows. $\alpha_i$ is the default budget share, i.e. what the budget share would have been if the price of the good was identical to the average price and real oncome was 1. $\beta_i$ measures the change in budget share of good i when real income increases by 1%. $\gamma_i$ is the already covered price effect.

To obtain these coefficients, I use data from the Consumer Survey of Statistics Norway for the period 1998 - 2008. These data reports average consumption expenditures on various categories, for different household types, for each year[16]. The sector-specific and general price indicies are obtained from Statistics Norway's price statistics for the same periods. The Consumer Surveys cover 5 different types of households. These are; single individual households, couples with children 0-6, couples with children 7-19, couples without children and single provider with young (0-19) children.

[16]As a matter of fact, Consumer Surveys are undertaken within 3-year intervals. The numbers reported as average for year t in this paper is actually the average of the Consumer Survey in the period(t-1 - t+1)

Since (43) is on equivalent income form, budgets have to be scaled according to the expected equivalence scale of the respective household types. Therefore, the expected equivalence scales are calculated. The probability of having X children, given that the household is in the relevant group, is multiplied with the corresponding equivalence scale. For households with three or more children, data is not reported, so these are given an equivalent scale corresponding to a similar household with three children. All data are taken from Statistics Norway's demographic statistics.

In principle, (43) can be estimated in multiple ways. Two approaches is especially popular when estimating such systems. The first is standard OLS, equation by equation. An alternative is to estimate the system by Feasible Generalized Least Squares (known as Seemingly Unrelated Regressions). However, the coefficients of OLS is consistent provided that the error term are uncorrelated with the regressors and has an expectation equal zero. I therefore estimate the unrestricted system by OLS.

In addition to multicollinearity I was worried about heteroskedasticity because low-income households are likely to be budget constrained. While it doesn't affect the unbiasedness of the estimators, it makes inferences methods less reliable. It should therefore be tested for. When estimating the system, I systematically obtained the residuals and regressed them again on the explanatory variable performing a *Breusch-Pagan* test for all the residuals. If the explanatory variables were able to predict the residuals to some extent, heteroskedasticity would have been a problem and Generalized Least Squares would have had to be applied. I did not however detect heteroskedasticity and the t-statistics is thus, at least keeping the possibility of heteroskedasticity in mind, reliable.

The results from estimating (43) are presented in table 22.

The perhaps most surprising fact is that the income effect sign on food is positive, as it is in most studies reported to be a necessessity. This is likely to be caused by the fact that, in my sample, families with children have higher equivalent income than those who don't. Other than this, most coefficients are significant and have an intuitive sign.

When using these estimated demand equations, I calculate indirect taxes paid in each income group by estimating expenditures on the different consumption categories, using the estimated average wages from table 4 and subtracting the savings rates from Halvorsen (2011) in the estimated demand system, before multiplying the results with the indirect tax rates, taken from table 3. The final results are given in appendix D. All estimated budget shares add up to a value the interval [0.97,1.06], where the inaccuracies are at the lowest deciles. The majority of the budget shares add up to approximately one.

## B.3 Robustness

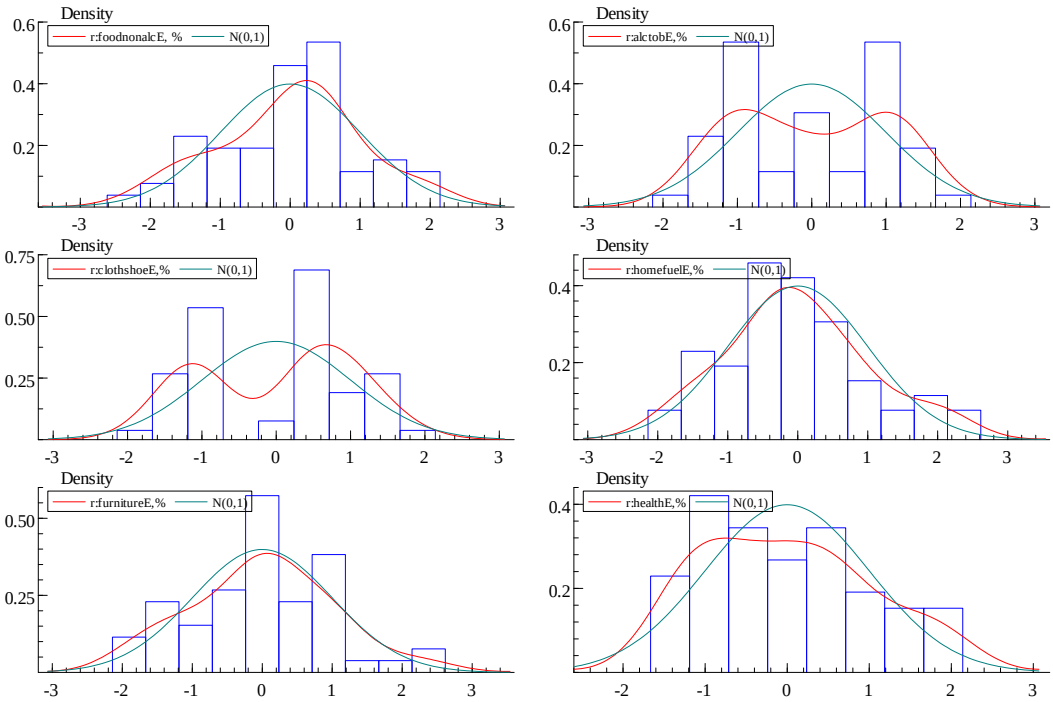
To investigate how well the zero-mean criteria is met, I plot the densities of the error terms against a distribution $N \backsim N(0,1)$. This is shown in figures 13 and 14.

Table 22: Estimated paramters, eq. (43)

| Consumption category | Eq. number | $\hat{\alpha}_i$ | $\hat{\gamma}_i$ | $\hat{\beta}_i$ | $R^2$ |
|---|---|---|---|---|---|
| Food and non-alcoholic beverages | 1 | -0,2005(-3,44)*** | 0,125(1,51) | 0,040(5,48)*** | 0,14 |
| Alcohol and tobacco | 2 | 0,2438()7,70)*** | 0,033(2,46)** | -0,027(-6,94)*** | 0,18 |
| Housing and fuel | 3 | 2,056(6,94)*** | 0,3541(6,73)*** | -0,2279(-6,01)*** | 0,43 |
| Car | 4 | -1,195(-10,2)*** | 0,615(9,05)*** | 0,16502(10,9)*** | 0,57 |
| Clothing and shoes | 5 | -0,0186(-0,398) | 0,011(3,01)*** | 0,0097(1,63) | 0,04 |
| Furniture and home-related goods | 6 | -0,148(-2,71)*** | 0,0612(3,41)*** | 0,0270(3,84)*** | 0,18 |
| Culture and recreational | 7 | 0,1627(1,85)* | -0,38(-2,68)*** | -0,000321(-0,0285) | 0,06 |
| Health services | 8 | 0,125(2,69)*** | 0,0234(2,74)*** | -0,0126(-2,12)** | 0,03 |
| Transportation | 9 | -0,201(-3,52)*** | -0,25(-8,19)*** | 0,036(5,03)*** | 0,29 |
| Postal- and telecom-services | 10 | 0,4593(15,5)*** | -0,04691(-11,0)*** | -0,0557(-14,8)*** | 0,65 |
| Education | 11 | 0,0377(5,27)*** | 0,0011(0,75) | -0,0045(-4,93)*** | 0,08 |
| Other | 12 | -0,0287(-0,293) | 0,2325(2,25)** | 0,01318(1,03) | 0,02 |

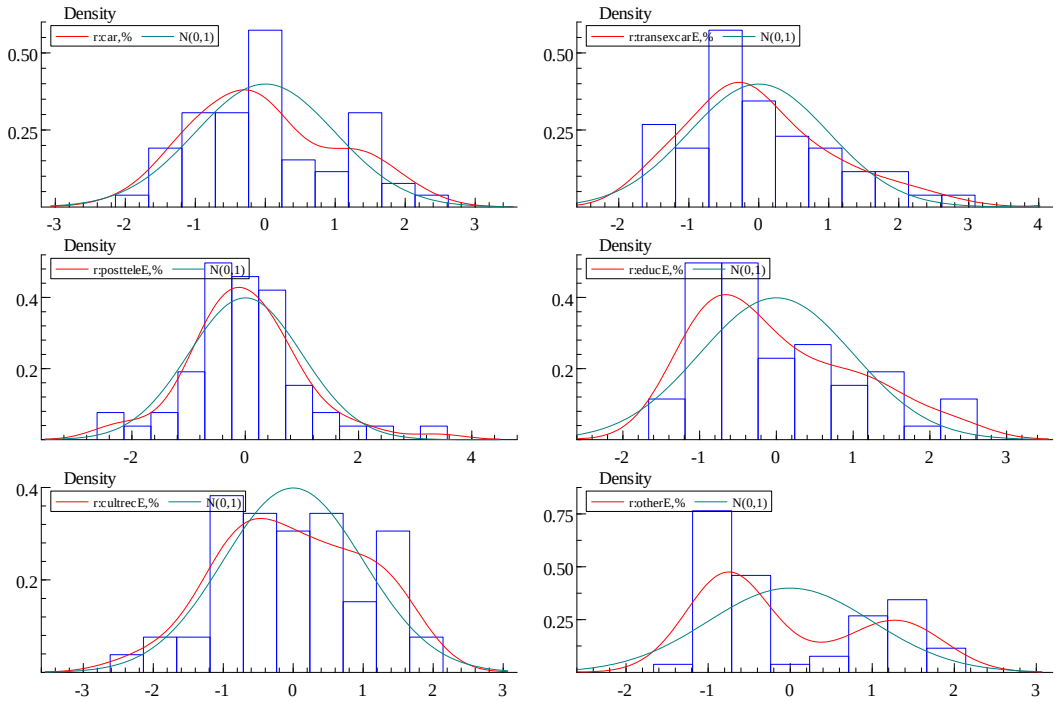
Source: Author

Figure 13: Density of residuals, equation 1 - 6




Source: Author

Figure 14: Density of residuals, equation 7 - 12

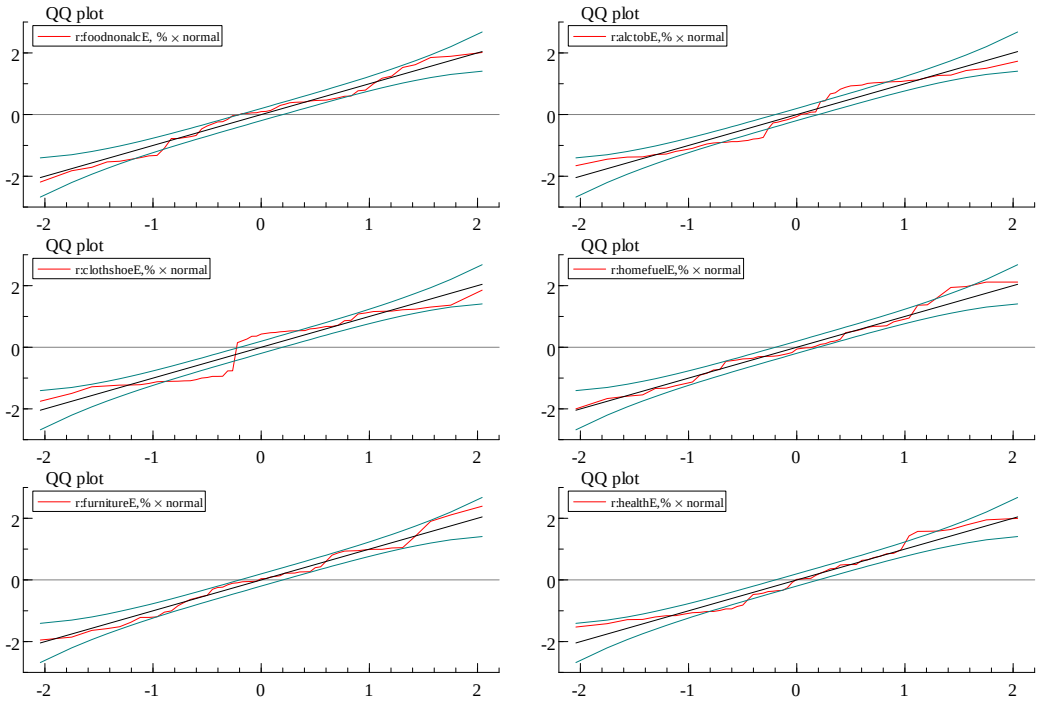



Source: Author

Even though the distributions do not exactly match those of an $N \backsim N(0,1)$ distribution, the mean of all residuals are zero. The different shapes of the distributions are a result of too few observations.

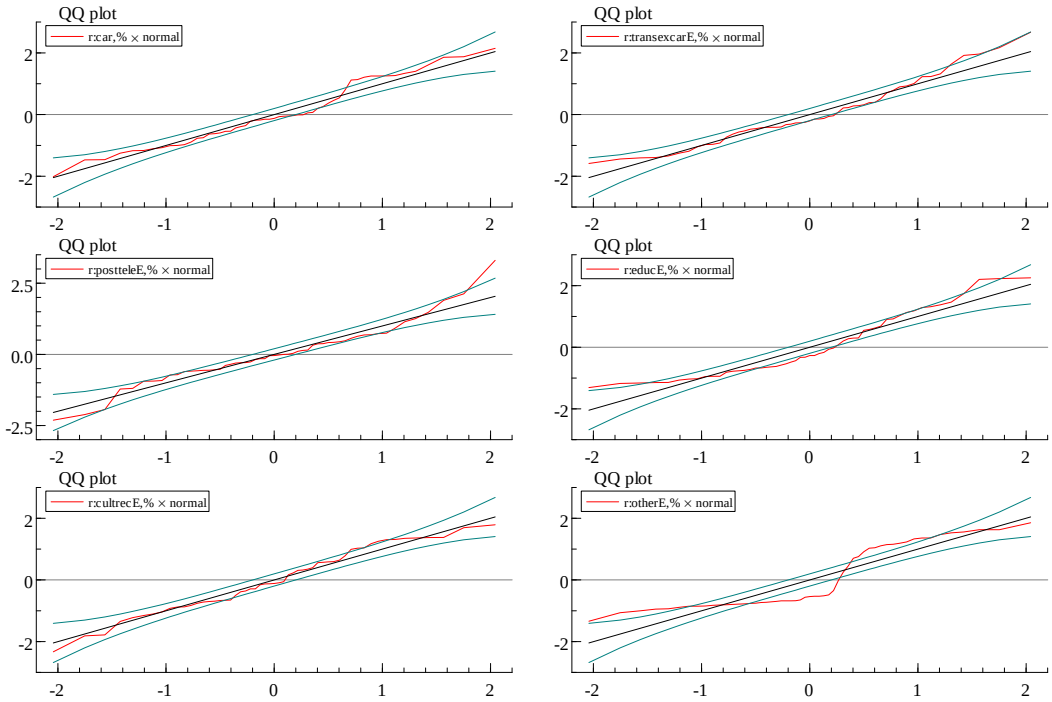
The relationship between the distribution of residuals and an $N(0,1)$ distribution can also be illustrated by QQ-plots - plotting the different quantile values of a $N(0,1)$ with the corresponding values of the predicted distribution. This is a useful non-parametric approach to compare the distributions of residuals with that of a normal distribution with mean zero and standard deviation 1. The bands represent the 95% confidence interval.

Figure 15: QQ-plot equation 1 - 6




Source: Author

Figure 16: QQ-plot, equation 7 - 12




Source: Author

We see that in most cases we are within the 95% confidence interval of the normal distribution. The QQ plots indicate however that a typical (and very predictable) phenomena of the estimated distributions is that mass is moved towards each tail. This is again likely to be a consequence of few observations.

# C More on the estimation of the ABLM-model

This appendix contains more information with respects to the ML-estimation of the minimum quantity parameters in chapter 3.4. The system was also estimated by OLS without producing different conclusions.

Counties will be referred to as numbers in the graphs, as will equations, and the number-county mapping is

Table 23: Counties and numbers

| County | Number |
|---|---|
| Østfold | 1 |
| Akershus | 2 |
| Hedmark | 3 |
| Oppland | 4 |
| Buskerud | 5 |
| Vestfold | 6 |
| Telemark | 7 |
| Aust-Agder | 8 |
| Vest-Agder | 9 |
| Rogaland | 10 |
| Hordaland | 11 |
| Sogn og Fjordane | 12 |
| Møre og Romsdal | 13 |
| Sør-Trøndelag | 14 |
| Nord-Trøndelag | 15 |
| Nordland | 16 |
| Troms | 17 |
| Finmark | 18 |
| Oslo | 19 |

Source: Author

The coefficients from the estimation of (17) are given in table 24.

Table 24: Complete estimation results of (17)

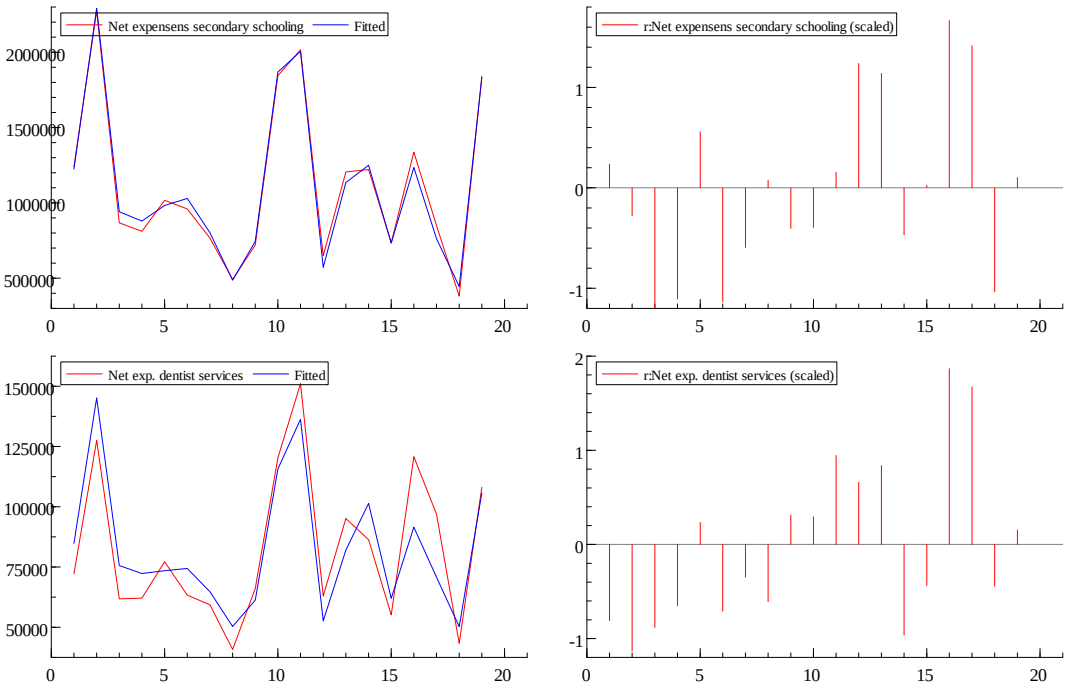
| | Equation 1 | Equation 2 | Equation 3 | Equation 4 |
|---|---|---|---|---|
| Children, aged 16-18 | 112.056 | | | |
| | [23.8]*** | | | |
| Children, aged 0 - 17 | | 0.802*** | | |
| | | [3.58] | | |
| Institutionalized patients | | 7.44* | | |
| | | [2.10] | | |
| Population | | | 6.183*** | 0.175** |
| | | | [4.09] | [3.07] |
| Population density | 688.756*** | - | 16834*** | - |
| | [4.04] | - | [14.6] | - |
| Share of population with at | - | - | - | - |
| least three years of higher ed | - | - | - | - |
| Average wealth tax. | -47.93*** | - | - | - |
| | [-3,51] | - | - | - |

Source: Author
t-statistics in brackets. ***, ** and * denotes $p<0.01$, $p<0.05$ and $p<0.1$ respectively. Insignificant variables are replaced with -.
Equation 1: Net. expenditures to secondary schooling, 1000 kroner
Equation 2: Net. expenditures to dentist services, 1000 kroner
Equation 3: Net. expenditures to administrative services, 1000 kroner
Equation 4: Net. expenditures to culture, 1000 kroner

As we see, population density increases both the cost of secondary schooling and admininistrative services by relatively much. I suspected this is biased, because of Oslo which, with a high amount of individuals and a low area, is somewhat of an outlier. Since I am most interested in the minimum quantity parameters, this is not vital for my analysis, unless it influences the estimate of the relevant parameters. To correct for this, I estimated (17) with the log of population density. It did not alter the minimum quantity parameters.

Except for the negative impact on expenditures to secondary schooling that the average wealth tax has, I find little effects of variables likely to reflect heterogenous taste.

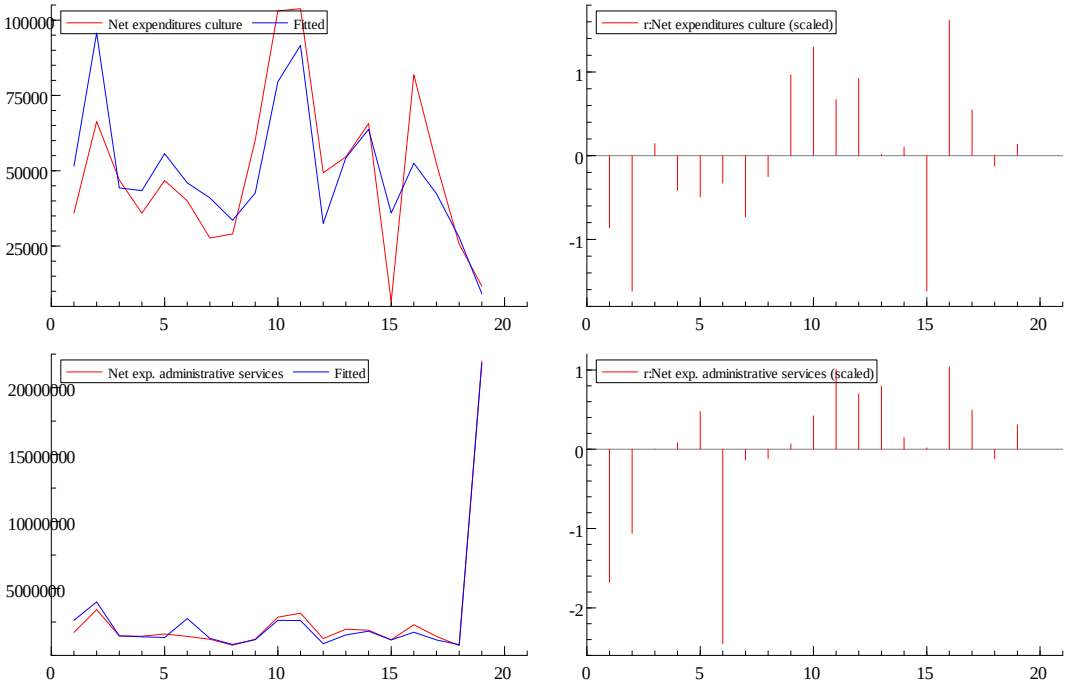
Figure 17: Predicted versus actual values




Source: Author

The figure above shows the actual and fitted values for the equations characterizing the minimum quantities in the dentist and secondary schooling equations. Note that the values on the y-axis is absolute spending in 1000 kroner, not per capita terms. On the right hand side, the corresponding residuals (scaled according to standard deviations) are shown. As we see, the best fit is when modelling secondary schooling expenses, where most residuals are below 1 standard deviation. When modelling net expenditures to dentist services, the deviations for each observation is somewhat bigger.

Figure 18: Predicted versus actual values

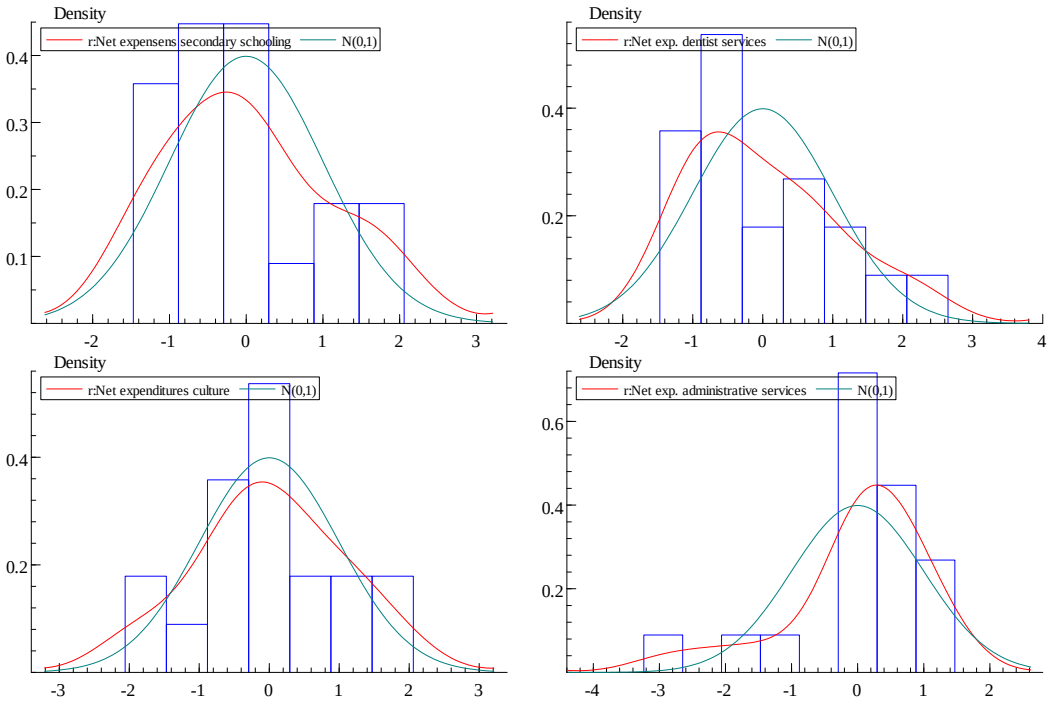



Source: Author

When modelling net expenditures related to culture and net expenditures on administrative services, predicated and actual values match fairly well, with most deviations being less than one standard deviation.

We can get a sense of how the zero-expectation criteria is met by plotting densities of the residuals relative to a $N(0, 1)$ distribution. This is shown below.

Figure 19: Density of residuals

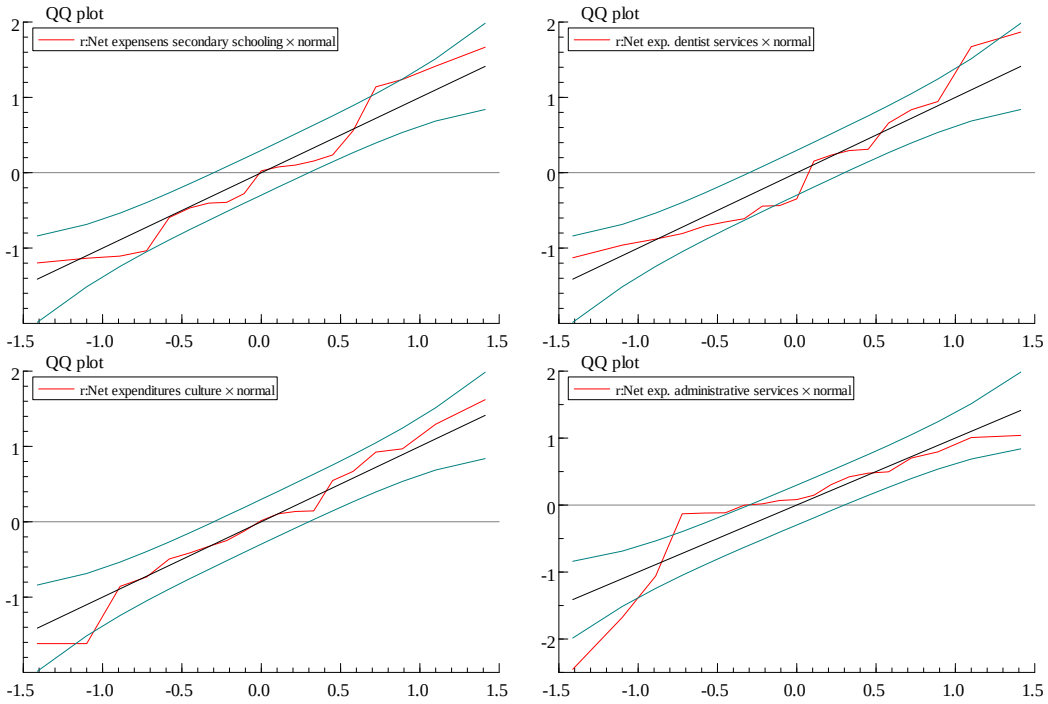



Source: Author

Taking the mean of the error term I find that all the average residuals are zero. We can see however, that the distribution is not $N(0,1)$. This is probably caused by having only 19 observations.

The corresponding QQ plots of the residuals are shown in figure 20.

Figure 20: QQ-plots



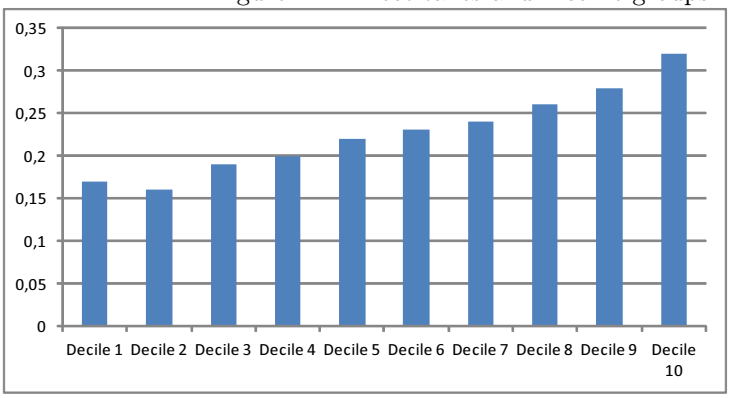

Source: Author

The QQ plots indicate that, while the two distributions are obviously related, the observed distribution adds more mass to the tails than a normal distribution, just as in appendix B. It should again be emphasized that the observed distribution is generated from 19 observations however, thus the difference is likely to arise.

# D Intermediate results

## D.1 Income groups and the various taxes as share of income

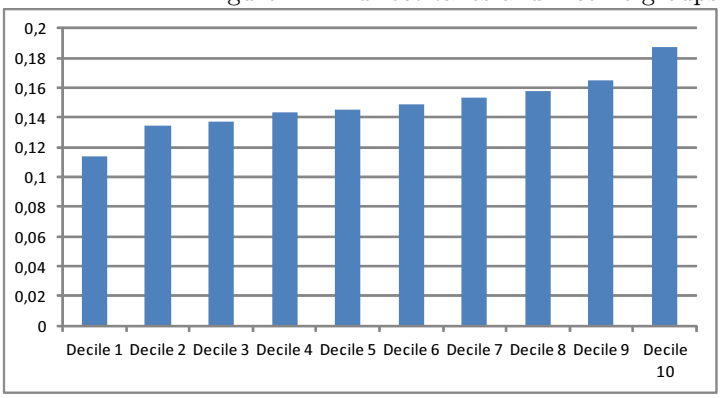
Figure 21: Direct taxes and income groups




Source: Author

Except for the predictable progressive pattern across most income deciles, we observe that the lowest decile paid higher direct taxes than the second lowest. Some of this is attributed to the fact that the lowest income decile comprises of wealthy individuals who have low or zero taxable *income*. They still pay a large sum in wealth taxes, thereby making the direct tax rate high on average. It should therefore be kept in mind that the lowest income decile, if we had removed these wealthy individuals, would most likely have had paid a substantially lower tax rate. Therefore, the results above is somewhat distorted if we interpret the income distribution as a direct representation of the relative welfare of poor(er) vs. rich(er). The income distribution is not wealth-adjusted.

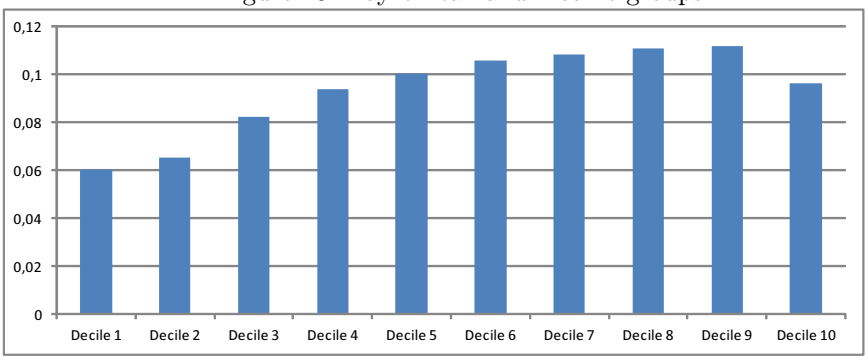
Figure 22: Indirect taxes and income groups




Source: Author

The distribution of indirect taxes is largely progressive. This is caused by varying consumption patterns across the income groups.

Figure 23: Payroll tax and income groups



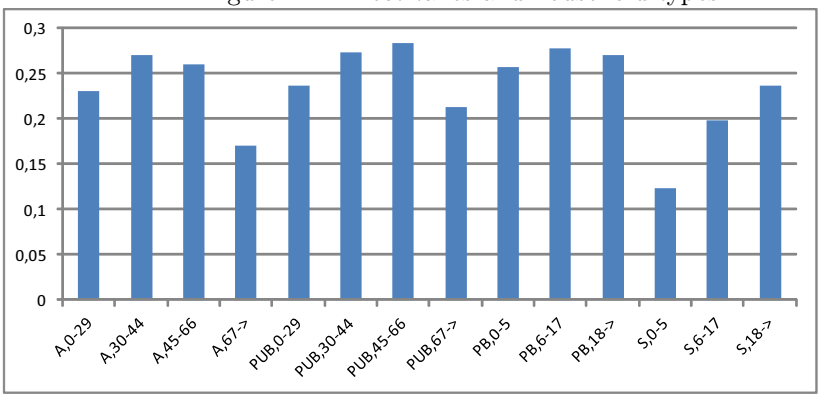

Source: Author

The distribution of the payroll tax is dependent on the composition of income. As we move up along the income distribution, labor income becomes increasingly important, and thus increases the payroll tax rate. However, for the richest decile, the payroll tax rate decreases. This is caused by the fact that capital income comprises of a larger share of their income relative to the other income groups.

## D.2 Various taxes as share of income and household types

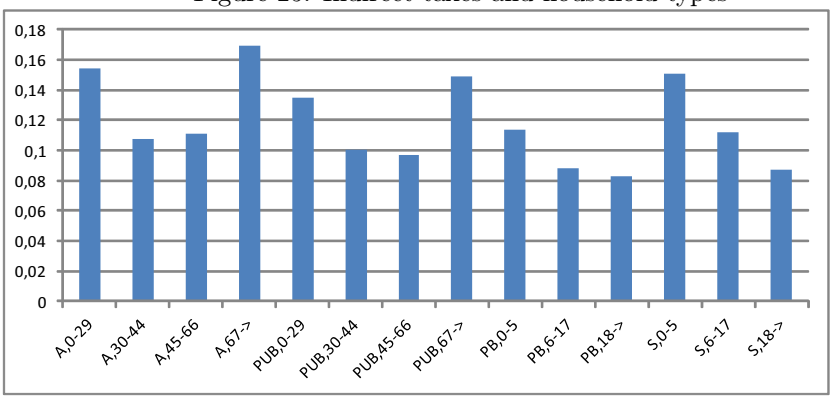
In addition to being a function of the level and composition of income as well as consumption patterns, total taxes is also dependent on the household type.

Figure 24: Direct taxes and household types



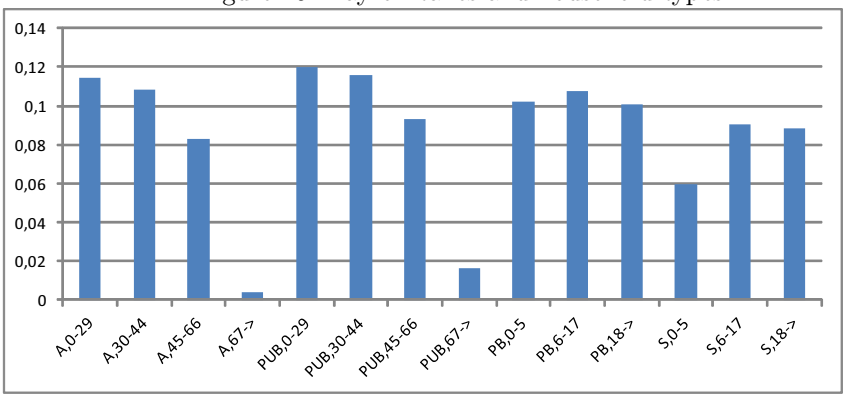

The direct tax rate varies largely across household types, with single parents with kids in the age 0-5 paying the lowest direct tax rate and couples without children pay the highest direct tax rate, both on average, with 12-13% and 28-29% respectively.

Figure 25: Indirect taxes and household types




Indirect taxes vary with consumption patterns, and one interesting observation is that these taxes are regressive in the sense that the "weakest" groups identified above are the ones paying the highest tax rate. Since consumption consists of many necessities adjusting slower than income, typical low income group such as retirees and single parents will face rather high indirect tax rates, relative to their income.

Figure 26: Payroll taxes and household types




Not surprisingly, low employment groups such as the retiree-abundant types pay a low payroll tax while groups with high employment rate pay a higher payroll tax on average. In addition to expected employment, the payroll tax rate is a function of sources of income and the geographical distribution of the various household types.

# E A brief review on the literature of fiscal incidence[17]

Research studying fiscal incidence including public goods began to emerge in the 1940s. One of the first, seminal works came with Barna's [6] study of the UK economy. Barna identified substantial income redistribution through the fiscal budget, far larger than what would have been observed if tax and transfers progressivity alone had been investigated. Barna's methodology has since become a conceptual framework for undertaking studies related to the topic.

In the 50's, other studies ([**?**, 37, 10, 12]) all developed the framework for fiscal incidence studies further, utilizing the emergence of more coherent, general datasets. In the 60's came two seminal papers ([19, 7]) by, respectively Irwin Gillespie and George Bishop, critizing the previous literature and calling for a revamp of the methodology used. Gillespie's critique was related to the limited scope of incidence analyses, while Bishop conducted an analysis using a representative household for the economy.

Aaron & McGuire [33] also provided a seminal critique of the methodology used in earlier studies and called for a more coherent way to combine theory with empirical methodology. Paying especially focus on public goods valuation, Aaon & McGuire offered a methodolgy of matching the theoretically correct valuation of public goods (the true willingness to pay) with empirical moments. This article, in addition to two later articles by Shlomo Maital ([29, 30]) divided the field into two camps. The first camp continued the traditional "cost of service" approach to incidence analysis. This methodology measures tax burdens and public good distributions according to how much it generates in terms of revenue, how much various services costs and which population units are likely to utilize them. The sources of tax revenue and the recipients of public spending are then identified and the taxes and expenditures are allocated accordingly. The second camp focused more on the "behavioral" approach, seeking to look at more normative implications of the fiscal system.

Notable, and more recent studies, containing similar methodology as used in this thesis is [31, 8, 18, 20, 27, 41, 11]. In addition to [11], a substantial survey of similar studies, as well as an excellent discussion of methodology, can be found in [14]. For studies incorporating the fiscal incidence effect on the income distribution and poverty, see [2] and citations within.

[17] For simplicity, I refer to each reference as its number in the reference list.