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# The more the merrier? Evidence on quality of life and population size using historical mines

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ABSTRACT

I investigate the relationship between population size and quality of life. The quantity and quality of consumer amenities will increase with urban scale if they are not offset by congestion effects. To deal with endogenous urban scale, I utilize a quasi-experimental design where I exploit the spatial distribution of mineral resources using Norwegian mines from the 12th to the 19th centuries. The findings suggest that cities become more attractive as a consequence of higher population size.



## 1. Introduction

In this study I seek to determine if higher population makes cities more attractive. There are several reasons why this might be the case. A populous area would be able to support more cultural services like museums, sports arenas, and concert halls. Cities are shown to provide a larger number and variety of cafes and restaurants that are valued by consumers (Couture, 2014; Schiff, 2014). Urban shopping opportunities are perceived to be better (Carlsen and Leknes, 2014), and the greater potential for social interaction in agglomerations might even be an amenity in itself. Nonetheless, the overall effect of population size is uncertain since the positive traits of urban environments might be offset by disamenities like crime, traffic, pollution, and other congestion effects.

The literature on this topic is rather scarce although the consumption advantages in cities are important for urban policies (Glaeser et al., 2001). I utilize a spatial equilibrium Rosen-Roback model to back out the willingness to pay for locations as a measure of the quality of life. Rappaport (2008) collects such quality of life measures from several U.S. studies and correlates them with population density; he finds mixed results. Albouy (2012) improves the equilibrium approach by taking into account other costs of living except for housing and local taxes. He finds a weakly positive association between the quality of life and urban scale. A related study from Norway that utilizes Albouy's approach and also controls for worker heterogeneity displays a positive association between the population size and the quality of life (Carlsen and Leknes, 2014).

It is challenging to identify how the quality of life varies with the population size since people want to live in places that are nice to start with (Mueser and Graves, 1995; Carlino and Saiz, 2008; Jeanty et al., 2010). A concern is that thick market benefits are conflated with natural advantage. Therefore, to investigate the robustness of the urban quality of life premium, I control for observable natural characteristics and use instrumental variable estimation. I instrument the regional population size by the number of mines that operated in Norway in the 12th to the 19th centuries. As far as I know, this is the first study to use such an approach to estimate the urban quality of life premiums.[1,2]

There are three reasons why historical mines might be feasible as an instrument. First, mining can be classified as the first industry in Norway and the discovery of mining resources led to economic activity and thereby population growth. A process of path dependence sparked by early industrialization ensures that mining regions still display relatively high population sizes today. Second, mineral and metal reservoirs

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[1] Boualam (2014) investigates how cultural production affects productivity and housing prices. He uses federal grants to instrument cultural employment.

[2] Geological features have been used in other applications to instrument the distribution of population by Combes et al. (2010) and Rosenthal and Strange (2008), and historical mines have been exploited in Glaeser et al. (2015) to explain the degree of innovation.

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are distributed independently of human behavior. Third, all of the registered mines were exhausted before the present amenity outcomes were observed. The mining industry has gone from being one of the largest national industries in the 18th century to being of marginal importance today.[3]

I find that cities tend to become more attractive with higher population sizes. The result seems to be robust to potential confounding factors and instrumental variable estimation. The urban quality of life premium is believed to flow through a higher quantity and variety of amenities, thick market effects, and other benefits from being around people rather than from a pleasant breeze that comes off the sea and other natural amenities. The result implies that the quality of life increases faster than congestion costs with increased urban scale in a country where the largest agglomerations are medium-sized cities.

The second section presents the measure of the quality of life. Section **3** describes the instrument. The main analyses are conducted in Section **4**, while Section **5** presents additional sensitivity analyses. Section **6** concludes.

## 2. Quality of life

### *2.1. Measuring local living quality*

I use the spatial equilibrium model of Rosen (1979) and Roback (1982) to measure the quality of life. The model assumes that households are compensated for having less amenities by higher real wages. This approach is especially suitable for a wealthy country like Norway since households are probably more inclined to consider local attributes as their standard of living and wealth increase (Brueckner et al., 1999; Rappaport, 2007).[4] Statistical tests of the measure's concurrent validity show that it is strongly correlated with likability indices (Rappaport, 2008; Albouy, 2012).

Albouy (2012) improved the quality of life measure by decomposing the price index into two sectors, calibrating it with additional micro price data, and taking into account local taxes. I mainly follow his approach, but add the extensions made in Carlsen and Leknes (2014), where a three-sector decomposition of the price index is used and empirical adjustment is made for worker heterogeneity.

### *2.2. The model*

Imagine many regions $r$ that vary in their endowment of local quality of life $QOL_r$, nominal wages $W_r$, post-tax disposable income $Y_r$, and prices. I assume that the relevant prices are those of housing $P_{H,r}$, non-tradables $P_{NT,r}$, and tradables $P_{T,r}$. Households are identical and completely mobile between regions. Hence, there are no costs related to relocation. Households supply one unit of labor in their home region.

Equilibrium requires that there is no migration, which implies that utility is equal across regions. The condition can be stated using an indirect utility function with the usual properties:

$$V(Y_r, P_{H,r}, P_{NT,r}, P_{T,r}, QOL_r) = \overline{V} \tag{1}$$

Following Albouy (2012) and Carlsen and Leknes (2014), I can derive a relative measure of the regional quality of life $\widetilde{QOL}_r$ from Eq. (1). The derivation details can be found in Appendix A. I assume that the prices of the non-tradables are a weighted sum of their factor prices and the prices of the tradables are equal across regions:

$$\widetilde{QOL}_r = \alpha_H \frac{P_{H,r}}{P_H} + \alpha_{NT}\left(\delta_H \frac{P_{H,r}}{P_H} + \delta_L \frac{W_r(1+s_r)}{\overline{W_r(1+s_r)}} + \delta_T\right) + \alpha_T - \frac{W_r - t_r(W_r)}{\overline{W_r - t_r(W_r)}}, \tag{2}$$

where $\widetilde{QOL}_r$ is specified as the quality of life measured as the share of post-tax average income and as the deviation from the national average. $\alpha_H$, $\alpha_{NT}$, and $\alpha_T$ are the budget shares of housing, non-tradables, and tradables, respectively. $t_r(W_r)$ is a wage- and region-specific tax function and $s_r$ is the average payroll tax rate paid by employers in the region. $\overline{W_r(1+s_r)}$ and $\overline{W_r - t_r(W_r)}$ are the national average costs per unit of labor and the national average net income, respectively. $\delta_H$, $\delta_L$, and $\delta_T$ are the factor shares of housing, labor, and a composite of traded goods in the non-tradable sector. Eq. (2) equates the regional quality of life by how much the cost of living exceeds the post-tax income relative to the national average.

### *2.3. Calibration*

I calibrate the quality of life measure by much of the same data as was set out in Carlsen and Leknes (2014), where a more detailed account of the data material can be found as well as multiple robustness tests of the calibration method. I calibrate Eq. (2) by micro data on earnings and house prices, and county-group[5] data of household spending for each region and year. Region averages are calculated for the period 1994–2002. This period is limited by the Norwegian tax reform of 1992, which makes earlier observations of earnings unavailable. Statistics Norway's house transaction database has comparable data until 2002, which set an upper bound. Descriptions of the components in the quality of life measure can be found in Appendix B.1.

The unit of observation is economic regions and there are 90; these have been created by Statistics Norway. The borders are determined by commuting flows across municipalities such that each unit denotes a separate local labor market. In general, the literature on urban amenities compares metropolitan areas. I use regional data with a national scope.

#### *2.3.1. Regional wage level and post-tax income*

The earnings data are computed from Statistics Norway's administrative registers, which encompass the entire Norwegian working population. The sample is restricted to full-time workers between the ages of 25 and 60 years with less than 10% of their total income from self-employment. This procedure provided me with 1.05–1.3 million annual observations. Capital income is independent of location and is therefore ignored. Local income and wealth taxes and local government taxes are subtracted from the earnings to derive post-tax income.

Wage differences across regions might reflect spatial differences in skills that arise because of worker sorting. To mitigate this potential bias in the regional wage estimates I utilize worker relocations to control for unobserved heterogeneity (Combes et al., 2008, 2010). This approach is supported by theory; migration equilibrium ensures that the marginal mover displays the most accurate wage level. There is a concern that the movers might not reflect the general working population. In sensitivity analyses I exploit variations across the entire working population and add controls for observed heterogeneity (Appendix D). The conclusions are unchanged.

I estimate the following wage equation to quantify the regional net wage:

$$W_{irt} = \alpha_r + \gamma_i + X_{irt}\beta + \epsilon_{irt}, \tag{3}$$

[3] The ratio of employees in the mining industry to total employment is less than 0.04% on average for the period 1995–2000. For the period 1994–2002 the mining industry accounts for less than 0.3% of GDP. These numbers incorporate sectors of mining production that are not relevant in a historical perspective; for instance, employment in mining thorium and uranium ores, the quarrying of sand, stone and clay, the mining of chemical and fertilizer minerals, and the production of salt.

[4] According to the World Bank, Norway had a GDP per capita of 56,628 in current U.S.$.

[5] Norway is divided into seven aggregate groups of counties by Statistics Norway.