DO PROFIT MAXIMISERS TAKE COLD SHOWERS? ANOTHER LOOK AT PROTECTION AND TECHNICAL EFFICIENCY

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In this paper we consider whether a 'cold shower' is possible if the firm we are analysing is a conventional neoclassical profit-maximising firm facing competitively determined prices. In the context of this analysis, the term 'cold shower' refers to a situation where the removal of a protective subsidy induces investment in a cost-reducing technology. First we show that if the investment lowers marginal cost everywhere, then our firm will never respond to the removal of the subsidy by making the investment. We then use this result to carefully construct examples where the investment does not lower marginal cost everywhere. These examples are devised to illustrate a cold shower scenario where, with no protection in place, the firm makes the investment, that would have been rejected, if the protection had have been in place.

I. Introduction

To most non-economists the idea of a cold shower is self evident. The term 'cold shower' refers to the idea that reducing protection to firms forces them, or at least induces them, to become more technically efficient.[1] The obvious thing that is troubling about this idea is the need to provide an explanation for why the reduction in protection should act as an incentive to improve technical efficiency. For example if there is a new technology that would increase the firm's profit, why would the firm wait for protection to be reduced before adopting this technology? We cannot simply dismiss the idea of a cold shower as a piece of *ad hoc* populism. This is because there is considerable empirical support. Rodrik (1995, p. 2971) summarises the literature as follows:

> ". . . , the available studies are generally favorable to the hypothesis that trade reform is conducive to gains in technical efficiency."

Various models have been devised to depict situations where cold showers occur. All of these approaches, not surprisingly, depart from the standard textbook story of the competitive firm acting to maximise profit. This leaves us with the question as to whether the conventional profit-maximising framework can possibly give a cold shower result. In this paper we show that it can if special assumptions are made about the firm's technology.

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[1] The term 'cold shower' can at least be traced back to the debate in the 1960s over whether Britain should join the European Economic Community (Corden, 1974, p. 227). An earlier reference to this idea can be found in Taussig's (1931, pp. 28–29) study of the development of protected American industries.

There is now a reasonably extensive theoretical literature on the topic of cold showers. Corden (1974) and Martin (1978) use a Scitovsky-type[2] framework with a utility-maximising, rather than profit-maximising, entrepreneur. The entrepreneur will only increase effort, in response to a reduction in protection, if the supply of managerial effort curve is negatively sloped over the relevant range. This analysis allows Corden to make the point that we should not expect a reduction in protection to necessarily result in increased managerial effort. Clearly it could be the case that managerial effort is actually reduced. The principal-agent framework has also been used to consider the cold shower question. Vousden and Campbell (1994) and Horn, Lang and Lundgren (1995) use this framework to show under certain circumstances trade liberalisation will cause an increase in managerial effort. In this literature the owner does wish to maximise profit but cannot simply order the manager to put in a profit-maximising level of effort because the owner cannot directly observe the manager's effort level. Hence the owner offers the manager a contract that will result in the manager putting in the profit-maximising level of effort, given the asymmetry of information. With a reduction in protection the owner, in general, will respond with a contract which will result in an altered level of managerial effort. Under certain conditions, managerial effort will be increased.

Campbell (1998) looks at the 'folklore' cold shower idea that cutting protection can cause a crisis forcing firms to either improve technical efficiency or leave the industry[3]. Here a protected firm is considered with the owner/manager acting to maximise utility where utility is purely a function of income. The firm has the option of investing in some cost-reducing technology. The investment may or may not be successful. The cold shower scenario formalised in this paper is as follows. The owner/manager rejects the investment while the protection is in place. Once the protection is removed the owner/manager decides to make the investment. The reason we can get this scenario is that, once the protection has been removed, if the investment is not made, the firm will have to leave the industry and this will have adverse consequences for the owner/manager's future income stream.

In this paper we consider the same idea of having the option of making a cost-reducing investment as used in Campbell (1998). However, we have no crisis story. Our firm is the standard neoclassical 'black box'. The choice of whether to invest or not is purely a question of whether higher expected profits will be yielded. The firm is protected by a per unit of output subsidy. Intuitively it may seem reasonable to believe that removing the subsidy cannot encourage investment because, without it, it would seem that the return on the investment would be lower. We show this intuition is definitely born out if the technology, that is invested in, lowers marginal cost everywhere. We then use this result to construct an example of a cost-reducing investment that generates a cold shower.

II. Analysis

Consider a single domestic firm producing a good that is sold at the world price p. We make the frequently used small country assumption. That is, we assume that the firm cannot influence the world price. In addition to the price, the firm receives a subsidy of s on each unit sold. The

[2] Modelling the entrepreneur or manager as a utility maximiser rather than a profit maximiser is a tradition which goes back to Scitovsky (1943).

[3] The reason we use the term 'folklore' is because this idea has been alluded to by various eminent economists such as Lipsey (1960, p. 512) and Balassa (1967, p. 105).

firm has the option of paying I to invest in a new technology. The investment will be successful with probability $g \in (0, 1]$. If the new technology is successful then the firm's cost function changes from $C_O(x)$ to $C_G(x)$ where $C_i'(x) > 0$, $C_i''(x) > 0$ for $i = O, G$. If the new technology is not successful, then the cost function continues to be $C_O(x)$. It is assumed that a successful investment lowers total cost, i.e. $C_G(x_G^s) < C_O(x_O^s)$ where x_O^s and x_G^s are the respective profit-maximising choices of output under subsidy $s \geq 0$. Under subsidy s the profit level is $\pi_i^s = (p + s)x_i^s - C(x_i^s)$ for $i = O, G$. Given a subsidy level s, we define the firm's incentive to invest A^s as the difference between expected profit from investing and expected profit from not investing:

$$A^s \equiv [g\pi_G^s + (1 - g)\pi_O^s - I] - \pi_O^s$$

The following question arises: 'Will a profit-maximising firm having rejected an investment at a subsidy level $s > 0$, ever choose to invest if the subsidy is reduced?' In answer to this we can say the following:

Proposition 1 If the investment lowers expected marginal cost everywhere, $C_G'(x) < C_O'(x)$ for all x, then the incentive to invest rises with the subsidy,

$$\frac{\partial A^s}{\partial s} = g(x_G^s - x_O^s) > 0.$$

Proof

Since

$$\pi_G^s = (p + s)x_G^s - C_G(x_G^s),$$

by the envelope theorem

$$\partial \pi_G^s / \partial s = x_G^s.$$

Similarly,

$$\partial \pi_O^s / \partial s = x_O^s.$$

Therefore,

$$\partial A^s / \partial s = g(x_G^s - x_O^s).$$

Now with the respective output quantities chosen to maximise profit, we have the following marginal revenue equals marginal cost relationships:

$$(p + s) = C_G'(x_G^s) \quad \text{and} \quad (p + s) = C_O'(x_O^s).$$

Therefore,

$$C_G'(x_G^s) = C_O'(x_O^s).$$

Now if $C_G'(x) < C_O'(x)$ for all x, then we must have $x_O^s < x_G^s$ since $C'' > 0$. This implies $\partial A^s/\partial s = g(x_G^s - x_O^s) > 0$. ■

The intuition is straightforward. If the subsidy is increased by \$1, then a profit-maximising firm will benefit by one dollar for each unit it is currently producing. Profit maximisation implies that a small change in the subsidy will have a negligible effect on profit via output responses. If the firm chooses to invest, the increased subsidy nets it $\$x_G^s$ with probability g and $\$x_O^s$ with probability $(1 - g)$. If the firm doesn't invest it gets an additional $\$x_O^s$ for sure. Since the cost of investment I does not change with the subsidy, the incentive to invest will rise with the subsidy if and only if $gx_G^s + (1 - g)x_O^s > x_O^s$, or equivalently, $g(x_G^s - x_O^s) > 0$. But clearly $x_G^s > x_O^s$ whenever the new technology has lower marginal cost.

This result shows that obtaining a cold shower in a profit-maximising setting will require the cost-reducing technology to raise marginal cost somewhere. We now give one such example. We assume, for simplicity, that the investment is always successful ($g = 1$). This not only slightly simplifies the analysis, but also emphasises that we do not require uncertainty to achieve a cold shower outcome. The world price $p = 20$ and the cost of the investment $I = 20$. The old and the new technologies are: $C_O(x) = [x^2/2]+ 150$, and $C_G(x) = x^2 + 20$. One might imagine a case where an investment leads to a technology with a lower overhead and thus lower total cost, but a higher marginal cost.

When $s = 1$ the investment is rejected since:

$$x_O^1 = 21, \quad x_G^1 = 10.5, \quad \pi_O^1 = 70.5, \quad \pi_G^1 = 90.25, \quad A^s = -0.25.$$

However, when $s = 0$ the investment is accepted since:

$$x_O^0 = 20, \quad x_G^0 = 10, \quad \pi_O^0 = 50, \quad \pi_G^0 = 80, \quad A = 10.$$

Let's see why the reduction in the per unit subsidy leads to the cold shower. Since the marginal cost of the old technology is lower, the firm produces more with that technology than with the new technology. Since the subsidy is paid per unit of output, the subsidy benefits users of the old technology more. When the subsidy is removed, the firm weighs the true benefits and costs and opts for the new technology.

It is useful to look at a second version of this example. In the first version we took the standard textbook static approach. In the second version we treat the cost of investing in the new technology and the fixed costs as upfront one-off costs, while we treat revenues and variable costs as flows over multiple periods. The rationale for doing this is to show that if the saving in upfront fixed costs is great enough then this saving will not be offset by higher marginal costs, even though, the marginal costs keep occurring over multiple periods. To make the point we assume an infinite number of periods. Our discount factor is $\delta = 0.9$. The world price is still $p = 20$ but the cost of investing in the technology is now $I = 378$. The old and the new technologies are:

$$C_O(x) = \frac{x^2}{2} + 1500, \quad \text{and} \quad C_G(x) = x^2 + 20.$$

When $s = 1$ the investment is rejected since:

$$x_O^1 = 21, \quad x_G^1 = 10.5, \quad \pi_O^1 = 705, \quad \pi_G^1 = 1082.5, \quad A^s = -0.5.$$

However, when $s = 0$ the investment is accepted since:

$$x_O^0 = 20, \quad x_G^0 = 10, \quad \pi_O^0 = 500, \quad \pi_G^0 = 980, \quad A = 102.$$

It is the same basic story as the first version. The subsidy benefits users of the old technology more and so if there is no subsidy it maybe the case that the firm will choose the new technology rather than the old technology.

III. Concluding Comment

The flavour of the results from this analysis are consistent with the rest of the cold shower literature. That is, the analysis indicates that a cold shower outcome is not a general result. Indeed, with this framework, devising a technology that can cause a cold shower requires some effort. This analysis is more than yet another rationale for why there is empirical evidence consistent with a cold shower. It gives us a condition (proposition 1) for when investment in new technology, following trade liberalisation, will not be encouraged by the nature of the technology itself. For example proposition 1 allows us to see that in Campbell (1998) the cold shower outcomes are in no way contributed to by the particular examples of technologies that are considered.

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