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Crunch Time:
The Optimal Policy to avoid the "Announcement Effect" when Terminating a Subsidy

by Marc Gürtler* and Gernot Sieg**

Abstract. We are considering for examination an *Irreversible Investment under Uncertainty*, subsidized by the government. If the government announces the termination of a form of subsidization, investors may decide to realize their investment in order to obtain the subsidy. These investors might have postponed an investment if future payment were assured. Depending on the degree of uncertainty and the time preference, the termination of said subsidy may cost the government more *in toto* than granting the subsidy on a continuing basis. We would like to show that a better strategy is to cut the subsidy in parts rather than terminate the subsidy in its entirety.

Keywords: Irreversibility, Investments, Announcement effect, subsidies

JEL classification: H3, D11

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1. Introduction

Governments that face tighter budget constraints or changing political majorities may consider cutting subsidies. An example for such a behavior is a subsidy that is paid when a private household builds a home to live in like the "First Time Buyers Program" in the USA or the "Eigenheimzulage" in Germany.

The decision to invest in a private home is a decision under uncertainty that is partly irreversible (Henry 1974).[1] Uncertainty may arise due to two factors: Location and size.
The investor is uncertain on the location of the house until he has specific information pertaining to permanent employment. Another variable is the number of rooms needed depending on the uncertain number of children. The investment in a house is partly irreversible because a family - specific design bears sunk costs. Specific taxes and costs of an estate agent are sunk as well. Furthermore, there is the actual reality of new or older homes' resale values being lower than their buying price, notwithstanding high repair costs of older homes also known as "Money Pits" (Akerlof 1970).

On the other hand a household has the option to delay the investment. Delay increases utility (and thus cash flow) because new information improves the investment decision (McDonald/Siegel 1986). Therefore, in addition to the decision rule "invest when the present value of the future cash flows is at least as large as the costs" the household should invest only if the net present value is at least as large as the net present value of the delayed investment (Pindyck 1991).

Government subsidy grants may alter the decision to invest because the subsidy enlarges the

[1] To get a cash flow presentation all scenarios that imply a utility change are identified with cash flows that lead to the same utility change. Such cash flows are called the monetary equivalent of a utility influencing scenario.

net present value of the house. For example, a permanently offered not too large subsidy would not change the timing of the investment. The announcement of a cut of the subsidy however may change the timing of the investment because the household has to choose between investing now and receiving the subsidy and investing later with better information but without a subsidy. We identify the conditions on households that would bring forward their investment if a subsidy cut were announced. This so-called *Announcement Effect* may be large enough so that the present value of subsidy payments for the government would rise with the announcement of the cut. A better strategy than cutting the subsidy completely is to cut the subsidy in parts small enough to prevent the *Announcement Effect.*

It is well known that the option to delay an investment is valuable (McDonald/Siegel 1986). Teisberg 1993 shows that firms may delay investment or choose smaller, shorter-lead-time technologies when facing uncertain regulation. She considers an industry that faces the uncertainty of frequent changes of regulation. We study the different case that a rationally expected change of policy may occur once only. There is a large literature that deals with the possibility of trading off flexibility and commitment build on Spence (1979) and Fudenberg/Tirole (1983), for example Saloner (1987), Mailath (1993), Maggi (1996) and Sadanand/Sadanand (1996). However, we analyze investors that trade off subsidies and flexibility.

2. The model

We consider a representative household that can invest at only one point in time t = 0, t = 1, t = 2, … . The investment enlarges cash flows by *X*. Investment costs are denominated by *I*. New information is independently and identically distributed over time and arrives with probability *P* at each point in time prior to arrival. New information leads to a monetary equivalent *Y* if the investor decides to invest. Therefore, the investor invests in period t after the arrival of new information or after he knows that new information does not arrive in this period. The discount factor for expected cash flows and for one period is 1/(1+r).

The investment is subsidized by the government.. Once in his lifetime an investor gets a grant S at the time of the investment (case A). However, by reason of tighter budgetary constraints the government considers the termination of the subsidy. Because of legal issues, the government has to announce that the subsidy is to be terminated. In this situation the government subsidizes the investment at time t = 0 but not later (case B). Investors do anticipate the cut and may bring forward the investment. For simplification we do not consider policy effects on market prices but assume X and I to be independent of the grant.

We assume

$$-I+X < 0, \tag{1}$$

i.e. without grant and without the additional information the investment is not profitable. If (1) does not hold no subsidy is necessary to induce investment. Since we consider a subsidy that is not completely needless assumption (1) is compulsive.

If $-I+X+S+Y < 0$ the grant is to small to induce investment of the “lucky” household which received the information. No household invests and the grant is never paid. This case is irrelevant and therefore not further considered.

First of all, we analyze case A. At each point in time, the investor faces an identical problem if he did not get any information up to this point in time. Thus, at each point in time (without information) the investor arrives at the same conclusion (to invest or not to invest). This implies that the investor invests at t = 0 or at that future point in time the information arrives. The actual decision depends on the parameter constellation, i.e. the grant S.

The value of investment at t = 0 without information obviously amounts to

$-I+X+S.$ (2)

If the investor realizes the investment when information arrives the present value of the cash flows can be calculated as follows:

$$\sum_{t=1}^{\infty}(1-p)^{t-1}\cdot\frac{p\cdot(-I+X+S+Y)}{(1+r)^{t}}=\frac{p}{r+p}\cdot(-I+X+S+Y). \qquad (3)$$

Consequentially, the investor waits until information arrives if and only if

$$\begin{aligned}&-I+X+S<\frac{p}{r+p}\cdot(-I+X+S+Y)\\ \Leftrightarrow\ \ &S<I-X+\frac{p\cdot Y}{r}.\end{aligned} \qquad (4)$$

In case B we have to consider that subsidy is only granted at t = 0. Thus, the value of future investment in the case of information arrival is

$$\sum_{t=1}^{\infty}(1-p)^{t-1}\cdot\frac{p\cdot(-I+X+Y)}{(1+r)^{t}}=\frac{p}{r+p}\cdot(-I+X+Y). \qquad (5)$$

In this situation the investor waits if and only if

$$\begin{aligned}&-I+X+S<\frac{p}{r+p}\cdot(-I+X+Y)\\ \Leftrightarrow\ \ &S<I-X+\frac{p}{r+p}\cdot(-I+X+Y).\end{aligned} \qquad (6)$$

Particularly, if the investor waits in case B he also waits in case A.

On the basis of (4) and (6) we want to analyze which parameter constellations lead to an announcement effect. If (4) is not fulfilled the investor invests at t = 0 anyway. Under consideration of (6) an announcement effect can only occur if S is sufficiently small to meet (4) and sufficiently large not to fulfill (6). Consequentially, we have an announcement effect if and only if

$$I-X+\frac{p}{r+p}\cdot(-I+X+Y)<S<I-X+\frac{p\cdot Y}{r}. \qquad (7)$$

The optimal time of investment differs depending on the grant S (see figure 1). If the grant is small the investor waits for information before he invests. If the grant is large the investor invests immediately even without information. However, if the grant is at medium level the announcement effect occurs. An announced cut causes the investment of households that otherwise postponed the investment.

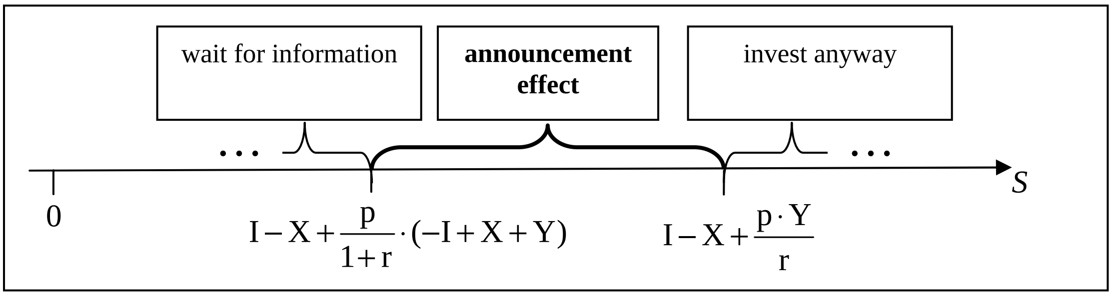

Figure 1: Investment behavior if the grant S is cut

3 The Policy

The question arises whether the Announcement Effect is large enough to increase the cost of the government. To put it into other words, may it more expensive to cut than to continue the grant? If we consider situations leading to no announcement effect the cut of subsidies has no influence on the investment behavior of the households and consequentially in these situations the cut improves the budget of the government. Therefore, we consider parameter constellations leading to an announcement effect.

In case A the fraction p of households invests at time t = 0 and the rest of the households invest later (t ≥ 1) or never. Because an investment is accompanied with a grant the present value of government's payments per household is

$$p \cdot S + (1-p) \cdot \sum_{t=1}^{\infty} (1-p)^{t-1} \cdot \frac{p \cdot S}{(1+r)^t} = p \cdot S + (1-p) \cdot \frac{p}{r+p} \cdot S = p \cdot S \cdot \frac{1+r}{r+p}. \quad (8)$$

In case B all households invest at t = 0. The government has to pay S per household. Thus, the excess expenditure of the government when cutting the subsidy is

$$S - p \cdot S \cdot \frac{1+r}{r+p} = S \cdot \left(1 - p \cdot \frac{1+r}{r+p}\right) = S \cdot r \cdot \frac{1-p}{r+p} > 0 \tag{9}$$

and the Announcement Effect enlarges the payments of the governments. Immediate cutting subsidies do not improve the budget but enlarges the deficit.

Consequentially, the question arises if it is possible to design an alternative cutting rule and an alternative sequence of subsidies $(S_t)_{t=0,1,\ldots}$, respectively, that leads to a reduced deficit. Firstly, we have to characterize the announcement effect for such a generalized situation. Analogical to (7) an announcement effect at a point in time $t \in \{0, 1, 2, \ldots\}$ exists if the investor does not wait until information arrives, i.e.

$$\begin{aligned} S_t &> I - X + \sum_{\tau=t+1}^{\infty} (1-p)^{\tau-t-1} \cdot \frac{p \cdot (-I + X + S_\tau + Y)}{(1+r)^{\tau-t}} \\ &= (I - X) \cdot \frac{r}{r+p} + Y \cdot \frac{p}{r+p} + \frac{p}{1-p} \cdot \sum_{\tau=1}^{\infty} \left(\frac{1-p}{1+r}\right)^{\tau} \cdot S_{t+\tau}, \end{aligned} \tag{10}$$

and the investor does not invest anyway (i.e. in case A) which is characterized by (4). Against this background we develop an optimal cutting rule in order to minimize the present value of subsidies (see the appendix for details):

$$S_0 = S;$$

$$S_{t+1} = \begin{cases} (1+r) \cdot S_t - \underline{S} \cdot (r+p) & \text{if} \quad S_t > S \cdot \dfrac{1+r+p}{1+r} \cdot \underline{S}, \\ (S_t - \underline{S}) \cdot \dfrac{1+r}{p} & \text{if} \quad \underline{S} < S_t \le S \cdot \dfrac{1+r+p}{1+r} \cdot \underline{S}, \\ 0 & \text{if} \quad S_t \le \underline{S}; \end{cases} \tag{11}$$

with $\underline{S} = (I - X) \cdot (r/(r+p)) + Y \cdot (p/(r+p))$. This policy is characterized by cutting the subsidy each period as much as possible to avoid the announcement effect. In each period the government is able to cut the subsidies to some extend. The increments are monotonically decreasing. Even if all households rationally expect the cutting rule the government is able to abolish the subsidy in finite time.

4. Summary

If governments want to cut subsidies they may fear the Announcement Effect: Investors realize an investment they would have postponed only to get a subsidy if the cut were not announced. This paper identifies the parameter constellations of when the cut of a subsidy does not improve the budget but enlarges the deficit.

The announcement effect interval is rather relevant from a political economy point of view. Voters are in favor of a grant because they seek windfall gains. However, if the grant is so large that anybody invests even without information the grant results in inefficient investment on the part of the government. This results in negative publicity such that a political majority is at risk. Therefore, for the rent seekers the optimal permanent grant is to be as large as possible but small enough to prevent obviously inefficient investment. The politically optimal grant is in the Announcement Effect interval.

In such a situation it is better not to cut the subsidy completely. However, the government is able to avoid the negative effects of the announcement and to improve the budget by following the optimal cutting rule (11). Following the rule the government cuts the grant incrementally and abolishes it in finite time.

Appendix (Derivation of (11))

The government minimizes the present value of grant payments

$$\min_{S_1, S_2, \dots} p \cdot S_0 + (1-p) \cdot \sum_{\tau=1}^{\infty} (1-p)^{\tau-1} \cdot \frac{p \cdot S_\tau}{(1+r)^\tau}$$

respectively

$$\min_{S_1, S_2, \dots} \sum_{\tau=1}^{\infty} \left(\frac{1-p}{1+r} \right)^\tau \cdot S_\tau \tag{A.1}$$

s.t.

$$S_0 = S, \tag{A.2}$$

i.e. the grant-sequence $(S_t)_{t=0,1,\ldots}$ starts with the present grant S,

$$0 \le S_t \le (I - X) \cdot \frac{r}{r+p} + Y \cdot \frac{p}{r+p} + \frac{p}{1-p} \cdot \sum_{\tau=1}^{\infty} \left(\frac{1-p}{1+r} \right)^{\tau} \cdot S_{t+\tau}, \quad t = 0, 1, \ldots . \tag{A.3}$$

i.e. (according to (10)) the investor waits until information arrives which corresponds with no announcement effect at t = 0, 1, 2, … .

We use $\underline{S} = (I - X) \cdot (r/(r+p)) + Y \cdot (p/(r+p))$, $b = p/(1-p)$ and $q = (1-p)/(1+r)$ as abbreviations. Since we know from (6) there is no announcement effect in the case $S_t \le \underline{S}$ if we set $S_{t+1} = S_{t+2} = \ldots = 0$. Thus, in following we consider the case

$$S_t > \underline{S}. \tag{A.4}$$

According to (A.3) at a point in time t and given subsidy $S_t > \underline{S}$ a necessary condition for the optimal subsidies $(S_\tau)_{\tau=t+1,t+2,\ldots}$ in the future is

$$S_t = \underline{S} + b \cdot \sum_{\tau=1}^{\infty} q^{\tau} \cdot S_{t+\tau}. \tag{A.5}$$

The latter statement is obvious, because a strict (second) inequality in (A.3) immediately implies the possibility to reduce one of the future subsidies $S_{t+\tau}$ ($\tau \ge 1$). Next, assume a point in time t so that (A.5) holds for t and t+1. Then

$$\begin{aligned} S_t &\underset{(A.5)}{=} \underline{S} + b \cdot q \cdot S_{t+1} + b \cdot q \cdot \sum_{\tau=1}^{\infty} q^{\tau} \cdot S_{t+1+\tau} \underset{(A.5)}{=} \underline{S} + b \cdot q \cdot S_{t+1} + q \cdot (S_{t+1} - \underline{S}) \\ &= \underline{S} \cdot (1-q) + S_{t+1} \cdot q \cdot (1+b) = \underline{S} \cdot \frac{r+p}{1+r} + S_{t+1} \cdot \frac{1}{1+r} \\ \Leftrightarrow S_{t+1} &= (1+r) \cdot S_t - \underline{S} \cdot (r+p) = S_t + r \cdot (S_t - \underline{S}) - \underline{S} \cdot p. \end{aligned} \tag{A.6}$$

At time t = 0 we know from (4) that $S_0 = S < I - X + Y \cdot (p/r)$ and therefore there exists $\varepsilon > 0$

such that $\underline{S} \leq I - X + Y \cdot (p/r) - \varepsilon$. Consider t to be an arbitrary point in time with $S_t \leq I - X + Y \cdot (p/r) - \varepsilon$ (e.g. t = 0). From (A.6) this implies

$$
\begin{aligned}
S_{t+1} &\leq S_t + r \cdot \left(I - X + Y \cdot \frac{p}{r} - \varepsilon - (I - X) \cdot \frac{r}{r+p} - Y \cdot \frac{p}{r+p} \right) - (I - X) \cdot \frac{r \cdot p}{r+p} - Y \cdot \frac{p^2}{r+p} \\
&= S_t - r \cdot \varepsilon + (I - X) \cdot \frac{r \cdot p}{r+p} + Y \cdot \left(p - \frac{p \cdot r}{r+p} \right) - (I - X) \cdot \frac{r \cdot p}{r+p} - Y \cdot \frac{p^2}{r+p} \qquad \text{(A.7)} \\
&= S_t - r \cdot \varepsilon.
\end{aligned}
$$

Thus, as long as $S_{t+1} > \underline{S}$ the series $(S_t)_{t=0,1,\ldots}$ of grants is strongly monotonically decreasing and the increment is at least $r \cdot \varepsilon$. The latter statement particularly implicates the existence of a maximal point in time T with $S_{T-1} > \underline{S} \geq S_T$. Consequentially, $S_\tau = 0$ for all $\tau \geq T+1$.

Follow the rule (A.6) and let T the maximal time. Then

$$(1+r) \cdot S_{T-1} - \underline{S} \cdot (r+p) < \underline{S} \Leftrightarrow S_{T-1} < \underline{S} \cdot \left(1 + \frac{p}{1+r} \right) \Leftrightarrow S_{T-1} - \underline{S} < \underline{S} \cdot \frac{p}{1+r}. \qquad \text{(A.8)}$$

For t = T–1 (A.5) holds and it follows:

$$S_{T-1} = \underline{S} + b \cdot q \cdot S_T = \underline{S} + \frac{p}{1+r} \cdot S_T \Leftrightarrow \quad S_T = (S_{T-1} - \underline{S}) \cdot \frac{1+r}{p}. \qquad \text{(A.9)}$$

To summarize, the optimal cutting rule is:

$$
\begin{aligned}
&S_0 = S, \\
&S_{t+1} = \begin{cases} (1+r) \cdot S_t - \underline{S} \cdot (r+p) & \text{if} \quad S_t > \dfrac{1+r+p}{1+r} \cdot \underline{S}, \\ (S_t - \underline{S}) \cdot \dfrac{1+r}{p} & \text{if} \quad \underline{S} < S_t \leq \dfrac{1+r+p}{1+r} \cdot \underline{S}, \\ 0 & \text{if} \quad S_t \leq \underline{S}. \end{cases}
\end{aligned} \qquad \text{(A.10)}
$$

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