The Shadow Economy of Finland: The Effect of the Reverse Value-Added Tax on Reported Revenue and Deductions

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Abstract

The shadow economy, which is sometimes referred to as the underground or the hidden economy among a number of other terms, remains quite a controversial topic in economics research. This paper presents current research on the shadow economy. In the empirical section I study the effect of a tax policy change in the construction industry.

Loosely the shadow economy can be defined as the combination of both legal and illegal transactions, both monetary and non monetary, that contribute to the gross national product but are unregistered. Thus the definition includes but is not limited to prostitution, drug dealing as well as manufacturing, and tax evasion. Companies that deal in legal goods and services, but fail to report their transactions and incomes to the tax authorities, can mean a loss of tax revenue for the government. However these losses are easy to overestimate. Even though the shadow economy clearly can have many undesirable effects on society, some of the estimates may be influenced by external or political factors.

The literature review presents commonly used methods for estimating the shadow economy and why some of them should be avoided. In addition I present current estimates of the shadow economy of Finland. I also discuss the implications of recent tax gap estimations by the IMF.

In the empirical section I attempt to estimate the effect of a reverse Value-Added Tax (VAT) policy reform in the construction industry on reported revenue and deductions in periodic tax returns. I use an autoregressive model with exogenous variables. Assume that the reform is discovered to have had an effect on reported revenue and/or deductions. Then the possible difference between an increase in reported revenue and deductions could be interpreted as an increase of the tax base in the industry. Finnish Tax Administration have hypothesized in 2012 that reported revenues may have increased after the reform.

The effect is estimated by studying the significance of a dummy variable indicating the reverse VAT reform on reported revenue and deductions. In addition I estimate reported revenue using a pure autoregressive model and compare forecasted values to actual observations. A systematic positive difference between actual observations and forecasted values may provide evidence that reported revenues have increased after the reform. In addition I estimate the difference between an estimate that includes the dummy and one that does not. However this method does not appear to be feasible for studying the effect of the dummy.

My data set is a collection of monthly observations of reported revenue by industry starting from 01/1999 and ending in 09/2015. The variable I am interested in is called lv Kotimaa (previously vermyper) which is a sum of all taxable revenue in Finland. It includes sales at di↵erent VAT rates as well as sales that are subjected to the reverse VAT (lv RakenPalvMyynti). I have restricted my analysis to the sector S11 i.e. the private sector for simplicity. The data was aggregated from actual periodic tax returns.

No evidence to support the hypotheses that reported revenue or deductions have increased after the reform is discovered. The dummy is discovered to be a significant explanatory variable in Civil Engineering at the 90% confidence level. However the Chow test of structural change is highly significant for break points in early 2011. This suggests that the model is unreliable due to a structural change in the time series. No systematic prediction errors of reported revenue are discovered using the pure autoregressive model.

Keywords
Shadow Economy
Times Series Econometrics
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Construction
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Tiivistelmä

Piilotalous on kiistanalainen tutkimuskohde taloustieteen alalla. Tämä tutkielma esittelee aiheeseen liittyvää kirjallisuutta ja tutkii veromuutoksen mahdollisia vaikutuksia piilotalouteen rakennusalalla.

Piilotalous voidaan määritellä transaktioiksi, jotka kontribuoivat bruttokansantuotteeseen, mutta niitä ei havaita tilastoissa. Piilotalouden osia ovat sekä harmaa- että laiton talous. Valtio voi menettää verotuloja niiden yritysten kohdalla, jotka myyvät laillisia tuotteita, mutta eivät raportoi toiminnastaan veroviranomaisille. Nämä menetykset on kuitenkin helppo yliarvioida. Ilmiöllä voi olla monia haitallisia vaikutuksia kansantalouteen. Kuitenkin osa piilotalouden koon arvioista on mahdollisesti harhaanjohtavia.

Kirjallisuuskatsaus esittelee yleisesti käytettyjä metodeja piilotalouden koon arvioimiseen kansantalouden tasolla sekä miksi joitakin niistä ei tulisi käyttää. Esittelen tuoreita estimaatteja piilotalouden koosta Suomessa. Lisäksi esittelen tuoreita IMF:n arvioita Suomen arvonlisäverovajeesta.

Empiirisessä osiossa tarkastelen käänteisen arvonlisäverovelvollisuuden vaikutuksia rakennusalan kausiveroilmoituksissa. Tutkin ovatko ilmoitetut liikevaihdot tai verovähennykset kasvaneet veromuutoksen jälkeen hyödyntäen autoregressiivistä mallia eksogeenisillä muuttujilla. Mahdollinen ero liikevaihtojen ja vähennysten kasvun välillä voi implikoida, että toimialan veropohja on laajentunut. Verohallinto on arvioinut vuonna 2012, että ilmoitetut liikevaihdot ovat mahdollisesti kasvaneet veromuutoksen jälkeen.

Tutkin ilmiön vaikutusta tarkastelemalla dummy-muuttujan merkitsevyyttä. Dummy kuvaa käänteisen arvonlisäverovelvollisuuden käyttönottoa huhitkuusta 2011 alkaen. Lisäksi estimoin aikasarjamallilla ilmoitettuja liikevaihtoja ja vertaan ennustetta toteutuneisiin ilmoituksiin. Jos malli tuottaa systemaattisen posiitivisen ennustevirheen, voidaan ajatella, että liikevaihdot ovat mahdollisesti kasvaneet veromuutoksen jälkeen. Lisäksi tutkin kahden sovitteen eroa, joista toinen sisältää dummy-muuttujan. Vaikuttaa kuitenkin, että tämä metodi ei sovellu dummyn vaikutuksen tarkasteluun.

Käytössä oleva data on kuukausittaisia havaintoja alkaen tammikuusta 1999 ja päättyen lokakuuhun 2015. Luvut ovat aggregoitu kuukausitasolle kausiveroilmoituksista. Muuttuja lv_Kotimaa sisältää veronalaisen myynnin eri arvonlisäverokannoilla sekä rakennuspalvelujen myynnin, joihin sovelletaan käännettyä arvonlisäverovelvollisuutta. Analyysi on rajoitettu koskemaan yksityistä sektoria S11.

Evidenssiä sille että liikevaihdot tai vähennykset olisivat kasvaneet veromuutoksen jälkeen ei löydy. Dummy on merkitsevä selittäjä 90% merkitsevyystasolla toimialla Maa- ja Vesirakentaminen. Chow testi on kuitenkin alkuvuodesta 2011 hyvin merkitsevä, joka indikoi, että aikasarjassa on tapahtunut jokin rakenteellinen muutos, joka tekee mallista epäluotettavan. Systemaattisia ennustevirheitä ei havaita tai ne ovat erittäin pieniä.

Avainsanat
Piilotalous
Harmaa talous
Käänteinen arvonlisävero
Aikasarjaekonometria
Verovaje
Kansantalouden tilinpito
Rakentaminen

Contents

1 Introduction

The shadow economy, which is sometimes referred to as the underground or the hidden economy among a number of other terms, remains quite a controversial topic in economics research. We still do not have a universally accepted definition for the phenomenon and estimates for e.g. Finland range from circa 1.5 % of GDP to over 15 % of GDP (Viren 2013). This paper presents current research on the shadow economy. In the empirical section I study the effect of a tax policy change in the construction industry. In addition I discuss the implications of recent research on the size of the shadow economy of Finland.

Loosely the shadow economy can be defined as the combination of both legal and illegal transactions, both monetary and non-monetary, that contribute to the gross national product but are unregistered (Schneider and Enste 2000). Thus the definition includes but is not limited to prostitution, drug dealing plus manufacturing, and tax evasion. Typically the definition used includes both the illegal economy and what we call the *grey economy* in Finnish. The definition that has been used by OECD (2002) is called the Non-Observed Economy, which also includes household production for their own use.

Consultants to the Parliament of Finland Hirvonen et al. (2010) produced a report on the shadow economy of Finland, where they defined the shadow economy as wages not reported to the tax authorities, which they call the *fiscal* shadow economy. Their definition includes capital gains not reported to the tax authorities, which they argue others do not. A number of other criticisms towards the report and its results have been raised by economists in Finland.

The Hirvonen et al. (2010) report and its methods have been heavily criticized by e.g. Viren (2013), who argues that since they aggregate the results of clearly non-random tax audits to the whole economy, the results are significantly overestimated due to selection bias. It is probably the case that if they had included the illegal economy in their estimates, the estimate would have been even higher. However it should be noted that some of the differences can possibly be explained with the fact that this report includes untaxed capital gains in their estimations, which are typically not included. OECD (2002) states that capital gains tax evasion is by definition not a productive activity and thus it is not included in the GDP.

There are plenty of reasons for economists to be interested in the shadow economy. Companies that deal in legal goods and services, but fail to report their transactions and incomes to the tax authorities, mean a loss of tax revenue for the government (Schneider and Enste 2000). However these losses are easy to overestimate.

This is partly because operating margins in fields that are typically associated with a high degree of informality, such as construction and restaurants, are on the low side. Thus even a small increase in costs would likely drive many of the affected businesses to bankruptcy (Viren 2015).

Schneider and Enste (2000) argue that one strategy for the government to try to decrease the size of the shadow economy is to introduce new regulation. Logically this can mean challenges for the companies that comply with regulations and this increase in regulation can lead to less choice and/or higher prices for the consumers.

Additionally people employed in the shadow economy can cause a strain on the welfare system and decrease labour market participation. Imagine that someone is earning unreported income in distribution of drugs or working in construction. Because this income is unreported and thus does not exist in the eyes of the unemployment office, this person can keep on claiming social security benefits while earning an income. This means that the true income of a person working in the shadow economy is higher than just the benefits they are receiving.

Thus taking a position in the formal economy might actually decrease his/her income even if the job pays more than the unemployment benefits are. This clearly creates bad incentives in the labour market. Also labour market laws are most likely not very well enforced in the shadow economy and there is potential for exploitation of labour in workplaces that do not comply with regulations.

In addition to labour market violations, a high shadow economy can also increase crime in other areas of society. Because participants in the shadow economy cannot turn to the judiciary system to settle their disagreements or increase marketing in order to capture more market share, they have to turn to violence (Miron 2012). Miron also argues that since people are breaking the law by dealing in illegal goods and services, the threshold for breaking other laws is reduced, since these people are already breaking the law to begin with.

Even though the shadow economy clearly can have many undesirable effects on society, some of the estimates may be influenced by external or political factors. Tanzi (1999), who incidentally is one of the earliest contributors to the field and has since become very critical of the large estimates produced by methods he himself has brought forward, has written about such incentives and how some of them are relevant for European countries.

Countries in the European Union (EU) may have an incentive to overestimate their GDP in order to meet the Maastricht Criteria with regards to budget deficits and debt-to-GDP ratio. [1] Countries might also want to underestimate their shadow economy and thus their GDP in order to lower their financial contributions to the EU, which are based on the size of the countries' GDPs (Tanzi 1999). In addition the Stability and Growth Pact of the EU limits the size of public debt in relation to a country's annual GDP. Thus if a given country estimates their shadow economy to be relatively large, then ceteris paribus this will decrease the debt-to-GDP ratio of that country. The estimated shadow economy is added on top of observed production in the national accounts since they are included in the production boundary and thus the GDP (ESA 2010).

There are other political incentives to promote a high estimate of the shadow economy. Takala and Viren (2012) write that politicians could promise that instead of cutting public services, the fiscal deficit in e.g. Finland could be brought down by assigning more resources to decreasing the shadow economy. This is based on the assumption that there exists significant unreported production in the economy

[1] The Maastricht Criteria are five economic criteria set in 1992 that an EU member state is required to comply with i.a. in order to join the Eurozone

that the government could start taxing if only they had the resources to do so. If the lawmakers make decisions based on a potentially biased estimate produced with an inappropriate method, they can end up misdirecting scarce resources and promoting potentially harmful economic policies that can have long-lasting effects on the national economy.

Banks and credit card companies have an incentive to promote high estimates as well. The government could start to discourage cash use in order to hamper shadow economic activity, which banks naturally hope will mean an increase in cash deposits. Credit card companies like VISA even fund some of the research on shadow economy, such as Schneider and A. T. Kearney (2013), because they would naturally like to see an increase in credit card usage. The logic here is that cash is being used to fund transactions in the shadow economy and thus reducing cash use is beneficial for society.

Overall the topic remains controversial. Comparing different estimates is troublesome, because of a variety of definitions being used and the huge differences in results due to the different methods available to researchers.

This paper reviews recent literature on the topic and defines the shadow economy as productive activities that are included in the production boundary of national accounts as defined by ESA (2010). Activities such as theft or capital gains tax evasion are not productive activities and as such are not included in the production boundary.

The literature review in section 2 discusses in detail why certain popular econometric methods are not appropriate for estimating the shadow economy of Finland. There are other methods available as well, but these two have been used a lot and thus are discussed here. These indirect methods and the estimates they produce have been under heavy criticism (see e.g. Tanzi 1999; Breusch 2005; Ahumada et al. 2007; Ahumada et al. 2008; Takala and Viren 2010). In fact OECD (2002) has suggested that such methods should be disregarded as unreliable.

The issue of tax compliance is also discussed in the literature review. When the tax rate of a given good or service changes, a company not declaring the right amount of taxes can sometimes be an honest mistake instead of being purposeful in order to hide economic activity. Through this example I also introduce some of the more recent papers like Kosonen and Ropponen (2013) that study tax compliance using field experiments.

In section 3 I review some of the most recent estimates for Finland in more detail. In addition I perform fresh calculations on the percentage of shadow economic activity in Finland by industry. I discuss new tax gap estimations by the IMF and the Finnish Tax Administration Vero. While these estimations are inherently uncertain, my argument is that since these estimations are being done by the IMF and they are at the disposal of economists, the use and applications of the potential VAT estimates should be studied further. The same argument was brought forward by Erard (2002) with regards to operational audit data collected by tax administrations.

In sections 4 to 6 I attempt to estimate the effect of the reverse Value-Added Tax (VAT) policy reform in the construction industry on reported revenue and deductions in periodic tax returns. Imagine that the reform is discovered to have had an effect on reported revenue and/or deductions. Then the possible difference between the increase in reported revenue and deductions could be interpreted as an increase of the tax base in the industry. I use monthly time series data aggregated from periodic tax returns in the construction industry. In section 7 I discuss the implications of my findings and section 8 concludes the paper.

2 Literature review

This section covers methods that have been previously used or could be used for studying the shadow economy. I describe a method of using operational audit data for extrapolating whole population estimates of tax noncompliance. This method requires the use of operational audit data collected by tax administrations, which may be difficult to obtain. However since operational audit data flow is continuous, this may be the most promising method available at present.

2.1 Commonly used methods

2.1.1 The currency method

One of the commonly used method for estimating the size of the shadow economy is called the *currency method*. This method assumes that transactions in the shadow economy are paid using cash. In order to estimate the size of the shadow economy, one must first estimate the demand for cash after accounting for all official registered transactions in the economy.

Schneider and Enste (2000) present the regression for estimating the demand for currency in its basic form as:

$$ln(C/M_2) = \beta_0 + \beta_1 ln(1+TW)_t + \beta_2 ln(WS/Y)_t + \beta_3 lnR_t + \beta_4 ln(Y/N) + u_t \qquad (1)$$

where $\beta_1 > 0$, $\beta_2 > 0$, $\beta_3 < 0$, $\beta_4 < 0$.

In the above equation C/M_2 denotes the amount of cash holdings relative to M_2[2], TW is the weighted average tax rate, WS/Y is the share of wages and salaries and national income Y, R signifies interest paid for savings deposits, and finally Y/N is per capita national income.

The idea of the currency method is that the demand for currency, i.e. the increase of cash in circulation, that cannot explained by the above equation, is assumed to go into transactions in the shadow economy. Then by simply multiplying that number with the velocity of money, which is typically assumed to be equal for both the shadow and the official economy, one obtains the size of the shadow economy.

[2] M_2 is the amount of cash in circulation plus non-interest bearing bank deposits, cheques etc.

This method has been under a lot of criticism. For example Thomas (1999) points out that the most problematic assumption that needs to be made in order for the method to work is that a year must be chosen when the shadow economy was zero and all currency was demanded for transactions in the legal economy.

This same problem was later pointed out by Ahumada et al. (2008), who refer to the assumption as the problem of initial conditions. They argue that the only way to get rid of the need for initial conditions is base all estimations on long-run estimates for cash demand. Nonetheless the method remains very problematic.

This assumption of initial conditions does appear to be unrealistic. It implies that in some period in the past we inexplicably experienced extremely large growth of the shadow economy from 0 % of GDP to some number > 0 % of GDP and that there was a time in the past when the shadow economy was nonexistent. Thomas (1999) also points out that a proportion of the currency demand should go into savings and not all demanded currency is in fact spent.

Thomas (1999) demonstrates the problem of initial conditions through an example of a study on the unobserved economy of the UK by Fiege (1981). In this study the base year is 1960 and thus it implies that in 1960 the shadow economy was 0 % of GDP, which then grew to around 6 % of GDP in 1961, reached its peak in 1974 at 22 % of GDP before falling back to 14 % of GDP in 1975. The problem, according to Thomas, is that it is extremely unlikely that such fluctuations in the economy could go unnoticed and he asks what is the implication for policy makers.

Takala and Viren (2010) list multiple reasons that could explain the recent increase in cash demand in the eurozone that have little to do with the shadow economy. First of all since we have experienced a period of low interest rates, cash could simply have become a more appealing asset, because it has a lower opportunity cost than if interest rates were higher.

They also argue that the financial crisis that started in 2008 has led to cash flight from banks. Other reasons include the fact that not all households in the eurozone have access to banking services and the fact that cross-border trade has increased and some of it occurs in cash. Additionally the eurozone is particularly affected by currency substitution [3] (Takala and Viren 2010).

Ahumada et al. (2007) argue that within the currency method there are internal inconsistencies that stem from the velocity of money assumption. They write that this assumption is only valid if income elasticity for cash demand equals one. Thus estimations produced with the currency method implicitly assume that this elasticity indeed equals one. Breusch (2005a) on the other hand has argued that this velocity is assumed to be too high and that if an appropriate value was used, the estimates would decrease significantly.

[3] This means that the Euro is being used as a medium of exchange outside the eurozone.

2.1.2 The MIMIC method

Another popular method is called the structural equation method or the *MIMIC* (Multiple Indicator Multiple Cause) method. In this method there are two kinds of observed variables; "causal and indicator, which are connected by an unobserved shadow economy index" (Breusch 2005b).

Both of these models can be generally referred to as indirect methods that try to estimate the shadow economy using a single model. These methods "tend to produce spectacularly high measures, which attract much attention from politicians and newspapers" (OECD 2002).

One paper that presents the MIMIC method in detail and uses it to estimate the shadow economy of Portugal from 1977 to 2004 is Dell'Anno (2007). His model contains two indicator variables and six cause variables. The model can be written as:

$$\eta = \alpha + \gamma_1 X_1 + \gamma_2 X_2 + \gamma_3 X_3 + \gamma_4 X_4 + \gamma_5 X_5 + \gamma_6 X_6 + \zeta \tag{2}$$

where η is the shadow economy index i.e. the latent variable and X_q are the six cause variables that are explained in Figure 1.

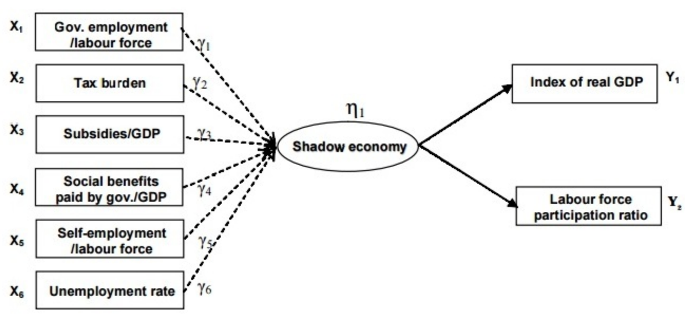

Figure 1: The MIMIC Model (Dell'Anno 2007)

As Figure 1 explains the two indicator variables are real GDP Y_1 and labour force participation Y_2. They are defined as:

$$Y_1 = \delta_1 + \lambda_1 \eta + \epsilon_1 \tag{3}$$

and

$$Y_2 = \delta_2 + \lambda_2 \eta + \epsilon_2 \tag{4}$$

For a more detailed explanation on the reasoning behind these cause variables were chosen and further definitions please refer to Dell'Anno (2007) pp. 258-263.

The MIMIC method has been heavily criticized by Breusch (2005a, 2005b). The method has its origins in psychometrics and Breusch (2005b) argues that agents in the shadow economy, unlike participants in a psychometric study, have a clear incentive to cover up their actions in order to avoid detection. This makes the activity extremely difficult to measure.

Additionally Breusch (2005a) writes that since the size of the shadow economy must be a well defined number i.e. illegal income has to be measured the same way as legal income, there is no room for interpretation or scaling estimates up or down, which makes the method unfit for purpose.

In the case of Dell'Anno (2007) the indicator variables Y_1 and Y_2 are supposed to measure the same latent variable η that are then scaled up, which is not possible given the characteristics described above. It also appears to be the case that the method requires the indicator variables, like real GDP, and the cause variables, such as the unemployment rate, are only related to each other through the shadow economy index, which seems highly unlikely (Breusch 2005b).

The MIMIC method is more or less a more complex version of the currency method. Both of these methods attempt to estimate a very complicated phenomenon using a single model and/or index and should generally be avoided (OECD 2002). Likewise both methods produce intuitively high estimates at least in the case of Finland (Viren 2013). Thus based on the extensive critique reviewed above, both methods are rejected for the purposes of this paper.

2.1.3 Direct estimation methods

The shadow economy could also be estimated with direct methods such as surveys or field experiments, which have their fair share of problems. Clearly there are a multitude of problems with surveys that ask questions about illegal activities. Participants have an incentive to lie and are generally thought to be reluctant to share information about laws that they have themselves broken (Schneider and Enste 2000).

Challenges in conducting surveys are related to formulating the questions so that the anonymous participants would not have to reveal any self-incriminating details. For the purposes of this paper such surveys are also disregarded due to time and resource constraints. Field experiments are a very appealing method and could provide very interesting results in the near future (Kosonen and Ropponen 2013), but the same resource constraints apply with regards to this paper.

Statistics Netherlands have studied the supply of labour in the underground sector using a mixed-mode survey, which means that a combination of face-to-face, online, telephone, and paper questionnaires were conducted. Face-to-face questionnaires had the best response rate at 61 % and also the largest share of respondents that admitted to having done undeclared work at 7.6 %. However face-to-face surveys were discontinued presumably due to the high costs of performing them and Statistics Netherlands continued to use online questionnaires.

The unrecorded wages captured by this survey sum up to 435 million euro, which is circa 0.1 % of GDP or 0.2 % of net household income. However no incomes of over 10000 euro were reported, which very likely implies that the estimate is downward biased. Out of 16-25 year olds 19.3 % admitted to having undeclared activities, while for 65-year-olds the number was 0 %.

Interestingly claiming social benefits was not one of the most commonly stated reasons for doing hidden work. 2.4 % of respondents stated claiming social benefits as a factor. This is contradiction to what I wrote earlier. The fact that one can lose their social benefits if they start work could lead to bad incentives in entering the official job market. However it is possible that this result is explained by differences in the social benefit structure between say the Netherlands and Finland. Or perhaps that the respondents do not have an incentive to answer truthfully.

The most common reasons were needing more disposable income (12 %) and wages being higher in the underground sector (20 %). Also 30 % of respondents stated that they would do hidden work if given the chance. The incidence was particularly high among young males working in a technical job or working in restaurants, hotels, and cafes. The perceived probability of getting caught was unsurprisingly an important factor in doing hidden work. If people believe there is small chance of getting caught they are more likely to participate in unlawful activities and vice versa.

Conducting field experiments or surveys can give valuable information on the causes of shadow economy. Kosonen (2014) argues that in fact the most important thing to know about the shadow economy is in fact not the absolute size. What we should focus on is where such activity is taking place, what it causes, and what could potentially be done to prevent it. Knowing these things would allow us to target resources of tax audits and policy reforms better.

2.1.4 National accounts approach

OECD (2002) describes how hidden activity can be measured from the national accounts using different indicators. The possible methods can be roughly divided into five subcategories; supply based, labour input, demand based, income based, and the commodity flow method. Additionally there are different industry specific methods available for researchers.

Generally this process is rather complex and many factors need to be taken into account (OECD 2002). Schneider and Enste (2000) argue that with regards to studying the difference between the expenditure and income measures in the national accounts, the problem is that these are typically not measured perfectly. According to them this makes estimates produced by such methods unreliable. However since estimating the shadow economy is by definition measuring something that is not directly observed, surely all methods available produce estimates with a high degree of uncertainty.

One such method was employed by the IMF (2015) in their attempts to estimate the Value-Added Tax Gap of Finland. Using data from a variety of sources including statistical input-out tables maintained by Statistics Finland and customs transaction data, they estimate the potential and actual VAT of Finland. These results can also be used to estimate unreported revenue in different industries as indicated by the VAT gap estimations. I cover the VAT gap more extensively in section 2.4.

2.2 Using operational audit data

A particularly interesting method of studying the shadow economy is the use of operational audit data collected by tax administrations. Erard (2002) describes a methodology where audited tax returns are combined with unaudited tax returns in order to try to get rid of the selection bias. The bias comes from the fact that tax audits in general are not performed at random, but rather they are being targeted towards companies where the auditors believe tax noncompliance to be high.

This could be due to previous irregularities discovered in audits or simply the fact that a given company operates in an industry where the authorities believe tax noncompliance to be high. It means that treating operational audit data as a random sample from the whole tax return population leads to selection bias.

Erard (2002) presents a methodology where a data sample containing s amount of returns that have been operationally audited and t > s amount of returns that have not been audited at all. First a likelihood for a given return to be audited is estimated. The likelihood is estimated by:

$$A* = \beta'_A X_A + \epsilon_A, \tag{5}$$

where A* is an index of the likelihood of an audit with X_a characteristics will be audited, ϵ_a is a normally distributed error term, and B_a is a vector of coefficients to be estimated. If the likelihood A* is > 0, it implies that a return has been audited.

In addition they allow correlation between the error term ϵ_a in (5) and error terms in equations estimating noncompliance. These correlations should be positive if there are problems with regard to unobserved characteristics of the audits. In other words returns that were selected for operational audits are likely to contain more noncompliance than unaudited returns as stated earlier. Thus by estimating these correlations, they can test hypotheses of selection bias and correct such bias by including the correlation terms in the noncompliance estimations.

Erard (2002) presents results of a study performed in the Chicago district using the methodology described above. The two different forms of noncompliance examined were under-reporting of business revenue and over-reporting of business expenses from self-employment. They disregarded the possibility of overpayments, because overpayments were uncommon in the data sample. Noncompliance is estimated as:

$$ln(R^* + D_R) = X_R \beta_R + \epsilon_R \tag{6}$$

$$ln(E^* + D_E) = X_E \beta_E + \epsilon_E, \tag{7}$$

where R is under-reporting of revenue, E is the over-reporting of expenses, X_r represents all recorded characteristics that could potentially increase under-reporting of revenue, X_e represents all recorded characteristics that could potentially increase over-reporting of expenses, and ϵ_a is the random error term of factors not recorded in X_e. D_r and D_e are estimated displacement parameters that influence the amount of mass under the displaced log-normal distribution where R=0 and E=0.

Noncompliance for two different business classes is estimated using the model specifications. The first is businesses with under 25,000$ in revenue and the second is businesses with 25,000$ < total gross receipts < 100,000$. The first sample consists of 221 audited returns and 911 unaudited returns while the second sample consists of 342 audited returns and 1336 unaudited returns.

The authors compare actual and predicted magnitudes of noncompliance in the returns and discover that the differences are very small. In this case the predictions seem accurate. Though predicting understated revenue is slightly less accurate than predicting overstated expenses. In the first class the model overpredicted revenue understatement by circa 7.7 % and in the second class the overprediction was circa 4.5 %. The results are summarized in the tables below:

Table 1: Revenue under $25,000 (Erard 2002)

	Understated revenue	Overstated expenses
Actual % of returns with:	17.2	54.3
Predicted % of returns with:	17.2	55.5
Actual mean amount of:	$1,365	$4,502
Predicted mean amount of:	$1,470	$4,492

Table 2: Revenue between $25,000 and $100,000 (Erard 2002)

	Understated revenue	Overstated expenses
Actual % of returns with:	21.1	62.3
Predicted % of returns with:	21.3	62.4
Actual mean amount of:	$3,920	$9,800
Predicted mean amount of:	$3,750	$9,s801

Kosonen (2014) writes that performing enough random audits for the purposes of shadow economy estimations is far too costly. The advantage of this method is that these audits are being performed as we speak and the data flow is continuous. Thus this data ought to be used for research (Erard 2002).

In my view this method is particularly well suited for estimating the amount of unreported business revenue and overstated expenses in Finland. By incorporating the data sample with a larger number of unaudited periodic tax returns on top of results from operational tax audits, whole population estimations could be extrapolated for different industries in Finland. The methodology could be used to double check whether or not current shadow economy estimations in the Finnish national accounts need revision. This is true if the estimations suggest that there is in fact unreported revenue in industries where we have previously shadow economy to be zero or close to zero.

2.3 Tax avoidance and compliance

One problem with measuring hidden economic activity is naturally the fact that not all taxes are left unpaid on purpose. Some of these are honest mistakes and thus should not be classified under the shadow economy.

Erard (1997) writes about the importance of tax compliance and critiques empirical research on the topic. He argues that in a situation where tax noncompliance is high among large tax contributors, the effective tax system is less progressive than thought. This results in an increase in inequality. This is true for both individuals as well as companies and in my view can result in an unfair advantage for large multinational companies that are able to afford expensive tax services such as transfer pricing in order to minimize their tax burden.

Kosonen and Ropponen (2013) designed a field experiment to study VAT compliance when there are changes in the tax system. They provided a randomly assigned treatment group information about the tax code with a questionnaire, while a randomly assigned control group was only given the questionnaire. This was related to the fact that the VAT rate was changed slightly a month before the experiment.

They discover that there is a 5 % point difference in mistakes made by the groups in favour of the treatment group. The result was statistically significant only with regards to the new and simple change of the VAT rate. This study does however illustrate that mistakes are being made in e.g. VAT reporting in Finland and that simply increasing the amount of information available to companies might lead to better compliance over all.

Thus the effective level of taxation depends not only on the law, but also on how well agents choose to comply with the regulations. The latter is influenced by the perceived probability of getting caught, but also factors such as reputation and social stigma, which can lead to higher compliance rates than a simple game theoretical model of risks and pay-offs would suggest (Andreoni et al. 1998).

Erard defines the GDP gap as the difference between market-based income, both legal and illegal, and the portion of market transactions in recorded GDP. However he writes that this gap should not be thought to be equal to unreported taxable income. Some income may be exempt from taxation and the concept of taxable income is larger than the definition of GDP e.g. capital gains are taxable income, but not recorded in GDP calculations.

Additionally some transactions that are unreported in tax returns can in fact be recorded elsewhere in the national accounts through e.g. shadow economy estimations. Thus the GDP gap is most likely smaller than the sum of unreported taxable income. Another problem lies in the fact that tax noncompliance also takes other forms. Companies can overstate their business expenses and apply for more deductions than they are entitled to.

However small corporations are likely to exhibit similar forms of noncompliance as individuals meaning that a large percentage of noncompliance will likely be in the form of undeclared revenue and overstated expenses or wages paid in cash. Large corporations on the other hand use more creative and expensive approaches such as transfer pricing in order to minimize their tax burden. Thus large companies that are e.g. listed in the stock exchange very likely contribute quite little to hidden economic production.

Slemrod (2007) writes about evasion of the income tax in the US. He argues that tax evasion has and will most likely always exist and that it is not clear how much tax noncompliance can be reduced by directing more funds to enforcement. This remark applies also to tax audits, which are very costly to perform.

Another important paper on tax evasion is Slemrod and Yitzhaki (2002), which presents theoretical models that have incorporated tax evasion as a gamble where losing naturally means getting caught by the tax administration. They called for more empirical research into the topic of tax evasion through e.g. field experiments and propose sometimes tax avoidance is caused by the difficulties in formulating well-defined laws.

Kleven et al. (2011) describe a tax enforcement experiment in Denmark. They draw attention to how taxes are being reported in developed countries and how it affects tax noncompliance. They discover that in a representative sample of over 40 000 income tax filers the tax evasion rate is close to zero when their taxes are being reported by a third party such as their employer. They also discover that the tax evasion rate is substantial if the incomes are self-reported and that having previously been audited or threatened to be affect tax evasion on self-reported incomes.

They argue that previous studies on tax audits have not discovered a statistically significant relationship between the threat of being audited and tax evasion because participants may have been aware of the randomization involved. They mention the Taxpayer Compliance Measurement Program (TCMP) that was conducted in the USA. If taxpayers were aware of the fact that the process of getting selected was random, they may have not perceived the threat of being audited to be very high.

Vero will be increasing the size of random audits in Finland to 500 small- and medium-sized enterprises in the near future. This could provide opportunities for studying the shadow economy with random audit data. However since we would need a substantial amount of random audits for each industry separately, it is most likely still the case that the amount of observations is far too small to perform any type of whole population estimates of the shadow economy.

2.4 The Value-Added Tax Gap of Finland

IMF in cooperation with the Finnish Tax Administration Vero published a report in November 2015 that estimates the annual VAT gap for Finland from 2008 until 2014. The report first estimates the potential VAT that could be collected and then compares this to the actual VAT collected. The difference between these two is the VAT gap, which is divided into two parts; the compliance gap and the policy gap (IMF 2015). This publication is a part of the Revenue Administration Gap Analysis Program (RA-GAP).

The policy gap refers to lost tax revenue from subsidies such as lower VAT rates and is not of interest for this study. The compliance gap however is defined as ”The difference between the potential VAT that could have been collected given the current policy framework and accrued VAT collections” (IMF 2015). The estimated compliance gap as a percent of GDP for Finland from 2008 until 2014 has been modest and was 0.8 % of GDP in 2008 and 0.5 % of GDP in 2014 (IMF 2015). Improvements have been made particularly in industries F, A-B, and K-L i.e. construction, agriculture, and real estate.

The compliance gap is further divided into two components. The assessment gap is defined as ”the difference between potential collections given the current policy framework and the VAT declared” and the collections gap is defined as ”the difference between VAT declared and the actual VAT revenue collected” (IMF 2015). Thus the assessment gap divided by the highest VAT rate of a given year can be interpreted as unassessed taxable revenue, which is a part of the shadow economy. The VAT gap of Finland is visualized in Figure 2. and tabulated in Table 3.

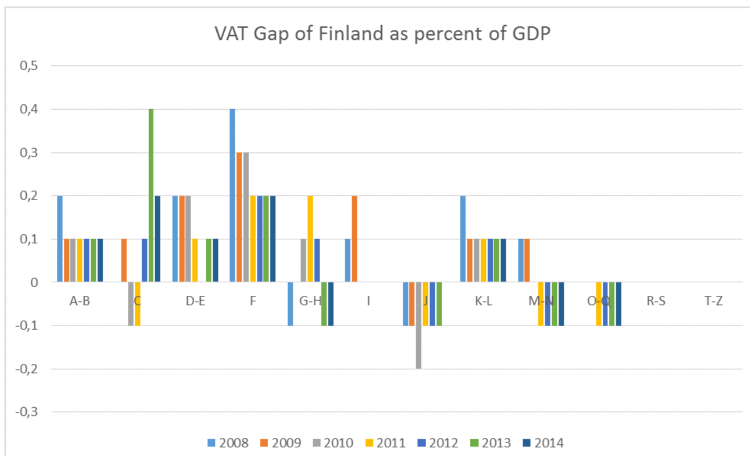

Figure 2: The VAT gap of Finland (IMF 2015)

To estimate the compliance gap IMF first employs the potential revenues model for estimating the taxable value-added sector by sector. The potential revenues model can be written as:

$$PV^s = \sum_c (M_c^s \tau_c) r^s + [\sum_c (Y_c^s - X_c^s)\tau_c] r^s - [\sum_c (N_c^s + I_c^s)\tau_c] r^s (1 - e^s)\eta_c \tag{8}$$

where PV^s is the potential VAT for a sector, MC_s are imports, YC_s is output, XC_s is exports, NC_s is consumption, IC_s is investment, τ_c is the applicable VAT rate, η_c^s is the proportion of input tax credits allowed to be claimed, r^s is the proportion of output produced by registered businesses in a sector, e^s is the proportion of exempt output in a sector, with s denoting sector and c commodity.

The first five variables i.e. Y, X, M, N, and I have been extracted from statistical supply-use tables that are maintained by Statistics Finland. τ_c is what the authors call a policy variable and the rate is whatever the applicable rate is for a given commodity c. η_c^s is another policy variable which was set to zero for commodities such as restaurant meals have a general disallowance for input tax credits and set to one for other commodities. Finally r^s was estimated in cooperation with authorities such as customs. R^s was assumed to be equal for Y, X, I, and N since coming up with separate values would "greatly increase the time and effort" with "no discernible difference in final results" (IMF 2015).

Determining actual VAT collected is more difficult than it might sound like. Actual collections were measured using the same variables as in the potential revenues model. The important thing is reallocating collections into the period the tax actually accrued. These accrued collections can be written as:

$$AV^s = C^s + P^s - R^s(+OP^s) \tag{9}$$

where AV^s is accrued VAT collections, C^s is collections at customs, P^s is payments received, R^s is excess credit accrued, and OP^s is payments offset by excess credit. Data for C^s is obtained from the customs declaration database, data for P^s is obtained from the payments transaction database presumably maintained by Vero, R^s is calculated from the tax returns database similarly to to OP^s. For a more detailed description of the methods used please refer to IMF 2015.

If we assume that the potential VAT has been measured accurately, which is a strong assumption, we can further assume that the assessment gap part of the compliance gap refers to VAT that should have been declared from taxable revenue. Perhaps this revenue was purposefully hidden from the authorities in order to avoid paying the VAT. This means that by using the compliance gap estimates it is possible to calculate the amount revenue that is missing from the national accounts indicated by the RA-GAP estimate

In my view the potential and accrued VAT calculations and the compliance gap should be used for economic research. The argument is that since they already exist it would be wise to take advantage of them.

My calculations are not exhaustive. Rather they just show what the RA-GAP estimate roughly indicates on the size of the shadow economy. IMF (2015) suggests that the compliance gap can be compared with effect of policy measures, by using the indicators based on hypothetical tax legislation and the analyses of the effects due to changes in tax policies.

The compliance gap is measured as a percentage of GDP. Thus the compliance of a given year should be multiplied with the GDP of that year in order to calculate the compliance gap in billions of euros. Table 3. shows the compliance gap as a percentage of GDP for all industries starting from 2008.

We can see that e.g. in F Construction the gap has shrunk from 0.4 % of GDP in 2008 to 0.2 % in 2011 of GDP implying that the compliance gap has halved. It should be noted that these percentages include both the collections and the compliance gap. Thus the estimates of hidden revenue indicated by the RA-GAP are by definition upward biased since they include the collections gap as well.

Table 4. is the annual GDP of Finland with current prices taken from the Statistics Finland website. It is evident that interesting industries are those where both the compliance gap and the gross output

Table 3: The compliance gap by industry as a percentage of GDP

	A-B	C	D-E	F	G-H	I	J	K-L	M-N	O-Q	R-S
2008	0.2	0	0.2	0.4	-0.1	0.1	-0.1	0.2	0.1	0	0
2009	0.1	0.1	0.2	0.3	0	0.2	-0.1	0.1	0.1	0	0
2010	0.1	-0.1	0.2	0.3	0.1	0	-0.2	0.1	0	0	0
2011	0.1	-0.1	0.1	0.2	0.2	0	-0.1	0.1	-0.1	-0.1	0
2012	0.1	0.1	0	0.2	0.1	0	-0.1	0.1	-0.1	-0.1	0
2013	0.1	0.4	0.1	0.2	-0.1	0	-0.1	0.1	-0.1	-0.1	0
2014	0.1	0.2	0.1	0.2	-0.1	0	0	0.1	-0.1	-0.1	0

Table 4: The GDP of Finland with current prices

Year	GDP
2008	193.711
2009	181.029
2010	187.100
2011	196.869
2012	199.793
2013	202.742
2014	205.178

are high. These industries such as C Manufacturing and F Construction are also the ones where major improvements have been made in recent years according to the RA-GAP.

I first divide the compliance gaps in Table 3. by 100 in order to get the decimal value. That decimal value is then multiplied with the GDP of that year in order to calculate the compliance gap. The numbers compliance gaps were divided with the highest VAT rate of a given year and the year 2010 was divided in half since the VAT rate increased starting from July 2011. This yields the unassessed revenue estimated straight from the compliance gap. The results are presented in tables 18. and 19. in the appendix.

It is evident that industries A-B, C, D-E, and F Construction appear to contribute to the compliance gap along with K-L. C in 2013 is the only industry where the compliance gap has gone up in these four industries since 2008 while in all other industries the gap has shrunk after the financial crisis. This may be explained by the fact that tax debts tend to increase during a recession (Ristola and Tiira 2012).

Table 5. shows the sum of unassessed revenue in billions of euros and as a percentage of GDP. Keep in mind that these estimates are by definition upward biased since the compliance gap includes the collections gap as well. According to these estimates the percentage of hidden revenue has declined sharply from 2008 to just below 1.7 % of GDP in 2014. In order to comply with the definition of the

Table 5: Unassessed revenue as a percentage of GDP

Year	Sum (bn euro)	Percentage
2008	8.81	4.55
2009	8.22	4.55
2010	4.16	2.22
2011	3.42	1.74
2012	2.60	1.30
2013	5.10	2.50
2014	3.42	1.67

shadow economy an estimate of illegal production should be added on top of these estimates. Statistics Finland has estimated the gross value added of illegal production in Finland at around 180 million euro in recent years. Thus the entire shadow economy would be less than 2 % of GDP in 2014.

Another option is to concentrate on the assessment gap on the national economy level. IMF (2015) does not tell us how the compliance gap is divided into the assessment and collections gaps for each industry. In addition Savolainen (2016) argues that the distribution of the compliance gap by industry are simply approximations. Thus the compliance gap on the national economy level is a more reliable estimate.

Table 6: The compliance gap as a percentage of GDP

Year	Collections gap	Assessment gap
2008	0.3	0.5
2009	0.2	0.5
2010	0.1	0.3
2011	0.1	0.5
2012	0.1	0.3
2013	0.2	0.3
2014	0.2	0.3

Unassessed revenue is calculated in euros by first dividing the gap by 100 and then multiplying with the GDP of that year. The result is then divided with the highest VAT rate just as earlier to derive the hidden revenue indicated by the assessment gap in table 7. This calculation indicates that the amount of unassessed revenue in Finland has been around 2.5 billion euro or about 1.3 % of GDP since 2012. No intermediate products have been subtracted from the numbers. Both ways of calculating hidden revenue from the RA-GAP estimates provide further evidence that the shadow economy of Finland is quite small. This is in contrast to both Hirvonen et al. (2010) and Schneider (2013).

There are a number of problems with the IMF RA-GAP estimates related to i.a. the negative values in some industries. We also do not know how the compliance gap is divided into the assessment and

Table 7: The assessment gap as a percentage of GDP

Year	Unassessed revenue (bn euro)	Percentage of GDP
2008	4.40	2.73
2009	4.11	2.73
2010	2.50	1.33
2011	4.28	2.20
2012	2.61	1.30
2013	2.53	1.25
2014	2.56	1.25

collections gap in each of the industries. Presumably the assessment gap should not be negative and the negative values are explained by margins of error or the collections gap.

The compliance gap has been on a downward trend since 2008 and is likely very small. If the amount of VAT that the government fails to collect given the current policy framework is small, it follows that the shadow economy of Finland should be small as well. Thus according to the RA-GAP estimate no large gains can be obtained from the shadow economy by increasing resources in surveillance.

However according to IMF (2015) the VAT gap of Finland is so small partly due to effective enforcement by Vero. This means that the small VAT gap does not indicate that resources should be cut. Perhaps that the amount of surveillance combined with the positive attitudes regarding taxes in Finland is good as it is.

3 Background

This section presents background on the shadow economy of Finland. I review some of the recent estimates of the size of the shadow economy in Finland. As mentioned before the range of estimates is very large.

A revised statistical standard industrial classification, TOL 2008, was introduced in Finland starting from the first release of data on each statistical topic in 2009. The detailed level classification is tabulated in Table 20 in the appendix.

In this section I present information on the size of the shadow economy currently being added into the Finnish national accounts in the private sector S11. I use the detailed level classification described in Table 20. In Table 21. in the appendix are hidden production numbers as a percentage of output added into the national accounts in 2014. The percentage of shadow economy is added on top of the GDP by industry.

It should be noted that intermediate products have not been subtracted from the estimates. In some industries, like $412 + 432\_439$ i.e. housebuilding, no hidden production is currently being added in the national accounts. This does not mean that the value of shadow economy is estimated to be zero. Statistics Finland estimates that hidden production of housebuilding is included in the output since output is calculated as a product of quantity and price. For all other industries that are not included in Table 21. the value of hidden production is zero in the national accounts.

From Table 21. in the appendix we can see that industries such as F construction, G wholesale- and retail trade, H transportation and storage, and L real estate activities are major contributors to the shadow economy of Finland according to the national accounts. These industries are also considered to have a relatively large compliance gap as indicated by Table 3. However there are disparities between the compliance gap estimate and the Finnish national accounts as well.

The industries D and E have been estimated to have had a compliance gap of 0.1 in 2014, but no hidden production was added to the national accounts in 2014. One possible explanation is that VAT has been allocated differently at Vero and Statistics Finland (Savolainen 2016). For example even if a company operates in multiple industries, Vero may allocate all of the VAT into one industry.

In addition some hidden production was added to both industries R Arts, entertainment, and recreation, and S other services in 2014. IMF (2015) has estimated the compliance gap of R-S to be zero. Most of these disparities are probably due to the fact that revenue has been allocated differently and also due to the margin of error of the estimations.

Current estimates for the size of the shadow economy of Finland vary substantially. In 2008 Statistics Finland estimated this number to be rather small at circa 1.5% of GDP (Nurminen 2008). Hirvonen et al. (2010) in a report conducted for the Parliament of Finland estimated estimated the *fiscal shadow economy* to be 6.9% of GDP.

Hirvonen et al. (2010) potentially treat the results of operational tax audits as random audits (Viren 2013 and include capital gains tax evasion in their definition but exclude the illegal economy. This causes a selection bias since tax audits are obviously not performed at random.

Due to problems with the methods employed and their atypical definition, this report is not comparable with other shadow economy estimates that are based on appropriate methods and use a definition approved by e.g. the OECD.

Hirvonen responded to Viren in 2013 in the Finnish Economic Journal where he stresses the fact that their study was concerned with how much revenue was hidden from the tax authorities and not missing production from the national accounts. This argument further emphasizes the point that the Hirvonen et al. (2010) report is in fact studying an altogether different phenomenon.

Attempting to estimate the loss of tax revenue might be even more difficult than estimating production missing from the national accounts. Hirvonen et al. (2010) discover that the difference between potential and actual tax revenue was around 2 billion euro in Finland, which would imply that the size of the shadow economy could very well be substantially higher than e.g. Nurminen (2008) estimated.

Viren (2015) argues that since the tax audits have produced so little revenue for the government, the size of the shadow economy must be quite small or at least a lot smaller than e.g. Schneider and Enste (2000) implies. Otherwise we would have seen better results from tax audits.

Additionally Viren (2015) also argues that in many of the fields typically associated with a high degree of informality such as construction and restaurants, the operating margins are so small that even a small increase in costs through taxes would lead many of these firms to bankruptcy. Thus potential tax revenue is small and salaries earned in the shadow economy are also being used to fund transactions in the formal economy and thus produce tax revenue through indirect taxes.

However both of these numbers are much smaller than estimates produced with indirect methods like some academic papers published even in top journals such as the Journal of Economic Literature. Most recently Schneider (2013) estimated the shadow economy of Finland at 13.3% of GDP in 2012, which translates into $(0.133 \cdot 199.8) \approx 26.44$ billion euro.

This estimate is difficult to compare with others. This publication was funded by the credit card company VISA and it advocates the usage of credit cards as a payment system in order to decrease the size of shadow economy.

The larger problem with these estimates, the ones based on indirect methods in particular, is that they are estimating something which is not based on any formal economic theory. In fact the models simply assume where people spend their cash. According to Thomas (1999) we should be very careful about accepting these estimates as they might be influenced by political beliefs as discussed in the introduction.

OECD (2002) writes that the reason behind economists using these methods is that the procedures of compiling the national accounts are not transparent enough. Perhaps not all relevant data is available. This may force researchers to employ these indirect methods.

4 Data

The data on revenue in the construction industry has been obtained from periodic tax returns that are stored at the Statistics Finland database. The industry has been divided into three parts i.a. due to differences in absolute size. These industries are 411 development of building projects, 412 + 432_439 housebuilding, and 42 + 431 civil engineering. Together these three roughly form the industry F construction, which accounts for over 6 % or 12 billion euro of Gross Value Added in the Finnish economy (Finnish National Accounts).

My data set is a collection of monthly observations by industry starting from 01/1999 and ending in 09/2015. The variable I am interested in is called $lv\_Kotimaa$ (previously vermyper) which is a sum of all taxable revenue in Finland. It includes sales at different VAT rates as well as sales that are subjected to the reverse VAT ($lv\_RakenPalvMyynti$). I have restricted my analysis to the sector S11 i.e. the private sector for simplicity. The red line in the graphs refers to 04/2011 which is when the reverse VAT was officially introduced.

In these periodic tax returns companies declare a number of things related to their business monthly, quarterly, or annually. Companies have to declare how much revenue they have subjected the three VAT rates. In addition they declare information on tax deductions they are entitled to and wage information. A taxpayer has to declare periodic tax returns if they are liable to pay VAT and/or if they have employees. The actual document that taxpayers fill and return to Vero can be found in the appendix.

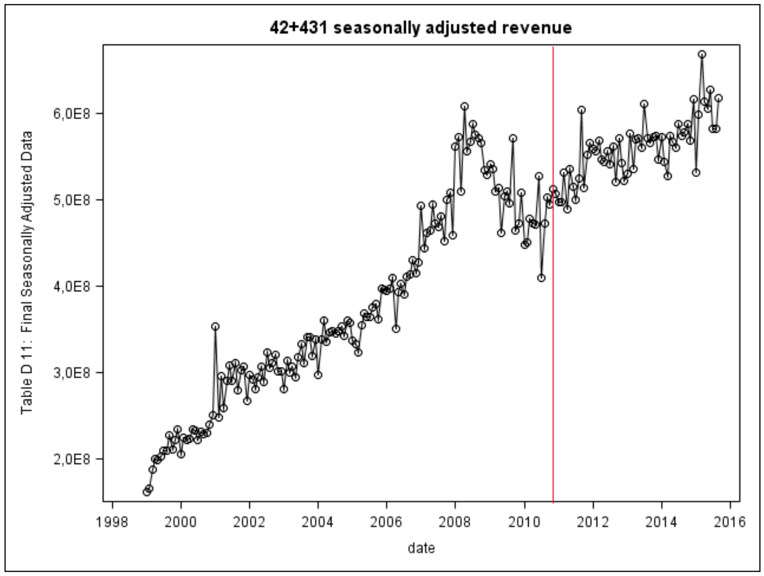

Figure 3: X12 seasonally adjusted revenue in 42+431

Figure 3. shows a seasonally adjusted graph of revenue in $42 + 431$ beginning in January 1999 and ending in September 2015. The data was aggregated from the actual periodic tax returns. Prior to 2008 the industry experienced steady growth in terms of reported revenue. The drop after 2008 is quite evident but the industry appears to have recovered at least in terms of reported revenue. In terms of gross output $42 + 431$ is a circa 6.5 billion euro industry annually. The reverse VAT was implemented for projects starting after April 2011 so roughly halfway between 2010 and 2012.

In addition to reported revenue I am also interested in how much deductions companies declare. Claiming too many deductions is a way for taxpayers to avoid paying taxes. Figure 4. is a seasonally adjusted graph of deductions in $42+431$. Unsurprisingly the trend has been very similar in deductions and reported revenue. Deductions in $42 + 431$ increased steadily until they came crashing down after 2008 and have since recovered.

The same data was naturally for the two other industries that fall under F construction as well. $412 + 432\_439$ is large in terms of gross output at over 16 billion euro in 2014. 411 on the other hand is a very small industry at just over 200 million euro in gross output in 2014.

Figure 5. is a graph that shows revenue in $412+432\_439$ starting from 01/1999 and ending in 09/2015. Again the reverse VAT was implemented for projects starting after April 2011. Similarly to $42 + 431$

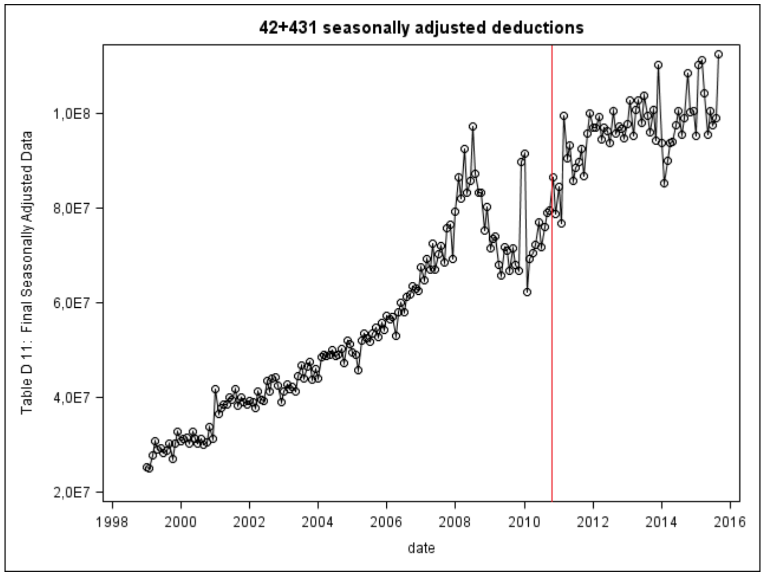

Figure 4: X12 seasonally adjusted deductions in 42+431

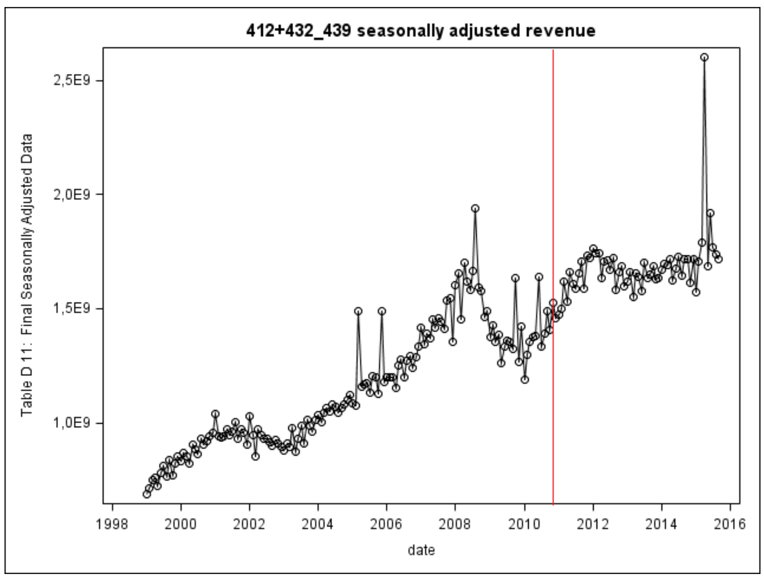

Figure 5: X12 seasonally adjusted revenue in 412 + 432_439

there is a clear seasonal trend and there was a dip in revenue from 2008 to 2009.

However the industry seems to have managed to recover from the crisis in terms of reported revenue. In fact we can see a very high peak in the data on reported revenue after 2014. Housebuilding is currently very active particularly in urban centres. Large scale projects are currently going on in e.g. old docklands in Helsinki. Presumably the trend will continue in the near future.

Figure 6. shows the graph for deductions. Again some high peaks are present in the data. This may

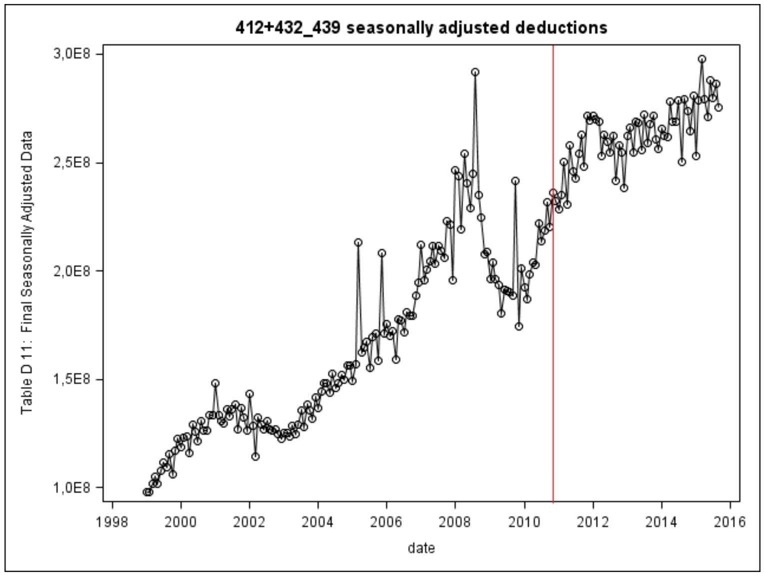

Figure 6: X12 seasonally adjusted deductions in 412 + 432_439

be due to the nature of the construction industry. Typically in the industry revenue is declared on an accrual basis. This means that revenue for a large project is declared after completion and not continuously throughout the project.

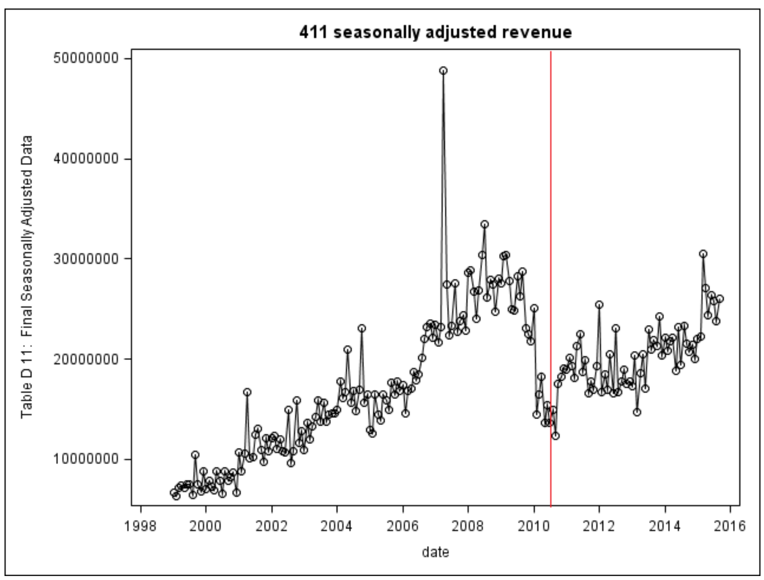

Figure 7: Revenue in 411

Figure 7. presents revenue in 411. Clearly the industry is much smaller than the other two in terms of reported revenue. Just before 2008 there was a large peak in the data. The small absolute size of the industry may be behind this. Just a few large development projects may cause such outliers.

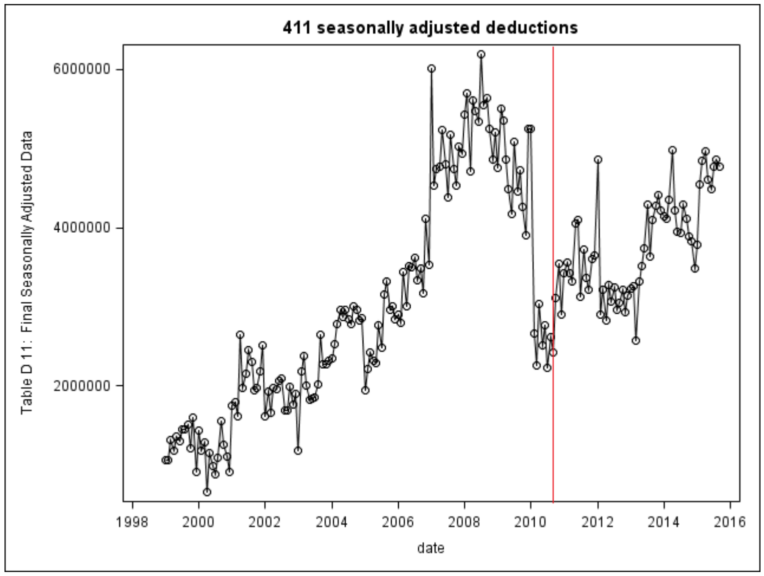

Figure 8: Deductions in 411

Deductions in 411 have followed roughly the same trend as shown by Figure 8. However the outliers are not as obvious as in the case of revenue.

5 Method

It is possible that prior to the reverse VAT reform some subcontractors have failed to declare and pay VAT. In addition Vero (2012) wrote that it is possible that after the reform subcontractors have started to report more revenues. This hypothesis provides motivation for my research.

The effect could be studied by comparing reported revenue in periodic tax returns before and after April 2011. But this does not take into account the business cycle or seasonal trends. Thus the specified model needs to eliminate the seasonal trend in the data. An autoregressive model with exogenous variables (ARX) and a dummy variable will be employed. The seasonal trend will be eliminated by taking the logarithm and adding 12 seasonal dummies as regressors.

Additionally it is possible to forecast reported revenue or deductions using the specified model. These forecasted values can be compared with actual observations of revenue and deductions, which allows us to see if there are any systematic differences between the two. The possible differences can then be compared with the estimate produced by Ristola and Tiira (2012).

In my research this forecast that is compared with actual observations is based on a pure autoregressive AR(p) model. The model can be written as:

$$Y_t = \theta_1 y_{t-1} + \theta_2 y_{t-2} + ... + \theta_p y_{t-p} + \epsilon_t \tag{10}$$

And the h-step forecast is obtained as:

$$Y_{t+h|T} = \theta_1 y_{T+h-1|T} + \theta_2 y_{T+h-2|T} + ... + \theta_p y_{T+h-p|T} \tag{11}$$

A highly statistically significant dummy variable could provide evidence that after the reverse VAT reform companies in the construction industry have started to report previously unreported revenue. The same logic applies for tax deductions as well. Thus by introducing the reverse VAT in other industries, tax revenue could be increased at relatively little cost based on the surveys conducted by Vero.

The significance of the dummy is studied by comparing the t and p values with critical values at different confidence levels. The hypotheses I am testing are:

Hypothesis 1 *Reported revenues have increased after the implementation of the reverse VAT in 2011.*

Hypothesis 2 *Reported deductions have increased after the implementation of the reverse VAT in 2011.*

In an ARX(p) model, the first p lags of each variable in the model will be used as regression predictors and the order p is selected using sequential testing. A general form ARX(p) model, with a dummy variable included, can be written as:

$$Y_t = \theta_1 Y_{t-1} + \theta_2 Y_{t-2} + ... + \theta_p Y_{t-p} + \eta_p G_{t-p} + \rho_p D_{t-p} + \epsilon_t \tag{12}$$

where Y_{t-p} are past values of Y_t i.e. reported revenue, D_t is the dummy variable for the reverse VAT that begins in March 2011, G_t is the sum of wages paid as the exogenous explanatory variable, and ϵ_t is the error term. For the estimation with no dummy, the variable D_t is simply set to equal zero. My model also includes seasonal twelve seasonal dummies as exogenous explanatory variables to help account for seasonal trends in construction. This is a necessary improvement of the model for the dependent variable to become stationary.

The construction industry has been estimated to be one of the largest industries of tax noncompliance in Finland (IMF 2015), though it has been on the decline since 2008. In fact IMF have estimated that the compliance gap in construction has decreased from 0.4% of GDP in 2008 and 0.3% of GDP in 2011 to 0.2% of GDP in 2011 and has remained constant since. Thus the compliance gap in construction was higher before the reverse VAT was implemented.

This may be explained simply by the business cycle. But both the size of the compliance gap and the recent downward trend make the industry an interesting topic of study. The reverse VAT implementation in April 2011 also allows us to study the indirect effects of a tax policy change on the shadow economy. According to Kleven et al. (2011) third party reporting may decrease tax evasion.

If the dummy variable indicating the reform is a statistically significant explanatory variable of the amount of revenue, it could provide evidence that the reform has had some effect. However I do not claim causality. The possible results should obviously be interpreted with caution.

The dummy variable was given the value one starting from a given month, which was chosen to be March 2011, and zero for all previous observations. The problem with studying the effect of the policy change is that it only concerns construction projects that began after April 1st 2011. This includes construction projects where the contract was made in e.g. March 2011 even if construction began after April 1st.

Since the law was passed in June 2010 this gave companies that were trying to hide revenue the opportunity to make contracts so that the projects did not fall under the reverse VAT legislation. This effect called the anticipation effect makes estimating the effects difficult. Another problem is the fact that the financial crisis led to a strong business cycle after 2008. I estimate the significance of a dummy variable starting in March 2011. This variable describes the implementation of the reverse VAT.

6 Results

I focus on the effect of a policy change on the shadow economy. Kosonen (2014) argues that since we cannot know the exact size of the shadow economy, focus should be on its causes and consequences. Construction is a field typically associated with a high shadow economy (Viren 2013). IMF (2015) has estimated that the compliance gap in the construction industry is high, but has been declining since 2008. This has likely been caused by the improved business cycle. But the reverse VAT may have played a role as well.

The results are presented separately for each of the three industries. First I present the results of the significance tests with logarithm of revenue as the dependent variable. However due to the fact this estimation is measuring something that cannot be directly observed poses a lot of challenges.

I also study if the same dummy is a statistically significant explanatory variable for the logarithm of tax deductions. If deductions have increased along with the amount of VAT declared, the increase in the tax base could be lower than the increase in reported revenue would imply.

I also estimate the effect of the dummy by comparing two different estimates. One estimate was calculated with the dummy included and one without. Systematic difference between the two could be interpreted as an effect of the dummy variable. However it seems that this method may not be suitable for estimating the effect of the dummy as the other parameter estimates change to account for the omitted dummy.

In addition I study if there are any systematic differences between actual observations of revenue and the forecasted values. This forecast is based on a pure autoregressive model AR(p) with seasonal dummies.

6.1 The effect of the reverse VAT reform

The Tax Administration of Finland introduced a reverse value-added tax (VAT) in construction services starting in April 2011. What it means is simply that for all new projects starting after April 1st 2011, the responsibility to declare and pay the VAT has been with the buyer instead of the multitude of sellers and subcontractors. This is applied for the sale of construction services and the hiring of labour where the buyer is a regular in the field of construction services or real estate.

The goal was to prevent financial crime and unrecorded economic activity in the industry. The competitive position of companies that have previously complied with all regulations was also thought to improve. The Tax Administration have themselves estimated that this has brought in at least 75 million euro in additional revenue annually. The problem with this estimate is that it has not been adjusted for the business cycle or seasonal trends. Also we know that tax debts typically tend to increase in a recession (Ristola and Tiira 2012).

In April 2012 Vero conducted a survey of 397 companies and 345 accounting companies where they inquired about possible challenges related to the reverse VAT system. Confederation of Finnish Construction Industries (RT) performed a similar though slightly smaller survey of their members around the same time. A majority of the companies had business revenue under 300k with the majority of respondents stating that the reverse VAT would increase red tape and thought it was confusing.

Over half of the respondents thought that the reform was useless, 21 % thought it might increase tax revenue, and finally the majority of respondents were doubtful that it would have an effect on the shadow economy (Ristola and Tiira 2012). However through later surveys and internal analysis Vero has concluded that after early challenges the system now works well.

RT, who originally opposed the reform, has now concluded that it has worked better than expected and has possibly decreased the shadow economy. Among others The Finnish Scrapdealers Associaton has indicated their interest in the reverse VAT system in order to decrease crime, shadow economy, and increase fair competition in the industry (Ristola and Tiira 2012).

In the Ristola and Tiira (2012) report two possible scenarios where additional revenue could come from were identified. First of all a subcontractor can previously have declared the tax, but has failed to pay it. If this scenario is estimated to have brought in additional tax revenue, it implies that the reverse VAT system has simply led to a decrease in the tax debt owned by companies in the industry.

Secondly the subcontractor could have both left the tax undeclared and unpaid. However in the estimate calculated by Vero all additional tax revenue has come from the first scenario and the second scenario has been assumed to equal zero.

Assume that the total amount of reported revenue and/or deductions have increased after implementing the reverse VAT. Then the second scenario were previously a subcontractor has failed to report revenue may not have been zero and it has decreased after the reform.

Kleven et al. (2011) discover that in the case of individual income tax filers the rate of tax evasion is close to zero if reported by a third party. This results may be applicable to the reverse VAT as well. After April 1st 2011 the responsibility to declare the VAT on the sale of construction services has no longer been with the seller but rather with the buyer.

If the result of Kleven et al. (2011) holds for corporate tax filers as well, the reverse VAT should have decreased tax noncompliance in the industry, because the companies may not be able to cheat in the same way as before.

In their risk analysis Vero stated that the purchases of construction services were smaller than expected after the implementation. This result is discovered when comparing the the purchases and sales of construction services. This perhaps implies that not all of the purchases of construction services subjected to the reverse VAT have been declared in the periodic tax returns (Ristola and Tiira 2012). This could mean that the estimated increase in tax revenue is downward biased and provides further motivation for empirical research.

This could be explained with mistakes such as declaring purchases of construction services as regular purchases in periodic tax returns. Additionally companies could have declared revenue not subjected to the reverse VAT as such. Or maybe some of the purchases of construction services, from which the VAT is calculated from, were not reported purposefully in order to avoid paying the tax.

One difficulty in measuring the changes in tax revenue is that only 73 % of construction services were filed under the construction industry in the national accounts. Thus 27 % of services that are subjected to the reverse VAT were not included in the estimations (Ristola and Tiira 2012). This could mean that the current estimate is downward biased due to lack of data.

In order to test for robustness of the results, the same regression can be estimated for industries where no VAT reform has been made. This is necessary only if the dummy is discovered to be statistically significant. Examples of such industries are wholesale trade and restaurants, which are quite similar in absolute size to $42 + 431$.

6.1.1 Estimating the effect in Civil Engineering

The regression I estimate in the industry $42 + 431$ has an autoregressive AR(p) part in addition to the dummy variables, and the sum of wages paid in the industry. Sequential testing is applied for selecting p. Apart from dummies the variables are made logarithmic. The results of the estimation and stationarity tests along with error diagnostics can be found in the appendix under regression 1 and diagnostics 1.

The series exhibits a clear seasonal trend such that reported revenue tends to increase through the end of the year. There was also quite a clear drop in revenue from in 2010 but the industry appears to have managed a quick recovery such that the peak of 2011 was higher than the peak of 2009. Figure 9. is the model I have fitted for the data.

Based on the Dickey-Fuller Unit Root test statistics and the root of the modulus being less than one in

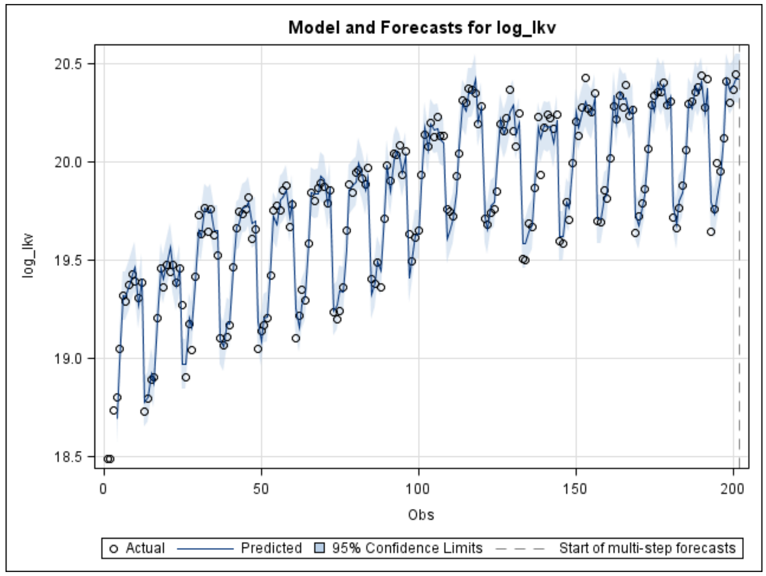

Figure 9: The model for logarithm of revenue 42+431

Regression 1, I conclude that the time series I am estimating is stationary. The seasonal trend has been eliminated with the help of the twelve seasonal dummy variables. Stationary holds for regressions with more observations as well. From the error diagnostics in the appendix we see that the series exhibits no autocorrelation and that the model fits the data quite well.

The dummy does not appear to be a statistically significant explanatory variable for revenue at the 95% confidence with a time series from 01/1999 to 12/2011. The conclusion is based on the relatively high p-value and relatively low t statistic. However it does appear to be significant at the 90% confidence level based on the t value being > 1.645 and p-value being < 0.1. The results for different data lengths can be found in Table 8. below. The results provide some weak evidence to support hypothesis 1.

Table 8: Significance of the dummy on revenue in 42+431

Data length	Estimate	t value	$Pr > \|t\|$
2011M12	0.11967	1.70	0.0919
2012M12	0.11396	1.67	0.0972
2013M12	0.11091	1.66	0.0992
2014M12	0.11333	1.74	0.0835

Based on these estimates the hypothesis that reported revenues have increased after the reform cannot be discarded and the sign of the estimate is positive. The estimate is in fact intuitively very high at over 0.11. Something else than the tax reform may be behind the high estimate.

In addition to testing the significance of the dummy I also compare the forecasted values with actual observations in 42 + 431. I want to see if the model systematically underpredicts revenue when comparing forecasted values with actual observations. The forecast is based on a pure AR(p) model described in equations 10 and 11. If this were true and the differences were substantial, it would imply that the actual observed values were systematically higher than the model suggests.

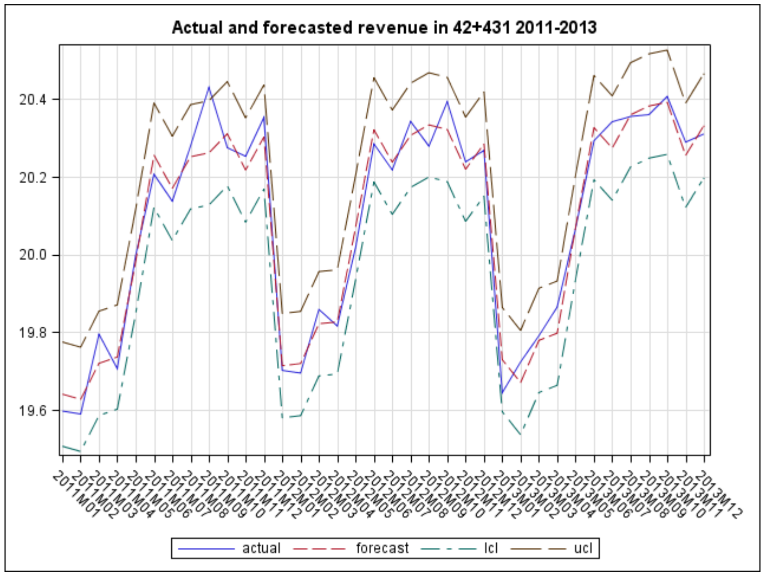

Figure 10: Forecasted values and actual observations of revenue in 42 + 431

Figure 10. shows the differences for years 2011, 2012, and 2013. Lcl and ucl denote lower and upper confidence limits respectively. The largest difference appears to be in 2011 where the observation for August is higher than the upper confidence limit. However in the long run the differences appear to be smaller. But something happened in 2011 that caused the observation to be higher than the model would have suggested.

Table 9: Difference of actual and forecasted revenue in 42 + 431

Year	Sum of log differences	Exponential
2011	0.143661	1.154492
2012	.-0.06356	0.938416
2013	0.079458	1.082701

The sum of annual differences from 2011 until 2013 are shown in Table 9. The model does produce a forecast error and the sum of the differences in generally positive. However the forecast error is very small. The industry currently has a gross output of over 6 billion euro. A difference of around 1 million euro is very small. This does not provide any evidence to support hypothesis 1. Something else must have caused the significance and the high estimate of the dummy variable in Table 8.

In order to measure the effect of the dummy variable I estimate two separate regressions using the same data. One has the dummy variable as an explanatory variable and the other does not. The possible difference between these two estimates could be interpreted as the effect of the dummy. The difference of estimates is plotted in Figure 11.

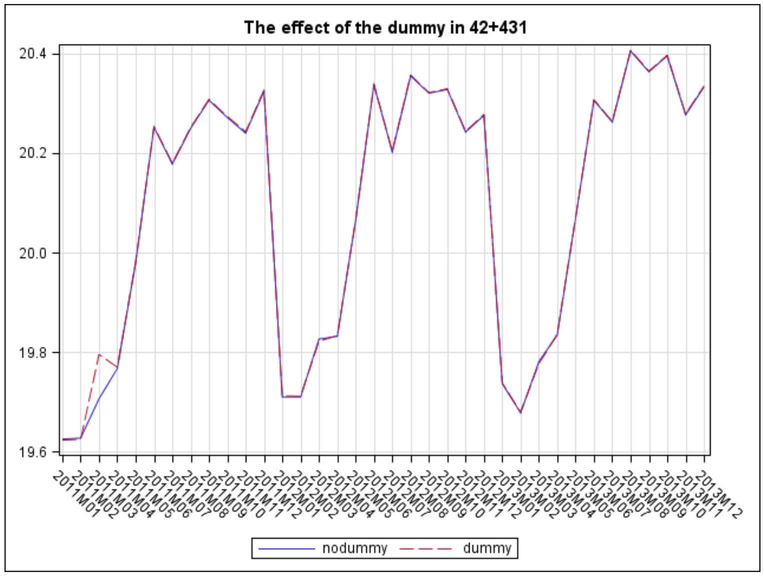

Figure 11: The difference of estimates of revenue in $42 + 431$

The difference of the estimates is close to zero everywhere else apart from March where the dummy variable first gets a value of one. No differences can be observed even in August even though Figure 10. may have suggested so. It seems that the other parameter estimates change in order to account for the omitted dummy. Thus this method does not seem to be feasible for estimating the effect of the dummy.

Vero (2012) also pointed out that even if the reverse VAT implementation has indeed led to an increase in reported revenues, it might also be the case that simultaneously companies have started to report more deductions. This would mean that the tax base in the industry has increased by less than the increase in reported revenue would suggest.

There seems to be a clear seasonal trend in deductions just as there was in revenue. There was a large drop in deductions after the financial crisis and recently deductions have been increasing.

I estimate a similar regression for the variable VahennVero (previously vahvero) as the dependent variable, which includes tax deductions for a given month. All of the variables are made logarithmic apart from the dummy. Sequential testing is used for order selection and the dummy equals one starting from 03/2011. Figure 12. is the model I have fitted for the logarithm of deductions.

The model seems to fit the data well and based on the Dickey-Fuller tests in regression 2 and the root of modulus being less than 1, I conclude that the series is stationary. The series exhibits no autocorrelation based on Diagnostics 2. in the appendix. The results of the significance tests and the estimate with data lengths can be found in Table 10.

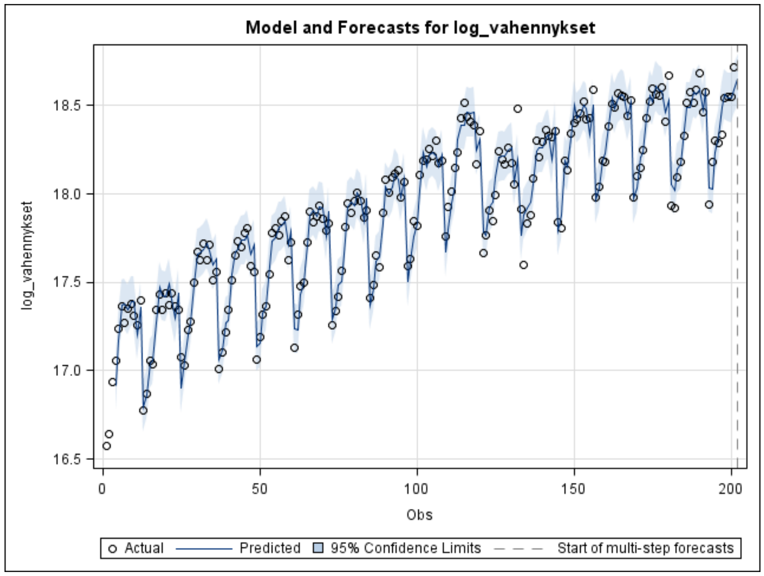

Figure 12: The model for logarithm of deductions in 42+431

Table 10: Significance of the dummy on deductions in 42+431

Data length	Estimate	t value	$Pr > \|t\|$
2011M12	0.05077	1.85	0.0668
2012M12	0.03524	1.71	0.0895
2013M12	0.03601	1.96	0.0516
2014M12	0.03111	1.82	0.0712

The results indicate that the dummy variable is a statistically significant explanatory variable of the logarithm of deductions at the 90% confidence level. These results provide some weak evidence to support hypothesis 2 in the industry $42 + 431$.

Figure 13. shows the difference of estimates in the case of deductions. The same conclusion is reached as with regards to revenue. The other parameter estimates change to account for the omitted dummy.

Additionally the estimates of the dummy seem suspiciously high. In 2014 the estimate of the dummy in revenue is 11.3% and 3.1% in deductions. This would imply that as a result of the policy reform the tax base, defined as the difference of the estimates, in $42 + 431$ has increased by 8.4%. In an industry with a gross output of over 6 billion euro annually that increase is simply too high to believe.

Most likely something else was happening in the industry around that time that caused a structural break in the time series. In order to see if this is the case, I perform a Chow test for the presence of a structural break in early 2011. The results of the Chow test at different break points are tabulated in Table 11.

Table 11. shows that the Chow test is significant for all break points specified. This implies that in

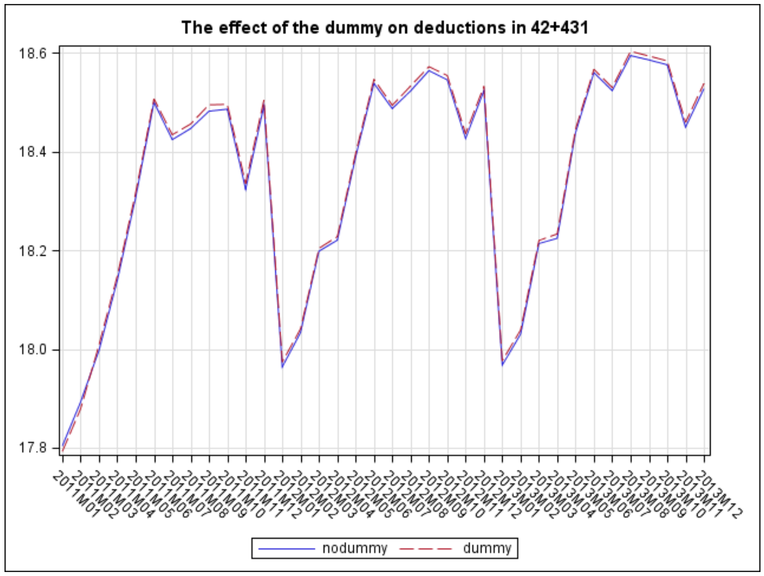

Figure 13: The difference of estimates of deductions in 42+431

Table 11: Chow Test with *log_lkv* as the dependent variable

Break point	Num DF	Den DF	F value	$Pr > F$
2011M01	3	195	6.33	0.0004
2011M02	3	195	5.23	0.0017
2011M03	3	195	4.53	0.0043
2011M04	3	195	4.58	0.0040
2011M05	3	195	4.22	0.0064
2011M06	3	195	4.13	0.0073

2011 the time series experienced a structural change of some sort and that is causing unreliability of the model. Thus the dubiously high estimates of the dummy variable can likely be explained with the presence of a structural break in the times series and not the reverse VAT implementation. This indicates that no evidence to support hypotheses 1 or 2 in $42 + 431$ is discovered.

6.1.2 Estimating the effect in Housebuilding

Housebuilding is a major industry in Finland and e.g. in 2014 its gross output was circa 16.7 billion euro. Similarly to $42 + 431$ the regression I estimate has an autoregressive AR(p) part in addition to the dummy variables, and the sum of wages paid in the industry during a given month. Sequential testing is applied for selecting p. Apart from dummies the variables are made logarithmic. Figure 14. is the model I have fitted for the data.

From the Dickey-Fuller tests printed out in regression 3 in the appendix and the root of the modulus

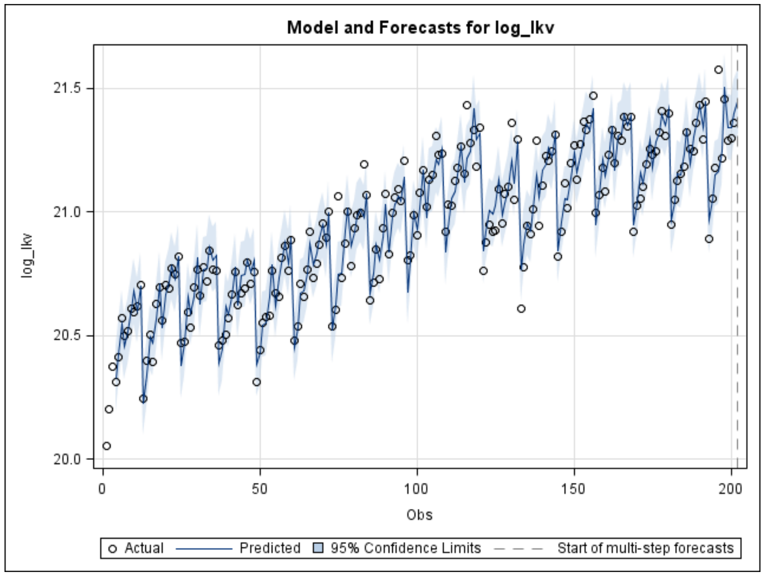

Figure 14: The model for logarithm of revenue in 412 + 432_439

being less than one, I conclude that the series has a single mean and is stationary i.e. the twelve seasonal dummies have eliminated the seasonal trend in the series. The series exhibits no autocorrelation.

The results of the regression with different data lengths are summarized below. In this industry the dummy is not a statistically significant explanatory variable of reported revenue at any confidence level. This conclusion is based on the low t values and high p values of the dummy variable. The results are shown in Table 12.

Table 12: Significance of the dummy on revenue in 412 + 432_439

Data length	Estimate	t value	$Pr > \|t\|$
2011M12	0.01657	0.70	0.4831
2012M12	0.00222	-0.13	0.9000
2013M12	0.01047	-0.66	0.5099
2014M12	0.01242	-0.84	0.4018

The large p values and small t values in all of the regressions indicate that no evidence to support hypothesis 1 in the industry is discovered. With data length until 2012M12 there is a 90% probability of observing a difference due to random sampling error.

Similarly to 42 + 431 I also study if there are any systematic differences between forecasted values and actual observations of revenue. Figure 15. shows that the difference between the actual and the forecasted values seems to fluctuate. No systematic underpredicting can be observed.

The sum of annual differences from 2011 until 2013 are shown in Table 13. The model produces a forecast error. However the sum of the forecast error is very small. Keep in mind that the industry has

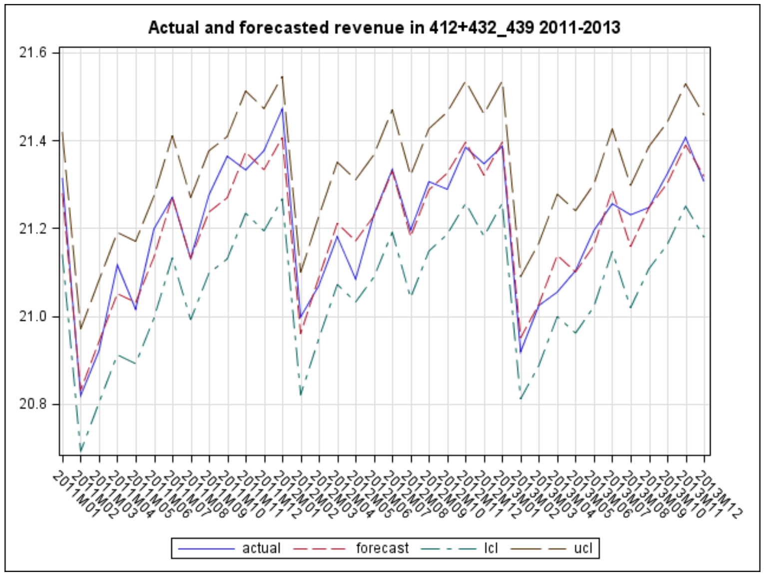

Figure 15: Forecasted values and actual observations of revenue in 412 + 432_439

Table 13: Difference of actual and forecast in 412 + 432_439

Year	Sum of log differences	Exponential
2011	0.250276	1.28438
2012	-0.01505	0.985057
2013	-0.02274	0.977517

a gross output of over 16 billion euro. Thus a difference of approximately 1 million euro is extremely small. No evidence to support hypothesis 1 is discovered in this industry either.

Figure 16. shows the possible effect of the dummy variable on revenue as the difference of estimates. Clearly the estimates are nearly perfectly aligned. Again the other parameter values change to account for the omitted dummy. The method may not be suitable for studying the effect of the dummy.

I estimate the same regression for the logarithm of deductions. Based on the Dickey-Fuller tests printed out in regression 4 in the appendix and the roots of the modulus being less than one, I conclude that the series is stationary with a single mean. The series does not exhibit autocorrelation and the model seems to fit the data well. The model is plotted below in Figure 17.

The dummy is not a statistically significant explanatory variable of deductions at any confidence level with any data length. The results are tabulated in Table 14. Thus no evidence to support hypothesis 2 in the industry is discovered.

Figure 18. shows the possible effect of the dummy variable on deductions as the difference of estimates. Again the estimates are nearly perfectly aligned. The other parameter values change to account for the omitted dummy. The method may not be suitable for studying the effect of the dummy.

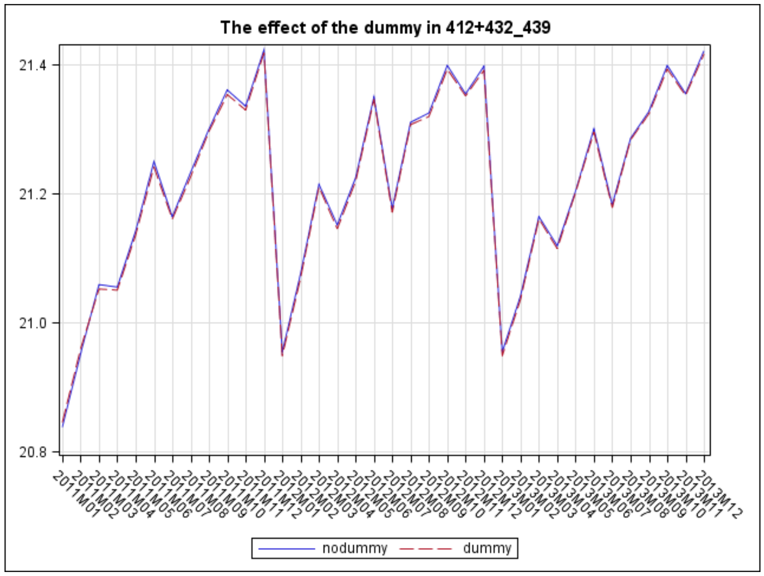

Figure 16: The difference of estimates of revenue in $412 + 432\_439$

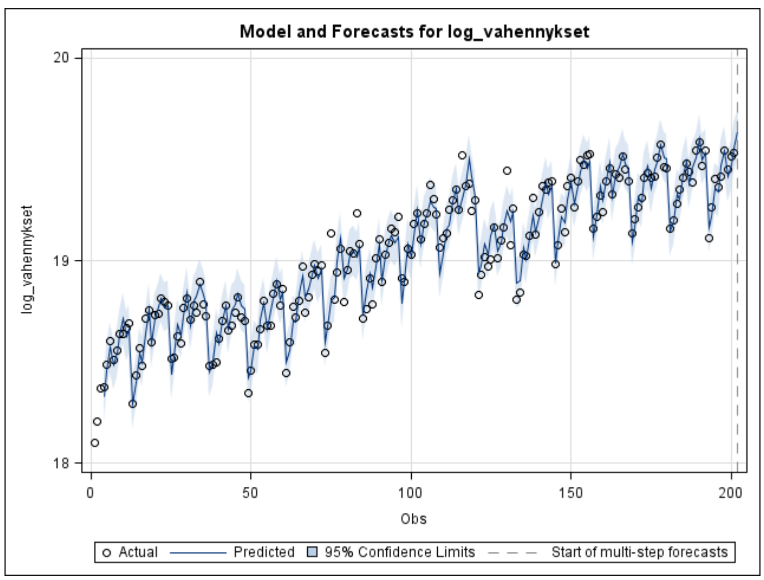

Figure 17: The model for logarithm of deductions in $412 + 432\_439$

Based on the evidence tabulated and plotted above no evidence to support either hypothesis 1 or hypothesis 2 is discovered in the industry $412 + 432\_439$.

6.1.3 Estimating the effect in Development of Building Projects

Development of Building Projects 411 is quite a small industry and in 2014 its gross output was circa 212 million euro. Again the regression I estimate has an autoregressive AR(p) part in addition to the

Table 14: Significance of the dummy on deductions in 412 + 432_439

Data length	Estimate	t value	$Pr > |t|$
2011M12	0.02573	0.93	0.3555
2012M12	0.01933	0.21	0.8343
2013M12	0.00403	0.23	0.8149
2014M12	0.00433	0.27	0.7878

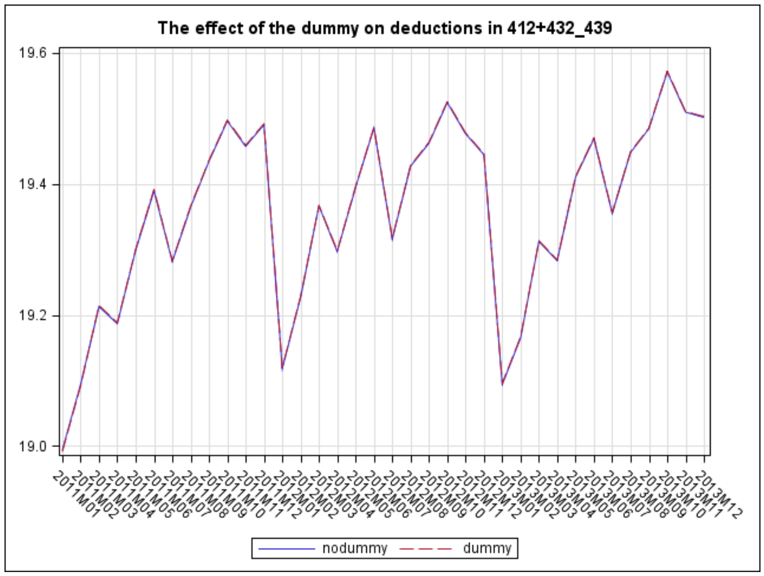

Figure 18: The difference of estimates of deductions in 412 + 432_439

dummy variable, and the sum of wages paid in the industry as an exogenous explanatory variable. Sequential testing is applied for selecting p. Apart from dummy the variables are made logarithmic.

From the Dickey-Fuller tests printed out in regression 5 in the appendix and the root of the modulus being less than one, I conclude that the series has a single mean and is stationary. The twelve seasonal dummies have eliminated the seasonal trend in the series and the series exhibits no autocorrelation.

Figure 19. is the model I have fitted for the data. There was a substantial dip revenue from 2009 to 2010 and the industry has not been able to recover in the same way as 42 + 431 and 412 + 432_439 have. This is not surprising given the small absolute size of the industry. Even a few projects can have a large impact on the overall revenue.

The results of the significance test and estimates with different data lengths are tabulated in Table 15. The dummy is not a statistically significant explanatory variable of revenue in the industry 411 with any data length at any confidence level.

Again in addition to studying the parameter estimates the possible increase in reported revenue was also studied by comparing forecasted values and actual observations. Figure 20. shows that the

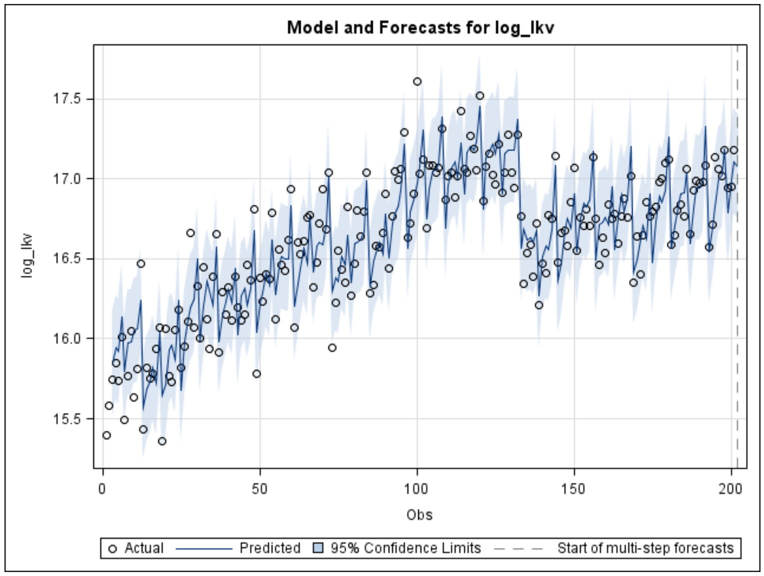

Figure 19: The model for logarithm of revenue in 411

Table 15: Significance of the dummy on revenue in 411

Data length	Estimate	t value	$Pr > \|t\|$
2011M12	0.01721	0.31	0.7605
2012M12	0.00161	0.04	0.9684
2013M12	0.03122	0.90	0.3672
2014M12	0.02774	0.91	0.3616

difference between the actual and the forecasted values fluctuates. No systematic underpredicting can be observed. Thus no evidence to support the hypothesis that revenues have increased after the reverse VAT reform is discovered.

Table 16: Difference of actual and forecast in 411

Year	Sum of log differences	Exponential
2011	0.020371	1.02059
2012	0.055476	1.0570437
2013	0.438184	1.549889

The sum of annual differences from 2011 until 2013 are shown in Table 16. The difference of approximately 1 million euro is relatively smaller than in the other industries. It is interesting that the difference seems to be relatively constant even if the absolute value of revenue changes. The difference fluctuates and no evidence to support hypothesis 1 is discovered.

Figure 21. shows the difference of the estimates of revenue. The regression with a dummy variable

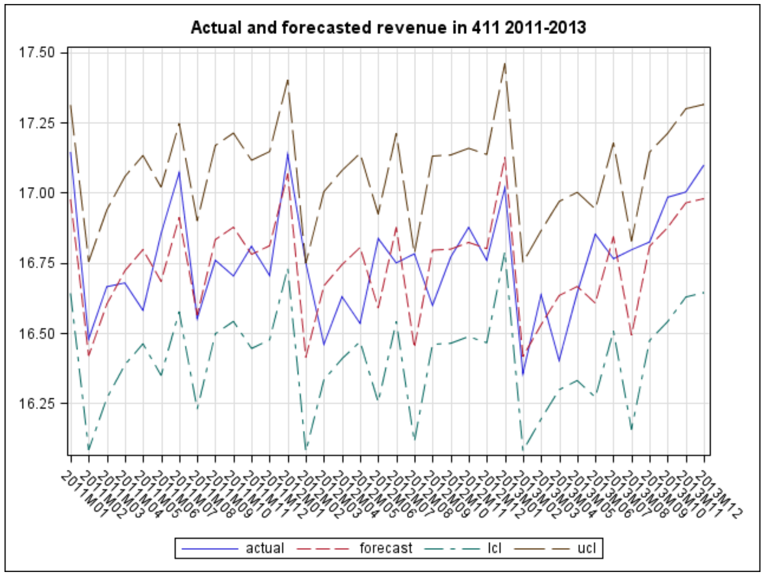

Figure 20: Forecasted values and actual observations of revenue in 411

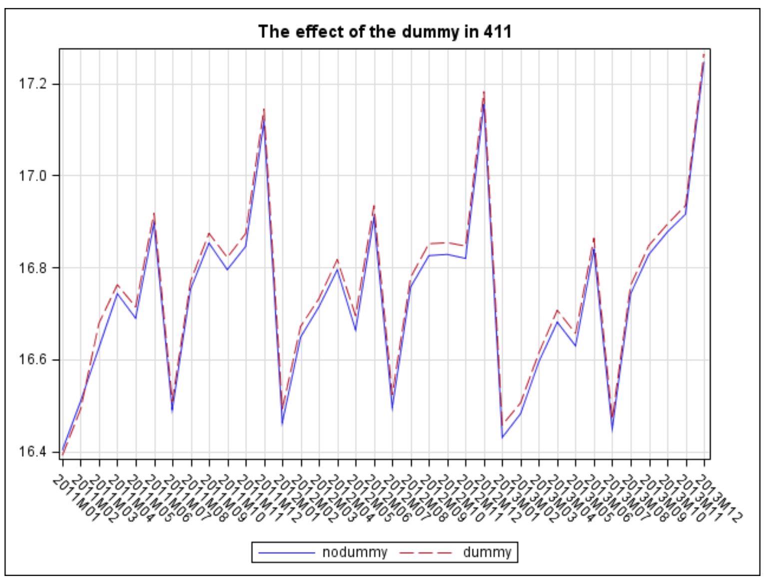

Figure 21: The difference of estimates of revenue in 411

estimates systematically higher values than one without the dummy. However that difference is very small. As before the other parameter values change to account for the omitted dummy. The method may not be suitable for studying the effect of the dummy.

I estimate the same regression for the logarithm of deductions. The results can be found in regression 6. The series is stationary with a single mean and exhibits no autocorrelation. The conclusion is the same i.e. the dummy is not a statistically significant explanatory variable of deductions at any confidence level. Figure 22. is the model I have fitted for deductions and the results of the significance

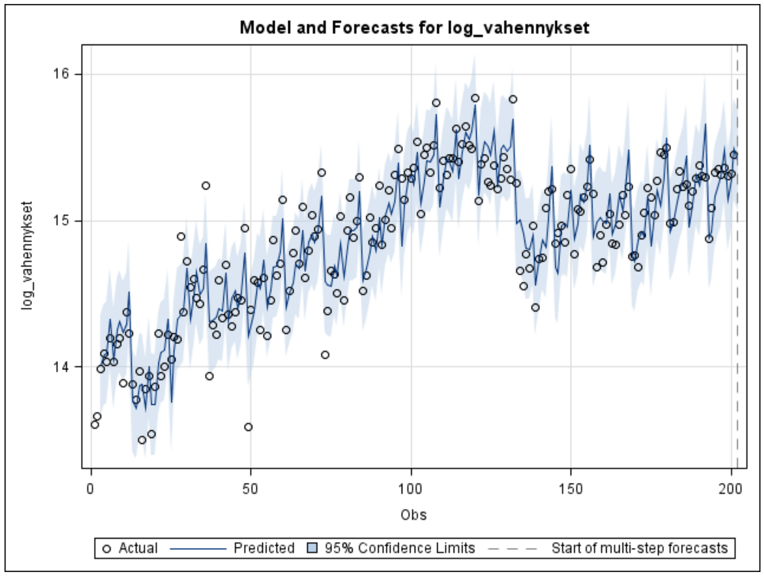

Figure 22: The model for logarithm of deductions in 411

tests are tabulated in Table 17.

Table 17: Significance of the dummy on deductions in 411

Data length	Estimate	t value	$Pr > \|t\|$
2011M12	0.4479	0.73	0.4684
2012M12	-0.0022	-0.01	0.9960
2013M12	0.4112	1.10	0.2720
2014M12	0.4163	1.24	0.2151

Figure 23. shows the possible effect of the dummy variable on deductions as the difference of estimates. Again the estimate with the dummy is consistently slightly higher than one without. However the other parameter values change to account for the omitted dummy. The method may not be suitable for studying the effect of the dummy.

Based on the evidence presented above I conclude that no evidence to support hypothesis 1 or hypothesis 2 is discovered in the industry 411.

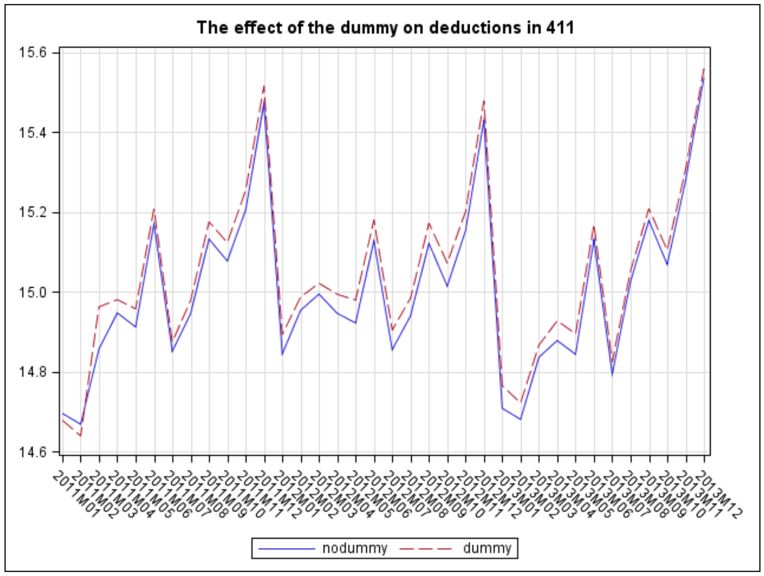

Figure 23: The difference of estimates of deductions in 411

7 Discussion

In the previous section I presented results on regressions I performed in the construction industry. The goal was to study if the implementation of the reverse VAT system has increased reported revenue or deductions in the industry. The industry is further divided into three industries in the national accounts.

In the industries 412+432_439 housebuilding and 411 development of building projects, no evidence to support hypothesis 1 or hypothesis 2 is discovered. Construction is an industry where subcontracting is highly typical. Thus the failure to reject the null is slightly surprising. It seems plausible that after the reform subcontractors would have started to report more revenue.

In the industry 42+431 Civil Engineering the regressions produced interesting results. With regards to reported revenue the dummy appears to be a statistically significant explanatory variable of reported revenue at the 90% confidence level. Sequential testing was applied in order selection based on the exogenous explanatory variable *log_palkat*, which is a logarithm of the sum of wages paid in the industry for a given month.

The same result was discovered with regards to deductions as well. In fact the p-values here are a bit smaller than with reported revenue. A similar conclusion is reached. The dummy is a statistically significant explanatory variable of deductions at the 90% confidence level.

However the Chow test of structural change suggests that in something happened in the industry in early 2011. This structural change is causing the results to be unreliable. One option to get rid of the problem is to estimate two separate regressions. One would be estimated with data ending in 2010M12 and one for the rest. However then the number of observations would be too small to draw any conclusions.

The reverse VAT can be a good reform even if it has not lead to an increase in reported revenue. It has led to improved payments of VAT and it simplifies the tax system. The reform has attracted interest in other industries as well. Additionally it is important to know how the shadow economy could be decreased even if we do not know the exact size of the change. This can help make better decisions on policy reforms regarding the shadow economy.

The effect was also studied by estimating the possible difference of two estimates in all three industries. One that included the dummy variable and one that did not. Both reported revenue and deductions were studied. No systematic difference between the estimates was discovered in any of the three industries.

In fact this method may not be appropriate for estimating the effect of the dummy. When the dummy is absent, other parameter estimates change, because they attempt to compensate for the omitted dummy. Thus no conclusions can be made from the lack of difference between the estimates.

In addition actual observations were compared with forecasted values of reported revenue. The goal was to see if the model systematically underpredicts revenue using a pure autoregressive model. No systematic underprediction was discovered in any industry. In $42 + 431$ one actual observation in 2011 was higher than the upper confidence limit of the model.

I performed similar analysis with the logarithm of deductions as the dependent variable, which are not reported in the paper. However the conclusion was the same. No large systematic difference between the estimate and actual observations was discovered. The autoregressive model failed to produce a large systematic prediction error.

No evidence to support the hypotheses that revenues or deductions have increased after the implementation of the reverse VAT was discovered. It does not mean that it has not happened. It simply means that this model produced no evidence to support this hypothesis. Third-party reporting could decrease tax avoidance among companies just as it has done among private individuals (Kleven et al. 2011). Third party reporting in this case is related to declaring and paying the tax.

8 Conclusion

I introduced the concept of the shadow economy and why economists should be concerned both with the phenomenon itself and the available estimates that may influence economic policy. Some studies have painted a picture of a large shadow economy in Finland. Many of these estimates are produced with methods that have problems with initial conditions and unrealistic assumptions. Indirect methods should generally be avoided based on the critique.

The shadow economy can clearly have negative impacts on the national economy. These impacts are related to crime, labour market participation, and potential loss of tax revenue. However these impacts should not be overestimated.

Recent RA-GAP estimates suggest that unassessed revenue in Finland currently lies somewhere between 1% and 3% of GDP. This estimate provides more evidence to contradict the large estimates produced with macro methods such as the currency method. If the unassessed VAT of Finland is small it follows that the unassessed taxable revenue must be small as well. The amount of shadow economy added to the Finnish national accounts is roughly in line with the RA-GAP estimate.

Together with an estimate of illegal production the RA-GAP suggests that the shadow economy of Finland is less than 2 % of GDP. Note that no intermediate products have been subtracted from the unassessed revenue estimate. The possible subtraction would make the estimate even smaller.

Based on the evidence and literature presented assigning significant resources to fight the shadow economy is likely not economical. The cost of further decreasing the compliance gap may be very high and the same applies to the shadow economy as well.

In addition discussion on the shadow economy and issues such as hiding capital gains and transfer pricing should be separated. They are different phenomena and the appropriate policy measures are likely different.

With regards to the reverse VAT it is plausible that it has had some effect on reported revenue or deductions. However studying the effect of a policy change when the variables of interest are unobserved is difficult. In the end the estimated ARX(p) and AR(p)models fail to provide evidence to support either hypothesis 1 or hypothesis 2 in any of the three industries.

The role of information was discussed in the literature review. Kosonen and Ropponen (2013) argue that providing additional information can help decrease tax noncompliance at a relatively low cost. Recent literature suggests that increasing third party reporting along with providing taxpayers with additional information may be a cost-effective way to decrease the shadow economy.

Vero has estimated that the reverse VAT has brought in 75 million euro in increased tax revenue due to a decrease in tax debts. The construction industry has been estimated to be the largest source of tax noncompliance in Finland. This finding indicates that even in construction the shadow economy appears to be small. And if the shadow economy is small in an industry with a high gross output and compliance gap, it could indicate that the shadow economy is small in other industries as well.

In the upcoming years Vero will increase the amount of random audits to 500 and they are being performed at small-and-medium sized enterprises (SMEs). However presumably there will be a very limited number of random audits for each industry. This means that the data most likely cannot be used to estimate the shadow economy by industry.

Thus resources in shadow economy research should in my view be directed to using operational audit data. The data flow from tax audits is continuous and there is a methodology for using it. The problem with using this methodology lies in the fact that this data is not easily available as it contains sensitive information on companies.

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10 Appendix

Table 18: The compliance gap in billions of euros by industry

	A-B	C	D-E	F	G-H	I
2008	0.387422	0	0.387422	0.774844	-0.193711	0.193711
2009	0.181029	0.181029	0.362058	0.543087	0	0.362058
2010	0.1871	-0.1871	0.3742	0.5613	0.1871	0
2011	0.196869	-0.196869	0.196869	0.393738	0.393738	0
2012	0.199793	0.199793	0	0.399586	0.199793	0
2013	0.202743	0.810972	0.202743	0.405486	-0.202743	0
2014	0.205178	0.410356	0.205178	0.410356	-0.205178	0

	J	K-L	M-N	O-Q	R-S
2008	-0.193711	0.387422	0.193711	0	2.745531
2009	-0.181029	0.181029	0.181029	0	3.085609
2010	-0.3742	0.1871	0	0	0
2011	-0.196869	0.196869	0	-0.196869	3.104063
2012	-0.199793	0.199793	-0.199793	-0.199793	3.127302
2013	0	0.202743	-0.202743	-0.202743	0
2014	0	0.205178	-0.205178	-0.205178	0

Table 19: Unassessed revenue estimated from the compliance gap

	A-B	C	D-E	F	G-H	I
2008	1.761009091	0	1.761009091	3.522018182	-0.8805045	0.8805045
2009	0.822859091	0.822859091	1.645718182	2.468577273	0	1.6457181
2010	0.831966403	-0.831966403	1.663932806	2.495899209	0.831966403	0
2011	0.855952174	-0.855952174	0.855952174	1.711904348	1.711904348	0
2012	0.868665217	0.868665217	0	1.737330435	0.868665217	0
2013	0.8447625	3.37905	0.8447625	1.689525	-0.8447625	0
2014	0.854908333	1.709816667	0.854908333	1.709816667	-0.854908333	0

	J	K-L	M-N	O-Q	R-S
2008	-0-880504545	1.761009091	0.880504545	0	0
2009	-0.822859091	0.822859091	0.822859091	0	0
2010	-1.663932806	0.831966403	0	0	0
2011	-0.855952174	0.855952174	0	-0.855952174	0
2012	-0.868665217	0.868665217	-0.868665217	-0.868665217	0
2013	0	0.8447625	-0.8447625	-0.8447625	0
2014	0	0.854908333	-0.854908333	-0.854908333	0

Table 20: The Standard Industrial Classification TOL 2008

Industry	Classification as based on the Standard Industrial Classification TOL 2008.
A	Agriculture, forestry and fishing (01-03)
B	Mining and quarrying (05-09)
C	Manufacturing (10-33)
D	Electricity, gas, steam and air conditioning supply (35)
E	Water supply; sewerage, waste management and remediation activities (36-39)
F	Construction (41-43)
G	Wholesale and retail trade; repair of motor vehicles and motorcycles (45-47)
H	Transportation and storage (49-54)
I	Accommodation and food service activities (55-56)
J	Information and communication (58-63)
K	Financial and insurance activities (64-66)
L	Real estate activities (68)
M	Professional, scientific and technical activities (69-75)
N	Administrative and support service activities (77-82)
O	Public administration and defence; compulsory social security (84)
P	Education (85)
Q	Human health and social work activities (86-88)
R	Arts, entertainment and recreation (90-93)
S	Other service activities (94-96)
T	Activities of households as employers (97-98)
U	Activities of extraterritorial organisations and bodies (99)
X	Industry unknown (00)

Table 21: Added hidden production by industry

Top level	Industry	Added hidden production in 2014
A	022	0.04
B	081	0.05
B	089	0.05
C	331	0.04
C	332	0.02
E	383	0.1
E	390	0.1
F	411	0.05
F	$42 + 431$	0.05
H	$4931 + 4939$	0.0013
H	4932	0.02
H	494	0.041
H	522	0.005
H	53	0.02
I	55	0.03
I	56	0.05
J	58	0.01
J	59_60	0.05
J	61	0.01
J	62_63	0.01
L	$681 + 68209$	0.07
L	6831	0.08
L	6832	0.05
M	69	0.03
M	701	0.01
M	702	0.02
M	71	0.02
M	72	0.02
M	73	0.02
M	74	0.02
N	77	0.02
N	78	0.01
N	79	0.02
N	80	0.02
N	81	0.01
P	85	0.03
Q	86	0.01
R	90_91	0.02
R	93	0.1
S	95	0.1
S	9602_9609	0.01

Regression 1

```
The VARMAX Procedure n=156 42+431

Number of Observations        156
Number of Pairwise Missing      0

Simple Summary Statistics

Standard
Variable     Type            N          Mean       Deviation
Min          Max

log_lkv      Dependent     156      19.69077        0.42448       18.48916
20.43086
log_palkat   Independent   156      17.99872        0.3138e1      17.07147
18.55971
dummy        Independent   156       0.06410        0.24572       0.00000
1.00000

Dickey-Fuller Unit Root Tests

Variable     Type            Rho     Pr < Rho       Tau     Pr < Tau

log_lkv      Zero Mean      0.08       0.7013      0.65       0.8552
Single Mean     -25.01    0.0026       -3.82    0.0034
Trend           -61.86    0.0005       -5.76    <.0001

Seasonal(Nseason=12) Dickey-Fuller Unit Root Tests

Variable     Type            Rho     Pr < Rho       Tau     Pr < Tau

log_lkv      Zero Mean      0.78       0.6078      3.60       0.9998
Single Mean     -20.62    0.0095       -3.79    0.0005

Type of Model                          ARX(3,1)
Estimation Method     Least Squares Estimation

Model Parameter Estimates n=156 42+431

Standard
```

Equation	Parameter	Estimate	Error	t Value	Pr > |t|	Variable
log_lkv	CONST1	0.18209	0.39226	0.46	0.6433	1
	SD_1_1	−0.03780	0.05709	−0.66	0.5090	S_1t
	SD_1_2	0.27858	0.05734	4.86	0.0001	S_2t
	SD_1_3	0.46603	0.05093	9.15	0.0001	S_3t
	SD_1_4	0.63832	0.05671	11.26	0.0001	S_4t
	SD_1_5	0.76386	0.06318	12.09	0.0001	S_5t
	SD_1_6	0.55943	0.06802	8.22	0.0001	S_6t
	SD_1_7	0.59603	0.04643	12.84	0.0001	S_7t
	SD_1_8	0.51750	0.03398	15.23	0.0001	S_8t
	SD_1_9	0.47081	0.03742	12.58	0.0001	S_9t
	SD_1_10	0.33747	0.03388	9.96	0.0001	S_10t
	SD_1_11	0.39499	0.03860	10.23	0.0001	S_11t
	XL0_1_1	0.48924	0.10444	4.68	0.0001	log_palkat(t)
	XL0_1_2	0.11967	0.07049	1.70	0.0919	dummy(t)
	XL1_1_1	−0.38180	0.10532	−3.63	0.0004	log_palkat(t−1)
	XL1_1_2	−0.10956	0.07420	−1.48	0.1422	dummy(t−1)
	AR1_1_1	0.17172	0.08076	2.13	0.0353	log_lkv(t−1)
	AR2_1_1	0.42809	0.07788	5.50	0.0001	log_lkv(t−2)
	AR3_1_1	0.27216	0.07649	3.56	0.0005	log_lkv(t−3)

Variance Estimate for the Innovation

log_lkv

0.00446

Information Criteria

AICC	−5.26261
HQC	−5.14496
AIC	−5.29783
SBC	−4.9215
FPEC	0.005009

Roots of AR Characteristic Polynomial

Index	Real	Imaginary	Modulus	Radian	Degree
1	0.93774	0.00000	0.9377	0.0000	0.0000
2	−0.38301	0.37886	0.5387	2.3616	135.3123
3	−0.38301	−0.37886	0.5387	−2.3616	−135.3123

Regression 2

The VARMAX Procedure

Number of Observations	156
Number of Pairwise Missing	0

Simple Summary Statistics

Variable	Type	N	Mean	Standard Deviation	Min	Max
log_vahennykset	Dependent	156	17.76826	0.43709	16.57589	18.58766
log_palkat	Independent	156	17.99872	0.31381	17.07147	18.55971
dummy	Independent	156	0.06410	0.24572	0.00000	1.00000

Dickey−Fuller Unit Root Tests

Variable	Type	Rho	Pr < Rho	Tau	Pr < Tau
log_vahennykset	Zero Mean	0.10	0.7050	0.81	0.8859
	Single Mean	−16.50	0.0242	−3.06	0.0320
	Trend	−65.68	0.0005	−5.87	<.0001

Seasonal(Nseason=12) Dickey−Fuller Unit Root Tests

Variable	Type	Rho	Pr < Rho	Tau	Pr < Tau
log_vahennykset	Zero Mean	1.15	0.6363	3.32	0.9996
	Single Mean	−19.49	0.0121	−3.31	0.0021

Type of Model ARX(2,0)
Estimation Method Least Squares Estimation

Model Parameter Estimates

Equation	Parameter	Estimate	Standard Error	t Value	Pr > |t|	Variable
log_vahennykset	CONST1	−1.02238	0.50522	−2.02	0.0449	1
	SD_1_1	0.27325	0.06090	4.49	0.0001	S_1t
	SD_1_2	0.57188	0.04685	12.21	0.0001	S_2t
	SD_1_3	0.50270	0.04075	12.34	0.0001	S_3t
	SD_1_4	0.62755	0.04078	15.39	0.0001	S_4t
	SD_1_5	0.62270	0.04556	13.67	0.0001	S_5t
	SD_1_6	0.42462	0.04435	9.57	0.0001	S_6t
	SD_1_7	0.46299	0.03661	12.65	0.0001	S_7t
	SD_1_8	0.48455	0.03418	14.17	0.0001	S_8t
	SD_1_9	0.45398	0.03342	13.58	0.0001	S_9t
	SD_1_10	0.33644	0.03315	10.15	0.0001	S_10t
	SD_1_11	0.48688	0.03897	12.49	0.0001	S_11t
	XL0_1_1	0.24122	0.08150	2.96	0.0036	log_palkat(t)
	XL0_1_2	0.05077	0.02748	1.85	0.0668	dummy(t)
	AR1_1_1	0.50291	0.08704	5.78	0.0001	log_vahennykset(t−1)
	AR2_1_1	0.28604	0.07921	3.61	0.0004	log_vahennykset(t−2)

Variance Estimate for the Innovation

log_vahennykset

0.00585

Information Criteria

AICC	−5.01952
HQC	−4.91545
AIC	−5.04362
SBC	−4.72809
FPEC	0.006455

Roots of AR Characteristic Polynomial

Index	Real	Imaginary	Modulus	Radian	Degree
1	0.84244	0.00000	0.8424	0.0000	0.0000
2	−0.33953	0.00000	0.3395	3.1416	180.0000

Regression 3

The VARMAX Procedure

Number of Observations	156
Number of Pairwise Missing	0

Simple Summary Statistics

Standard
Variable Type N Mean Deviation
Min Max

log_lkv Dependent 156 20.85821 0.28607 20.05450
21.47169
log_palkat Independent 156 19.21836 0.26502 18.57180
19.79640
dummy Independent 156 0.06410 0.24572 0.00000
1.00000

Dickey−Fuller Unit Root Tests

Variable Type Rho Pr < Rho Tau Pr < Tau

log_lkv Zero Mean 0.06 0.6953 0.81 0.8856
Single Mean −18.55 0.0141 −3.13 0.0270
Trend −74.73 0.0005 −6.15 <.0001

Seasonal(Nseason=12) Dickey−Fuller Unit Root Tests

Variable Type Rho Pr < Rho Tau Pr < Tau

log_lkv Zero Mean 0.51 0.5869 3.00 0.9988
Single Mean −23.24 0.0057 −3.45 0.0013

Type of Model ARX(3,0)
Estimation Method Least Squares Estimation

Model Parameter Estimates n=156 4 1 2 +432_439

Equation Variable	Parameter	Estimate	Standard Error	t Value	Pr > |t|	Variable
log_lkv	CONST1	0.61363	0.52049	1.18	0.2405	1
	SD_1_1	0.07011	0.04947	1.42	0.1587	S_1t
	SD_1_2	0.32533	0.04924	6.61	0.0001	S_2t
	SD_1_3	0.36579	0.04360	8.39	0.0001	S_3t
	SD_1_4	0.40097	0.04369	9.18	0.0001	S_4t
	SD_1_5	0.42386	0.05390	7.86	0.0001	S_5t
	SD_1_6	0.26606	0.04494	5.92	0.0001	S_6t
	SD_1_7	0.34157	0.03941	8.67	0.0001	S_7t
	SD_1_8	0.38768	0.03435	11.28	0.0001	S_8t
	SD_1_9	0.46039	0.03607	12.76	0.0001	S_9t
	SD_1_10	0.36864	0.03032	12.16	0.0001	S_10t
	SD_1_11	0.37529	0.03733	10.05	0.0001	S_11t
	XL0_1_1	0.29044	0.08003	3.63	0.0004	log_palkat(t)
	XL0_1_2	0.01657	0.02356	0.70	0.4831	dummy(t)
	AR1_1_1	0.03859	0.08579	0.45	0.6535	log_lkv(t−1)
	AR2_1_1	0.35540	0.07079	5.02	0.0001	log_lkv(t−2)
	AR3_1_1	0.29426	0.07843	3.75	0.0003	log_lkv(t−3)

Variance Estimate for the Innovation

log_lkv

0.00415

Information Criteria

AICC −5.35346
HQC −5.24446
AIC −5.38124

SBC	−5.04453
FPEC	0.004606

Roots of AR Characteristic Polynomial

Index	Real	Imaginary	Modulus	Radian	Degree
1	0.85574	0.00000	0.8557	0.0000	0.0000
2	−0.40857	0.42063	0.5864	2.3417	134.1667
3	−0.40857	−0.42063	0.5864	−2.3417	−134.1667

Regression 4

The VARMAX Procedure

Number of Observations	156
Number of Pairwise Missing	0

Simple Summary Statistics

Standard
Variable Type N Mean Deviation
Min Max

log_vahennykset Dependent 156 18.91523 0.30592 18.10149
19.52815
log_palkat Independent 156 19.21836 0.26502 18.57180
19.79640
dummy Independent 156 0.06410 0.24572 0.00000
1.00000

Dickey−Fuller Unit Root Tests

Variable Type Rho Pr < Rho Tau Pr < Tau

log_vahennykset Zero Mean 0.07 0.6973 0.86 0.8939
Single Mean −15.04 0.0356 −2.83 0.0570
Trend −71.01 0.0005 −6.00 <.0001

Seasonal(Nseason=12) Dickey−Fuller Unit Root Tests

Variable	Type	Rho	Pr < Rho	Tau	Pr < Tau
log_vahennykset	Zero Mean	0.64	0.5970	2.61	0.9963
Single Mean	−27.80	0.0024	−3.70	0.0006	

Type of Model ARX(2,0)
Estimation Method Least Squares Estimation

Model Parameter Estimates n=156 412+432_439

Equation	Parameter	Estimate	Standard Error	t Value	Pr > |t|	Variable
log_vahennykset	CONST1	−0.58028	0.52659	−1.10	0.2724	1
SD_1_1	0.13623	0.04648	2.93	0.0040	S_1t	
SD_1_2	0.39365	0.04543	8.67	0.0001	S_2t	
SD_1_3	0.28086	0.03859	7.28	0.0001	S_3t	
SD_1_4	0.34905	0.03895	8.96	0.0001	S_4t	
SD_1_5	0.34035	0.05303	6.42	0.0001	S_5t	
SD_1_6	0.14200	0.03930	3.61	0.0004	S_6t	
SD_1_7	0.28276	0.03803	7.44	0.0001	S_7t	
SD_1_8	0.37086	0.03626	10.23	0.0001	S_8t	
SD_1_9	0.37903	0.03311	11.45	0.0001	S_9t	
SD_1_10	0.29721	0.03023	9.83	0.0001	S_10t	
SD_1_11	0.24763	0.03684	6.72	0.0001	S_11t	
XL0_1_1	0.33761	0.08844	3.82	0.0002	log_palkat(t)	
XL0_1_2	0.02385	0.02573	0.93	0.3555	dummy(t)	
AR1_1_1	0.26055	0.08973	2.90	0.0043	log_vahennykset(t−1)	
AR2_1_1	0.41323	0.07270	5.68	0.0001	log_vahennykset(t−2)	

Variance Estimate for the Innovation

log_vahennykset

0.00502

Information Criteria

AICC	−5.17309
HQC	−5.06902
AIC	−5.19718
SBC	−4.88166
FPEC	0.005536

Roots of AR Characteristic Polynomial

Index	Real	Imaginary	Modulus	Radian	Degree
1	0.78617	0.00000	0.7862	0.0000	0.0000
2	−0.52562	0.00000	0.5256	3.1416	180.0000

Regression 5

The VARMAX Procedure

Number of Observations	156
Number of Pairwise Missing	0

Simple Summary Statistics

Variable	Type	N	Mean	Standard Deviation	Min	Max
log_lkv	Dependent	156	16.53716	0.48125	15.35645	17.60810
log_palkat	Independent	156	14.76022	0.23111	14.17426	15.29358
dummy	Independent	156	0.06410	0.24572	0.00000	1.00000

Dickey−Fuller Unit Root Tests

Variable	Type	Rho	Pr < Rho	Tau	Pr < Tau
log_lkv	Zero Mean	0.08	0.6994	0.51	0.8251

```
Single Mean       -18.61        0.0139        -3.25        0.0193
Trend             -49.79        0.0005        -5.00        0.0004

Seasonal(Nseason=12) Dickey-Fuller Unit Root Tests

Variable     Type                Rho     Pr < Rho        Tau     Pr < Tau

log_lkv      Zero Mean          0.63       0.5963       1.51       0.9465
Single Mean       -48.14        0.0023        -6.09        <.0001

The VARMAX Procedure

Type of Model                             ARX(2,0)
Estimation Method      Least Squares Estimation

Model Parameter Estimates n=156 411

Standard
Equation     Parameter          Estimate            Error     t Value     Pr > |t|
Variable

log_lkv     CONST1              -5.17674         1.23214       -4.20       0.0001
1
SD_1_1              0.32901         0.10355        3.18       0.0018     S_1t
SD_1_2              0.42759         0.08809        4.85       0.0001     S_2t
SD_1_3              0.45222         0.08410        5.38       0.0001     S_3t
SD_1_4              0.34271         0.07817        4.38       0.0001     S_4t
SD_1_5              0.45102         0.09688        4.66       0.0001     S_5t
SD_1_6             -0.01245         0.08112       -0.15       0.8782     S_6t
SD_1_7              0.40386         0.09606        4.20       0.0001     S_7t
SD_1_8              0.51931         0.07994        6.50       0.0001     S_8t
SD_1_9              0.42471         0.07611        5.58       0.0001     S_9t
SD_1_10             0.47575         0.07670        6.20       0.0001     S_10t
SD_1_11             0.66293         0.08762        7.57       0.0001     S_11t
XL0_1_1             0.89024         0.16582        5.37       0.0001     log_palkat(t)
XL0_1_2             0.01721         0.05636        0.31       0.7605     dummy(t)
AR1_1_1             0.29678         0.08094        3.67       0.0003     log_lkv(t-1)
AR2_1_1             0.19947         0.08003        2.49       0.0139     log_lkv(t-2)

Variance Estimate for the Innovation
```

log_lkv

0.02855

Information Criteria

AICC	−3.43385
HQC	−3.32977
AIC	−3.45794
SBC	−3.14241
FPEC	0.031518

Roots of AR Characteristic Polynomial

Index	Real	Imaginary	Modulus	Radian	Degree
1	0.61902	0.00000	0.6190	0.0000	0.0000
2	−0.32224	0.00000	0.3222	3.1416	180.0000

Regression 6

The VARMAX Procedure

Number of Observations	156
Number of Pairwise Missing	0

Simple Summary Statistics

Variable	Type	N	Mean	Standard Deviation	Min	Max
log_vahennykset	Dependent	156	14.77671	0.54082	13.50222	15.83665
log_palkat	Independent	156	14.76022	0.23111	14.17426	15.29358
dummy	Independent	156	0.06410	0.24572	0.00000	1.00000

Dickey−Fuller Unit Root Tests

```
Variable          Type            Rho    Pr < Rho      Tau    Pr < Tau

log_vahennykset   Zero Mean       0.10     0.7044      0.55      0.8347
Single Mean     -15.79      0.0293     -2.99     0.0384
Trend           -42.74      0.0005     -4.64     0.0013

Seasonal(Nseason=12) Dickey-Fuller Unit Root Tests

Variable          Type            Rho    Pr < Rho      Tau    Pr < Tau

log_vahennykset   Zero Mean       0.59     0.5935      0.84      0.8302
Single Mean     -44.32      0.0023     -5.19     <.0001

Type of Model                   ARX(2,0)
Estimation Method    Least Squares Estimation

Model Parameter Estimates n=156 411

Standard
Equation        Parameter      Estimate        Error  t Value Pr > |t| Variable

log_vahennykset CONST1         -7.88384      1.60582    -4.91   0.0001 1
SD_1_1          0.21798      0.10397    2.10    0.0379  S_1t
SD_1_2          0.40945      0.09471    4.32    0.0001  S_2t
SD_1_3          0.37725      0.09037    4.17    0.0001  S_3t
SD_1_4          0.29273      0.08553    3.42    0.0008  S_4t
SD_1_5          0.39134      0.10597    3.69    0.0003  S_5t
SD_1_6          0.02064      0.08961    0.23    0.8181  S_6t
SD_1_7          0.34647      0.09639    3.59    0.0005  S_7t
SD_1_8          0.55628      0.08459    6.58    0.0001  S_8t
SD_1_9          0.35821      0.07950    4.51    0.0001  S_9t
SD_1_10         0.48815      0.08271    5.90    0.0001  S_10t
SD_1_11         0.60477      0.09279    6.52    0.0001  S_11t
XL0_1_1         0.99904      0.18348    5.45    0.0001  log_palkat(t)
XL0_1_2         0.04479      0.06160    0.73    0.4684  dummy(t)
AR1_1_1         0.27385      0.07951    3.44    0.0008  log_vahennykset(t-1)
AR2_1_1         0.23920      0.07795    3.07    0.0026  log_vahennykset(t-2)

Variance Estimate for the Innovation
```

log_vahennykset

0.03348

InformationCriteria

AICC	−3.27467
HQC	−3.1706
AIC	−3.29877
SBC	−2.98324
FPEC	0.036957

Roots of AR Characteristic Polynomial

Index	Real	Imaginary	Modulus	Radian	Degree
1	0.64481	0.00000	0.6448	0.0000	0.0000
2	−0.37096	0.00000	0.3710	3.1416	180.0000

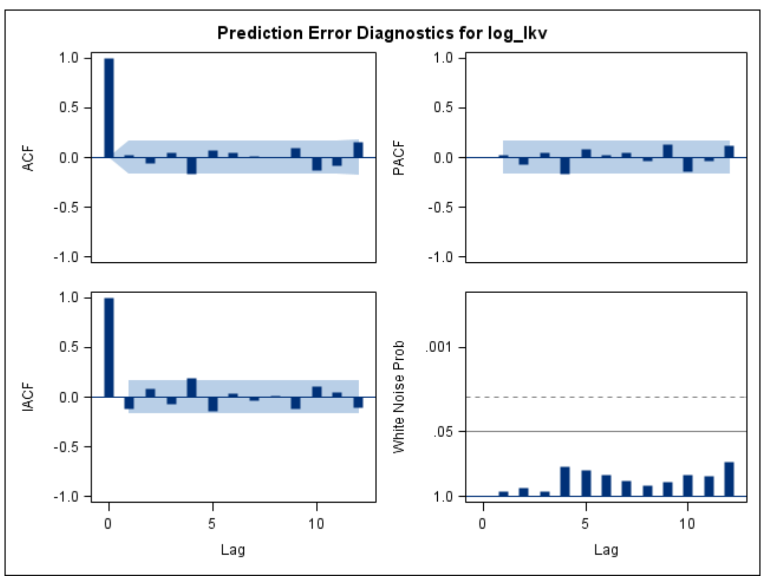

Figure 24: Diagnostics 1. revenue in 42+431

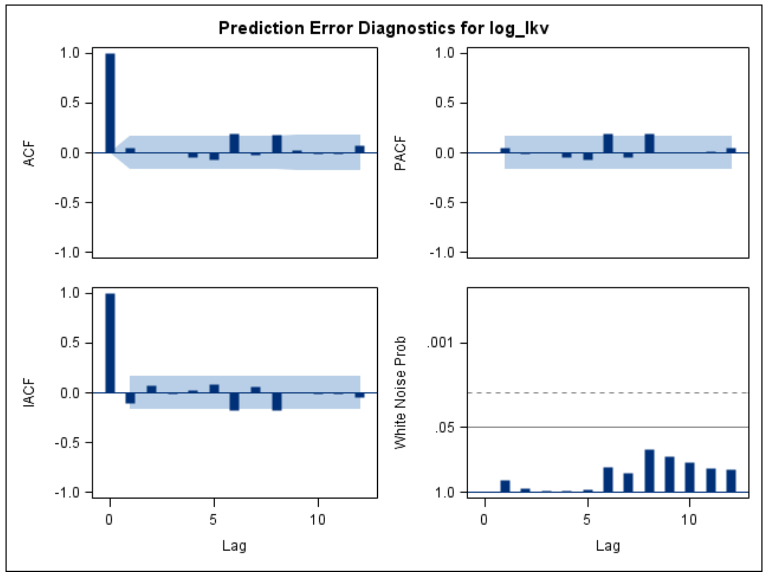

Figure 25: Diagnostics 2. revenue in 412 + 432_439

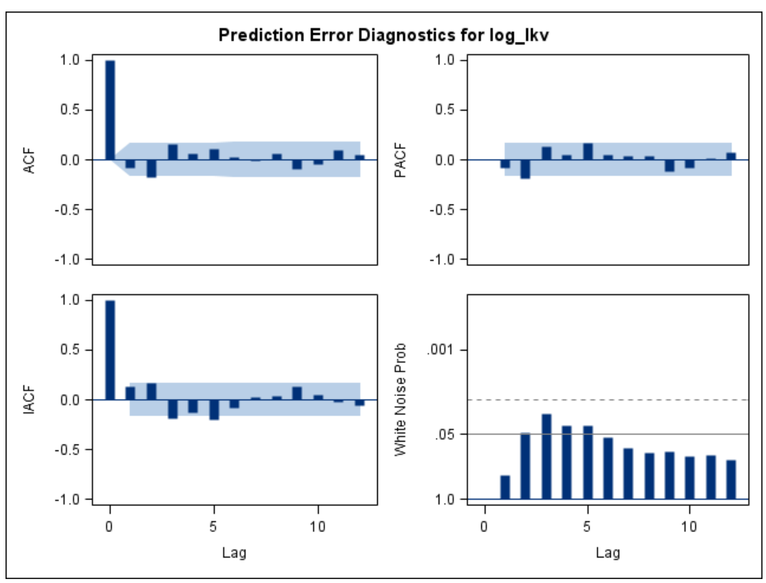

Figure 26: Diagnostis 3. revenue in 411

Send completed form to:

FINNISH TAX ADMINISTRATION
PO Box 5000
00053 VERO

PERIODIC TAX RETURN **K**

If making corrections to an earlier filing, please only submit difference amounts instead of full amounts.

Do not send any enclosures with the Periodic tax return form.

Taxpayer's name (Name of VAT payer, Name of employer)	**010** Business ID or personal identity number

46

VALUE ADDED TAX

050 Reporting frequency	**052** Period in question	**053** Year
☐ Month ☐ Quarter ☐ Year		

	euro	cents
Tax on domestic sales by tax rate		
301 24 % tax		
302 14 % tax		
303 10 % tax		
305 Tax on goods purchased from other EU Member States		
306 Tax on services purchased from other EU Member States		
318 Tax on construction services purchased (reverse charge)		
307 Tax deductible for period in question		
317 Amount of VAT relief		
308 **Tax payable / Negative tax that qualifies for refund (-)**		
309 Sales taxable at zero VAT rate		
311 Sales of goods to other EU Member States		
312 Sales of services toother EU Member States		
313 Purchases of goods from other EU Member States		
314 Purchases of services from other EU Member States		
319 Sales of construction services (reverse charge)		
320 Purchases of construction services (reverse charge)		

K

No VAT activity

054 Period-start	**055** Year	**056** Period-end	**057** Year

EMPLOYERS' CONTRIBUTIONS

050 Reporting frequency	**052** Period in question	**053** Year
☐ Monthly ☐ Quarterly		

	euro	cents
601 Wages/other compensation subject to withholding		
602 **Tax withheld**		
605 Wages/other payments subject to tax at source		
606 **Tax at source on wages/ other payments**		
609 Wages subject to social security contribution		
610 **Social security contribution payable**		

Period of no wage payments

054 Period-start	**055** Year	**056** Period-end	**057** Year

For taxpayers within VAT relief scheme

	euro	cents
315 Sales that qualify for VAT relief		
316 Tax that qualifies for VAT relief		
Amount of VAT relief (transfer to line 317)		

Date	Signature and printed name	**042** Telephone

VEROH 4001e/1 1.2016

VERO SKATT

K

Send completed form to:

FINNISH TAX ADMINISTRATION
PO Box 5000
00053 VERO

PERIODIC TAX RETURN (page 2) **M**

If making corrections to an earlier filing, please only submit difference amounts instead of full amounts.

Do not send any enclosures with the Periodic tax return form.

Taxpayer's name	**010** Business ID or personal identity number

TAX RETURN FOR OTHER UN-PROMPTED TAXES

46 Please enter type of tax (code numbers from list below), reporting frequency, taxable period in question, year, and amount of tax payable.

10 Lottery tax
16 Tax on insurance premiums
24 Amount withheld from purchase price for timber
25 Amount withheld from payment to limited company, cooperative or other corporation
68 Amount withheld from interest paid out
92 Amount withheld from dividends, and distributions of profit surplus by a cooperative
39 Tax at source withheld from dividends (paid out to nonresidents)
69 Tax at source withheld from interest and royalties (paid out to nonresidents)
84 Tax at source withheld from interest income (of residents)

M

060 Tax type code	**050** Reporting frequency	**052** Period in question	**053** Year	**061** Amount of tax payable	
				euro	cents
	☐ Monthly ☐ Quarterly				
	☐ Monthly ☐ Quarterly				
	☐ Monthly ☐ Quarterly				
	☐ Monthly ☐ Quarterly				
	☐ Monthly ☐ Quarterly				

For taxpayers of tax on insurance premiums (vakuutusmaksuvero):

No-activity period of business subject to insurance-premium tax			
054 Period-start	**055** Year	**056** Period-end	**057** Year

Date	Signature and printed name	**042** Telephone