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Tittel *:	An inquiry into the relation between Business cycles and Income Inequality
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Abstract

We evaluate the role of business cycles and some key economic indicators on income disparity within- and between municipalities. We decompose Norwegian mainland GDP between 2006-2017 to a cyclical and trend component and key macroeconomic variables which vary within municipalities. Using Mundlak's correlated-random effects model we estimate the effect of the business cycle on official inequality measures, the Gini-coefficient and P90/P10. These measures are complemented by a set of individual income measures and fractiles constructed from pensionable- and general income which aims to capture distributional changes. We find that the business cycle is regressive within municipalities while the underlying trend component has an equalizing effect. The between-municipality effects are ambiguous, some evidence speak for a regressive behaviour of the trend component and from the estimated within- and contextual effects it is difficult to infer significant between-effects

Preface

This thesis marks the end of a two-year Master of Science programme in Applied Economics at the Department of Economics, BI Norwegian Business School.

First and foremost we would like to thank our supervisor Jørgen Juel Andersen for his guidance and inspiration. We would also like to thank Rune J. Sørensen for access to data on the income distribution.

Mads would like to express his gratitude toward his fiancé, Katrin Frøder, and their daughter, Siren, for their patience and support through the last couple of years.

David would like to express his heartfelt gratitude to his loved ones for their understanding, and patience during the last years of study.

Contents

1 Introduction

Norway is generally considered as one of the countries with the lowest levels of inequality in the developed world. The last decade, however, the idea that Norway is particularly egalitarian has been disputed. Aaberge, Modalsli and Vestad (2020) points to retained income in firms as one way the income disparities are suppressed, and Halvorsen and Stjernø (2021) argues that with regards to wealth, Norway is among the least equal countries in the world, where the richest 10 percent own more than 60 percent of Norwegian wealth. The country is a narrow, far-stretching one, with relatively few large cities and an uneven distribution of the population, with the majority of the population being located in cities or towns[1]. The Norwegian landscape with its fjords and mountains, the vast coastline and –importantly– the rights to the continental shelf has provided the country with an abundance of natural resources.

The regions in Norway are relatively different with respect to industry composition and demographic characteristics, which in turn may affect inequality. Furthermore, the regions are likely to differ in their sensitivity to changes in the business cycle, assuming that certain industries are more vulnerable to economic up- and downturns than others. We therefore analyse how income inequality develops across municipalities in Norway, as these offer more depth and nuance than the broader county-level. Our focus of is to shed a light on the development in income inequality over the business cycle and within and across municipalities. Formally, we ask two research questions:

1. What is the relation between the business cycle and income inequality in Norway?

2. Is there a difference in the measures of income inequality's responsitivity to the business cycle across municipalities?

We use a combination of municipality- and national level data over a thirteen-year time frame, from 2004 to 2017, and investigate whether municipalities with certain industry characteristics respond differently to changes in the

[1] In 2019 approximately 83% of the Norwegian population lived in cities or towns, according to Statistics Norway (Haus, 2019)

business cycle and variation in other economic indicators. We define three economically important industries, petroleum, aquaculture and hydropower. Although the chosen industries may appear somewhat arbitrary, they have all been either significant contributors to GDP or for local value creation. They also have the advantage that they are quite simple to isolate from other industries whereas other industries, for instance manufacturing, can be difficult to decompose at a regional level as one would have to know exactly what was manufactured where for our analysis to give a precise interpretation. Neither are services easily applied even though it is very important for value creation, as it needs the same decomposition as manufacturing.

In 2017, the three largest industries in Norway in terms of employment were health and care, retail and trade, and construction. In terms of value creation, the three largest are extraction of oil and gas, retail and trade, and industry. Lastly, in terms of gross product, measured after main industries, the three largest are industry, construction, and extraction of oil and gas (Chaffey, 2017). Retail and trade is present everywhere, and can be assumed to be highly correlated with relative purchasing power. Under this assumption it would be more fitting as a measure of overall income discrepancy than inequality in the income distribution. Health and care is largely maintained by the public sector, and is as such unfit for our purposes. Other than industrial compositions Norway in known for small rural municipalities. Earlier studies have shown that income inequality differs greatly between rural and urban areas.

We evaluate income inequality in light of the business cycles and closely related macroeconomic variables in order to estimate effects both within and between municipalities. This is achieved using Mundlaks' correlated-random effects model. In order to extract the business cycles from Norwegian GDP we use two detrending methods, the HP-filter and Hamilton (H84) and evaluate them before deciding which is appropriate.

First we describe the historical- and institutional setting of Norway before we outline relevant literature to business cycles, income inequality, and the intersection between the two in Section 2. In Section 3 we describe the data we are working with together with some descriptive statistics. Section 4 covers methodology and models, while Section 5 contains the main results while we take time to discuss then implications of the results in Section 6. In Section 7 we will conclude our findings.

1.1 Historical economic and institutional setting

Since Norway gained its sovereignty in 1814, the economy has experienced significant growth and undergone significant structural changes. The primary sector[2] decreased from about 55% to 2.5% of total value creation in Norway from 1820 to 2020, and secondary industries such as manufacturing peaked at approximately 35% following the second world war, and have since remained around this level[3]. Services has always been important in the Norwegian economy, and has been the largest contributor to Norwegian GDP since the 1860s. This is in part due to a lack of self-sufficiency, which has made trade very important for the country (Grytten, 2020).

The Norwegian economy has generally been relatively close to the European average in terms of growth and wealth, and the state of the Norwegian economy has generally – to some extent – mirrored the state of the European economy. The "Panic of 1873" jump-started a significant economic downturn in both Europe and North America (History central, n.d.), after which the Norwegian economy fell into a decades-long relative stagnation. In the 1890's the economic development turned around in Norway, as the country experienced rapid industrialization based on hydroelectricity.

After World War II, Norway adopted a social democratic rule and established an economic structure with a high degree of economic planning. This contributed to a large public sector and a system where wealth and resources were evenly distributed. Since the 1970's, the petroleum industry has also

[2] Agriculture, forestry, fishing, etc.

[3] Manufacturing decreased significantly during the 1970's, but this was compensated by a vast increase in oil- and gas extraction, so that the total percent of total value creation by secondary industries remained approximately the same

spurred the country's growth and become one of the most important building blocks of the Norwegian economy, making it one of the wealthiest countries in the world measured per capita (Grytten, 2020).

In the recent decades the aquaculture industry has been experiencing significant growth both domestically and internationally, and is often named one of the potential key industries for the future of the Norwegian economy. Fisheries and aquaculture is regarded a key driver in rural and coastal economic well-being. In 2018, Norway produced 4 million tonnes of fish, valued at 10.814 million USD, where 77% of this value came from aquaculture. Over a ten-year period (2008-2018), production increased by 17%, while the value of production increased 104% (OECD, 2021).

2 Literature Review

There are many studies on the connection between the business cycle and economic inequality, but among the studies we review the measures of inequality or estimation of the business cycle is usually taken for granted, and isn't discussed to much extent. For completeness, we therefore include literature on income inequality and the business cycle both separately and jointly. We do this to improve our understanding of the relationship between the cycle and inequality.

2.1 Income inequality

Economic inequality has been brought back into the public debate in the 2000's, particularly fuelled by a handful of books. Wilkinson and Pickett's (2012) "The Spirit Level: Why More Equal Societies Almost Always do Better" sets out to show how income inequality affects many other aspects of our society, from life expectancy and mental health to obesity, and that all layers of society is worse off the less equality in their society. They find that income inequality heavily affects health issues. The book has been challenged, and a common criticism is that their linear estimation approach is inappropriate for measuring the effect of economic on health, and that thus their results overestimate the causation (Rambotti, 2015).

Joseph Stiglitz's "The Price of Inequality" (2013) and "The Great Divide: Unequal Societies And What We Can Do About Them" (2015) both discuss income inequality with a particular focus on the US, and how the challenges surrounding income inequality can be handled. Stiglitz argues that inequality in the US could be significantly reduced by implementing policies similar to those of the Scandinavian countries. In "The Great Divide", he also points out the connection between growth and inequality, where he writes that Inequality stifles, restrains, and holds back growth" (Stiglitz, 2015, p.277), and goes on to argue that there are four major reasons for this; the middle class in the US is too weak to support the consumer spending that has historically driven economic growth, and a hollowing out of the middle class makes them unable to invest in their future. A weak middle class also holds back tax revenue, particularly when those at the top manage to largely avoid taxation. Finally, inequality is associated with "more frequent and more severe boom-and-bust cycles that make our economy more volatile and vulnerable"[4]. Referring to the financial crisis in 2008, he argues that although inequality was not the direct cause of the crisis it was a significant factor. The last time economic inequality was as high as prior to the financial crisis of 2008, he states, was in the 1920s and resulted in the Great Depression (Stiglitz, 2015, p.277-278).

Finally, the perhaps most popular is Thomas Piketty's "Capital in the Twenty-First Century" (2017). Piketty argues that – without interventions – we are moving toward a system where economic elites inherit their wealth rather than earn it, reminiscent of the 19th century in Western Europe. Among his conclusions is that, in the long run, the economic inequality that will matter is not that between high- and low income, but rather that of those that inherit large sums and those that don't. Piketty still devotes some time to income inequality, where he discusses the possible reasons for the vastly increasing wage gap between the top income earners and the rest. One of the reasons Piketty finds most compelling is that the top income earners has more power over their own salaries, and that people tend to overevaluate their own contribution. That way, they create an upward pressure on wages among their peers, so that over time the wages in this group increases more than for the other income recipients.

[4]boom-and-bust cycles is simply another term for the business cycle.

2.2 Measures of Inequality

Amartya Sen (1973) writes that the proposed measures of inequality in economic literature crudely can be put in two categories. One is positive measures, that aims to catch the extent of inequality in an objective sense, using statistical measures of relative variations of income. The other is normative measures, where higher levels of inequality implies lower social welfare. Which approach to pursue is not obvious and they are not exclusive, in the sense that an objective approach is necessarily - in some ways - related to normative concerns, and vice versa. Sen states that "in one way or another, usable measures of inequality must combine factual features with normative ones".

The most widely used measures of inequality today is the *Gini coefficient.* This coefficient is a statistical measure presented by Gini in 1912 that quantifies the amount of inequality in a population. It is represented either as a ratio (ranging from 0 and 1) or in terms of percent (0 to 100) where 0 means there is no inequality, e.g. there is perfect equality, and 1 (or 100) means that there is perfect inequality, as if all income in a country was received by one person. The Gini coefficient is derived from Max Lorenz' *Lorenz curve* and the two are often represented together[5]. The Lorenz curve is a graphical representation of the distribution of wealth or income in a society. It is measured in terms of deviation from the bisector, a 45-degree line cutting through the unit square (Sen, 1973).

In Norway, Statistics Norway is responsible for the official measurement of inequality. Statistics Norway primarily focuses on the Gini-coefficient, the P90/P10 decile ratio, and the S80/S20 ratio. P90/P10 is the ratio of the income of the individual that has slightly higher income than 90 percent of the population, i.e. the individual that is located between the 9th and the 10th deciles, and the income of the individual that is located between the 1st and 2nd deciles in the income distribution. S80/S20 is a ratio measuring the average income of the 20 percents of the population with the highest income to that of the 20 percent of the population with lowest income (Epland & Tuv,

[5]see A.1.1

2019).

2.3 The Business Cycle

A widely accepted definition of the business cycle is that it is a four-stage cycle of fluctuations in the gross domestic product (GDP) around it's long-term natural growth rate. The four stages in the cycle are expansion, peak, contraction, and trough, respectively (Estevez, 2022). The idea that there is some alternating economic cycles is centuries old. For instance, Charles Dunoyer (1786-1862) is credited as one of the first to formalize a theory stating that the economy cycled between two phases periodically (Benkemoune, 2009). It is, however, not until the postwar-period the current understanding emerged, when Burns and Mitchell provided their definition of the business cycle in their book *"Measuring Business Cycles* from 1946. In addition to giving the modern definition of the term, one of the key insights of their paper was the acknowledgement that many important economic indicators move together (Romer, 2008). Burns and Mitchell's findings were viewed with skepticism due to their "arcane methodology", until Hodrick and Prescott in 1980 re-examined the empirical regularities of the business cycle using modern time-series tools (King & Rebelo, 1999).

The empirical relationship between the GDP and other economic factors are referred to as 'stylized facts' or 'broad regularities' of business cycles (Husebø & Wilhelmsen, 2005). These stylized facts are – importantly – not to be considered universal, as they vary between countries (Kufenko & Geiger, 2017). Hilde Bjørnland has presented such stylized facts for Norway, using an array of detrending methods over quarterly data in the period 1967-1994. Here, she shows that economic indicators such as consumption, exports, imports, investment and productivity are procyclical (positively cross-correlated with GDP), whereas unemployment is countercyclical (negatively cross-correlated with GDP). The results on real wages are conflicting, but Bjørnland believes that the cyclical component is best captured by the detrending methods that indicate that real wages are countercyclical (Bjørnland, 2000).

Husebø and Wilhelmsen (2005) revisits the stylized facts for the Norwegian business cycles with an expanded set of macroeconomic variables, and limiting the methodology to one detrending method, the HP-filter, and for a different sample period, 1982-2003. Husebø and Wilhelmsen's results agree with Bjørnland (Bjørnland, 2000) on the procyclicality of consumption, investment and imports, but disagrees with respect to labor productivity and real wages which they find to be acyclical and procyclical, respectively. Particularly the procyclicality of real wage income is in contrast to the results of Bjørnland (2000), but also with results from the Euro area (Mojon & Agresti, 2001) and the US (Stock & Watson, 1999). Husebø and Wilhelmsen (2005) points to that their finding of a procyclical real wage income is in line with Kydland and Prescott (1990), but that more recent studies support a view of acyclical real wage income. Additionally, they report that *prices in levels* are negatively correlated with output, whereas consumer price inflation is strongly procyclical and lagging output by approximately 4 quarters. Predating the 1990's, price levels were assumed to be procyclical, but according to Kydland and Prescott (1990) this is not the case, which is further substantiated by Husebø and Wilhelmsen (2005).

Closely related to the stylized facts of the business cycle is Okun's law, which describes the relation between output and employment. Arthur Okun (1962) originally claimed that a 1 percentage point increase in unemployment followed a 3 percentage point decrease in GDP from its long-run level, and vice versa (Beggs, 2021). Okun's law is considered consistent in advanced economies although the estimates has been revised, implying a lower ratio than originally formulated (Prachowny, 1993).

2.4 Income Inequality & the Business Cycle

That the business cycle impacts income inequality seems intuitive, given that the cycle is generally considered correlated to an array of economic variables such as, for instance, unemployment and real wage income. The empirical results are not, however, unanimous, as there is some disagreement between studies across time. This may be attributed to differences in measurement techniques, diluted effects or weakened links over time due to societal change, or other systemic differences in sampled time series across the different studies.

Mendershausen (1946) and Kuznets and Jenks (1953) finds that inequality in the U.S. followed an anticyclical pattern, but that the income share of the highest groups rose in recessions and declined in booms. Creamer (1956), and Blank (1987) shows that household income generally is sensitive to the business cycle. Blank also detected significant cyclical effects where income inequality followed a countercyclical pattern, meaning income inequality is reduced in economic booms, both between and within different demographic groups. Additionally, she shows that transfer income[6] – both public and private – is countercyclical for most middle income groups, although the cyclicality varies over types of transfers.

Johnson and Shipp (1999) finds that the trends in the distribution of income and consumption responded similarly to changes in inflation and unemployment over quarterly data in the period 1980-1994. They also cite that unemployment has no significant effect on the inequality measures, whereas inflation has a progressive effect. This is, however, conflicted by Hoover, Giedeman and Dibooglu (2009) who uses asymmetric cointegration tests in showing that unemployment and immigration shocks have real impacts on income inequality.

Barro (2000) argues that government expenditure as a share of GDP is a determinant for inequality and can serve as a mitigator for changes in inequality, particularly with respect to effects on unemployment, which tends to not affect incomes uniformly. Heathcote, Perri and Violante (2010) finds that the income

[6] i.e pensions

of the lower percentiles of the income distribution decline rapidly in recessions. Krueger, Mitman and Perri (2015) also finds that a recession features lower aggregate wages and higher unemployment. Bayer, Born and Luetticke (2020) makes a note that data on economic inequality adds no significant change to the estimated shocks and frictions in the business cycle, but that their estimated shocks bear significant impact on the development of income- and wealth inequality in the US.

Parker (1998) reviews some evidence on inequality and the business cycle in developed economies. His review further reinforces the notion that cyclical downturns have a disequalizing effect, and that upturns have an equalizing effect on the income distribution. He also finds some evidence that inflation has some equalizing effects with middle income takers – at the expense of the top income share.

2.5 Income inequality in Norway

Statistics Norway (SSB), is the main producer of official statistics and publish statistics on economic inequality in Norway annually, which mainly comprise three different measures - the Gini coefficient, P90/P10 and S80/S20. Much of the important research on economic inequality in Norway also comes from researchers at, or affiliated with, Statistics Norway.

Aaberge and Atkinson (2010) analyze the development of top income shares in the Norwegian population over a span of 140 years - from 1875 to 2006. Their work suggests that, while the income shares of those at the top overall declined from 1875 to 1980, the top income shares grew significantly from the early 1990's, particularly due to a rapid increase in the income share of the top 1 percent. One year prior, Solbu (2009) also investigates the development of income inequality in Norway over approximately the same period. These results are generally aligned with Aaberge and Atkinson, but Solbu also points out that whereas inequality measured in terms of general income falls until the early 1990's, income inequality measured in terms of pensionable income, which is generally considered an indicator for wage inequality, increases also throughout the 1980's.

Lund (2012) also studies the development of income inequality in Norway since the late 19th century, and finds that prior to world war II, income inequality in cities and rural areas move in opposite directions. She hypothesizes that since the economic basis in these two areas are quite different, business cycle fluctuations may impact rural and urban areas differently. Modalsli (2018) studied the regional dispersion of income inequality for Norway in the 1900s and found that the average Gini coefficient was twice as high in cities than that of rural areas. Aaberge, Atkinson, and Modalsli (2020) review the long-run income inequality in Norway and their estimates consolidated the view of Aaberge and Atkinson (2010) in showing that changes in inequality from 1875 to 2017 was mainly due to income changes in the top-half of the distribution, particularly driven by the income recipients at the very top.

In 2021, Statistics Norway published an extensive article on economic inequality in Norway authored by Aaberge, Mogstad, Vestad and Vestre, which describes the development of income- and wealth inequality in Norway during the 21st century. It supplements the official statistics by comparing the measures used in official statistics with a set of more extensive measures of income and wealth (Aaberge, 2021). As a rather extensive article that summarizes many important features of economic inequality and redistribution in Norway, Aaberge et al. feature many distinct characteristics of the Norwegian economy and the economic system. When investigating the difference in inequality between urban and rural areas, they find that average income in the largest cities in Norway is both higher and more varied than the average income elsewhere, and whereas the difference in median income is smaller than that of average income, median income is also higher in the large cities. Another notable contribution is the effect of local government services on inequality. The value of these services are generally not included in measures of the income distribution, which weakens the comparability of income inequality over time and across borders. Aaberge et al. (2019) show that the redistributive effect of municipality-produced services has increased over time, and in 2013 it surpassed the redistribution effect of cash transfers from the national government.

3 Data collection & descriptive statistics

In order to evaluate the impact of the business cycle on income inequality in Norwegian municipalities we retrieve data from a collection of official sources, and tailor a dataset that will allow us to study this relation. All data is retrieved- or constructed based on information from official sources such as Statistics Norway and government directorates. In this section we describe our data collection process, the nature of our variables and data modifications.

3.1 Dependent variables - Measures of inequality

To measure how income inequality develops we use a set of different measures of income inequality; the Gini coefficient, the P90/P10 ratio. Gini and P90/P10 is measured using household disposable income, which includes capital income and public cash transfers. These are complemented by fractile ratios of pensionable-[7] and general[8] income (Statistics Norway, 2022g, 2022h). With the exception of the Gini coefficient and the P90/P10 ratio, which is retrieved directly from Statistics Norway (2022b), the distribution of personal- and general income has been collected and arranged by Professor Rune J. Sørensen.

Table 1: Dependent variables - Measures of income and inequality

Name	*Definition*	*Level*[a]	*Source*
Gini	Gini coefficient of Income in Norwegian households	M	Statistics Norway
P90P10	The income decile ratio P90/P10	M	Statistics Norway
pinnt_*	Pensionable income, *th fractile[b]	M	Statistics Norway
ainnt_*	General income, *th fractile[b]	M	Statistics Norway

[a] Whether it is municipality (M) or national (N) level data.

[b] We use the 10^{th}, 25^{th}, 50^{th}, 75^{th} and 90^{th} fractiles as well as ratios 90/10, 90/50, 50/10.

[7]Pensionable income is the sum of personal income: wages and personal income: self-employment.

[8]general income before deductions. General income is a net income and is calculated by all taxable entities, both persons and firms. Any taxable income, with deductions for all deductible costs, are included.

3.2 Main variables of interest and control variables

The main variable of interest is the cyclical component of output, but since there is not necessarily a direct connection between the business cycle and income inequality, and literature suggests possible connections, we extend what is considered main variables of interest to also include a set of common variables connected directly to the business cycle as shown in table 2. The measures of the business cycles are constructed using data on annual, national GDP collected from Statistics Norway (2022c). Fiva, Halse and Natvik (2020) provide data on demographics and municipality-specific characteristics, such as population and age composition, unemployment, consumer price inflation, local government expenditures, in which we also add the real interest rate and education levels. These are complemented by four indicator variables which acts as markers for municipal characteristics which are constant across our sampled years. Three of the four indicators are considered important for Norwegian value creation and assumed to, to some extent, affect income inequality. The fourth is aimed to capture differences between heavily populated municipalities and more rural municipalities.

Since business cycles and trends are derived from economic activity and total value creation, there are pitfalls pertaining the selection of complementary control variables. For example, the real interest rates are results of economic activity, inflation and several other factors. Components that are not explicitly modelled are likely captured by the business cycle and trend and the interpretation of the these two components would therefore be challenging if it pools unidentified variables. Demographic compositions including immigration and education are connected and has a well documented effect on income distributions and are therefore appropriate controls when analyzing differences between sub-populations. Municipal expenditure are likely correlated with government spending – which we know is counter-cyclical – and is progressive in nature. There is also a direct connection between municipal earnings, tax income – and in extension spending – and hydroelectric production. Our set of controls are mainly demographics and are considered exogenous, we do not believe that economic variables, or income has a substantial effect on the demographic composition or level of education. Whether immigration affects economic up- and downturns, or economic swings affects immigration is a potential article in itself. We consider immigration as an exogenous force driven in general by labour immigration in the Schengen area starting in the early 2000's.

Table 2: Explanatory variables

Name	*Definition*	*Level*[a]	*Source*
Main variables of interest			
Cycle	HP-filtered business cycles	N	Own calculations
Trend	HP-filtered trends	N	Own calculations
Unemployment	Unemployment rate of population	M	Fiva, Halse & Natvik[b]
CPI	Consumer Price Inflation, with baseline year 2011	N	Fiva, Halse & Natvik[b]
Real Rate	Real interest rate (after taxes)	N	Statistics Norway, 2022e
Control variables			
Population	population in municipality	M	Fiva, Halse & Natvik[b]
Pre-schoolers	Share of population at pre-school age	M	Fiva, Halse & Natvik[b]
School age	Share of population at school age	M	Fiva, Halse & Natvik[b]
Elders	Share of population defined as elders (>66 years)	M	Fiva, Halse & Natvik[b]
Mun.Exp	Total expenditure by local government over different government spending areas (per capita in 1000NOK)	M	Fiva, Halse & Natvik[b]
Immigrants	number of new immigrants per year	M	Statistics Norway, 2022a
Primary school	Share of pop. with primary school as highest education	M	Statistics Norway, 2022d
University	Share of pop. with higher education	M	Statistics Norway, 2022d

[a] Whether it is municipality (M) or national (N) level data.

[b] Local Government Data, 2020.

The indicator variables in table 3 are Petroleum, Aquaculture, and producers of hydroelectric power. The fourth is an indicator which includes the 10 biggest cities, all of which takes the value 1 if a municipality is containing one of them and 0 otherwise.

Municipal producers of hydroelectric power are many, the data is collected from the Norwegian Water Resources and Energy Directorate (NVE, 2022).

309 municipalities has active production in our sample period but both the output and number of facilities differ greatly. To separate the effects of hydroelectric production we also create a "narrow" variable to only include those who either are in the 90th percentile of average yearly production, or those who have above average number of facilities.

The Petroleum indicator includes the municipalities who have a large share of workers within the sector, or related sectors as well as municipalities with oil- and/or gas onshore facilities. These are identified firstly through publications by Statistics Norway (Ekeland, 2014, 2015a, 2015b, 2017; Johannessen, 2009; Johannessen et al., 2010; Sandvik & Johannessen, 2013; Thoen & Johannessen, 2011), historically commissioned by The Norwegian Oil and Gas Association or the Ministry of Petroleum and Energy, and secondly through the location of Norwegian oil- and gas onshore facilities.

Municipalities with aquaculture are indexed using data from the Directorate of Fisheries with statistics for 2017 on recipients of the government *Aquaculture Fund* as a proxy for aquacultural municipalities. One third of Norwegian municipalities are in the Aquaculture registry and has approval from The Directorate of Fisheries to conduct salmon and trout farming. The aquaculture industry is a large contributor to value creation and is spread throughout the coastal line. As with hydroelectric producers we create a narrow[9] definition variable consisting of municipalities which is in the 90th percentile of employed persons within "Aquaculture" in the period 2008-2017 (2022f).

[9] All municipalities in these narrow defined industries is listed in the appendix table B.4, B.5 and B.6, additionally figure B.2 shows the geographical dispersion.

Table 3: Indicator variables

Name	*Definition*	*Level*[a]	*Source*
Aquaculture	Recipients of the Norwegian Aquaculture fund. Indicates whether a municipality has fish farms or is otherwise engaged in aquaculture	M	Directorate of Fisheries
Petroleum	Whether the municipality is oil dependent and/or has onshore facilities	M	Statistics Norway[b]
Hydropower	Whether the municipality has functioning hydropower plants	M	NVE[c]
Large Cities	Whether the municipality has a large city		Thorsnæs, 2022

[a] Whether it is municipality (M) or national (N) level data.

[b] Supplemented by Norwegian Petroleum.

[c] The Norwegian Water Resources and Energy Directorate.

3.3 Data modifications

We work with a set of variables that are represented in different terms. We transform several variables in order to structure our panel in an appropriate manner, but also to simplify the interpretation. All economic variables such as GDP and income (pensionable and general) are in nominal values, and we deflate these prior to any further modifications, using consumer price inflation with 2011 as base year. Most variables are altered to approximate percentage changes using logarithmic transformations.

We have made certain changes in the two income variables, pensionable and ordinary income. Sørensen replaces missing observations with zero. We reverse this to avoid inducing skewness in the distribution due to measurement errors or lacking data. Out of the 441 municipalities in our initial data, we omit 21 of these due to municipalities either merging or dissolving during the period of interest. Working with unbalanced panels may complicate the analysis, and the approach to unbalanced panels depends on whether data is missing randomly or non-randomly (Baltagi & Song, 2006). Therefore, omitting the municipalities that are not consistent throughout our sampled period greatly simplifies the methodological approach.

3.4 Descriptive Statistics

In this section we present summary statistics of the inequality measures Gini, P90P10, pensionable- and general income to get a broad sense of how the different measures vary, or behave over time. Additionally, we summarize pensionable- and general income statistics over indicators in table B.2 and B.3 in the appendix. In table 4 we present an overview of inequality measures at the national level over 14 years.

Unlike the Gini-coefficient and P90/P10, our municipal data on pensionable- and general income is based on individual income, and not households. Thus, these two groups are not directly comparable. The implication of aggregating individual income to a household level is that variation decreases, thus stabilizing Gini and P90P10 compared to the pensionable- and general income measures. As Statistics Norway points out, the official measures of inequality are relatively stable over time, especially P90/P10 (Epland & Tuv, 2019). This is not necessarily an issue by itself, but is something to consider when analysing changes over time.

Table 4: National summary statistics

Inequality Measures	*Mean*	*SD*	*Min*	*Max*	*Median*	*N*
Gini	0.2138	0.0308	0.1490	0.6740	0.2080	5,879
P90/P10	2.4689	0.1901	2.0000	3.8000	2.4000	5,879
pinnt9010[a]	19.38	5.76	5.99	49.34	18.90	4,620
pinnt9050	1.94	0.34	1.52	6.43	1.84	5,880
pinnt5010[a]	10.61	3.01	3.49	26.52	10.37	4,620
ainnt9010[b]	627.43	8,211	5.01	438,677	15.78	4,177
ainnt9050	2.29	0.17	1.87	3.20	2.26	5,880
ainnt5010[b]	260	3,382.35	2.51	180,434	7.0226	4,177

[a] 10^{th} percentile is missing for 2014-2016. [b] 10^{th} percentile is missing for 2004-2007.

Pensionable (pinnt), General (ainnt). Observations equal to zero are omitted.

Gini and P90/P10 varies considerably less than the other six measures. The four measures using the 10th fractile in pensionable- and general income has a remarkably high standard error compared to what was expected initially. Even after omitting the zero-observations, there are several suspiciously low observations. As shown in table 6, the lowest observation for general income implies either measurement errors or errors in the data collecting process. A third, perhaps less likely, reason is that there are far more individuals that receive next to no income but are still included in the statistics. This is also observed in the distributions of the lower fractiles in figure 1. A complete overview of the distributions are outlined in the appendix section B.1 figure B.1.

There is a clear indication that the 25th fractile in pensionable income is contaminated by measurement errors as shown in table 6, where the minimum value is below that of the 10th decile's minimum observation. This challenge our confidence in the measurement of the lower fractiles overall, where one of the implications is that the mean is significantly downward biased and that as such the previous mentioned inequality measures for pensionable- and general income might not be appropriate.

Table 5: National summary Pensionable Income

Pensionable income	*Mean*	*SD*	*Min*	*Max*	*Median*	*N*
10^{th} fractile	32,685	14,127	9,618	105,721	29,311	4,620
25^{th} fractile	124,410	57,037	168	257,873	133,094	5,565
50^{th} fractile	299,102	45,683	78,301	440,877	302,044	5,880
75^{th} fractile	435,625	46,831	294,420	671,906	433,367	5,880
90^{th} fractile	571,809	79,977	387,536	992,000	563,395	5,880
Mean	306,658	45,615	184,119	524,263	302,901	5,880

Observations equal to zero are omitted.

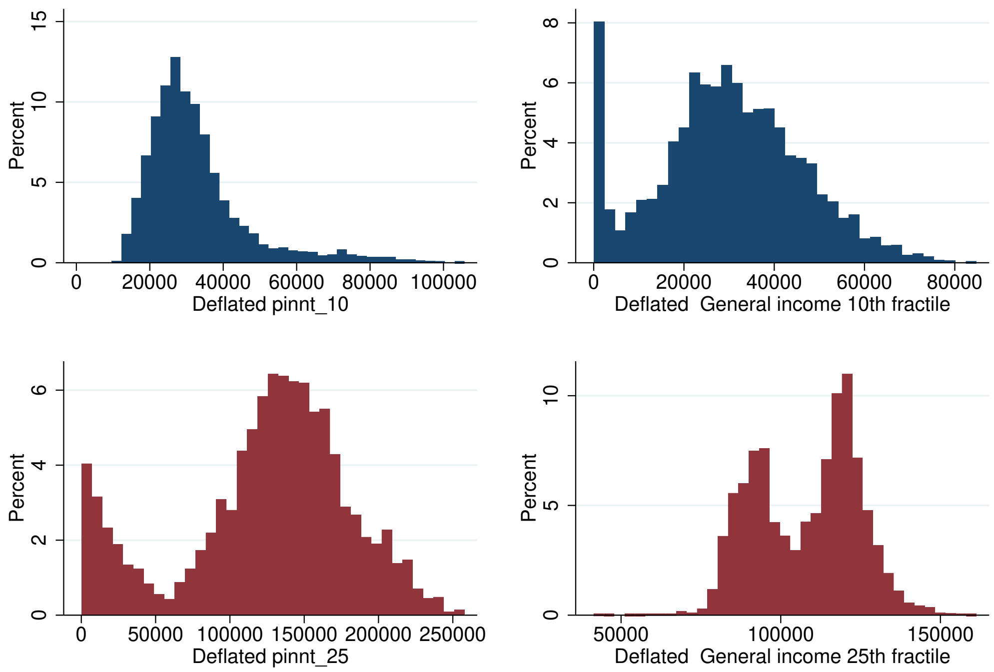
It is worth noting that overall the mean exceeds the median – albeit slightly – in both pensionable- and general income. The difference between the mean and the median is indicative of skewness in the distribution. A mean higher than the median indicates that the distribution is right-skewed,

Table 6: National summary General Income

General income	*Mean*	*SD*	*Min*	*Max*	*Median*	*N*
10^{th} fractile	29,845	16,256	1	84,807	29,766	4,177
25^{th} fractile	108,117	16,309	41,386	161,297	111,389	5,877
50^{th} fractile	195,141	30,568	109,321	304,267	195,812	5,880
75^{th} fractile	309,860	43,404	199,359	523,318	308,952	5,880
90^{th} fractile	446,392	77,153	277,853	895,124	437,869	5,880
Mean	236,772	41,520	139,272	675,206	234,487	5,880

Observations equal to zero are omitted.

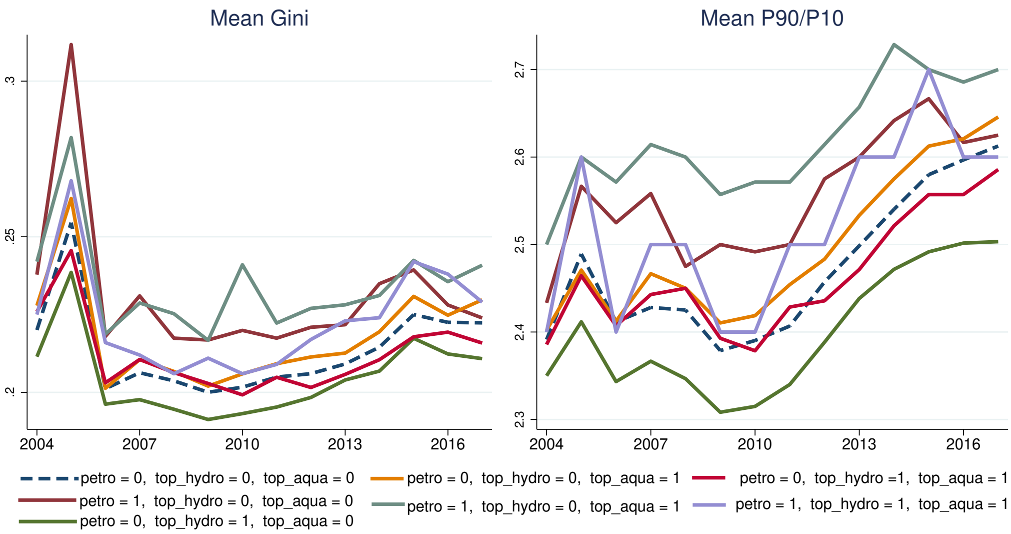
Figure 1: Histogram of lower fractiles



After adjusting for observations equal to zero.

In appendix section B.1 table B.1 we present an overview of the same descriptive statistics as in table 4 divided into industrial groups which depends on the "*narrow*" indicator variables, Petroleum-, Hydroelectic-, and Aquaculture over three different years spanning our data set, figure 2 below shows a graphical representation of the table, but reduced to the two official inequality measures that we have collected for a more simple graphical comparison over the whole time period. In the left panel we observe that the Gini-coefficient peaked in the years before 2006. In 2003 the Ministry of Finance received a proposition from the Skauge committee (NOU 2003: 9) from royal resolution which outlined a tax change that led to people with ownership in limited companies increasing their dividend payouts vastly in the years before the new tax on share of dividends were introduced in 2006 (Aaberge et al., 2020). During this period the official inequality measure of the Gini-coefficient also increased significantly, resulting in a spike in 2005 that dilutes any attempt to coherently measure the comovement between the business cycle and inequality when this particular period is included.

Figure 2: Inequality measures over indicator status



None (n=278), aqua (n=48), hydro (n=60), hydro×aqua (n=14), petro (n=12), petro×aqua (n=7), All (n=1)

4 Methodology

We use a combination of national- and municipality-year data in a panel structure to evaluate the impact of the business cycle on a set of different measures of income inequality in Norwegian municipalities over a thirteen-year time frame, from 2004 to 2017. The relationship between the business cycle and income inequality is in the literature measured using various econometric approaches and different measures of both the business cycle and income inequality. Our analysis thus depend not only on choice of econometric model, but also which inequality measures we use and the estimation of the business cycles. In this section we provide a formal representation of our econometric model, our chosen measures of income inequality and our approach to extracting the business cycles, before summarizing our methodological approach.

4.1 On Panel Data Hierarchies

When working with panel data it is useful to think of the structure as hierarchical, with different levels. In longitudinal studies, such as ours, typically "within"-effects occur at level 1, and "between" or "contextual" effects occur at level 2. Somewhat crudely put, the (level 1) within-effects can be considered variation in the estimated effects of changes between observations in an individual variable, whereas (level 2) between- or contextual effects are the estimated effects of changes between observations *across* individuals. To exemplify, consider differences in the income distribution. The (level 1) within effect can be thought of as the estimated effect of an individual receiving higher income at time t, whereas the (level 2) contextual effect is the effect of an individual having higher income than others throughout the time period. It is important to note that contextual effects and between effects are not the same. With the example above, the contextual-effect is the effect of having a higher level of income than others across all years, whereas the between-effect is the effect of both having higher income and receiving more, i.e. the sum of the within- and contextual effects (Bell et al., 2019).

Commonly applied panel data methods are fixed effects- and random effects models. Fixed effects models are the preferred method when wanting to investigate within-effects, i.e. effects that vary within each observed unit/group. A caveat is that it is not able to estimate between-effects. Random effects models allows estimating between-effects also, but there are certain disadvantages to this model as well, such as for instance imprecise within-estimates when the models are insufficiently specified. Since we set out to measure the effects of the business cycle on income inequality, and also hypothesize that any such effect may be different across municipalities, we need a model specification that allows to test for both these simultaneously. One such model, which is the one we intend to apply in our analysis, is Mundlak's (1978) correlated random effects model.

4.2 Mundlak's correlated-random effects model

Mundlak's (1978) correlated-random effects model showed that choosing between fixed- and random effects models was unnecessary, as his proposed specification would allow for random effects while efficiently retrieving the within-estimator as in the fixed effects model. As briefly mentioned in the previous section, fixed effects model cannot estimate between-effects. This is due to that time-invariant variables are "wiped out" by the within-transformation. Mundlak shows that in an error component model with individual effects that are possibly correlated with the explanatory variables, then one can take into account the correlation so that the retrieved GLS-estimator is the within-effect. In practice, this amounts to including the mean of the explanatory variables in the regression. The Mundlak model can formally be parameterized[10] as:

$$y_{it} = \alpha + \beta_{1W} x_{it} + \beta_{2C} \bar{x}_i + \beta_3 z_i + (v_i + \varepsilon_{it}) \tag{1}$$

Where y_{it} is the dependent variable, x_{it} a time-varying individual (level 1) independent variable and z_i is a time-invariant clustered (level 2) independent variable. x_{it} has two separate effects captured by β_{1W}, the average within-effect, and β_{2C}, the average contextual effect. The estimated coefficients from the mean variables, β_{iC}, are considered contextual effects and can together with the within effects be used to derive the between effects. That is, it has been shown (Bell et al., 2019; Mundlak, 1978) that the simple arithmetic relation $\beta_{iB} = \beta_{iW} + \beta_{iC}$ correctly calculates the between-effect. For our purposes, x_{it} can be considered a vector including all explanatory variables and indicator variables, i.e. national-level macroeconomic variables, municipality-level control variables and dummy-variables for the selected industries. For clarity we decompose these, so that the following parameterization is the one we work with onwards:

$$Y_{it} = \alpha + \beta_{iW} X_{it}^m + \beta_{iC} \bar{X}_i^m + \beta_{iW} X_{it}^c + \beta_{iC} \bar{X}_i^c + \beta_i Z_i + (v_i + \varepsilon_{it}) \tag{2}$$

[10] To keep the representation of our considered model specifications consistent, we lean on Bell, Fairbrother and Jones' (2019) paper "*Fixed and random effects models: making an informed choice*" and use the same notation as in this paper.

Which is the same as the model in eqn.(1) but expanded to show the different types of variables and with variables capitalized to denote that these are vectors and not singular variables. Our variables of interest are denoted X_{it}^{m}, to indicate that these are our main explanatory variables, and include the cyclical- and the trend component of output, unemployment, real interest rate and consumer price inflation. X_{it}^{c} are the variables we control for, which includes demographic variables, municipality expenditure and education levels. X_{it}^{c} also includes a vector of our indicator variables, where we include cities and three assumed important industries; the hydro power industry, aquaculture and the petroleum industry and Z_i are time-invariant clustered variables for municipalities.

The model appears a fitting choice for our purposes in allowing to estimate both the effects of the business cycle on income inequality generally, but also to retrieve estimates that can be used to calculate the average difference between the municipalities. There are some caveats if either the within- or the contextual effect is insignificant, one should be cautious as to whether one assumes significance in the calculated between-effect. The contextual effect in itself is also, according to Bell et al., 2019, not of interest in longitudinal studies, as there is no possibility for level 1 observations to move between the level 2 groups.

Concerning level 1 observations, it should also be noted that one of the key properties with the model's estimated contextual effect is that the intent with adding mean regressors is to capture any correlation between the individual effects and the explanatory variables. Some of our main variables of interest are national level observations, which means that both the variable and the mean variable identical across municipalities. This implies that the estimated contextual effects depends on the variation in municipality-level regressands and – as we have not encountered similar studies applying this particular technique – we are careful in interpreting these causally. There is uncertainty as to whether these estimates capture what we intend, or whether they are assigned explanatory power that otherwise would be pooled in residuals or the intercept.

4.3 Measuring income inequality

A multitude of inequality measures exist, but the most commonly applied measures today are the Gini-index and fractile ratios. Statistics Norway annually describes the development of economic inequality in Norway, using the Gini-coefficient, the P90/P10 decile ratio and the S80/S20 ratio. We focus on Statistics Norway's estimated Gini-coefficient and P90/P10 at the municipality-level as measures of income inequality, and extend the analysis with fractile ratios for pensionable- and general income.

4.3.1 The Gini Coefficient

The Gini coefficient is the most popular measure of inequality, and is represented as a ratio of the difference between the Lorenz curve - a curve representing the distribution of income in a population - and the "line of absolute equality"[11]. Sen, 1973 shows that it can be represented as half the relative mean difference;

$$G = \frac{1}{2n^2\mu}\sum_{i=1}^{n}\sum_{j=1}^{n}|y_i - y_j| \tag{3}$$

The Gini coefficient is a very direct measure of income differences, and also satisfies the Pigou-Dalton principle. The sensitivity of the Gini coefficient is dependent on the number of people in between the different income levels rather than the income levels themselves, and implies a welfare function that is simply a weighted sum of individuals' income levels.

It, unfortunately, also has a number of limitations. Among these are that it may be misleading when ranking differences between two countries/regions, and fails to capture absolute differences in income. The first implies that two countries with widely different income distributions may appear similar. The second implies that although poverty-rates may be declining there may still be an increase in income inequality, which is in violation of the Pareto improvement principle (Chitiga & Sekyere, n.d.).

[11] see appendix A.1.1

4.3.2 Income Ratios - the P90/P10

It is common to use fractile shares or ratios in measuring inequality, often as complementary measures alongside the Gini-coefficient. Three measures applied by Statistics Norway annually are the Gini-coefficient, P90/P10 and S80/S20. P90/P10 is a decile ratio, comparing the income of the person that earns just above 90% of the population to that of the person that earns just above 10% of the population (Epland & Tuv, 2019). .

Using decile ratios is a simple way of measuring inequality. It is widely used, and P90/P10 is according to Burkhauser (2009), the most commonly used measure of wage dispersion in U.S. labour economics.

4.3.3 Measuring Inequality in Norway

Official inequality statistics varies between countries, as statistical agencies often modify measures to better fit the reality of their countries, using what is referred to as equivalence scales. This adjustment compares households instead of individuals in the income distributions. In the OECD's definition of household income, all individuals in a household are weighted when aggregating the data, 1 for the first adult, 0.7 for other adults, and 0.5 for children. Hagenaars, de Vos, and Zaidi (1994) proposed a "*modified OECD-scale*" where the first adult is weighted as 1, all other adults as 0.5, and children as 0.3. This modified scale corresponds to the EU-scale (Strøm et al., 2008, p.45), in imposing a lower weight on larger households based on an assumption that households experience some economics of scale-properties. Statistics Norway uses a modified EU-scale, where student households and single person households under 18 years of age are excluded (Epland & Tuv, 2019).

We use both the Gini-coefficient and P90P10 and will complement these two with individual-level decile ratios constructed from pensionable- and general income.

4.4 Measuring the Business Cycle

The business cycle is a theoretical construct that shows the cycle of fluctuations of a country's gross domestic product (GDP) around the long-term natural growth rate (Corporate Finance Institute, 2022). A general assumption is that GDP can be thought of as a time-series y_t consisting of two (or four) components, a cyclical component and a growth component, and alternatively also a seasonal- and a noise component:

$$y_t = c_t + g_t \ \ (+s_t + \varepsilon_t) \tag{4}$$

Since these components are not explicit features of the gross domestic product, they must be extracted from the data through filtering in order to evaluate the impact of the cycle. There are several ways to detrend data, but we focus on Hodrick and Prescott's popular HP-filter and James D. Hamilton's H84-filter.

The HP-filter is a minimization problem where it is assumed that output can be decomposed into a cyclical component and a trend component:

$$\min_{\{g_t\}_{t=-1}^{T}} \{\sum_{t=1}^{T}(y_t - g_t)^2 + \lambda \sum_{t=1}^{T}[(g_t - g_{t-1}) - (g_{t-1} - g_{t-2})]^2\} \tag{5}$$

In decomposing the time series, the problem's smoothing parameter, λ has a determining role, and has to appropriately selected. Hodrick and Prescott, 1997 argued that $\lambda = 1600$ was appropriate for quarterly data. Based on this value, Ravn and Uhlig, 2001 showed that an appropriate transformation from quarterly to annual time series gave $\lambda = 6.25$. For Norwegian business cycles, $\lambda = 40.000$ is commonly used, and following Ravn and Uhlig's tranformation this implies $\lambda = 156.25$ for annual data. The HP-filter unfortunately tends to infer cyclicality also when there is none present in the data, and end-of-sample values are unreliable as they differ from those in the middle of the sample, due to the detrending process. As such the filter induces spurious dynamic relations, and is unsuited as an all-purpose detrending method (Hamilton, 2018).

The H84-filter is a regression of the variable at time $t + h$ on its four most recent values:

$$y_{t+h} = \beta_0 + \beta_1 y_t + \beta_y y_{t-1} + \beta_3 y_{t-2} + \beta_4 y_{t-3} + v_{t+h} \tag{6}$$

Where the residuals are given by:

$$\hat{v}_{t+h} = y_{t+h} = \hat{\beta}_0 + \hat{\beta}_1 y_t + \hat{\beta}_2 y_{t-1} + \hat{\beta}_3 y_{t-2} + \hat{\beta}_4 y_{t-3} \tag{7}$$

Hamilton suggests this is more robust than the HP-filter, due to the underlying process being less dependent on assumptions regarding the data generating process. Schüler, 2021, however, points out that the Hamilton filter is based on ad hoc assumptions and also induces a "certain cyclical structure" in time series data. It also tends to strongly emphasize cycles exceeding regular business cycles in length and mutes shorter-term fluctuations.

Figure A.2.1 shows our estimates of the cyclical component of Norwegian mainland GDP from 1972-2018, as computed by H84 and two versions of the HP-filter, using $\lambda = 6,25$ and $\lambda = 156,25$. We compare the performance of the three filtered cycles in relation to each other and against the reference cycles for the Norwegian economy as argued by Aastveit et al., 2016. They find that the mean duration of the cycle is approximately 23 quarters, with 6 quarters as the mean duration from peak to trough and 16.4 from trough to peak. Overall we consider the HP-filter to correspond better to these reference cycles, although it is not very apparent which is better. One of the more apparent features is the exaggerated volatility of the H84-filter, which is in line with Dritsaki and Dritsaki, 2022; Hall, Thomson, et al., 2020. Among the two HP-filters, the value of λ only affects the magnitude of the cycles. As it is hard to infer which is better, we rely on established practice for the Norwegian business cycle with using $\lambda = 40.000$ for quarterly, and use $\lambda = 156,25$ as suggested by Ravn and Uhlig, 2001.

4.5 Our model

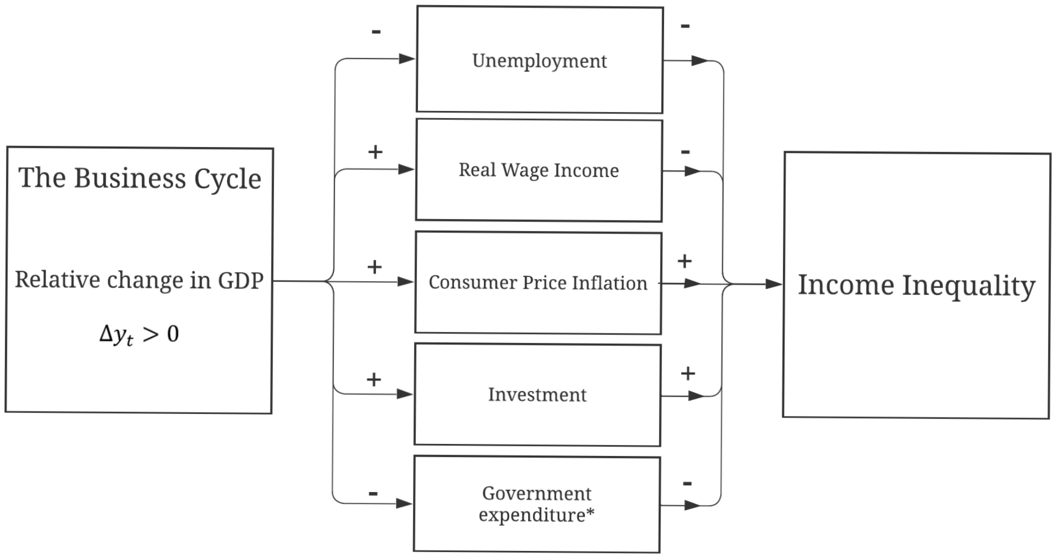
To estimate the effects of the business cycle on income inequality in- and across Norwegian municipalities we use Mundlak's correlated random effects model. Revisiting our parameterization in 4.2, we formulated the model as:

$$Y_{it} = \alpha + \beta_{iW} X_{it}^{m} + \beta_{iC} \bar{X}_{i}^{m} + \beta_{iW} X_{it}^{c} + \beta_{iC} \bar{X}_{i}^{c} + \beta_{i} Z_{i} + (v_{i} + \varepsilon_{it}) \qquad (2)$$

Where we estimate the effects of the cyclical component of Norwegian mainland output on a set of inequality and income measures; the Gini coefficient, the P90/P10 ratio, and pensionable- and general income. The cycles are estimated using the HP-filter with a smoothing parameter $\lambda = 156, 25$. In addition to the cycle, we include some key economic indicators that in the literature are used to explain the connection between the cycle and income inequality; consumer price inflation, real interest rates, and unemployment. In our main specification we control for the trend-component of output, as well as municipality-level characteristics that are also considered as affecting the distribution of income. These are population, age composition, immigration levels, municipality expenditure and education levels. Finally, we include four dummy-variables. The first is whether municipalities have large cities or not, and the other three denote selected industries that is – or have been – considered important for local value creation; hydropower, aquaculture and petroleum.

Literature points toward inequality being sensitive to the business cycle (Bayer et al., 2020; Blank, 1987; Creamer et al., 1956; Gramlich & Laren, 1984). Which economic indicators best explain this sensitivity and the underlying mechanisms, is however not widely agreed upon. Based on the empirical evidence we have reviewed on the links between business cycles and income inequality, as well as stylized facts on the Norwegian business cycle, we build our analysis around assuming that the business cycle impacts income inequality through unemployment, real wage income, consumer price inflation (CPI), investments and government spending:

Figure 3: Assumed transmission from the business cycle to income inequality



Unemployment and government expenditure is assumed to be countercyclical and progressively impact income inequality, real wage income is procyclical and progressive, and investments and inflation are procyclical and regressively impacts income inequality. As in most literature we have familiarized ourselves with, these assumed connections between income inequality and the business cycle are founded mostly upon business cycle theory.

Unemployment and consumer price inflation are explicitly included in our model, whereas government expenditure and investments are excluded. This is due to the complex nature of these variables. Government expenditure includes a number of posts and programs and it is less than obvious which of these should be included and how, and the same goes for investments. The impact of investments, in a study such as ours, depend both on where the investments are done, both geographically and with regards to industries, and from where they come. Real wage income is not included as an explanatory variable, but including fractile measures of pensionable- and general income as dependent variables allow us to separately estimate and the effect of the cycle on the different income groups in the population, and compare these against each other and our measures of income inequality. Furthermore, a fraction of government expenditure is being used on social benefits, and some of this is assumed to be reflected in our measures of pensionable income relative to the general income measures. Although we are not able to quantify this or measure it in any substantial way, a broad comparison between the differences in pensionable and general income may give some indication about the effect of social benefits.

Before continuing to the main results, we make a note that we omit the first two years due to the spike in the Gini-coefficient in 2005. Including 2004 and 2005 would induce spurious results. We also limit the analysis to the "broad" definition of industry indicators[12]. As a sanity check we also outline a toy model in appendix section A.3.4 were we compare the estimates between a Fixed-, Random and Mundlak model and show in table A.3.2 that the Mundlak model indeed captures the intended within effects from the Fixed effects model as well as contextual effects from the mean transformed variables and that we can use these two effects to estimate the between-municipality effect (Bell et al., 2019).

[12] see appendix section C.1 tables C.1 and C.2

5 Regression Results

5.1 Main Results - Gini & P90/P10

Table 7 displays the estimated coefficients from the Mundlak model on the Gini-coefficient and the P90/P10 ratio. As a robustness test, column (1) and (2) displays the estimated effects of our main variables and indicators without the municipality-level variables that otherwise control for, whereas column (3) and (4) shows the estimated coefficients from the full model, with indicators and control variables.

Table 7: Estimated effects on Gini (log) and P90P10 2006-2017

	(1) Gini		(2) P90P10		(3) Gini		(4) P90P10	
Cycle, log	1.026***	(0.054)	2.048***	(0.088)	0.937***	(0.056)	1.850***	(0.089)
Trend, log	-0.126*	(0.075)	-0.761***	(0.121)	-0.289***	(0.079)	-1.031***	(0.125)
Real rate, log	-0.010***	(0.001)	-0.011***	(0.002)	-0.009***	(0.001)	-0.008***	(0.002)
CPI, log	0.839***	(0.126)	2.546***	(0.204)	0.661***	(0.133)	2.120***	(0.211)
Unempl., log	-0.004	(0.003)	-0.003	(0.005)	0.002	(0.003)	0.007	(0.005)
Large Cities	0.149***	(0.022)	0.313***	(0.041)	0.057***	(0.021)	0.150***	(0.039)
Petroleum	0.062***	(0.018)	0.083**	(0.033)	0.058***	(0.015)	0.108***	(0.029)
Hydropower	-0.016	(0.013)	-0.042**	(0.021)	-0.014	(0.013)	-0.029	(0.021)
Aquaculture	-0.013	(0.008)	-0.005	(0.015)	-0.006	(0.007)	-0.003	(0.013)
mean(Cycle)					-3.178	(5.967)	5.323	(11.159)
mean(Trend)	0.373***	(0.079)	0.922***	(0.130)	0.513***	(0.081)	1.188***	(0.129)
mean(Real rate)	0.829	(0.554)	-0.282	(1.035)	0.021	(0.104)	0.191	(0.195)
mean(CPI, log)	5.305	(8.086)	31.476**	(15.097)	-0.587	(1.089)	1.468	(2.030)
mean(Unempl)	0.017	(0.012)	0.034	(0.023)	-0.007	(0.014)	-0.012	(0.027)
mean(Hydropower)	-0.026*	(0.016)	-0.034	(0.027)	-0.012	(0.015)	-0.026	(0.026)
population, log					-0.058***	(0.009)	-0.101***	(0.017)
Immigrants, log					0.010***	(0.002)	0.012***	(0.003)
Mun. exp., log					-0.000*	(0.000)	-0.000	(0.000)
Pre-schoolers, share					-0.262	(0.180)	-1.032***	(0.286)
School age, share					-0.590***	(0.143)	-1.758***	(0.227)
Elders, share					0.654***	(0.120)	1.018***	(0.191)
Primary school, rate					-0.002*	(0.001)	0.001	(0.002)
University, rate					0.010***	(0.001)	0.020***	(0.002)
mean(immigrants)					0.056***	(0.008)	0.099***	(0.014)
mean(Mun. exp).					-0.000	(0.000)	0.001*	(0.000)
mean(Pre-schoolers)					0.274	(0.664)	0.813	(1.232)
mean(School age)					0.357	(0.474)	0.855	(0.878)
mean(Elders)					-0.668***	(0.255)	-0.686	(0.464)
mean(Primary school)					0.004***	(0.001)	0.005**	(0.002)
mean(University)					-0.004**	(0.002)	-0.005*	(0.003)
Constant	0.000	(.)	0.000	(.)	0.000	(.)	0.000	(.)
Observations	4617		4617		4552		4552	
Controls	No		No		Yes		Yes	
R^2 within	0.348		0.448		0.376		0.485	
R^2 between	0.207		0.214		0.487		0.493	
R^2 overall	0.252		0.283		0.450		0.487	
ρ	0.690		0.750		0.605		0.685	

Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

5.1.1 Robustness of the Model

This simple robustness test indicates that our the estimated coefficients for our variables of interest are, by and large, robust to the inclusion of our control variables. We include the trend-component of output also in the specification without controls, since we believe these should not be estimated in isolation. It is worth noting that without the control variables the model is not able to estimate a coefficient for the mean(cycle), which means we do not obtain any contextual effects in this case. This coefficient estimate is also insignificant in the full model where it is estimated. The estimated coefficients for the mean-variables are the estimated contextual effects, and the others are estimated within-effects. Note that some variables do not vary sufficiently in the within-effect estimates for the model to sensibly extract a mean estimate. In our main results with included controls this pertains only to the petroleum indicator and log(population). Positive estimated effects on our measures of inequality imply that the variable is regressive, i.e. it increases inequality, whereas a negative estimated effect implies progressive effects.

5.1.2 Variables of interest

The estimated coefficients for both measures of inequality are sign-consistent for both specifications, and the within-effects for both are significant at all conventional levels, with an estimated within-effect of the cycle equal to $\beta_W^{cycle} = 0.937$ for the Gini-coefficient and $\beta_W^{cycle} = 1.850$ for the P90/P10 ratio. The contextual effects are insignificant for both where these are estimated. Ideally, we would compute the between-effects from the within- and contextual effects for both the cycle and trend, but since the contextual effects of the cycle is insignificant for both inequality measures we interpret these with caution[13]. Recalling that $\beta_B = \beta_W + \beta_C$ The estimated between effect is $\beta_B^{cycle} = 0.937 + (-3.178) = -2.241$ for the Gini-coefficient and, by the same procedure, equal to 7.173 for P90/P10, but due to the very high standard errors in the contextual effects we cannot dismiss the possibility that the con-

[13] Kelvyn Jones (2019) states that a situation where a level-1 variable is insignificant but the group-mean centered level 2-variable is significant simply implies that although the effect on an individual level is not significant, at a group-level it is.

textual effects are in fact zero, which would imply $\beta_W^{cycle} = \beta_B^{cycle}$, i.e. there may not be any difference between municipalities.

The other variables of interest show mixed results. The estimated effects of unemployment is, interestingly, insignificant for our measures of inequality both in the within- and contextual effects. Consumer price inflation has no contextual effect, but the within-effect estimates are highly significant for both measures of inequality, and shows that income inequality is increasing with inflation. The real interest rate is also significant in the within-effects but not for the contextual effects, and affects inequality in the opposite direction of inflation.

5.1.3 Control- and indicator variables

Among the control variables, the trend component of output is perhaps the most interesting. In the full specification, the trend component of output is highly significant for both within- and contextual effects. The within-effect is negative, with a coefficient estimate of $\beta_W^{trend} = -0.289$, and the contextual effect is positive, with a coefficient estimate of $\beta_C^{trend} = 0.513$, which implies a between effect $\beta_B^{trend} = -0.289 + 0.513 = 0.224$. This can be interpreted as that the average within-effect of trend output is progressive, but that between municipalities there is an average difference in this effect of 0.224. The trend component of the business cycle has an estimated positive between effect of 0.224 which would indicate two effects, an increase in the trend component of the Norwegian economy is progressive within municipalities, while the between estimates corresponds to increasing inequality between municipalities. Combined with the significant regressive impact of the cycle we have conflicting within-municipality-effects.

As previously pointed out there is not sufficient variation in log(population) to estimate the contextual effects. The within-effect is, however, highly significant and negative for both inequality measures, implying that inequality falls as population increases. Immigration rates are significant and positive both in within- and contextual effects, meaning inequality increases with immigration both within- and between municipalities. The estimated effect of variables related to age composition show that children and elderly affect inequality opposite to each other. The youngest children do not affect the Gini-coefficient significantly in either effects, but the within-effect on P90/P10 is significantly negative. Children in school-age, however, has a negative estimated within-effect on both measures. Elderly has a positive and significant within-effect, and a negative and significant contextual effect. With regard to education levels, the rate of the population that has primary school as highest finished education is overall insignificant whereas the rate of the population with a university degree is overall significant, with a positive correlation in the within-estimate and negative correlation in the contextual effect. Finally, municipality expenditure does not vary sufficiently to provide a mean-variable estimate, but is nevertheless insignificant on both measures with an estimated effect of zero.

The indicator variables for industries show that being a large city and/or a petroleum municipality is highly significant and positively correlated with inequality in the within-estimates. Contextual effects are not estimated for these due to lack of variation.

5.2 Pensionable- & General Income Distribution

In addition to estimating effects on the inequality measures, we run an identical regression as for the main results on a set of fractiles in the income distribution using two measures of income, pensionable and general, that contrast those used in the inequality measures. Unlike the latter, that are based on equivalence scale household income, these income measures are based on individual income. The results can be found in appendix C.1. The estimated effect of our full model on these income measures can be found in tables C.3 and C.4. We also estimate effects on the income distribution within each of the groups in the indicator variable, by conditioning the model on these sequentially. We do this to compare the effect of our variables of interest on the income distribution in these particular municipality groups, as can be seen in tables C.5 & C.6.

5.2.1 Pensionable income

Table C.3 shows the estimated effects from our full model on the fractiles in the pensionable income distribution. The first thing that stands out is that it appears that the estimated within-effects of the business cycle on income in all groups are negative, with the notable exception of the 10th fractile. These effects are also highly significant for all fractiles. The estimated contextual effects are more varied, both in terms of coefficient estimates and significance levels. The 25th fractile seems to be hit hardest in both effects, and the highest end of the distribution, the 75th- and 90th fractile, appear to be the least sensitive to the cycle. The trend component has the opposite effect as the cycle for the 10th fractile, and through the distribution it is negative for all but the 75th and 90th fractile. Indicating that the natural growth rate of the economy is regressive as income decreases for low income takers, and increases for high income takers.

Also here are the real interest rate and inflation highly significant, except for the estimated contextual effects of the real interest rate. The estimated effects seem to follow a similar pattern as for the effect of the cycle, where the magnitude of the coefficient estimates are lower in absolute terms for the 10th fractile than for the 25th, and then gradually declines as we move up in the distribution. The contextual effect of the real interest rate is only significant for the 25th fractile, which appears as somewhat a curiosity. Unemployment is insignificant only for the 10th fractile in the within-effects estimates, and significant only for the 25th- and 50th fractile in the contextual effects.

In table C.5, selected ratios of pensionable income is estimated across indicators. This measure of income contrasts that used in our main results, in that the estimated within effects of the two pensionable income ratios 90/10 and 50/10 is progressively affected by business cycles. The 50/10 fractile ratio in cities is the only insignificant estimate over all indicators and ratios but still has a point-estimate which indicates a progressive within-effect. This is not the case when examining the effects on 90/50 where the cycle has a significant regressive within-estimate. This is consistent with the point estimates in table C.7 – where we instead of ratios as dependent variables use the different income fractiles, 10, 25, 50, 75 and 90 – in which we can interpret the point estimates as growth rates of income. In line with the estimates of the full model on the income fractiles above, the different industry characteristics do not change the estimated effects of the business cycles. The results on both the income ratios, and fractiles imply that gini fails to capture the redistributive effect of an increase in the cyclical component of the business cycle, this further reinforces the fact that for gini – to be effective – needs complementary measures to be able to reflect real changes in income inequality.

5.2.2 General income

Table C.4 shows the estimated effects of our model on general income. As for pensionable income, most within estimates are highly significant, but in contrast to pensionable income the 10th fractile follows the same tendencies as the others, where only magnitude increases the further down the distribution you go. The effects of the cycle are negative for all fractiles, with a diminishing magnitude in absolute terms from bottom to top. The estimated effects on the 10th fractile in this income measure as opposed to the pensionable income is striking; the effects of, e.g., the estimated impact of the cycle is slowly increasing from the 90th fractile ($\beta_W^{cycle} = -0.093$) down to the 25th ($\beta_W^{cycle} = -1.845$), whereas the estimated effect on the 10th fractile is $\beta_W^{cycle} = -56.594$. This pattern is more or less consistent for all coefficient estimates. The contextual effects are, with the exception of unemployment, insignificant. The estimated contextual effects of unemployment appear more in line with established empirical evidence than the within-effect, in that the estimated within-effect of unemployment is positive for the lowest group, whereas it is consistently increasing in magnitude as one moves down in the distribution.

The estimated effect of the trend component can be thought of as counteracting the effects of the cyclical component, in that the coefficient estimates are within the same range with respect to magnitude as those of the cycle, but with a positive estimated effect instead of a negative. If the trend components can be viewed in isolation from the cycle it does – with general income – have a progressive and redistributive effect.

The estimated within-effects on the general income ratios in table C.8 are significant for all three, 90/10, 90/50, 50/10 and are regressive in nature. This is again consistent with the main results but contradicting the observed pattern in pensionable income above. The responsiveness of general income to unemployment does not seem to stem from the indicators, but rather the economy as a whole given differences with the baseline where the within- and contextual effects of unemployment are regressive and progressive respectively.

6 Discussion

Revisiting the research question and the methodological approach of our analysis, our focus is to answer two research questions regarding income inequality and the business cycle in Norway:

1. What is the relation between the business cycle and income inequality in Norway?
2. Is there a difference in the measures of income inequality's responsitivity to the business cycle across municipalities?

where we apply Mundlak's correlated-random effects model to estimate both within- and contextual effects concurrently. Recalling the hierarchical levels in section 4.1, we perform our analysis so that municipalities function as level-2 variables, meaning that contextual- and calculated between-effects are estimated effects across municipalities.

6.1 The Economic Cycle and Income Inequality

Our results indicate that income inequality increases in economic booms, i.e. when output grows at a higher rate than trend output, and declines in recessions. The estimated within-effect of the cycle on the Gini-coefficient implies that a 1 percent increase in the cyclical component of output increases inequality by 0.937 percent. Although this may appear a quite large effect at the first glance, recall that the Gini-coefficient is represented as a rate that averages about 0.25, so that the estimated effect does not imply a full percentage point increase. The estimated effects on P90/P10 says that a 1 percent increase in the cyclical estimate increases the ratio of the income received by the individual that earns just more than 90 percent of the population over that of the individual that earns just more than 10 percent of the population by 1.85.

The estimated within effects directly opposes much of the empirical evidence we have reviewed, where e.g. Blank, 1987 finds that the income distribution narrows in economic upturns. Empirical results on the relation between income inequality and the business cycle does not, however, necessarily need to be the same in different countries – we even hypothesize that it differs across municipalities – since the institutional and structural settings play a determining role in how different economic variables affect each other. Thus, we cannot dismiss the results of our analysis based solely on how it corresponds to similar studies done in other countries.

A possible explanation for the estimated effect of the cycle on the Gini-coefficient, that may also be linked to the estimated effect of P90/P10 is that income for the lowest income groups are less sensitive to the economic activity than it is for the higher income groups. The measures of inequality measures disposable income, which also includes capital income. Capital gains are far more volatile than ordinary wage income, and generally strongly correlated with the aggregate economic performance. As capital ownership is usually concentrated at the upper end, or upper half at the very least, of the income distribution it is not an improbable explanation for why the estimated within-effects for both the Gini-coefficient and P90/P10 are positively related to the cycle.

Among possible institutional explanations for why our results differ from those found by Blank (1987) is that Norway has strict minimum wage regulations, particularly relative to the USA, where Blank - and most other reviewed empirical evidence we have reviewed - was conducted. The Norwegian labour market is heavily regulated, and job security is also likely higher in Norway than in the US. A higher degree of job security and the presence of regulated minimum wages may be thought to come at the cost of some bargaining power regarding ones own salary. Piketty, 2018 also points out that those at the top has more bargaining power over their own wages and tend to overestimate their own relative contribution or importance in in their work, and thus justify paying themselves more.

The estimated contextual effects of the cycle were, as pointed out in 5.1.2, insignificant for both measures of inequality. That does not necessarily mean that estimated between-effects aren't significant, but whether this is the case appear to be a judgement call more than anything else, as we have not found any meaningful way to test this. The estimated hypothetical between effects were -2,241 for the Gini-coefficient and 7,173 for P90/P10. Assuming significance, this implies a downward relation across municipalities between the cyclical component of output and the Gini-coefficient. For a graphical example of such instances, with differing between- and within effects, see A.3.1. For P90/P10, the between effects pull in the same direction as the within-effects.

The different directions in the within- and between effect estimates may also point to a possible explanation for why our results differ from that in most of our reviewed literature. Single level models fail to capture the different effects, and in such instances the single-level estimates are a weighted blend of each of the effects, where the weighting is dependent on the ratio of the between-group sums of squares of the predictor to the total sums of squares (Jones et al., 2013). As such, a single-level model of the effects of the business cycle could possibly yield a negative coefficient estimate. Remember that our contextual effects – and by extension possibly also the calculated between effects – are insignificant in our model, hence we cannot say with certainty that this is the case. Neither do we assume that the models used in our reviewed literature estimate the effects in ways that induce this error, but we find it an interesting point for reflection that could – if true – possibly further remedy the difference in our results to the empirical evidence.

6.2 Growth and inequality

The estimated within-effect of the trend component of output are negative, which can be interpreted as that inequality on average decreases within the population as the economy grows. What's perhaps most interesting about the within-effects is that the estimated effect on the P90/P10 ratio is approximately one-to-one, i.e. that the ratio decreases as much as the economy grows.

It is not intuitive that this should be the case, but letting the economic trend be indicative of overall economic growth, this fits the "Kuznet's curve" rather well. Kuznet's curve is a theoretical relationship between growth and inequality that claims that inequality will increase as the economy develops to a point where the economy is sufficiently developed, whereupon inequality naturally will decline as the economy continues developing. Several studies (Fjære, 2014; Lund, 2012; Solbu, 2009) has discussed Kuznet's curve in Norway, mostly concluding that the Norwegian economy is well beyond the "tipping point" of the curve where inequality is decreasing in economic growth.

The estimated contextual effect of the economic trend, however, points in a different direction and, in terms of magnitude, outperforms the within-effect resulting in an estimated between-effect of 0.224 for the Gini-coefficient and 0.157 for P90/P10. As both the within- and contextual effects are significant, we feel more confident in that the calculated between-effects actually show valid results. This means that, with respect to trend growth in the economy, we can interpret our estimates as that income inequality is reduced within municipalities, whereas it increases between municipalities.

6.3 Cycles, Trends and Income Inequality

Our focus is on how the business cycles affect income inequality, and we therefore emphasize the cyclical component of output in our analysis. The economic trends and cycles should however not be considered in isolation if the intention is to comprehend how income inequality de facto develops over time.

By combining the estimated effects of the trends and cycles, the overall estimated within-effect on Gini is 0.648, and for P90/P10 it is 0.819, although simply adding these together is problematic for various reasons. The most compelling argument against this additive trickery is that the two variables are not independent of each other, as the economic trend is defined by the sum of the economic cycles. The coefficient estimates imply that if e.g. the trend increases one percent, then the Gini-coefficient should be reduced by -0.289 percent. It seems less than likely that the growth rate of the cyclical component should coincide with the rate of the trend over time. Nevertheless, it serves as an illustrative point that the overall effect of the two components are likely smaller than implied by the cycle alone.

The between effects of these again fall victim to the insignificance of the estimated contextual effects of the cycle. Unlike the case of the cycle in isolation, attempting to calculate a "joint" between effect of the two variables seem less sensible, but it can be noted that for P90/P10 both contextual effects estimates pull in the same direction, and the only countering estimate of the four estimated coefficients that pulls in the opposite direction is the estimated within-effect of the trend. This points toward a – hypothetical – large between-effect across municipalities.

6.4 Economic Indicators and Income Inequality

Unemployment and consumer price inflation are in our model assumed to be among the direct links between the business cycle and income inequality, as they are both considered important economic indicators in business cycle theory. Including these as explanatory variables alongside our "pure" business cycle estimates therefore means that we potentially dilute the estimated effect of the cycle on our measures of income inequality. An alternative specification could be one that estimated the effects of any such links rather than the – perhaps ambiguous – catch-all business cycle variable, but that would require a deeper understanding of the underlying mechanisms, and access to a rather exhaustive amount of data. We therefore assume that the effects of our estimated business cycle-variable captures the mechanisms that are not explained by either inflation, real interest rates or unemployment.

The estimated within-effects of consumer price inflation are highly significant and regressive for both the Gini-coefficient and P90/P10, which seem to contradict the findings of, amongst other, Johnson and Shipp, 1999. The contextual effects of inflation are insignificant, which intuitively makes sense as we find it reasonable to assume that inflation does not discriminate on where in the country one is located[14]. As for inflation, the estimated within effects of the real interest rate is highly significant, whereas the contextual effects are not - and we assume the same reasoning applies here. The within-effects estimate point to a slightly progressive effect of the real interest rate.

A priori, we expected unemployment to be an important explanatory variable in our model. The estimated effects, both within and contextual, turned out insignificant, and near-zero in magnitude. Initially we found this quite puzzling, but recalling the definition of income used in the inequality measures, it may point toward some important features of the Norwegian welfare state. The income is defined as household disposable income, and consists of wage earnings, self-employment earnings, capital income and public cash transfers.

[14]Although it should be mentioned that prices often may differ between regions, at an aggregate level we assume it to be overall the same.

In the following section, we delve into the distributions of pensionable- and general income, and discuss how the Norwegian welfare system may help mitigate any regressive effects on income inequality

6.5 Measures of the Income Distribution

Recall from sections 5.2.1 and 5.2.2 that in the general income distribution the estimated negative within-effects of the cycle increased the further down in the distribution we went, whereas for pensionable income, that pattern changed at the bottom, where the income in the 10th fractile switched directions and the cycle had a positive estimated within-effect on this fractile's income. Also recall that general income is a net measure, including any taxable income, whereas pensionable income is a gross measure that includes wages, self-employment and – as part of wages – public benefits.

The difference in the estimated effects on the 10th fractile in the two income measures point toward there being mitigating effects in place. The observed effect at the bottom of the distribution from general- to pensionable income is likely due to the lack of income being compensated by public benefits. As the income definition used in the Gini-coefficient and P90/P10 ratio includes all disposable income, benefits are also included here. Assuming that benefits is a large part of the income for the income-taker that represents the lower end of the distribution, the estimated effects of the P90/P10 ratio may therefore be partly explained by benefits being insensitive to the business cycle, whereas the income of the individual at the top of the distribution is more exposed to cyclical changes.

Benefits mitigating the effects on our measures of income inequality also points toward what can be considered a weakness of complementing the Gini-coefficient only with the P90/P10 ratio. Benefits are presumably directed at the lower end of the income distribution which means that, again under the assumption that benefits make up a significant portion of the 10th fractile individual's income, the ratio can only explain changes in the Gini-coefficient that are due to changes at the upper end of the distribution. The Gini-coefficient, on the other hand, does not place any particular weight on either side of the distribution, and is commonly considered to be particular to changes in the middle of the distribution. We attempt to construct ratios based on pensionable and general income to nuance the debate on this, but the estimated effects on these ratios conflict both empirical evidence and our intuition. The estimated effects on the 90/10 and 50/10 ratios in pensionable income in table C.5 imply a progressive effect of the cycle. This is in itself not an issue, but it implies that income in the lower groups either grow significantly faster than that of the higher groups or that the two upper measures decline relative to the 10th fractile. This should, according to our understanding, likely be reflected in the effect of the unemployment rate. Since this is not the case, we are either mistaken in assuming that the inclusion of unemployment is diluting the effects of the cycle, but that it is rather the opposite, or the estimated effects are unreliable. If it was the case that the cycle diluted the effect of the unemployment rate, we find it strange that this isn't also reflected in the inflation- and real interest rates.

6.6 On controls and indicator variables

We defined a set of control variables which we believe can be related to dispersion of income. These are mostly demographics, but also includes immigration and education levels. They help us separate potential effects from the cycle. Many of these controls will not have contemporaneous effects on inequality. We include these variables, not necessarily because we wish to explicitly say something about them, but since we want to examine potential differences between municipalities. We know that municipalities will differ in demographic composition and education levels, immigration will not have have a asymmetric effects as certain places are more exposed to immigration than others. Municipal expenditure is hypothesized as countercyclical, and by including expenditures we would be able to separate the inherently conflicting fluctuations of the cycle and expenditures to further cultivate the cyclical effect. Based on the retrieved estimates, municipal expenditure has no significant effects on inequality. As shown in table 7, the inclusion of the control variables does not have a large impact the cyclical components within-effects on either Gini or P90/P10, but the controls do help us retrieve the contextual differences between municipalities in the cyclical component, albeit insignificant.

We hypothesised that three key industries might have a direct effect on inequality in Norway, and that they also could point to some differences between municipalities. We know that hydroelectric- production contributes to municipalities profits, which could in extension have equalizing effects due to the nature of local government spending. Furthermore, the aquaculture industry has since long been criticized in media concerning ground rent, which for many involved in the debate meant it was set too low top compensate for the environmental impact, further increasing the super profits within the sector. The Petroleum sector has historically – and still is – one of the most important industries in Norway. It is heavily affected by global conflicts, and general economic trends which makes it a potential key industry which may create large economic up- and downturns which potentially could reinforce or equalize economic inequality.

Our results points towards the Petroleum sector having a significant regressive effect on the inequality (Gini and P90/P10) within municipalities categorized as especially exposed to the industry. This is consistent with what we hypothesised a priori. While we do not find any contextual effect which could help us identify differences between, which in turn implies that the 20 identified municipalities are more or less similar. The other two industries are both insignificant with regards to inequality. This might be due to composition of the industries, it is not unlikely that the household/and individual incomes of persons employed within the different industries we selected are not as sensitive as e.g. service- and manufacturing sectors which we know can be heavily effected by demand shocks.

Our estimated effects on the largest cities in Norway is in line with Modalsli, 2018, where he finds that inequality is substantially higher in cities compared with rural areas, albeit not as large in magnitude, but we are not investigating historical inequality levels from the 19th century so the difference in magnitude is not that surprising. Our within-estimates indicate that municipalities which houses large cities have a 5,7% higher gini-coefficient than those who do not, and that there is no significant differences between these municipalities.

As a whole, the included industry indicators did not have as substantial impact as was first expected. Even when restricting the indicators to municipalities which could be considered relatively more invested in the sectors, we did not uncover any direct link to income inequality.

7 Conclusion

We evaluate the role of business cycles and some key components on income disparity within- and between municipalities. We decompose Norwegian GDP between 2006-2017 to a cyclical and trend component and add a set of key macroeconomic variables identified from business cycle literature which vary within municipalities while we also control for municipal demographics. Though a correlated-random effects model we estimate the effect of the business cycle on official inequality measures, the Gini-coefficient and P90/P10. We tried to complement these two measures with pensionable- and general income ratios and fractiles, but the coefficient estimates are difficult to reconcile with the main results and appear unreliable. We set out to investigate the following two research questions:

1. What is the relation between the business cycle and income inequality in Norway?

2. Is there a difference in the measures of income inequality's responsitivity to the business cycle across municipalities?

Our findings indicate that business cycles are regressively related to income inequality while the trend component is progressive within municipalities. These findings contradicts some other studies e.g. Blank, 1987; Parker, 1998, but this is likely due to institutional and/or structural differences which explains the effects as this study is from the U.S. Surprisingly, unemployment has no role in determining how inequality evolves[15] while the consumer price inflation on the other hand is regressive.

Whether municipalities differ with regards to the business cycle is not as clear, evidence points towards a regressive behaviour of the trend between-estimate and cycles not having any explanatory power at all between municipalities. It it however unclear if the cyclical component should be viewed in isolation from the trend, since they are not independent of each other. If we assume that the cycle can be viewed isolated in the short run we conclude that the business cycle does not explain differences between municipalities. But if we are inter-

[15]which is in line with Johnson and Shipp, 1999

ested in the long run effect, the trend and cycle should be viewed together, suggesting that they in sum have a regressive effect between municipalities.

There are some potential weaknesses with this approach. The properties and interpretation of the Mundlak correlated-random effects model when level 1 variables are not varying between groups are to our knowledge not widely agreed upon. The interpretation and validity of the contextual – and in extension the between – effects are therefore uncertain. Furthermore, the nature of the business cycle as an aggregate measure is on its own not appropriate as an explanatory variable since it is hard to separate potential conflicting or other pooled effects within the measure. Since we are using annual data, we have not taken into account common lag values that we observe in business cycle theory, this might affect the estimates. Another potential confounder is the distributions of pensionable- and general income. Both suffer from heavily skewed distributions for lower fractiles, which incidentally corresponds with the most significant estimates.

We have evaluated the role of business cycles and some of its key components on income inequality. The very nature of this approach makes it hard to exactly identify the individual roles of the business cycle components, as they to some degree may counteract or reinforce each other. One can further expand on this relation by decomposing the business cycle intro a wider set of components and use these to identify key relations. Some key components that we have not touched upon are real wage and investments.

References

Aaberge, R. (2021). *Økonomisk ulikhet i norge i det 21. århundre.* Oslo: Statistisk sentralbyrå.

Aaberge, R., & Atkinson, A. B. (2010). Top incomes in norway. *Top incomes: A global perspective*, *2*, 448–480.

Aaberge, R., Eika, L., Langørgen, A., & Mogstad, M. (2019). Local governments, in-kind transfers, and economic inequality. *Journal of Public Economics*, *180*, 103966.

Aaberge, R., Modalsli, J. H., & Vestad, O. L. (2020). Ulikheten–betydelig større enn statistikken viser. *SSB analyse*, *13*.

Aastveit, K. A., Jore, A. S., & Ravazzolo, F. (2016). Identification and real-time forecasting of norwegian business cycles. *International Journal of Forecasting*, *32*(2), 283–292.

Baltagi, B. H., & Song, S. H. (2006). Unbalanced panel data: A survey. *Statistical Papers*, *47*(4), 493–523.

Barro, R. J. (2000). Inequality and growth in a panel of countries. *Journal of economic growth*, *5*(1), 5–32.

Bayer, C., Born, B., & Luetticke, R. (2020). Shocks, frictions, and inequality in us business cycles.

Beggs, J. (2021). *Learn the definition what is okun's law in economics.* Retrieved May 23, 2022, from https://www.thoughtco.com/overview-of-okuns-law-1148111

Bell, A., Fairbrother, M., & Jones, K. (2019). Fixed and random effects models: Making an informed choice. *Quality & Quantity*, *53*(2), 1051–1074.

Benkemoune, R. (2009). Charles dunoyer and the emergence of the idea of an economic cycle. *History of Political Economy*, *41*(2), 271–295.

Bjørnland, H. C., Brubakk, L., & Jore, A. S. (2005). The output gap in norway-a comparison of different methods.

Bjørnland, H. C. (2000). Detrending methods and stylized facts of business cycles in norway–an international comparison. *Empirical Economics*, *25*(3), 369–392.

Blank, R. M. (1987). Disaggregating the effect of the business cycle on the distribution of income.

Burkhauser, R. V., Feng, S., & Jenkins, S. P. (2009). Using the p90/p10 index to measure us inequality trends with current population survey data: A view from inside the census bureau vaults. *Review of Income and Wealth*, *55*(1), 166–185.

Chaffey, P. (2017). *Hva er Norges største næringer?* Retrieved April 25, 2022, from https://enerwe.no/hva-er-norges-storste-naeringer/149262

Chitiga, M., & Sekyere, E. (n.d.). *Income inequality and limitations of the gini index: The case of south africa.* Retrieved June 16, 2022, from http://www.hsrc.ac.za/en/review/hsrc-review-november-2014/limitations-of-gini-index

Corporate Finance Institute. (2022). *What is a business cycle.* Retrieved May 15, 2022, from https://corporatefinanceinstitute.com/resources/knowledge/economics/business-cycle/

Creamer, D. B., Bernstein, M., & Moore, G. H. (1956). *Personal income during business cycles.* Princeton University Press Princeton, NJ.

Directorate of Fisheries. (2017). *Utbetalinger Havbruksfondet 2017, [statistics].* Retrieved March 3, 2022, from https://www.fiskeridir.no/Akvakultur/Tema/Havbruksfondet

Dritsaki, M., & Dritsaki, C. (2022). Comparison of hp filter and the hamilton's regression. *Mathematics*, *10*(8), 1237.

Ekeland, A. (2014). Sysselsatte i petroleumsnæringene og relaterte næringer 2012. *SSB Rapporter*, *12*, 38.

Ekeland, A. (2015a). Sysselsatte i petroleumsnæringene og relaterte næringer 2013. *SSB Rapporter*, *5*, 33.

Ekeland, A. (2015b). Sysselsatte i petroleumsnæringene og relaterte næringer 2014. *SSB Rapporter*, *48*, 35.

Ekeland, A. (2017). Sysselsatte i petroleumsnæringene og relaterte næringer 2016. *SSB Rapporter*, *48*, 39.

Epland, J., & Tuv, N. (2019). *Slik måler ssb ulikhet.* Retrieved April 8, 2022, from https://www.ssb.no/inntekt-og-forbruk/inntekt-og-formue/statistikk/inntekts-og-formuesstatistikk-for-husholdninger/artikler/slik-maler-ssb-ulikhet

Estevez, E. (2022). *Economic cycle.* Retrieved May 22, 2022, from https://www.investopedia.com/terms/e/economic-cycle.asp

Fiva, J. H., Halse, A., & Natvik, G. J. (2020). Local government dataset. *Dataset. Available at www.jon.fiva.no/data.htm.*

Fjære, J. S. (2014). *Income development in norwegian municipalities a descriptive analysis of 16 norwegian municipalities over 150 years* (Master's thesis).

Gramlich, E. M., & Laren, D. S. (1984). How widespread are income losses in a recession. *The social contract revisited: Aims and outcomes of President Reagan's social welfare policy*, 157–180.

Grytten, O. H. (2020). The wealth of a nation: Norways road to prosperity. *NHH Dept. of Economics Discussion Paper*, (17).

Hagenaars, A. J., De Vos, K., Asghar Zaidi, M., et al. (1994). Poverty statistics in the late 1980s: Research based on micro-data.

Hall, V. B., Thomson, P. et al. (2020). *Does hamiltons ols regression provide a better alternative to the hodrick-prescott filter? a new zealand business cycle perspective* (tech. rep.).

Halvorsen, K., & Stjernø, S. (2021). *Økonomisk og sosial ulikhet i norge*. Universitetsforlaget.

Hamilton, J. D. (2018). Why you should never use the hodrick-prescott filter. *Review of Economics and Statistics*, *100*(5), 831–843.

Haus, M. (2019). *Mer enn 8 av 10 bor i tettsteder*. Retrieved June 18, 2022, from https://www.ssb.no/befolkning/artikler-og-publikasjoner/mer-enn-8-av-10-bor-i-tettsteder

Heathcote, J., Perri, F., & Violante, G. L. (2010). Unequal we stand: An empirical analysis of economic inequality in the united states, 1967–2006. *Review of Economic dynamics*, *13*(1), 15–51.

History central. (n.d.). *Economic panic of 1873*. Retrieved June 18, 2022, from https://www.historycentral.com/rec/EconomicPanic.html

Hodrick, R. J., & Prescott, E. C. (1997). Postwar us business cycles: An empirical investigation. *Journal of Money, credit, and Banking*, 1–16.

Hoover, G. A., Giedeman, D. C., & Dibooglu, S. (2009). Income inequality and the business cycle: A threshold cointegration approach. *Economic Systems*, *33*(3), 278–292.

Husebø, T. A., & Wilhelmsen, B. (2005). *Norwegian business cycles 1982-2003*. Staff Memo.

Johannessen, J. H. (2009). Sysselsatte i petroleumsnæringene. *SSB Rapporter*, *43*, 25.

Johannessen, J. H., Aamodt, M., & Michaelsen, E. (2010). Sysselsatte i petroleumsnæringene og relaterte næringer. *SSB Rapporter*, *55*, 45.

Johnson, D. S., & Shipp, S. (1999). Inequality and the business cycle: A consumption viewpoint. *Empirical Economics*, *24*(1), 173–180.

Jones, K. (2019). *Is it still appropriate to calculate a contextual effect in a group-mean centered 2-level hierarchical model when the level 1 effect is insignificant?* Retrieved June 14, 2022, from https://www.researchgate.net/post/Is_it_still_appropriate_to_calculate_a_contextual_effect_in_a_group-mean_centered_2-level_hierarchical_model_when_the_level_1_effect_is_insignificant

Jones, K., Wright, C., & Bell, A. (2013). Do multilevel models ever give different results? or why bother with multilevel models.

King, R. G., & Rebelo, S. T. (1999). Resuscitating real business cycles. *Handbook of macroeconomics*, *1*, 927–1007.

Krueger, D., Mitman, K., & Perri, F. (2015). Macroeconomics and heterogeneity, including inequality. *Handbook of Macroeconomics (forthcoming)*.

Kufenko, V., & Geiger, N. (2017). Stylized facts of the business cycle: Universal phenomenon, or institutionally determined? *Journal of Business Cycle Research*, *13*(2), 165–187.

Kuznets, S., & Jenks, E. (1953). *Shares of upper income groups in income and savings (1953)*. National Bureau of Economic Research, Inc. https://EconPapers.repec.org/RePEc:nbr:nberbk:kuzn53-1

Kydland, F. E., Prescott, E. C. et al. (1990). Business cycles: Real facts and a monetary myth. *Federal Reserve Bank of Minneapolis Quarterly Review*, *14*(2), 3–18.

Lund, M. E. (2012). *Inntektsfordelingen i norge i et historisk perspektiv: Årsaker til endringer i fordelingen av inntekt fra slutten av 1800-tallet og frem mot i dag med skille mellom by og bygd.* (Master's thesis).

Mendershausen, H. (1946). Changes in income inequality. *Changes in income distribution during the great depression (studies in income and wealth, vol. 7)* (pp. 23–80). National Bureau of Economic Research, Inc. https://EconPapers.repec.org/RePEc:nbr:nberch:5308

Modalsli, J. (2018). The regional dispersion of income inequality in nineteenth-century norway. *Explorations in Economic History*, *67*, 62–79.

Mojon, B., & Agresti, A. M. (2001). Some stylized facts about the euro area business cycle.

Mundlak, Y. (1978). On the pooling of time series and cross section data. *Econometrica: journal of the Econometric Society*, 69–85.

Nerlove, M. (2005). *Essays in panel data econometrics*. Cambridge University Press.

OECD. (2021). *Fisheries and aquaculture in norway*. Retrieved June 18, 2022, from https://www.oecd.org/agriculture/topics/fisheries-and-aquaculture/documents/report_cn_fish_nor.pdf

Parker, S. C. (1998). Income inequality and the business cycle: A survey of the evidence and some new results. *Journal of Post Keynesian Economics*, *21*(2), 201–225.

Piketty, T., & Goldhammer, A. (2017). *Capital in the twenty-first century*. Harvard University Press.

Piketty, T. (2018). *Capital in the twenty-first century*. Harvard University Press. https://doi.org/10.4159/9780674982918

Prachowny, M. F. (1993). Okun's law: Theoretical foundations and revised estimates. *The review of Economics and Statistics*, 331–336.

Rambotti, S. (2015). Recalibrating the spirit level: An analysis of the interaction of income inequality and poverty and its effect on health. *Social Science & Medicine*, *139*, 123–131.

Ravn, M. O., & Uhlig, H. (2001). On adjusting the hp-filter for the frequency of observations. *Available at SSRN 276784*.

Romer, C. D. (2008). Business cycles. *The concise encyclopedia of economics*, *26*, 2010.

Sandvik, O., & Johannessen, J. H. (2013). Sysselsatte i petroleumsnæringene og relaterte næringer 2011. *SSB Rapporter*, *5*, 37.

Schüler, Y. S. (2021). On the cyclical properties of hamilton's regression filter. *Available at SSRN 3559776*.

Sen, A. (1973). On economic inequality. Oxford University Press.

Solbu, P. T. (2009). *Inntektsulikhet i norge 1858-2006: En analyse av fordelingen av inntekt i norge før, under og etter industrialiseringen.* (Master's thesis).

Statistics Norway. (2022a). *05426: Immigration, emigration and net immigration (m) 1999 - 2021*. Retrieved May 11, 2022, from https://www.ssb.no/en/statbank/table/05426

Statistics Norway. (2022b). *09114: Measures of income despersion. Household equivalent income (EU-scale) between persons (M) (UD) 2004 - 2020, [statistics]*. Retrieved January 8, 2022, from https://www.ssb.no/statbank/table/09114/

Statistics Norway. (2022c). *09189: Final expenditure and gross domestic product 1970 - 2021, [statistics]*. Retrieved January 8, 2022, from https://www.ssb.no/en/statbank/table/09189

Statistics Norway. (2022d). *09429: Educational attainment, by municipality and sex (M) 1970 - 2021, [statistics]*. Retrieved April 12, 2022, from https://www.ssb.no/en/statbank/table/09429/

Statistics Norway. (2022e). *12880: Main economic indicators. Accounts and forecasts 1991 - 2025, [statistics]*. Retrieved April 13, 2022, from https://www.ssb.no/en/statbank/table/12880

Statistics Norway. (2022f). *13470: Employed persons by industry division (5 digit level, SIC2007). 4th quarter (M) 2008 - 2021, [statistics]*. Retrieved April 12, 2022, from https://www.ssb.no/en/statbank/table/13470

Statistics Norway. (2022g). *Concept variable*. Retrieved May 1, 2022, from https://www.ssb.no/a/metadata/conceptvariable/vardok/1985/en

Statistics Norway. (2022h). *Concept variable*. Retrieved May 1, 2022, from https://www.ssb.no/a/metadata/conceptvariable/vardok/3495/nb

Stiglitz, J. (2013). *The price of inequality*. Penguin.

Stiglitz, J. (2015). *The great divide: Unequal societies and what we can do about them*. W. W. Norton.

Stock, J. H., & Watson, M. W. (1999). Business cycle fluctuations in us macroeconomic time series. *Handbook of macroeconomics*, *1*, 3–64.

Strøm, F., Lunde, H., Løvbak, T., & Mørk, E. (2008). Flere tar del i inntektsveksten: Inntekt, lønn og forbruk.

The Norwegian Water Resources and Energy Directorate. (2022). *Vannkraftdatabase, [statistics]*. Retrieved December 4, 2021, from https://www.nve.no/energi/energisystem/vannkraft/vannkraftdatabase/

Thoen, H., & Johannessen, J. H. (2011). Sysselsatte i petroleumsnæringen og relaterte næringer 2010. *SSB Rapporter*, *49*, 36.

Thorsnæs, G. (2022). *Byer i norge i store norske leksikon på snl.no*. Retrieved February 18, 2022, from https://snl.no/byer_i_Norge

Wilkinson, R., Pickett, K., & Poulsson, P. (2012). *Ulikhetens pris: Hvorfor likere fordeling er bedre for alle*. Res Publica.

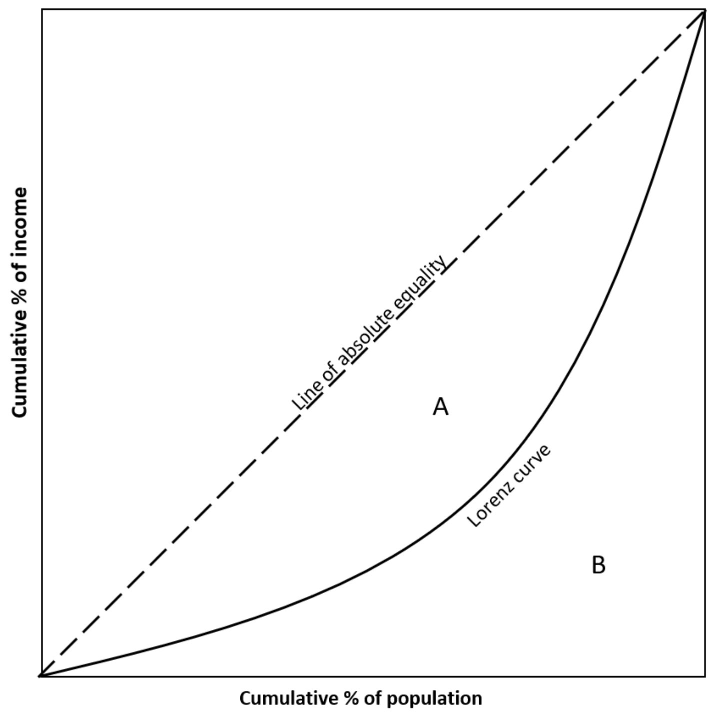
A Appendix

The appendix is divided into three parts. The first (A) section provides more in-depth explanations of some concepts that are related to our methodology and inequality measures but are not strictly related to our chosen methods and measures, and are as such given less room in the discussion. The second (B) presents some descriptive statistics on municipalities, and dispersion of indicator variables, and third (C), a collection of regressions used in the results section.

A.1 The Gini Index & the Lorentz curve

The Gini coefficient can be formulated in several different ways, but the simplest representation is $\frac{A}{A+B}$, where A and B are as in figure A.1.1. Amartya Sen (1973) shows that it can be represented as half the relative mean difference;

Figure A.1.1: the Gini coefficient and the Lorenz curve



A.2 The Business Cycle

A.2.1 The Hodrick-Prescott filter

The Hodrick-Prescott (HP) filter assumes that the time series y_t can be decomposed into a trend- and a cyclical component, $y_t = c_t + g_t$. The decomposition of these two are obtained through the minimization problem given by;

$$\min_{\{g_t\}_{t=-1}^{T}} \{\sum_{t=1}^{T}(y_t - g_t)^2 + \lambda \sum_{t=1}^{T}[(g_t - g_{t-1}) - (g_{t-1} - g_{t-2})]^2\} \tag{A.2.1}$$

Where λ is referred to as a "smoothing parameter". When $\lambda \to 0$ the long-term growth rate is approaches the rate of the series y_t itself, i.e. there is no difference in the series and the growth rate, and when $\lambda \to \infty$ the long-term growth rate approaches a least-squares fit of a linear trend model. The choice of the smoothing parameter λ is as such a determining factor of the extraction of the trends and cycles. Hodrick and Prescott (1997) argued that $\lambda = 1600$ was appropriate for quarterly data. Ravn and Uhlig (2001) showed that one can decompose a time series for annual data using the frequency-based transformation $\lambda_{annual} = \frac{\lambda_{quarterly}}{\alpha^4}$, where $\alpha \approx 4$. Based on Hodrick and Prescotts chosen λ for quarterly data, Ravn and Uhlig argued that a fitting value of lambda for annual data is $\lambda = 6.25$.

A.2.2 Hamilton's H84 detrending method

Hamilton (2018) proposes an alternate detrending method. Hamilton's H84-filter is a regression of the variable at date t+h on the four most recent values, which Hamilton suggests is a more robust detrending method than the Hodrick-Prescott filter and that it achieves all the same goals. The Hamilton filter proposes to estimate an OLS regression of y_{t+h} on a constant and the $p = 4$ most recent values of y as of date t:

$$y_{t+h} = \beta_0 + \beta_1 y_t + \beta_y y_{t-1} + \beta_3 y_{t-2} + \beta_4 y_{t-3} + v_{t+h} \tag{A.2.2}$$

Where the residuals are given by:

$$\hat{v}_{t+h} = y_{t+h} = \hat{\beta}_0 + \hat{\beta}_1 y_t + \hat{\beta}_2 y_{t-1} + \hat{\beta}_3 y_{t-2} + \hat{\beta}_4 y_{t-3} \tag{A.2.3}$$

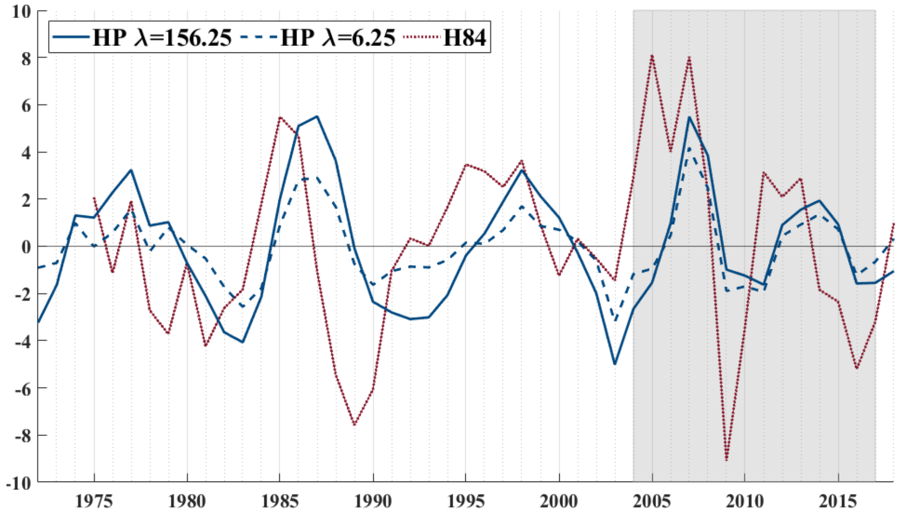
which, according to Hamilton, can be used to construct the transient component for a broad class of underlying processes. The residuals, $\hat{v}_{t+h}$ have several features that, according to Hamilton, make this filtering method more efficient than the HP-filter. If the residuals predict some other variable x_{t+h+j}, this represents an ability of predicting x rather than being an artifact. The value of the residuals are "essentially assumption-free" and can not easily be predicted from variables predating t, where any such predictability indicates something about the true data-generating process (DGP). If the fourth differences of y_t are stationary the series itself is considered stationary, meaning that regardless of the DGP one can retrieve a population linear projection of y_{t+h} on $(y_t, y_{t-1}, y_{t-2}, y_{t-3}, 1)'$. This can be used to define what is referred to as the cyclical component of the process.

In line with Schüler (2021), others have critized the H84 detrending method. Dritsaki & Dritsaki (2022) compares the performance of H84 and the HP-filter on Greek business cycles, and also concludes that the H84 lead to significantly higher volatility than the HP-filter. This is the same result as for the New Zealand business cycle, where it is found to exaggerate the volatility and infer uncredible trend movements (Hall, Thomson, et al., 2020).

A.2.3 Comparing the HP-filter and H84

Figure A.2.1 shows estimations of the cyclical component of Norwegian mainland GDP from 1972-2018, as computed with H84, and two estimations by the HP-filter using $\lambda = 6,25$ and $\lambda = 156,25$. We apply Ravn and Uhlig's (2001) transformation for annual data, based on quarterly values of 1.600 and 40.000. The former is in line with Kydland and Prescott (1990), whereas the latter is based on Statistics Norway's analyses of the Norwegian Economy (Bjørnland et al., 2005).

Figure A.2.1: Deviation from estimated trend GDP (1972-2018)



A.2.4 The Reference cycle

Aastveit et al., 2016 compares different turning points of the Norwegian business cycle as defined by Markov-switching models and the nonparametric Bry-Broschan method. The following table is an excerpt from table 2 in their paper:

Table A.2.1: Excerpt from table 2: Business cycle characteristics 1978-2012. Ex post; four Methods, Aastveit et al., 2016

Business cycle characteristics 1978-2012. Ex post; four Methods				
Norway				
	BB-GDP	MS-GDP*	BB-ISD	MS-FMQ**
Mean duration (quarters)	27.3	22.2	22.6	22.6
- Peak to trough	4	7.3	3.2	6
- Trough to peak	23.5	15.2	19.4	16.4
Mean amplitude				
- Peak to trough	-1.8	-0.6	-1.2	-1
- Trough to peak	19.6	15.2	15.7	15.4
Cumulative change				
- Peak to trough	-5.6	-1.7	-2.3	-3.5
- Trough to peak	330.8	191	224.5	200.9

Aastveit et al. reports what they find to be the average duration of the cycles split into movements from peak to trough and from trough to peak. Among the four methods applied, they find that both Markov Switching (MS) models outperform the Bry-Broschan (BB) methods, and argue that the Markov Switching factor model (MS-FMQ) provided what they deem the most reasonable definition of the Norwegian business cycles.

A.3 Econometric model

A.3.1 Fixed Effects Model

An important assumption of fixed effects models is that there are time-invariant characteristics that are unique to the entity and uncorrelated with other individual characteristics. If each unit is different and characteristics are unique, the error term and the constant should not be correlated across entities.

$$y_{it} = \beta_1(x_{it} - \bar{x}_i) + (v_i + \varepsilon_{it}) \tag{A.3.1}$$

$$\tag{A.3.2}$$

Where α_i is the unknown intercept for each unit, Y_{it} is the dependent variable, x_{it} represents one independent variable, β_i is the independent variables' coefficient and ε_{it} is the error term. Since the model is unable to incorporate the effect of explanatory variables that do not change over time, the fixed effect models disregard important information about the relation between the dependent and the independent variables (Nerlove, 2005, p.20).

A.3.2 Random Effects Models

Random effects models are based on the rationale that the variation across entities is assumed to be random and uncorrelated with the predictors and predicted variables in the model. If there are differences across the observed units that may influence the dependent variable, then RE is potentially a more suitable model.

$$y_{it} = \beta_1 x_{it} + \beta_2 z_i + u_{it} + \varepsilon_{it} \tag{A.3.3}$$

Where the interpretation are as for the fixed effects model, except that the error term is divided so that u_{it} represents the between-entity error and ε_{it}

represents the within-entity error. This simple RE model assumes that there is no difference between the average within and -between effects. An advantage of random effects models is that time-invariant variables can be included. This is because the entity's error term is assumed to not be correlated with the predictors, hence allowing time-invariant variables to function as explanatory variables. A drawback with the RE models are that, due to the very same assumption of no correlation between the error term and the predictors, the characteristics that may influence the predictor variables must be included as to not induce omitted variable bias. In RE models, level 2 random effects are treated as if they were random draws from a normal distribution. On the individual/entity level, the variance is typically assumed to follow a normal distribution for both FE and RE specifications (Bell et al., 2019).

Table A.3.1: Fixed versus Random effects

	Fixed Effects	**Random effects**
Assumptions	None	Individual effects are not correlated with regressors
Intercept	Varying across groups and/or time	Constant
Error Variances	Constant	Randomly distributed across entities and/or time
Hypothesis test	F-test	Breusch-Pagan LM test

A.3.3 Relationship between the contextual- and the between effect

The following set of equations shows that the within- and contextual effects can be used to derive the between effects:

$$\Leftrightarrow y_{it} = \beta_0 + \beta_{1W}(x_{it} - \bar{x}_i) + \beta_{2B}\bar{x}_i + \beta_3 z_i + (v_i + \varepsilon_{it}) \quad \text{(A.3.4)}$$

The difference between the first and fourth equation in the system above is that the first, the Mundlak model, uses the regressor in its pure form, estimating a contextual effect, whereas the fourth is the within-between random effects model where the between effect is estimated directly, as parameterized by Bell et al., 2019.

A.3.4 Testing model specification

Table A.3.2: Estimated effects on gini using FE-, RE-, and Mundlak's model

	Fixed Effects		Random Effects		Mundlak	
Cycle, log	1.026***	(0.054)	1.037***	(0.054)	1.026***	(0.054)
Trend, log	-0.126*	(0.075)	-0.139*	(0.075)	-0.126*	(0.075)
Real rate, log	-0.010***	(0.001)	-0.010***	(0.001)	-0.010***	(0.001)
CPI, log	0.839***	(0.126)	0.862***	(0.126)	0.839***	(0.126)
Unempl., log	-0.004	(0.003)	-0.003	(0.003)	-0.004	(0.003)
Large cities	0.000	(.)	0.154***	(0.022)	0.149***	(0.022)
Petroleum	0.000	(.)	0.062***	(0.018)	0.062***	(0.018)
Hydropower	-0.016	(0.013)	-0.035***	(0.007)	-0.016	(0.013)
Aquaculture	0.000	(.)	-0.011	(0.008)	-0.013	(0.008)
mean(Cycle)					0.373***	(0.079)
mean(Real rate)					0.829	(0.554)
mean(CPI)					5.305	(8.086)
mean(Unempl.)					0.017	(0.012)
mean(Hydropower)					-0.026*	(0.016)
Constant	4.862***	(1.095)	5.060***	(1.090)	0.000	(.)
Observations	4617		4617		4617	
Municipalities	420		420		420	
Corr w. u_i	0.028		0 (Assumed)		0 (Assumed)	
R^2 within	0.348		0.347		0.348	
R^2 between	0.049		0.192		0.207	
R^2 overall	0.134		0.243		0.252	
ρ	0.736		0.690		0.690	

Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In line with Bell, Fairbrother and Jones (2019), we estimate a fixed effects model, a random effects model, and the Mundlak model with a small subset of our variables on the logarithm of the Gini-coefficient. In table A.3.2, we present the estimated coefficients generated from the three models. This is a reduced model without control variables which purpose is to test whether the fixed effects are appropriately captured by the Mundlak model. The estimated coefficients of Mundlak and FE are overall the same both in terms of coefficient estimates and significance. The fixed effects model by construction omits the four indicator variables[16], which are included in both the Random effect and Mundlak specifications.

The fact that the Mundlak model is able to capture the fixed effect estimates by itself does not necessarily indicate that the Mundlak model should be preferred over the fixed effects model, but the proponents of the within-between RE models tend to favor these due to efficiency gains. For a random effects-model to work properly, any characteristic that may influence the independent

[16]Since they are time-invariant within municipalities/groups

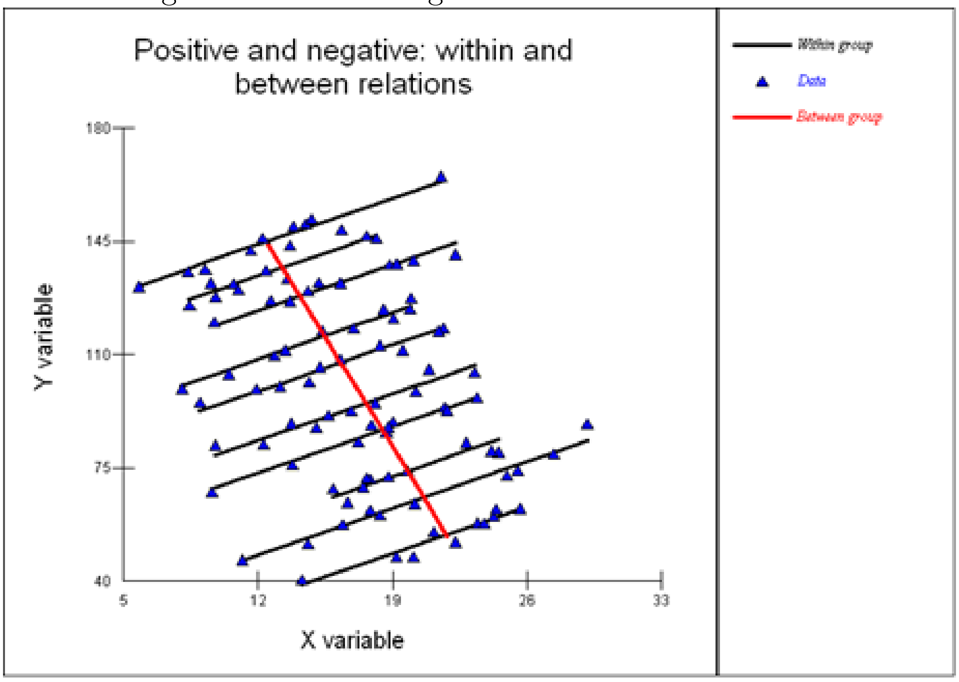
variables must be included in order not to generate omitted variable bias.

With the coefficients estimated in the Mundlak model, one can estimate the between effect of the cycle on the variables of interest. Bell et al., 2019 proposes a simple arithmetic relation $\beta_{iW} + \beta_{iC} = \beta_{iB}$ where one can isolate the between effect from the Mundlak model based on the within- and contextual effects.

A.3.5 Differing within- and between effects

The following table is retrieved from Jones et al., 2013, and shows a situation where estimated within- and between effects goes in different directions.

Figure A.3.1: Differing within- and between effects



Jones points out that any single-level model fails to recognize such differing effects, and instead provides a weighted blend of each type, that is more or less uninterpretable, and the weighting depends on “the ratio of the between-groups sum of squares of the predictor to the total sum of squares” (Jones et al., 2013).

B Appendix

B.1 Descriptives

Table B.1: Summary statistics over "narrow" indicators

			Interdecile ratios					
	Gini	*P90P10*	*Pensionable income*			*General income*		
2004			90-10	90-50	50-10	90-10	90-50	50-10
None	.220	2.39	19.48	1.80	10.75	-	2.31	-
Aquaculture	.227	2.40	19.41	1.80	10.74	-	2.33	-
Hydropower	.211	2.35	18.88	1.75	10.75	-	2.22	-
Hydro.×Aqua.	.225	2.38	20.27	1.83	11.05	-	2.36	-
Petroleum	.237	2.43	21.74	1.97	10.91	-	2.56	-
Petro.×Aqua.	.242	2.5	19.35	1.96	9.79	-	2.58	-
All	.225	2.4	21.32	1.96	10.85	-	2.70	-
National avg.	.220	2.38	19.48	1.80	10.74	-	2.32	-
2011								
None	.204	2.40	21.24	1.83	11.57	35.32	2.23	14.90
Aquaculture	.209	2.45	21.48	1.87	11.47	20.99	2.29	9.14
Hydropower	.195	2.34	20.91	1.76	11.88	17.22	2.13	8.08
Hydro.×Aqua.	.204	2.42	22.17	1.84	12.02	18.96	2.23	8.44
Petroleum	.217	2.5	20.10	2.00	10.04	26.48	2.47	10.49
Petro.×Aqua	.222	2.57	18.30	2.03	8.98	24.69	2.55	9.62
All	.209	2.5	18.89	2.03	9.28	26.47	2.56	10.33
National avg.	.204	2.40	21.16	1.83	11.53	30.10	2.24	12.83
2017								
None	.222	2.61	10.13	1.79	5.61	10.57	2.25	4.64
Aquaculture	.229	2.64	9.62	1.81	5.32	10.63	2.27	4.62
Hydropower	.210	2.50	9.90	1.72	5.72	8.99	2.14	4.19
Hydro.×Aqua.	.215	2.58	10.36	1.80	5.72	10.46	2.24	4.61
Petroleum	.223	2.62	9.88	1.93	5.11	13.34	2.45	5.33
Petro.×Aqua.	.240	2.7	9.83	1.94	5.05	17.19	2.49	6.71
All	.229	2.6	9.56	1.92	4.97	13.77	2.46	5.58
National avg.	.221	2.60	10.03	1.79	5.57	10.54	2.25	4.63

None (n=278), Aquaculture (n=48), Hydropower (n=60), Hydro×Aqua (n=14)
Petroleum (n=12), Petro×Aqua (n=7), All (n=1), National avg.(n=420)

Table B.2: Summary statistics Pensionable income

Pensionable income for fractiles over main indicators and national level

Petroleum	*Mean*	*SD*	*Min*	*Max*	*Median*	*N*
10th fractile	39,032	14,230	13,702	89,872	35,719	220
25th fractile	139,306	58,220	1,003	247,105	151,936	274
50th fractile	325,896	41,698	187,177	430,897	329,922	280
75th fractile	482,714	53,422	349,550	643,834	481,315	280
90th fractile	675,596	100,854	449,917	968,863	672,488	280
Mean	351,360	50,992	246,052	496,574	349,746	280
Hydropower	*Mean*	*SD*	*Min*	*Max*	*Median*	*N*
10th fractile	32,147	13,471	12,030	97,656	28,640	825
25th fractile	123,196	57,585	409	257,873	131,334	997
50th fractile	300,497	45,429	78,301	405,845	303,764	1,050
75th fractile	432,373	43,680	307,235	562,495	432,815	1,050
90th fractile	558,182	66,678	404,137	791,334	555,737	1,050
Mean	302,705	41,799	194,347	425,226	299,542	1,050
Aquaculture	*Mean*	*SD*	*Min*	*Max*	*Median*	*N*
10th fractile	33,774	14,856	12,988	105,316	29,611	770
25th fractile	127,182	56,507	1,003	248,624	135,867	931
50th fractile	304,729	44,461	96,279	428,249	307,417	980
75th fractile	447,574	45,848	334,125	634,518	445,168	980
90th fractile	593,709	80,742	424,998	959,303	588,268	980
Mean	315,647	45,498	210,116	496,513	313,554	980
National	*Mean*	*SD*	*Min*	*Max*	*Median*	*N*
10th fractile	32,685	14,127	9,618	105,721	29,311	4,620
25th fractile	124,410	57,037	168	257,873	133,094	5,565
50th fractile	299,102	45,683	78,301	440,877	302,044	5,880
75th fractile	435,625	46,831	294,420	671,906	433,367	5,880
90th fractile	571,809	79,977	387,536	992,000	563,395	5,880
Mean	306,658	45,615	184,119	524,263	302,901	5,880

Observations equal to zero are omitted.

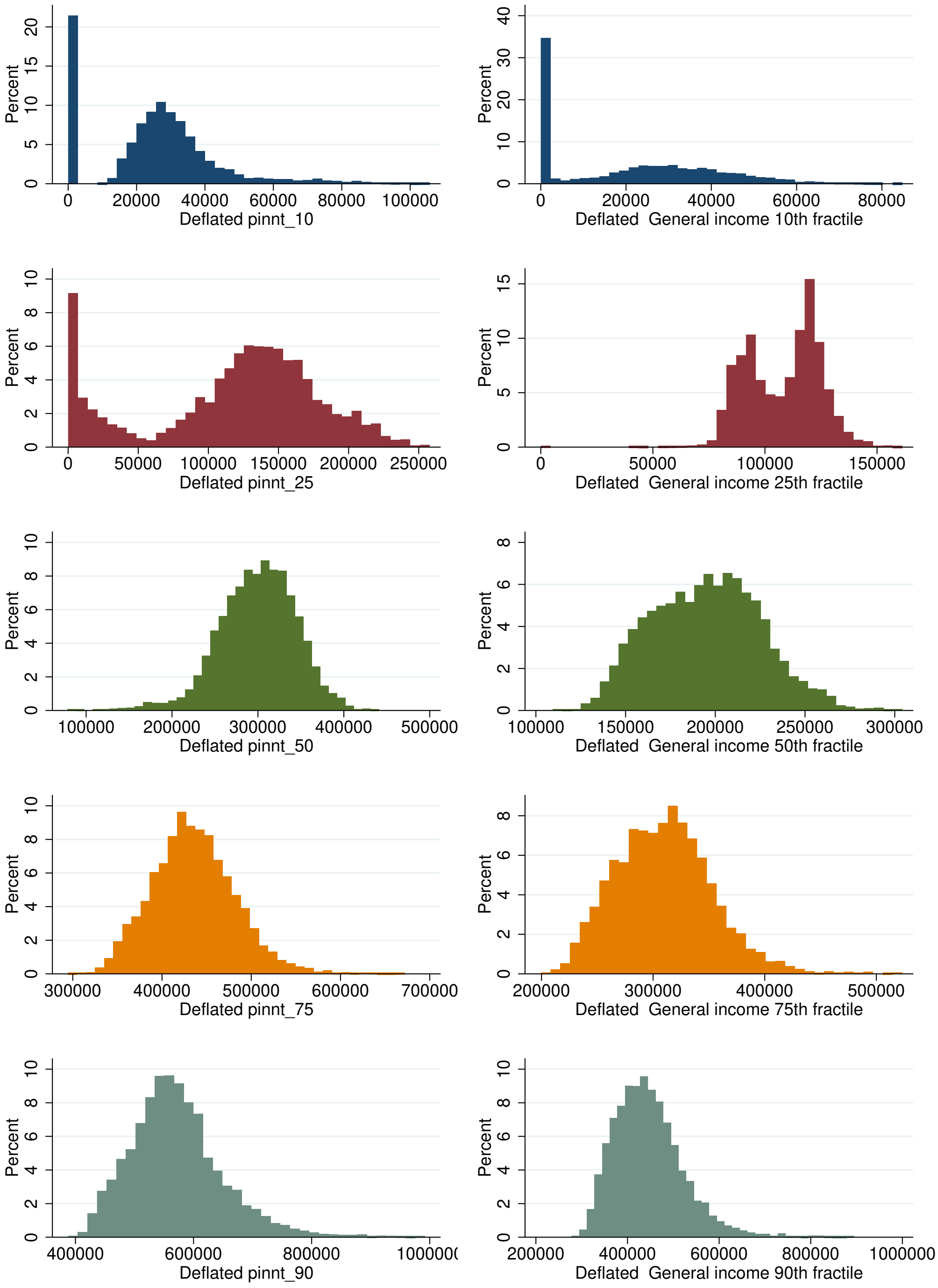
Table B.3: Summary statistics General income

General income for fractiles over main indicators and national level

Petroleum	*Mean*	*SD*	*Min*	*Max*	*Median*	*N*
10th fractile	27,756	13,112	8	59,750	26,151	196
25th fractile	108,265	17,623	63,654	139,615	114,836	280
50th fractile	210,939	33,230	143,196	290,986	210,455	280
75th fractile	348,507	50,934	246,692	493,393	349,886	280
90th fractile	540,085	100,302	343,656	823,403	535,092	280
Mean	274,542	48,900	182,477	412,860	275,723	280
Hydropower	*Mean*	*SD*	*Min*	*Max*	*Median*	*N*
10th fractile	31,981	16,475	28	78,812	32,135	748
25th fractile	110,584	16,799	55,338	161,297	113,873	1,050
50th fractile	198,856	30,400	118,581	265,757	199,736	1,050
75th fractile	310,348	40,540	199,359	426,806	310,848	1,050
90th fractile	437,957	65,205	277,853	655,2465	435,302	1,050
Mean	235,068	36,702	139,887	351,470	235,188	1,050
Aquaculture	*Mean*	*SD*	*Min*	*Max*	*Median*	*N*
10th fractile	30,139	16,015	4	77,324	30,021	697
25th fractile	106,924	16,422	55,338	146,994	112,190	980
50th fractile	195,702	31,233	118,581	279,382	198,064	980
75th fractile	315,762	43,601	217,313	473,522	317,458	980
90th fractile	459,329	78,438	311,926	810,620	453,669	980
Mean	241,959	42,156	148,418	402,141	241,933	980
National	*Mean*	*SD*	*Min*	*Max*	*Median*	*N*
10th fractile	29,845	16,256	1	84,807	29,766	4,177
25th fractile	108,117	16,309	41,386	161,297	111,389	5,877
50th fractile	195,141	30,568	109,321	304,267	195,812	5,880
75th fractile	309,860	43,404	199,359	523,318	308,952	5,880
90th fractile	446,392	77,153	277,853	895,124	437,869	5,880
Mean	236,772	41,520	139,272	675,206	234,487	5,880

Observations equal to zero are omitted.

Figure B.1: Distribution of pensionable- and general income 2004 - 2017



Full sample. Including observations equal to zero.

Table B.4: List of Petroleum municipalities

Municipalities with Petroleum (n=20)				
Sveio	Stavanger	Rennesøy	Øygarden	Tysnes
Strand	Eigersund	Austrheim	Stordal	Sola
Fjell	Sund	Randaberg	Aukra	Sandnes
Tysvær	Verdal	Bokn	Haugesund	Fitjar

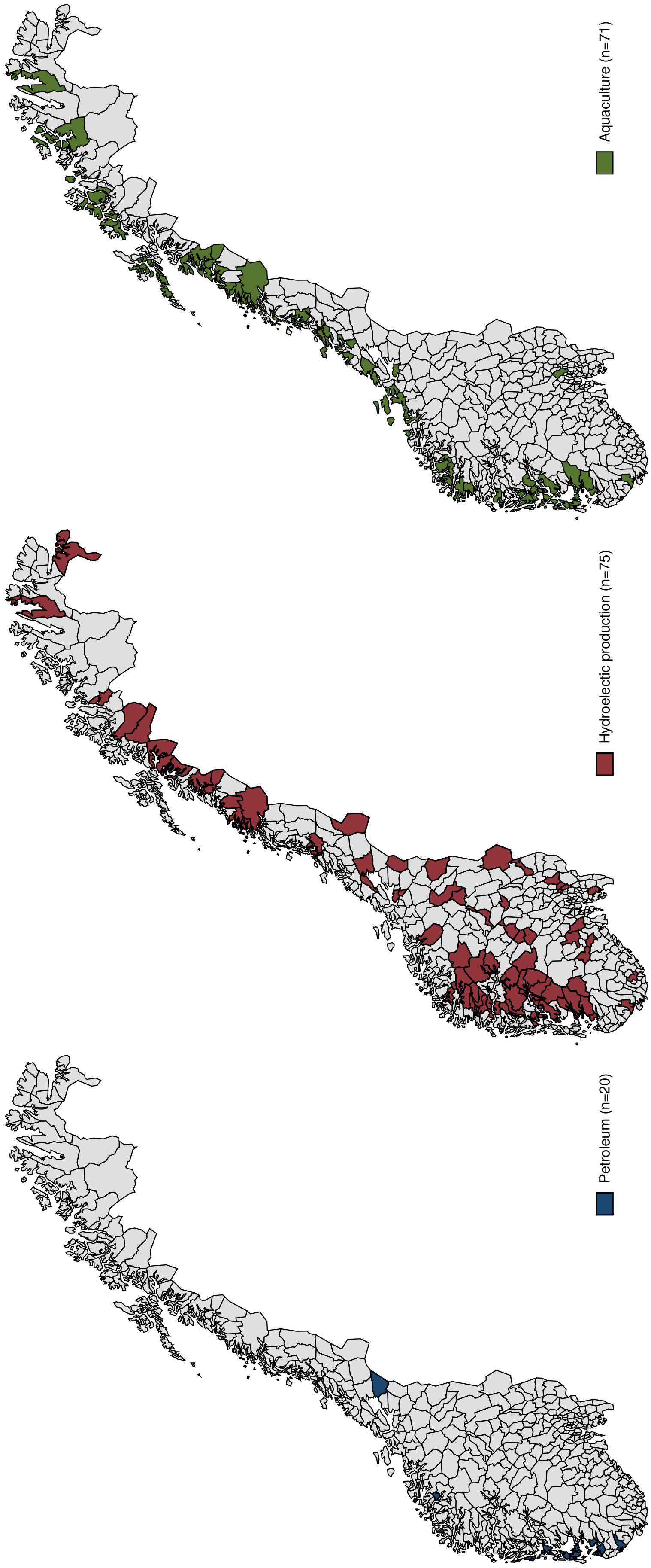
Table B.5: List of top hydropower municipalities

Municipalities with Hydropower (n=75)			
Lillehammer	Sarpsborg	Tynset	Gloppen
Lierne	Meløy	Notodden	Os (Hordaland)
Sørfold	Meråker	Modalen	Nord-Aurdal
Nes (Akershus)	Bykle	Røros	Bardu
Tysfjord	Våler (Hedmark)	Rødøy	Alvdal
Hornindal	Sør-Fron	Bindal	Vennesla
Kongsberg	Suldal	Narvik	Kvinnherad
Hjelmeland	Steinkjer	Ulvik	Rana
Nes (Buskerud)	Beiarn	Trysil	Fet
Førde	Volda	Klæbu	Jondal
Kåfjord	Sunndal	Ullensvang	Høyanger
Naustdal	Eidfjord	Aurland	Trondheim
Odda	Ballangen	Sør-Varanger	Sauda
Gaular	Kviteseid	Stryn	Luster
Sørum	Skjåk	Gol	Flekkefjord
Evenes	Lebesby	Verran	Vaksdal
Strand	Jølster	Hol	Voss
Fusa	Skedsmo	Granvin	Årdal
Fauske	Nome	Målselv	

Table B.6: List of top aquaculture municipalities

Municipalities with Aquaculture (n=70)			
Bømlo	Hammerfest	Tingvoll	Alta
Gulen	Osterøy	Stord	Åfjord
Bergen	Øksnes	Flekkefjord	Vestvågøy
Smøla	Haugesund	Vågsøy	Alstahaug
Hemne	Rødøy	Vanylven	Tysnes
Oslo	Ålesund	Fjell	Bjugn
Sørfold	Flora	Frøya	Hjelmeland
Tranøy	Bremanger	Skjervøy	Nærøy
Nesna	Flatanger	Askøy	Strand
Bodø	Trondheim	Vågan	Fauske
Snillfjord	Brønnøy	Gildeskål	Averøy
Lebesby	Halsa	Suldal	Tysvær
Vikna	Tromsø	Stavanger	Sortland
Volda	Rana	Ørsta	Sveio
Namsos	Lenvik	Fusa	Lurøy
Kvinnherad	Kvam	Os (Hordaland)	Hitra
Øygarden	Meløy	Austevoll	Hadsel
Herøy (Nordland)	Steigen		

Figure B.2: Map over "narrow" indicators



C Appendix

C.1 Regressions

Here we outline some preliminary analyses, the first concerns our the time aspect. As briefly stated in the descriptive analysis before the Gini-coefficient peaked in the years before 2006. If we where to include the period before 2006 we would get spurious results, in table C.1 below this is evident from the cycle effect on the gini-coefficient in column (1) and (3) where the coefficient shifts from negative top positive, both significant, why we restrict the model to 2006-2017.

The second test outlines two specifications in table C.2 regressed on both Gini-coefficient and P90P10. These two specifications differ in terms of indicators, where column (1) and (2) are the "*broad*" definition and (3) and (4) are the "*narrow*" definition. The former are simply given the value 1 if the municipality has any of the respective industries present, the latter is restricted to only account for the most significantly municipalities in terms of production and/or employment. Initially, we assumed that cultivating potential differences in our indicator variables would affect the estimates retrieved simply because we found it reasonable to assume that municipalities where, e.g., aquaculture had a larger relative presence, this industry would be a greater contributor to the observed differences in inequality. On the contrary, we find that the narrow indicators does not change the model much, although the hydro indicator coefficient becomes significant we would have expected larger effects, for both aquaculture and hydropower since – as mentioned above – we cultivated the narrow indicators definition to those being a significant producers. Since there are such small changes in the model we will continue the analysis with the broad definition.

Table C.1: Estimated results when including and excluding 2004-2005

	(1) Gini (2004-)		(2) P90P10 (2004-)		(3)Gini (2006-)		(4) P90/P10 (2006-)	
Cycle, log	**-0.490*****	(0.083)	0.868***	(0.089)	**0.937*****	(0.056)	1.850***	(0.089)
Trend, log	-0.722***	(0.113)	-1.529***	(0.122)	-0.289***	(0.079)	-1.031***	(0.125)
Real rate, log	0.004***	(0.001)	0.002*	(0.001)	-0.009***	(0.001)	-0.008***	(0.002)
population, log	-0.066***	(0.011)	-0.086***	(0.017)	-0.058***	(0.009)	-0.101***	(0.017)
Unempl., log	0.028***	(0.005)	0.028***	(0.005)	0.002	(0.003)	0.007	(0.005)
Immigrants, log	-0.002	(0.003)	0.006**	(0.003)	0.010***	(0.002)	0.012***	(0.003)
Mun. exp., log	-0.000***	(0.000)	-0.000*	(0.000)	-0.000*	(0.000)	-0.000	(0.000)
CPI, log	0.211	(0.203)	2.175***	(0.218)	0.661***	(0.133)	2.120***	(0.211)
Pre-schoolers, share	0.141	(0.259)	-0.776***	(0.279)	-0.262	(0.180)	-1.032***	(0.286)
School age, share	-1.069***	(0.208)	-2.224***	(0.223)	-0.590***	(0.143)	-1.758***	(0.227)
Elders, share	2.432***	(0.169)	1.846***	(0.181)	0.654***	(0.120)	1.018***	(0.191)
Primary school, rate	-0.010***	(0.001)	-0.001	(0.001)	-0.002*	(0.001)	0.001	(0.002)
University, rate	0.017***	(0.002)	0.028***	(0.002)	0.010***	(0.001)	0.020***	(0.002)
Large cities	0.068***	(0.023)	0.145***	(0.039)	0.057***	(0.021)	0.150***	(0.039)
Petroleum	0.064***	(0.017)	0.106***	(0.029)	0.058***	(0.015)	0.108***	(0.029)
Hydropower	-0.014	(0.017)	-0.041**	(0.018)	-0.014	(0.013)	-0.029	(0.021)
Aquaculture	-0.006	(0.008)	-0.002	(0.013)	-0.006	(0.007)	-0.003	(0.013)
mean(Cycle)	-2.697	(4.805)	-12.672	(7.915)	-3.178	(5.967)	5.323	(11.159)
mean(Trend)	-3.624	(7.040)	10.559	(11.607)	0.513***	(0.081)	1.188***	(0.129)
mean(Real rate)	0.072	(0.088)	0.402***	(0.146)	0.021	(0.104)	0.191	(0.195)
mean(Unempl.)	-0.047***	(0.016)	-0.044*	(0.027)	-0.007	(0.014)	-0.012	(0.027)
mean(Immigration)	0.073***	(0.009)	0.093***	(0.014)	0.056***	(0.008)	0.099***	(0.014)
mean(Mun. exp.)	0.000	(0.000)	0.001**	(0.000)	-0.000	(0.000)	0.001*	(0.000)
mean(CPI)	7.277	(12.207)	-15.503	(20.122)	-0.587	(1.089)	1.468	(2.030)
mean(Pre-schoolers)	0.245	(0.818)	1.227	(1.325)	0.274	(0.664)	0.813	(1.232)
mean(School age)	0.502	(0.571)	0.874	(0.915)	0.357	(0.474)	0.855	(0.878)
mean(Elders)	-2.448***	(0.303)	-1.436***	(0.457)	-0.668***	(0.255)	-0.686	(0.464)
mean(Primary school)	0.012***	(0.002)	0.006***	(0.002)	0.004***	(0.001)	0.005**	(0.002)
mean(University)	-0.011***	(0.002)	-0.014***	(0.003)	-0.004**	(0.002)	-0.005*	(0.003)
mean(Hydropower)	-0.016	(0.019)	-0.017	(0.023)	-0.012	(0.015)	-0.026	(0.026)
Constant	66.864	(102.649)	-129.148	(169.237)	0.000	(.)	0.000	(.)
Observations	5348		5348		4552		4552	
Municipalities	420		420		420		420	
Corr w. u_i	0 (Assumed)		0 (Assumed)		0 (Assumed)		0 (Assumed)	
R^2 within	0.198		0.348		0.376		0.485	
R^2 between	0.462		0.476		0.487		0.493	
R^2 overall	0.335		0.432		0.450		0.487	
ρ	0.389		0.623		0.605		0.685	

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.2: Estimated results - “broad” and “narrow” indicators

	(1) Gini		(2) P90P10		(3) Gini		(4) P90P10	
Cycle, log	0.937***	(0.056)	1.850***	(0.089)	0.937***	(0.056)	1.849***	(0.089)
Trend, log	-0.289***	(0.079)	-1.031***	(0.125)	-0.289***	(0.079)	-1.031***	(0.125)
Real rate, log	-0.009***	(0.001)	-0.008***	(0.002)	-0.009***	(0.001)	-0.008***	(0.002)
population, log	-0.058***	(0.009)	-0.101***	(0.017)	-0.058***	(0.009)	-0.102***	(0.017)
Unemployment, log	0.002	(0.003)	0.007	(0.005)	0.002	(0.003)	0.007	(0.005)
Immigrants, log	0.010***	(0.002)	0.012***	(0.003)	0.010***	(0.002)	0.012***	(0.003)
Mun. exp., log	-0.000*	(0.000)	-0.000	(0.000)	-0.000*	(0.000)	-0.000	(0.000)
CPI, log	0.661***	(0.133)	2.120***	(0.211)	0.658***	(0.133)	2.115***	(0.211)
Pre-schoolers, share	-0.262	(0.180)	-1.032***	(0.286)	-0.265	(0.180)	-1.034***	(0.286)
School age, share	-0.590***	(0.143)	-1.758***	(0.227)	-0.591***	(0.143)	-1.758***	(0.227)
Elders, share	0.654***	(0.120)	1.018***	(0.191)	0.653***	(0.120)	1.015***	(0.191)
Primary school, rate	-0.002*	(0.001)	0.001	(0.002)	-0.002*	(0.001)	0.001	(0.002)
University, rate	0.010***	(0.001)	0.020***	(0.002)	0.010***	(0.001)	0.020***	(0.002)
Large cities	0.057***	(0.021)	0.150***	(0.039)	0.053**	(0.021)	0.143***	(0.039)
Petroleum	0.058***	(0.015)	0.108***	(0.029)	0.058***	(0.015)	0.111***	(0.028)
Hydropower	-0.014	(0.013)	-0.029	(0.021)				
Aquaculture	-0.006	(0.007)	-0.003	(0.013)				
Hydro-intensive					-0.035***	(0.008)	-0.072***	(0.015)
Aqua-intensive					0.002	(0.009)	0.008	(0.016)
mean(Cycle)	-3.178	(5.967)	5.323	(11.159)	-3.474	(5.910)	5.154	(11.028)
mean(Trend)	0.513***	(0.081)	1.188***	(0.129)	0.511***	(0.080)	1.183***	(0.129)
mean(Real rate)	0.021	(0.104)	0.191	(0.195)	0.002	(0.104)	0.151	(0.194)
mean(Unempl.)	-0.007	(0.014)	-0.012	(0.027)	-0.005	(0.014)	-0.006	(0.026)
mean(Immigration)	0.056***	(0.008)	0.099***	(0.014)	0.056***	(0.007)	0.101***	(0.014)
mean(Mun. exp.)	-0.000	(0.000)	0.001*	(0.000)	0.000	(0.000)	0.001*	(0.000)
mean(CPI)	-0.587	(1.089)	1.468	(2.030)	-0.683	(1.077)	1.378	(2.003)
mean(Pre-schoolers)	0.274	(0.664)	0.813	(1.232)	0.060	(0.652)	0.423	(1.207)
mean(School age)	0.357	(0.474)	0.855	(0.878)	0.350	(0.465)	0.941	(0.859)
mean(Elders)	-0.668***	(0.255)	-0.686	(0.464)	-0.733***	(0.249)	-0.771*	(0.450)
mean(Primary school)	0.004***	(0.001)	0.005**	(0.002)	0.004***	(0.001)	0.005**	(0.002)
mean(University)	-0.004**	(0.002)	-0.005*	(0.003)	-0.004**	(0.002)	-0.005*	(0.003)
mean(Hydropower)	-0.012	(0.015)	-0.026	(0.026)				
Constant	0.000	(.)	0.000	(.)	0.000	(.)	0.000	(.)
Observations	4552		4552		4552		4552	
Municipalities	420		420		420		420	
Corr w. u_i	0 (Assumed)		0 (Assumed)		0 (Assumed)		0 (Assumed)	
R^2 within	0.376		0.485		0.376		0.485	
R^2 between	0.487		0.493		0.495		0.500	
R^2 overall	0.450		0.487		0.455		0.492	
ρ	0.605		0.685		0.601		0.680	

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Broad indicators are represented in (1) & (2), narrow in (3) & (4).

The Petroleum indicator is the same for broad and narrow definitions.

Table C.3: Estimated results log Pensionable income 2006-2017

	(1) 10^{th} fractile		(2) 25^{th} fractile		(3) 50^{th} fractile		(4) 75^{th} fractile		(5) 90^{th} fractile	
Cycle, log	2.883***	(0.170)	-16.272***	(0.888)	-3.001***	(0.157)	-0.853***	(0.040)	-0.596***	(0.033)
Trend, log	-9.847***	(0.249)	-26.979***	(1.237)	-1.486***	(0.221)	0.366***	(0.056)	0.787***	(0.046)
Real rate, log	0.041***	(0.004)	0.438***	(0.016)	0.039***	(0.003)	0.019***	(0.001)	0.014***	(0.001)
population, log	0.075***	(0.019)	0.081**	(0.037)	0.028***	(0.008)	0.008	(0.007)	-0.006	(0.009)
Unemployment, log	-0.002	(0.010)	-0.313***	(0.054)	-0.107***	(0.010)	-0.043***	(0.002)	-0.037***	(0.002)
Immigrants, log	-0.014**	(0.006)	0.090***	(0.030)	0.020***	(0.005)	0.009***	(0.001)	0.009***	(0.001)
Mun. exp., log	-0.001***	(0.000)	0.003**	(0.001)	0.001***	(0.000)	0.000***	(0.000)	0.000***	(0.000)
CPI, log	17.955***	(0.414)	42.926***	(2.080)	2.949***	(0.371)	0.247***	(0.094)	-0.344***	(0.077)
Pre-schoolers, rate	1.292**	(0.565)	1.083	(2.865)	-0.485	(0.501)	-0.362***	(0.127)	-0.414***	(0.105)
School age, rate	-2.511***	(0.448)	-0.348	(2.281)	0.617	(0.399)	0.046	(0.101)	0.035	(0.084)
Elders, rate	1.775***	(0.372)	-11.479***	(1.933)	-3.229***	(0.335)	-1.041***	(0.085)	-0.947***	(0.070)
Primary school, rate	-0.026***	(0.003)	0.033**	(0.016)	0.013***	(0.003)	0.001	(0.001)	-0.002***	(0.001)
University, rate	0.027***	(0.004)	-0.121***	(0.020)	-0.012***	(0.004)	-0.006***	(0.001)	-0.005***	(0.001)
Large cities	-0.017	(0.043)	-0.052	(0.079)	-0.033*	(0.018)	-0.008	(0.016)	0.018	(0.023)
Petroleum	0.012	(0.032)	0.002	(0.058)	0.018	(0.013)	0.041***	(0.012)	0.085***	(0.017)
Hydropower	0.108***	(0.040)	0.050	(0.215)	0.027	(0.037)	0.002	(0.009)	0.010	(0.008)
Aquaculture	0.008	(0.014)	0.015	(0.026)	0.017***	(0.006)	0.029***	(0.005)	0.035***	(0.008)
mean(Cycle)	-22.670**	(9.684)	-111.520***	(17.557)	-0.261	(5.604)	1.901	(4.554)	-6.737	(6.663)
mean(Trend)	10.691***	(0.251)	28.039***	(1.238)	2.351***	(0.221)	0.500***	(0.057)	0.109**	(0.049)
mean(Real rate)	-0.100	(0.199)	0.943***	(0.281)	-0.148	(0.098)	-0.075	(0.080)	0.034	(0.117)
mean(Unempl.)	-0.056*	(0.030)	0.220***	(0.076)	0.050***	(0.015)	0.016	(0.011)	0.021	(0.016)
mean(Immigration)	0.012	(0.016)	-0.109***	(0.042)	-0.020**	(0.008)	-0.000	(0.006)	0.015*	(0.008)
mean(Mun. exp.)	-0.001**	(0.001)	-0.004**	(0.002)	-0.001***	(0.000)	-0.000	(0.000)	-0.000	(0.000)
mean(CPI)	-20.972***	(2.158)	-74.128***	(3.872)	-5.687***	(1.109)	-1.219	(0.833)	-1.376	(1.210)
mean(Pre-schoolers)	5.273***	(1.399)	4.630	(3.761)	1.661**	(0.745)	1.771***	(0.504)	2.352***	(0.726)
mean(School age)	-3.423***	(1.006)	-5.304*	(2.850)	-1.299**	(0.558)	0.280	(0.359)	0.927*	(0.515)
mean(Elders)	-5.458***	(0.587)	6.697***	(2.141)	1.920***	(0.388)	0.675***	(0.192)	0.833***	(0.263)
mean(Primary school)	0.022***	(0.004)	-0.033**	(0.016)	-0.013***	(0.003)	-0.001	(0.001)	0.002	(0.001)
mean(University)	-0.037***	(0.005)	0.113***	(0.020)	0.013***	(0.004)	0.010***	(0.001)	0.011***	(0.001)
mean(Hydropower)	-0.143***	(0.043)	-0.064	(0.217)	-0.044	(0.038)	-0.029***	(0.011)	-0.058***	(0.012)
Constant	0.000	(.)	0.000	(.)	0.000	(.)	0.000	(.)	0.000	(.)
Observations	3720		4287		4553		4553		4553	
Municipalities	420		420		420		420		420	
Corr w. u_i	0 (Assumed)		0 (Assumed)		0 (Assumed)		0 (Assumed)		0 (Assumed)	
R^2 within	0.802		0.344		0.213		0.673		0.801	
R^2 between	0.769		0.617		0.710		0.631		0.601	
R^2 overall	0.788		0.364		0.364		0.649		0.651	
ρ	0.446		0.000		0.059		0.642		0.856	

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.4: Estimated results log General income 2006-2017

	(1) 10^{th} fractile		(2) 25^{th} fractile		(3) 50^{th} fractile		(4) 75^{th} fractile		(5) 90^{th} fractile	
Cycle, log	-56.594***	(0.904)	-1.845***	(0.041)	-0.671***	(0.027)	-0.342***	(0.021)	-0.093***	(0.025)
Trend, log	55.459***	(1.178)	2.478***	(0.057)	2.056***	(0.037)	1.794***	(0.029)	1.858***	(0.035)
Real rate, log	-0.160***	(0.015)	0.026***	(0.001)	0.007***	(0.000)	0.001***	(0.000)	-0.001*	(0.000)
population, log	0.212***	(0.066)	0.045***	(0.008)	-0.017**	(0.008)	-0.030***	(0.007)	-0.033***	(0.009)
Unemployment, log	0.260***	(0.055)	-0.000	(0.002)	-0.018***	(0.002)	-0.024***	(0.001)	-0.024***	(0.002)
Immigrants, log	-0.068**	(0.032)	-0.003**	(0.001)	0.002**	(0.001)	0.003***	(0.001)	-0.000	(0.001)
Mun. exp., log	-0.000	(0.001)	0.000**	(0.000)	0.000***	(0.000)	0.000***	(0.000)	0.000	(0.000)
CPI, log	-85.752***	(2.022)	-2.741***	(0.097)	-2.052***	(0.063)	-1.883***	(0.049)	-1.892***	(0.059)
Pre-schoolers, rate	2.888	(3.076)	0.574***	(0.131)	0.124	(0.085)	-0.169**	(0.067)	-0.176**	(0.081)
School age, rate	-13.864***	(2.494)	-0.050	(0.104)	0.007	(0.068)	-0.013	(0.053)	0.047	(0.064)
Elders, rate	10.721***	(2.228)	0.658***	(0.087)	-0.233***	(0.057)	-0.131***	(0.044)	-0.032	(0.054)
Primary school, rate	-0.006	(0.017)	-0.003***	(0.001)	-0.008***	(0.000)	-0.005***	(0.000)	-0.004***	(0.000)
University, rate	0.027	(0.023)	0.003***	(0.001)	-0.001	(0.001)	0.003***	(0.000)	0.005***	(0.001)
Large cities	-0.289**	(0.146)	-0.072***	(0.019)	-0.032	(0.020)	-0.000	(0.019)	0.026	(0.026)
Petroleum	0.097	(0.108)	-0.002	(0.014)	0.019	(0.014)	0.048***	(0.014)	0.098***	(0.020)
Hydropower	0.705***	(0.272)	-0.006	(0.010)	0.006	(0.006)	-0.009*	(0.005)	-0.006	(0.006)
Aquaculture	0.051	(0.049)	0.007	(0.006)	0.005	(0.007)	0.018***	(0.006)	0.024***	(0.009)
mean(Cycle)	34.669	(31.412)	-0.375	(5.429)	-1.068	(5.569)	-0.887	(5.356)	-2.456	(7.552)
mean(Trend)	-43.531	(36.267)	-1.705***	(0.059)	-1.201***	(0.040)	-0.922***	(0.032)	-0.970***	(0.040)
mean(Real rate)	0.470	(0.756)	-0.110	(0.095)	-0.041	(0.098)	-0.034	(0.094)	-0.056	(0.133)
mean(Unempl.)	-0.799***	(0.113)	-0.072***	(0.013)	-0.056***	(0.013)	-0.032**	(0.013)	-0.027	(0.018)
mean(Immigration)	0.017	(0.060)	-0.013*	(0.007)	0.029***	(0.006)	0.034***	(0.006)	0.044***	(0.008)
mean(Mun. exp.)	0.002	(0.002)	0.000**	(0.000)	-0.000	(0.000)	-0.000	(0.000)	-0.000	(0.000)
mean(CPI)	65.284	(60.152)	1.690*	(0.986)	2.185**	(1.011)	1.445	(0.972)	1.249	(1.369)
mean(Pre-schoolers)	10.214*	(5.228)	0.245	(0.598)	0.471	(0.607)	1.347**	(0.582)	2.101**	(0.819)
mean(School age)	0.019	(3.948)	-1.721***	(0.426)	-0.730*	(0.430)	0.289	(0.412)	0.775	(0.580)
mean(Elders)	-6.860**	(2.726)	-1.092***	(0.224)	-0.978***	(0.219)	-0.567***	(0.209)	-0.428	(0.293)
mean(Primary school)	0.003	(0.018)	0.004***	(0.001)	0.007***	(0.001)	0.004***	(0.001)	0.003***	(0.001)
mean(University)	-0.074***	(0.024)	-0.004***	(0.001)	0.005***	(0.001)	0.002**	(0.001)	0.001	(0.001)
mean(Hydropower)	-0.720***	(0.278)	-0.008	(0.012)	-0.022**	(0.010)	-0.012	(0.008)	-0.040***	(0.011)
Constant	-164.435	(529.137)	0.000	(.)	0.000	(.)	0.000	(.)	0.000	(.)
Observations	3717		4552		4553		4553		4553	
Municipalities	420		420		420		420		420	
Corr w. u_i	0 (Assumed)		0 (Assumed)		0 (Assumed)		0 (Assumed)		0 (Assumed)	
R^2 within	0.789		0.926		0.954		0.958		0.946	
R^2 between	0.339		0.181		0.663		0.662		0.626	
R^2 overall	0.737		0.779		0.813		0.791		0.732	
ρ	0.222		0.711		0.864		0.907		0.930	

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.5: Estimates on relative pensionable income fractiles across indicators

	(1) 90/10		(2) 90/50		(3) 50/10	
Baseline - all municipalities						
Cycle, log	-45.143***	(3.689)	5.466***	(0.361)	-24.233***	(1.952)
Unempl., log	-0.231	(0.225)	0.169***	(0.022)	-0.033	(0.119)
CPI, log	-290.168***	(8.969)	-6.459***	(0.854)	-153.902***	(4.746)
mean(Cycle)	30.254	(191.106)	-1.515	(13.178)	231.721**	(91.661)
mean(Unempl.)	1.079*	(0.589)	-0.060*	(0.036)	0.194	(0.285)
mean(CPI)	265.198***	(42.764)	10.812***	(2.595)	183.351***	(20.649)
Observations	*3720*		*4553*		*3720*	
Aquaculture-municipalities						
Cycle, log	-47.890***	(6.483)	5.105***	(0.665)	-26.250***	(3.398)
Unempl., log	-0.019	(0.378)	0.107***	(0.039)	0.043	(0.198)
CPI, log	-298.756***	(15.969)	-9.485***	(1.574)	-157.108***	(8.371)
mean(Cycle)	-447.253	(378.748)	28.131	(19.820)	-79.134	(180.213)
mean(Unempl.)	-1.469	(1.166)	-0.076	(0.066)	-0.558	(0.559)
mean(CPI)	175.853**	(74.958)	15.618***	(3.825)	125.245***	(35.945)
Observations	*1406*		*1724*		*1406*	
Hydropower-municipalities						
Cycle, log	-45.973***	(4.114)	5.689***	(0.425)	-25.390***	(2.209)
Unempl., log	-0.059	(0.253)	0.187***	(0.026)	-0.019	(0.136)
CPI, log	-297.003***	(9.952)	-6.294***	(0.995)	-160.265***	(5.343)
mean(Cycle)	-130.153	(212.667)	7.639	(11.256)	9.959	(105.574)
mean(Unempl.)	1.233*	(0.658)	-0.071*	(0.039)	0.320	(0.327)
mean(CPI)	62.443	(338.946)	12.675	(20.253)	-138.920	(169.176)
Observations	*2820*		*3453*		*2820*	
Petroleum-municipalities^a						
Cycle, log	-49.712***	(12.504)	2.840***	(0.845)	-24.298***	(5.990)
Unempl., log	-1.163	(0.749)	0.056	(0.051)	-0.552	(0.359)
CPI, log	-252.519***	(29.966)	-7.686***	(2.039)	-116.619***	(14.354)
mean(Unempl.)	-7.240***	(1.301)	-0.428**	(0.177)	-2.167***	(0.715)
Observations	*179*		*219*		*179*	
Cities^b						
Cycle, log	-14.589**	(7.187)	3.893***	(1.348)	-4.482	(3.705)
Unempl., log	-0.340	(0.588)	0.165	(0.106)	0.272	(0.304)
CPI, log	-143.088***	(19.159)	-6.026*	(3.409)	-63.067***	(9.903)
mean(Unempl.)	9.386	(6.636)	0.171	(0.486)	4.967**	(2.478)
Observations	*117*		*143*		*117*	

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

^{a,b}: Cycles and CPI are not demeaned due to insufficient within-variation

Table C.6: Estimates on relative general income fractiles across indicators

	(1) 90/10		(2) 90/50		(3) 50/10	
Baseline - all municipalities						
Cycle, log	89715.937***	(11059.875)	37497.185***	(4557.217)	1.298***	(0.065)
Unempl., log	-1519.432**	(677.921)	-595.027**	(279.337)	-0.014***	(0.004)
CPI, log	144383.743***	(24744.193)	60565.434***	(10195.834)	0.327**	(0.154)
mean(Cycle)	285390.322	(217753.228)	116193.439	(89725.121)	1.475	(14.211)
mean(Unempl.)	2974.560***	(932.109)	1182.769***	(384.075)	0.097***	(0.033)
mean(CPI)	75240.861	(413664.497)	38799.971	(170450.254)	-1.673	(2.576)
Observations	*3717*		*3717*		*4553*	
Aquaculture-municipalities						
Cycle, log	117781.978***	(25256.772)	49396.748***	(10472.784)	1.242***	(0.112)
Unempl., log	-1754.011	(1500.822)	-676.845	(622.319)	-0.019***	(0.007)
CPI, log	195643.312***	(56013.140)	82485.779***	(23225.989)	0.123	(0.265)
mean(Cycle)	316320.539	(467260.639)	130853.359	(193750.794)	-16.377	(21.936)
mean(Unempl.)	4115.548*	(2260.681)	1641.282*	(937.397)	-0.007	(0.062)
mean(CPI)	600570.431	(871556.776)	255384.377	(361393.212)	-79.810*	(42.197)
Observations	*1412*		*1412*		*1724*	
Hydropower-municipalities						
Cycle, log	77615.512***	(14038.721)	32367.978***	(5759.820)	1.328***	(0.071)
Unempl., log	-1618.709*	(863.320)	-640.561*	(354.204)	-0.010**	(0.004)
CPI, log	120739.838***	(31119.829)	50464.396***	(12767.873)	0.290*	(0.167)
mean(Cycle)	270978.032	(251944.093)	113917.665	(103367.863)	-17.566	(11.340)
mean(Unempl.)	3350.666***	(1173.379)	1343.856***	(481.415)	0.094***	(0.034)
mean(CPI)	179129.304	(434556.743)	75211.756	(178290.355)	-0.828	(16.286)
Observations	*2831*		*2831*		*3453*	
Petroleum-municipalities[a]						
Cycle, log	158224.009***	(30271.503)	60431.384***	(11393.495)	1.605***	(0.304)
Unempl., log	1529.299	(1893.714)	584.884	(712.750)	0.050***	(0.018)
CPI, log	196749.543***	(70737.118)	75826.873***	(26623.818)	-1.130	(0.734)
mean(Unempl.)	-608.459	(3123.621)	-231.452	(1175.659)	-0.583**	(0.248)
Observations	*175*		*175*		*219*	
Cities[b]						
Cycle, log	132195.796**	(53065.392)	53642.596**	(21678.378)	1.134***	(0.170)
Unempl., log	-351.619	(3704.160)	-72.850	(1513.231)	-0.054***	(0.013)
CPI, log	94033.460	(130840.642)	38667.135	(53451.276)	-0.647	(0.423)
mean(Unempl.)	19178.437**	(9379.097)	7830.500**	(3831.567)	0.098	(0.425)
Observations	*117*		*117*		*143*	

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

[a,b]: Cycles and CPI are not demeaned due to insufficient within-variation

Table C.7: Estimated effects on pensionable income across indicators

	(1) 10^{th} fractile		(2) 25^{th} fractile		(3) 50^{th} fractile		(4)75^{th} fractile		(5) 90^{th} fractile	
Baseline - all municipalities										
Cycle, log	2.893***	(0.170)	-16.266***	(0.887)	-2.998***	(0.157)	-0.850***	(0.040)	-0.593***	(0.033)
Unempl., log	-0.001	(0.010)	-0.312***	(0.054)	-0.106***	(0.010)	-0.042***	(0.002)	-0.037***	(0.002)
CPI, log	17.982***	(0.414)	42.940***	(2.078)	2.958***	(0.371)	0.252***	(0.094)	-0.337***	(0.077)
mean(Cycle)	-23.947**	(9.657)	-111.811***	(17.516)	1.171	(5.679)	3.825	(4.895)	-4.421	(7.310)
mean(Unempl.)	-0.052*	(0.030)	0.222***	(0.076)	0.055***	(0.015)	0.027**	(0.012)	0.040**	(0.017)
mean(CPI)	-21.218***	(2.150)	-74.208***	(3.862)	-5.374***	(1.120)	-0.806	(0.892)	-0.920	(1.325)
Observations	*3720*		*4287*		*4553*		*4553*		*4553*	
Aquaculture-municipalities										
Cycle, log	3.042***	(0.284)	-14.307***	(1.375)	-2.775***	(0.268)	-0.863***	(0.066)	-0.586***	(0.053)
Unempl., log	0.000	(0.017)	-0.186**	(0.081)	-0.074***	(0.016)	-0.041***	(0.004)	-0.034***	(0.003)
CPI, log	18.228***	(0.701)	46.198***	(3.245)	4.151***	(0.634)	0.464***	(0.156)	-0.303**	(0.125)
mean(Cycle)	9.809	(17.135)	-68.672**	(31.090)	1.717	(7.651)	8.015	(6.432)	2.550	(9.865)
mean(Unempl.)	0.062	(0.053)	0.141	(0.130)	0.061**	(0.026)	0.029	(0.018)	0.031	(0.028)
mean(CPI)	-15.309***	(3.384)	71.237	(65.133)	-6.564***	(1.491)	-17.084	(12.400)	-35.503*	(18.984)
Observations	*1406*		*1604*		*1724*		*1724*		*1724*	
Hydropower-municipalities										
Cycle, log	2.960***	(0.195)	-16.426***	(1.042)	-3.073***	(0.185)	-0.827***	(0.046)	-0.563***	(0.037)
Unempl., log	-0.005	(0.012)	-0.316***	(0.064)	-0.113***	(0.011)	-0.041***	(0.003)	-0.035***	(0.002)
CPI, log	18.358***	(0.471)	44.344***	(2.415)	2.989***	(0.433)	0.282***	(0.107)	-0.285***	(0.087)
mean(Cycle)	15.796	(11.016)	-82.461***	(21.335)	1.169	(5.314)	3.636	(4.065)	1.767	(5.740)
mean(Unempl.)	-0.069**	(0.034)	0.202**	(0.089)	0.051***	(0.018)	0.024*	(0.012)	0.030*	(0.017)
mean(CPI)	-7.563	(17.464)	54.307	(37.414)	3.397	(9.341)	6.781	(5.968)	7.693	(8.248)
Observations	*2820*		*3249*		*3453*		*3453*		*3453*	
Petroleum-municipalities[a]										
Cycle, log	3.078***	(0.585)	-17.053***	(4.036)	-1.954***	(0.455)	-0.756***	(0.169)	-0.710***	(0.154)
Unempl., log	0.051	(0.035)	-0.472*	(0.245)	-0.067**	(0.027)	-0.046***	(0.010)	-0.040***	(0.009)
CPI, log	14.479***	(1.401)	28.375***	(9.755)	2.601**	(1.099)	-0.147	(0.408)	-1.139***	(0.372)
mean(Unempl.)	0.090	(0.125)	0.545	(0.491)	-0.106**	(0.053)	-0.181***	(0.067)	-0.298***	(0.107)
Observations	*179*		*214*		*219*		*219*		*219*	
Cities[b]										
Cycle, log	0.735	(0.520)	-13.191***	(5.055)	-2.313***	(0.757)	-0.776***	(0.220)	-0.704***	(0.194)
Unempl., log	-0.074*	(0.043)	-0.286	(0.400)	-0.136**	(0.060)	-0.075***	(0.017)	-0.079***	(0.015)
CPI, log	8.332***	(1.390)	35.686***	(12.708)	2.892	(1.916)	0.159	(0.553)	-0.461	(0.484)
mean(Unempl.)	-0.822**	(0.377)	-0.082	(1.560)	-0.012	(0.196)	-0.137	(0.222)	-0.553	(0.352)
Observations	*117*		*137*		*143*		*143*		*143*	

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

[a,b]: Cycles and CPI are not demeaned due to insufficient within-variation

Table C.8: Estimated effects on general income across indicators

	(1) 10^{th} fractile		(2) 25^{th} fractile		(3) 50^{th} fractile		(4)75^{th} fractile		(5) 90^{th} fractile	
Baseline - all municipalities										
Cycle, log	-56.586***	(0.905)	-1.843***	(0.041)	-0.670***	(0.027)	-0.341***	(0.021)	-0.091***	(0.025)
Unempl., log	0.265***	(0.055)	-0.000	(0.002)	-0.018***	(0.002)	-0.024***	(0.001)	-0.024***	(0.002)
CPI, log	-85.656***	(2.024)	-2.738***	(0.097)	-2.049***	(0.063)	-1.882***	(0.049)	-1.890***	(0.059)
mean(Cycle)	33.185	(31.179)	0.269	(5.476)	-0.625	(5.629)	0.384	(5.579)	-0.788	(8.104)
mean(Unempl.)	-0.800***	(0.113)	-0.072***	(0.013)	-0.053***	(0.013)	-0.023*	(0.013)	-0.010	(0.019)
mean(CPI)	67.214	(59.274)	1.842*	(0.993)	2.276**	(1.020)	1.697*	(1.010)	1.538	(1.467)
Observations	*3717*		*4552*		*4553*		*4553*		*4553*	
Aquaculture-municipalities										
Cycle, log	-58.610***	(1.409)	-1.698***	(0.062)	-0.686***	(0.043)	-0.392***	(0.035)	-0.134***	(0.043)
Unempl., log	0.183**	(0.084)	0.008**	(0.004)	-0.018***	(0.003)	-0.026***	(0.002)	-0.025***	(0.003)
CPI, log	-91.176***	(3.125)	-2.606***	(0.147)	-2.136***	(0.102)	-2.013***	(0.082)	-2.054***	(0.101)
mean(Cycle)	-2.279	(40.688)	-0.774	(6.155)	10.276	(7.159)	5.758	(7.461)	2.487	(11.098)
mean(Unempl.)	-0.147	(0.177)	-0.015	(0.018)	0.011	(0.020)	0.008	(0.021)	0.008	(0.031)
mean(CPI)	-88.649	(76.030)	-19.291	(11.866)	-3.183	(13.787)	-8.954	(14.340)	-34.056	(21.292)
Observations	*1412*		*1724*		*1724*		*1724*		*1724*	
Hydropower-municipalities										
Cycle, log	-54.660***	(1.008)	-1.813***	(0.046)	-0.667***	(0.031)	-0.327***	(0.024)	-0.070**	(0.028)
Unempl., log	0.179***	(0.062)	-0.006**	(0.003)	-0.020***	(0.002)	-0.025***	(0.001)	-0.024***	(0.002)
CPI, log	-81.867***	(2.235)	-2.639***	(0.107)	-2.007***	(0.071)	-1.847***	(0.055)	-1.859***	(0.066)
mean(Cycle)	85.369***	(31.750)	4.341	(4.873)	5.675	(4.903)	-1.339	(4.672)	-3.097	(6.400)
mean(Unempl.)	-0.781***	(0.129)	-0.080***	(0.015)	-0.061***	(0.015)	-0.026*	(0.014)	-0.018	(0.019)
mean(CPI)	126.518***	(48.299)	-1.567	(7.086)	6.266	(7.041)	4.721	(6.687)	5.516	(9.148)
Observations	*2831*		*3452*		*3453*		*3453*		*3453*	
Petroleum-municipalities[a]										
Cycle, log	-69.872***	(4.948)	-2.075***	(0.190)	-0.825***	(0.119)	-0.448***	(0.097)	-0.247**	(0.119)
Unempl., log	-0.318	(0.310)	-0.003	(0.011)	-0.030***	(0.007)	-0.023***	(0.006)	-0.013*	(0.007)
CPI, log	-103.298***	(11.561)	-3.838***	(0.458)	-2.835***	(0.286)	-2.935***	(0.235)	-3.366***	(0.286)
mean(Unempl.)	0.134	(0.511)	-0.070*	(0.040)	-0.190***	(0.039)	-0.255***	(0.060)	-0.410***	(0.108)
Observations	*175*		*219*		*219*		*219*		*219*	
Cities[b]										
Cycle, log	-79.021***	(5.649)	-2.267***	(0.184)	-0.987***	(0.108)	-0.678***	(0.083)	-0.555***	(0.094)
Unempl., log	0.143	(0.394)	-0.009	(0.014)	-0.030***	(0.008)	-0.040***	(0.006)	-0.055***	(0.007)
CPI, log	-120.652***	(13.928)	-3.910***	(0.463)	-2.854***	(0.270)	-2.812***	(0.205)	-3.174***	(0.232)
mean(Unempl.)	-3.720***	(0.998)	-0.375***	(0.142)	-0.494**	(0.218)	-0.462**	(0.234)	-0.666*	(0.355)
Observations	*117*		*143*		*143*		*143*		*143*	

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

[a,b]: Cycles and CPI are not demeaned due to insufficient within-variation