SUBSIDIZATION OF RISKY INVESTMENT UNDER INCOME TAXATION AND MORAL HAZARD

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Abstract

A simplified version of an analysis by Mayshar (1977) is established in order to expose and explain the key factor behind the case for subsidizing private risky investment. A critical evaluation of the analysis motivates an extension of the model to incorporate moral hazard. It is demonstrated that the main conclusion of the former analysis carries over to the revised model under reasonable assumptions.

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1. Introduction

The analysis of government intervention to cure market failure is a central issue in economics. The existence of risk may appear to provide a particularly strong case for government action since lack of insurance markets is one of the most frequently cited examples of incomplete markets. Within the public economics literature the role of taxation as social insurance was analysed by Varian (1980). Roughly speaking the idea is that by taxing favourable outcomes and subsidizing unfavourable outcomes a welfare-improving insurance device is provided. The same idea was put forward in Mayshar (1977), but his focus is on a different aspect. His point of departure is to take the tax policy as given and then analyse the case for government subsidies to risky private projects. The subsidy is provided through a lowering of the interest rate that lowers the cost of risky investment in real capital.

Other authors have strongly questioned the validity of the standard case for government intervention. See for instance Stiglitz (1982) and Dixit (1986). The argument is that normally the government's ability to cope with market failure is limited by exactly those factors that lead to the market failure. Government information may be just as imperfect as the information of private agents and institutions. The problems of moral hazard caused by private insurance may as well be induced by tax-transfer devices that serve as a substitute for private insurance. As shown by Shavell (1979) the existence of moral hazard does not necessarily mean that private insurance markets break down, but it implies that there is an optimum amount of insurance (less than full coverage) which balances the benefit from insurance against the cost of moral hazard. This may be an informationally constrained social optimum which cannot be improved upon by a government that is also constrained by the available information and policy tools.

However, there does appear to be at least one reason why private insurance may not be offered, while government policy may play a role. There is presumably a cost to establishing and operating private insurance schemes which could render the insurance unprofitable, especially when there is a moral hazard problem curtailing the extent to which insurance will be provided[1]. By comparison the cost of allowing for an insurance motive in the tax policy may be small. The main reason is that the tax collecting system has to be operated for fiscal purposes, and hence the marginal administrative cost of serving an insurance purpose may be small. In other words, the setting up of the system is a sunk cost when it comes to insurance. The condition is that some insurance is obtained without making the tax system significantly more complicated and costly than would otherwise be required.

If this or similar arguments are accepted, it is not inconsistent to assume that private insurance is not offered, while a concern with insurance may be part of the tax policy. But since moral hazard or other reasons for the non-existence of private insurance cannot be overlooked by the government, it should be modelled explicitly as a problem that the government is faced with and has to allow for.

The paper by Mayshar (1977) offers a very interesting analysis of the case for subsidizing risky investment, which is an issue often raised in the policy debate. But it seems to be vulnerable to the kind of criticism reviewed above since private insurance is assumed away without incorporating into the model any of the problems that undermine the private markets and are likely to be a source of government concern. On the other hand the model is already rather complicated with a heterogeneous population, private and public real investment and a number of risk classes.

The present paper has a twofold purpose. The first is to present a version of the model applied by Mayshar that is stripped of all features that are not essential for the main conclusion of his analysis. This simplified version may serve a

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1 Scattered observations seem to indicate that in many cases insurance opportunities are not available.

pedagogical purpose by making the underlying mechanism more easily accessible. This model is then extended in a new direction by incorporating a moral hazard problem, which may be the reason why there is no private insurance. The extension is shown to reinforce rather than to overturn the case for subsidization presented by Mayshar.

In both versions of the model the tax-transfer mechanism serves an insurance purpose. In Mayshar's analysis the tax rate it taken to be exogenous, but it is pointed out that a 100 percent tax rate would be socially desirable under circumstances covered by the model. This is a reflection of the failure to include disincentive effects in terms of moral hazard or similar effects. In the absence of any adverse effects insurance should be pushed to the point of full coverage, which implies a 100 percent tax rate when the provision of insurance is through the tax-transfer system. If such a tax policy were actually implemented the case for subsidization would in fact break down! With perfect insurance there is no reason to encourage further the extent to which the insurance is exploited. A revision of the model that eliminates this feature is more than cosmetics. In contrast, the analysis of the present paper leads to a trade-off between the benefit of insurance and the moral hazard effect, which endogenously determines a tax rate less than 100 percent.

The paper is organized in the following way. The basic model is presented in section 2, and the optimal interest policy implied by the model is derived in section 3. The analysis is extended to capture the implications of moral hazard in section 4, while section 5 concludes the paper.

2. The model

The population is assumed to consist of a number of individuals that are identical ex ante, i.e. before the outcomes of the investment decisions are known. Each individual has an initial resource endowment, w, that is allocated to real investment, y, and a financial asset, b, which is the amount of government bonds held by each private agent. If b is negative, there is government lending. The resource constraint implies that

(1) $$w = y + b.$$

The amount borrowed by the government is in turn invested in the world capital market at a fixed interest rate i. (Or the amount lent to the private sector is borrowed in the external financial market.) Hence the government acts as an intermediary. This role allows the government to offer or charge an interest rate, r, that deviates from that of the world market. There is effectively an interest subsidy or tax.[2] The investment in production capital yields a random return to each individual, while the average return for the population as a whole is safe. This means that pure individual risk is assumed. In formal terms the income generated by the amount of investment y is sf(y), where f(y) is interpreted as a deterministic production function with standard properties, while s is a stochastic variable. The average gross return is equal to f(y)E(s), where E is the expectations operator. Similarly, the average gross marginal productivity is f'(y)E(s).

An income tax is imposed at a constant rate, t. The tax is levied on a net income concept defined as $sf(y) - y + rb = sf(y) + (1+r)b - w$.

The net revenue accruing to the government due to taxation and interest payments is returned to the private sector as a lump sum transfer. The per capita transfer is then

(2) $$G = E[t(f(y)s + (1+r)b-w)] - (r-i)b.$$

Each individual is assumed to maximize the expected utility of net terminal wealth including the transfer payment. The expected utility is then

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2 A formally different, but effectively equivalent, procedure would be to actually collect a tax from or pay out a subsidy to consumers who are themselves borrowers or lenders in the world capital market.

(3) $$E = E[u((1-t)(f(y)s + (1+r)b) + tw + G)],$$

where u denotes the utility function in von Neumann-Morgenstern sense. It is assumed to satisfy the standard assumptions (i.e., $u' > 0$, $u'' < 0$). The tax, transfer and interest policy is perceived as exogenous by each individual. Maximization of the expected utility with respect to y, taking account of relation (1), requires that the following first order condition is satisfied

(4) $$E_y = Eu'(f'(y)s - (1+r))(1-t) = 0,$$

where the subscript and primes denote derivatives. The second order condition is

(5) $$E_{yy} < 0.$$

The first order condition can be rewritten as

(6) $$f'(y)\ E(u's) = Eu'(1+r),$$

or as

(7) $$f'(y)\ E(s) = (1+r) - f'(y)\ \mathrm{cov}\ (u',s)/E(u').$$

With standard assumptions the covariance is negative. We can then interpret the condition as requiring the expected gross marginal return to real capital to be equal to the gross marginal return to financial assets plus a risk premium.

3. Optimal interest policy

I shall now analyse the problem addressed by Mayshar (1977). Taking the tax rate as given, what is the optimal interest rate to be set by the government? The expected utility is used as the objective function. The task is then to maximize the expected utility with respect to the interest rate r taking as given the investment behaviour of the private agents as described by (4) and the transfer mechanism defined by (2). It follows from the latter equation that

$$(8) \qquad \partial G/\partial r = E[t(f'(y)s - (1+r)] \; \partial y/\partial r - (1-t)b + (r-i)\partial y/\partial r$$

The effect on the expected utility is

$$(9) \qquad \partial E/\partial r = E(u')(1-t)b + E(u' \; \partial G/\partial r)$$
$$= t \; E(u')(f'(y)E(s) \; -(1+r))\partial y/\partial r \; +(r-i) \; E(u')\partial y/\partial r.$$

Then, invoking equation (7), it follows that

$$(10) \qquad \partial E/\partial r = - \; t \; f'(y) \; \mathrm{cov} \; (u',s)\partial y/\partial r + (r-i) \; E(u')\partial y/\partial r.$$

This expression must be equated to zero to satisfy the first order condition of the social maximization problem. Hence at the optimum

$$(11) \qquad i-r = - \; t \; f'(y) \; \mathrm{cov} \; (u',s)/E(u').$$

Since the covariance is negative, it is implied that in the presence of income taxation the optimal policy is to set the domestic interest rate lower than the international interest rate, which is the opportunity cost of using capital domestically. If there is no income tax, the interest rate should reflect the social income foregone by investing at home, i.e. the world market interest rate.

The nature of the optimum can be explained as follows. If more is invested in real capital, more of the <u>net</u> tax load is shifted to the more favourable states (those who face lucky outcomes). The insurance offered by the tax-transfer system is utilized to a greater extent. This has a beneficial risk-reducing effect. But this is an effect that is not allowed for by the individual decision-maker because from the point of view of each single individual the extra contribution to the total tax revenue made by investing more, has to be shared with everybody else when returned through the transfer mechanism. There is an external benefit to additional investment. When manipulating the interest rate is the only policy instrument available to cope with the externality, the optimal response is to lower the return to financial investment in order to increase the relative return to real investment. The unfortunate effect is to distort the interest rate. The optimum is characterized by an optimum balance between the desire to exploit the tax externality and the conflicting desire to avoid a serious distortionary wedge between the domestic and foreign capital market.

It is important to note that in this model a subsidy to risky investment is not a low tax on the return to this investment. On the contrary it is desirable to set a high tax rate to mimic an insurance mechanism. The subsidy takes the form of a low interest rate which keeps down the cost of risky investment.

4. The role of moral hazard

A revision of the previous model is necessary to encompass moral hazard. It is convenient to model the uncertainty in terms of discrete states. Let π_s denote the proportion of the population that will end up in state s. This is then the (ex ante) probability that a person will face state s. To introduce moral hazard this probability is assumed to depend on the effort, e, made by the investor to attain a favourable state and reduce the probability of a bad state occurring. The probability is then expressed as $\pi_s(e)$ which has the property that

$$\Sigma\pi_s(e) = 1, \; \Sigma\pi_s'(e) = 0,$$

where the summation is over all states, and the prime denotes the derivative. Moreover,

$\pi_s'(e) < 0$ for a sufficiently small s,

$\pi_s'(e) > 0$ for a sufficiently large s, On the other hand the effort entails a cost. It is convenient to measure the cost in terms of utility units and to set the effort level equal to the cost. The net expected utility then becomes

(12) $E = \Sigma \pi_s(e) u_s - e,$

where u_s denotes the (gross) utility obtained in state s:

(13) $u_s = u((1-t)(f(y)s + (1+r)b) + tw + G).$

Optimal individual behaviour is to maximise the expected utility with respect to investment and effort level. The first and second order conditions are

(14) $E_y = E[u'(f'(y)s - (1+r))](1-t) = 0,$

(15) $E_e = \Sigma \pi_s' u_s - 1 = 0,$

which is equivalent to cov $(\pi_s', u_s) = 1,$

$$E_{yy} < 0, \ E_{ee} < 0,$$

$$D = \begin{vmatrix} E_{yy} & E_{ye} \\ E_{ey} & E_{ee} \end{vmatrix} > 0.$$

It should be noted that cov (π_s', u_s) is the covariance of π_s' and u_s across states, and not across individuals. By definition

$$\text{cov}\ (\pi_s', u_s) = \Sigma u_s\ (\pi_s' - \Sigma \pi_s'),$$

where the summation is over all states, and the number of states has been normalized to unity.

The tax revenue available for the lump sum grant is

(16) $G = \Sigma \pi_s(e)[t(f(y)s + (1+r)b-w) - (r-i)b].$

The effect of changing the interest rate is

(17) $G_r = -(1-t)b + E[t(f'(y)s - (1+r))](\partial y/\partial r)$

$$+ (r-i)(\partial y/\partial r) + t\ f(y)\ \text{cov}\ (\pi_s', s)(\partial e/\partial r).$$

The effect on the expected utility is

(18) $E_r = E[u'((1-t)b + G_r)] = ((1-t)b + G_r)E(u')$.

At the optimum choice of policy

(19) $E_r = 0$,

implying that

(20) $(1-t)b + G_r = 0$.

Inserting (17) and making use of (7), which is still valid, we get the optimality condition

(25) $-t[f'(y)\ \mathrm{cov}\ (u',s)/E(u')](\partial y/\partial r) + (r-i)(\partial y/\partial r)$

$+ t\ f(y)\ \mathrm{cov}\ (\pi_s',s)(\partial e/\partial r) = 0$.

Solving with respect to (r-i) we get

(26) $r-i = t\ f'(y)\ \mathrm{cov}\ (u',s)/E(u')$

$- t\ f(y)\ \mathrm{cov}\ (\pi_s',s)(\partial e/\partial r)/(\partial y/\partial r)$.

Since the former covariance is negative and the latter is positive, a sufficient condition for $r < i$ when there is moral hazard is that

$(\partial e/\partial r)/(\partial y/\partial r) > 0$.

These quantities can be derived by means of the first order conditions of the individual optimum. From (15) we find that

(27) $E_{ee}(\partial e/\partial r) + E_{ey}(\partial y/\partial r) + \Sigma\pi_s' u_s'((1-t)b + G_r) = 0$

Also invoking the optimality condition, we find that at the optimum

(28) $(\partial e/\partial r)/(\partial y/\partial r) = - E_{ey}/E_{ee}$.

This expression has the same sign as

(29) $$E_{ey} = \Sigma\pi'_s u'_s[f'(y)s - (1+r)](1-t)$$

The first order condition that $E_y = 0$ implies that the term in square brackets must be negative for some values of s and positive for some other values of s. For the smallest values of s that exist, the term is negative and so is π'_s. For sufficiently high values of s both terms are positive. Even if there may be intervals in which these terms have different signs, it seems the more reasonable assumption that $E_{ey} > 0$. This can be interpreted as follows. When more is invested in real capital, the high utilities (i.e. those of the favourable states) become even higher, while the low utilities are further reduced. Then it becomes more important than before to make efforts to achieve a favourable state. We could say that the investment, y, and the effort, e, are expected utility complements. This being the case, we can draw the conclusion that both terms on the right hand side of (26) are negative, and <u>the second best optimal domestic interest rate is lower than the world market interest rate</u>. The conclusion from the Mayshar model not only carries over to the moral hazard model, but <u>the case for this policy is reinforced</u> by the emergence of a second argument in favour of that conclusion[3]. Not only is there a social gain from more investment in real capital, but there is also a social gain from discouraging the moral hazard induced by the insurance that is in fact provided by the tax-transfer system.

So far the tax rate has been treated as fixed. Let us now consider the optimal choice of tax rate. The effect of a marginal tax reform on the lump sum grant is

(30) $$\partial G/\partial t = [f(y)E(s) + (1+r)b-w] + t\, f(y)\mathrm{cov}\,(\pi'_s,s)(\partial e/\partial t) - t\, f'(y)(\mathrm{cov}(u',s)/E(u'))(\partial y/\partial t) + (r-i)(\partial y/\partial t).$$

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3 But we cannot tell how the total quantitative effects compare.

The effect on the expected utility is

(31) $\partial E/\partial t = [E(u')\ f(y)\ E(s) - E(u's)\ f(y)] + t\ f(y)\ cov\ (\pi'_s, s)\,.$

$(\partial e/\partial t)\ E(u') - E(u')\ t\ f'(cov\ (u', s)/E(u'))\ (\partial y/\partial t)$

$+ (r-i)\ E(u')\ (\partial y/\partial t)$,

and the optimality rule is

(32) $\partial E/\partial t = 0$.

This condition requires that a number of effects cancel out at the margin. The term in square brackets in (31) is equal to $-\ cov\ (u', s)\ f(y)\ E(u')$. This is the insurance effect of taxation. By increasing the marginal tax rate and the lump-sum grant, the variability in disposable income is reduced. The second term reflects the moral hazard effect. Since some of the social return to the efforts made to prevent unfavourable states, accrues to the public coffers, private optimization produces a too low effort level. Further discouragement of these efforts will then have a negative effect on welfare. The third term captures the welfare effect of a change in risky investment that will change the distribution of net taxes across states. If less capital investment is made, less is paid in tax on returns. As the tax base shrinks, the transfer payment is reduced, and the net effect is that a larger amount of tax is paid by those facing an unfavourable state, while less tax is paid by those who end up in a favorable state. A more uneven distribution of income results to the disapproval of a risk-averse population. The last term is a conventional distortionary effect. When the world market interest rate is higher than the domestic interest rate, investing less at home and more abroad implies a higher return to the total stock of capital.

If we consider the case without moral hazard, the second term of (31) vanishes, and the last two terms cancel out when the interest policy is optimal, as we see from (25). We are left with only one effect which is positive as long as the tax rate is less than unity. This is the insurance effect of taxation. The prescription is to increase t up to unity. But when t reaches unity, everybody gets a state-independent disposable income, and the covariance of formula (11) becomes zero. The case for a subsidy has gone. However, when there is a moral hazard, there is an optimum value of t at which there is a trade-off between further insurance and the moral hazard effect that is entailed.

If we make use of condition (26) to eliminate the terms including $\partial y/\partial t$, we can rewrite (31) as

(33) $$t\, f(y)\, \mathrm{cov}(\pi'_s, s)\, E(u')\, [\partial e/\partial t - (\partial e/\partial r)(\partial y/\partial t)/(\partial y/\partial r)] - \mathrm{cov}(u', s)\, E(u')\, f(y) = 0 .$$

As the second term is positive, the first term must be negative at the optimum. Since $-(\partial y/\partial t)/(\partial y/\partial r)$ is the change in r needed to neutralize the effect on y of increasing t, the interpretation is that the combined effect of increasing t and changing r to neutralize the effect on y, must be to encourage moral hazard at the optimum to balance the beneficial insurance effect.

5. Conclusion

This paper has presented a skeleton version of the model used by Mayshar (1977) to analyse the case for subsidizing risky investment. This framework allows us to isolate and expose in a simple way the key factor behind the subsidy argument. The idea is that the tax-transfer system operates as an insurance device. When the tax-rate is less than unity the insurance system is socially underutilized. There is still a discrepancy between private and social risk-taking, and it is desirable to subsidize to encourage investment that is privately risky.

A weakness of Mayshar's analysis is that it does not introduce any factors that explain why there is no insurance in the first place. This is no innocent omission. Actually, if the implications of the model are fully spelt out, the basis for the main conclusion collapses. The tax-rate is pushed to unity, and the subsidy has no role to play. The case for subsidization then hinges on the ad hoc assumption that the tax rate is exogenously pegged at less than 100 percent.

Against this background it seemed important to explore if the conclusion is retained when the model is extended to incorporate moral hazard. The main contribution of the current paper has been to carry out this analysis and provide an affirmative answer.

References.

Dixit, A., 1986, Trade and insurance with moral hazard, Journal of International Economics 23, 201-220.

Mayshar, J., 1977, Should government subsidize risky private projects? American Economic Review 67, 20-28.

Shavell, S., 1979, On moral hazard and insurance, Quarterly Journal of Economics 93, 541-562.

Stiglitz, J.E., 1982, The inefficiency of the stock market equilibrium, Review of Economic Studies 49, 241-261.

Varian, 1980, Redistributive taxation as social insurance, Journal of Public Economics 14, 49-68.