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# Price Matters

*An Empirical Analysis of the Effects of House Prices on Fertility in Norway*

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# Abstract

Since the late 1970s, the fertility rate in Norway has been relatively stable, slightly below replacement level. After a peak in 2009, fertility has declined, and in 2018 it dropped to the lowest level ever recorded. At the same time, house prices have more than doubled since the turn of the millennium. Recent literature has investigated how variation in house prices has contributed to changes in fertility in other countries. Against this backdrop, this thesis aims to answer the question *"Do house prices affect fertility in Norway?"*

We construct a panel data set by obtaining data on fertility, house prices, ownership, and controls at a labour market level from 2003 to 2018. Our main specification is an OLS model regressing current period fertility on house prices and the interaction between house prices and ownership rates, controlling for economic covariates and fixed effects. We extend our analysis by introducing a set of alternative specifications.

We find that for a NOK 1,000 increase in price per square metre, fertility decreases 7.2 per cent, while the effect of the interaction with ownership is a 9 per cent increase. These coefficients are statistically significant individually, and in sum. However, the economic significance at the average ownership level is small, as the net effect is only a 0.2 per cent increase. Our findings are consistent with previous literature finding different effects for owners and non-owners in other countries, but the magnitude of our net effect is smaller. The significance of the main results are robust across most alternative specifications. A heterogeneity analysis reveals that the result seems to be driven by women between the ages of 30 and 49. Our findings imply that changes in house prices might redistribute fertility between groups depending on ownership, but that the net effect on aggregate fertility is small.

## Acknowledgements

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# Abbreviations

| | |
|---|---|
| **APE** | Average Partial Effect |
| **ASFR** | Age Specific Fertility Rate |
| **IV** | Instrumental Variable |
| **NAV** | Norwegian Labour and Welfare Administration |
| **NOK** | Norwegian Kroner |
| **NSD** | Norwegian Centre for Research Data |
| **OLS** | Ordinary Least Squares |
| **SSB** | Statistics Norway |
| **TFR** | Total Fertility Rate |
| **USD** | United States Dollars |
| **WLS** | Weighted Least Squares |

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# 1. Introduction

"Norway needs more children!" said the Prime Minister, Erna Solberg in her 2019 New Year's speech (Solberg, 2019). The statement comes at a time when the Norwegian fertility rate is at a historical low, and far below replacement level fertility. This worries the Prime Minister, as the Norwegian welfare model depends on a large working population to finance social services. These worries have also prompted the Norwegian Ministry of Children and Families to launch an investigation into the low birth rates (Jor & Bulai, 2018).

For much of the 1990s and early 2000s, the Total Fertility Rate (TFR) was relatively stable, slightly below the replacement level of 2.1 (Statistics Norway, 2019d). However, since the most recent peak in 2009, the fertility rate has fallen every year, and in 2018, the TFR was a mere 1.56. The sub-replacement fertility rates in Norway conform to the declines that have been observed in most Western-European countries since the global economic downturn in 2008 (Eurostat, 2019).

At the same time, house prices have risen continually since the early 1990s, with the price growth only slowing briefly during the "Great Recession" of 2008-2009. Consequently, national house prices have doubled since 2005, and multiplied by a factor of six since the early 1990s (Statistics Norway, 2019e). The growth in house prices has been particularly pronounced in the Oslo area, Norway's largest housing market. The ownership rate is above 80 per cent in Norway, so the price growth has had a large impact on the net worth of many Norwegians. On the other hand, Norges Bank is concerned that many people now overextend to get into the housing market, and that a potential crash could threaten financial stability (Norges Bank, 2018). Like the fall in fertility, the increase in house prices has been a focus of the media and politicians alike.

Recent literature has focused on the academic intersection of fertility and house prices; specifically, the effect of house prices on fertility. Lovenheim and Mumford (2013) use US register data and find that an increase in housing wealth is associated with an increased probability of having a child. Related studies support these findings. Dettling and Kearney (2014) use aggregated data to investigate how house prices affect household decisions regarding fertility, by exploiting differences in ownership among demographic subgroups across the US. They find a positive effect for owners and a negative effect for non-owners, resulting in a positive net effect at the US mean home ownership rate. Daysal, Lovenheim and Siersbæk (2019) estimate the effect of housing price changes on fertility in Denmark using registry data for home-owning women aged 20-44. Their estimates are similar to the findings from the US on a per dollar basis of price changes.

Against the backdrop of rising house prices and declining fertility in Norway, along with recent developments in the literature, our research question is *"Do house prices affect fertility in Norway?"*

In order to answer this question, we constructed a panel data set based on aggregated data from Statistics Norway (SSB). Our panel runs from 2003 to 2018 and consists of information on fertility, house prices, and a set of relevant control variables for the 46 labour markets of Norway, as defined by Bhuller (2009). Our main estimation strategy is an OLS model where we regress fertility on house prices, controlling for labour market and year fixed effects, in addition to controls on local economic parameters. We extend our empirical approach by conducting a heterogeneity analysis and Instrumental Variable (IV) estimation.

Our results support the findings in the literature. A decomposition of our main results indicate that the isolated price effect of a NOK 1,000 increase in the square metre price, is a 7.2 per cent decrease in current period fertility. However, this component is dominated by the interaction term between price and ownership, which indicates that a price increase has an additional, positive effect of 9 per cent for owners. Both coefficients and their sum are significant at the 5 per cent level. This leads to a net positive effect of 2.8 per cent at a 100 per cent ownership rate. At the average ownership rate of 82.9 per cent, we find that the net increase in fertility is relatively small, at 0.2 per cent for a NOK 1,000 price increase. The heterogeneity analysis indicates that the significance and magnitude of effects depend on the age demographic. The results from the main model are mostly robust across our alternative specifications.

Fertility decisions and timing have consequences for firms, due to the strong rights associated with parental leave. New parents get a total of either 49 or 59 weeks with full or 80 per cent paid leave. NAV compensates the leave up to roughly NOK 580,000 (NAV, 2019b). It is common that the firm covers the difference if the regular salary exceeds this amount. This means that long, consecutive periods of leave have consequences for firms' strategic planning and staffing. The quality of business processes can deteriorate due to these absences, to such an extent that some firms want to buy key personnel out of the leave (Udland, 2018).

Housing development, and consequently the construction firms, need to adapt to the demographic patterns and trends in Norway. This concerns both the amount and type of new housing constructed. Changing preferences regarding family size has an impact on the optimal mix of construction. Adapting to this change is essential for firms in the construction sector in order to maximise profits and strike the right balance of what they can charge in the market, in relation to construction costs. Low volume of new construction, combined with a pattern of more and smaller-sized households, partly explain the increase in house prices in recent decades (Statistics Norway, 2004).

Throughout this paper, we refer to fertility as if it were a straightforward decision. We do recognise that fertility is a stochastic outcome, and several more or less controllable life aspects play a crucial role. This implies that the latent demand for fertility will not be fully realised. However, the decision is also to a certain extent controllable by sexual activity, fertility treatments, contraception, and abortion.

The rest of this paper is organised as follows. Chapter 2 introduces the historical and institutional background of fertility and housing prices in Norway. Chapter 3 presents the most relevant literature on fertility and house prices. Chapter 4 describes the data set, before Chapter 5 lays out our empirical strategy. The results are presented in Chapter 6, and Chapter 7 contains a discussion of the results, including limitations and suggestions for further research. Finally, the conclusion is found in Chapter 8.

# 2. Background

We start with a description of fertility trends and population growth in Norway since the Second World War, with a particular focus on recent years. Thereafter, a short overview of government policies and benefits relevant for households with children is provided. Then, a brief description of parental leave rights, and maternity care follows. The next part of this chapter concerns housing, and describes recent price developments and the prevalence of owner-occupied housing. Finally, the regulatory environment and consumer preferences in home financing is covered in the last subchapter.

## 2.1. Fertility Trends

The total fertility rate is a widespread measure of fertility, as it is independent of the age structure of the population and is easily understandable. The rate refers to the total number of children that would be born to a woman in her lifetime if she were subject to the prevalent age-specific fertility rates (ASFRs) in the population (World Health Organization, 2019).

The fertility rate in Norway, as in most other European countries, was high during the 19$^{th}$ and early 20$^{th}$ centuries. Right before 1900, the TFR was 4.4, before falling to 1.9 during the economic hardship of the 1930s (Folkehelseinstituttet, 2017). The birth rate increased again after the Second World War, reaching a peak of 2.9 by the end of the 1960s. As we can see in Figure 1, there was another trough in the 1980s where fertility dropped to about 1.7, before it recovered somewhat and mainly stayed between 1.8 and 2.0 from the early 1990s until 2012.

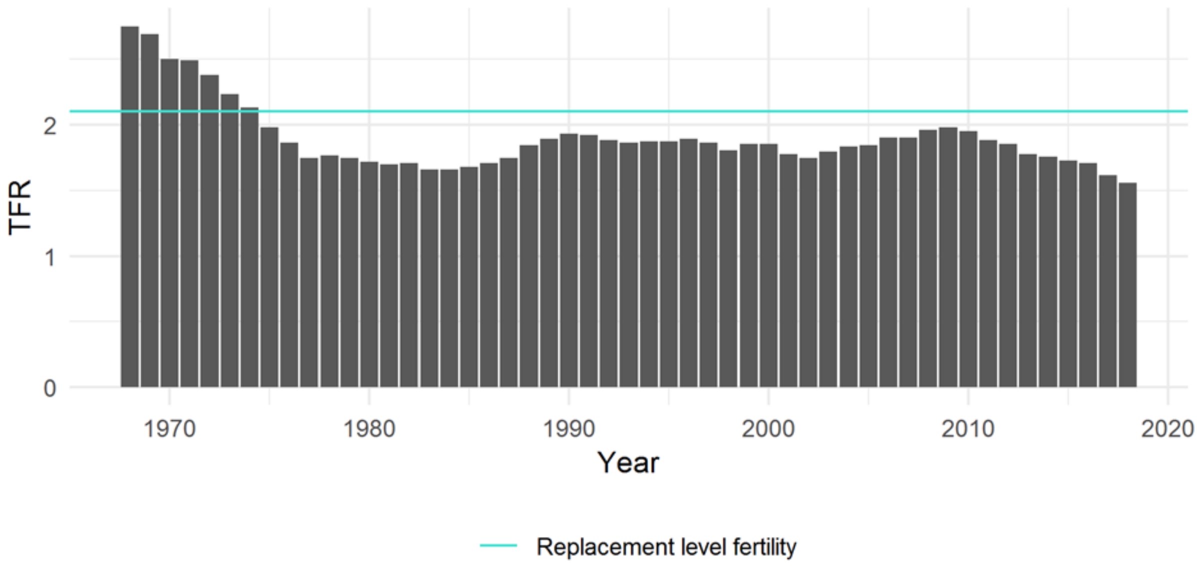
Since 2012, fertility has declined dramatically, especially in 2017 and 2018, when the birth rate dropped to 1.56, the lowest level ever recorded by Statistics Norway. Fertility has now declined every year since the most recent peak of 1.98 in 2009.

Replacement level fertility is the fertility level required to maintain a population at the same level over time (Statistics New Zealand, 2009). [1] This replacement level is often approximated to be 2.1 children per woman, slightly above two because of child mortality and a small majority of male babies.

As we can see in Figure 1, Norway's fertility level has been below replacement level since the mid-1970s. However, during this period there has also been positive net migration to Norway in all but two years. This was particularly high between 2006 and 2016 (Statistics Norway, 2019c). The combination of fertility and migration has led to a continuous increase in the population since the Second World War. A spike in net migration contributed to very high population growth in the ten years from 2005.

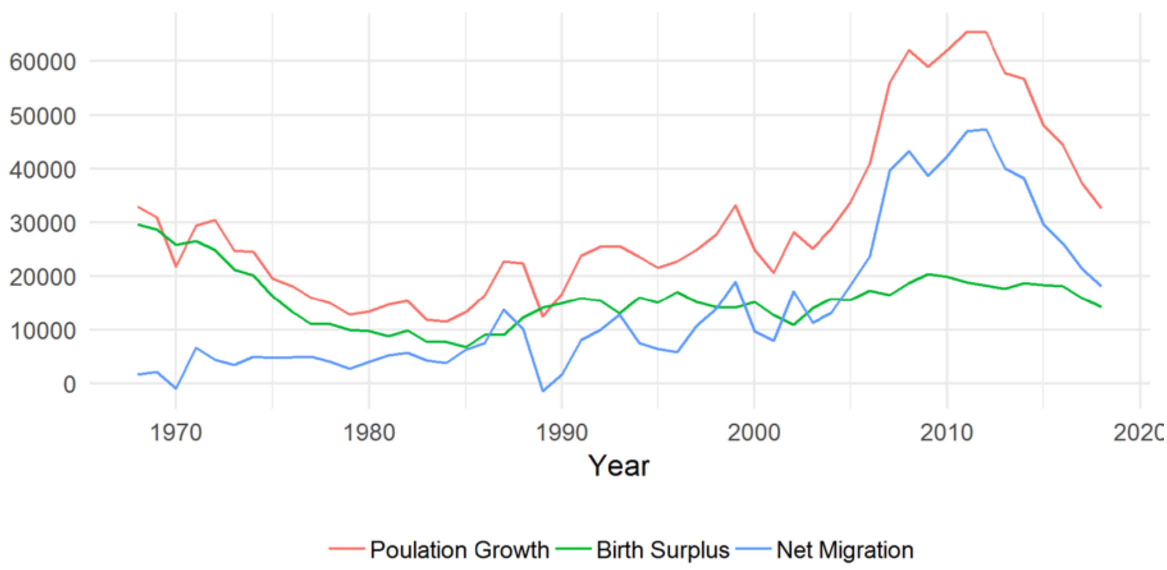
[1] With no migration.

*Figure 1: Total Fertility Rate (Statistics Norway, 2019d)*




Although net migration remains high in a historical perspective, it has been declining since 2012, and in 2018, it was less than half the level from the peak years, see Figure 2. Combined with the birth rate decline, this has resulted in a steep fall in the overall population growth since 2013. If the current trends in immigration and fertility continue, the population growth will stop, and Norway could experience a long-term population decline.

*Figure 2: Population Trends (Statistics Norway, 2019b)*



The prospect of a declining population has recently led to a national debate about the causes and potential consequences of lower fertility. Some, like the Prime Minister, worry that low fertility and population decline will lead to lower economic growth, a higher dependency ratio, [2] and difficulties in financing pensions and the welfare state (NTB, 2019b). On the contrary, others view the low fertility rates as beneficial, pointing to the reduced strain on the environment, and higher standard of living per capita when the population shrinks (Vaaland, 2019). Some also claim that a higher fertility rate would make it more difficult to finance the welfare state, as people are expensive for the state until adulthood (NTB, 2019a).

## 2.2. Government Incentives and Benefits

Norway has an extensive welfare state, and new mothers are entitled to a range of services and benefits. The first universal children's allowance was introduced in 1946, and paid a flat rate per child under 16, except for the first-born child (NAV, 2017). It has since been amended several times and has previously been differentiated based on the child's age, birth order and location. Since 2014, it has been a flat, tax-exempted, and universal payment, made every month to the primary caregiver until the child turns 18. The current rate, valid from March 2019, is NOK 1,054 per child (NAV, 2019a). Parents of children between one and two years old also get cash transfers[3] if the child is not – or only partly – enrolled in kindergarten,[4] up to a maximum of NOK 7,500 per month if the child does not attend at all.

Kindergartens are subsidised, and there is a maximum price per month. From August 2019 the maximum price is NOK 3,040 per month (Kunnskapsdepartementet, 2018). Over 90 per cent of children in Norway between the ages of one and five are enrolled in kindergarten, so the maximum price has a direct impact on the disposable income of most families with small children (Bjørkli, 2018). Children are entitled to 20 hours per week of free kindergarten if the parents' income is below a certain threshold,[5] and a substantial share of children are currently eligible (Utdanningsdirektoratet, 2018).

## 2.3. Parental Leave

Another important benefit for new parents is the right to paid leave. New parents get the option to choose between a total of 49 weeks of paid leave at 100 per cent of their income, or 59 weeks at 80 per cent. Of these, 15 weeks are reserved for each parent, or 19 at 80 per cent (NAV, 2019b). The

[2] The ratio of people under 16 and over 64 to the size of the working age population.
[3] In Norwegian: Kontantstøtte.
[4] We use kindergarten as the translation of the Norwegian «Barnehage». It refers to all pre-school day care and education.
[5] From august 2019, the threshold is a household income of about NOK 550,000.

remaining weeks can be freely allocated between them. Although NAV does not reimburse any income above NOK 580,000, many employers choose to cover the difference if the regular salary exceeds that amount. This means that either the employer or employee incur additional costs related to pregnancies if the salary is above the threshold.

## 2.4. Pregnancy and Maternity Care

Pregnant women in Norway have the right to maternity care at a Health Care Centre,[6] or from their General Practitioner. The prenatal care programme is comprehensive, with regular controls and consultations during and after the pregnancy. The care is free of charge, and women are entitled to paid leave for consultations (Helsenorge, 2017).

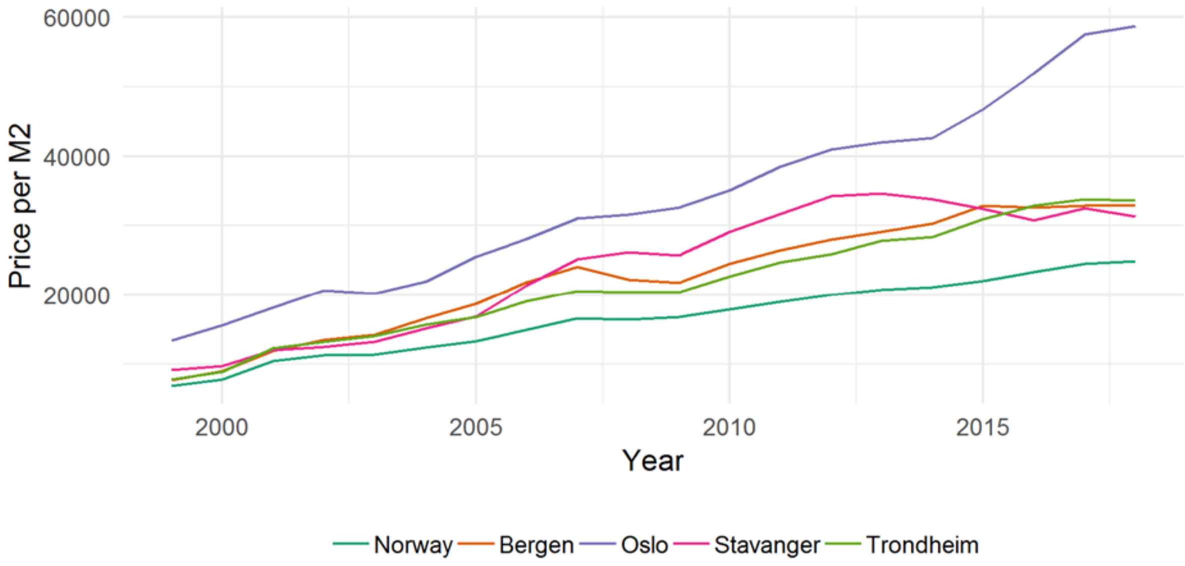
Easy and free access to maternity care is an important difference between Norway and some other countries, notably the United States. While maternity care in Norway is free and uniform for all pregnant women, the situation is more complex in the US, where care is provided based on personal health insurance, or government programmes for low-income individuals. This results in larger variation in both cost and quality of maternity care in the US. Socioeconomic differences also contribute to an unequal use of prenatal care throughout America. Chen, Oster and Heidi (2014) suggest that differences in access to maternity care, both during and after the pregnancy, partly explain why the infant mortality rate is higher in the US compared to other developed countries. The US is ranked 51st internationally, and the rate is roughly twice that of Scandinavian countries.

## 2.5. House Prices in Norway

House prices rose continuously in Norway from the start of the 1990s until 2017, apart from the immediate aftermath of the global financial crisis in 2007-2008. This long increase led to historically high prices in real terms, several times higher than during the last trough in the early 90s. However, falling oil prices in 2015 slowed the activity in the Norwegian economy, and this has affected house prices. Since 2015, prices have grown at a slower rate, and in some parts of the country even declined.

[6] In Norwegian : Helsestasjon.

*Figure 3: Average Price per Square Metre, Used Houses (Statistics Norway, 2019e)*




Although the general patterns in the last paragraph are true for the whole country, there has been some regional variation. In particular, house prices increased quicker in Oslo, and areas of Western Norway with higher exposure to the petroleum industry, between 2008 and 2015. Since then, prices have declined in the Stavanger area, which is considered the “Oil Capital” of Norway. In the surrounding counties, growth has also been close to zero in recent years. Price growth in Oslo has continued to exceed growth in the rest of the country, although prices have stabilised somewhat during the last two years, see Figure 3.

Some industry actors have commented that the restrictions on lending introduced in 2015, combined with enduring high prices, have made it difficult for first time buyers to enter the housing market, especially in Oslo. One illustrative example of this is the “Nurse Index” that indicates that a single nurse (supposedly representative of the lower middle class) could afford to buy 30 and 35 per cent of sold units in Stavanger and Bergen respectively, but only 5 per cent in Oslo (Eiendom Norge, 2018).

Concerns about the high house price growth led the government to introduce a policy in 2015 requiring banks to demand at least 15 per cent equity for new mortgages and capping the debt-to-income[7] ratio at five. According to the government, the policy has worked as intended, reducing the number of very large and potentially risky mortgages, and the upward pressure on prices (Finansdepartementet, 2018). The policy was reviewed in June 2018 and has been extended until the end of 2019. The government further responded by increasing the amount young people can save and receive tax credits for in designated home-savings accounts. This scheme now allows people under 34 to save up

[7] Including student loans.

to NOK 25,000 annually, up to a total of NOK 300,000. These funds are tax-free on the condition that they are used to purchase a home or pay down a mortgage (Skatteetaten, 2019).

One significant difference between Norway and neighbouring countries is the distinctive cultural emphasis on home ownership – some have even claimed that there is a social stigma around renting for people in their mid-30s or older (Iversen & Skorven, 2017). Norwegians' focus on home ownership, and the government's interest in housing developments and incentives, are exemplified in the housing policy which was introduced after the Second World War. 1946 brought the establishment of Husbanken, a state-owned bank dedicated to stimulate construction and purchasing of affordable housing. Another significant initiative came with the foundation of the housing cooperative OBOS in 1929, whose mission is to develop housing for its members. Property development has been immense since the war, resulting in over 1.5 million new units (Valheim, 2014).

The rental market in Norway is neither professionalised nor price regulated. This is different from Sweden and Denmark, where approximately 20 per cent of the housing stock is both price-regulated and has restricted access (Jacobsen, 2013). The non-regulated rental market of Norway has resulted in generally higher prices, and a marketplace mainly controlled by landlords that capitalise on the free market. This creates uncertainty for long-term renters in terms of both stability and price, and makes it more attractive to own ones residence.

## 2.6. Mortgages

Floating rate mortgages are much more common and popular than fixed rate mortgages in Norway. According to the Norwegian Financial Supervisory Authority, 94 per cent of household mortgage debt had floating rates at the end of 2017 (Finanstilsynet, 2018). Of the small percentage of debt that has a fixed interest rate, most are fixed for less than five years, and few banks offer fixed interest rates for more than ten years. This is in stark contrast to the U.S. and many other European countries, where fixed rate mortgages are more popular than floating rate, and fixed rates are available for the duration of the loan (European Mortgage Federation, 2018; Riquier, 2018). The high share of floating interest rates and high levels of debt make Norwegian households sensitive to increased interest rates or economic downturns.

# 3. Literature Review

In this chapter, we present the literature most relevant to our paper. The chapter begins with a description of the literature on the determinants of fertility in general. Next, we focus on the literature on the effects of changing house prices on consumption. We conclude the chapter by describing the effect of house prices on fertility.

## 3.1. The Determinants of Fertility

There exists a large body of economic literature on the nature and determinants of fertility in developed countries. In his seminal paper on determinants of fertility, Becker (1960) introduces children into economic models as durable goods in the utility function of parents. He considers parents to be consumers, who maximise their lifetime utility based on the price of children and the budget constraint they face. The theory is that there are few substitutes for children, who are therefore considered to be normal goods. He further extends his model by including a quality-quantity trade-off component, as parents might prefer to increase the quality per child, rather than bringing up an additional child. By quality, the author means money spent on schooling, extracurricular activities and so on. Becker and Lewis (1973) further elaborate on the theory of the quality-quantity trade-off in their follow-up paper, by specifying a model with the implications of shadow prices of children, with respect to both their number and quality.

Modern research on the economics of fertility has found mixed evidence on Becker's quality-quantity trade-off model. Mogstad and Wiswall (2016) use register data from Statistics Norway and apply unrestricted models in family size using both OLS and IV strategies to test the quality-quantity model. Their results are consistent with Becker and Lewis (1973). In contrast, Angrist, Lavy and Schlosser (2010) find no evidence of a quantity-quality trade-off using exogenous variation in family size by looking at twin births and sibling-sex composition in Israel.

Additional research within the field of determinants of fertility in industrialised countries has focused on other aspects than the quality-quantity trade-off. One research area of interest is the opportunity cost of time. Devaney (1983) uses US time series data from 1947-1977 and finds that increased female wages lead to both depressed fertility and increased labour force participation among women. Cain and Dooley (1976) use 1970 US census data, and their results are in line with Devaney's findings of a negative relationship between female labour participation and fertility.

Although increased female labour force participation in recent decades has coincided with the decline in fertility, newer studies dispute the causal relationship of labour force participation on fertility. Feyrer, Sacerdote and Stern (2008) use labour force participation rates as a crude index of woman's status in the labour market. They note that many of the European countries with the lowest birth rates also have the lowest levels of women's labour force status. By analysing multinational time survey data, they discover a U-shaped relationship between women's labour force participation and fertility. A specific example is an observation that in the United States, women were providing roughly 83 per cent of the childcare in 1975, falling to 62 per cent in 2000. Similar patterns were found in Norway and the United Kingdom, and the share appears to be trending downward in Europe. This fall has a positive association with fertility. The authors note that women's burden of the housework is probably not the causal variable, but rather a marker of how societies view the burden of raising children. Because of the U-shaped relationship, the authors suggest that we should see a modest increase in fertility in the coming decades for the high-income countries studied. We note that this has not been the case for Norway so far.

Matysiak and Vignoli (2007) explore the aspect of female labour participation further, and consider the effect of welfare regimes on women's employment and fertility in a socio-cultural and institutional context. They do this by conducting a meta-analysis based on longitudinal studies on the transition to childbirth and employment entry. The authors notice that the conflict between employment and family is relatively low in social-democratic and socialist welfare regimes. They suggest that the explanations for this are a liberal attitude towards working mothers in social-democratic regimes, and strong institutional support of working mothers in socialist regimes. In the remaining regimes, the conflict between work and family is much stronger, and its magnitude increases when they move from liberal to conservative welfare regimes. They further find that there is an overall significant reduction in the negative impact of women's work on fertility over time, albeit at very diverse rates.

## 3.2. The Effects of House Price Changes

Our paper also relates to the literature on the consequences of changes in house prices. The two aspects most relevant to our thesis are the income and wealth extraction effects of house price growth.

The income effect is often called the wealth effect when the "income" is an appreciation of an asset. The wealth effect of housing may differ from that of other assets due to rules of thumb or framing, as proposed by Shefrin and Thaler (1988). An example of framing is separating different kinds of wealth, such as housing and financial holdings, into "mental accounts," each with different propensities to consume. Case, Quigley, and Shiller (2005) further suggest that difficulties in measuring housing wealth, bequest motives, and tax discrimination might also contribute to a housing wealth effect that differs from other kinds of wealth.

Numerous papers estimate the wealth effect of house prices. For example, Case et al. (2005) estimate the effect of housing wealth on consumer spending using a panel of 14 countries and all US states in various periods in the 1980s and 90s. The effect of housing wealth on consumption was positive and significant across international and US panels and several specifications. Specifically, in the international panel, a 10 per cent increase in housing wealth led to at least a 1.1 per cent increase in consumption. Similarly, Bostic, Gabriel, and Painter (2009) use microdata and find that homeowners increase consumer spending by 0.6 per cent in response to a 10 per cent increase in housing wealth.

The other consequence of rising house prices is the closely related but distinct effect of increased home equity extraction. When prices increase, homeowners are able to extract more of the equity in their homes. Mian and Sufi (2011) estimate that the average American homeowner extracts 25 to 30 per cent of increases in home equity. Further, this extracted equity is not used to pay down credit card debt or reinvested in real estate, and the authors suggest that one explanation is that it is used for consumption or home improvement. Dettling and Kearney (2014) point out that "consumption" in the form of increased fertility is another possible explanation. Bhutta and Keys (2016) find that only 7 per cent of increases in home equity is extracted, and that low interest rates are a much more important factor for equity extraction. They suggest that the very high estimate of Mian and Sufi (2011) could be caused by a general interest rate decline in the period studied in that article. However, similarly to Mian and Sufi (2011), they find that younger owners are more responsive to house price increases. Subsequently, it is possible that the effect of equity extraction is stronger among the homeowners most likely to have children.

The significant and positive wealth and equity extraction effects found in previous analyses have implications for our paper. When considering the effect of house prices on fertility, these findings lead to predictions of increased consumption for homeowners. This could dominate any substitution effect, and the consumption could take the form of increased fertility. Therefore, it is necessary for us to consider not only the negative substitution effect of a house price increase but also the possibility of a positive effect for homeowners. This leads us to consider approaches where the effects of house price changes are heterogeneous in ownership.

## 3.3. The Effects of House Prices on Fertility

Recent research on fertility has recognised that housing is a significant cost associated with having children, and a major store of wealth for home-owning families. A relevant distinction in the literature on the direct effect of housing prices on fertility is whether ownership status is included or not when estimating the effects on fertility. Including ownership enable researchers to look beyond the net effects and distinguish between the effects on renters and homeowners.

The general findings of papers that do not consider ownership status is that aspects that make the housing situation more expensive or uncertain, such as regulations, availability and prices, have a negative net impact on fertility. Yi and Zhang (2010) use annual aggregated-level census data and the house price index from Hong Kong for the period 1971-2005 to estimate the effect of house prices on fertility. They observe that a 1 per cent increase in housing prices is significantly related to a 0.45 per cent decrease in total fertility rates, controlling for female labour participation and wages. They further imply that high house price inflation can account for 65 per cent of the fertility decrease in Hong Kong in the past four decades. The authors conclude the paper by pointing out that the tightened household budget constraint has induced a demographic transition in Hong Kong, and may do the same in mainland China.

Feyrer et al. (2008) on the other hand, find no evidence that neither levels nor changes in housing prices have been a major driver of total fertility, by using housing cost data obtained from the OECD and Integrated Public Use Microdata Series (IPUMS) for the US. They argue that either the endogeneity of house prices and population, or omitted variables like income, make the lack of correlations hard to interpret.

We do consider ownership status to be a relevant measure, as this enables us to isolate the effects on renters and homeowners. Two relatively recent studies from the US and one from Denmark consider this aspect, and are therefore the most relevant for our thesis.

Lovenheim and Mumford (2013) conduct a study that uses wealth changes driven by housing market variation to estimate the effect of family resources on fertility decisions. Using US data from the Panel Study of Income Dynamics (PSID) from the years 1985 to 2007, they show that a USD $100,000 increase in housing wealth among owners causes a 16 to 18 per cent increase in the probability of having a child. They find no evidence of an effect of Metropolitan Statistical Area (MSA)-level housing price growth on the fertility of renters.

Dettling and Kearney (2014) investigate how changes in MSA-level house prices affect household fertility decisions, assuming that children are normal goods. The regression specifications control for both year and MSA-fixed effects. By exploiting differences in ownership rates among groups differentiated by ethnicity and age, they estimate that a USD $10,000 increase leads to a 5 per cent increase in fertility rates among owners and a 2.4 per cent decrease among non-owners.

Daysal, Lovenheim and Siersbæk (2019) estimate the effect of housing price changes on fertility in Denmark. They use population registry data among women aged 20-44 who own a home, and find that each DKK 100,000 increase in home price corresponds to a 2.3 per cent increase in the likelihood of giving birth. The estimates are similar to the findings from the US on a per dollar of home price change basis. This suggest that house prices could have a significant impact on fertility even in countries with generous government programs.

# 4. Data

In order to investigate the effects of housing prices on fertility, we construct a panel data set for 46 Norwegian labour markets, as defined by Bhuller (2009). Our data runs from 2002 to 2018, where fertility runs from 2003 to 2018, and all other variables run from 2002 to 2017. The panel contains information on house prices, ownership rates, median income, unemployment rates, and the fraction of the female population with higher education, in addition to the dependent variable, fertility. All the variables were gathered from Statistics Norway. See Table 1 for an overview of the descriptive statistics of our data.

*Table 1: Descriptive Statistics*

| Statistic | N | Mean | St. Dev. | Min | Pctl (25) | Pctl (75) | Max |
|---|---|---|---|---|---|---|---|
| Income | 736 | 319.819 | 36.813 | 233.741 | 288.013 | 348.056 | 413.713 |
| House Price | 708 | 15.388 | 4.919 | 6.815 | 11.760 | 17.773 | 40.850 |
| Unemployment | 736 | 2.708 | 0.971 | 0.752 | 2.004 | 3.370 | 6.794 |
| Ownership | 736 | 0.829 | 0.023 | 0.780 | 0.813 | 0.844 | 0.879 |
| Higher Education | 736 | 26.039 | 5.370 | 14.019 | 22.067 | 29.573 | 43.638 |
| Fertility | 736 | 0.021 | 0.003 | 0.011 | 0.019 | 0.023 | 0.032 |
| Population | 736 | 105,537 | 221,634 | 17,815 | 28,295 | 86,267 | 1,654,653 |

*Notes: Income is cited in units of thousand NOK. Price is cited in thousand NOK per square metre. Unemployment is cited in percentage. Ownership is cited as a fraction. Higher education is cited as percentage. Fertility rate is cited as crude birth rate. Population is cited in absolute numbers. Source for all variables is Statistics Norway. The geographical detail of all variables is at the labour market level, aggregated using municipal level numbers. Note that 28 observations of house price are missing. The reason is provided in Subchapter 4.2.*

## 4.1. Fertility Data

The dependent variable, fertility, is calculated as the total number of births in a municipality divided by the total number of women living in the municipality at the time. In other words, our measure of fertility is the number of births per woman in a given year. This number is often reported per 1000 women and called the “crude birth rate” (Statistics New Zealand, 2009). It is also equivalent to the measure used in Dettling and Kearney (2014). We use data from Statistics Norway for both the number of live births and the population of each municipality per year.

The birth rate is “crude,” because it does not take into account either the age composition of the population or the changing timing of births within each cohort. The advantage of this measure is that it is easy to interpret and compute without detailed data on demographics at a municipal level. We control for fixed effects between labour markets, so different age compositions and timing decisions should be controlled for in our regression. Furthermore, we use yearly data, and the composition and timing preferences of the population likely change only slowly over time. The heterogeneity analysis is an exception regarding the measure of fertility. It uses age-specific birth rates rather than the crude rate. Data on births by mother’s age are gathered from the Norwegian Centre for Research Data (NSD, 2019).

## 4.2. House Prices

The main independent variable of interest is *House Price*. Data on house prices were collected from Statistics Norway per municipality, and aggregated into labour markets. We chose to use data on price per square metre for detached houses, as this was readily available for most municipalities and easily comparable across different areas. As we control for fixed effects in our main specification, different price levels in labour markets will not affect the coefficient estimates. All prices were adjusted to 2015 Norwegian kroner using the CPI.

Statistics Norway collects prices per building type, and we opted for prices on detached houses, instead of terraced housing or flats. There are several reasons for this choice. Firstly, this is the type of accommodation for which Statistics Norway has the best data, as most municipalities have a substantial number of detached houses. Flats, on the other hand, are rare in smaller and more rural labour markets. Secondly, detached housing is the most relevant for comparing labour markets, because they are common in all labour markets, and half of all Norwegian households live a detached house (Statistics Norway, 2018a). Lastly, this type of housing is highly relevant for individuals who consider having a child, as detached houses are generally larger and more suitable for families. Therefore, prices on detached housing are the most appropriate for our research.

Although the data is more complete for detached houses than for other types of housing, there are some municipalities where there are missing observations. Statistics Norway does not give a specific reason for missing values, but it seems to be closely linked to the municipalities size, most likely due to an insufficient number of transactions in a given year. Reporting seems to have improved around 2005, as missing values are much rarer after that year. House price observations are absent in municipalities containing only a small fraction of the population in the overwhelming majority of the labour markets. However, some labour markets do miss observations for all municipalities in a few years.

There is a total of 28 missing price observations. Nine different labour markets miss at least one observation. These labour markets are generally smaller and more rural than the average labour market. No individual labour market has more than four missing observations. There are only two missing observations after 2005 and none after 2007.

The labour markets with missing observations have a much lower population and income than average, and a slightly lower fertility rate. If the instances of missing values correlate with trends in fertility, it is possible that the omission of these observations will introduce bias into the regression. However, relatively few observations are missing, and the ones that are missing do not seem to be outliers. Therefore, we do not consider the potential bias to be substantial.

There is also a related potential problem of smaller municipalities that lack observations and are located in larger labour markets. Again, if the relationship between fertility and our explanatory variables is systematically different in these municipalities compared to areas with no missing values, it could bias our results. However, as above, we note that this only affects municipalities representing a relatively small share of the population, under 10 per cent. This will likely make any adverse effect on the results limited.

## 4.3. Controls

We include control variables on unemployment, median personal income, percentage of females with higher education and house ownership rates. Unemployment and income are included to control for the economic conditions of an area. For income, we opted for median gross individual income on a municipal level. The gross income refers to an individual's total income before taxes or other deductions. The income could come from an employer or other sources, such as rental income or pensions. Income is adjusted to 2015 kroner using the CPI.

We define higher education as the share of females above the age of 16 with a university level degree. In 2017, the share was 37.2 per cent for women, compared to a share of 29.5 per cent for men. Women have a generally higher level of education in all labour markets (Lorentsen, 2019). For ownership rates, we have included all forms of owner-occupied housing.[8] We use the ownership rates for 2017 in our analysis (Statistics Norway, 2018b). 82.9 per cent is the average ownership in our data set. The exception is the heterogeneity analysis, where 2001 ownership rates are used because data on age

[8] Most properties have freehold ownership ("selveier"), but shares in a housing cooperative ("borettslag") are also common.

specific ownership rates were only available from the 2001 census. The ownership rates are constant within labour markets in all specifications.

## 4.4. Labour Markets

We use the labour market regions suggested by Bhuller (2009). He divides Norway into 46 labour markets based on the fraction of workers commuting between the different municipalities. A minimum population of 17,500 is also imposed for each labour market. This enables some of the less populous areas to be included in a labour market of sufficient size for analysis. Because this is mostly smaller municipalities being included in larger neighbouring labour markets, we do not expect this restriction to have a meaningful impact on the data.

Labour markets were created by combining the observations of all the constituent municipalities, weighted by population. There had only been a few amalgamations of municipalities during the period considered, so obtaining a consistent series of observations was straightforward for most municipalities (Statistics Norway, 2017). Even for the amalgamated municipalities, Statistics Norway has produced consistent series for some variables, such as population and births. However, a few variables had incomplete series because some municipalities disappeared from the data set in the middle of the period, and observations for the new municipality started in the next year. These municipalities were matched manually and aggregated to produce consistent series for all municipalities that existed on 1st January 2019, before further aggregating all municipalities into labour markets. Population in each year was used as weights when creating the labour markets. Observations with missing values were ignored when creating the data set. These observations represented a relatively small share of the population in each labour market, so we do not expect this to have a significant effect on the figures. All but one amalgamation happened within the same labour market.[9]

The labour market aggregation was performed to mitigate the simultaneity problem in women's location and fertility decisions. Because the decision to have a child and the decision of where to live are highly connected, a regression at the municipal level would not give causal results of the effects of more costly housing on fertility. Norwegian municipalities differ in size, but most, especially in more populated parts of the country, are small enough that living and working in two different municipalities is possible and sometimes very common. If prospective parents need to move to a larger home before having a child, they might commonly move to a nearby municipality with less costly housing. This would

[9] The exception was the small municipality Mosvik that merged with the larger Inderøy municipality, in a different labour market. We merged Mosvik with the rest of Inderøy for the whole period.

lead to a strong negative correlation between house price movements and fertility, which needs to be accounted for in order to find causal effects.

The main advantage of aggregating the municipalities into labour markets is that it is much harder for families to move across labour markets in response to diverging house prices. In effect, this reduces the problem of a family responding to house prices by “choosing” a lower price in a neighbouring municipality. Because the labour markets are based on the prevalence of cross-municipality commuting, we can expect that a person would usually need to change jobs to move to a different labour market. It is also far more common in Norway to move within the same municipality, or into other nearby municipalities, than it is to move into municipalities far away (Statistics Norway, 2005). This reduces the possible endogeneity issue between location and family size decisions. However, it does not consider the potential heterogeneity of price developments within a labour market.

## 4.5. Oil Data

For the purpose of extending our analysis with an IV approach, we have gained access to data on oil activity in Norwegian municipalities. This dataset was provided by Menon Economics AS and contains information on the number of employees per municipality for firms in the petroleum extraction and supply sectors. We use this data to create the *oil share*, defined as the share of a labour market population that worked for a company directly related to the oil and gas industry in 2015. This measure is then multiplied by the Brent Crude oil price to provide a measure of exogenous *House Price* variation for each labour market each year. This variable, which we will call *oil intensity*, will be used as an exogenous instrument for *House Price* in the IV analysis.

# 5. Empirical Strategy

This chapter provides an overview of the strategy for estimating causal effects of housing prices on fertility. The main specification regresses fertility on *House Price* and the interaction between *House Price* and *Ownership*, controlling for time and labour market fixed effects, as well as indicators of the local economic conditions. We will start by describing this specification, which we will refer to as the baseline, along with the logic of including fixed effects and other controls. An explanation of why we use clustered standard errors is provided, before two alternative models, a heterogeneity analysis and an IV-specification, are presented.

## 5.1. A Model of Fertility and House Prices

Inspired by Dettling and Kearney (2014), we specify a baseline model of fertility and house prices in the following form:

$$\begin{gathered} Ln(Fertility_{lt}) = \alpha_0 + \beta_1 House\ Price_{lt-1} + \beta_2(House\ Price_{lt-1} * Ownership_l) + \\ \beta_3 Unemployment_{lt-1} + \beta_4 Higher\ Education_{lt-1} + \\ \beta_5 Income_{lt-1} + \gamma_l + \gamma_t + \varepsilon_{lt} \end{gathered} \tag{1}$$

Subscript l (lower case L) denotes the labour markets, while subscript t denotes time. We have lagged the variables by one year as the relevant conditions are at the time of conception, rather than at birth. The coefficients of primary interest are $\beta_1$, which captures the effect of housing prices on fertility, and $\beta_2$, which captures the interaction effect of housing prices and ownership on fertility. In addition to the model in equation (1), we will estimate models without labour market fixed effects $\gamma_l$, and time fixed effects $\gamma_t$ , to investigate how sensitive the model is to specification changes.

The variables *Unemployment* and *Income* are included to control for local economic fluctuations. The underlying assumption is that housing prices are conditionally exogenous to the fertility decision (Lovenheim & Mumford, 2013). For this assumption to hold, the changes in housing prices must be unrelated to unobserved labour market-specific shocks that also correlate with the likelihood of giving birth (Daysal, Lovenheim, & Siersbæk, 2019). A threat to this assumption is that there exists a correlation between housing prices and other economic conditions at a municipal level. Better economic circumstances will lead to higher birth rates, all else equal.[10] On the other hand, unemployment could also lead to lower opportunity cost of time for women, and thus higher fertility.

[10] Assuming that children are normal goods, as discussed in literature chapter.

If fertility responds positively to local economic variation, our housing price measure might be picking up this relationship, rather than identifying the actual effect of the housing prices on fertility. We control for this by including median income and the unemployment rate directly in our model. By including these as controls, we hope to estimate the ceteris paribus effect of house prices by holding income and unemployment constant. This will be successful if fertility is independent of economic conditions, conditional on *Income* and *Unemployment*. The theoretical justification for this relationship is the conditional independence assumption (Angrist & Pischke, 2009). We also control for share of the female population with higher education, as education affects women's opportunity cost of time and other aspects.[11]

## 5.2. Fixed Effects Estimation

We use a fixed effects framework to control for local variation in fertility rates between labour markets, as well as national shocks in fertility rates in a given year. By including labour market fixed effects, we control for all time-invariant unobservables. Examples include different attitudes towards large families or contraceptives, and the quality of kindergartens in a particular labour market. Similarly, by including year fixed effects, we control for time variable shocks that affect all labour markets equally. Relevant examples of such shocks are changes in the size of benefits for new mothers,[12] or a national epidemic that could make it riskier to get pregnant. The 2009 outbreak of the "Swine Flu" virus is an example of the latter, as there was considerable focus on the risk it presented for pregnant women (Fjellheim, 2009).

It is critical for causal interpretation that the specification control for labour market fixed effects, so that the estimated relationship between house prices and fertility is not confounded with unobserved time-invariant differences in preferences across labour markets (Dettling & Kearney, 2014). Specifically, this means that if people with different preferences for fertility sort into different labour markets, based on unobserved, time-invariant characteristics that affect both house prices and fertility, it will lead to *selection bias*. An example of selection bias would be that people with a strong preference for a large family move to less expensive labour markets because they require more space, which is easier to afford there. Another example is if people with a lower preference for fertility also have a stronger preference for living in urban areas.[13] Both these situations would lead to a negative relationship between house prices and fertility, but only because of self-sorting. The estimated

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[11] Assuming that education increase labour market opportunities, related to discussion in literature chapter.
[12] One such change occurred in 2019, with a substantial increase in benefits, although we are not aware of any large changes during the period covered by the data set.
[13] Where house prices are generally higher.

relationship without fixed effects does not represent the causal effect because it is confounded by unobserved preferences.

After controlling for fixed effects, the unobserved characteristics drop out of the regression, as long as they are constant. This means that if selection bias increase or decrease over time, using fixed effects will only limit the problem, not overcome it. However, it is unlikely that selection bias changes substantially over the relatively short space of time covered by our data set, and we have no information to suggest that regional changes in selection bias has occurred. Controlling for fixed effects at the labour market level is also much more robust than controlling at the municipal level, as discussed in the next subchapter.

After controlling for labour market fixed effects, our model explains changes in fertility based on changes in house prices, the interaction between house prices and ownership rates, and control variables within each labour market. If all variables are measured correctly and there are no other time varying omitted variables, the coefficient estimates represent the causal effects of house prices on fertility.

It is significant that we look at changes within each labour market, net of unit-invariant yearly shocks. To identify causal effects, we need convincing “counterfactuals” (Angrist & Pischke, 2015). The true causal effect is defined as the difference between the actual outcome, and the counterfactual: what would have happened in an alternative version of the world? In our case, the counterfactual is what hypothetically would have happened with fertility if there were a different change in house prices than what was observed in reality for a given year. However, as the true counterfactual can never be observed, we rely on an estimate. As our model is specified, we implicitly assume that the conditional changes in house prices and fertility within the same labour market in different years are a good representation of the counterfactual. In other words, we assume that only house prices, fertility, and the control variables change within a labour market over time. As discussed above, these counterfactuals are convincing if the unobserved characteristics of the labour markets remain the same across periods. However, the possible consequences if this assumption is invalid are discussed in Subchapter 7.3 on limitations.

## 5.3. Labour Market Aggregation

As previously discussed, where to live and how many children to have are two decisions that are intrinsically linked. This leads to an endogeneity problem if the empirical specification allows people to choose their house prices, rather than being “treated” by them, to borrow the language of Angrist and Pischke (2015). Such a problem will be more prevalent if the geographic units in the analysis are small, and it is easy to relocate from one to another. Smaller municipalities are much more likely to experience changes in unobserved characteristics over time, simply because only a small change is needed to significantly alter the municipalities' characteristics. For example, a new housing development or transport link could substantially alter the unobserved effects of a small municipality. This prohibits an analysis at the municipal level, because many Norwegian municipalities are relatively small. Therefore, they are merged to form labour markets in our analysis.

The labour markets we use are mainly defined on the basis of cross-municipality commuting (Bhuller, 2009). This means that it is not practical[14] to live in one labour market and work in another. This helps to lessen the selection bias problem already before controlling for fixed effects. Further, larger labour market units are more robust as they are less likely to experience changes to unobserved characteristics over time. Another advantage of using labour markets rather than municipalities is that the aggregated data is much less sensitive to data collection errors and outliers.

## 5.4. Serial Correlation and Clustered Errors

Our panel data set contains repeated observations on labour markets over time. Citizens of the same labour market are to some extent exposed to the same economic conditions, policies, social mentality, and so on. The consequence of this exposure is that observations in nearby periods are of similar value, rather than randomly distributed. It is therefore likely that two observations at different points in time are correlated, and we consequently expect serial correlation. If we ignore the serial correlation and only specify the model with regular standard errors, our statistical conclusions might be misleading, as we exaggerate the precision of our estimates (Angrist & Pischke, 2015). We control for this issue in our analysis by applying clustered standard errors on a labour-market level, which allow for correlated data within the defined clusters (Angrist & Pischke, 2015).

## 5.5. Heterogeneity Analysis

We extend our baseline model by splitting our dataset in two distinct groups defined by age. We do this to investigate if the net effects of changing house prices vary across groups. The demographic group "young" consists of the ages between 20 and 29, while the rest of the dataset is aged between 30 and 49. The extended model is in the following form:

[14] Or at least not common.

$$
\begin{aligned}
Ln\left(Fertility_{ltg}\right) = \alpha_0 &+ \beta_1 House\ Price_{lt-1} + \beta_2 Ownership_{lg} + \beta_3\left(House\ Price_{lt-1} * Ownership_{lg}\right) \\
&+ \beta_4\left(House\ Price_{lt-1} * \delta Young\right) + \beta_5\left(Ownership_{lg} * \delta Young\right) \\
&+ \beta_6\left(House\ Price_{lt-1} * Ownership_{lg} * \delta Young\right) \\
&+ \beta_7 Unemployment_{lt-1} + \beta_8 Higher\ Education_{lt-1} \\
&+ \beta_9 Income_{lt-1} + \beta_{10}\delta Young + \gamma_l + \gamma_t + \varepsilon_{ltg}
\end{aligned} \tag{2}
$$

The new specification introduces group level data on fertility and ownership rates and includes an age group dummy that is interacted with *(House Price * Ownership)* to create a new three-way interaction. *Young* is also included separately and in two-way interactions with *House Price* and *Ownership*. The new dataset ranges from 2002 to 2014, while the ownership rates are 2001-numbers. Table A4 contains summary statistics of the data used in the analysis. Note that subscript *g* denotes group. The dummy variable takes the value of 1 if the age group is defined as “young”, 0 otherwise. The interaction terms containing *Young* represent the difference in estimated effect for the young age group. The essential assumption for the analysis to be meaningful is that the groups have distinguishable characteristics, in our case fertility and ownership rates.

## 5.6. Instrumental Variables

In another extension of our baseline model, we run an IV-estimation to verify that using an exogenous instrument for *House Price* does not fundamentally alter our results from the main specification. IV estimation utilises changes in an endogenous independent variable caused by an exogenous instrument, to find an unbiased estimate of the causal effect of the endogenous variable. We will use the constructed *Oil Intensity* as an instrument for our variable of primary interest, *House Price*. The reasoning is that the oil price provides a positive, exogenous shock to the local economy, which puts an upwards pressure on house prices, independent of effects on income and unemployment. The main reason for applying an IV estimation is that it could be argued that *House Price* is an endogenous variable. This is because the price might be correlated to some omitted variables that are included in the error term. For example, the selection bias discussed in Chapter 5.2 might change over time.

The instrument could be lagged one year, so that a certain year’s *Oil Intensity* is relevant for house prices in the following year. An argument for doing so is if one expects the potential effects of an oil price change to take some time to manifest before society responds with concern to house prices. However, if people take new information on economic conditions into account relatively quickly, then this change is effectively reflected in the house prices within the same year. We will report the results of IV estimations both with and without a lag between the instrument and *House Price*.

An instrument must satisfy three assumptions in order to serve as a suitable instrument: *relevance*, *exclusion* and *independence* (Angrist & Pischke, 2015). An explanation of the IV assumptions is given in Appendix A2. That *Oil Intensity* fulfils the relevance assumption is straightforward to test. We simply regress *House Price* on *Oil Intensity* and the other exogenous variables in our baseline regression, using OLS. The result of this regression, shown in Table A3 in the appendix, verifies that log-transformed oil intensity is a relevant instrument.

It is not possible to formally test whether the other two assumptions are satisfied, so we must rely on careful discussion. Our instrument consists of two components: the oil price and the share of a labour market population that works for a company in the petroleum industry. Therefore, if either component violates an assumption, the instrument will be invalid. In the following paragraphs, we will present what we argue to be the most plausible violations of the independence and exclusion requirements, and discuss why we do not consider the assumptions to be breached.

The independence assumption states that the instrument must be as good as randomly assigned (Angrist & Pischke, 2015). This is assumed to be true for the oil price component, because oil prices are decided on the global market. Global macroeconomic conditions are a potential omitted variable that threatens this assumption. However, the potential channels through which these conditions might affect fertility are controlled for directly by *Income* and *Unemployment*. The petroleum employment share component is assumed to be randomly assigned because the geographic distribution of petroleum sector jobs is mainly decided by distance to the offshore oil fields. Although the exact location of a facility in one labour market or another could be influenced by political or business considerations, the overall distribution is still largely determined by proximity to the oil fields. The independence assumption is therefore considered to be fulfilled, because both components of the instrument are clearly decided outside our model.

For the oil price component, the exclusion assumption could be infringed through a mechanism where the oil price has an effect on fertility through another channel. Two potential channels are financial wealth or career prospects. An increase in oil prices could lead to an increase in financial wealth or better career prospects, which then cause changes in fertility. However, there are a few reasons why we believe that these factors are unlikely to cause problems. Changes in financial wealth should not be an issue because only a small portion of the Norwegian population actually own stocks, and the fertile age groups are underrepresented in this already small group (Oslo Børs, 2019). Furthermore, changes might have to persist for some time before they affect behaviour. Likewise, perceptions about career prospects are likely to update only slowly over time. Therefore, these channels should not violate the exclusion assumption, also considering that we control for current period income and unemployment directly. This leaves house prices as the channel through which oil prices affect fertility.

There are also some channels through which the petroleum industry employment component of the instrument could have an impact on fertility. One potential mechanism is that the oil sector attracts employees that have different fertility rates. The direction of this effect is ambiguous. Oil sector employees could have higher fertility if they are attracted to the industry because its high wages make it easier to fund their underlying preference for large families. On the other hand, working offshore, as many in the industry do, is not very conducive to having children. If either of these hypotheses are true, the exclusion requirement is not fulfilled, because the share of the population in the oil sector could then cause fertility to change. However, it is likely that any such effects are limited. Because oil sector employees constitute a quite small proportion of the population, any difference in fertility would have to be implausibly large to show up in the aggregate. The hypotheses also outline opposing effects, which would make the net effect even less likely to be problematic.

Based on this discussion of the IV requirements, we assume that the necessary assumptions of independence and exclusion are met. However, we also acknowledge that there are some potential mechanism that could violate the assumptions. The exclusion restriction in particular have some potential violations that are not entirely implausible. This is an inherent limitation of the IV analysis.

# 6. Results

This section contains our estimates of the effect of house prices on fertility. It is divided into four parts. The first part presents the main results, containing the estimates of the baseline model, along with specifications without fixed effects. Next, the robustness of our results is challenged. We do this by running the baseline model with Weighted Least Squares (WLS), and a specification with natural logarithm[15] transformed house prices. The third part introduces oil intensity as an instrument for *House Price* to mitigate concerns about omitted variable bias in the relationship between house price and fertility. Finally, we examine possible heterogeneity between age groups by including an age-based dummy.

## 6.1. Main Results

Table 2 shows the main results of this paper. Columns (1) and (2) present the results of two pooled OLS estimations. The former is a naïve specification with no controls, while the latter contains the usual control variables. Column (3) includes both the covariate controls and labour market fixed effects, but no year fixed effects. Columns (1) to (3) are included to check how consistent and robust the results are. Column (4) presents the results of our preferred specification from equation (1). This is the baseline model, which will be compared to other specifications in later subchapters.

[15] Which we will sometimes refer to as ln or log.

*Table 2: Main results*

| | *Dependent variable:* | | | |
|---|---|---|---|---|
| | Ln(Fertility) | | | |
| | Pooled OLS | | Fixed effects | |
| | (1) | (2) | (3) | (4) |
| House Price | -0.032$^{***}$ | -0.070 | -0.031 | -0.072$^{**}$ |
| | (0.011) | (0.090) | (0.046) | (0.033) |
| House Price * Ownership | 0.055$^{***}$ | 0.114 | 0.048 | 0.090$^{**}$ |
| | (0.014) | (0.111) | (0.057) | (0.041) |
| Higher Education | | 0.004 | -0.027$^{***}$ | 0.016$^{**}$ |
| | | (0.006) | (0.002) | (0.007) |
| F-statistic | 61.741$^{***}$ | 4.222$^{**}$ | 2.558 | 4.544$^{**}$ |
| $APE_{\text{House Price}}$ | 0.013$^{***}$ | 0.025$^{***}$ | 0.009$^{***}$ | 0.002 |
| | (0.001) | (0.004) | (0.002) | (0.002) |
| Controls | No | Yes | Yes | Yes |
| Labour Market FE | No | No | Yes | Yes |
| Year FE | No | No | No | Yes |
| No. of labour markets | 46 | 46 | 46 | 46 |
| Observations | 708 | 708 | 708 | 708 |

*Notes:* $^{*}$p<0.1; $^{**}$p<0.05; $^{***}$p<0.01

*F-statistic is of a test with null hypothesis that the sum of House Price and interaction between House Price and Ownership is zero. APE is the Average Partial Effect of House Price at the average ownership rate. Robust standard errors clustered at the labour market level in parenthesis. Control variables include unemployment rate and median income. Ln(Fertility) is the natural logarithm of the fertility rate. House price is NOK 1,000 per square metre for detached houses. Ownership is defined as a share between 0 and 1. Higher education is percentage of the female population a university level degree. The data set covers 16 years, and 28 observations are dropped due to missing price data.*

The preferred model specification in column (4) shows that a NOK 1,000 increase[16] in price per square metre is associated with a 7.2 per cent decline in fertility, in a theoretical labour market where the ownership rate is zero. In a labour market with a 100 per cent ownership rate, the negative effect of *House Price* would be dominated by the positive coefficient on the interaction term, which shows a 9 per cent increase in fertility per NOK 1,000 increase in square metre price. Both coefficients are significant at the 5 per cent level. The coefficients imply that the net effect of an increase in house prices is positive for labour markets with an ownership rate higher than 80.5 per cent. Nine labour markets have a lower ownership rate than this. This means the direction of the net effect varies across labour markets. It is worth noting that the average square metre price in our dataset is NOK 15,400, so that a NOK 1,000 price increase represents a 6.5 per cent change.

The two estimated coefficients of interest in the baseline specification are of similar magnitude in opposite directions. This raises the question of whether they are still significant in sum. We therefore conduct an F-test that the sum of *House Price* and the interaction term equals zero. The F-statistic is displayed in Table 2. The null hypothesis is rejected at the 5 per cent level of significance for our baseline model, and we conclude that the net effect is indeed significant.

Although the coefficients on square metre price and interaction terms are statistically significant, the practical magnitude in a typical labour market is small in the baseline. The national average ownership rate was 82.9 per cent in 2017. In a labour market with this ownership rate, the estimated net effect of a NOK 1,000 increase in square metre price is an increase in fertility of only 0.2 per cent. This net effect of *House Price* at the average ownership rate is also called the *Average Partial Effect* (APE) of house prices, as defined by Wooldridge (2016, p. 179).[17] The APE of each model is included in Table 2, and the APE of the baseline model in column (4) is not significant. The highest observed ownership rate in our dataset is 87.9 per cent, implying a maximum increase in fertility to be 0.66 per cent in response to a NOK 1,000 increase in price. Conversely, at the lowest ownership rate of 78 per cent, the fertility rate would *decrease* 0.23 per cent. The partial effect of the former is significant at the 5 per cent level, providing evidence that house prices have had an effect on fertility at least in some labour markets. For comparison, the annual average decrease in fertility from 2009 to 2018 was 2.24 per cent.

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[16] This is a plausible shift, as a NOK 1,000 change is approximately the standard deviation in the within-labour market variation in our dataset. Calculated using method from Mummolo and Peterson (2018).

[17] APE is calculated by running a regression including the demeaned value of ownership. E.g. for the baseline specification, this involves replacing *Ownership* with (*Ownership* – 0.829) in the interaction term. The coefficient on *House Price* in this regression reflects the partial effect of house prices at an ownership rate of 82.9 per cent. Also sometimes called the average marginal effect.

This means that rising house prices over the past decade have slowed the decline in fertility, but the magnitude is relatively small.

We include alternative specifications in columns (1) to (3) to challenge the validity of our main specification. Dramatically different results might indicate the presence of errors in our modelling design, and cast doubt on whether we actually estimate the effects of interest. The general conclusion is that the signs of the coefficients remain the same throughout the specifications, although there is variation in the significance and size of the coefficients. Model (2) and (4) have coefficients of similar magnitudes, although only significant for the latter. This similarity suggests that the magnitude of our coefficients is robust to including fixed effects. However, a comparison of models (2), (3) and (4) reveals that the size of the coefficients decreases when only including labour market fixed effects, and increase again when including year fixed effects. This might indicate that there are important unobserved differences between both labour markets and years that must be controlled for. Although the coefficients in column (2) and (4) are similar, we note that the standard errors are much higher in the pooled model, resulting in no statistical significance. The result of the baseline model is in line with Dettling and Kearney (2014), although at a smaller magnitude. Further comparisons are provided in the discussion chapter.

Because the primary focus of this paper is the effect of house prices, we generally do not present or interpret the coefficients on the controls. However, among the control variables, we note that the coefficient on *Higher Education* is both significant and positive in our baseline specification. Here, we provide a short discussion of this result as it is unexpected in light of theory and previous studies from the US.

There are some fundamental differences between the US and Norway in regard to education, most notably widespread access to free higher education in Norway. This could lower the bar for taking a university-level degree and not forego other aspects, such as starting a family. A related argument is that higher education serves as a proxy for social status and prospects. It may be assumed that women who hold a degree feel like they are in a better position to start a family, all else equal. As discussed in the literature chapter, the potential negative effects of labour force participation on fertility among working mothers in Norway might be relatively small, due to both strong social and institutional support. The positive significance could also partly be the result of a masked effect. A characteristic of large cities is that the share of women with higher education is generally greater than in other labour markets. A linked characteristic is that these cities, and especially Oslo, also have a greater share of immigrants, who in turn have higher fertility than non-immigrants do (Tønnessen, 2014). This potential underlying relationship might be reflected through the coefficient.

## 6.2. Sensitivity Analysis

This subchapter analyses the sensitivity of the results to alternative specifications and methods. If the results are not robust to these changes, it might signal flaws in our estimated models. First, we amend the baseline by introducing the natural logarithm of house prices instead of the raw value. We then estimate the baseline using Weighted Least Squares, weighting the labour markets by population. This last model is estimated both with and without the populous Oslo labour market, which is suspected to be an outlier.

### Logarithmic Transformation

We run an alternative specification where *House Price* is transformed by the natural logarithm. Because we now have a log-transformed variable both as a dependent and independent variable, the interpretation becomes one of elasticities. The coefficient on *House Price* shows how many per cent fertility changes in response to a one per cent change in house prices. This could be reasonable for our data as there is a general increase in house prices throughout the period in question, so the effect of a given absolute change might be more impactful in the beginning of the period than at the end. Furthermore, this specification reduces the impact of any outliers.

Table A1 in the appendix shows the result of the regression with log-transformed *House Price*. A 1 per cent increase in house prices leads to a 0.97 per cent decrease in fertility in isolation. This is dominated by a 1.22 per cent increase in fertility in a labour market with universal ownership. The APE of *ln(House Price)* is an increase of 0.04 per cent, essentially zero. It is also not significant. In addition to being *economically* insignificant, the sum of the coefficients is only statistically significant at the 10 per cent level in an F-test. Apart from having the expected signs, the logarithmic regression does not provide much evidence of an effect of house prices on fertility.

### Weighted Least Squares

One of the alternative specifications we perform is WLS, using population as weights. Our primary motivation for carrying out this specification is to ascertain whether our main results are driven by developments in sparsely populated labour markets. It could also be argued that observations for larger labour markets are more important and reliable, and thus should be given more weight. Additionally, we want to examine the weighted impact of Oslo, which has had abnormally high price growth in recent years compared to the rest of the country. The irregularity is confirmed by our data, represented by Figure 3 in Chapter 2.5. The Oslo labour market accounts for around 30 per cent of the population in Norway, and we therefore run the WLS without Oslo to check if this substantially alters the estimates.

The results of the WLS regression, presented in Table A2 in the appendix, corresponds to the baseline when it comes to the direction and statistical significance of the variables of interest. Both variables are statistically significant, but the point estimates are somewhat lower than the baseline. Both F-tests are significant at least at the 5 per cent level. The weighted regression without Oslo is not much different, perhaps indicating that the Oslo labour market is not an outlier as expected. A possible reason could be that the effect of the city of Oslo itself is diluted in the labour market defined around it. While the city has seen extreme movement in its housing market during the period in question, it accounts for less than half of the population of the wider labour market called Oslo.

## 6.3. Instrumental Variable Results

As mentioned in Subchapter 5.6, we introduce an instrumental variable estimation strategy to mitigate concerns about endogeneity problems of house prices in our baseline model. We run the first stage test with both one- and two- year lags in relation to fertility.[18] To further investigate the instrument relevance for the endogenous variable, we run specifications both with and without log-transformation of the instrumented variable. The results of the first stage regressions are presented in Table A3 in the appendix. The IV-specification results are displayed in Table 3 below:

[18] Zero or one lag in relation to house price, which itself is lagged one year relative to fertility.

*Table 3: IV regressions*

| | *Dependent variable:* | | | |
|---|---|---|---|---|
| | Ln(Fertility) | | | |
| | (1) | (2) | (3) | (4) |
| House Price | -0.434** | | -0.267** | |
| | (0.176) | | (0.130) | |
| Ln(House Price) | | -6.096** | | -3.795** |
| | | (2.462) | | (1.823) |
| House Price * Ownership | 0.529** | | 0.326** | |
| | (0.213) | | (0.156) | |
| Ln(House Price) * Ownership | | 7.362** | | 4.605** |
| | | (2.953) | | (2.181) |
| F-statistic | 6.624** | 6.601** | 4.882** | 5.039** |
| First Stage | | | | |
| Ln(Oil Intensity) | 2.245*** | 0.087** | 2.683*** | 0.127*** |
| | (0.676) | (0.036) | (0.622) | (0.035) |
| Time FE | ✓ | ✓ | ✓ | ✓ |
| Labour market FE | ✓ | ✓ | ✓ | ✓ |
| No. of instrument lags | 1 lag | 1 lag | 2 lags | 2 lags |
| No. of labour markets | 46 | 46 | 46 | 46 |
| Observations | 708 | 708 | 708 | 708 |
| *Notes:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

*F-statistic is of a test with null hypothesis that the sum of House Price and interaction between House Price and Ownership is zero. Robust standard errors clustered at the labour market level in parenthesis. Control variables include higher education, median income and unemployment in all specifications. All models have a log-transformed instrument specification. Ln(Fertility) is the natural logarithm of the fertility rate. House price is NOK 1,000 per square metre for detached houses. Ownership is defined as a share between 0 and 1. For specification (2) and (4), the House Price has been log-transformed. Log-transformation refers to the natural logarithm. The data set covers 16 years, and 28 observations are dropped due to missing price data.*

The first stage in Table 3 shows the coefficients on the log-transformed instrument in the first stage regressions, with *House Price* or logged *House Price* as the dependent variables. It confirms that the instrument is relevant at least at the five per cent level of significance in all chosen specifications. For model (1) and (3), where *House Price* has not been logged, the interpretation is that for a 10 per cent increase in the oil price, the square metre price increase by NOK 225 and NOK 268. The numbers for the logged models in columns (2) and (4), are 130 and 190 respectively, at the average square metre price of NOK 15,400.

The raw value of *Oil Intensity* was also tried as an instrument, but it was not significant at the first stage, and therefore failed the relevance assumption. This might be because a few labour markets have a considerably larger share of oil related employment than all others, so the values for these dominate the rest of the dataset. A logarithmic transformation better utilises the variation in the rest of the dataset by attenuating the importance of these outliers. As the instrument is relevant, we run the full IV estimation in regressions using the instrument at one and two lags and instrumenting both for the raw value and log-transformation of *House Price*. The results are shown in Table 3. Refer to Subchapter 5.6 for a discussion of the instrument's exogeneity.

The general finding of the IV-estimation is that the results are in line with our baseline specification, in regard to the sign of the coefficients. All of the estimated coefficients are significant at a 5 per cent level of significance. As described in the previous section, all specifications meet the relevance assumption, and the sum of the primary variables are significant according to the F-tests.

For model (1) and (3), which has a *House Price* variable that has not undergone a log-transformation, the size of the coefficients are noticeably large. In fact, the resulting coefficients are so large that the usual approximate percentage change interpretation is no longer valid. For the *House Price* variable, the estimated effect of a NOK 1,000 increase is a 35 per cent decrease in fertility in model (1) and a 23 per cent decrease in model (3). The associated interaction coefficients indicate a 70 and 38 per cent increase, respectively.

For the log-transformed IV estimates in columns (2) and (4), the comparable OLS model is presented in Table A1. The interpretation is again one of elasticities. We see that the relevant estimates for that specification is a 0.9 per cent decrease and 1.2 per cent increase on house price and interaction term, respectively. The equivalent IV models (with one and two lags) estimate a 6.1 (model (2)) and 3.8 (model (4)) per cent decrease for price and a corresponding value of 7.4 and 4.6 per cent increase for the interaction term.

A potentially more relevant approach for comparing the results to the baseline model is to calculate net effects. For models (1) and (3), with one and two lags respectively, the estimated net effects are 22 and 8 per cent. Both of these estimates are much higher than elsewhere, to such an extent that we consider these specifications potentially flawed, and thus do not assign much weight to the results. This could indicate that one of the underlying IV assumptions is violated. For the log-transformed models, the net effects are more in line with previous estimates, at practically zero for model (2) and an increase of 1.8 per cent for model (4).

The concluding remarks of the IV-estimation is that the output justifies scepticism towards whether the instrument exogeneity requirement is met. Subsequently, it indicates that the instrument might be correlated to an omitted variable or have a direct effect on fertility. The resulting effect of such a violation is that the model assigns a causal effect to the noise that then affects the estimate. Consequently, we are careful not to put considerable emphasis on the causal interpretation of these results, especially in the specification with *House Price* in levels. However, to the extent that the IV specification are believable, they support the direction in our main results.

## 6.4. Heterogeneity Analysis

We perform a heterogeneity analysis by obtaining data on fertility and ownership of different age groups. The young group is defined as ages 20-29, while the other group is aged 30-49. Due to the nature of the group analysis, the fertility rate we calculate is age-specific, rather than the more general "crude" rate used in the main analysis. Consequently, we cannot directly compare the size of fertility changes, as a crude change is larger than an age-specific change. While we cannot directly compare the magnitude of the results, this analysis provides new information by examining if the effects are heterogeneous across groups, and whether the direction and statistical significance of the baseline results are robust to different ownership data. See Equation (2) in Subchapter 5.5 for a detailed specification of the model.

*Table 4: Heterogeneity Analysis*

| | *Dependent variable:* |
|---|---|
| | Ln(Fertility) |
| House Price | -0.164** |
| | (0.071) |
| House Price * Ownership | 0.217** |
| | (0.087) |
| House Price * Young | 0.089 |
| | (0.079) |
| House Price * Ownership * Young | -0.124 |
| | (0.097) |
| Non-young $APE_{\text{House Price}}$ | 0.015*** |
| | (0.003) |
| F-statistic non-Young | 11.115*** |
| Young $APE_{\text{House Price}}$† | -0.012 |
| F-statistic Young | 1.504 |
| Labour Market FE | Yes |
| Year FE | Yes |
| No. of labour markets | 46 |
| Observations | 1,140 |
| *Notes:* | *p<0.1; **p<0.05; ***p<0.01 |

*F-test is the significance of the sum of House Price and interaction terms relevant for each group. APE refers to the Average Partial Effect of House Price at the average (group) ownership rate. Robust standard errors clustered at the labour market level in parenthesis. Control variables include higher education, median income and unemployment. Ln(Fertility) is the natural logarithm of the age-specific fertility rate. House price is NOK 1,000 per square metre for detached houses. Ownership is defined as a share between 0 and 1. The data set covers 13 years, and 56 observations are dropped due to missing price data.*

*†: Standard error not calculated because Young APE is the sum of four coefficients. See F-test for significance.*

Table 4 shows the results of the heterogeneity analysis. The coefficients on the “base” *House Price* and *House Price * Ownership* terms are significant in the expected directions, supporting our findings in the main analysis. The coefficients are much larger than in the baseline specification, but we stress that we cannot directly compare the magnitude to the baseline results because we necessarily use different measures of fertility. These coefficients represent the estimated effects of house prices on fertility for the part of the data set that are not in the young group.

The interaction terms containing *Young* represent the difference in estimated effect for the young age group. In other words, the estimated effect in the young group is the sum of all terms shown in Table 4. For example, the interpretation of *House Price* * *Young* is that is an increase in price is 9 per cent *less negative* for the young group in isolation. This gives an interesting result: the fertility rate in the young group reacts less to changes in house prices than the older group, at the same ownership rates. However, it is important to note that the ownership rates in the young group are always smaller than the older group, so the last clause of the previous sentence is not realistic. Table 4 also shows the calculated APE for young and old age groups at their respective average ownership rates of 67.5 and 82.3 per cent. The APE for the over-30 group is a 1.5 per cent increase in fertility in response to a NOK 1,000 house price increase, significant at the 1 per cent level, while the young group has a negative APE.

Furthermore, F-tests verify that the sum of *House Price* and *House Price * Ownership* is significant. This supports the results from the baseline analysis in the non-young group. However, the null hypothesis of an F-test that the sum of all four displayed coefficients net out to zero cannot be rejected. This indicates that fertility in the young group might not be affected by house prices at all. An F-test of the net effect of *House Price * Young* and *House Price * Ownership * Young* being zero, was rejected at the 10 per cent level of significance. This also provides some evidence of differences between the groups. Altogether, the heterogeneity analysis implies that the main results are driven by the older age group.

## 6.5. Concluding Remarks on Results

This chapter has presented our estimates of the effect house prices have on fertility. In the baseline specification, we find that fertility declines 7.2 per cent in a labour market as house prices increase by NOK 1,000 per square metre. However, this isolated effect is dominated by the interaction of prices and ownership rates, which is estimated to be a 9 per cent increase in fertility in a labour market with universal ownership. Both of these effects are significant at the 5 per cent level. The APE is positive but small, and an F-test confirms that the variables of interests are in sum significantly different from zero.

We then presented a series of alternative specifications and estimation strategies in order to check the robustness of the results from the baseline specification. Both WLS and the IV-estimation supported the significant effect of house prices on fertility, although there was some doubt about the validity of the instrument. The heterogeneity analysis revealed that fertility of the group aged 30-49 years was significantly affected by price increases, while fertility of the 20-29 age group was not. The only alternative specification that did not find significant effects at the 5 per cent level was the log-estimation. We found evidence of the expected significant effect of house prices on fertility in the baseline specification, and most of our alternative specifications support this finding. Hence, we conclude that house prices do seem to have a causal effect on fertility, and that the net effect is positive for a representative labour market.

# 7. Discussion

We start this chapter by discussing and elaborating on some interesting aspects of our results. Next, we comment on limitations concerning the data and analysis. Based on these limitations, we provide suggestions for further research, before focusing on the implications of our study.

## 7.1. Discussion of Results

### Demographics

Data on the Norwegian real estate market show that square metre prices have increased by almost 120 per cent between 2003 and 2018 (Statistics Norway, 2019e). During the same period, the crude fertility rate has fallen by 10.4 per cent (Statistics Norway, 2019d). Our main specification estimates a positive net effect of 0.2 per cent in a labour market with an average ownership rate, for a NOK 1,000 increase in the square metre price. An implication of this is that the isolated effect of square metre prices has increased fertility by 1.4 per cent in total, for a representative labour market over the years from 2003 to 2018.[19] Therefore, it has slightly reduced the overall decline. As discussed in the results chapter, the estimated net effect is sensitive to the average homeownership rate of the labour markets.

House prices have increased faster than the real wages in recent times, and a continuation of this trend could lower the ownership rate (Wig, 2016). However, it is reasonable to assume that in a long-term perspective, there must be a balance between house prices (and subsequently rents) and the real wage. The average age of first-time buyers has been stable for the past 8 years, and flats are overrepresented among first-time buyers, partly due to the price level of these abodes (NEF; Ambita, 2018). These two factors suggest that people are still able to enter the relevant[20] housing market in economic hotspots such as Oslo, but potentially do so in smaller houses or flats. This could induce a partial demographic transition, as the reality of smaller living conditions has the consequence that people adapt and might only have one child, despite preferring more, for a given utility function. This is, to some extent, what has been observed in Hong Kong, according to Yi and Zhang (2010). This could indicate that the preference for central housing dominates the preference for more children, and induces a local transition to higher quality per child rather than additional children.

[19] The average increase in square metre price is NOK 7,000 across labour markets for the years 2002-2017.
[20] Assuming that people put a major emphasis on living centrally and close to relevant work and other city amenities.

## Aggregated Data and Individual Level Implications

We are careful to point out that our analysis is performed at the labour market level. This means that we must be cautious about making claims regarding causality at the individual level. To be clear, our finding is that fertility increases more in response to house price increases in labour markets with higher ownership rates. This is consistent with the hypothesis of a positive effect for owners and a negative effect for non-owners. Further, like us, Dettling and Kearney (2014) use aggregated data and find that a larger positive effect on fertility is tied to higher rates of home ownership. They also conduct a simple analysis at the individual level, which indicates that their findings are transferrable to individual data. Other papers from Denmark and the US also find similar results at the individual level (Daysal, Lovenheim, & Siersbæk, 2019; Lovenheim & Mumford, 2013). In the following paragraphs, we will discuss some of the possible implications at the individual level, with the caveat that further research is needed to properly establish that this link to the individual level also holds in Norway.

As discussed in the literature review, our thesis relates to the literature on the implications of increasing house prices. We presented papers, which found that increased house prices lead to increased consumption. Our findings are consistent with a positive income effect of housing, as it leads to increased "consumption" in the form of additional children. Distinguishing between an income and a wealth extraction effect is beyond the scope of this paper, but our findings indicate that the sum of these two effects is positive.

Another related topic of interest is whether children are normal goods. Becker (1960) assumed that children were normal goods, using a quantity-quality trade-off to explain the seemingly negative cross-sectional relationship between income and fertility. Blake (1968) was an early critic of this assumption, and the direction of the income effect of children has been the subject of debate since then. As Lovenheim and Mumford (2013) point out, owners' responses to a house price increase are a very good test of the income effect. This is because a house price increase is an exogenous change in owners' wealth, while avoiding the inherent endogeneity between preferences for children and income that is present in most forms of income. Because our results indicate that owners do increase fertility when they are made richer by a house price increase, this paper supports the assumption that children are normal goods.

The negative impact that rising house prices seem to have on fertility among non-owners also suggest that there is a negative substitution effect of house prices on fertility. This is in line with expectations, because housing is a major cost associated with having children. As house prices, and thereby the cost of having children rise, people substitute to other forms of consumption. This substitution can take the form of increasing the quality of children, rather than the quantity, or other, entirely unrelated consumption.

## Alternative Mechanisms

Although our results are consistent with previous papers, which find different effects for owners and non-owners, and we consider this the most likely cause of our findings, a discussion of alternative mechanisms is warranted.

We obtain a positive coefficient on the interaction between ownership rates and house prices. It could be the case that a high ownership rate is rather a proxy for certain labour market characteristics, such as a more established and close-knit community, or higher levels of financial wealth. The interaction between a price increase and ownership might then represent the differential effect of price increases across communities with a stronger "community feeling," or wealth. It is possible that high-ownership communities respond to higher house prices by improving the quality of the local amenities and services in a way that raises fertility for everyone, regardless of ownership. Indeed, it is also possible that house prices themselves increase because of local investments that make it more attractive to have children in a certain area. These investments may also be more likely to take place in high-ownership locations. Any such mechanisms that increase fertility among owners and non-owners alike in areas with higher ownership will invalidate the conclusions from the discussion above. While we still view different effects across ownership to be the most likely explanation, factors such as the ones outlined in this paragraph, cannot be disregarded. This is why we stress the need for restraint when interpreting at an individual level.

## Heterogeneity Across Age Groups

It is interesting that the heterogeneity analysis finds that an increase in prices is significant for the older group, but not the younger. On one hand, the younger group has traditionally been more fertile, and thus we would expect a more prominent effect on this group. On the other hand, the younger group also own homes at much lower rates, so they have less opportunity for being affected by a price change. This also implies that the older group is more affected by the price increase, as they have a higher rate of ownership. At first glance, the increasing fertility of homeowners and the decreasing fertility of non-owners in response to increasing house prices, present a plausible explanation of why the average age of first time mothers has increased from 27.9 in 2003 to 29.5 in 2018 (Statistics Norway, 2019a). However, this explanation is not supported by our heterogeneity analysis. We find that the younger group is not significantly affected by house prices, while the older group is. Rising house prices can thus not explain the decrease in fertility among younger people, although they might have contributed to the increase observed in the older groups. This could indicate that younger parents have different preferences and are not as concerned with owning a home prior to having children.

### Timing of Fertility Versus Completed Lifetime Fertility

It is important to stress that what we are estimating with our static model is the impact on the *timing* of fertility, and not *completed lifetime fertility*. Changes in prices and income over the life cycle might affect the timing of fertility demand, but not necessarily cause the completed lifetime fertility to change. The impact on lifetime fertility is an aspect we are not able to estimate, given our data and modelling. Dynamic life cycle models, on the other hand, make explicit the assumption of margins over which parents might choose to substitute their fertility, specifically, childbearing at different ages over the life cycle. A model in a life cycle context is better equipped to consider the consequences of the stochastic nature of human reproduction (Hotz, Klerman, & Willis, 1997). However, such a model is outside the scope of this thesis.

## 7.2. Data Limitations

We do not have access to individual-level data, meaning that we cannot control for individual characteristics such as marital status and financial wealth. These, and other individual factors, will obviously have a great impact on fertility decisions, and not controlling for them could cause omitted variable bias. Further, even at the aggregated level, there are other potentially important factors that we have not controlled for. Examples include female labour force participation and kindergarten access. These could also lead to omitted variable bias if they are correlated with both house prices and fertility.

Most of our data are official statistics obtained directly from Statistics Norway. However, two of our variables are less reliable than the rest. In addition to the previously discussed question of the exogeneity of the oil instrument, there is also some measurement error. The instrument is constructed using the share of people in a labour market employed in the petroleum industry, and the oil price. The share of people in the petroleum industry is based on which municipality each company is registered in. This is where the headquarter is located, but there is often substantial activity in other labour markets too. The data we obtained corrects for this by allocating some of the employees in each company to the subsidiaries' municipalities. However, this correction might be imperfect and there is more uncertainty around this variable as it is not based on official statistics.

The second variable that might be less reliable is *House Price*. Statistics on prices are prone to missing observations for smaller municipalities, and even for some medium-sized municipalities in the earlier years of the data set. This leads to 28 missing observations even after aggregating to labour markets.

Other observations are based on data for only one or a few municipalities in certain years, potentially missing a significant part of the labour market. Data are disproportionally missing from rural municipalities, and house price growth in rural areas has lagged behind since 2002 (Statistics Norway, 2019e). Therefore, the observed price growth in our data could be too large, and our estimates of the effect on fertility could be biased.

Further, the house prices we use reflect changes in prices for detached houses only. In the short term, there could be discrepancies between price growth in houses and flats, and the prices of flats could be a more relevant measure in some labour markets, especially for first-time buyers. We attempted to estimate a model using prices on flats instead, but unfortunately, the data was not of sufficient quality for the estimates to be reliable. Compared to 28 missing observations for detached houses, the number of missing observations for flats was 137, and a further 240 observations were based on only one municipality. A manual inspection of the data suggests that this happens because there are too few transactions involving flats in most municipalities.

Our measure of fertility also has some drawbacks. The main part of our analysis uses the crude fertility rate, which is imprecise, as it could be influenced by changing demographics. If the number of births in a labour market declines due to a sizable change in the proportion of its female inhabitants that are of fertile age, crude fertility will change, even if the total fertility rate remains constant. Thus, we could, to some degree, actually be measuring the correlation between house prices and age composition changes. However, we think the extent of this problem is limited. First, year fixed effects control for any national changes in demography. Furthermore, our data only cover 16 years, and substantial demographic changes are unlikely to occur during such a relatively short period. Finally, the results are supported by our heterogeneity analysis in Subchapter 6.4, which uses age-group fertility. This measure is more robust to demographic changes.

## 7.3. Analysis Limitations

As discussed in Chapter 5, a key assumption is that unobserved labour market characteristics remain constant over time. This will allow them to be controlled for by the labour market fixed effects. However, if the unobserved characteristics are time-variant, they will not be controlled for and could potentially confound the regressions. For example, the share of young children having access to, and attending kindergarten, rose remarkably during the period covered by our data. If increased kindergarten access and quality have contributed to increased fertility, it could cause bias if the degree of service improvement is correlated with house prices. In general, if unobservables change systematically over time, the changes between different years in the same labour markets will no longer be good counterfactuals to each other, and the results could be biased.

Ideally, we would like to match all births with economic conditions exactly nine months earlier, but we have instead used economic variables in the previous year to explain fertility. This approximation is necessary as we only have access to yearly data for most of our variables, crucially including fertility. Because it takes around nine months to complete a pregnancy, the relevant economic conditions will be in the previous year for births occurring before October. This means that any large changes in fertility occurring in October through December could create noise in our estimates. However, more than 75 per cent of births in Norway occurred before October in every year covered by the data set. This means that even if the fertility decision were made no longer than nine months before birth, the overwhelming majority of decisions would still be taken in the previous year as we have assumed.

## 7.4. Further Research

We do not have access to registry data. Consequently, we cannot estimate causal effects on an individual level. Our findings are estimated on a labour market level, and as a result, we cannot say anything certain about individual outcomes, but have to assume that our findings must be true for a certain number of individuals on an aggregated level. Investigating the causal effects based on registry data would increase our knowledge of individual effects, and further contribute to the international literature.

An implication of having access to registry data is that it would possibly allow us to test the quality-quantity trade-off for a house-related wealth increase. When the house prices increase, home-owning parents may prefer to use this increase in wealth to increase quality per child, rather than have additional children. A potential quality effect is something we are not able to estimate. Subsequently, we cannot capture the full range of effects that the real estate market might have on childbearing and rearing decisions.

Furthermore, our data do not allow us to differentiate between first-time and higher order births. Parents who consider having a second or third child might be more or less price and income sensitive regarding the fertility decision, and thus have different responses to a price or wealth shock. Being able to estimate the different levels of impact would contribute to the understanding of the underlying nature and dynamics of the effects in a Norwegian context.

Another interesting aspect is how house prices affect the demand for children and completed lifetime fertility, rather than fertility timing. If individuals wait for an extensive period before entering the real estate market and having their first child, this could have an effect on lifetime fertility. Women's fertile period is often roughly recognised to be between 15 and 50, but the chances of becoming pregnant decrease significantly after the age of 35 (Nesheim, 2017). Answering this question would provide deeper insight into the longer-term consequences regarding fertility, and examine whether the effects found in this paper reflect changes in timing only, or if they also cause lasting changes in completed fertility.

## 7.5. Implications

Our paper contributes to the growing literature in recent years on the effects of house prices on fertility. It is to our knowledge also the first to estimate such effects in a Norwegian context. It is somewhat difficult to compare the results directly to other papers within the field, due to dissimilarities in house price variation, different variable definition and the characteristics of aggregated data versus microdata. However, as we are estimating the same underlying dynamics, we proceed with a comparison, keeping the uncertainty in mind. If we standardise our numbers for the sake of comparison, we find that a USD $10,000 increase in house prices is associated with a 0.9 per cent increase in fertility for owners.[21] Dettling and Kearney (2014) estimate that a USD $10,000 increase leads to a 5 per cent increase in fertility rates among homeowners, and a 2.4 per cent decrease for non-owners. Another US study by Lovenheim and Mumford (2013) estimate a positive effect of 1.78 per cent for the same increase, while they find no significant effect on renters. Daysal, Lovenheim, and Siersbæk (2019) estimate this is in a Scandinavian context, and find that a USD $10,000 increase in house prices indicates a 1.55 per cent increase in fertility using Danish register data.

The nature of our data and model makes it more relevant to calculate representative net effects, as this better reflects reality. Our model estimates a positive net effect of 0.1 per cent[22] at the average ownership rate, compared to Dettling and Kearney's 0.8 per cent for a USD $10,000 increase. If our model is specified correctly, a reason for the difference is that there exists a systematic difference in the strength of the relationship between house price and fertility. This systematic difference is potentially related to unobservable social and institutional factors. These may include access to financing, regulations, and housing preferences concerning the fertility decision. A related aspect is the relatively large difference in mean home ownership rates in the datasets,[23] which could affect the net effects estimation. We also note that the group-structure on ethnicity of Dettling and Kearney's data could contribute to the different magnitudes. Our results further confirm the findings of Daysal,

[21] Assuming a theoretical labour market with a 100 per cent ownership rate, an exchange rate of NOK 8 per USD, and a 160 square metre average house, a NOK 500 increase $M^2$ price is then the equivalent, 0.5 (0.090-0.072) = 0.009.

[22] Estimate of the effect of an NOK 80,000 increase on fertility in Norway. Based on a back-of-envelope calculation assuming an exchange rate of NOK 8 per USD and a 160 square metre average house, at the average Norwegian ownership rate.

[23] 0.44 in Dettling and Kearney, compared to 0.829 in our dataset.

Lovenheim, and Siersbæk (2019), that the housing market also has an effect on fertility even for countries with strong welfare systems.

Overall, our findings indicate that the relatively steep house price increase over the past two decades has only had a minor effect on fertility. This implies that if the Norwegian Government has an overall goal of increasing fertility, it can largely ignore house prices, other motives for controlling the house prices notwithstanding. However, our results suggest that there are important effects in opposite directions between owners and non-owners. This might also contribute to effects on the geographic distribution of fertility.

# 8. Conclusion

This paper has investigated the effects of house prices on current period fertility, using a panel data set of Norwegian data aggregated to the labour market level. The question we aimed to answer was *"Do house prices affect fertility in Norway?"*

In order to investigate the relationship in question, we used an OLS model controlling for economic covariates and fixed effects as our main specification. This specification utilises the assumption that most important differences between labour markets will remain constant over time, and can therefore be controlled for by the labour market fixed effects. In addition to this, we employed an IV estimation and several alternative specifications to test the robustness of our results. We also conducted a heterogeneity analysis to establish whether house prices affect fertility differently for women between the ages of 20 and 29, and those between 30 and 49.

Our results suggest that house prices have a significant effect on current period fertility. We find a 7.2 per cent negative effect on fertility for a NOK 1,000 square metre price increase, while the interaction between ownership and house prices has a 9 per cent positive effect. The coefficients are significant at the 5 per cent level both individually, and in sum. However, the economic significance of the aggregate net effect is small, as a labour market with the average ownership rate experience a 0.2 per cent increase. Our findings are consistent with a positive effect on owners' fertility and a negative effect on non-owners'. The findings were robust to alternative specifications using a WLS model and an IV-approach, although there was some doubt regarding the robustness of our instrument. A log-log specification only found weakly significant effects. The heterogeneity analysis reveals that the results seem to be driven by the older group. We did not find a significant effect for the younger age group.

The background for examining this topic is that house prices are at a high level, while fertility has dropped to its lowest level ever. Our findings, although statistically significant, suggest that the overall effects of house prices is practically small. Therefore, we do not find evidence that boosting house building or other schemes aimed at reducing price growth will have a positive effect on fertility. However, our findings imply that there are large differences in the effects at the individual level, between owners and non-owners. Therefore, further price growth, or a potential policy intervention might redistribute the fertility between groups, depending on their ownership rates. Although different effects on owners and non-owners is the most likely explanation of our results, further research using individual level data is needed to properly establish this relationship.

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# 10. Appendices

## A1 Tables

*Table A1: Log-log model*

| | *Dependent variable:* |
|---|---|
| | Ln(Fertility) |
| Ln(House Price) | -0.971 |
| | (0.674) |
| Ln(House Price) * Ownership | 1.221 |
| | (0.813) |
| F-statistic | 2.993* |
| $APE_{Ln(House\ Price)}$ | 0.040 |
| | (0.032) |
| Controls | Yes |
| Labour Market FE | Yes |
| Year FE | Yes |
| No. of labour markets | 46 |
| Observations | 708 |
| *Notes:* | $^{*}$p<0.1; $^{**}$p<0.05; $^{***}$p<0.01 |

*F-statistic is of a test with null hypothesis that the sum of House Price and interaction between House Price and Ownership is zero. APE refers to the Average Partial Effect of House Price at the average ownership rate. Robust standard errors clustered at the labour market level in parenthesis. Controls include higher education, median income and unemployment. Ln(Fertility) is the natural logarithm of the age-specific fertility rate. House price is NOK 1,000 per square metre for detached houses. Ownership is defined as a share between 0 and 1. Log-transformation refers to the natural logarithm. The data set covers 16 years, and 28 observations are dropped due to missing price data.*

*Table A2: WLS estimation*

| | *Dependent variable:* | |
|---|---|---|
| | Ln(Fertility) | |
| | Population weights | Weighted, no Oslo |
| | (1) | (2) |
| House Price | -0.049*** | -0.044** |
| | (0.018) | (0.018) |
| House Price * Ownership | 0.060*** | 0.057** |
| | (0.022) | (0.023) |
| F-statistic | 4.346** | 6.008** |
| $APE_{House\ Price}$ | 0.001 | 0.003* |
| | (0.001) | (0.002) |
| Labour Market FE | Yes | Yes |
| Year FE | Yes | Yes |
| Controls | Yes | Yes |
| No. of labour markets | 46 | 45 |
| Observations | 708 | 692 |
| *Notes:* | | *p<0.1; **p<0.05; ***p<0.01 |

*F-statistic is of a test with null hypothesis that the sum of House Price and interaction between House Price and Ownership is zero. APE refers to the Average Partial Effect of House Price at the average ownership rate. Robust standard errors clustered at the labour market level in parenthesis. Control variables include higher education, median income and unemployment. Ln(Fertility) is the natural logarithm of the age-specific fertility rate. House price is NOK 1,000 per square metre for detached houses. Ownership is defined as a share between 0 and 1. The data set covers 16 years, and 28 observations are dropped due to missing price data.*

*Table A3: First Stage Regressions*

| | *Dependent variable:* | | | |
|---|---|---|---|---|
| | House Price | Ln(House Price) | House Price | Ln(House Price) |
| | (1) | (2) | (3) | (4) |
| Unemployment | -0.436*** | -0.026*** | -0.495*** | -0.028*** |
| | (0.131) | (0.007) | (0.136) | (0.007) |
| Higher Education | 1.360*** | 0.028*** | 1.326*** | 0.026**** |
| | (0.333) | (0.010) | (0.330) | (0.010) |
| Income | 0.026 | 0.004*** | 0.023 | 0.004*** |
| | (0.053) | (0.001) | (0.053) | (0.001) |
| Ln(Oil Intensity) | 2.245*** | 0.087** | 2.683*** | 0.127*** |
| | (0.676) | (0.036) | (0.622) | (0.035) |
| Observations | 708 | 708 | 708 | 708 |

*Note:* *p<0.1; **p<0.05; ***p<0.01

*First stage of the IV specification in Subchapter 6.3. Ln(Oil Intensity) is the instrument, and House Price or Ln(House Price) are the instrumented variables. Robust standard errors clustered at the labour market level in parenthesis.*

*Table A4: Heterogeneity Analysis Summary Statistics*

| Statistic | N | Mean | St. Dev. | Min | Pctl(25) | Pctl(75) | Max |
|---|---|---|---|---|---|---|---|
| Total Fertility | 1,140 | 0.070 | 0.033 | 0.025 | 0.038 | 0.101 | 0.152 |
| Young Fertility | 570 | 0.101 | 0.016 | 0.060 | 0.090 | 0.110 | 0.152 |
| Old Fertility | 570 | 0.039 | 0.006 | 0.025 | 0.035 | 0.043 | 0.058 |
| Total Ownership | 1,140 | 0.749 | 0.082 | 0.561 | 0.683 | 0.824 | 0.873 |
| Young Ownership | 570 | 0.675 | 0.042 | 0.561 | 0.657 | 0.703 | 0.761 |
| Old Ownership | 570 | 0.823 | 0.030 | 0.734 | 0.808 | 0.847 | 0.873 |
| Income | 1,140 | 313.595 | 34.795 | 233.741 | 282.556 | 339.785 | 413.713 |
| Price | 1,140 | 14.795 | 4.608 | 6.815 | 11.375 | 16.861 | 33.349 |
| Unemployment | 1,140 | 2.774 | 0.974 | 0.752 | 2.039 | 3.440 | 6.481 |
| Higher Education | 1,140 | 24.958 | 4.751 | 14.019 | 21.562 | 28.028 | 40.454 |

*Notes: Income is cited in units of thousand NOK. Price is cited in thousand NOK per square metre. Unemployment is cited in percentage. Ownership is cited as a fraction, and young and old refers to group specific fractions. Higher education is cited as percentage. Young and old fertility rates are age specific, and cited as group level births over group population. Total fertility refers to the fertility considered in sum. Group specific birth rates are calculated based on data from Norwegian Centre for Research Data. The rest of the variables are from Statistics Norway. The geographical detail of all variables is at the labour market level, aggregated using municipal level numbers.*

## A2 Instrumental Variable Assumptions

Instrumental variables (IV) estimation is a way to obtain causal effects, even in the presence of omitted variable bias, or simultaneity between the dependent and at least one independent explanatory variable. To illustrate the approach, consider a simple regression model (Wooldrigde, 2016, p. 463):

$$y = \beta_0 + \beta_1 x + \varepsilon \tag{A1}$$

The instrumental variables estimation involves replacing the endogenous variable $x$, by a observable proxy variable $z$, which need to satisfy two assumptions in order to obtain consistent estimators of $\beta_0$ and $\beta_1$:

1. Instrument exogeneity : $z$ is uncorrelated with $\varepsilon$ , $Cov(z, \varepsilon) = 0$
2. Instrument relevance : $z$ is correlated with $x$ , $Cov(z, x) \neq 0$

The instrument exogeneity assumption can be summarised as $z$ being exogenous in equation A1. This assumption is often divided into two sub-assumptions (Angrist & Pischke, 2015). The first, *independence,* implies that that $z$ is as good as randomly assigned, in the sense of being unrelated to omitted variables, and thus unrelated to the error term. The second, *exclusion*, requires that the instrument only have an effect on the dependent variable though the instrumented endogenous variable, and thus no direct effect on $y$.

The instrument relevance assumption dictates that $z$ has to be correlated, either positively or negatively, to the endogenous variable. This means that the instrument is required to have explanatory power for the endogenous variable after conditioning on all the remaining exogenous variables. This is referred to as instrument relevance.

The relevance assumption can be tested, while we need to rely on economic reasoning and theory for the exogeneity assumption. The easiest way to test for relevance is to estimate a simple regression between the endogenous variable and the instrument (Wooldrigde, 2016). This regression is called the first stage in a Two Stage Least Squares context:

$$x = \pi_0 + \pi_1 z + v \tag{A2}$$

Then, because $\pi_1 = Cov(z,u)/Var(z)$, assumption 1 holds if, and only if $\pi_1 \neq 0$. As a result, it must be possible to reject the null hypothesis $H_0: \pi_1 = 0$ against the two-sided alternative $H_0: \pi_1 \neq 0$.

All assumptions must be met in order for $z$ to serve as a good instrument for $x$ and to obtain unbiased estimators. We refer to Wooldridge (2016) for a comprehensive review of the IV estimator.