The Norwegian oil bonanza and the Scandinavian Model in comparative perspective

Abstract

This paper aims at highlighting the effects of large natural resource endowments on the institutions of the so-called Scandinavian or Nordic model, through a comparative quantitative case study. Focusing on two key features of the Scandinavian model, namely (I) low income inequality and (II) high welfare spending, this study presents evidence on the shocks to these features for Norway after the country became one of the world's largest oil exporters. A synthetic control unit constructed by weighting Nordic countries provides the most reliable comparison unit to estimate the comparative effects constituting the paper's twofold contribution. First, the resource windfall contributed to slightly higher top income shares. Second, resource revenues contributed to finance the steadily increasing gap between Norway and other Nordic countries in the degree of welfare generosity.

JEL codes: E02, H53, I38, Q33.

Key words: Scandinavian model, Resource revenues, Comparative quantitative case study.

1 Introduction

The aim of this research is to evaluate the response of two economic and institutional features of the so-called Scandinavian model (namely low income inequality and high welfare spending) for Norway, after the country became one of the world's largest oil exporters. In other words, this paper provides a quantitative comparative case study that can highlight the robustness of the key features of the Nordic model when subjected to a substantial structural shock. In doing so, this paper complements previous studies with a similar focus, such as Mideksa (2013) and Larsen (2006), which analyze the impact of the resource windfall on the Norwegian GDP per capita. The supposed exceptionality of the Nordic model has been analyzed, questioned, and tested by scholars (among others, Lane et al., 1993) with regard to a variety of aspects, with egalitarianism of the wealth distribution getting the most attention. Fochesato and Bowles (2015) attempted to measure the relative egalitarian performance of the Nordic economies by comparing their level of material wealth inequality with respect to a large group of economies over the past three thousand years. Their conclusion is that the Nordic economies do not produce a more egalitarian distribution of material wealth than, for example, some horticultural and forager economies, although they show a higher level of intergenerational and social mobility. Barth et al. (2014, 2015) provide a theoretical overview of the main political and economic features of the Nordic open economies, summarizing and putting together results from previous economic research on the issue: Moene et al. (1993), Moene and Wallerstein (1997) and Barth et al. (2013). This research follows Barth et al. (2014) in representing the Nordic model as a set of three distinct but interconnected mechanisms. These are: (I) collective bargaining which leads to labor wage compression (i.e., high

minimum wages and low maximum wages) through a combination of central wage negotiations and local wage negotiations at the firm level; (II) high labor productivity which, combined with wage compression, stimulates high private investments and creation of new highly productive enterprises; (III) political support for large ratios of public welfare spending to GDP. The scope of the present study is to briefly review and empirically evaluate the robustness of mechanisms (I) and (II), by comparing Norway to the other Nordic economies. In order to observe a wholly hypothetical counterfactual, the treatment (i.e., the resource windfall) would ideally impact only a unit or a subgroup of the four Nordic economies (i.e., Norway, Denmark, Finland and Sweden) representing the full sample of this study. For this reason, the donor pool provided by the untreated countries represents the perfect sample in order to construct a counterfactual that matches the treated country. The countries of Denmark, Finland and Sweden, resembling the economy of Norway without being (large) oil producers[1], therefore provide the most reliable donor pool of comparison units. Non-Nordic countries are arbitrarily not included in the sample due to the chosen focus on the functioning of the Scandinavian model. The Synthetic Control Method (SCM, hereafter) is implemented to assign weights to the countries of the donor pool, in order to obtain a synthetic control unit that is subsequently used to estimate the comparative effects constituting the paper's twofold contribution.

First, results show that the windfall contributed to slightly higher top income shares relative to the Nordic neighbors. This finding adds natural resources to the set of variables that explain the increase in income inequality in Norway documented in the economic

[1] Figure 1 in Corak (2013) shows that the four Nordic economies of Norway, Sweden, Denmark and Finland have in common a remarkably low level of income inequality (measured as the Gini coefficient) jointly with a high degree of intergenerational economic mobility (measured as the elasticity between parental and children's earnings).

literature, and summarized in Aaberge and Atkinson (2010).

Second, results indicate that the oil bonanza contributed to financing a steadily increasing gap in the degree of welfare generosity[2] between Norway and the other Nordic countries, with an increase in generosity in Norway. The result of an increasing gap in the overall degree of welfare generosity could for instance be explained by the volatile income streams in the resource sector, which increase individuals' exposure to the risk of income losses and hence foster the voters' preferences for public spending and welfare generosity. In addition, resource revenues boosted tax revenues, allowing the Norwegian government to finance a sustained level of overall welfare generosity.

The paper proceeds as follows: Section 2 presents the windfall that accrued to the Norwegian economy, Section 3 analyzes the comparative effects on top income shares, Section 4 focuses on the effects on public welfare spending. Section 5 provides concluding remarks.

2 The resource windfall

This paper considers the jump in Norway's total production of petroleum above the substantial threshold of 50 million standard cubic meter (Sm^3) oil equivalents (i.e., including oil, condensate, NGL and gas), which happened around 1980, as the "treatment"; this was the start of the oil adventure that caused a structural change in the Norwegian economy without substantially affecting the other Nordic countries[3]. The

[2] Generosity scores for social insurance programs in the four Nordic countries are derived from the Comparative Welfare Entitlements Data Set in Scruggs (2014) and Scruggs et al. (2014).

[3] Mideksa (2013) estimated the causal comparative effect of natural resource endowment on the level of the Norwegian GDP per capita. Results in Mideksa (2013) show that about 20% of the Norwegian annual GDP

specific choice of the 1980 as the treatment year is partially also determined by data availability. Figure 1 plots the yearly production of oil equivalents on the Norwegian continental shelf, 1971-2016, as reported by the Norwegian Petroleum Directorate.

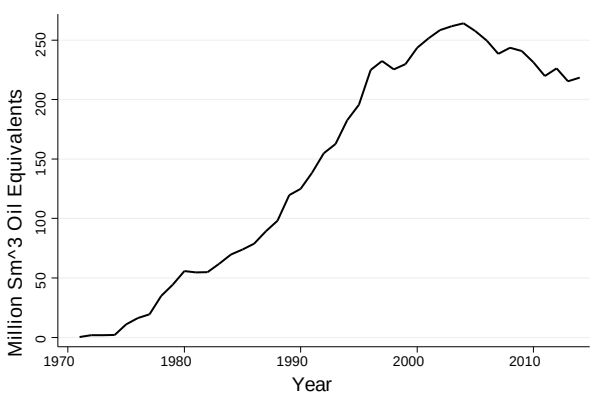

Figure 1 - Total production of oil equivalents on the Norwegian continental shelf, 1971-2016. Source: The Norwegian Petroleum Directorate

Although extraction started as early as 1971, as plotted in Figure 1, the fact that the impact of extraction on income and GDP did not significantly appear until a few years later (as documented in Bjørnland, 1998; Larsen, 2006; and Mideksa, 2013), contributes as well to justify the choice of the treatment year. The intuition behind the empirical analysis of this paper is that becoming a main oil exporter significantly modifies the structure and performance of labor market institutions that determine top income shares (and income inequality), productivity and investments, as well as public welfare spending through higher resource revenues. The broad research question then becomes: did oil extraction and the related structural changes determine a new path for the Norwegian economy, significantly different comparatively to those of its Nordic neighbors? Whether the answer is affirmative or negative, the results of this paper offer additional empirical

per capita increase in the post-windfall period 1971-2007 can be attributed to the petroleum endowment.

evidence on the Scandinavian model's relevance as an analytical framework.

3 Top income shares

The economic literature related to the dispersion of wage earnings, income inequality and labor market institutions (summarized in the survey by Salverda and Checchi, 2013), introduces the context for the first empirical exercise of this paper: how has the oil windfall affected the wage structure and more precisely top income shares (income concentration at the top) in Norway, compared to its Nordic neighbors?

First, I will provide some qualitative predictions. An initial high degree of wage compression may attract foreign companies due to the lower upper bound they will be able to offer to high-skilled labor in the oil sector, as compared to the hypothetical upper bound for the same high-skilled worker in other countries. This would lead *ceteris paribus* to higher expected profits for the representative extracting company and hence boosts investment opportunities. In turn, increased labor demand in the resource sector of the economy causes a jump in the whole range of resource sector wages, which is not fully reflected in the wages of the rest of the economy due to institutional constraints, at least at first[4]. Hence, this determines a lower degree of wage compression in the labor force as a whole after the oil bonanza that can result in, for given capital incomes, higher top income shares (considered as a key driver of total income inequality, and given by sum of labor and capital incomes[5]). Note that substantial upward wage adjustments for high-skilled workers might also be justified in case of perfect mobility of labor in the oil sector

[4] This wage inflation mechanism in the Norwegian resource sector that reduces the overall degree of wage compression has been closely analyzed in Dyrstad (2017).

[5] A methodological discussion about whether and how high top income shares translate into high concentration of power can be found in Aaberge et al. (2013).

across countries, leading to the above-mentioned jump in the whole range of resource sector wages[6]. Some caveats about the identifying assumption (i.e., the fact that no other important factors but the expansion of the resource sector have affected Norway) are relevant here. The comparative effect of the oil bonanza on top income shares in Norway might also be partially explained by additional factors that are not related to the resource windfall, such as tax reforms and the deregulation of financial markets (through their effects on capital income). Aaberge and Atkinson (2010), for instance, identify the implementation of the 1992 Norwegian tax reform as a decisive factor leading to a sharp increase in capital income (dividends and capital gains) received by households, which in turn boosted inequality of the income distribution. In order to partially take into account these possible limitations, the dependent variable considered in the analysis below will be given by top income shares excluding capital gains. Another question is to what extent the liberalization of financial markets, which created strong incentives to shift labor income to capital income, was an exclusive feature of the Norwegian economy compared to the Nordic neighbors. Bjorklund et al. (1995) estimated that Sweden also experienced a significant increase in income inequality in the period 1989-1991 due to a boost in capital gains that resulted from changes in the tax legislation. For Finland, Riihelä et al. (2008) claim that the increase in inequality at the high end of the income distribution observed over the period 1990-2004 can be seen as a consequence of the 1993 Finnish tax reform

[6] The effect of the oil bonanza on unemployment rates can be ambiguous and it will not be explicitly tested in this study. On the one hand, boosted labor demand in the resource sector might reduce unemployment rates with respect to the neighboring countries, although this positive could be mitigated or even canceled by migration flows from the other Nordic countries to Norway. On the other hand, the uncertain resource income due to high variance of the resource price for oil might lead to lower investments at times and hence relatively higher unemployment rates.

that introduced the so-called Nordic dual income tax model. Similar tax reforms took place in Denmark in 1994, as highlighted in Fritzell et al. (2011). Hence, to the extent that these changes in financial and tax legislation in Scandinavia did not exclusively concern the Norwegian economy, they do not seem to invalidate the identifying assumption of this paper.

3.1 The comparative effect on top income shares

The SCM has been implemented in Abadie et al. (2010), Abadie et al. (2011) and Abadie et al. (2015), in order to estimate the causal effect of policies or shocks, as the difference between the outcome for the actual treated unit and the predicted outcome of the synthetic control unit, constructed by weighting the units of the donor pool. The aim of this exercise is to apply the SCM in order to test whether the prediction of higher top income shares for Norway is confirmed by the data. As noted above, the donor pool of potential comparison units includes Denmark, Finland and Sweden, which are assumed to resemble the series of income inequality in Norway before the oil bonanza. Define top 5% income shares (excluding capital gains)[7] as the dependent variable Y for country $j = 1, \ldots, 4$. A set of k macro determinants of the dependent variable Y are included in the analysis as predictors, namely: UTIP-UNIDO industrial pay-inequality[8]; Top 1% income share (excluding capital gains); Unemployment rate; Trade Union Density (TUD, details

[7] The time series of wage dispersion (d9/d1) would also qualify as a relevant dependent variable for this exercise; however, data for the whole time range of this empirical exercise (1960-2009) were not available for the whole sample of countries.

[8] UTIP-UNIDO industrial pay-inequality (further details in the Data Appendix) is an indicator of industrial wage dispersion and hence can be considered as a good proxy for top income shares, thereby contributing to the efficacy of matching the treated and synthetic control unit in the pre-treatment period.

in Data Appendix); and real GDP per capita (constant 2005 USD). For each unit, the predictors are observed throughout the time range 1960-2009 and constitute a balanced panel. The entire time range is divided into a pre-treatment 1960-1979 and a post-treatment period 1980-2009, in order to estimate the comparative effect of the treatment on post-treatment top income shares. The implementation of the SCM[9] assigns the following weights to the countries of the donor pool[10]:

Country	Synthetic control weights W^*
Denmark	0
Finland	.272
Sweden	.728

Hence, the synthetic control unit is a linear combination of two countries of the donor pool, specifically Finland (0.272) and Sweden (0.728). The zero weight assigned to Denmark is not sufficient to justify the exclusion of this country from the donor pool, for two reasons. First, dropping a zero weight country *a posteriori* does not improve the quality of the estimation. Secondly, a zero weight only means that the specific country is *relatively* less powerful in resembling the predictors of the treated unit in the pre-treatment country. More generally (and differently from an OLS regression), a synthetic

[9] Define Π_1 as the $(kx1)$ matrix containing the pre-treatment values of the predictors for the treated unit, whilst Π_0 is the $(kx3)$ matrix containing the pre-treatment values of the three comparison units. Following Abadie et al. (2011) and Abadie et al. (2015), the synthetic control unit is given by the convex combination of weights $W^* = (w_2, w_3, w_4)$ with $w_2 + w_3 + w_4 = 1$, chosen in order to minimize the weighted sum of the squared differences $\sum_{m=1}^{k} v_m (\Pi_{1m} - \Pi_{0m} W)\text{^}2$ in which v_m represents the relative importance of each predictor. Kaul et al. (2016) advice not to use all pre-treatment outcomes as predictors in the analysis, claiming that using all outcome lags as separate predictors renders all other covariates irrelevant. I followed the prescription by Kaul et al. (2016) in this empirical exercise.

[10] The averaged values for each of the predictors, for both the treated unit and the synthetic unit, can be found in Table 2 in the appendix. Further details about the algorithm of the Synthetic Control Method can be found in Abadie et al. (2011) and Abadie et al. (2015). The statistical software package "Synth" is available online at http://stanford.edu/~jhain/software.htm#Synth

weight indicates the explanatory power of a unit relative to others, rather than its absolute explanatory power[11]. Define Y_{jt} as the top 5% income shares for country $j = 1, \ldots, 4$ at time t. The weights presented above can then be used to construct the synthetic control unit given by $\sum_{j=2}^{4} w_j^* Y_{jt}$, which will be compared to the post-treatment dependent variable of the actual treated unit Y_{1t}. In other words, the difference $Y_{1t} - \sum_{j=2}^{4} w_j^* Y_{jt}$ will represent the estimation of the comparative effect of the oil bonanza on the Norwegian values of the top 5% income shares. The series of the top 5% income shares for both the treated and the synthetic unit are plotted in the following Figure 2:

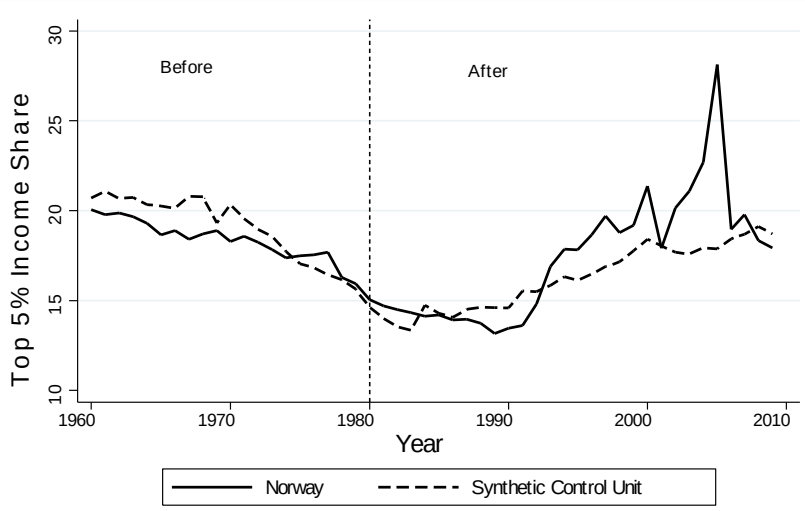

Figure 2 - The comparative effect on Top Income Shares

Figure 2 shows several noteworthy trends. Firstly, top 5% income shares for the Nordic countries seem to have a common declining trend up to the mid-1980s (declining from a 20% share to slightly below 15%), and an increasing trend from then onward. In the pre-1980 period, the solid line for Norway does not show a significantly different development

[11] In order to observe a study in which most of the units included in the construction of the synthetic unit receive a zero weight, see Abadie et al. (2010), page 500, Table 2.

from that of the comparison unit (dotted line), which hence successfully resembles the treated unit and allows us to turn to the analysis of the right hand side of the 1980 line in Figure 2. From the 1980 and onwards, the top 5% income share for Norway displays higher values for the period 1992-2008 (although the magnitude of this increase is on average within an income share of 5%) and, more generally, substantially higher volatility[12]. I cannot exclude that this result can be as well partly explained by the 1992 Norwegian tax reform. However, as explained above, tax reforms from the 1990s do not in principle invalidate the identifying assumption because they were contemporaneously implemented in all the countries constituting the sample of this study. One hypothesis is that the same tax reform had a different effect on the capital income component of the top income shares, causing a stronger jump in income inequality for Norway. In any case, the results of this empirical exercise can be seen as complementary to the analysis in Aaberge and Atkinson (2010), because they add the booming resource sector to the group of explanatory variables underlying the actual jump in Norwegian concentration of income at the top.

Robustness checks can be done by conducting in-time placebo tests and more traditional difference-in-differences exercises. In-time placebo tests consist of reassigning the treatment to a year before or after the large increase in oil extraction activity actually took place in Norway. In the case of a treatment year earlier than 1980 - for example, 1970 - the shorter pre-treatment period over which predictors are averaged might result in a less powerful set of synthetic weights. These in-time placebo tests were conducted for

[12] As documented in Aaberge et al. (2013), the exceptionally high peak of top income shares in 2005 is due to the anticipation of a new tax on dividends introduced in 2006 by the Norwegian tax authorities.

different treatment years both before and after 1980; they validate the main results of Figure 2 by showing no significant changes in the predictive power of the synthetic control unit[13]. In order to provide more robustness checks, a standard difference-in-differences exercise was conducted:

$$Top5\%_{j,t} = \gamma_j + \delta_t + \lambda T_{j,t} + X'_{j,t}\beta + \varepsilon_{j,t} \quad (1)$$

where $Top5\%_{j,t}$ stands for the top 5% income share of country j; γ_j is a country fixed effect; δ_t represents a dummy variable estimating time fixed effects; $T_{j,t}$ is a dummy variable which equals one when the country under observation is the treated country (i.e., Norway) *and* the time of observation is within the post-treatment period 1980-2009; $X'_{j,t}$ includes a set of covariates (details in Table 3 in the appendix); and $\epsilon_{j,t}$ are country-clustered error terms. The OLS estimate of the coefficient λ will then represent the difference-in-differences estimator of the effect of the oil bonanza. As shown in Table 3 (in the appendix), the difference-in-differences estimator λ of the causal effect of oil production on top income shares for Norway does not invalidate the evidence of Figure 2; neither does it provide additional insights. The coefficient λ is positive, although weakly significant when controlling for key labour market features of the Nordic countries - for instance, trade union density.

The second contribution of this study looks at another key element of the Scandinavian model framework analyzed in Barth et al. (2014): the political economy of public welfare spending. How did the oil bonanza affect the relative growth of welfare spending in

[13] Results are available in the Appendix, and are shown in Figures 2a and 2b.

Norway compared to the other Nordic countries?

4 Public welfare spending

The focus of this section will be on the Nordic countries as providers of public services and social insurance, as for instance unemployment and sickness insurance, health expenditure and pensions. How does a booming resource sector in Norway influence the growth of welfare spending relative to its Nordic neighbors? In other words, does the structural change implied by the treatment, imply a shift to less or more welfare generosity in Norway? At first, let us briefly review the recent literature. The Nordic model benchmark described in Barth et al. (2014) and Barth and Moene (2015) predicts that wage compression might boost productivity and raise average wages, which in turn leads to increased demand for welfare spending and a shift to the left (i.e., higher welfare generosity) of the entire political spectrum. Let us see in more detail how this happens. In Barth et al. (2014) and Barth and Moene (2015), both income level and the marginal benefit of public services determine the voter s preferences for welfare spending. The authors show that, for a given exposure to the risk of income loss, higher income (i.e., higher equilibrium wage induced by higher average labor productivity) increases the demand for welfare spending (i.e., welfare spending is assumed to be a normal good). This is because, as voters become richer, the income loss associated with a less generous welfare state gets larger, whilst the utility cost necessary to finance welfare programs gets smaller. Hence, these modified preferences move both the right and left political parties toward a new equilibrium with a more generous welfare state. Barth et al. (2015) focus on changes in the income distribution (for a given mean income) and the consequent shift in preferences for generous welfare spending. They hypothesize that, for voters below the

mean, an increase in income inequality reduces their willingness to finance welfare, hence leading to a shift toward the political right and less welfare generosity; they label this the political reinforcement hypothesis. It has to be pointed out that the empirical analysis below does not aim at precisely testing the predictions of the above models, for a straightforward reason. The results of Barth et al. (2014, 2015) and Barth & Moene (2015) build on the assumption of a given exposure to the risk of income losses in absence of shocks, which does no longer hold when the treatment is defined to be the volatile booming resource sector of Norway. To summarize, the comparative effect of the oil bonanza on welfare generosity estimated in the following empirical exercise might confirm either one of the following predictions: (a) oil revenues causes higher top income shares and income inequality, hence less demand for social insurance and in turn a lower overall degree of welfare generosity (as in Barth et al., 2014, 2015; and Barth and Moene, 2015); (b) a booming resource sector with high but volatile income streams increases the exposure to the risk of income loss, and hence increases support for public spending and a high overall degree of welfare generosity.

4.1 The comparative effect on welfare generosity

The set-up of this last empirical exercise resembles the first one, with Norway being the treated unit and the donor pool of potential comparison units consisting of Denmark, Finland and Sweden, which are assumed to resemble the overall welfare generosity for Norway before the oil bonanza. The implementation of the SCM is also technically similar to the first empirical exercise, but with a new dependent variable and predictors. The data set collected for this exercise comes from the Comparative Welfare Entitlements Data Set in Scruggs et al. (2014), which contains annual country data (1971-2010) on the

provision of the main three social insurance programs: unemployment insurance, sick pay insurance, and public pensions. For each of these three main areas, Scruggs et al. (2014) contains data on replacement rates for individuals and families, program coverage and a program generosity index (with a numerical score from 0 to 25). In addition, Scruggs (2014) sums up the three program indices to compute a combined generosity index, which is the Z dependent variable of the exercise below. The maximum theoretical score for this combined index is 75, namely the sum of the three program scores. Additional details on calculation of replacement rates and program generosity indices can be found in Scruggs (2014). A set of n determinants of the dependent variable Z are included in the analysis as predictors, namely: program generosity indices (unemployment, sickness and pension); replacement rates: single (100% earnings) (unemployment, sick pay and standard pension); replacement rates: family (100% earnings) (unemployment, sickness and standard pension); program coverage: (% of the labor force insured for unemployment risk, % of the labor force with sick pay insurance, portion of those above official retirement age who are in receipt of a public pension). For each country, these predictors are observed throughout the time range 1971-2010 in order to form a strongly balanced panel. The treatment year is 1980, as in the previous exercise. The SCM now assigns the following weights to the countries of the donor pool[14]:

[14] The averaged values for each of the predictors, for both the treated unit and the synthetic unit, can be found in Table 4 in the appendix.

Country	Synthetic control weights W^*
Denmark	0
Finland	.275
Sweden	.725

Quite similarly to the weights assigned in the first empirical exercise, Finland counts for (0.275) whilst Sweden is (0.725) in the synthetic control unit. Once again, Denmark is assigned a zero weight, which is, however, not sufficient to justify its exclusion from the donor pool, for the reasons described above. More interestingly, the similar weights obtained for completely different predictors not only prove that Sweden provides a better match with Norway, but also show the overall robustness of these weights. Let us proceed now with the computation of the difference $Z_{1t} - \sum_{J=2}^{4} w_j^* Z_{jt}$ that will represent the estimation of the causal effect of the treatment on the treated unit s post-treatment values of the combined generosity index, measuring the generosity of the welfare state. The series of the combined generosity index for both the treated and the synthetic unit are plotted in Figure 3:

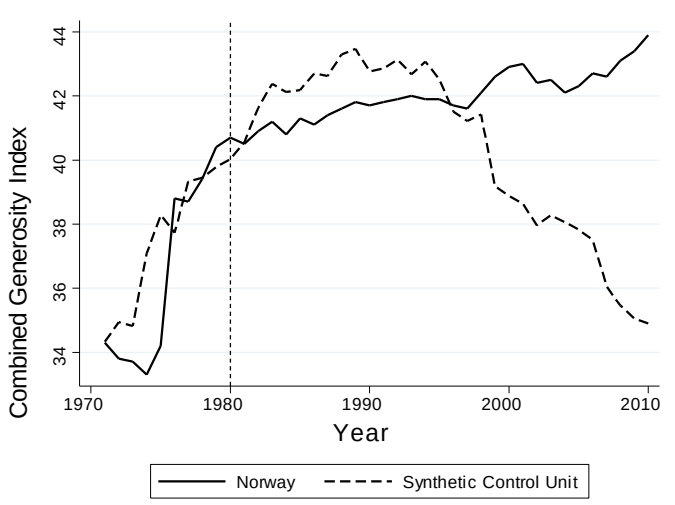

Figure 3 - The comparative effect on the Combined Welfare Generosity Index

At first, the left hand side (before 1980) of Figure 3 highlights that the synthetic control unit matches the dynamics of the combined generosity index series for Norway (however weakly than in the case of the first empirical exercise), thereby allowing to turn to the analysis of the causal effect of the treatment, on the right hand side of Figure 3. The u-shaped series of the synthetic control unit shows that, from the 1990s onward, the synthetic control unit unambiguously declines toward roughly the same level of combined generosity as in 1971, hence marking a sharp reduction in welfare generosity (more precisely, a reduction of more than 50% with respect to the level of the index in 1990). On the other hand, the combined generosity index for Norway steadily increases until 2010, showing a structurally different trend. It is relevant to issue certain caveats here, when it comes to the economic interpretation of this result, since other confounding decisive factors might have contributed to the result shown in Figure 3, as for instance political reforms of social insurance programs unrelated to the oil bonanza. However, and to the extent that we can claim that the gap in welfare generosity observed in Figure 3 has been fostered by the huge resource revenues received by Norway from the 1980s onward, the intuition behind this result is the following: there is no evidence of a decreased overall welfare generosity in Norway in response to the resource revenues shock. More likely, the volatile income streams of the resource sector increased the exposure to the risk of income loss, which can in turn boost the voters preferences for public spending and welfare generosity. On the fiscal revenue side, resource revenues enlarged the tax base through the post-treatment years, allowing the Norwegian government to finance a constantly growing level of overall welfare generosity. Before turning to the concluding remarks, a few robustness checks for this last empirical exercise should be mentioned. In-time placebo tests were conducted here as well, for different treatment years throughout

the range of years 1985-1990, with no significant changes in the predictive power of the synthetic control unit[15]. In addition, and for the sake of consistency with the previous empirical exercise, a more traditional difference-in-differences estimation was set up:

$$CGI_{j,t} = \eta_j + \nu_t + \pi D_{j,t} + \Psi_{j,t}\varphi + \varepsilon_{j,t} \qquad (2)$$

in which $CGI_{j,t}$ is defined as the score of the combined generosity index of welfare programs (1971-2010) for country j; η_j and ν_t estimate respectively countries fixed effects and time fixed effects; $D_{j,t}$ is a dummy for the interaction of the treated country with the post-treatment period; $\Psi'_{j,t}$ includes a set of covariates (replacement rates and program coverage for each of the three programs); and $\epsilon_{j,t}$ are error terms adjusted for country clustering. As shown in Table 5 (in the Appendix), the difference-in-differences estimator of the causal effect of the treatment on the combined generosity index, represented by the coefficient π, is positive and is significant in most of the regressions with controls. This supports the main result of increased overall welfare generosity in Norway in response to the oil bonanza.

5 Concluding remarks

How has the Norwegian oil bonanza comparatively affected the functioning on the Scandinavian model, measured by top income shares and public welfare spending? This was the aim of this research, which provided evidence on the development of two main economic features of the so-called Scandinavian model for the case of Norway, after the

[15] Results are available in the appendix, and are shown in Figures 3a and 3b.

country became one of the world's largest oil exporters. The identifying assumption relies on the fact that Denmark, Finland and Sweden, which jointly resemble the economic outcomes of Norway, are not (large) oil producers; hence they provide the most reliable donor pool of comparison units. The main results are summarized as follows, together with some considerations for future research. The first empirical exercise showed that the oil bonanza contributed to slightly higher and definitely more volatile top income shares relative to the Nordic neighbors. The magnitude of this effect is not large, and hence shows the need for further research employing different proxies and indicators of income inequality. Still, this finding contributes to adding resource revenues to the set of factors explaining the increased income inequality in Norway that has been documented in Aaberge and Atkinson (2010). Secondly, results showed that the streams of resource revenues induced a steadily increasing gap in the degree of welfare generosity (measured by the combined generosity index) in which Norway s generosity pulled ahead of the other Nordic countries. As highlighted in the paper, other decisive factors might also have contributed to this empirical fact, as for instance political reforms in public service provision and social insurance programs. More research at both the individual and cross-country levels is therefore needed. Regardless of the possibility of confounding factors, the result of the second empirical exercise clearly shows no evidence of decreased overall welfare generosity in Norway. Instead, the results support the testable hypothesis that a windfall of resource revenues enlarged the tax base, allowing the Norwegian government to finance a sustained level of overall welfare generosity.

Data appendix

- **Top income shares:** top income shares for the four Nordic countries (1960-2011) were retrieved from The World top Incomes Database, and are based on Atkinson and Søgaard (2016), Jäntti et al. (2010), Aaberge and Atkinson (2010), Roine and Waldenström (2010).
- **UTIP-UNIDO industrial pay inequality:** industrial pay-inequality data (1963-2008) are available from the University of Texas Inequality Project (UTIP) at http://utip.gov.utexas.edu/data.html. The data set constitutes a panel comprised of the between-groups component of Theil's T statistic (fully described in Conceição et al., 2000) measured in different countries across a stable and consistent set of industrial sectors.
- **Unemployment:** unemployment rates, as a % of Labor Force (1960-2013), were collected from the OECD Labor Force Statistics.
- **Trade Union Density (TUD):** TUD corresponds to the ratio of wage and salary earners that are trade union members, divided by the total number of wage and salary earners (1960-2013, OECD Labour Force Statistics). OECD (2015): Density is calculated using survey data, wherever possible, and administrative data adjusted for non-active and self-employed members otherwise.
- **Program generosity scores:** calculation of the program generosity sub-indices (1971-2010, unemployment, sickness and pension) is explained in detail in Scruggs (2014).
- **Replacement rates:** as explained in the CWED codebook in Scruggs, Detlef and Kuitto (2014), "replacement rates are calculated for a fictive average production worker in the manufacturing sector who is 40 years old, has been working for the 20 years preceding the loss of income or the benefit period". Single: 100% earnings, living alone, no children or other dependents. Family: 100% earnings, cohabiting with a dependent spouse with no earnings, two children aged 7 and 12. Data are extracted from Scruggs et al. (2014).
- **Program coverage:** program coverage (1971-2010, % of the labor force insured for unemployment risk, % of the labor force with sick pay insurance, portion of those above official retirement age who are in receipt of a public pension). Data are extracted from Scruggs et al. (2014).
- **GDP per capita**: GDP per capita constant 2005 USD (1960-2014) was obtained from the World Bank s World Development Indicators.
- **Total production of petroleum:** yearly production of oil equivalents (oil, NGL and condensate, million Sm^3) on the Norwegian continental shelf, 1971-2014. Source: The Norwegian Petroleum Directorate.

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Tables and figures

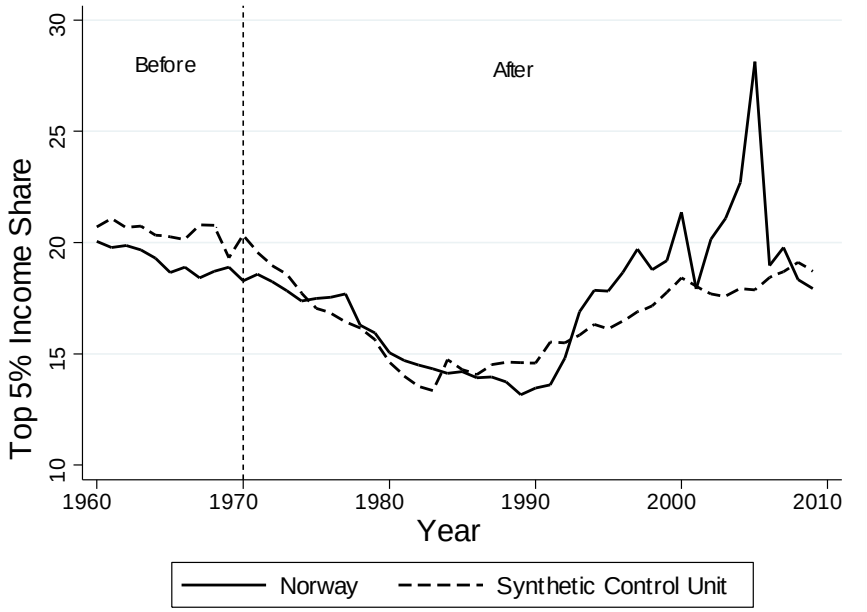
Table 1 - Descriptive statistics and variable descriptions.

Variable description	Data Source	Mean	Std. Dev.
Top5% Income share, excl. capital gains	World Top Incomes Database	17.906	2.9616
Top1% Income share, excl. capital gains	World Top Incomes Database	6.371	1.8374
Industrial pay-inequality	UTIP-UNIDO	0.007	0.0028
TUD-Union members, % of wage earners	OECD Labor Force Statistics	66.308	11.1696
Unemployment rate, % of labour force	OECD Labor Force Statistics	4.620	3.2355
GDP per capita, constant 2005 USD	World Development Indicators	33831.6	13972.7
GDP per hr. worked, constant 2010 USD	OECD Productivity Statistics	44.05	15.9021
Gross fixed capital, mill. constant 2005 USD	World Development Indicators	44946.64	20161.09
Gross capital, mill. constant 2005 USD	World Development Indicators	49000.64	20461.49
Education expenditure, % of GNI	World Development Indicators	5.9733	0.996
Gross savings, % of GNI	World Development Indicators	27.4696	4.5409
Unemployment generosity score	CWED	10.558	2.426
Sick pay generosity score	CWED	14.924	2.056
Pension generosity score	CWED	12.693	1.403
Unemployment replacement rate (single)	CWED	0.662	0.124
Sick pay replacement rate (single)	CWED	0.806	0.155
Pension replacement rate (single)	CWED	0.569	0.086
Total prod. of oil equivalents, mill. Sm^3	Norwegian Petroleum Direct.	145.015	94.324

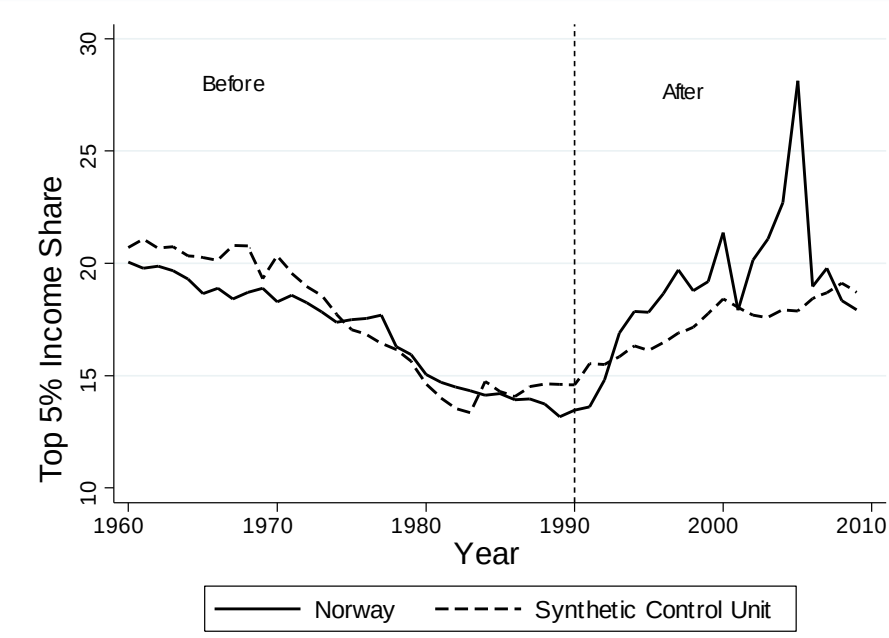
Table 2: Predictor Means before treatment for Treated and Synthetic Unit

Predictor	Treated	Synthetic
Industrial pay-inequality	0.0083	0.0065
GDP per capita, constant 2005 USD	25063.09	19663.97
Top5% Income share	18.379	19.107
Top1% Income share	5.843	6.546
TUD-Union members	56.483	65.395
Unemployment rate	1.295	2.151

Note: predictors are averaged over the period $1960 - 1979$.



Note: figure 2a shows in-time placebo test with treatment year 1970.



Note: figure 2b shows in-time placebo test with treatment year 1990.

Table 3: Dependent variable is the Top 5% Income share.

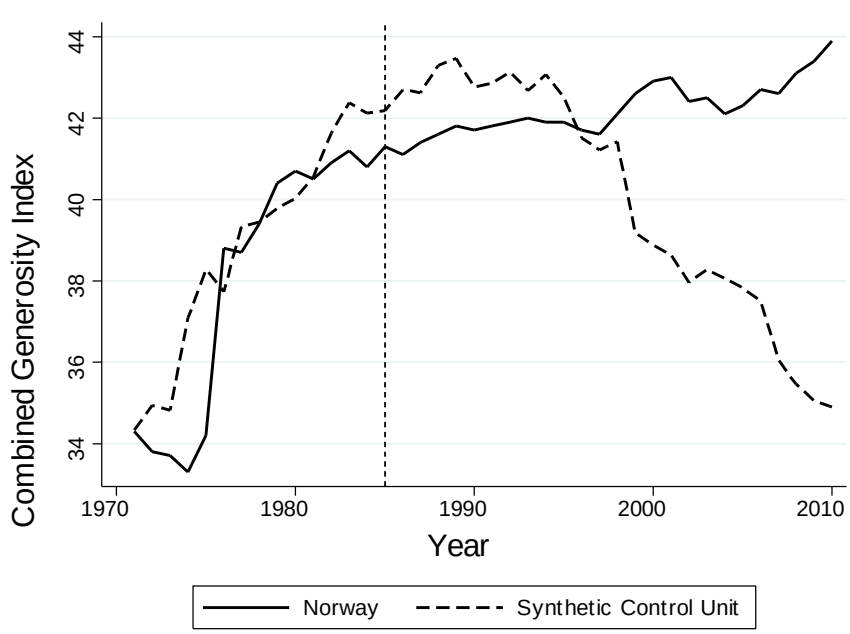
	(1)	(2)	(3)	(4)
Diff-in-Diff	**2.605***	**2.709***	**1.958**	**1.791**
	(**0.943**)	(**0.906**)	(**1.197**)	(**0.994**)
Industrial pay-inequality		2.373	-51.22	-1.947
		(273.7)	(236.4)	(180.4)
Trade Union Density			-0.0675	-0.0969**
			(0.0331)	(0.0275)
Unemployment rate				0.165
				(0.206)
Time FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES
Observations	207	180	180	180
R-squared	0.779	0.762	0.774	0.783
Number of countries	4	4	4	4

Note: robust standard errors adjusted for country clustering in parentheses.
***p<0.01,**p<0.05,*p<0.1

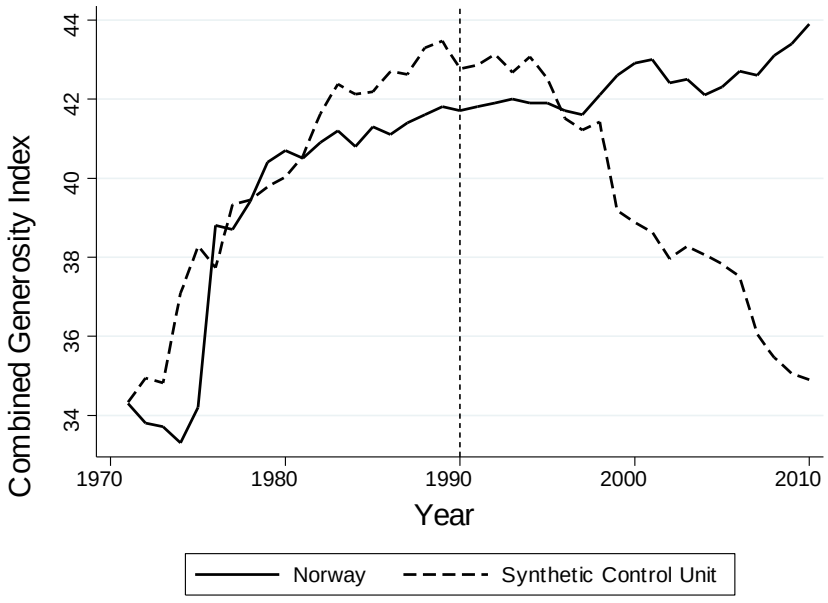
Table 4: Predictor Means before treatment for Treated and Synthetic Unit

Predictor	Treated	Synthetic
Unemployment generosity score	10.36	8.15
Sick pay generosity score	14.03	16.47
Pension generosity score	11.86	12.74
Unemployment replacement rate (single)	0.571	0.702
Sick pay replacement rate (single)	0.740	0.828
Pension replacement rate (single)	0.467	0.537
Unemployment replacement rate (family)	0.662	0.747
Sick pay replacement rate (family)	0.809	0.883
Pension replacement rate (family)	0.529	0.673
Unemployment coverage	0.802	0.615
Sick pay coverage	0.98	1
Pension coverage	0.995	1

Note: predictors are averaged over the period 1971 – 1979.



Note: figure 3a shows in-time placebo test with treatment year 1985.



Note: figure 3b shows in-time placebo test with treatment year 1990.

Table 5: Dependent variable is Combined Generosity Index

	(1)	(2)	(3)	(4)
Diff-in-Diff	**2.369**	**3.611****	**1.487****	**1.565****
	(1.488)	**(0.843)**	**(0.462)**	**(0.392)**
Unemp. repl. single	13.24	10.73**	9.339**	9.853**
	(6.667)	(2.875)	(2.702)	(2.453)
Unemp. repl. family	-3.182	1.486	4.409	4.037
	(6.487)	(3.729)	(2.954)	(2.259)
Sick pay repl. single	9.095	14.03***	7.096	6.030
	(7.542)	(2.147)	(3.022)	(2.625)
Sick pay repl. family	-6.894	-8.898*	-0.324	0.769
	(9.884)	(3.231)	(3.619)	(3.171)
Pension repl. single	-14.61	-20.40**	-16.40**	-16.10**
	(7.651)	(5.572)	(4.211)	(3.566)
Pension repl. family	24.81**	25.58***	18.81**	18.49***
	(5.225)	(3.993)	(3.489)	(2.792)
Unemp. cov.		16.06***	5.407*	5.726*
		(2.481)	(2.247)	(1.882)
Sick pay cov.			24.35***	24.32***
			(4.041)	(3.402)
Pens. cov.				7.163*
				(3.027)
Time FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES
R-squared	0.893	0.931	0.970	0.971
Observations	159	159	159	158

Robust standard errors adjusted for country clustering in parentheses.
***p<0.01,**p<0.05,*p<0.1