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The Causal Impact of Proximity on Firms

Evidence from large infrastructure projects in Norway

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Abstract

This paper empirically analyse the effects of large changes in infrastructure on plant-level performance in Norway. More specifically, the construction of new tunnels and bridges. The results of this thesis is relevant because increased performance at plant-level stimulates economic growth.

I compute an econometric analysis on plant-level data from Norwegian firms during 2003 – 2011. The main analysis investigates the effect on return on assets from the opening of new road projects that opening in 2006 – 2008, and projects opening in 2008. I also present a similar analysis on the effect on employees. When I look at the entire period I cannot conclude that the opening of new projects have an effect on return on assets and employees. However, I find that return on assets increases with 11.4 % and employees increases with 6.2 when I only use tunnels and bridges that opens in 2008.

Preface

This paper is a part of the master degree in financial economics at the Norwegian School of Economics (NHH). The comprehensiveness of this work extends over one semester and marks the end of a five-year study in economics.

Working with the thesis has been an educational and challenging process. Providing me with an excellent opportunity to expand my competence within corporate finance and develop knowledge in the field of econometric. It has truly been a valuable experience.

By writing this thesis, I wish to contribute to the understanding of the effect from improvements in proximity on firms. This topic is important because it stimulates economic growth.

I would like to thank my supervisor, Cornelius Schmidt, for providing me with valuable advices and guidance throughout the entire process, and for suggesting this topic. Cornelius has challenged me to work independently and provided me with great insights.

I also like to thank Vegdirektoratet and Statens Vegvesen for providing information about large road projects in Norway.

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1 Introduction

1.1 Background

A thoroughly studied area in financial literature is theory about agency problems and corporate governance. Important aspects within this theory is mechanisms of monitoring and information acquiring. Studies that are more recent investigate the effect of proximity as an extension of these mechanisms. Findings from studies on mutual funds (Coval and Moskowitz, 1999; 2001) and venture capitalists (Lerner, 1995) show strong relationships between proximity and the ability to monitor an acquire information. In a more recent study, Giroud (2012) finds a strong effect on plant-level performance because of improvements in proximity between headquarters and plants. However, little information exists on how improvements in proximity affects firms at plant-level in Norway.

Improvements in proximity can come from the introduction of new airline routes, boat connections, railways or changes in road networks. The biggest and most frequent improvements in proximity in Norway are from the construction of road projects.

Norwegian infrastructure is continuously developing and substantial amounts of money is used. Despite the resources allocated to maintain roads, are roads in Norway considered to be amongst the worst in Europe (Kjølleberg and Ansari, 2014) because of lag in maintenance (Seehusen, 2013). Simultaneously, Norwegian engineers is amongst the best in the world regarding road constructions. The special geography in Norway offer challenges, resulting in special expertise in building of tunnels and bridges (Kjølleberg and Ansari, 2014). This makes using large infrastructure projects in Norway, as an improvement in proximity, interesting.

1.2 Focus and Demarcation

This thesis origin from a similar research by Giroud (2012) on plant-level data in the United States. Giroud's (2012) method constitutes the basis for my analysis. A strength in this method is the use of reduction in travel time as a plausible exogenous variable. This takes care of the endogenous problem associated with physical distance. Similarly, I use changes in infrastructure as an exogenous variable in my analysis on plant-level data in Norway.

I investigate the effect of changes in infrastructure on plant-level performance and employees. Financial theory includes numerous measures of financial performance. However, I focus only on one, return on assets. The Norwegian Corporate Account provides me with data containing financial information on companies in Norway. It also puts a constraint on the period I include in my analysis. Furthermore, I focus only on industries ranging from A to F in the NACE codes, as they have similar characteristics. Providing me with a broader specter of industries compared to Giroud’s (2012) study that only focused on manufacturing industry.

The Norwegian infrastructure is suffering and the government is granting substantial resources to improvements and developments. The outcome is several large changes in infrastructure over time. Continuous developments in infrastructure is why I choose to use reduction in travel time due to road projects as an exogenous variable.

1.3 Research Question

I test the hypothesis first presented by Giroud (2012), to see if it applies to firms in Norway. In which openings of new tunnels and bridges constitute improvements in proximity. Moreover, I investigate if profitability and employees increases as it becomes easier for headquarters to visit plants. As an increase in traveling is likely to increase monitoring and information acquiring on plants.

Consequently, I raise the following research question:

How does a reduction in travel time between headquarter and plant improve plant management?

1.4 Structure of Thesis

In section 2, I provide a theoretical framework including theory about agency problems and corporate governance mechanisms. The focus is however on the presentation of previous research to give a better understanding of the background for my thesis. Section 3 gives a thoroughly presentation of the empirical strategy including construction of the dataset and econometric issues. Section 4 contains findings of the main analysis. I provide a discussion of the result and present a sensitivity analysis. Finally, I sum up and conclude upon my findings in section 5.

2 Related Literature

This section opens with an introduction of corporate governance and agency theory. I follow up with an explanation of how they relate to proximity and why it is important. Finally, I turn my attention towards previous empirical studies concerning proximity in different applications. My main focus is on Giroud’s (2012) study of plant-level performance in the United States.

2.1 Corporate Governance

When a corporation separates ownership and control, conflicts of interests often arises. Corporate governance is an attempt to minimize such conflicts (Berk and DeMarzo, 2011). It constitutes a set of mechanisms to protect investors’ interests against potential mismanagement. A successful implementation of corporate governance creates value for both corporations and society. Society benefit from economic growth through investments in projects that creates value. Whilst corporations profit from aligned interests between the principal, provider of financial capital, and the agent, contributor of human capital. More specifically, with aligned interests the agent benefits from resources and trust from the principal, and the principal gain higher returns. In contrast, misaligned interests destroy value.

A method to govern agents is monitoring (Berk and DeMarzo). The principal learns about the plant’s daily business through monitoring, and becomes more confident to allocate assets. A problem arises if the principal becomes overconfident, this can destroy value instead of creating it. Improvements in proximity encourage more active monitoring, which strengthens supervision. Consequently, proximity facilitates monitoring and access to information (Giroud, 2012).

2.2 Agency Problem

Agency problem is the conflict between the principal and the agent. The principal owns assets and provides financial capital (headquarter). The agent is the management responsible for the company’s daily operations and manages the invested resources (plants management). Jensen and Meckling (1976) define an agency relationship as a contract between one person that engages another person to perform some service on their behalf which involves delegating decision-making authority.

Agency problems arise because contracts are not free from problems (Jensen and Meckling, 1976). If principals and agents objectives and incentives are different, then the agent may not act in the principal's best interest, and a potential agency conflict arises between them. Another problem with agency is the presence of asymmetric information. An example is agents possessing company-specific information, due to involvements in the daily business, of which the principal has no knowledge. Conflicts also arises from an agent being reluctant to take on new projects that creates value, because he has concerns about how undertaking more risk reflects upon him.

Headquarters allocate investments and budget resources to plants, and monitor in effort to avoid agency problems (Giroud, 2012). Improvements in proximity makes it easier for headquarters to travel more and develop better insights in plants operations, which reduces agency conflicts. Frequently monitoring may induce motivation amongst plant managers and workers to improve the plant's performance (Giroud, 2012).

2.3 Proximity in Plant-level Data

Until recently, little research has been done on how improvements in proximity affects firms at plant-level. In a very thorough study, Giroud (2012) finds a positive effect in headquarters plant-level investment and plants productivity due to reduction in travel time because of the introduction of new airline routes. He finds that headquarters are more likely to invest in plants that are located closer to headquarters, and that proximity to headquarters improve plant-level productivity.

Location is important to establish improvements in proximity. A concern is that location of both headquarters and plants are made by choice, hence proximity is likely to be endogenous. Making it problematic to establish causality. Previous empirical studies measures proximity in physical distance as a proxy for the ease of monitoring and acquiring information. To remove endogeneity, Giroud (2012) suggests using travel time as it entails plausible exogenous variation. However, a limitation of this approach is that it relies on variation in travel time, not in monitoring or access to information. Further, Giroud (2012) argues that it is plausible that travel time reduction leads to an improvement in monitoring and information acquisition, and thus improves the plants performance. Moreover, that larger reductions in travel time results in stronger effects of treatment.

Giroud (2012) combines plant-level data with airline data, in which he exploits the introduction of new airline routes that reduces travel time between headquarters and plants, as a source of exogenous variation. He then applies difference-in-differences approach to examine the effect on plant-level investment and productivity. In this approach, Giroud (2012) uses a treatment window of equal length both prior to and after treatment. A treatment window compares performance several years before and after treatment providing a better picture of the change due to the treatment. To account for the possibility of other factors that may affect firms behavior to increase return on investment, a control group is included that consists of all plants not yet treated.

A strength in the empirical design of Giroud's (2012) model is that it accounts for the fact that reduction in travel time can vary for other reasons, such as new roads, changes in speed limit and expansion of railroad networks. Plants affected by such changes are included in the control group, and if these sources of travel time reductions lead to increased performance then the result understate the true effect of travel time reduction.

An important assumption is that managers make optimal decisions. Hence, they choose the route and transportation that minimizes travel time between headquarters and plants. This implies that the distance between treated plants and headquarters need to be appropriate so that the optimal transportation is the transportation method included in treatment. Moreover, as treatment depends on time reduction as of new commercial airline routes in Giroud's (2012) study. It ensures that the registered effect is a result of increased personal transport, managers traveling more frequently, and not increased cargo transport, e.g. shipping of equipment or products.

Moreover, reasons for changes in infrastructure can depend on several factors. As long as these factors are unrelated to plant-level performance this constitute no concern. However, if these factors drive both the change in infrastructure and plant-level performance, any relationship between them might be forged (Giroud, 2012).

If a change in infrastructure improves headquarters ability to monitor and acquire information about plants, this may be reflected in plants performance. A plant that is easier to monitor is less likely to have private information, and may receive more investments from its headquarter. If monitoring increases, it can improve plant managers' incentives to be more aligned with headquarters incentives. It also allows headquarters to learn more about the plant, which can improve plants productivity (Giroud, 2012). However, there is also a down side with improved monitoring. Headquarters can become “too well informed” or “monitors too much” (Giroud, 2012). Consequently, this can impair plant managers’ incentives to create new investment opportunities or work hard.

If symmetric information exists, everyone have the same knowledge, and no agency problem is present then a change in travel time might not matter as there are no need to monitor more frequently to learn more or discipline.

Giroud (2012) argues that increased productivity not necessarily implies that the company is better off. Even though traveling become easier for headquarters, more frequent monitoring might not add value even if they believe it does. If this is the case, they might draw comfort from their added involvement and invest more in the plant. Hence, the plant receives more investments and becomes more productive. Especially if the difference between the plant and plants who originally received most investments are large, due to financial constraints in the firm. In this situation, the rest of the firm is likely to suffer because of inefficient reallocation of resources based on a mistake.

2.4 Previous Research

2.4.1 Evidence from Mutual Funds

It is well known that investors tend to be home biased, investing more in their home country instead of investing internationally and diversifying risk away. Moreover, the bias often extent towards local firms as well (Coval and Moskowitz, 1999; 2001). Investors’ preference for locally headquartered firms are a result of easier access to information. Implying existence of asymmetric information in the market, driving investors to prefer proximate investments (Coval and Moskowitz, 1999).

Local investors have many advantages compared to outside investors when acquiring information about firms. Being proximate to a firm, they can contact associates, retrieve important information through local media and similar channels (Coval and Moskowitz, 1999). This proves the importance of and advantages with proximity.

Fund managers appear to earn substantial abnormal returns on local investments (Coval and Moskowitz, 2001). Suggesting a strong geographical connection between mutual fund investment and performance. Local mutual funds have improved monitoring capabilities or access to private information of geographical proximate firms (Coval and Moskowitz, 2001). Accordingly, funds that are more superior in exploiting local knowledge, profit more from these investments. Areas that for some reason are more difficult for outsiders to obtain local information about, offer larger profit for local investors (Coval and Moskowitz, 2001).

2.4.2 Evidence from Venture Capitalists

Venture capital organizations provide equity to young start-up firms unqualified for external funds. These organizations take on substantial risk by investing in young firms. However, the potential upside is large. Venture capitalists depend on having detailed knowledge of firms they finance to control risk. Hence, closely monitoring is important to limit opportunistic behavior (Lerner, 1995).

Venture capitalists take substantial roles in firms they are financing. They often become board members, visit frequently, and meet with both customers and suppliers. Further, they also have an active involvement in key personnel and strategic decisions (Lerner, 1995). Monitoring of this extension results in extensive transaction costs.

Proximity to firms reduces transaction costs associated with frequent visits and intensive involvement (Lerner, 1995). Accordingly, geographic proximity is an important determination of venture board membership. More proximate firms, to the office of venture capitalists, are more likely to have board members compared to more distance firms (Lerner, 1995).

3 Empirical Strategy

I now explain my empirical strategy. First, I present my dataset and its sources, and provide an explanation of assumptions and adjustments. Then the focus shifts towards variables and calculations of plant-level profitability. Finally, I describe technicalities and outline empirical issues before I present my regression analysis.

3.1 Construction of Dataset

3.1.1 Plant-level Data

The Norwegian Corporate Account provides me with data on plants and headquarters. The database contains financial statements and descriptive information from companies in Norway throughout the years of 1992 to 2011. Financial statements consist of income statements and balance sheets, for both groups and individual for each company. Key variables are net income and total assets, which I use to calculate plant level profitability. The descriptive information contains knowledge about a firm being active, postal codes, number of employees, industry code and headquarters organization number. Organization numbers identify both plants and headquarters. I use these to connect plants with their respective headquarter.

A problem with the Norwegian Corporate Account is missing values amongst key variables in my dataset, especially in early years. Missing values put a constraint on my sampling period. Prior to 1997 are there no registrations of postal codes. Headquarters organization number are missing before 2002, and there are no recordings of a firm being active until 2003. All three variables are important in constructing my dataset, limiting me to include only nine years of plant-level observations from 2003 through 2011.

Another issue is missing registrations on employees in 2006 and 2007. Both years are critical to my dataset and my regression analysis. Nevertheless, I assume that the number of employees does not change rapidly. A solution is using data on employees from 2005 for 2006 and from 2008 for 2007. Combining this approximation with information on a plant being active, allow me to keep these years within my sample. It is important to recognize this as a weakness in my analysis that can affect my findings. Particularly the effect from openings of new road projects on employees.

For a plant to be included in my sample I require that the plant

- is active at least for two years within 2003 – 2011.
- has minimum one employee in a plant-year observation.
- has at least one year prior to treatment and one year after treatment.

The latter requirement provide some degree of symmetry in my dataset and remove firms that opens after the road project opens. This is important, as I am interesting in the difference before and after in already existing plants.

I also remove plant-year observations that have missing values in postal codes, net income, total assets, or industry code. Subsequently the dataset consists of several plant observations not listed throughout the entire period. Making it an unbalanced panel dataset (Wooldridge, 2009). However, this constitute no concern and do not affect the empirical method.

Similar requirements apply for headquarters. More specifically, I require that a plant's headquarter is active and have minimum one employee. I exclude headquarter-year observations not fulfilling these requirements from my sample. Additionally, they must also have postal code, this being the most important information about headquarters.

The Norwegian Corporate Account database includes yearly observations of both plants and headquarters within the same column. I remove headquarter observations from the dataset to ensure that the effect I find is only from plant-level profitability and employees. Furthermore, I assign all key information concerning headquarters to the respective plant-level observation that matches year and headquarters organization number. This is important, as I am only interesting in plant-level profitability and employees.

Table 3-1: Descriptive statistics.

		Mean	Std. Dev.	Min	Max	Obs
				Plant-Level		
Return On Assets (ROA)	All	0.071	0.674	-65.659	44.000	30131
	Treatment	0.052	0.216	-1.165	0.532	66
	Control	0.071	0.674	-65.659	44.000	30065
Employees	All	25.6	119.2	1	3776	30131
	Treatment	36.8	41.4	1	143	66
	Control	25.5	119.4	1	3776	30065
Age	All	21.5	12.6	8	172	30116
	Treatment	22.9	14.7	10	80	66
	Control	21.5	12.6	8	172	30050
				Headquarter		
Employees	All	224.2	960.5	1	20068	3876
	Treatment	257.1	1332.8	1	10813	66
	Control	223.6	954.0	1	20068	3810
Age	All	29.4	23.1	3	172	3847
	Treatment	36.5	27.2	8	99	66
	Control	29.3	23.0	3	120	3781

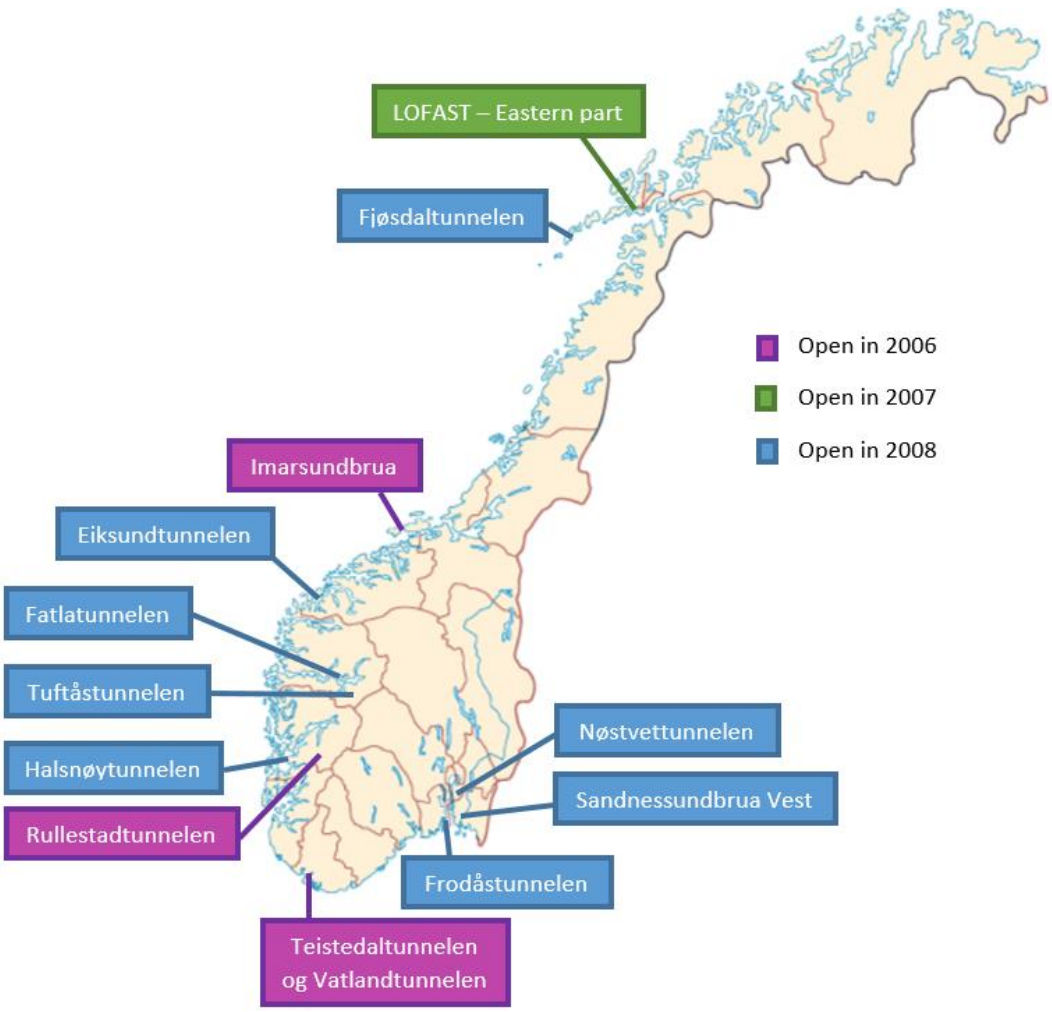
After removing all plants not fulfilling my requirements, I have 30131 plant-year observations. This corresponds to 5764 plants with an average of 5.2 plant-year observations. The substantial difference in observations between the control group and the treatment group comes from an extensive fraction of single unit firms. These firms consist of a single establishment having headquarter and plant at the same location. Hence, they can never have a treatment so they are included in the control group.

My sample only contains nine years of data because of missing registrations. Accordingly, I can maximum have a treatment window of four years before and after a treatment. Unfortunately, not many infrastructure projects opens in 2007. I therefore chose to use a three-year window before and after treatment. Giving me a sample period on tunnels and bridges from 2006 to 2008. However, there is a tradeoff between choosing to reduce the number of years before and after treatment and having a larger group of changes in infrastructure. Including more years before and after treatment, reduces any impact of extreme values. On the other hand, a larger sample of road projects give a more representative result for Norway in general.

3.1.2 Tunnel and Bridge Data

I collect information about tunnels and bridges from Vegdirektoratet. They provide me with a information on of road projects including name, opening year, location, length and what they replaced. Tunnels and bridges opening during 2006 – 2008 are included in my sample. See appendix 1 for the list of tunnels and bridges.

Figure 3-1:Map of road projects.



Road projects open at different times during a year, and this can potentially induce problems. If a project opens in the beginning of a year one can include that year as *after*, whilst for projects opening at the end of a year one can include that year as *before*. However, if a project opens in the middle of a year then there is no easy solution on whether to treat that year as before *or* after. To provide consistency and avoid this problem, I exclude the year when a project opens from my dataset.

3.1.3 Postal Codes

I use postal codes to connect data on road projects with plant-level data from the Norwegian Corporate Account database. A combining usage of Google Maps and Bring (2014 b) provide me with relevant postal codes. Bring (2014 a) also equip me with a map of Norway including postal code boundaries. Collecting postal codes on either side of the road project define two areas so that the optimal travel route is via the project. A natural assumption in my model is that the optimal travel route has the lowest travel time.

A concern when defining areas from postal codes, is addresses in the outer part of an area having another optimal route. This is highly dependent on the traveler's starting point and destination. Nonetheless, I assume these are few, if any, and constitute no threat. On the other hand, another optimal travel route can reduce the impact on profitability understating my result. Not utilizing changes in infrastructure means no reduction in travel time and hence no incentives to travel more often. Moreover, a different combination of postal codes may give a different result and also increase plant-year observations, or reduce. Similar with treatments.

The Norwegian Corporate Account database contains postal codes on both the actual location of the operation and the business address. No registrations on postal codes of operations prior to 2010, forces me to use postal codes of plants' business addresses. However, the two groups of postal codes do not necessarily share the same address. I assume that any difference is insignificant and do not affect my results.

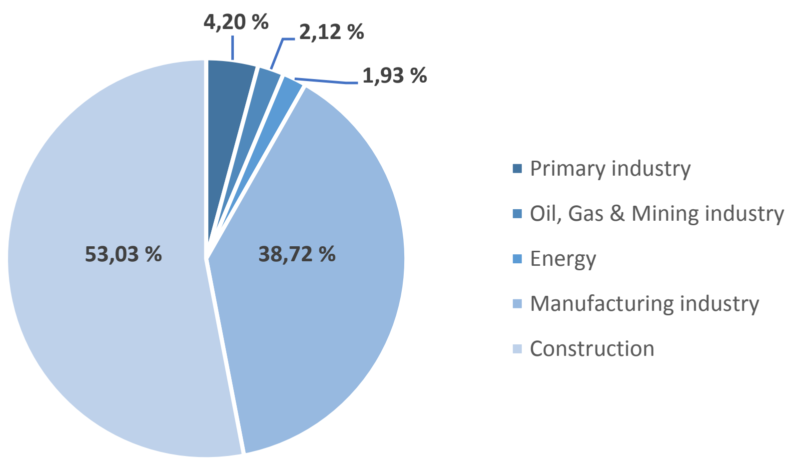
3.2 Determining Variables

3.2.1 Industry Sectors

My sampling period contains two different classifications of industry codes, SN2002 and SN2007. The introduction of the latter replaces the initial classification in 2007. However, my dataset includes both classifications for the entire sampling period.

I focus on industry sectors ranging from A to F in SN2007/NACE. These industries constitute the primary industry, oil, gas and mining industry, energy, manufacturing, and construction (Statistisk sentralbyrå, 2014; European Commision, 2012). See appendix 2 for more details about industry sectors and classifications. I that plants are within sectors A to F in both classifications to be included in my dataset.

Figure 3-2: Distribution in industry sectors of year plant-level observations, 2003 – 2011.



(Norwegian Corporate Account)

A noteworthy observation is that *construction* includes the industry of building tunnels and bridges. A concern in my analysis is that the effect on plant-level profitability from road projects can derive from the construction companies building them.

3.2.2 Postal Code Areas

I determine the effect from changes in infrastructure on plant-level performance from travel time reduction between two areas. See appendix 3 for a list of areas. The areas constitute collections of postal codes. I try to include a more densely populated town or village, when possible. A focus is on keeping travel time reasonable avoiding unrealistically long distances. Large travel distances absorb the impact from travel time reduction, requiring a more sufficient travel time reduction. Moreover, longer travel distances also increases the probability for being several other changes in infrastructure, not involving a project within my sample. This can have an impact on plant-level profitability.

I assume that managers choose the travel route that minimizes travel time. Accordingly, travel time is the only factor in consideration when determining areas. Implying that the route with the shortest travel time not necessarily has shortest distance (km). A challenge with roads is the opportunity to choose between several alternative routes between two locations. Fortunately, one area is often easier to determine because of natural boundaries, i.e. an island or a headland. I exploit this area to determine the optimal route to the area on the opposite side of the project.

Combining resources from Bring (2014 a) and Google Maps give the fastest route through a project. My focus is on finding the outer limits, as the outer limits of one area determine the width of the other area so the optimal travel route is via the project. This approach also determines the length of an area if another route with a better travel time exists.

Limiting the areas are the difficult part. Factors to consider are travel time, borders to a different area, and population density. Travel time is most important as it is unlikely that managers drive for several hours to visit a plant. Alternative transportation venues as airports, train stations or boat terminals is not a consideration in my model. However if they provide a shorter travel time then management uses alternative transportation. Consequently, it reduces the effect on plant-level profitability from road projects. Not utilizing the change in infrastructure means no changes in travel time, which reduces the likelihood of changes in monitoring habits. Other changes in infrastructure, including alternative transportation, resulting in travel time reduction, are included in the control group. The presence of these understate the effect on profitability from projects in my sample.

3.3 Calculating Profitability

3.3.1 Return On Assets (ROA)

The plant's profitability determines the effect from travel time reduction. I use return on assets (ROA) which measures both the operating and investing performance of a firm. ROA consists of two parts, net profit margin and asset turnover (Berk and DeMarzo, 2011). Hence, ROA show firms profitability relative to its assets. An increase in ROA indicates that a firm makes the best possible use of its assets to generate profits. I calculate ROA as:

$$ROA = \frac{Net\ Income}{Average\ Total\ Assets} \qquad \textit{3–1}$$

(Berk and DeMarzo, 2011)

The nominator is from the income statement and the denominator is from the balance sheet. In the denominator, I use average over the year compounding the opening balance and closing balance (Damodaran, 2012), in which a year's opening balance is the closing balance the year before. To avoid reducing my sample period I include balance sheet data from 2002 into my sample.

A problem with ROA occurs if a plant have substantial current assets, which understates the profitability of the plant (Damodaran, 2012).

3.3.2 Differences-in-Differences

I use Differences-in-Differences as an approach to calculate the causal effect of changes in infrastructure since my dataset include the same plants before and after a treatment. The approach works by separating data into two groups, one group of observations with treatment and one control group consisting of all observations not having a treatment. Then it calculates the difference before and after for the treatment group, and the difference before and after for the control group. Subtracting these differences reveal the effect of treatment. (Stock and Watson, 2003).

In my sample, a treatment represents the opening of a new tunnel or a bridge between two areas. To have a treatment I require that a plant is located in one area and the respective headquarter is positioned in the other area, one on each side of a specific project. If a plant or headquarter is placed in one area but have no counterpart in the other area connected through the project, then they are in the control group. Plants remain in the control group until they are treated, hence some plants is never treated (Giroud, 2012).

There are two methods to estimate the effect of treatment:

1. Compute the differences in averages between the treatment and control group in each time period, and difference the results over time

$$\hat{\beta} = \left(\bar{y}_{After,Treatment} - \bar{y}_{After,Control}\right) - \left(\bar{y}_{Before,Treatment} - \bar{y}_{Before,Control}\right) \tag{3–2}$$

2. Compute the changes in averages over time for each of the treatment and control groups and difference these changes

$$\hat{\beta} = \left(\bar{y}_{After,Treatment} - \bar{y}_{Before,Treatment}\right) - \left(\bar{y}_{After,Control} - \bar{y}_{Before,Control}\right) \tag{3–3}$$

The estimate of $\hat{\beta}$ is not depending on how I do the differencing (Wooldridge, 2009). Nevertheless, I use the latter approach.

Specifically, I compare the difference in profitability at plants before and after the year of treatment with the difference in profitability at control plants before and after the year of treatment. The difference-in-differences estimator:

3–4

$$\beta_{After\,x\,Treatment} = \left[ROA_{Treatment,\ After} - ROA_{Treatment,\ Before}\right]$$

$$-\left[ROA_{Control,\ After} - ROA_{Control,\ Before}\right]$$

The difference between the two differences is the estimated effect on plant-level profitability of opening a new road project between headquarter and plant (Giroud, 2012). Using difference-in-differences approach I remove the impact from all other sources except the effect on ROA from the project, $\beta_{After\,x\,Treatment}$, which is the factor of interest.

Table 3-2: Illustration of difference-in-differences.

	Before	**After**	**After – Before**
Control	β_0	$\beta_0 + \beta_{After}$	β_{After}
Treatment	$\beta_0 + \beta_{Treatment}$	$\beta_0 + \beta_{After} + \beta_{Treatment}$ $+ \beta_{After\,x\,Treatment}$	$\beta_{After} + \beta_{After\,x\,Treatment}$
Treatment - Control	$\beta_{Treatment}$	$\beta_{Treatment} + \beta_{After\,x\,Treatment}$	$\beta_{After\,x\,Treatment}$

(Wooldridge, 2009)

A problem with a difference-in-differences analysis is the possibility for more than one treatment. More specifically, another project opening in the three years before or after my treatment can have an effect on my results. This can bias my result. If it happens before my treatment, it absorbs and reduces the effect of my project, and after it increases the effect.

3.4 Econometric Issues

To ensure a reliable result I need to consider relevant econometric issues before implementing my regression model. Ignoring these issues can bias my result and overestimate test statistics giving a false significant result.

3.4.1 Fixed Effects Estimation (FE)

Panel data often has correlation between an unobserved effect and the explanatory variables, $X_{j,it}$. If I believe that such correlation exist, I need to include fixed effects into the regression model (Wooldridge, 2009). The fixed effect estimator allows for arbitrary correlation between, α_i, and the explanatory variables in any period, and accordingly, remove any explanatory variables remaining constant over time. Hence, datasets whose key variables remains constant over time should not use fixed effects (Wooldridge, 2009).

Including fixed effects into a regression allow controlling for variables that varies across entities but not changing over time in addition to variables that are constant across entities but evolves over time (Stock and Watson, 2003).

Fixed effects varying across entities (firm-fixed effects) have n different intercepts, one for each entity. Representing these are a set of binary (or indicator) variables, that absorb the influence of all omitted variables that differ from one entity to the next, but are constant over time (Stock and Watson, 2003). Converting into a formula, the regression model is as follows:

$$y_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 Z_i + u_{it} \tag{3–5}$$

In which Z_i is the unobserved variable that varies from one entity to the next but does not change over time. The entity-specific intercept is:

$$\alpha_i = \beta_0 + \beta_2 Z_i \tag{3–6}$$

Combining these give the fixed effect regression model:

$$y_{it} = \beta_1 X_{it} + \alpha_i + u_{it} \tag{3–7}$$

(Stock and Watson, 2003)

Time fixed effects (year-fixed effects) controls for variables that are constant across entities but changes over time. To include time fixed effect into a regression model I use a binary variable that indicates different years. The regression model including time fixed effects is:

$$y_{it} = \beta_0 + \beta_1 X_{it} + \delta_2 B2_t + \cdots + \delta_T BT_t + u_{it} \tag{3–8}$$

In which T_t is a binary variable indicating different years, and $B2_t$ is a dummy variable that equals one if it is the second period and zero otherwise (Stock and Watson, 2003).

Fixed effects remove the effect of non-normal events that might have taken place during a year or at a plant (Bertrand, Duflo and Mullainathan, 2004).

3.4.2 Random Effects Model (RE)

The random effects model include all the fixed assumptions, in addition it also requires that the unobserved variable is independent of all explanatory variables in all periods. If I believe that the unobserved effect is uncorrelated with all the explanatory variables, I should apply random effects (Wooldridge, 2009).

$$Cov\left(X_{j,it}, \alpha_i\right) = 0, \qquad t = 1, 2, \dots, T; j = 1, 2, \dots, k \tag{3–9}$$

Removing the uncorrelated unobserved effect makes the estimators inefficient. Not eliminating the unobserved effect introduces serial correlation in the error term when using ordinary least squares (OLS), and bias standard errors and test statistics. Causing potential false significant results. As a solution, Wooldridge (2009) suggests using generalized least squares (GLS) instead of OLS, as occurrence of serial correlation has no impact on GLS.

3.4.3 Fixed Effects or Random Effects

Using fixed effects or random effects depends on the explanatory variables and beliefs concerning correlation with the unobserved effect. An important factor to keep in mind is if key explanatory variables are constant across time. Then the use of fixed effects eliminate its effect on the dependent variable, y_{it}. It is important to determine which of these to include into the regression model, the wrong effects can give false significant results.

I solve this by conducting the Hausman test. If FE = RE, there is no difference between the estimate done with FE and RE. In this case, random effects are appropriate to use. However, a sufficiently large difference between FE and RE implies using fixed effects (Wooldridge, 2009).

I believe that my explanatory variables correlate with the unobserved effect since I am comparing data before and after an event. In addition, the Hausman test reveal a sufficiently large difference between FE and RE estimates in my dataset confirming that my explanatory variables correlate with the unobserved effect. Consequently, I use fixed effects in my regression model.

3.4.4 Ordinary Least Squares (OLS)

I use ordinary least squares (OLS) to estimate the regression line. The OLS estimator chooses the regression coefficients, β_j, so that the estimated regression line is as close as possible to the observed data. The distance to the observed data is calculated from the sum of squared mistakes made in predicting the dependent variable, y_{it}, given the explanatory variables, X_{it} (Stock and Watson, 2003).

OLS standard errors are vulnerable, they are easily biased, and often over- or underestimate standard deviation of coefficient estimates. Nevertheless, standard errors estimated by OLS are correct and unbiased as long as there are no fixed effects in the residual and the independent variable (Petersen, 2008). OLS also removes serial correlation in the error term that can lead to understated standard errors and give a false significant result (Bertrand, Duflo and Mullainathan, 2004)

Heteroskedasticity

It is important to control for heteroskedasticity when using OLS. Heteroskedasticity is when the error term, u_{it}, is not constant (Stock and Watson, 2003). For simple OLS analysis to be valid the error terms need to be constant, the presence of homoscedasticity (Wooldridge, 2009). If not, I need to adjust for this in my regression model. Otherwise, the OLS is both inefficient and biased.

To test for heteroskedasticity I use the Breusch-Pagan/Cook-Weisberg test (Breusch and Pagan 1979). If the test shows constant error terms, I have homoscedasticity present in my dataset and no further correction to the OLS is necessary. On the other hand, if the test shows that the error terms are not constant I have heteroskedasticity in my dataset and I need to include clustered robust standard errors into my regression model (Petersen, 2008). The Breusch-Pagan test confirms the presence of heteroskedasticity in my dataset.

Serial Correlation

Another important concern, deriving from using difference-in-differences estimations, is serial correlation of the error terms (Giroud, 2012). Bertrand, Duflo and Mullainathan (2004) list three factors that make serial correlation an especially important issue when using difference-in-differences estimation:

1. It often relies on long time series.
2. Dependent variables most commonly used in difference-in-differences estimation are serial correlated.
3. The treatment variable changes very little within a state over time.

Further Bertrand, Duflo and Mullainathan (2004) emphasizes that these factors reinforce each other. Hence the standard errors of the estimated treatment effect, $\hat{\beta}$, can severely understate its standard deviation and overestimate the test statistics. Clustering standard errors in the regression model addresses any problems with serial correlation.

Robust Standard Errors, Clustering

To produce unbiased estimates I use clustered standard errors. Clustered standard errors account for dependence common in data from panel datasets. In other words, robust standard errors estimated using clustering, is close to the true standard error (Petersen, 2008). Moreover, clustered standard errors are unbiased, as they account for residual dependence created by fixed effects, and they are robust to heteroskedasticity (Petersen, 2008). Clustered standard errors also correct for the presence of serial correlation within the same plant as well as correlation of the error terms across plants in the same area code in any given year and over time (Giroud, 2012).

Clustered standard errors are estimated with a variance-covariance matrix that is consistent in presence of any correlation pattern within areas over time (Bertrand, Duflo, Mullainathan, 2004). Using a generalized White-like formula to compute clustered standard errors, the estimator for the variance-covariance matrix becomes:

3–10

$$W = (V'V)^{-1}\left(\sum_{j=1}^{N} u_j{}'u_j\right)(V'V)^{-1}$$

In which N is the total number of states, V is the matrix of independent variables (year dummies, state dummies and treatment dummy) and u_j is defined for each state to be:

$$u_j = \sum_{t=1}^{T} e_{jt} v_{jt}$$

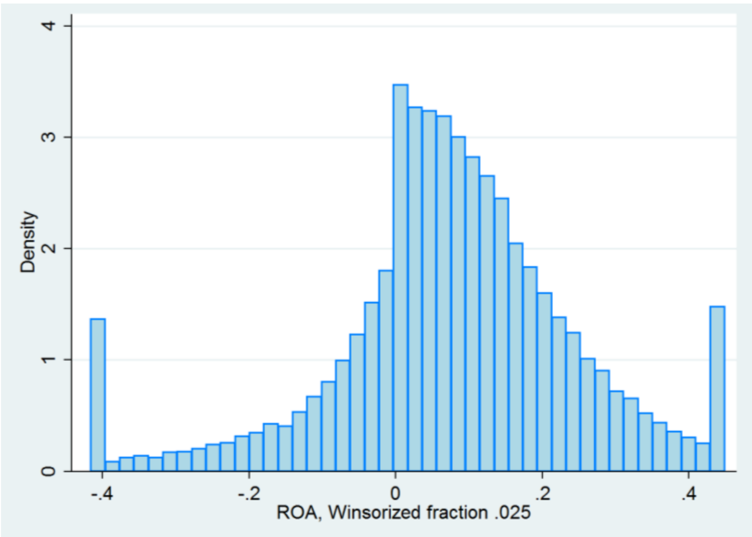
In which e_{jt} is the estimated residual for state i at time t and v_{jt} is a row vector of dependent variable (including the constant) (Bertrand, Duflo, Mullainathan, 2004).

I cluster standard errors at area codes, see appendix 3 for a list of area codes. This account for the presence of heteroskedasticity, serial correlation and any arbitrary correlation of the error terms across plants in the same area code in any given year over time.

3.4.5 Winsorization of Variables

Outliers are often present in a dataset giving the distribution long tails (Tukey, 1962). This is a problem. Instead of removing the outliers from my sample I winsorize them. Winsorizing means replacing the original value of an outlier with the nearest value of a more representative observation (Tukey, 1962). I winsorize my sample at the 2.5th and the 97.5th percentile. This means that values *below* the 2.5th percentile changes to be *at* the 2.5th percentile, and similar for observations *above* the 97.5th percentile.

Figure 3-3: Winsorized ROA, 2003 – 2011.



3.4.6 Regression Model

Combining econometric issues provide me with the following regression model:

$$y_{it} = \beta_1 X_{1,it} + \cdots + \beta_k X_{k,it} + \alpha_i + \delta_t + u_{it} \quad (3\text{–}11)$$

(Stock and Watson, 2003)

Subscript i refers to the observed plant and subscript t refers to the year of observation. The dependent variable is y_{it}, winzorised ROA, and $X_{1,it}$ to $X_{k,it}$ is the explanatory variables, these include dummy variables *After*, *Treatment* and *After x Treatment*. α_i is the firm fixed effects and δ_t is the year fixed effects. Finally, u_{it} is the error term also called the idiosyncratic errors or idiosyncratic disturbances because these change across t as well as across i. (Wooldridge, 2009)

3.5 Criticism of Empirical Method

A concern when using ROA is that it varies across industries and is cyclical. Some industries carry more fixed assets than other industries and this affect the variability in ROA (Selling and Stickney, 1989). I need to industry-adjust ROA to account for this and to compare it across different industries and years. The Norwegian Corporate Account provides me with two sets of industry codes, 2-digit and 5-digit. To industry-adjust ROA I need to include industry year controls into my regression model. Using 2-digit industry codes means including 324 fixed variables into my regression. Alternatively, 2304 fixed variables using the 5-digit industry codes.

$$36\ industry\ codes * 9\ years = 324\ variables$$

$$256\ industry\ codes * 9\ years = 2304\ variables$$

Unfortunately, including industry-adjusted ROA in my analysis is extensive and time-consuming, and beyond the magnitude of this paper. Nevertheless, not using industry-adjusted ROA is a weakness and can bias my result.

An important issue when clustering standard errors is to ensure a sufficiently high number of clusters, because it places no restriction on the correlation structure of the residuals within a cluster. If the number of clusters is limited then the clustered standard errors become less accurate and bias (Petersen, 2008). However, because of the model design and limitations on sample period, I only have twelve defined area codes that I cluster. According to theory is twelve clusters not sufficient. Ideally, it should be above hundred. As comparison, Giroud (2012) has around five hundred clusters. This is a weakness in my method, and consequences can be false significant results as standard errors are likely to be understated.

4 Empirical Analysis

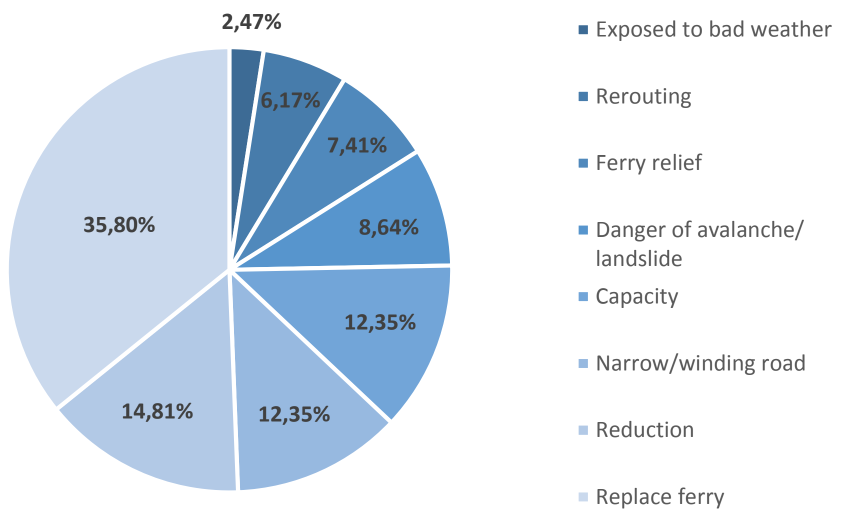
In this section, I present findings from my analysis and look at possible explanations. I introduce my analysis by discussing potential impacts of changes in infrastructure in which I also present an example from the opening of Eiksundtunnelen. After this, I briefly sum up my model before I discuss my findings. Finally, I finish the discussion and interpretation of my main result with a sensitivity analysis.

4.1 Changes in Infrastructure

Reasons for building tunnels and bridges often depend on location. In rural areas changes in infrastructure usually replaces ferries, dangerous stretches and roads exposed to bad weather. In more densely populated areas, new tunnels and bridges enhance capacity, or reroute traffic from already overloaded road networks.

Historically, the majority of large road projects replaces ferries. Other reasons are making the infrastructure more efficient by shortening exiting roads. An example is a tunnel through a mountain or a bridge over a fjord, instead of the long way around. Accordingly, changes in infrastructure of this magnitude have substantial impact on travel time. Whilst other projects, not directly affecting travel time, still matter as they make the road safer and more attractive to drive. Examples include improvement of a road stretches, or reducing the danger of landslide or avalanche. Both reasons can lead to an increase in speed limits, reducing travel time at some extent. Finally, larger cities often suffer from insufficient capacity imposing large queues. Enhancing capacity reduces waiting associated with queues. This does not necessarily reduce travel distance it can however have great impact on travel time.

Figure 4-1: Reasons for building tunnels and bridges, 1992 – 2013.



(Vegdirektoratet, 2014)

Consequently, changes in infrastructure make it more attractive for headquarters to travel more as it becomes easier and less time-consuming. Enhancing the opportunity to monitor more actively and acquire information about plants. According to theory, the effect can be more aligned incentives as headquarters learn more about plants and its daily operations, and plant managers' incentives improve. Making it more attractive for headquarters to allocate resources to treated plants. However, an increase in monitoring can also be destructive. Headquarters can monitor too much, impairing plant managers' incentives to perform. A more serious issue occurs if a firm is financially constraint, and overconfident managers start to overinvest in plants. Instead of creating value, they potentially make the overall firm suffer as other more profitable plants loses resources. However, if information is symmetric and agency problems is absent then a change in infrastructure will not necessarily lead to increased monitoring (Giroud, 2012).

4.1.1 Firms Influence on Road Projects

If a firm has influence on changes in infrastructure, it can bias the effect on profitability from new projects. On the other hand, building tunnels and bridges is time consuming and often proceed over several years making it sensitive to economic fluctuations. Which can result in delays and building stops. This is because of the substantial price of constructing new road projects. Therefore is it unlikely that firms are able to influence much by lobbying.

Occasionally firms partially finance road projects or finance parts of projects to speed up the building process. If firms finance changes in infrastructure then any effect on profitability from new projects are misleading. An example is Ikea building a new warehouse in Bergen. The city council initially denied the project because of already insufficient capacity on E39 and E16 passing the new location. The solution for Ikea became to finance the construction of a new junction on E39 and E16 (Stølås, 2010; Helgheim, Magnus, Svåsand, 2012).

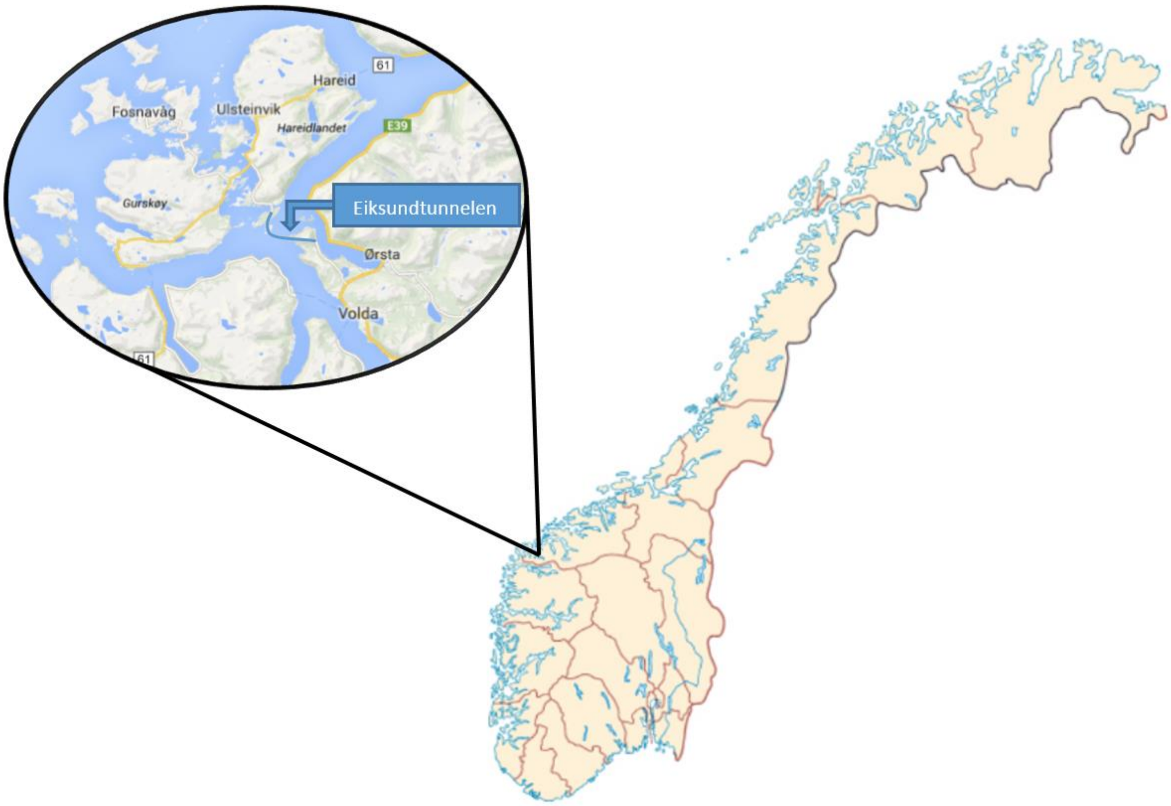
Another explanation on what can influence the building of road projects is increasing population. If a firm expands a plant and provide job opportunities, it can result in migration. Making an improvement in infrastructure more urgent. Having said that, smaller areas are more vulnerable for people moving away, especially young people, leaving a demand in workforce. The construction of road projects becomes an effort to make the village more available, reducing depopulation and attract workers.

The following subsection provides a description of the situation before and after a change in infrastructure in more detail. I utilize Eiksundtunnelen as an illustrating example.

4.1.2 An Example – Eiksundsambandet

When Eiksundtunnelen opened in 2008, it was the deepest undersea tunnel in the world (Statens Vegvesen, 2008) and is the longest tunnel in my sample at 7.8 km. It replaces a ferry servicing the crossing between Eiksund and Rjånes connecting the island municipalities Hareid, Herøy, Sande and Ulstein to the mainland in southern Møre and Romsdal, more specifically to Ørsta and Volda. The construction took five years and when it opened, it reduceing travel time with 30 minutes between the islands and the mainland (Båtevik, Dvergsdal and Krumsvik, 2012; Ulstein et al., 2014). The motivation for building the tunnel was to reduce travel time, an effect of reduced travel distance. Moreover, the expectations for the new mainland connection were positive impact on flexibility in both the labor market and business community (Ulstein et al., 2014).

Figure 4-2: Map of Eiksundtunnelen.



Situation Before Eikesundtunnelen

Before the tunnel opened, travelers depended on ferries servicing the mainland connection. Ferries are generally not a very efficient means of transportation as they follow a fixed time schedule and often have infrequent departures, especially at evenings and nights. Moreover, capacity constriction imposes uncertainty associated with being included on the first departure. During rush hours, at the beginning and end of a workday, this uncertainty is more severe and travelers need to calculate extra time to ensure a place on the preferred ferry departure. Accordingly, depending on a ferry implies waiting in queue both at the pier, and when boarding and leaving the ferry. Before Eiksundtunnelen opened, it took approximately 72 minutes to drive from Fosnavåg to Volda (Båtevik, Dvergsdal and Krumsvik, 2012).

Little flexibility puts constraint on travelers and impede personal and cargo transport for industries. A consequence are that expanding industries in the islands municipalities find it difficult to attract qualified workforce, partly because of the nonexistent mainland connection (Ulstein et al., 2014). Signals from industries to move large future investments away from the Eiksund region became an important factor in the decision to build the mainland connection (Ulstein et al., 2014).

Figure 4-3: Eiksundsambandet – travel route before and after tunnel.

Note to figure 4-3: The dashed line marked (3) represents Eiksundtunnelen. The total red line represents new road built in connection with the tunnel. The entire road is 14.9 km (Statens Vegvesen, 2008).

Description of Situation After

When Eiksundtunnelen opened, the ferry shut down. Several advantages came with the new mainland connection, such as more flexibility, open at night, and no more imposed waiting. After the new road opened the drive from Fosnavåg to Volda is reduced to 45 minutes (Båtevik, Dvergsdal and Krumsvik, 2012), a 30 minutes reduction. Another explanation to travel time reduction can be increased speed limits due to improved roads. However, Ulstein et al. (2014) find that the travel time reduction is solely a result of the construction of Eiksund connection.

The effective travel time reduction for personal transport between the island municipalities and the mainland municipals can be seen in table 4-1. While table 4-2 shows the total travel time reduction for personal transport. See appendix 4 for calculation and assumptions behind total travel time reduction. Furthermore, there are reasons to believe that travel time reduction is less significant for cargo transport due to the steep slope of 9.8 % in Eiksundtunnelen (Store norske leksikon, 2005 – 2007), which is likely to reduce velocity for heavier vehicles.

Table 4-1: Effective travel time reduction, from 2006 to 2011.

		Island municipalities			
		Hareide	Herøy	Sande	Ulstein
Mainland municipals	Volda	-20 min	-19 min	-21 min	-20 min
	Ørsta	-10 min	-10 min	-11 min	-10 min

Note to table 4-1: The effective travel time consist of time driving and time spent on ferry, excluding additional waiting. The reduction in travel time is more extensive to Volda due to larger reduction in travel distance, as travelers no longer need to drive through Ørsta (Ulstein et al., 2014).

Table 4-2: Total travel time reduction, from 2006 to 2011.

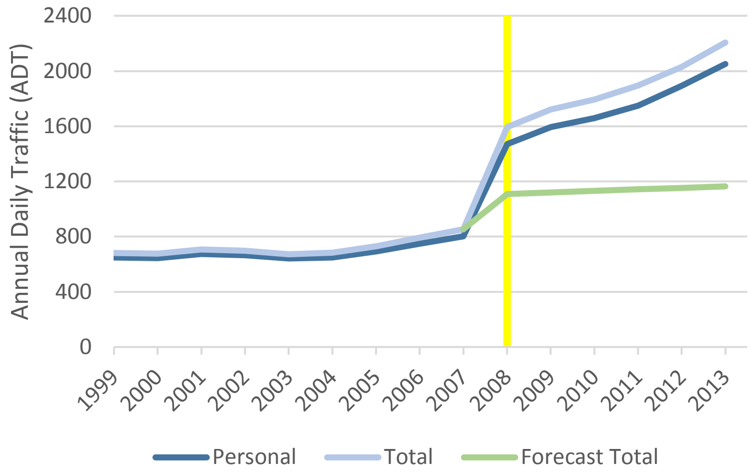
		Island municipalities	
		Shortest departure time	Longest departure time
Mainland municipals	Volda	- 30 min	- 40 min
	Ørsta	- 20 min	- 30 min

Note to table 4-2: Total reduction in travel time including waiting at pier, when boarding, and when leaving the ferry (Ulstein et al., 2014).

Local industries have found it easier to recruit employees after the tunnel opened. The labor market is affected in both size and flexibility. Consequently, industries are more productive (Ulstein et al., 2014).

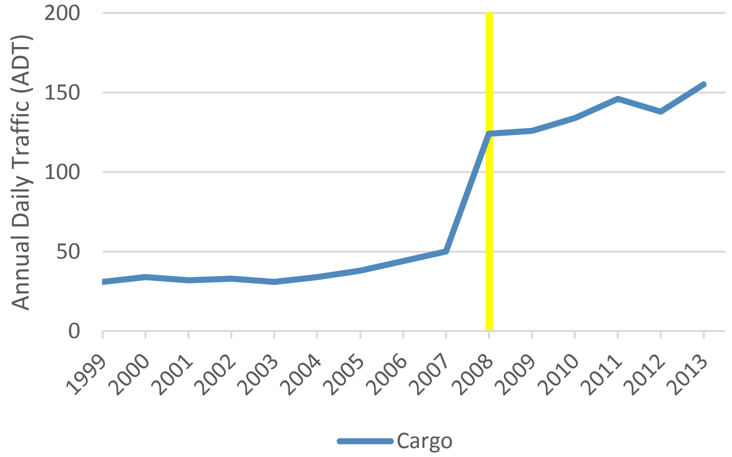
Traffic between the islands and the mainland increased when Eiksundtunnelen opened. Annual daily traffic (ADT) shows a considerable increase after the connection opened in 2008. Statens Vegvesen (2008) forecasted a growth rate in traffic of 30 % the opening year and 1 % thereafter. In reality, ADT almost doubled. Increased personal traffic explains most of the growth. On the other hand, cargo traffic has also increased, but its magnitude is less substantial compared to personal traffic, although the growth is actually higher. The growth in cargo traffic is 148% compared to 83 % growth in personal traffic. However, the large number in cargo traffic after 2008 is likely to be bias as it also includes cars with trailers. The real increase in traffic of heavier vehicles are probably lower. Heavier vehicles faces challenges with the steep slope inside Eiksundtunnelen, making it more attractive to utilize other connections when possible (Ulstein et al., 2014). See appendix 5 for ADT data.

Figure 4-4: Development in ADT data from personal and total traffic – Eiksundtunnelen.



(Statens Vegvesen, 2014; Statens Vegvesen)

Figure 4-5: Development in ADT data from cargo transport – Eiksundtunnelen.



Note to figure 4-5: Cargo after 2008 include all vehicles > 5.6 meter. This include cars with trailers in addition to cargo transport (Statens Vegvesen, 2014; Statens Vegvesen).

4.2 Main Results

In this section, I present the findings of my analysis. First, I explain the model including potential problems. I then move on to the result and provide a discussion of my findings.

4.2.1 Choice of Variables

In my analysis, I investigate how the opening of road projects affect plant-level profitability, and employees. I follow the method used by Giroud (2012), but I use different variables.

Giroud (2012) studied the effect from new airline routes on plant-level production and investments by implementing difference-in-differences estimation. By using difference-in-differences estimation on ROA, I measure the effect of both operating and investments performance. ROA is winsorized to remove extreme outliers not representative to the sample. In addition to ROA, I also study the effect from projects on the number of employees at plant-level.

Fixed Effects

My regression model include both firm- and year-fixed effects to remove potential changes in ROA instigated by the plant or year. It is natural to assume that there exists both firm and year effects on ROA not caused by a plant's properties.

The year-fixed effects explain much of the variation in ROA in the sample period. Hence, removing such effects are important because influence from historical events can contaminate the result. An example is the recent financial crisis. Despite its impact, I chose to remove the year-fixed effects from the following result table to make the table more presentable. The entire result included the year-fixed effects is presented in appendix 6.

Industry Sectors

In my analysis, I include plants within industry groups of primary industry, oil, gas and mining, manufacturing, energy, and construction from the classification SN2007 (Statistisk Sentralbyrå, 2014; European Commission, 2010). As comparison, Giroud (2012) only include manufacturing industry. However, Norway is a small country and to ensure I have enough observations I chose to include a broader specter of industries.

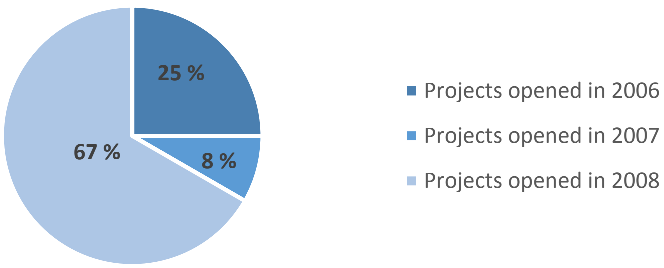
Potential Problems

Two potential problems are the occurrence of heteroskedasticity and serial correlation. Heteroskedasticity means that the error terms is not constant, which leads to underestimated standard errors. If the error terms correlates across time then serial correlation is present, which often is the case with difference-in-differences analysis. I solve both issues by clustering standard errors at area codes.

Time Period

My sample include tunnels and bridges that opened during a three-year period from 2006 to 2008. However, not equally spread out over the years. In fact, most of the tunnels and bridges in my sample opened in 2008. In addition to run the regression on the entire period, I also run it on projects opening in 2008.

Figure 4-6: Opening year of tunnels and bridges.



(Vegdirektoratet, 2014)

4.2.2 Regression Result

The coefficient of interest is *After x Treatment*, it tells the effect from opening a new tunnel or bridge on plant-level ROA, and employees.

Table 4-3: Regression results.

	Tunnels opened in 2006 - 2008		Tunnels opened in 2008	
	ROA	**Employees**	**ROA**	**Employees**
After	0.005	0.081	0.014	6.779
	(0.005)	(0.704)	(0.013)	(4.997)
Treatment	-0.034	0.394	-0.037	-3.924 **
	(0.022)	(2.349)	(0.039)	(1.495)
After x Treatment	0.043	2.513	0.114 **	6.266 ***
	(0.041)	(2.679)	(0.040)	(1.279)
Constant	0.046 ***	28.087 ***	0.085 ***	24.873 ***
	(0.005)	(1.795)	(0.005)	(0.213)
Number of observations	30 131	30 131	19 123	19 123
Number of groups	5 764	5 764	3 739	3 739
Avg. plant-year obs.	5.2	5.2	5.1	5.1
R2 within	0.045	0.005	0.049	0.001
R2 between	0.002	0.000	0.000	0.000
R2 overall	0.027	0.000	0.028	0.000

Robust standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Projects Opening in 2006 - 2008

In the first regression, I include tunnels and bridges opening in 2006 through 2008. Column 1 shows the regression on ROA in this period. I find that changes in infrastructure opening during this period increase profitability with 4.3 %. However, the result is not statistically significant. Meaning that I cannot conclude that this is the effect on ROA from the projects. I also note that none of the other explanatory variables is significant, except the constant.

In column 2, I show the regression on employees. It shows the effect from changes in infrastructure on the number of employees at treated plants. I find an increase in employees of 2.5 persons. However, this result is not statistical significant, hence I cannot conclude that this is the effect from the projects. The same applies for the other explanatory variables except the constant.

Projects Opening in 2008

The third and fourth column in table 4-3 show the effect on ROA and employees, respectively, when I only include changes in infrastructure opening in 2008. From the regression on ROA, I find that newly opened projects increase plant-level profitability with 11.4 %. Moreover, this result is statistically significant. Consequently, I can conclude that this is the effect from opening of road projects.

The last column contains the regression on employees for projects opening in 2008. I find that employees increase with 6.27 persons due to new projects. This result is also statistically significant. Hence, I can conclude that this increase is an effect of project openings.

Later I perform a sensitivity analysis on the effect on ROA using changes in infrastructure opening in 2008. This analysis reveals if the opening of projects in 2008 drives the effect on ROA, or if the effect is from other factors. In the reminder, I base my analysis on results from the regressions containing projects opening in 2008.

4.2.3 Effect on ROA

My findings show a positive effect on plant-level ROA for Norwegian firms from improvements in proximity, due to openings of changes in infrastructure during 2008. This is in analogy with the findings from Giroud (2012) on plant-level data in the United States, and findings from other studies on the effect and advantages of proximity.

Financial theory states that an increase in ROA indicates a firm succeeding in allocating its assets optimally to generate profit. According to theory on agency problems and corporate governance, this implies that improved proximity increases monitoring and information acquiring. Resulting in increased resource allocation from headquarters, and a change in incentives by plant managers as interests align more.

A problem with this explanation of the effect on ROA from road projects, in my model, is that I cannot separate personal transport from transport of goods. Tunnels and bridges are normally built high and wide enough for cargo transport to pass. Accordingly, the effect on plant-level performance can be a result of increased transport of equipment and products to and from plants, instead of increased monitoring from headquarters. Annual daily traffic (ADT) provides information about the development in personal and cargo traffic. However, ADT data on Eiksundtunnelen showed a considerable increase both in personal and cargo transport. Although it can provide an indication on what causes the effect on profitability, it is not sufficient to draw any conclusions. Hence, one need to be careful with explaining the effect on ROA as an outcome of increased in monitoring and information acquiring.

Changes in infrastructure can increase tourism and through traffic after a new road project opens, especially when it replaces a ferry. Increase in tourism and through traffic can lead to increased sales, and increased profitability. However, the industries in my dataset is not sensitive to increases in tourism or through traffic, typical industries that are more likely affected is retail businesses, hotels, restaurants etc. This strengthens the hypothesis that the effect on ROA is from either increased monitoring or cargo transport.

4.2.4 Analysis of Other Factors That Can Affect ROA

A concern in my dataset is that the inclusion of the construction industry, more specifically construction of tunnels and bridges, drive the effect on ROA from opening of road projects. As the entrepreneurs have current costs, they receive consecutive payments. If this drive ROA, I should potentially find a negative effect from the opening of projects as the entrepreneurs income ceases. I find no such effect in my regression result.

I chose areas of postal codes within a reasonable travel time to drive. The option of alternative transport as airplanes, train or boat within the area is not considered. Accordingly, other means of transportation can be preferred. An important assumption in my analysis is that managers choose the travel route that minimizes travel time. If alternative transportations is optimal, then the opening a road project has no influence on incentives to monitor more frequent. Moreover, not utilizing the project should underestimate its effect on ROA.

Changes in local business markets can drive the effect on ROA. A plausible effect of changes in infrastructure, especially in a more remote area with larger distances, is that entrepreneurs and artisans expanding their business market. As it becomes easier to travel, they are able to accept orders in previously unavailable areas. This can result in increased profitability due to newly opened changes in infrastructure. Moreover, local firms can also suffer from increased competition. Subsequently this can reduce the effect on ROA.

Road projects take several years to construct before they are finished and opens. However, sometimes parts of a project open sooner allowing travelers to utilize it. This can lead to an improvement in proximity. If ROA is affected then my findings are understated. Although parts of a new road may open earlier, travelers cannot use the road as intended until the entire project is finished. In addition, early opened parts are often only just passable because of ongoing construction work that for example can impose waiting. Accordingly, I should find no effect on ROA from partially early openings.

4.2.5 Effect on Employees

My findings show a positive effect on plant-level employees for firms in my dataset from changes in infrastructure during 2008.

If a change in infrastructure leads to an increase in employees this can signal increased resource allocation from headquarters. Improved proximity to plants enhance headquarters ability to monitor more, this can potentially reveal a demand for additional workforce. Especially if markets are expanding and the competition increases. Alternatively, investments in new technology or equipment can force companies to hire skilled personnel. Conversely, growth in employees is unlikely to come from increased cargo transport, implying that personal transport causes the effect. This is in analogy with both expanding markets and increased monitoring from headquarters.

4.2.6 Analysis of Other Factors That Can Affect Employees

As with ROA, an increase in employees is improbable to come from construction work regarding the road project. If this is a source to an increase in employees then the effect had been prior to the opening, during the building period, and not after. It is plausible that construction firms hire extra personnel to finish a project, but when finished, the extra personnel is redundant. Especially since contractor contracts often only extend until the project is finished. If construction work have had an effect on ROA, I should find a decrease in employees.

4.2.7 Heterogeneity

A problem in Giroud's (2012) study is exposure to substantial heterogeneity. Findings show a stronger treatment effect when headquarters are more time-constraint, which is consistent with theory of monitoring and information acquiring being time demanding activities. To measure if headquarters are time-constraint Giroud (2012) divide headquarter employees by the number of plants. However, the number of treatments in my dataset are few, making it difficult to divide the group equally into time-constraint and non-time-constraint. Subsequently this calculation is vulnerable to headquarters with a high number of employees. As a result most of the headquarters in my dataset is considered time-constraint. Accordingly, the effect on plant-level ROA is unchanged when I only include plants with time-constraint headquarters.

Another heterogeneity issue is developments in information technology that reduces the need for personal travel to monitor. Giroud (2012) finds a stronger effect from treatment in earlier years when innovations in for example internet and video conferencing were less extensive. As my dataset is narrow, it only includes three years of treatments. Therefore, substantial changes in information technology are unlikely to affect treatment effect differently within these years.

4.3 Placebo Analysis

As a sensitivity analysis, I do a placebo test. This analysis shows the effect on ROA if tunnels and bridges opens in a different year. I use the same method as described under the main analysis. The regression is a difference-in-differences estimation including both firm- and year-fixed effects. I also cluster standard errors at area codes to account for the presence of heteroskedasticity and serial correlation. Further, I only include changes in infrastructure opening in 2008. Each regression only includes two years of data, one year before treatment and one year after treatment.

Table 4-4: Regression results of sensitivity analysis.

	ROA, 2005 - 2006	ROA, 2006 - 2007	ROA, 2007 - 2009	ROA, 2009 - 2010	ROA, 2010 - 2011
After	0.015 ***	0.012 ***	-0.005	0	0
	(0.004)	(0.003)	(0.022)	(omitted)	(omitted)
Treatment	-0.237	-0.114 ***	0.011	0.139 ***	0.088 **
	.	(0.034)	(0.041)	(0.002)	(0.028)
After x Treatment	-0.021 ***	-0.012	0.117 ***	-0.045 **	0.008
	(0.004)	(0.031)	(0.025)	(0.015)	(0.057)
Constant	0.086 ***	0.099 ***	0.043 *	0,033 ***	0.048 ***
	(0.002)	(0.002)	(0.020)	0,001	(0.001)
Number of observations	5 842	6 401	7 109	6 686	6 172
Number of groups	2 996	3 640	3 661	3 624	3 426
Avg. plant-year obs.	1.9	1.8	1.9	1.8	1.8
R2 within	0.007	0.004	0.096	0.002	0.002
R2 between	0.001	0.000	0.003	0.000	0.001
R2 overall	0.002	0.001	0.037	0.000	0.001

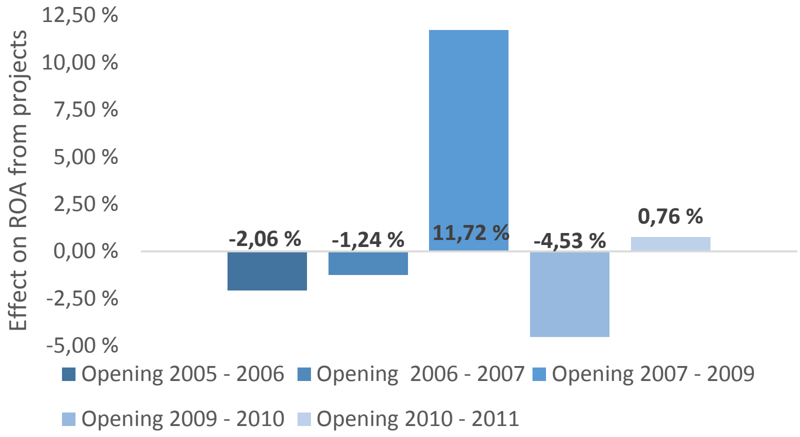
Robust standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Similar to prior regression analysis', the factor of interest is *After x Treatment*, which shows the effect on ROA from road projects. The effect of *After x Treatment* should be close to zero for other years than 2008. Indicating no effect on ROA from the road projects in years before or after the actual opening.

I find that most of the explanatory variables are significant in all regressions. Noteworthy is *After x Treatment* not being statistically significant in column two and five, thus I cannot conclude that the effect on ROA from projects is correct for these years. In addition, other variables are also not significant or omitted. This weakens the reliability of the placebo analysis and its impact on my main result. Nevertheless, the effect on ROA from road projects is significant for most years.

Findings in the main analysis show an increase in ROA of 11.4 % from road projects. If other factors drive this increase, the placebo analysis reveals it. More specifically, I should find that the coefficient *After x Treatment* is large and significant in years prior and posterior to 2008. Additionally, its magnitude should be similar to findings when treatment actually occurs. I find no evidence of such effects, neither prior nor posterior to treatment.

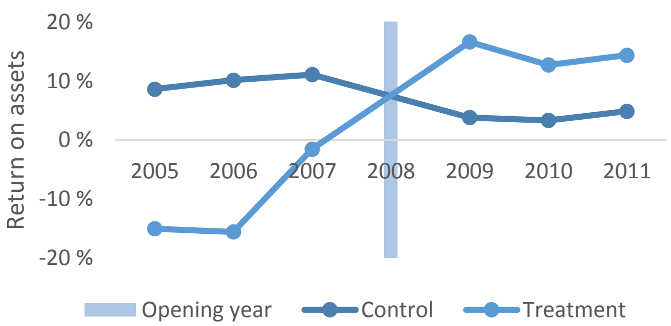
Figure 4-7: Effect on ROA from opening of a new tunnel or bridge.



The absence of effects on ROA prior and posterior to treatment in 2008 suggest that the effect found on ROA in the main analysis is specific to the year 2008, when changes in infrastructure occurred. This indicates that the effect on ROA solely comes from projects and not from other factors such as partially opened projects, the inclusion of construction industry in my dataset, or the expansion of markets and increased competition.

A comparison of ROA in control group and treatment group shows the effect of changes in infrastructure allotted to treated firms. The figure shows that ROA in the control group have been stable both before and after 2008, but has experienced a reduction after road projects opened. Moreover, the treatment group has experienced the opposite. Negative coefficients from *Treatment* prior to 2008 result in negative ROA. However, after the projects open ROA increases and stabilizes. Because of several non-significant coefficients one need to be careful to interpreting the result of this analysis.

Figure 4-8: Placebo analysis - comparison of control group and treatment group.



Note: The graph plots the regression result. ROA is calculated using before numbers for 2005 and after for the remaing years. See appendix 7 for calculations.

I have only done a sensitivity analysis on ROA, because of the missing observations on employees in 2006 and 2007. Employees are estimated for these years, accordingly it is not plausible that a sensitivity analysis provides any additional insights.

4.4 Limitations

Throughout this paper, I have made many assumptions and simplifications. These are potential weaknesses and can affect my result.

A weakness in my analysis is that the design of my model and limitations in the dataset leave me with only a few area codes to cluster. Consequently, the clustered standard errors is likely to be underestimated, which could result in overestimated test statistics and a false significant result. A solution to this problem is to include more road projects into the sample, increasing the number of area codes. Nonetheless, I recognize that more area codes give a more reliable and accurate result.

The identification of suitable area codes comes from reasoning, and constitutes the largest uncertainty in my dataset and model. Accordingly, the established area codes are not the only possible combination of postal codes. They may not even represent optimal areas. This implies that a dissimilar reasoning and other assumptions ends up with other sets of areas made from postal codes. Moreover, it can change the result of the analysis, and potentially find a stronger or a weaker effect on ROA.

Excluding industry-adjusted return on assets is another limitation in this paper. ROA is cyclical and varies a lot across different industries. Including industry-adjusted ROA, remove these effects. I recognize that inclusion of industry-adjusted ROA could improve the quality and accuracy of my results.

Missing observations on employees in 2006 and 2007 instigate a weakness in my regression analysis. A limited sample period forces me to estimate the number of employees for these years in order to do my analysis. This can potentially bias my result and give a wrong effect from changes in infrastructure on employees.

Another problem with my model is that it cannot separate personal traffic from cargo traffic, as I cannot exclude cargo traffic from my analysis. This have implications on the interpretation of my analysis because of uncertainty surrounding the effect on ROA and employees from treatment. On one hand, it can be a result of managers traveling more often and on the other hand a result of increased transport of products and equipment.

4.5 Suggestions for Future Research

My analysis only include nine years of plant-level observations and five industry sectors. A more profound study can be to include more plant-year observations, maybe look at different industries or a broader specter of industries. Another interesting angle can be a similar study on alternative transportation in Norway.

The design of my model cannot separate personal traffic and cargo traffic. Hence, it would be interesting to investigate what actually causes the effect from changes in infrastructure. Whether it is increased personal traffic or because of increased cargo traffic to and from the plant. Alternatively, a combination of both.

If increased plant-level profitability is not an outcome of increased personal traffic, then an idea can be to investigate reasons for increased cargo traffic. It can also be interesting to do research on whether increased personal traffic reflects more frequent monitoring by headquarters, or if it reflects something else, e.g. expanding markets, increased competition.

Finally, I only study the effects of changes in infrastructure on plant-level data. It can therefore be interesting to study how increased plant-level profitability affects the entire firm.

5 Conclusion

In this paper, I investigate the effect of changes in infrastructure on plant-level performance. I examine the profitability measure return on assets and in addition, I study the effect on employees.

Conducting a difference-in-differences analysis with firm- and year-fixed effects, and clustered standard errors, I find the effect on ROA from changes in infrastructure. In the period from 2006 to 2008 I find a positive effect on plant-level ROA and employees, but unfortunately not significant. The same approach indicates a statistically significant effect on plant-level ROA and employees when I only use projects opening in 2008. Specifically, I find that plant-level ROA increase with 11.4 % and employees increase with 6.2 persons due to the changes in infrastructure.

It is difficult to conclude on what drives the effect found on profitability. Since my model cannot separate personal and cargo traffic, it is difficult to exclude transport of goods and equipment as the potential driver. However, there are strong indications implying that the effect come from either increased cargo transport, increased monitoring or expanding markets. This can indicate better allocation of resources as an effect of changes in infrastructure.

Moreover, combining the effect from changes in infrastructure on ROA and on employees indicates that the found effect is more likely a result of increased personal transport, monitoring or expanding business markets, rather than increased cargo transport. Keeping in mind the weakness in computation of the effect on employees, one need to be careful to draw a conclusion based on the combination of the two regression results.

Findings from the placebo analysis indicate no evidence of potential effects on ROA, from other factors than projects opening in 2008, contaminating my regression result. This support my previous findings and conclusion that changes in infrastructure increase plant-level profitability.

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6 Appendix

Appendix 1: Road Projects

Area Code	County	Project	Road	Tunnel/Bridge	Length	Opening Year	Time Reduction	Replaces
1	Møre and Romsdal	Eiksund connection	Fv 653	Eiksundtunnelen	7.8 km	2008	27 min	Ferry free connection to Hareidlandet.
2	Nordland / Troms	LOFAST - Eastern part	E 10	Sørdalstunnelen Raftsundtunnelen Vesterstraumen bru Austerstraumen bru	6.4 km 1.6 km 305 m 196 m	2007	57 - 105 min *	Part of development of Lofotens mainland connection between Gullesfjord-botn og Fiskebøl (eastern and western part).
3	Nordland	Fjøsdaltunnelen	E 10	Fjøsdaltunnelen	1.6 km	2008	2 min	Replaces a road with high danger of landslide/avalanche (Lysvold and Johansen 2008).
4	Møre and Romsdal	Imarsund project	Fv 680	Imarsundbrua	550 m	2006	10 min	Entire project opened in 2007. The project provided a ferry free connection from Tømmervåg to the municipal center Aure and further to Kyrksæterøra/Trondheim.
5	Sogn and Fjordane	Fatlaberget	Rv 55	Fatlatunnelen	2.3 km	2008	1 min	Replaces a road with high danger of landslide/avalanche and road with poor curvature. Little shortening.
6	Sogn and Fjordane	Tuftåstunnelen	E 16	Tuftåstunnelen	2.0 km	2008	5 min	Shortening of E16.
7	Hordaland	Rullestanjuvet	E 134	Rullestadtunnelen	3.0 km	2006	2 min	Replaces road with high danger of landslide/avalanche and narrow/winding road.
8	Hordaland	Halsnøy connection	Fv 544	Halsnøytunnelen	4.1 km	2008	30 - 35 min	Ferry free connection to Halsnøy.
9	Vest - Agder	Listerpakken	E 39	Teistedaltunnelen Vatlandtunnelen	1.9 km 3.2 km	2006	27 min	Part of new road between Lyngdal and Feda. Shortening (Statens Vegvesen, 2014).
10	Vestfold	Tønsberg road project, phase 1	Fv 300	Frodåstunnelen	1.9 km	2008	4 min	Part of circle road north, Tønsberg
11	Akershus	Nøstvettunnelen	E 6	Nøstvettunnelen	3.2 km	2008	8 min	Development of E6 Svinesund – Oslo. Capacity/shortening on E6.
12	Østfold	Sandnessundbrua	E 6	Sandnessundbrua Vest	1.5 km	2008	0 min	New bridge parallel to the old for traffic in southbound direction. Remove queues.

(Ålesund kunnskapspark, 2008; Gjerdåker, Lian and Rønnevik, 2008; Rommetveit and Svendsen, 2008; Google Maps)
* Travel time from Svolvær, includes Lofotens mainland connection - western part which opened in 1998.

Appendix 2: Industry Sectors, SN 2002 & SN 2007

		Norwegian Corporate Account	SN2007 / NACE codes	
Included in my sample	1	Primary industry	A	Agriculture, forestry and fishing
Included in my sample	2	Oil, Gas and mining	B	Mining and quarrying
Included in my sample	3	Manufacturing	C	Manufacturing
Included in my sample	4	Energy, water, sewerage, waste disposal	D E	Electricity, gas, steam and air conditioning supply Water supply, sewerage, waste management and remediation activities
Included in my sample	5	Construction	F	Construction
	6	Wholesale and retail trade	G	Wholesale and retail trade; repair of motor vehicles and motorcycles
	7	Shipping	H: 50	Water transport
	8	Transport and tourism	H I	Transporting and storage Accommodation and food service activities
	9	Communication, IT and media	J	Information and communication
	10	Finance and insurance	K	Financial and insurance activities
	11	Real estate and service	L	Real estate activities
	12	Service	M N	Professional, scientific and technical activities Administrative and support service activities
	13	Research and development	M: 72	Scientific research and development
	14	Public and culture	O P Q R S T	Public administration and defence; compulsory social security Education Human health and social work activities Arts, entertainment and recreation Other services activities Activities of housholds as employers; indifferentiated goods - and services - producing activities of housholds for own use

(Statistisk Sentralbyrå, 2014; European Commission, 2010)

	Norwegian Corporate Account		SN2002 / NACE codes	
Included in my sample	1	Primary industry	A B	Agriculture, hunting and forestry Fishing
	2	Oil and gas	C: 11	Extraction of crude petroleum and natural gas
	3	Manufacturing	C D	Mining and quarrying Manufacturing
	4	Energy and construction	E F	Electricity, gas and water supply Construction
	5	Wholesale and retail trade	G H	Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household good Hotels and restaurants
	6	Shipping	I: 60 I: 61	Transport via pipelines Water transport
	7	Transport and tourism	I	Transport, storage and communication
	8	Finance and insurance	J	Financial intermediation
	9	Real estate and service	K O: 90	Real estate, renting and business activities Sewage and refuse disposal, sanitation and similar activities
	10	Health and social work	N	Health and social work
	11	Culture	O	Other community, social and personal service activities
	12	IT and communication	D: 30 I: 64 K: 71 K: 72	Manufacture of office machinery and computers Post and telecommunications Renting of machinery and equipment without operator and of personal and household goods Computer and related activities
	No observations of in database for relevant years		*L* *M*	*Public administration and defence; compulsory social security* *Education*

(Statistisk Sentralbyrå, 2009; European Commission, 2014)

Appendix 3: Areas of Postal Codes

Area code	Tunnel / Bridge		One side of project	Other side of project
1	Eiksundtunnelen	2008	6060 – 6085, 6090 - 6099	6100 – 6120, 6150 – 6174, 6184 – 6196, 6218,
2	LOFAST – Eastern part	2007	8300 - 8328	8400 – 8412, 8415 – 8439, 8465 – 8591, 9402 - 9498
3	Fjøsdaltunnelen	2008	8001 – 8092, 8390 - 8398	8340 - 8388
4	Imarsundbrua	2006	6501 – 6518, 6530 - 6590	6689 – 6699, 7206
5	Fatlabergtunnelen	2008	6861 – 6863, 6898 – 6899, 6991 - 6995	6858 – 6859, 6851 – 6854, 6866 – 6870, 6872 - 6885
6	Tuftåstunnelen	2008	5700 – 5706, 5710 – 5718, 5741 – 5749, 6855, 6886 – 6887, 6891 - 6896	2900 – 2923, 2939 – 2985, 3550 – 3561, 6888
7	Rullestadtunnelen	2006	5626 – 5629, 5750 - 5788	4250 – 4299, 5501 – 5550, 5555 – 5598
8	Halsnøytunnelen	2008	5401 – 5440, 5445 – 5449, 5454 – 5459, 5484, 5554	5450 – 5453, 5460 – 5472, 5480, 5486 - 5499
9	Teistedaltunnelen and Vatlandtunnelen	2006	4001 – 4099, 4301 – 4333, 4339 – 4438, 4460 – 4465, 4484 - 4485	4501 – 4525, 4532 – 4534, 4575 – 4590, 4604 - 4703
10	Frodeåstunnelen	2008	3125, 3159 – 3161, 3168 - 3173	3113 – 3114, 3118, 3124, 3150 - 3154
11	Nøstvettunnelen	2008	0001 – 0192, 0194 – 1161, 1164 – 1165, 1170 – 1176, 1178, 1181 – 1215, 1263 – 1369, 1394 – 1397, 1404, 1412 – 1413, 1417, 1468 – 1471, 1469, 1473, 1475 – 1476, 1478, 1481 - 1488	1407 – 1409, 1429 – 1449, 1540 – 1556, 1592, 1820 – 1859, 1878 - 1880
12	Sandnessundbrua Vest	2008	1501 – 1539, 1560 – 1591, 1593 – 1599, 1640, 1642, 1661 – 1667, 1701 – 1705, 1707 – 1721, 1723 – 1727, 1816	1657 – 1659, 1738, 1745 - 1796

Appendix 4: Travel Time Reduction in Eiksundtunnelen

Ulstein et al. (2014) define the ferry crossing between Eiksund and Rjånes as urban and assume that most of the traffic is local. Moreover, waiting at pier constitute a quarter of the departure frequency. If the crossing is not considered urban, the estimated waiting increase to half of the departure frequency.

	Shorterst departure time 35 min	**Longest departure interval 75 min**
Estimated waiting time (1/4)	9 min	19 min
Boarding and leaving ferry	2 min	2 min
Effective time reduction (Volda / Ørsta)	20 min / 10 min	20 min / 10 min
Total reduction in travel time	30 min / 20 min	40 min / 30 min

(Ulstein et al., 2014)

This is a considerable reduction in travel time on a relatively short travel distance between the islands, and Ørsta and Volda.

Moreover, scarcity capacity on ferry leads to queues that increases waiting time beyond what account for in these calculations. Ulstein et al. (2014) finds that this often is the case at rush hours on the ferry crossing Eiksund – Rjåneset.

Appendix 5: ADT Data Eiksundtunnelen

Year	Personal	Cargo	Total	Forecast Total
1999	650	31	681	
2000	644	34	678	
2001	674	32	706	
2002	665	33	698	
2003	642	31	673	
2004	650	34	684	
2005	692	38	730	
2006	748	44	792	
2007	803	50	853	853
2008	1471	124	1595	1109
2009	1595	126	1721	1120
2010	1660	134	1794	1131
2011	1749	146	1895	1143
2012	1893	138	2031	1154
2013	2051	155	2206	1165

(Statens Vegvesen 2014; Statens Vegvesen)

Appendix 6: Complete Regression Results

	Tunnels opened in 2006 - 2008		Tunnels opened in 2008	
	ROA	**Employees**	**ROA**	**Employees**
After	0.005	0.081	0.014	6.779
	(0.005)	(0.704)	(0.013)	(4.997)
Treatment	-0.034	0.394	-0.037	-3.924 **
	(0.022)	(2.349)	(0.039)	(1.495)
After x Treatment	0.043	2.513	0.114 **	6.266 ***
	(0.041)	(2.679)	(0.040)	(1.279)
Constant	0.046 ***	28.087 ***	0.085 ***	24.873 ***
	(0.005)	(1.795)	(0.005)	(0.213)
Year 2003	0.012 *	-5.600 *		
	(0.006)	(2.596)		
Year 2004	0.044 ***	-6.337 **		
	(0.009)	(2.765)		
Year 2005	0.042 ***	-4.264	0	0
	(0.006)	(2.407)	(omitted)	(omitted)
Year 2006	0.059 ***	-3.852	0.016 ***	0.014
	(0.005)	(2.159)	(0.004)	(0.076)
Year 2007	0.070 ***	-1.341	0.027 ***	1.833 ***
	(0.004)	(1.492)	(0.003)	(0.379)
Year 2008	0.036 ***	-1.554		
	(0.005)	(1.299)		
Year 2009	-0.004 *	-2.039 **	-0.057 ***	-5.172
	(0.002)	(0.794)	(0.011)	(4.952)
Year 2010	-0.009 ***	-1.470 **	-0.064 ***	-5.172
	(0.041)	(0.655)	(0.010)	(5.130)
Year 2011	0	0	-0.053 ***	-4.287
	(omitted)	(omitted)	(0.005)	(5.128)
Number of observations	30 131	30 131	19 123	19 123
Number of groups	5 764	5 764	3 739	3 739
Avg. plant-year obs.	5.2	5.2	5.1	5.1
R2 within	0.045	0.005	0.049	0.001
R2 between	0.002	0.000	0.000	0.000
R2 overall	0.027	0.000	0.028	0.000

Robust standard errors in parentheses
* p < 0.10, ** p < 0.05, *** p < 0.01

Appendix 7: Sensitivity Analysis - Calculation of ROA

Calcuation of ROA in placebo analysis

		Constant		After		Treatment		After x Treatment		ROA
Control Group	2005	8,61 %							=	8,61 %
	2006	8,61 %	+	1,52 %					=	10,13 %
	2007	9,93 %	+	1,16 %					=	11,09 %
	2008	Opening year of road project								
	2009	4,31 %	+	-0,50 %					=	3,81 %
	2010	3,32 %	+	0,00 %					=	3,32 %
	2011	4,84 %	+	0,00 %					=	4,84 %
Treatment Group	2005	8,61 %			+	-23,67 %			=	-15,05 %
	2006	8,61 %	+	1,52 %	+	-23,67 %	+	-2,06 %	=	-15,60 %
	2007	9,93 %	+	1,16 %	+	-11,42 %	+	-1,24 %	=	-1,57 %
	2008	Opening year of road project								
	2009	4,31 %	+	-0,50 %	+	1,10 %	+	11,72 %	=	16,63 %
	2010	3,32 %	+	0,00 %	+	13,93 %	+	-4,53 %	=	12,72 %
	2011	4,84 %	+	0,00 %	+	8,76 %	+	0,76 %	=	14,36 %