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Self insurance and public employment programs

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Abstract

The paper studies the labor allocation decision by households faced with non-insurable labor income risks and establishes a case for a government sponsored public employment program as a provider of self-insurance to such households. We study the equilibria of a two period general equilibrium model with incomplete markets and two types of firms - a privately owned one offering a risky wage contract and a public works program offering a relatively riskfree one. We show that the employment level in the public program is higher in our model economy compared to that in a benchmark complete markets economy.

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1 Introduction

The paper studies the labor allocation decision by households faced with non-insurable idiosyncratic labor income risks and establishes a case for a government sponsored public employment program as a provider of self-insurance to such households. Many developing economies uses these programs as a poverty alleviating device (see Murgai and Ravallion (2005)) and several OECD countries have used similar programs over the last two decades, as a labor market policy tool to move the long-term unemployed into employment or to assist the most disadvantaged segments of the labor market (see for example, Brodsky (2000), Fredriksson (1999), Rose (2001), Dahlberg and Forslund (2005)). A common feature of these programs across nations is that the government committs to employ a part of the household's labor supply at a relatively stable wage rate. The present paper analyzes the importance of this feature as a means whereby households faced with unisurable labor income risks can achieve a smoother consumption stream. The current literature is predominantly focused on the effectiveness of these programs as an anti-poverty device or as a means of raising employment levels. Little attention has been paid on their role as a provider of self insurance and the present work attempts to fill that gap. The paper complements the existing literature on formal and informal methods of risk sharing and consumption smoothening in the presence of idiosyncratic risks (see for example, Arnott and Stiglitz (1991), Townsend (1994, 1995), Townsend and Mueller (1998), Lim and Townsend (1998)).

We consider an economy with multiple sectors of production, each subject to an idiosyncratic productivity shock and incomplete asset markets, so that such shocks cannot be completely diversified away. A working household with a sector specific skill chooses to allocate its available time between a private and a public firm in that specific sector. Private firms pay a wage rate equal to the marginal product which is therefore risky. The public firms on the other hand pool their output across all sectors together and distibute the total output as wages among all their workers. By pooling their output, public firms are able to diversify some of their sector specific risks and the resulting wage rate they provide is less variable than the private wage rates.

The paper compares the equilibrium employment levels in the private and public firms in our model economy with those in a benchmark economy in which a complete set of Arrow securities are traded - that is all diversifiable idiosyncratic risks are diversified away.

The main qualitative result of the paper is that the employment levels in the private firms are lower and in the public firms higher in the incomplete markets economy compared to their counterparts in the benchmark complete markets economy, for reasonable levels of risk aversion. Thus public firms, by offering a relatively more stable wage rate than private firms, act as a provider of insurance in the incomplete markets economy. Preliminary results also indicate that several factors can influence the difference in the employment levels of the two economies - such as the degree of risk aversion, the correlation between the sectoral shocks etc.

2 The Model

The economy consists of J sectors of production or activities, lasts for two periods 0 and 1, and experiences S possible states of Nature at date 1. It is inhabited by a continuum of households who are either workers or entrepreneurs. In either capacity, a household has sector specific skills which allow it to seek employment or operate a firm in one sector or activity only, that is there is no mobility between sectors. We shall indicate household type by the sector in which it has specific skill.

In each sector, output is produced by numerous private firms and a state owned or public firm. Thus a worker-household of type j chooses to allocate its available time between a private and the public firm. At date 1, at state s, each sector j suffers a total productivity shock η_j^s with probability ρ_s. Shocks are multiplicative. The output of a private firm in state s, in sector j is given by $y_j^p(s) = \eta_j^s f(l_j, k_j)$ where l_j and k_j stand for labor and capital respectively.

The private wage rate in any sector is state contingent - that is depends on the productivity shock realized at date 1. Employment decisions however are made at date 0 and adhered to regardless of the state of nature. The present model thus fits situations in which labor is contractual rather than casual - such as sharecropping, jobs in unionized industries etc. This further implies that production risks are shared by entrepreneurs and workers through fluctuations in the the wage rate rather than in the level of employment. W_j^s denotes the wage rate paid to the worker in the private firm in sector j in state s.

State firms are subject to the same productivity shocks as private firms are in any sector. For simplicity, we assume state firms to operate with fixed stocks of capital. The output of the state firm in sector j, in state s is given by $y_j^g(s) = \eta_j^s g(l_j^g)$ where l_j^g represent labor employed by the state firm. Private and public production functions are assumed to satisfy the usual neoclassical assumptions of linear homogeneity and Inada conditions.

In addition to engaging in production, households can trade in financial assets, which allow them to diversify the sectoral shocks. In particular, households trade in equities or ownership shares of the private firms. These are assumed to be the only assets in the economy. Thus there are J independent assets in the economy. We assume $J < S$, implying that markets are incomplete and households can only partially diversify the sectoral shocks using these. We denote by δ_i^j the share of a firm in sector i purchased by an entrepreneur household of type j. θ_i^j denotes the share of a representative firm in sector i purchased by a worker household of type j. We denote by Q_i the full price of a firm in sector i and by V_s^j the dividend paid to the shareholders of a private firm in sector j in state s.

Finally all households have identical preferences and maximize expected utility over two periods. The state independent utility function satisfies the usual Inada conditions and concavity.

Entrepreneur's decision: At date 0, firms purchase capital stock for the next period and shares of other firms. Denote by $x^j = \{x_s^j\}_{s=0}^S$ the consumption vector and by $e^j = \{e_s^j\}_{s=0}^S$ the given endowment vector of the entrepreneur household of type j. Then the feasible consumption set of type j entrepreneur is given by,

$$x_0^j = e_0^j + (1-\delta_j^j)Q_j - \sum_{\substack{i=1 \\ i\neq j}}^{J} \delta_i^j Q_i - k_j$$

$$x_s^j = e_s^j + \sum_{i=1}^{J} \delta_i^j V_s^i, \forall s \tag{1}$$

Entrepreneur households choose x^j, k_j, l_j and $\{\delta_i^j\}_{j=1}^J$, to maximize

$$U(x^j) = u(x_0^j) + \sum_{s=1}^{S} \rho_s u(x_s^j)$$

subject to the budget constraint (1) and given asset prices and wage rates.

Worker's decision: A worker household in any sector is assumed to have 1 unit of time available to allocate between the private and the state firms. Without loss of generality, we assume that working for the private firm is costly (in terms of effort and leisure) but working for the state firm is not. The cost of supplying labour to the private firm is $c_j(l_j)$, where $c_j'(l_j) > 0$ and $c_j'' \geq 0$. Since it is costless for households to work for state firms, it is optimal for them to supply any residual labour to it. Hence $l_j^g = 1 - l_j$.

Denote by $m^j = \{m_s^j\}_{s=0}^S$ the consumption vector, by $\omega^j = \{\omega_s^j\}_{s=0}^S$ the endowment vector and by G_s the wage rate at a state firm. The feasible consumption set of the worker household of type j is given by,

$$m_0^j = \omega_0^j - \sum_{i=1}^J \theta_i^j Q_i$$

$$m_s^j = \omega_s^j + W_s^j l_j + (1 - l_j) G_s + \sum_{i=1}^J \theta_i^j V_s^i, \forall s \tag{2}$$

The household chooses m^j, l_j, and $\{\theta_i^j\}_{j=1}^J$ to maximize

$$U(m^j, l_j) = u(m_0^j) + \sum_{s=1}^S \rho_s u(m_s^j) - c_j(l_j)$$

subject to the budget constraint (2), given private and public wages and asset prices.

Government's decision: We assume that state firms pay a uniform wage rate across all sectors and are also self financing. Hence the total ouput of the state firms from all the sectors are pooled and distributed through an uniform wage rate. Hence

$$G_s = \frac{\sum_{l=1}^J \eta_j^s g^j (1 - l_j)}{\sum_{l=1}^J (1 - l_j)} \tag{3}$$

Note that the state firm wage rate is state contingent but uniform across the sectors because of the pooling of output. Thus G_s has less variance than W_s^j, as the pooling of output diversifies away some of the sector specific risks. This is the key feature of the model which drives most of the results reported.

Finally profit maximization by private firms ensure that private wages are equal to marginal products at each state. Moreover under competition firms earn zero profits in equlibrium. Hence, output net of wage costs are paid out as dividends to the shareholders.

$$W_s^j = \frac{\partial Y_j^p(s)}{\partial l_j}, \forall s, \forall j \tag{4}$$

$$V_j^s = y_j^p(s) - W_s^j l_j \tag{5}$$

3 Preliminary Results

The model has closed form solution if preferences are assumed to have constant absolute risk aversion (CARA) and shocks are normal. CARA preferences however do not satisfy the Inada conditions. This combined with normal shocks lead to the possibility (albeit with a vary small probability) of negative consumption in some state in equlibrium. Hence CRRA utility function is preferred. With CRRA preferences however closed form expressions for equlibrium allocations are no longer possible. The preliminary results reported here in the tables are therefore based on numerical solutions of the model for reasonable parameter values.

We assume CRRA preferences, Cobb-Douglas production functions for the state and private firms and linear disutility from labor. We assume two sectors and five states of Nature. We then solve for the equilibrium of the model numerically for some reasonable values of the preference, technology and shock parameters. For purposes of comparison, we also numerically solve for the equlibrium of a benchmark Arrow-Debreu economy with the same preferences and technology but having a complete set of Arrow securities. The numerical results are reported in Tables 1-3 and the qualitative results are summarized below. The interested reader is also referred to the Appendix for the first order and market clearing conditions which characterize the equlibrium of our model.

The main conclusion that emerges from a comparison of the equilibrium employment levels of the private firms in our model and the benchmark economies is that these levels are higher (public employment levels are lower) in the benchmark (complete markets) economy. By offering a wage contract which is less variable than the wage contract offered by private firms under competitive settings, public firms enable workers to smooth their consumption across states. Thus public firms provide insurance to workers when markets fail to do so.

The difference between the private employment levels under complete and incomplete markets depends amongst other factors, on the degree of relative risk aversion of workers. The difference is higher the lower the coefficient of relative risk aversion. As this coefficient increases workers seek employment in the private firms less and less, *irrespective of whether markets are complete or incomplete*. The difference between the two cases also diminishes as a result.

The difference between the private employment levels under complete and incomplete markets also depends on whether the sectoral shocks are negatively or positively correlated and on how high these correlations are. A comparison of the three tables reveal this. When sectoral shocks are negatively correlated, the public firms are better able to diversify these shocks by pooling together their output across sectors. This results in a less variable wage rate across states in the public sector compared to a situation in which the shocks are positively correlated. Thus public firms are able to insure better when shocks are negatively correlated than when they are otherwise. The higher the absolute magnitude of the negative correlation, the greater the insurance gains from working in public firms and the greater the difference in the private employment levels in the two cases.

The preliminary results show that public employment programs provide insurance when markets are incomplete. It is futher reinforced by the fact that when we allow private firms to adopt a different wage setting (instead of wages equal to marginal product) - for instance one under which a fully informed entrepreneur take the worker's optimal labor supply response into account in setting a wage rate - there is no difference between the employment levels between our model and the benchmark model (Tables 4-5).

4 Appendix I

Here we lay down the agents' first order and the market clearing conditions which characterize the equilibrium of our model economy. Numerical solutions of the employment levels for selected parameter values are reported in the tables.

Individual first order conditions

For each worker household of type j, the optimal choice of l_j and θ_i^j must satisfy,

$$\sum_{s=1}^{S} \rho_s u'(m_s^j)(W_s^j - G_s) - c_j'(l_j) = 0 \tag{6}$$

$$\sum_{s=1}^{S} \rho_s u'(m_s^j)(Y_i^p(s) - W_s^i l_i) - u'(m_0^j) Q_i = 0, \forall i \tag{7}$$

For each entrepreneur household of type j, the optimal demand for l_j, k_j and the optimal choice of δ_i^j must satisfy,

$$\begin{aligned}
\sum_{s=1}^{S} \rho_s u'(x_s^j)\left(\frac{\partial Y_j^p(s)}{\partial l_j} - W_s^j\right) &= 0 && (8)\\
\sum_{s=1}^{S} \rho_s u'(x_s^j)\left(\delta_j^j \frac{\partial Y_j^p(s)}{\partial k_j}\right) - u'(x_0^j) &= 0 && (9)\\
\sum_{s=1}^{S} \rho_s u'(x_s^j)(Y_i^p(s) - W_s^i l_i) - u'(x_0^j) Q_i &= 0 \forall i && (10)
\end{aligned}$$

market clearing conditions

Since all assets are shares of the private firm, in equilibrium the shares in each sector must add up to one. Hence asset market clearing conditions are given by,

$$\sum_{i=1}^{J} \delta_j^i + \sum_{i=1}^{J} \theta_j^i = 1, \forall j \tag{11}$$

The first order and market clearing conditions above together with equations (4) and (5) characterize the equilibrium of the model economy.

5 Appendix II

This section describes the benchmark Arrow-Debreu economy against which we compare our model numerically.

An Arrow security pays an unit of the consumption good at date 1 contingent on the realization of a specific state of Nature. Let p_s represent the price of an Arrow security which pays an unit of the good contingent on the realization of state s. Let ξ_s^j represent the quantity of such an Arrow security purchased by the entrepreneur household of type j. Then the budget set of the jth type of entrepreneur is given by

$$
\begin{aligned}
x_0^j &= e_0^j - k_j - \sum_{s=1}^{S} p_s \xi_s^j \\
x_s^j &= e_s^j + Y_j^p(s) - W_s^j l_j + \xi_s^j, \forall s
\end{aligned}
\tag{12}
$$

Let ζ_s^j represent the quantity of an Arrow security which pays one unit of the good at state s, purchased by a worker household of type j. The budget set of the jth type of worker household is given by,

$$
\begin{aligned}
m_0^j &= w_0^j - \sum_{s=1}^{S} p_s \zeta_s^j \\
m_s^j &= W_s^j + W_s^j l_j + (1 - l_j) G_s + \zeta_s^j, \forall s
\end{aligned}
\tag{13}
$$

An entrepreneur of type j chooses x^j, k_j, l_j and ξ_s^j for all s to maximize its expected utility subject to its budget constraint. A worker household of type j chooses m^j, l_j and ζ_s^j for all s to maximize its utility subject to its budget constraint.

An Arrow Debreu equlibrium is charaterized by the first order conditions of the entrepreneurs and workers with respect to their choice variables, the labor market clearing conditions and the following Arrow securities market clearing conditions,

$$
\sum_{j=1}^{J} (\xi_s^j + \zeta_s^j) = 0, \forall s \tag{14}
$$

The specific first order conditions are not provided here for lack of space but are availble on request.

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Table 1: Private employment levels under competitive wage settings in the incomplete markets and Arrow-Debreu economies

	Sector 1		Sector 2	
β	$\overline{l_1}$	$\hat{l_1}$	$\overline{l_2}$	$\hat{l_2}$
0.9	0.78	0.85	0.60	0.72
1.0	0.50	0.56	0.41	0.51
1.1	0.32	0.37	0.28	0.36
1.3	0.15	0.18	0.14	0.18
1.6	0.06	0.07	0.06	0.07
2.0	0.02	0.02	0.02	0.02

$\overline{l_j}$ = private employment in sector j under incomplete markets (model economy), $\hat{l_j}$ = private employment in sector j in an Arrow-Debreu (benchmark) economy, $\eta_1 = \{1,6,6,1,1\}$, $\eta_2 = \{4,1,1,2,2\}$; correlation = -0.75; $\frac{\sigma}{\mu}(\eta_1) = 0.91$; $\frac{\sigma}{\mu}(\eta_2) = 0.75$

Table 2: Private employment levels under competitive wage settings in the incomplete markets and Arrow-Debreu economies

	Sector 1		Sector 2	
β	$\overline{l}_1$	$\hat{l}_1$	$\overline{l}_2$	$\hat{l}_2$
0.9	0.79	0.81	0.77	0.81
1.0	0.51	0.53	0.51	0.55
1.1	0.33	0.35	0.34	0.37
1.3	0.15	0.16	0.16	0.17
1.6	0.06	0.06	0.06	0.06
2.0	0.02	0.02	0.02	0.02

$\overline{l_j}$ = private employment in sector j under incomplete markets (model economy), $\hat{l_j}$ = private employment in sector j in an Arrow-Debreu (benchmark) economy, $\eta_1 = \{2,6,6,2,2\}$, $\eta_2 = \{4,4,2,3,3\}$; correlation = -0.22; $\frac{\sigma}{\mu}(\eta_1) = 0.61$; $\frac{\sigma}{\mu}(\eta_2) = 0.26$

Table 3: Private employment levels under competitive wage settings in the incomplete markets and Arrow-Debreu economies

	Sector 1		Sector 2	
β	$\overline{l}_1$	$\hat{l}_1$	$\overline{l}_2$	$\hat{l}_2$
0.9	0.81	0.83	0.77	0.79
1.0	0.52	0.54	0.52	0.54
1.1	0.34	0.35	0.35	0.36
1.3	0.16	0.16	0.16	0.17
1.6	0.06	0.06	0.06	0.07
2.0	0.04	0.04	0.05	0.05

$\overline{l_j}$ = private employment in sector j under incomplete markets (model economy), $\hat{l_j}$ = private employment in sector j in an Arrow-Debreu (benchmark) economy, $\eta_1 = \{2,6,6,2,2\}$, $\eta_2 = \{4,4,3,2,3\}$; correlation = 0.33; $\frac{\sigma}{\mu}(\eta_1) = 0.61$; $\frac{\sigma}{\mu}(\eta_2) = 0.26$

Table 4: Private employment levels under full insurance in the incomplete markets and Arrow-Debreu economies

	Sector 1		Sector 2	
β	$\overline{l_1}$	$\hat{l_1}$	$\overline{l_2}$	$\hat{l_2}$
0.85	0.71	0.71	0.70	0.70
0.9	0.55	0.55	0.55	0.55
1.0	0.34	0.34	0.34	0.34
1.1	0.22	0.22	0.22	0.22

$\overline{l_j}$ = private employment in sector j under incomplete markets (model economy), $\hat{l_j}$ = private employment in sector j in an Arrow-Debreu (benchmark) economy, $\eta_1 = \{2,6,6,2,2\}$, $\eta_2 = \{4,4,2,3,3\}$; correlation = -0.22; $\frac{\sigma}{\mu}(\eta_1) = 0.61$; $\frac{\sigma}{\mu}(\eta_2) = 0.26$

Table 5: Private employment levels under full insurance in the incomplete markets and Arrow-Debreu economies

	Sector 1		Sector 2	
β	$\overline{l_1}$	$\hat{l_1}$	$\overline{l_2}$	$\hat{l_2}$
0.85	0.71	0.71	0.69	0.69
0.9	0.55	0.55	0.54	0.54
1.0	0.34	0.34	0.34	0.34
1.1	0.22	0.22	0.22	0.22

$\overline{l_j}$ = private employment in sector j under incomplete markets (model economy), $\hat{l_j}$ = private employment in sector j in an Arrow-Debreu (benchmark) economy, $\eta_1 = \{2,6,6,2,2\}$, $\eta_2 = \{4,4,3,2,3\}$; correlation = 0.33; $\frac{\sigma}{\mu}(\eta_1) = 0.61$; $\frac{\sigma}{\mu}(\eta_2) = 0.26$