Do large industrial investments drain competence from the public sector?

Johan Lundberg and Jonas Westin

[This is work in progress. Please do not quote.]

1. Introduction

What are the local labor market effects of a large private investment in a relatively small municipality?

In many countries, local governments have assumed greater responsibility for their own economic development. As a consequence, regions tend to compete to attract businesses and private investments with the main purpose to stimulate population growth and labor demand. Many of the regions who tend to try the hardest have a long tradition of net out-migration, losing manufacturing jobs and focus is often set to attract a large manufacturing plant to replace lost jobs and, in many cases, to stimulate the demand primarily for low-skilled labor.

As a specific example, after decades of disinvestment and population decline, several areas of northern Sweden are now attracting largescale industrial investments, such as wind farms, battery factories, and underground mines. The Norrbotten and Västerbotten Chambers of Commerce have estimated that the area will receive more than SEK 1,000 billion in new investments over the next two decades. If realized, the region will need an estimated 100,000 additional inhabitants in the next ten years to meet the anticipated increased demand for labor, a population growth of about 20% (Larsson, 2022). A large share of these jobs will be created in the manufacturing industry (low-skilled). Such large investment relative to the regional economy is expected to have a long-term positive effect on regional employment.

However, in the short run with restricted migration across regions a new establishment might come with a cost if the competence of the excessed labor supply does not match the demand. In such case, it is likely that the new plant will (through higher wages) attract workers from other sectors causing a shortage of workers in, for instance, the local public sector. If key personnel such as teachers, social workers, nurses, medical-doctors leave the public sector, this could have effect on the quality of the services provided by the local public sector, which, in turn, might affect private sector productivity.

This paper focus on the likelihood that individuals with specific competence such as teachers, nurses, medical-doctors leave the public sector for jobs in the private sector. We derive a simple economic model with two regions which build heavily on the previous literature while at the same time have its own features not always at center of attention in the previous literature. The likelihood that individuals with specific competence (teachers, nurses, medical-doctors) leave the public sector for jobs in the private sector is then estimated.

2. The model

Intuition
To give an intuition, our model consists of three parts; labor supply, production and the housing market.

The industrial investment is assumed to have a positive impact on the productivity among low-skilled which differs from the typical setting where a positive productivity shock is assumed to occur among high-skilled workers.

The region affected by the investment is very small population wise compared to the rest of the country (or the rest of the world).[1] That is, a wage increases in the small region do not affect wage levels outside the treated region.

We assume the wage level within the public sector to be determined outside the model. Influenced by Guillouzouic, Henry and Monras (2021), the quality of the services provided by the local public sector enters the private production function. As the share of formally educated teachers, nurses and/or medical doctors decrease, so does the quality of the locally produced public services which, in turn, have a negative effect on the productivity of the private sector.

We consider three periods with different time spans; short (no migration across regions), medium (migration and adaption to the new equilibrium) and long run effects (the new equilibrium). In the first period, the higher wages in the private sector attract both high- and low-skilled in the public sector. As the restricted labor mobility is relaxed, low-skilled (and perhaps also high-skilled in the public sector) in other areas will be attracted by higher wages. With an inelastic housing supply, this will cause housing prices to increase and benefit landowners. In the long-run, housing supply will catch up and in-migration will cause wages to equalize across regions.

The theoretical model is calibrated and used to simulate different scenarios. [To be done.]

Our theoretical model is then confronted with register data. [So far we have only estimated the local labor supply of nurseses.]

[1] The definition of the alternative region depends on the geographical surroundings and from where outside the treated region potential workers are likely to move from in to the treated region.

Labor supply

Three types of workers, high (h) and low (l) skilled trained for the public (o) and low-skilled trained for the private sector (p) respectively, denoted by h_o, l_o and l_p.[2]

With no migration across regions (short run), we only consider the region where the positive productivity shock takes place.

Normalize by the price of other goods ($p_x = 1$), denote by τ the local income tax and cost of housing $p = p(N)$ were N is the population, the indirect utility function[3] of worker i with skill level s in sector t is given by

$$(1)\quad u_{it}^{s} = Ae_{it}^{s}\left(\frac{\delta w_{it}^{s}(1-\tau)}{p}\right)^{\delta}\left(w_{it}^{s}(1-\tau)(1-\delta)\right)^{1-\delta}Q_t^{\beta}$$

where A reflect local amenities, e reflect worker i's idiosyncratic preference for her work (work environment)[4], z is the utility from housing, x represents other goods and Q locally provided public goods and services.[5] Taking logarithm, we get

$$(2)\quad ln(u_{it}^{s}) = ln(A) + ln(e_{it}^{s}) + ln\left(w_{it}^{s}(1-\tau)\right) - \delta ln(p) + \beta ln(Q_t) + \delta ln(\delta) + (1-\delta)ln(1-\delta)$$

To simplify the notation, let

$$(3)\quad \tilde{u}_{it}^{s} = \tilde{A} + \tilde{e}_{it}^{s} + \tilde{w}_{it}^{s} + ln(1-\tau) + \beta\tilde{Q}_t - \delta\tilde{p} + \underline{\delta}$$

where $\underline{\delta} = \delta ln(\delta) + (1-\delta)ln(1-\delta)$.

Consider now individual i's choice of sector given her skill category s. Assume $\tilde{e}_{it}^{s}$ to be to be a continuously variable between 0 and 1 reflecting her satisfaction with her work in sector t. Given multiple sectors, each individual chooses t to maximize her utility. Assume $\tilde{e}_{it}^{s} = \tilde{e}_{t}^{s} + \varepsilon_i$ where ε_i is i.i.d. extreme value distributed such that the choice probability for sector t that maximizes her utility can be described as a multinomial logit model. The parameter $\tilde{e}_{t}^{s}$ is a skill category individual specific constant.

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[2] We assume high-skilled trained for the private sector such as civil-engineers not to be interested to switch to a low-skilled job in the private sector nor any other job in the public sector.
[3] To save space, we go directly to the indirect utility function and the wage equation and leave the full derivations to the appendix.
[4] Think of e as a ranking between 0 and 1, where 1 is complete job satisfaction.
[5] Q is regarded as a quality measure of the public services provided and depend on the employees such that $Q(N^{h_o}, N^{l_o})$, $\partial Q/\partial N^{h_o} > 0$ and $\partial Q/\partial N^{l_o} > 0$.

Denote by N_s the number of individuals in the region with skill category s, then the probability that a worker within skill category s chooses sector t, $\text{Prob}(pr_{st} = 1)$, is given by

$$(4)\quad \text{Prob}(pr_{st} = 1|\boldsymbol{X}) = \frac{e^{\tilde{A}+\tilde{e}_{it}^{s}+\tilde{w}_{it}^{s}+ln(1-\tau)+\beta\tilde{Q}_t-\delta\tilde{p}+\underline{\delta}}}{\sum_{t'} e^{\tilde{A}+\tilde{e}_{it'}^{s}+\tilde{w}_{it'}^{s}+ln(1-\tau)+\beta\tilde{Q}_t-\delta\tilde{p}+\underline{\delta}}} = \frac{e^{\tilde{e}_{it}^{s}+\tilde{w}_{it}^{s}}}{\sum_{t'} e^{\tilde{e}_{it'}^{s}+\tilde{w}_{it'}^{s}}}$$

In the short run, with no migration across regions, $\text{Prob}(pr_{st} = 1|\boldsymbol{X}) = \frac{e^{\tilde{e}_{it}^{s}+\tilde{w}_{it}^{s}}}{\sum_{t'} e^{\tilde{e}_{it'}^{s}+\tilde{w}_{it'}^{s}}}$ and the total number of workers in each sector $N_t = \sum_s N_s \frac{e^{\tilde{e}_{it}^{s}+\tilde{w}_{it}^{s}}}{\sum_{t'} e^{\tilde{e}_{it'}^{s}+\tilde{w}_{it'}^{s}}}$.

A high-skilled worker in the public sector will stay in the public sector if her attachment to her present work is large enough to compensate for a (potentially) higher wage from a low-skilled job in the private sector; i.e. if $e_{io}^{h} - e_{ip}^{l} \geq (1-\tau)\left(w_{ip}^{l} - w_{io}^{h}\right)$.

The same reasoning applies for low-skilled in the public sector; in equilibrium the marginal low-skilled worker in the public sector is also indifferent between her options such that[6] $e_{io}^{l} - e_{ip}^{l} = (1-\tau)\left(w_{io}^{l} - w_{ip}^{l}\right)$.

It is reasonable to assume that $w_{io}^{h} > w_{io}^{l}$ and $e_{io}^{l} < e_{io}^{h}$ while $w_{ip}^{l} \lesseqgtr w_{io}^{l}$ and $w_{ip}^{l} \lesseqgtr w_{io}^{h}$. That is, a high-skilled in the public sector earn more than a low-skilled in the same sector, but its not a priori determined if a low-skilled in the private sector earn more or less compared to a low or a high-skilled in the public sector.

Later, when introducing migration, the marginal worker choses region a over b if $0 < (\tilde{e}_{i1}^{sa} - \tilde{e}_{i2}^{sa}) + (\tilde{w}_{i1}^{sa} - \tilde{w}_{i2}^{sa}) + \left(\tilde{A}^{a} - \tilde{A}^{b}\right) + \left(ln(1-\tau^{a}) - ln(1-\tau^{b})\right) + \beta\left(\tilde{Q}_t^{a} - \tilde{Q}_t^{b}\right) + \delta(\tilde{p}^{a} - \tilde{p}^{b})$

[6] As high-skilled trained for the private sector may only choose between a low-skilled work in the public sector and a high-skilled work in the private sector, we assume they will not consider the option to switch to the public sector. We also disregard from the possibility to switch from a high to a low-skilled work within the same sector which we believe is unlikely.

Production[7]

Assume a Cobb-Douglas type of production function for each sector t

$$y_t = X_t\big(Q_t(N^{h_o}, N^{l_o})\big)N_t^{\alpha}K_t^{1-\alpha}$$

where y is total output, X is a productivity shifter which depend on the provision of public goods Q_t, N is labor and K is capital. Assume all workers to supply one unit of labor and a total labor supply N. Both private and public sectors are price takers and labor paid its marginal product

$$w_t = \frac{dy}{dN} = \alpha X_t(Q_t)N_t^{\alpha-1}K_t^{1-\alpha}$$

$$ln(w_t) = ln\alpha + lnX_t(Q_t) + (\alpha - 1)lnN_t + (1-\alpha)lnK_t$$

It is assumed that $\frac{\partial Q}{\partial N_o^{h_o}} > 0$ and $\frac{\partial Q}{\partial N_o^{l_o}} > 0$. As $N_o^{h_o}$ and $N_o^{l_o}$ decreases, so will Q, and consequently, y_t and w_t.

For each sector t and skill level s,

$$w_{it}^{s_t} = w_{it\_}^{s\_} + \left(e_{it\_}^{s\_} - e_{it}^{s}\right)\frac{N_t^{s_t} - N_{t\_}^{s_t}}{N^{s_t}} = \alpha + X_t(Q_t) + (\alpha - 1)N_t + (1-\alpha)K_t$$

where subscript _ indicate the alternative.

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[7] We disregard incumbent firms. Assuming no spillover effects from the new plant to incumbent firms, the effects on incumbent firms are similar to the effects on low-skilled jobs in the public sector.

Housing
Each individual is assumed to consume one unit of housing. In the short-run, hosing supply equals the number of inhabitants, N, and the inverse supply of housing is given by

$$p = b + dN$$

where b is a constant, $\frac{\partial p}{\partial N} = d > 0$, and d the elasticity of housing supply. As N is fixed in the short-run, so is housing prices p. Each individual demand on unit of housing, i.e. $z = N$ in the demand function for housing, and equilibrium in the housing market is given by

$$p = \frac{\delta w_{it}^{S}(1-\tau)}{N} = b + dN$$

This close the model.

Comment: $p = \frac{\delta w_{it}^{S}(1-\tau)}{N} = b + dN$ can easily be estimated on a panel of local labor markets.

Short-run effects
We will now analyze the short-run effects of a large investment, which is in this case assumed to affect low-skilled workers in the region. Even though we consider short-run effects, we still need two periods, 1 and 2, to illustrate the effects. Let K_t shift between period 1 and 2 from K_{t1} to $K_{t2} = K_{t1} + \Delta$. Taking logarithm, this will cause w_{ip}^{l} to shift by $w_{ip2}^{l} - w_{ip1}^{l} = (1-\alpha)\Delta > 0$.[8] As w_{ip}^{l} increase it will be more attractive for both low and high-skilled in the public sector to switch to a low-skilled job in the private sector. This shift does not give employees in the private sector incentives to switch to the public sector. In this short perspective, work environment (e) is constant across regions within the same sector.

To summarize. The productivity shock in the manufacturing sector, which translate to higher wages in manufacturing, will give incentives for workers in the public sector to take a low-skilled job in the private sector. The effect depends on the attachment to work among workers in the public sector. With no in-migration from other regions, housing prices and supply are unaffected. Imposing wage rigidities in the public sector, wages in the public sector will not adapt to the new situation. Hence, those most attached to their public sector job and/or not suitable for a job in the private sector stay in the public sector.

Semi-long-run
To analyze the semi-long-run effects, we allow for in (or out) migration between region b and a which affect the local housing market and, consequently, the distribution of income between workers and house owners. As we allow for migration, local amenities, A, housing prices, p, and the quality of the locally provided public goods, Q, also becomes factors.

To be more specific, consider two regions, a and b, where the investment shock appeared in region a in the previous period causing $w_{ip}^{l,a} > w_{ip}^{l,b}$.[9] Region a is small in terms of labor supply compared to region b, ($N^b \gg N^a$).[10] Consequently, Q^b, $p^b(N^b)$ and w^b will not be affected by an out-migration from region b.[11] [12] Assume the local income tax τ to be equal across regions and the work environment or attachment to work to be constant within the same sector across regions, e.g. $e_{ip}^{l,b} = e_{ip}^{l,a}$. For the marginal individual to be indifferent between the two regions

$$u_{it}^{l,a} - u_{it}^{l,b} = (A^a - A^b) + \left(w_{ip}^{l,a} - w_{ip}^{l,b}\right) + (Q^a - Q^b) + \left(p^b(N^b) - p^a(N^a)\right) = 0$$

$$\left(w_{ip}^{l,a} - w_{ip}^{l,b}\right) = (A^b - A^a) + (Q^b - Q^a) + \left(p^a(N^a) - p^b(N^b)\right)$$

Then, using $p(N) = b + dN$ and normalize population such that $N^a + N^b = 1$, we get

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[8] $w_{ip2}^{l} - w_{ip1}^{l} = \alpha X_t(Q_t) N_t^{\alpha-1} K_{t2}^{1-\alpha} - \alpha X_t(Q_t) N_t^{\alpha-1} K_{t1}^{1-\alpha} = \alpha X_t(Q_t) N_t^{\alpha-1}((K_{t1}+\Delta)^{1-\alpha} - K_{t1}^{1-\alpha})$
[9] Unemployment benefits are for now included in the wage differential between the two regions.
[10] This is motivated by the fact that our interest is on industrial investments in a sparsely populated area.
[11] So far, we have not considered the effect on Q which, of course, depend on N^{h_o} and N^{l_o} such as $Q(N^{h_o}, N^{l_o})$ and $\partial Q/\partial N^{h_o} > 0$ and $\partial Q/\partial N^{l_o} > 0$.
[12] Alternatively, think of region b as all other regions and that only a small number of workers will migrate from each and every one of these regions to a.

$$\left(w_{ip}^{l,a} - w_{ip}^{l,b}\right) = (A^b - A^a) + (Q^b - Q^a) + (b^a + d^a N^a - b^b - d^b N^b)$$

$$\left(w_{ip}^{l,a} - w_{ip}^{l,b}\right) = (A^b - A^a) + (Q^b - Q^a) + (b^a - b^b) + (d^a N^a - d^b N^b)$$

$$\left(w_{ip}^{l,a} - w_{ip}^{l,b}\right) = (A^b - A^a) + (Q^b - Q^a) + (b^a - b^b) + d^a N^a - d^b (1 - N^a)$$

$$\left(w_{ip}^{l,a} - w_{ip}^{l,b}\right) = (A^b - A^a) + (Q^b - Q^a) + (b^a - b^b) + (d^a + d^b) N^a - d^b$$

$$\frac{\left(w_{ip}^{l,a} - w_{ip}^{l,b}\right) + (A^a - A^b) + (Q^b - Q^a) + (b^b - b^a) + d^b}{(d^a + d^b)} = N^a$$

To summarize and give some comments on what's next:

- The shift in relative wages, $w_{ip}^{l,a} > w_{ip}^{l,b}$, depend on housing prices, attachment to the region (friends, relatives, etc.), $A^a - A^b$, and the quality of locally provided public services, $Q^b - Q^a$.
- We have information on $w_{ip}^{l,a}$ and $w_{ip}^{l,b}$ for the marginal mover.
- b and d in $p = b + dN$ can be estimated for different regions.
- There are indexes for Q so $Q^b - Q^a$ can be calculated based on that.
- Then, $A^a - A^b$ can be calculated and/or estimated on different factors.
- Given this, it is possible to simulate the effects of a large investment in any other region.

Housing

Housing supply is still fixed and the potential in migration to region a only causes lower housing quality (overcrowding) at a fixed price and/or higher prices as $\frac{\partial p}{\partial N} > 0$.

<u>The long-run perspective (to be done)</u>

In the long-run (the time perspective of short, semi-long and long-run can always be discussed) the productivity shock will transfer outside of region a. That is, wages will equalize across regions.

Simulations

[To be completed]

3. Data, empirical model and results

The likelihood that individuals with specific competence (nurses) leave the public sector for jobs in the private sector.

(So far, we have only done the estimations for nurses.)

Data
Estimations are based on detailed register data provided by Statistics Sweden (SCB). Our data cover all individuals living in Sweden between 2014 and 2019 with a professional (university or university college) degree as a nurse.

To be done: The probability of choosing either the public or private as well as different hypothesis related to the individual income to be estimated separately for several categories (medical doctors, teachers, social workers).

So far, the model is only estimated for those who live and work in the same municipality during the whole period 2014 to 2019. That is, short run effects. Then we do not need to control for local amenities, the local public service or housing prices.

257 491 observations.

About 43 057 individuals.

Descriptive statistics

Table 1: Descriptive statistics. Nurses. 2019

		Total	Man		Woman	
			Public	Private	Public	Private
Wage	Mean	37 605	40 606	41 445	37 206	36 928
	St dev	8 916	9 449	10 543	8 660	9 388
	Min - Max	16 667 – 74 972	16 695 – 74 924	16 872 – 74 049	16 687 – 74 972	16 703 – 74 490
dWage	Mean	1.034	1.037	1.042	1.033	1.036
	St dev	0.167	0.174	0.173	0.164	0.180
	Min - Max	0.255 – 3.002	0.369 – 2.211	0.340 – 1.700	0.255 – 3.002	0.334-2.165
Experience	Mean	20 208	17 419	18 542	20 512	21 194
	St dev	10 204	9 902	9 983	10 181	10 232
	Min - Max	1 – 49	1 - 46	1 - 43	1 – 49	1 – 47
Job change	Mean	0.041	0.029	0.155	0.029	0.143
Change public/private	Mean	0.003	-	0.024	-	0.028
Change private/public	Mean	0.003	0.003	-	0.003	-
Observations		43 057	4 803 (11.2%)	459 (1.1% or 8.7% of men)	33 865 (78.7%)	3 930 (9.1% or 10.4% of women)

Results

Wage equation

$$\ln(w) = \ln(experience) + public\ to\ private + man + public\ to\ private\#man + private\ to\ public + man\#private\ to\ public + job\ change + public\ to\ private\#job\ change + man\#job\ change + public\ to\ private\#man\#job\ change + private\ to\ public\#job\ change + man\#private\ to\ public\#job\ change + constant$$

Table 2: Wage. Random effects GLS regression. 2014 – 2019.

	Nurses
Experience	0.072 (94.07)
Change public to private	0.008 (0.25)
Man	0.107 (36.21)
Change public to private # man	0.003 (0.03)
Change private to public	0.013 (0.65)
Change private to public # man	0.038 (0.41)
Job change	0.026 (18.35)
Change public to private # job change	0.012 (0.03)
Man # job change	-0.010 (-2.40)
Change public to private # man # job change	0.022 (0.22)
Change private to public # job change	0.001 (0.03)
Man # change private to public # job change	-0.004 (-0.04)
Constant	10.259 (4 456)
Observations	257 491

Note: z-statistic within parenthesis

- There is a higher wage premium for women who change job.
- Men have higher wages than women
- There is no wage premium for changing from private to public or from public to private

Wage increase

$$d(w) = \ln(experience) + public\ to\ private + man + public\ to\ private\#man + private\ to\ public + private\ to\ public\#man + job\ cahnge + public\ to\ private\#job\ change + man\#job\ change + public\ to\ private\#man\#job\ change + private\ to\ public\#job\ change + man\#private\ to\ public\#job\ change + constant$$

<u>Table 3: Wage increase. Random effects GLS regression. 2014 – 2019.</u>

	Nurses
Experience	-0.035 (-61.58)
Change public to private	-0.119 (-2.56)
Man	-0.007 (-5.19)
Change public to private # man	0.235 (1.93)
Change private to public	-0.034 (-1.27)
Change private to public # man	0.031 (0.27)
Job change	0.048 (21.85)
Change public to private # job change	0.098 (2.31)
Man # job change	-0.019 (-2.83)
Change public to private # man # job change	-0.192 (-1.53)
Change private to public # job change	0.019 (0.67)
Man # change private to public # job change	-0.004 (-0.03)
Constant	1.156 (699.85)
Observations	171 932

Note: z-statistic within parenthesis

- The wage decreases if changing from public to private. This can be due to dissatisfaction with the public sector work environment.
- A change of job has a positive effect on the wage but less so for men.
- The wage increase decrease with experience.
- Men have lower wage increases than women. Do women catch up?

The probability of nurses choosing the private sector

$$Prob(private = 1) = w + man + experience + constant$$

Table 5: Prob($private = 1$). 2014 – 2019.

	Nurses	
Wage	0.00002 (11.80)	0.00002 (10.57)
Man	-0.246 (-4.02)	-0.528 (-2.65)
Experience	0.017 (9.19)	0.016 (8.48)
Constant	-8.362	-8.326 (-122.41)
Man # Wage		0.00000 (1.25)
Man # Experience		0.004 (0.62)
Observations	257 491	257 491

Note: z-statistic within parenthesis

- Men are less likely to choose the private sector.
- Those with long(er) experience tend to choose the private sector with a higher probability than those with less experience.