

The Dynamic Consequences of Public Employment : An Agent Based Approach

Guinevere Nell*

Market failure and the effect of government policy on employment and wages are areas of economic theory still being investigated. Government employment programs may crowd out private investment and growth under certain circumstances, rendering well-intentioned policy ineffective or even destructive. Agent based models can allow micro-level behavior to inform the outcome, with macro effects emerging from interaction of agents. Here I present an agent-based model of the labor and product market in which an Employer of Last Resort program (ELR) is introduced, and crowd out effects are investigated.

*A significant initial inspiration for this model was Basu & Pryor (1997). I would also like to acknowledge Thomas Moore of *Inductive Systems* for many hours of discussion, and provision of advice and ideas on the design of the model and Alexander Volokh for help with economic rationale and realism of the model and for thoughtful insights.

Background

Economists have long debated whether government can reduce perceived failures of the market such as involuntary unemployment, business cycles, and wage inequality. While government action is used to solve market failure, it must necessarily affect the private sector. The crowding out effect of government employment policy is an area of economic theory still under investigation. Macroeconomic models, such as general equilibrium models, are unable to capture all of the unintended consequences of government action, as they necessarily must abstract away from the underlying interactions of individual actors. An agent based model builds from accepted micro-level behavior and hence can inform macro models as to the expected effect on the private sector of government action.

Here I present an agent-based model of the labor and product market in which an Employer of Last Resort program (ELR) is introduced, and crowd out effects are investigated. The model combines heterogeneous agents with uncertainty and incomplete information, interacting within a complex system of differing tastes, heterogeneous products, adaptability (learning) and the allowance for the growth of market power. In such a system the emergence both of market failure and of unintended consequences becomes possible, and insight (though not quantitative prediction) may be gained. The focus is on how the institution of property and resulting profit motive may produce different results than the soft budget constraint of government, and how the imposition of the latter may affect the former.

Employment Policy

There has been more than a century of policy debate regarding the role of government in generating and protecting employment for citizens and providing for the economic welfare of those who cannot find work or are unable to work. Although there is apparently now consensus that a single public sector monopoly – Socialism – cannot replace the private market effectively, a lesser role for government employment remains attractive to economists and policy-makers.

Sweden famously tried a “third way” between capitalism and Socialism (Lindbeck, 1997), and other countries have also experimented with increasing the role of the public sector in their economies. In the United States there have also been governmental attempts to employ out-of-work citizens (Bell and Wray 2004). Some have argued that these programs are not economically sound (Gelb, Knight and Sabot 1991); yet there remains literature supporting the policy of government as “employer of last resort”.

The idea of an Employer of Last Resort (ELR) is based on the desire for “full employment” and Keynesian and Post-Keynesian economists desire to achieve full employment without an increase in inflation, with government acting as the employer for the unemployable. Economic theory suggests that this may create endogenous effects as government influences the ability of the private sector to employ workers and also affects the incentives of the worker (Malley and Moutous, 1996).

Interestingly, this ELR idea has been increasing in momentum in some circles even as the need for it may be decreasing. In 1997 a big proponent of the ELR program L. Randall Wray, wrote in *Government as Employer of Last Resort: Full Employment*

without Inflation: “Many, perhaps most, economists doubt that it is even possible to achieve anything close to a 3% unemployment rate without at the same time inducing accelerating inflation.” In 2000 the US unemployment rate fell to almost an all time low of 4% (with employment at an all time high), and inflation remained at its all time low, 15 years at or below 3%. Although 2000 was a bubble year, unemployment has been almost consistently at levels previously considered as “full employment” levels, for the past decade according to the OECD¹.

Another proponent of ELR wrote in 1998 about the meaning of full-employment “Writing in the 1940s, Beveridge thought that full employment would be achieved when the number of job vacancies would be higher than the number of jobless (Beveridge 1945) a condition that would guarantee no long-term unemployment.” Long-term unemployment has been very low in the United States in recent years, at only about 8-10% according to the OECD.

A proposal for an Employer of Last Resort (ELR) program was described in the Eastern Economic Journal for the European Monetary Union in 1999 (Kregal, 1999). The ELR program was likened to market maker in a stock market, which sets the price by buying and selling in order to dampen price fluctuations and soak up excess supply. The theory predicts that the ELR program could reduce involuntary unemployment and help to stabilize wages.

One notable difference between supply in a stock market and supply in a labor market is the lack of uniformity in the latter. Unlike a commodities market or a stock market, labor is supplied individually, conforming to expectations of the given employer, the employee and the particular position. One person can supply a wide variety of labor

¹ See statistics at www.oecd.org

depending on what is expected of him or her. If the ELR program expects less of the worker, less may be provided; if the ELR program treats a person as “unemployable”, he may become so. If those in the ELR program are offered a higher wage for a lower level of output, the program may drag down productivity in the economy.

The market is also malleable. If the ELR program offers a higher wage than the worker is worth, the market will become inflationary as the other firms struggle to compete; if the ELR program offers only what the worker is worth, it will do nothing but compete in a marketplace where the worker could already find work if the market determines the worth.

The ELR theory assumes that the worker has an inherent (or already determined) worth but there are no buyers. But as demand falls so does price; if the ELR program pushes up price by offering a wage higher than the market can support, it may have a crowding out effect on the private sector. If wages are sticky, the ELR program may hire workers who would not have found jobs; but if the unemployed would take any job offered, the ELR program will compete with the private sector. This may affect future investment and hiring capabilities of the private sector.

Falling wages allow a firm to dig itself out of a slump; demand for labor has fallen because profits have fallen, lower wages allow the firm to hire and expand even with lower profits and thus the economy can improve and wages can rise again, in time. The ELR-induced higher market wages could make this impossible and hence hurt the private sector, so that only the public sector can expand.

The ELR proponents also claim that wages would be stabilized by the policy as the wage chosen by the public sector – the “policy” wage rate – would be a fixed point

around which the overall wage level would be determined. If market wages fell too much, the public sector would expand to take in new workers unhappy with private sector wages, and as market wages went up, public workers would exit to join the private sector.

However, for that to be true, the public sector must absorb the excess supply of labor *with no effect on the private sector*. Proponents of the theory claim, “the supply of private and public sector jobs will always be equal to demand.” But this is not going to be true if the hiring in the public sector damages the ability to hire in the private sector. With wage competition, the private sector might shrink leading wages to fall for many. Meanwhile the public sector, with this policy, may continue to expand as the “unemployable”, or those unwilling to work for a lower wage, go to it for jobs as a last resort.

One may ask whether it is truly an “employer of last resort” program if people go to it for a higher wage than the private sector offers. But because of political pressure the program may not be able to offer a below-poverty wage or turn away workers who can only find such a low wage. It is unclear what the purpose of the program is if the private sector can hire the workers by allowing the wage to drop arbitrarily low. The program may have to accept all who desire to work in the public sector unless the private sector is bound by a minimum wage.

Evidence indicates that countries with more heavily regulated or unionized labor markets, such as Sweden, have longer and deeper recessions (Agell and Lundborg, 1999). Sweden has both wage rigidity due to collective bargaining and public firms that act as employer of last resort (Skedinger and Widerstedt, 2003). In 1998 Sweden abolished its “relief works” program, which had been part of active labor market policy and had acted

as an employer of last resort program but had been found to crowd out private employment (Calmfors, Forslund and Hemstrom, 2002; Malley and Moutous, 1996).

The model presented in this paper attempts to characterize the effects of a public sector that acts as an employer of last resort.

Defense of the Model

Models that assume complete information and perfect competition suffer from an inability to illustrate dynamic market characteristics such as entrepreneurship, market power and market failure (Hayek (1937), McNulty (1968)). Static models (which may start from a presumption of market failure and introduce government intervention) suffer from the inability to illustrate the dynamic consequences of the policy, which may differ from first-round effects (Baldwin (1988)). Traditional dynamic macroeconomic models that explore market failure suffer from their aggregation and homogenization of individual behavior, hiding the trade-offs that necessarily occur among individual transactions and which may lead to significantly different outcomes than predicted (Kirman and Zimmerman (2001)). The agent-based approach allows for micro-level behavior and interaction of heterogeneous agents to lead to the emergence of a macroeconomic environment capable of market failure, growth and unexpected policy consequences (Hommes (2005)).

The model presented is composed of heterogeneous agents with different tastes and abilities, who have incomplete information and interact in an environment in which learning is possible. Perfect competition is not assumed because the profit motive and

heterogeneity allows for growth of market power. In this system the emergence both of market failure and of unintended consequences becomes possible.

The model is intentionally very simple, and is designed to produce insight not quantitative prediction. Several incarnations of the model allow for an analysis of the robustness of the results subject to the behavioral and simplifying assumptions. The model is designed to compare the income effects of the pure private market and its use of the profit motive, with a system in which the government attempts to supplement the market with directed aid for those in need.

Government action can take many forms, and these may produce drastically different results. Several are investigated, including a fixed size employment program (a policy promising to employ the first low-skilled, for example 10%, of the workforce who apply), a responsive ELR program which expands and contracts based on the unemployment level in the economy, and each of these with a supplementary minimum wage.

The first incarnation of the model (Model 1) simplified the market by representing it with a single product, leaving agents with simple and identical preferences. Individuals have incomplete information about prices in the market, and heterogeneous initial productivity levels, which they may train to improve. Firms sell only one product, but use a learning algorithm to determine the profit-maximizing price to sell the product. Firms bid in a labor market for workers based on heterogeneous capital and the given worker's level of productivity. Model 1 offers both a fixed size ELR program and a responsive ELR program.

The second version of the model (Model 2) adds complexity with multiple products. Firms choose what to sell based on perceived demand and heterogeneous capital costs. Individuals have heterogeneous preferences based on Cobb-Douglas utility functions. Model 2 also simulates both a fixed size and responsive ELR program. Both models include entrepreneurship and population growth.

The primary assumptions of the model are as follows (more details can be found in the Appendix).

1. Individuals purchase goods as cheaply as possible, according to their preferences.
2. Individuals work at the firm offering the highest wage.
3. Private firms choose labor based on productivity of the worker (which they can detect) and bid on the worker in a labor market on this basis, up to the expected worth of the worker to the firm (this worth is based on expected profits of products sold, and the expected output of the worker, based on his productivity).
4. Private firms face a hard budget constraint, and must go out of business once they face losses, while public sector firms hire, fire and shut down based on policy choices by government.
5. Individuals may (given a stochastic component) open a firm if they expect to be able to make significantly more in profit than they make as a worker. Individuals do not have perfect foresight.
6. Private firms (using a learning algorithm) determine at what price to sell their products based on past profit and sales and on what other firms are charging.
7. Public firms hire low productivity workers at a flat rate and charge a low set price for products, as part of the policy set by the government ELR program.

8. Government sets the tax rate appropriately to pay for the program, and hires according to the given rule (to keep a fixed size or to hit the target unemployment level) unless it goes over-budget, in which case it attempts to come under budget again, by raising taxes, reducing the wage rate or in the last resort by contracting in size.

Just as important as the assumptions made are the assumptions left out. This model does not include any assumed behavioral responses to wage level by workers, individuals simply choose the job which pays the highest wages, and produce at the level which they are able. On the other hand, workers only choose to train, and hence increase their productivity, if they determine that there is a possibility that they can earn a higher wage in the marketplace. Hence, if wages in the market are flat, workers won't choose to train. But the simple offering of higher wages to workers is not assumed to increase their productivity. Similarly, workers do not choose leisure over work based on a wage-leisure trade-off, but they will choose a public sector job if the wage is higher than the wage offered by firms in the private sector.

The model also does not assume any lower productivity of public sector firms, due to factors such as principal-agent problems, bureaucracy or rent-seeking. This is not due to an assumption that these factors are negligible. Rather, it is to make the hard case that any negative effects caused by public sector employment in the model occur even without these factors.

The primary economic question which the model attempts to address is the hard case that profit-maximization is superior to government organization for redistributive

purposes, even if behavioral effects are set aside. Just as, during the “economic calculation debate,” Austrian economists argued that even disregarding incentives, socialism would be impossible because of the calculation problems which occur when markets are absent², the argument here is that, even disregarding behavioral effects, profit maximization produces a more efficient emergent economy than government is able to produce, and hence static estimations of redistribution effects underestimate efficiency concerns.

Proponents of government redistribution policies such as employer of last resort programs often admit to incentive concerns, but argue that government allocation actually offsets some of these inefficiencies by putting wealth in the hands of those with the most demand for consumption goods. However, if profit maximization alone makes a large difference to efficiency, then inefficiencies may be underestimated. The hard case is as follows: even if workers are willing to expend as much effort to work at a public firm, regardless of any principal-agent problems, and even if the public sector is not less efficient for other reasons such as rent-seeking, the possibility still remains that the organization of profit-seeking by private firms outperforms the organization of public sector firms in an economy.

If public sector firms crowd out private sector firms by offering higher wages to low-productivity workers and undercuts them in the marketplace with low-price goods, making up the difference with taxes, then this should be purely redistributory if efficiency is constant between public and private firms. With equal efficiency, crowd-out should result only in a transfer from rich to poor with no loss in total output, no increase

² See, for example, Mises (1990 [1920])

in unemployment, a reduction in poverty should be seen, and so forth. Pure redistribution of wealth should occur, without added negative effects.

However, if dead weight loss occurs, despite the assumptions of the hard case – that productivity of workers is not affected, no rent-seeking occurs, there are no bureaucratic costs, etc – then there must be some other inefficiency due solely to the organizational structure dependent on the institutions of the private sector. In that case, profit-maximization must be rewarded the sole credit for the difference in outcome.

This is an interesting case to study, and should inform economic theory. This outcome would suggest that the hard budget constraint, price and wage-setting according to profit, information transfer according to profit, and evolutionary growth of superior capital endowments, with inferior endowments dying off, determines economic performance. This emergent result would recommend a market without interference by government redistribution for optimal results, and indicates that even without behavioral incentives private property based allocation is superior due to the price interaction and evolutionary dynamics of markets.

Robust Results

Certain outcomes were robust across all incarnations of the model. Several results stood out, and were explicable according to economic theory. The fixed size public sector crowded out private firm expansion, leveled and lowered wages. A small size public sector did reduce unemployment and poverty, at the expense of wages in the rest of the economy, but as the public sector grew and cost more in taxes, this positive

effect diminished and at certain sizes the program actually increased unemployment.

Both models produced these results.

One shortcoming of the model is that it must model choices as to how to respond to an unsustainable program – realistic scenarios include contracting the program, continuing to raise taxes, or lowering the wages of existing ELR workers. Each of these occurs in the model, but different simulation runs rely on different policy choices. The government tries to maximize revenue, but the time at which taxes are raised leads to different revenue and hence differently sized programs.

The most robust results are summarized below.

1. If the public sector remains small, for example, with the fixed size public sector of only 5% or less of employment, the bottom quintile is able to benefit.
2. The public sector is difficult to keep within budget when larger than 5-8% and begins to crowd out private market employment, whether it is acting responsively to unemployment, or maintaining a fixed larger size.
3. The top quintile suffers the most from a larger public sector, but other wages also suffer. The program is able to reduce unemployment only at the expense of the median wage rate unless it goes into deficit. Rather than supporting a “living wage” or setting a “policy wage” as

proponents desire, the ELR program drags down the wages of private sector firms by reducing their profitability.

4. If the program gets too large, it begins to increase unemployment and poverty.
5. A flat tax was correlated with a higher median wage (and higher wages of the upper quintiles) and higher standard of living than a progressive tax; and also maximized revenue at a lower rate.
6. A minimum wage helped the poorest but generally hurt the average worker. The minimum wage also had the greatest impact on unemployment.

Details of Results

The results shown here are selected to highlight the most general and robust outcomes. It should be noted that the size of the coefficient in the tables presented are not to be taken to indicate the magnitude of the variables with any precision. The parameters differ greatly and somewhat arbitrarily in the way in which they quantitatively relate to the dependent variables, and the model is not calibrated to empirical values in the economy. The model is intended to provide qualitative insight, not quantitative measurements.

The public sector in this model depressed the median wage both with a fixed public sector and with a responsive ELR program (Tables 1-6 Figures 1-3), particularly when it was unable to remain small. When the “real percent public” was taken into

account, not just the initial planned size, this mattered, while the targeted size did not matter or mattered less.

The flat tax (unfortunately indicated with a 2 in the first and a 0 in the second model) had a positive effect on the median wage rate (Tables 1 and 2) compared with a progressive tax (indicated with a 1).

Wages of the bottom quintile were reduced by a sufficiently large size public sector (Tables 3 and 4) and wages of the upper quintiles were also reduced by the ELR program (Tables 3 and 5).

A fixed size public sector did not reduce unemployment but when the program was responsive to the unemployment rate, unemployment was reduced unless the program became large (Tables 7, 8, 9 and 10 and Figures 4 and 5).

The most controversial results were introduced by the second model's responsive ELR program. While the particular indicators did not conform to the same simple analysis as the earlier versions, due largely to highly volatile budget and policy responses, one clear outcome stood out. Higher taxes, necessary to support either kind of ELR program, led to lower private sector, and overall median wage rates (Figures 2 and 3 and Table 6).

It is also clear that the public sector cannot grow indefinitely without affecting revenues collected (Table 12). The size of public sector that maximizes revenue seems to be 10% for a progressive tax and 10 or 15% for a flat tax.

Lastly, standard of living (SOL) measurements (determined by the number of products an individual can purchase with his wage) matched the results of wages in the first model, for both responsive and non-responsive programs (Tables 9 and 10).

Poverty, measured by having a standard of living below a certain threshold, was not reduced and was sometimes increased by the ELR program (Tables 7 and 11). The results from the second model were, again, more complex due to volatile policy reaction by government, particularly with a responsive ELR program. Future investigation will reveal whether an ideal policy might produce beneficial outcomes for low-productivity workers under these conditions, without incurring unsustainable deficits.

Explanatory Factors

Lower wages will result in lower tax revenue given that it is a percentage of the wage that is taken in taxes (whether the tax is flat or progressive). The Laffer Curve suggests that raising taxes will not always increase revenue because of the disincentive to work caused by higher tax rates; this model finds that the size of the public sector and correspondingly higher tax rates together will cause a decrease in revenues, even without considering all incentive effects. This is likely due to the crowding out of private sector firms, which causes the average wage rate to drop and hence produces lower tax revenues.

Private sector firms profit-maximize by learning the appropriate price to charge for their products, and expand based on profit. When they expand, they offer wages that correspond to the worth of the worker. Public sector firms in the ELR program do not base their price, expansion or wage rates on profitability factors, instead these are based on policy parameters. This is the underlying difference which must explain the worse economy with a larger public sector; when the public sector replaces the private sector through crowding out.

A large public sector means a large set of bids at the public sector wage rate. Other firms will bid near that wage rate and there will be fewer private firms to bid up the rate for each worker so that even high productivity workers will end up choosing a job at a lower rate. This seemed to have an effect of flattening out wages in the market that retained a large public sector.

Higher taxation means that the net wages will be lower. Lower consumption means that firms make less profit and more firms either go out of business, must make lay-offs or not expand. Fewer firms hiring once again depresses wages. These same effects may cause an increase in unemployment.

Although a non-zero ELR program appeared to have some beneficial effects, it was not costless. With a non-responsive ELR program, unemployment was increased if the public sector grew too large, and wages were reduced. When the program was responsive, especially in the more complex second version, budgetary effects and policy choices by government complicated results. No single indicator triumphed in the responsive version of the second model. However, severe budget deficit and large real public sector produced the same negative effects as seen in the simpler version.

It is also important to remember that most modern industrial states already have public employment of at least 10-20% (see Figure 10). All public sector employment may not conform to the assumptions of the public sector in the model. However, modern states also retain social welfare programs, which do reflect more of these assumptions, even if they are not pursuing active employment policies (see Table 13). Therefore, the rates of public employment in the model which maximize welfare of the poor and tax revenue may reflect smaller sizes than currently exist in each of these countries.

Finally, it is important to remember that the model leaves out important factors, such as self-interested incentives of the workers, which may differ between public and private employment. The model also ignores rent-seeking by firms, and other ways in which public firms may be less productive than private firms.

Conclusion

The agent-based modeling approach provides unique insights into the dynamic of the labor market, and the potential consequences of government intervention. Heterogeneous actors with limited information interacting in an evolutionary environment, with learning and without the assumptions of perfect competition or equilibrium, allow for emergence of both market failure and also unexpected consequences of policy – government failure.

Results from two agent models and with a multitude of parameters, indicate that in fact government employment does crowd out private employment, even using a hard case of altruistic workers and efficient public administration. Given the generous assumptions, it appears that organization directed to profit-maximization must be the primary factor distinguishing the more prosperous market system from the reduced prosperity seen with the government employment program in place.

References

Agell, J.; Lundborg, P. "Survey Evidence on Wage Rigidity and Unemployment: Sweden in the 1990s." Working Paper, *Office of Labor Market Policy Evaluation (IFAU)*, Sweden, 1999.

Axelrod, Robert. "Advancing the Art of Simulation in the Social Sciences." *Japanese Journal for Management Information Systems*. Dec 2003.

Baldwin, Richard E. "Measurable Dynamic Gains from Trade" *The Journal of Political Economy*, Vol. 100, No. 1 (Feb., 1992), pp. 162-174

Basu, N.; Prior, R. J. "Growing a Market Economy." *Sandia Labs*, Working Paper. 1997

Bell, S.; Wray, L.R. "The 'War on Poverty' after 40 Years: A Minskyan Perspective." Working Paper Number 404. *Levy Economics Institute of Bard College*. 2004.

Calmfors, L.; Forslund, A.; Hemstrom, M. "Does Active Labour Market Policy Work? Lessons from the Swedish Experience." Seminar Paper No. 700. *Institute for International Economic Studies, Stockholm University*. 2002.

Dawid, Herbert; Reimann, Marc. "Evaluating Market Attractiveness: Individual Incentives Versus Market Profitability." *Computational Economics*. 2004.

Gelb, A.; Knight, J.B.; Sabot, R.H. "Public Sector Employment, Rent Seeking and Economic Growth." *The Economic Journal*. Sept. 1991.

Gilbert, Nigel; Terna, Pietro. "How to build and use agent-based models in social science." 1999

Hayek, F. A. von "Economics and Knowledge." *Economica*, New Series, Vol. 4, No. 13 (Feb., 1937), pp. 33-54, 1937.

Hommes, Cars H. "Heterogeneous Agent Models in Economics and Finance," *Tinbergen Institute Discussion Papers*, Tinbergen Institute, 05-056/1, 2005.

Immervoll, Herwig; Marianna, Pascal; D'Ercole, Marco Mira. "Benefit Coverage Rates and Household Typologies: Scope and Limitations of Tax-Benefit Indicators." *OECD Employment and Migration Working Papers*, 2004.

Invest in Sweden Fact Sheet. "Working in Sweden." *Invest in Sweden Agency*. July 2003.

Kirman, Alan; Zimmerman, Jean Benois (eds). Economics with Heterogeneous Interacting Agents. Series: Lecture Notes in Economics and Mathematical Systems, Vol. 503, 2001.

Kregal, J. A. "Currency Stabilization Through Full Employment: Can EMU Combine Price Stability With Employment And Income Growth?" *Eastern Economic Journal*; Winter 1999.

Lindbeck, A. "The Swedish Experiment." *Journal of Economic Literature*. Sept 1997.

Malley, J.; Moutos, T. "Does Government Employment 'Crowd Out' Private Employment? Evidence from Sweden. *Scandinavian Journal of Economics*. Vol. 98, issue 2, 1996.

McNulty, Paul J. "Economic Theory and the Meaning of Competition." *The Quarterly Journal of Economics*, Vol. 82, No. 4 (Nov., 1968), pp. 639-656

Michell, W.; Watts, M. "A Comparison of the Macroeconomic Consequences of Basic Income and Job Guarantee Schemes." *Rutgers Journal of Law & Urban Polic*. Vol. 2; Fall 2005; No.1

Mises, Ludwig von. Economic Calculation in the Socialist Commonwealth. Alabama: The Ludwig von Mises Institute. 1990.

Nell, Guinevere. "Prosperity and the Welfare State: The Effect of Benefit Generosity and Wage Coordination on Absolute Poverty and Prosperity in Cross-National Perspective."

Working Papers, #424, *Luxembourg Income Study*, 2006

Nickell, J; Vainiomaki, S; Wadhvani, S. "Wages and Product Market Power,"

Economica, New Series, Vol. 61, No. 244 (Nov., 1994), pp. 457-473

Papadimitriou, Dimitri B. "(Full) Employment Policy: Theory and Practice." Working Paper 258. *Jerome Levy Economics Institute*. December 1998.

Ramsay, Tony. "The Socialization of Investment in a Contemporary Setting." *Journal of Australian Political Economy*. June 2004

Skedinger, P.; Widerstedt, B. "Recruitment to Sheltered Employment: Evidence from Samhill, a Swedish, State-Owned Company." Working Paper, *Office of Labor Market Policy Evaluation (IFAU)*, Sweden, 2003.

Wray, L. Randall. "Government as Employer of Last Resort: Full Employment Without Inflation." Working Paper No. 213. *The Jerome Levy Economics Institute*. November 1997.

Wray, L. Randall. "The Employer of Last Resort Approach to Full Employment."

Working Paper No. 9, *Center for Full Employment and Price Stability, University of*

Missouri-Kansas City, July 2000.

Table 1: Effect of Public Sector on Median Wage (Model 1)

| | <i>Coeff</i> | <i>Std Error</i> | <i>t Stat</i> |
|---------------------|--------------|------------------|---------------|
| Intercept | 3.56 | 0.17 | 20.79 |
| Cycles | 0.01 | 0.00 | 10.58 |
| Percent Public | 0.00 | 0.01 | 0.38 |
| Tax Type* | 0.34*** | 0.07 | 4.76 |
| Minimum Wage | -0.02*** | 0.00 | -4.74 |
| Target Unemployment | 20.68*** | 2.55 | 8.12 |
| Real Percent Public | -0.05*** | 0.00 | -11.27 |
| Average Tax Rate | -2.70*** | 0.54 | -5.02 |

R Square = 0.68; n = 530

* Tax Type
1 = progres-
sive 2 = flat**Table 2: Effect of Public Sector on Median Wage (Model 2)**

| <i>Median Wage</i> | <i>Coeffi- cients</i> | <i>Standard Er- ror</i> | <i>t Stat</i> |
|--------------------------|---------------------------|-----------------------------|---------------|
| Intercept | 11.83 | 6.99 | 1.69 |
| Cycles | 0.23 | 0.05 | 5.16 |
| Percent Public | 0.15 | 0.17 | 0.85 |
| Tax type* | -5.25* | 4.08 | -1.29 |
| Minimum wage | 0.43*** | 0.13 | 3.23 |
| Living Wage | 5.73* | 3.20 | 1.79 |
| Target Unemploy- ment | 34.08 | 62.65 | 0.54 |
| Real Percent Public | -0.35*** | 0.08 | -4.16 |
| Average Tax Rate | -36.87* | 21.00 | -1.76 |

R Square = 0.38, n = 116

* Tax Type
0 = flat
1 = progressive

Table 3: Effect of Public Sector on Wages (Model 1, non-responsive)

| Variable | MEDIAN_WAGE | Quin1_Wage | Quin2_Wage | Quin3_Wage | Quin4_Wage | Quin5_Wage | Prod- Wage Slope |
|-------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| Constant | 111.073*** (22.400) | 25.730*** (31.619) | 60.686*** (22.402) | 110.790*** (22.403) | 150.964*** (22.267) | 194.178*** (21.114) | 27.322** * |
| PUB | -2.850*** (-21.837) | -0.340*** (-20.243) | -1.340*** (-20.689) | -2.842*** (-21.834) | -4.115*** (-22.878) | -5.519*** (-23.014) | -0.925*** (-19.064) |
| TAX | 3.335 (1.210) | -0.009 (-0.021) | 0.565 (0.387) | 3.318 (1.207) | 10.067*** (2.640) | 20.036*** (3.798) | 3.727*** (3.524) |
| σ | 21.823 | 3.470 | 11.570 | 21.774 | 30.159 | 41.784 | 8.404 |
| N | 254 | 254 | 254 | 254 | 254 | 254 | 254 |
| R^2 / \bar{R}^2 | 0.77 / 0.77 | 0.66 / 0.65 | 0.73 / 0.73 | 0.77 / 0.77 | 0.79 / 0.79 | 0.78 / 0.78 | 0.71 / 0.71 |
| F* | 428 | 239 | 335 | 427 | 470 | 445 | 311 |

* = 90%, ** = 95%, *** = 99% confidence, numbers in parentheses are t-statistics. Heteroskedasticity Consistent. These t-values and standard errors are based on White's heteroskedasticity consistent variance matrix.

Figure 1: Effect of Public Sector on Median Wage (Model 2)

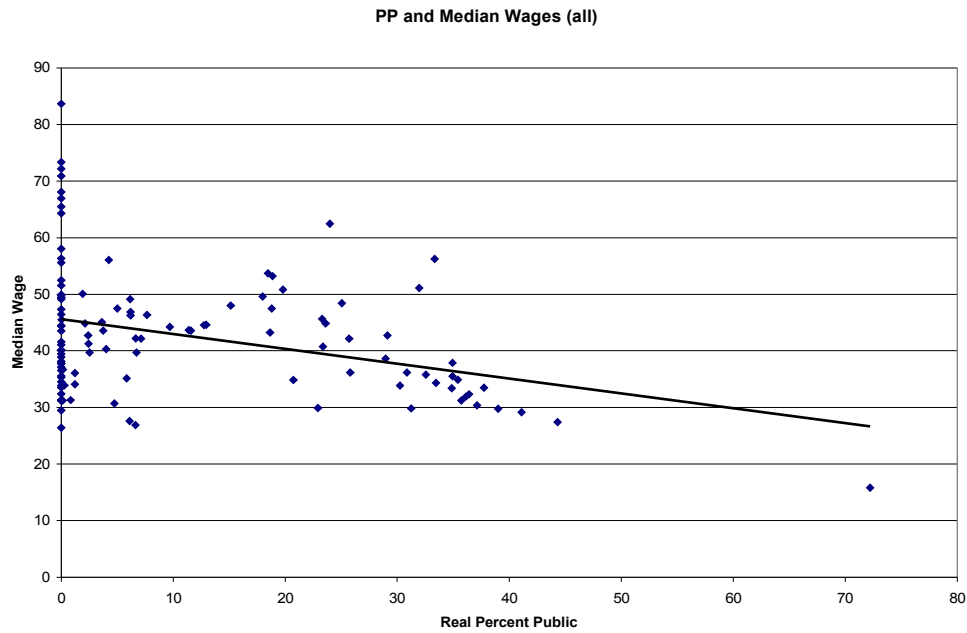


Table 4: Effect of Public Sector on Bottom Quintile Wage (Model 2)

| <i>1st Quintile Wage</i> | <i>Coefficients</i> | <i>Standard Error</i> | <i>t Stat</i> |
|--------------------------|---------------------|-----------------------|---------------|
| Intercept | 8.37 | 4.45 | 1.88 |
| Cycles | 0.04 | 0.03 | 1.27 |
| percent public | -0.16 | 0.11 | -1.49 |
| tax type* | -2.75 | 2.60 | -1.06 |
| min wage | 0.90*** | 0.08 | 10.61 |
| Living Wage | -0.73 | 2.03 | -0.36 |
| Target Unemployment | 46.35 | 39.84 | 1.16 |
| Real Percent Public | -0.16*** | 0.05 | -2.98 |
| Average Tax Rate | 26.44* | 13.35 | 1.98 |

R Square = 0.66, n = 116

* Tax Type
 0 = flat
 1 = progressive

Table 5: Effect of Public Sector on Top Quintile Wage (Model 2)

| | <i>Coeffi- cients</i> | <i>Standard Er- ror</i> | <i>t Stat</i> |
|--------------------------|---------------------------|-----------------------------|---------------|
| Intercept | 18.37 | 16.62 | 1.11 |
| Cycles | 0.59 | 0.11 | 5.49 |
| Percent Public | 0.54 | 0.41 | 1.31 |
| Tax Type* | -14.93 | 9.70 | -1.54 |
| min wage | 1.07*** | 0.32 | 3.37 |
| Living Wage | -5.61 | 7.60 | -0.74 |
| Target Unemploy- ment | 160.69 | 148.91 | 1.08 |
| Real Percent Public | -0.47*** | 0.20 | -2.32 |
| Average Tax Rate | -207.52*** | 49.91 | -4.16 |

R Square = 0.53, n = 116

* Tax Type
0 = flat
1 = progressive

Table 6: Effect of Public Sector on Median Wage (Model 2)

| | <i>Coeffi- cients</i> | <i>Standard Error</i> | <i>t Stat</i> |
|--------------------------|---------------------------|---------------------------|---------------|
| Intercept | 40.32 | 3.33 | 12.12 |
| percent public | 0.19 | 0.16 | 1.17 |
| min wage | 0.29 | 0.16 | 1.81 |
| Target Unemploy- ment | 67.80 | 52.52 | 1.29 |
| Average Tax Rate | -23.61 | 10.22 | -2.31 |

R Square = 0.13 n = 69

Figure 2: Effect of Tax Rate on Private Sector Median Wage (Model 2)

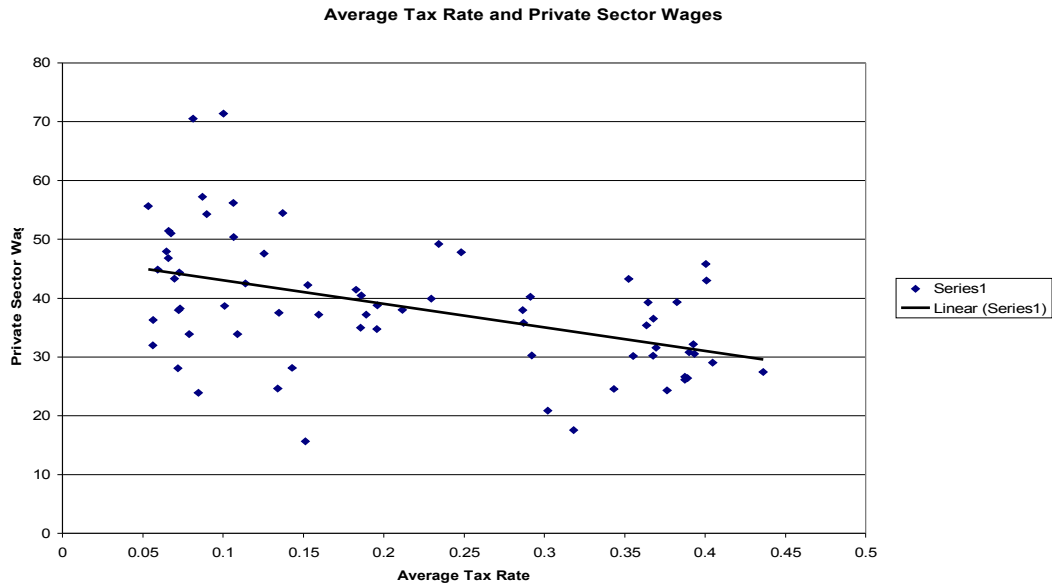


Figure 3: Effect of Tax Rate on Median Wage (Model 2)

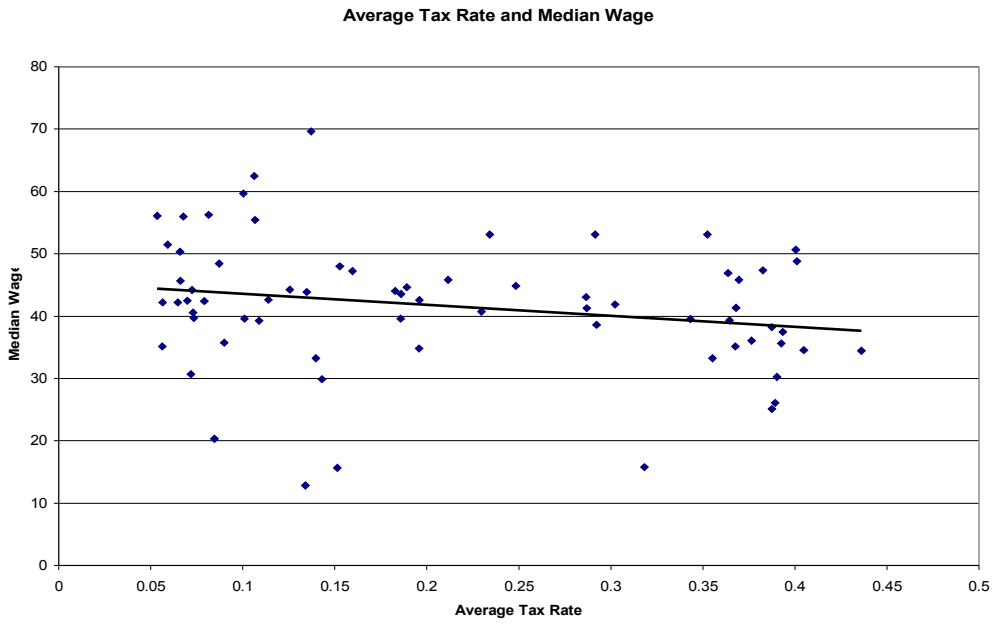


Figure 4: Effect of Public Sector on Unemployment (Model 1, responsive)

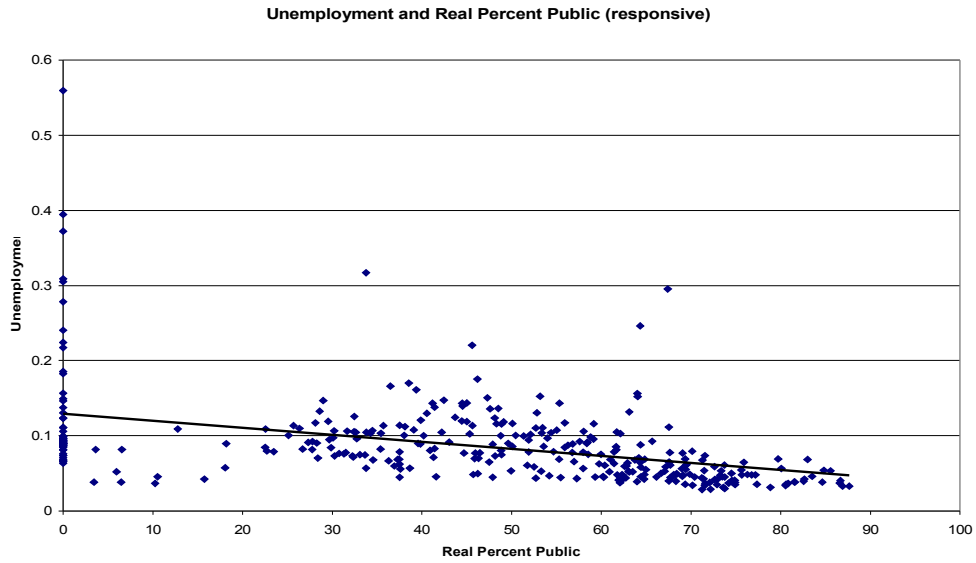


Figure 5: Effect of Public Sector on Unemployment (Model 1, non-responsive)

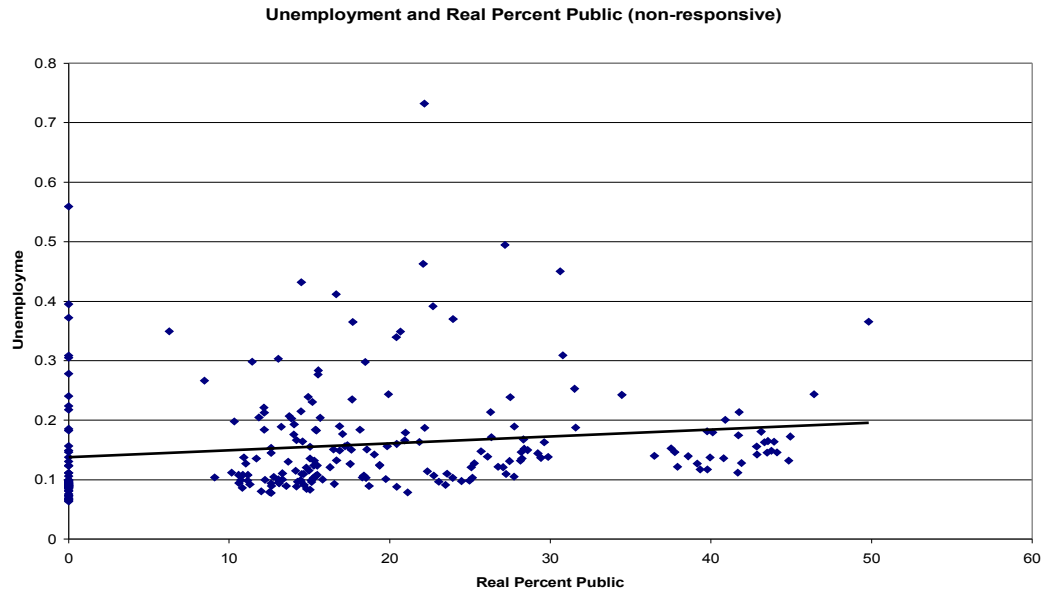


Figure 6: Effect of Public Sector on Unemployment (Model 2)

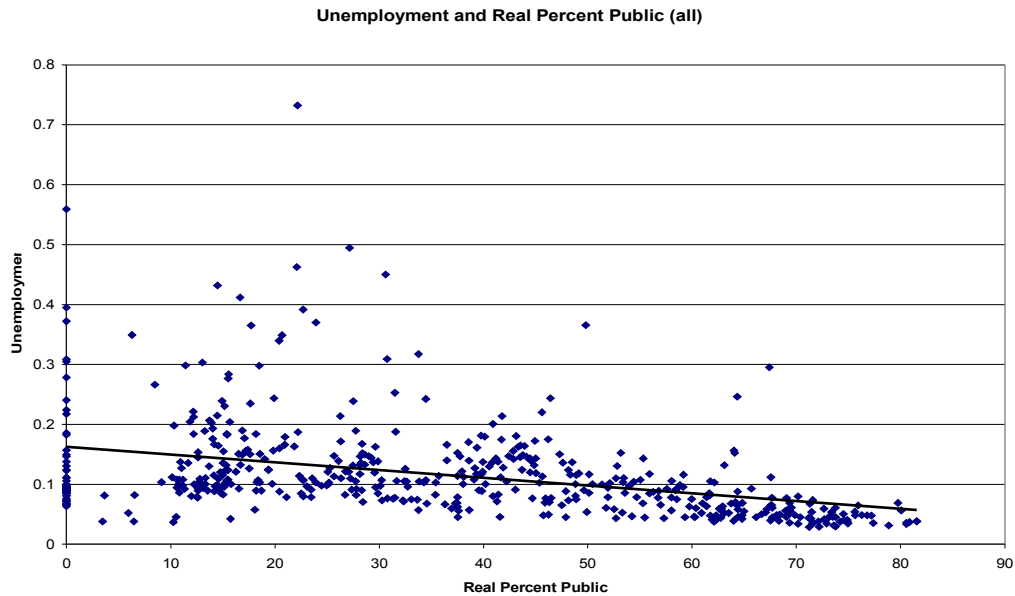


Table 7: Effect of Public Sector on Unemployment and Poverty (Model 1, responsive)

| Variable | MEDIAN SOL | Unemp | Poverty |
|-------------------|------------------------|----------------------|---------------------|
| Constant | 4.490*** (58.347) | 0.174*** (12.179) | -0.030* (-2.000) |
| PUB | -0.057*** (-28.974) | 0.002*** (4.180) | 0.003*** (4.479) |
| TAX | 0.099** (2.309) | 0.004 (0.456) | 0.001 (0.129) |
| $\hat{\sigma}$ | 0.340 | 0.062 | 0.067 |
| N | 254 | 254 | 254 |
| R^2 / \bar{R}^2 | 0.85 / 0.85 | 0.22 / 0.22 | 0.27 / 0.27 |
| F* | 714 | 36 | 47 |

Table 8: Effect of Public Sector on Unemployment (Model 2)

| | <i>Coeffi- cients</i> | <i>Stan- dard Er- ror</i> | <i>t Stat</i> |
|--------------------------|---------------------------|-----------------------------------|---------------|
| Intercept | 0.160 | 0.014 | 11.783 |
| Cycles | -0.000*** | 5.04E-05 | -3.949 |
| percent public | -0.001*** | 0.000 | -2.430 |
| tax type | 0.005 | 0.006 | 0.929 |
| min wage | 0.002 | 0.000 | 8.583 |
| Target Unemploy- ment | -1.684*** | 0.203 | -8.319 |
| Real Percent Public | 0.000 | 0.000 | 0.629 |
| Average Tax Rate | 0.011 | 0.042 | 0.260 |

R Square = 0.395 n= 530

Table 9: Effect of Public Sector on SOL Quintiles (Model 1, non-responsive)

| Variable | Quin1 SOL | Quin2 SOL | Quin3 SOL | Quin4 SOL | Quin5 SOL |
|-------------------|-------------|-------------|-------------|-------------|-------------|
| Constant | 2.507*** | 3.320 *** | 4.48*** | 5.943*** | 8.167*** |
| | (29.427) | (51.578) | (58.565) | (39.502) | (28.596) |
| PUB | -0.022*** | -0.028*** | -0.057*** | -0.101*** | -0.163*** |
| | (-9.253) | (-12.885) | (-28.914) | (-29.010) | (-24.198) |
| TAX | 0.040 | 0.033 | 0.099** | 0.301*** | 0.665*** |
| | (0.853) | (0.925) | (2.320) | (3.482) | (4.099) |
| $\hat{\sigma}$ | 0.379 | 0.281 | 0.339 | 0.686 | 1.283 |
| N | 254 | 254 | 254 | 254 | 254 |
| R^2 / \bar{R}^2 | 0.40 / 0.39 | 0.67 / 0.67 | 0.85 / 0.85 | 0.81 / 0.81 | 0.77 / 0.77 |
| F* | 82 | 254 | 714 | 548 | 415 |

* = 90%, ** = 95%, *** = 99% confidence, numbers in parentheses are t-statistics. Heteroskedasticity Consistent. These t-values and standard errors are based on White's heteroskedasticity consistent variance matrix.

Table 10: Effect of Public Sector on Wages and SOL (Model 1, responsive)

| Variable | MEDIANWAGE | MEANWAGE | MEDIANSOL | MEANSOL |
|-------------------|-----------------------|-----------------------|---------------------|----------------------|
| Constant | 46.85*** (9.36) | 0.174*** (12.18) | 4.508*** (9.15) | 4.702*** (9.33) |
| PP* | -1.38*** (-3.019) | -1.22 (-1.30) | -0.083* (-1.84) | -0.109*** (-2.35) |
| TAX | 5.13 (1.600) | 7.80 (1.18) | 0.279 (0.88) | 0.400 (1.24) |
| MINWAGE | 0.025 (0.142) | -0.24 (-0.68) | -0.040** (-2.32) | -0.035* (-1.99) |
| RESPONSIVE | -11.57*** (-3.355) | -29.54*** (-4.170) | -0.637* (-1.878) | -0.780** (-2.25) |
| $\hat{\sigma}$ | 9.69 | 19.90 | 0.95 | 0.97 |
| N | 47 | 47 | 47 | 47 |
| R^2 / \bar{R}^2 | 0.53 / 0.47 | 0.69 / 0.48 | 0.34 / 0.58 | 0.40 / 0.63 |
| F* | 11.88 | 9.5 | 5.33 | 7.09 |

Percent Public was either 0 or 10 in this series of runs, while Responsive was either 1 or zero. Another regression was done comparing the “real percent public” taken as an average over the cycles. For this the coefficient was 19.90 with a t-stat of -2.44 and p-value of 0.019

Table 11: Effect of Public Sector on Poverty (Model 2)

| | <i>Coeffi- cients</i> | <i>Standard Er- ror</i> | <i>t Stat</i> |
|---------------------|---------------------------|-----------------------------|---------------|
| Intercept | 0.17 | 0.09 | 1.95 |
| Cycles | 0.00 | 0.00 | -0.90 |
| percent public | 0.00 | 0.00 | -0.83 |
| tax type | 0.01 | 0.03 | 0.39 |
| min wage | 0.00 | 0.00 | -1.60 |
| Living Wage | 0.02 | 0.04 | 0.36 |
| Target Unemployment | -1.12** | 0.62 | -1.79 |
| Real Percent Public | 0.00 | 0.00 | -0.15 |
| Average Tax Rate | -0.03 | 0.16 | -0.20 |

R Square = 0.16 n =
116

Table 12: Effect of Tax Type on Revenue Collection (Model 1, non responsive)

| % Public | Progressive | Flat | Cost |
|----------|-------------|-------|-------|
| 0 | 2670 | 1516 | 0 |
| 5 | 11367 | 7308 | 2500 |
| 10 | 17104 | 12719 | 5000 |
| 15 | 11613 | 14893 | 7500 |
| 20 | 7394 | 8191 | 10000 |
| 25 | 3238 | 5188 | 12500 |
| 30 | 3140 | 2972 | 15000 |
| 40 | 2272 | 2183 | 20000 |
| 50 | 3434 | 3001 | 25000 |

Figure 7: Share of Public Employment in OECD countries

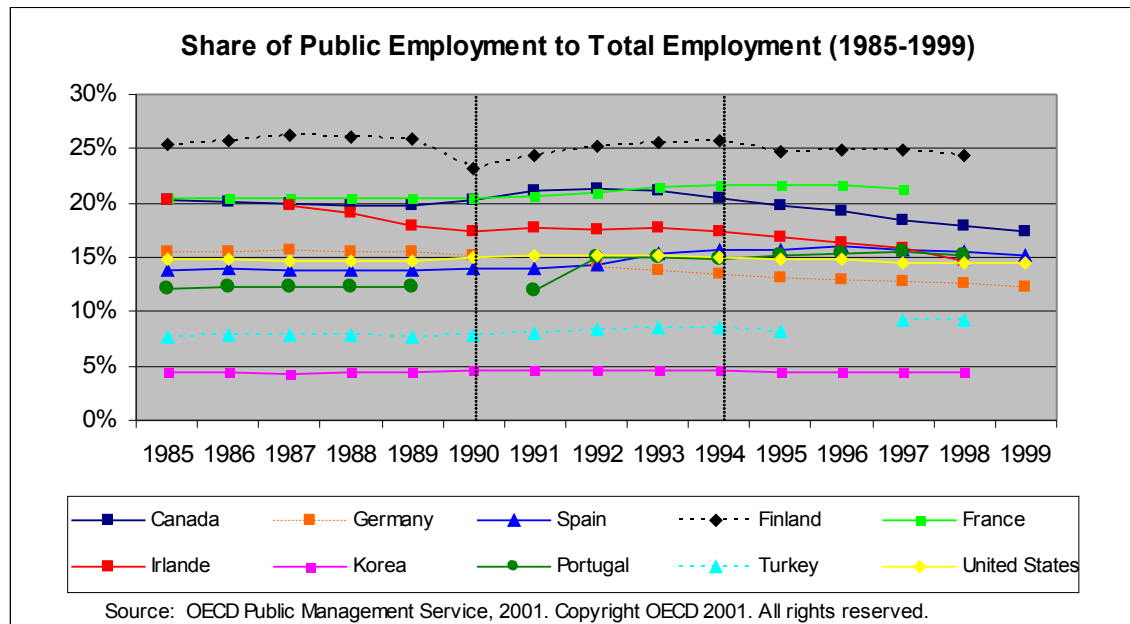


Table 13: A sample of social assistance spending and unionization

| Country | SOCX | WCOORD | GDPC |
|-------------|-------|--------|-------|
| Sweden | 29.99 | 4 | 19770 |
| Denmark | 26.99 | 5 | 20948 |
| Netherlands | 26.92 | 3 | 17606 |
| Belgium | 25.94 | 5 | 16987 |
| Austria | 24.10 | 4 | 17403 |
| Germany | 23.95 | 4 | 19011 |
| France | 23.09 | 2 | 17125 |
| Italy | 21.62 | 2 | 18914 |
| UK | 21.10 | 1 | 16377 |
| Norway | 19.10 | 5 | 19942 |
| Canada | 17.39 | 1 | 21719 |
| Switzerland | 14.20 | 5 | 22413 |
| Australia | 13.26 | 4 | 18386 |
| US | 12.96 | 1 | 24179 |

Notes: SOCX is the percent of GDP of social welfare spending; WCOORD is an index of wage coordination, with 1 as the least and 5 the most coordinated; GDPC is GDP per capita in constant US dollars. For more information, see Nell (2005) and for the complete dataset, see

<http://www.lisproject.org/publications/welfaredata/welfareaccess.htm>

Appendix

The Model

The following describes an agent based model of the market. The model employs three kinds of agents: private firms, individuals and public firms which act as subsidized or government entities. Individuals work at a public or private firm and purchase goods from at the cheapest price available, given imperfect information. The public firms play the role of *employer of last resort* (ELR), provide goods at a flat price and pay the same wage to all employees, regardless of productivity. Private firms hire and sell their product for profit, using learning to determine the most profitable price given demand and costs, and bid for labor based on productivity in a labor market.

Two kinds of ELR are considered. One is fixed-size, with a certain percentage of the labor force hired by the government. This models the kind of policy in which, for example, a bill is passed to provide a certain amount of public relief employment for those in need. The second is a responsive ELR, which represents a program aimed to keep unemployment low by growing to hire the unemployed as necessary.

Two kinds of income tax are also compared, flat and progressive, and a parameter determines the minimum wage.

The revenue of taxation is not matched to the profit/loss of individual public firms but is based on learning by the public sector as it attempts to pay for the ELR program, and taxes are cut when revenue exceeds costs. Inventory in the public sector is based on productivity of the workers, as it is in the private sector.

The basic model is as follows.

Agents

Individual: An individual works at private or public firm, but can become an entrepreneur and open a private firm (and then exit as individual). Population growth refreshes the stock of individuals. Individuals begin with a certain level of productivity based on a uniform distribution between 0 and 1 and are later able to train to increase this level. Individuals may also receive on-the-job training by an employing firm. This productivity level helps to determine the amount of products the individual can create for the employing firm (and hence the individual's worth to the firm) when the individual is employed.

Public Firm: A public firm is funded by taxation, need not make profit and hires the least productive workers looking for work first. It hires workers at a flat rate which is determined by the government based on revenue and difficulty of hiring, or may be set by a parameter to a “living wage” level determined by the price level in the market. If revenue falls short of wage costs for several cycles even as taxes have been adjusted, the wage is reduced and some workers are laid off, in an attempt to bring the program back under budget. Once the budget is balanced it may expand again to soak up unemployment and adjust taxes to pay for the expansion.

Private Firm: a private firm must make a profit or it will shut down. Profits are used to expand – to hire more workers. Private firms bid on workers in the labor market based on the level of productivity of the worker.

A. Individual

1. Decision to start business:

Entry is based on an individual's level of productivity, the highest wage in the job market (an indicator of profit levels) and a stochastic factor.

Open firm if $Pr_i > 0.7$ and $W_a > 0$ and $c > 5$ and $W_h > r * W_a$ and rr
Otherwise no action

Where Pr_i is the productivity of the individual, W_a is the accepted wage, W_h is the highest wage on the market, r is a multiplier between 1 and 4, rr is a stochastic condition and c is the total number of cycles that have passed in the lifetime of the model.

2. Choice of workplace:

Individuals take the highest offered wage if it is higher than their previous wage, higher than an expected wage or if they have waited and nothing else becomes available.

Job Strategy :

Accept if $W_j > W_i$
Accept if $W_j > (W_a * Pr_i * 5)$
Accept if $t > 2$ and $Pr_i < 0.5$
Accept if $t > 4$
Else wait

Where W_j is the wage offered by firm j , W_l is the last wage of the worker, W_a is the average wage in the marketplace, Pr_i is the productivity of the worker and t is the time in cycles that the worker has been on the job market.

3. Choice to train:

Individuals who do not choose to become an entrepreneur can instead train.

$Pr_i = Pr_i + r$ and $W_a = 0$ and $J = 0$ if $Pr_i < 0.9$ and $W_a > 0$ and $c > 5$ and $W_H > 2.5 * W$ and rr
Otherwise no action

Where r is a random addition to productivity, J is the firm with which the individual works. The decision to train is based on having a job and a wage, the chance to earn at least 2.5 times as much (W_H is the highest wage in the market) and a stochastic factor. Training has a cost associated with it: the individual's current job and the wage for the cycle. Training adds a 0.0-0.1 increase in productivity and hence earning power.

4. Shopping:

Individuals shop at firms which offer the lowest price, subject to their own utility (based on a randomized set of preferences³), and a stochastically determined level of incomplete information.

B. Private firm

1. When to hire:

³ Results which agree, from several versions of the model, are presented here. In the simpler versions only one product is sold on the market by all firms, and hence individual's preference is only for the lower price. In the more complex versions, individuals have stochastically generated preferences, which firms recognize and respond to by offering the various products according to the ones they expect the best return on. One version of the model uses Cobb-Douglas utility functions for the individuals.

Private firms hire when they have profit, subject to a profit-maximization learning scheme similar to the GALCS used to set product price. Firms may also choose to reduce costs by investment in capital instead of labor, subject to the same GALCS learning algorithm. Earlier versions of the model used a simpler reinvestment algorithm in which profits were immediately invested in hiring.

2. Whom to hire:

The wage offered by the firm (W_{0ji}) before the firm is profitable is determined by the price (P_j) and cost (C_j) of the firm's product, the capital (Cap_j) of the firm and the individual's productivity level (Pr_i). Once the firm is profitable, the initial wage offering is determined based on pre-wage profitability (PWP) and the productivity of the worker.

$$W_{0ji} = (P_j - C_j) \times Cap_j \times Pr_i$$

$$W_{0ji} = (PWP_j / NE_j) \times Pr_i$$

$$Wh_{ji} = HB_i + (HB_i \times Pr_i \times 0.25) + Cap_j$$

The higher wage that the firm is willing to bid (Wh_{ji}) is the highest bid in the market (HB_i), plus a percentage higher which is based on the productivity of the worker, plus a small increase based on the capital of the firm, such that even low productivity workers will have bidding up especially by the advantaged firms in the market. This bidding will only occur if the higher bid is less than the maximum the firm is willing to offer (Max_{ji}) for the worker.

$$\text{Max}_{ji} = (\text{PWP}_j / \text{NE}_j) \times (\text{Pr}_i / \text{Pr}_a)$$

3. Firing and Failure:

First a firm will adjust price when it incurs a loss. If the loss continues, the firm will lay off low profit employees. Beginning with the employees whose wages are highest compared to their profitability (those where the firm had to bid up the most in order to hire them) the firm lays off workers as necessary.

If the firm incurs loss for a certain number of cycles (determined stochastically, with advantage to firms with higher capital) or remains without employees or inventory for three consecutive cycles, the firm fails and the agent exits.

4. What to Sell

Firms, in versions of the model with multiple preferences, survey demand on the marketplace, and base the decision about what to sell according to the number of other sellers in the marketplace for the given product, and a comparison of the average price asked by those sellers with the cost of producing that product, for the given firm. Firms have a stochastically generated cost function, but costs can be reduced by investing in capital.

5. Pricing Strategy:

This pricing strategy taken directly from Basu and Prior (1997).

Each private firm uses a genetic algorithm learning classifies system (GALCS) to set product prices. A private firm determines four trends daily: (a) whether product price has been recently increasing or decreasing, (b) whether sales have been recently increasing or

decreasing, (c) whether profits have been recently increasing or decreasing, and (d) whether prices are higher or lower than the industry average. Based on answers to (a) through (d), the firm finds itself in one of 16 states.

The GALCS assign a probability vector (P_D, P_I, P_C) to each state. Each state begins with a probability vector (P_D, P_I, P_C) set to the default $(0.4, 0.3, 0.3)$ where

P_D = the probability that the firm will decrease a given price.

P_I = the probability the firm will increase the price.

P_C = the probability the firm will keep the price constant.

When profit is higher than the previous cycle, the action which produced the higher profit is increased in probability in the vector.

C. Public Firm

1. Hiring decision

Target Size:

The government hires using a default wage and maintains the defined percentage of the labor market as employees.

hire $n \times (PP_t - PP) / 100$ if $PP_t > PP$

fire $n \times (PP - PP_t) / 100$ if $PP_t < PP$

Target Employment Levels:

The government hires using a default wage and targets the defined unemployment level.

hire $n \times (U - U_t) / 100$ if $U > U_t$

fire $n \times (U_t - U) / 100$ if $U < U_t$

2. Taxation:

The government uses a strategy similar to the private firm's pricing strategy, except the government has only one state, it increases and decreases tax level according to whether revenue is increased. However it only maximizes revenue when it must in order to afford the ELR program. When revenues exceed the cost of the program, government cuts taxes.

$$\text{Flat tax logic} \begin{cases} T_f = PP \times W_i \text{ if } W_i \geq W \\ \text{Otherwise } T_f = 0 \end{cases}$$

$$\text{Progressive tax logic} \begin{cases} T_p = 0 \text{ if } W_i < W \\ T_p = PP \times W_i \text{ if } W_i < W \times 2 \\ T_p = (PP \times 2 \times W) + (1.5 \times PP \times (W_i - (2 \times W))) \\ T_p = (PP \times 2 \times W) + (1.5 \times PP \times W) + (2 \times PP \times (W_i - (3 \times W))) \end{cases}$$