ECONOMICS WEB INSTITUTE

PRO-DIFFUSION-OF-INNOVATION TAX

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Contents

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1. Overview

A wider diffusion of an innovative good, service or behaviour is often a key goal for the policymaker aiming at modernizing the economy, enhancing more productive technologies, reducing pollution and energy consumption.

Usually, the tools used by governments and public bodies fall in three main categories:

* incentives, in terms of public expenditure devoted to cut the price of adoption;

* tax breaks, which reduces the tax burden to adopters (and the tax revenue of the policymaker);

* laws, which compel the use of the good (possibly within certain future deadlines).

The first two instruments are costly to the policymaker, whereas the latter, by renouncing to market logics, forces adoption even to agents who might face huge costs of adaptation, often provoking a strong opposition front and a delay in the approval of the measure at political level.

In this paper, we explore an alternative which is costless for the policymaker and let the market work, leaving people free to adopt or not: a simple tax whose revenue is distributed to recent adopters.

We shall call it PRODINT: PRO-Diffusion of INnovation Tax.

2. The simplest case

Let's concentrate on a situation in which innovation is embodied in a durable good, thus adoption means just to purchase it by paying a given price P. Let's further assume that the use of the good does not generate any additional flow of money neither positive nor negative (see chapter 6.3. for the removal of this hypothesis). Adoption thus has a sunk cost (P) but no fixed or variable cost.

Although in general the cost C of adopting the good comprehends not only P but also monetary and non-monetary components due to the difficulty of using the new good, any cultural resistances to adopt, and possibly the cost of overwhelming the very unawareness of its existance, in this simplest case the adoption cost might be reduced to P.

The **tax on non-adopters will be a lump-sum** whose value is **a fraction f of C**. The tax revenue be distributed in **equal shares** to **recent adopters**, defined as the agents that at a certain date can demonstrate of having adopted the innovation after a previous date.

Were the tax levied just once, it would be a mere payment from non-adopters to users. However we assume that it is levied several times, thus turning out to be:

* the first time: a payment to the entire population of adopters, but

* the further times: a payment just to whom adopted meanwhile, i.e. between two application dates.

Each adopter can get the revenue just once.

If the tax is levied at the beginning of the diffusion curve, when only a very small number of pionieers has adopted, then the tax revenue will be extremely high, even if the fraction f is small, because almost everybody is a non-adopter; the adopters will receive many times more than C, making a large profit, which will have a strong media coverage, prompting for imitation by free advertising.

In the next round, the tax will be gathered another time, with non-adopter again to pay f. In order to avoid paying, some (not all) will adopt; their strategy clearly pays off: they receive a larger sum than C because non-adopters are still a large majority.

If the tax is levied frequently enough, the receipients will be less numerous than the payers, with a ratio of f needed to cover the adoption cost.

The logics behind this tool is that the entire burden of adopting is brought by non-adopters. Not only they pay but they do not recieve the tax revenue and they do not have the advantages of owning and using the good. Accordingly, being a non-adopter is fairly unconvenient.

As far as the diffusion process proceeds and non-adopters become a minority ("late comers"), there might be a change: the tax revenue could be distributed as **a loan to those who promise to adopt** in this new period. If they adopt, the loan is forgiven, if not they have to pay it back. Since a minority of them will promise to adopt, they will be prized with a loan fairly near to the entire C (although possibly not covering it in whole).

In another vein, as the number of non-adaptors goes down, one might increase the percentage of tax. This will raise a larger revenue even at this stage and will encourage everyone to "get on board" early [1].

If non-adopters are a very small minority, they can be left in peace with the tax scrapped (if it is tolerable that somebody does not adopt), or the loan structure can be in place indefinetely.

In this simplest form, the tax does not generate revenue for the state, it's a mere redistribution within an industry or a population; some receives what other pays.

3. A real-world application: distribution stations of alternative fuel

To **reduce CO2 emissions** and **save energy**, new "fuels" have been proposed for cars (e.g. GPL, electricity, hydrogen, compressed air,...) with distribution infrastructure being a major obstacle to their diffusion. The consumer does not want to buy a car that has no stations nationwide, while no distribution chain wants to set up stations if the number of consumers is too low. This vicious cycle can be broken by PRODINT, levied on existing gasoline stations.

A small tax is levied on each station that does not distribute the alternative fuel, irrespective of the ownership of the station (large chains, independent owners,...). The total tax revenue is given to the very few pioneers that add the new fuel to their existing supply lines (e.g. some environmentally-minded independent owners). They receive a huge amount of money, since non-adopters are thousands and outnumber the adopters.

The news spread, the profits lure new adopters (e.g. environmentally-sensitive owners that were afraid of the cost of adoption). Again the small tax is levied and they receive a very good amount of money, attracting a third wave of adopters (owners attracted by money only, without a particular environmental sensitivity).

This should be enough for chains to take in serious consideration stopping financing adoptions of their competitors. One or two can establish plans for adding alternative fuel to their offer in a number of stations over time. These plans are credible commitments, so car purchaser begin to have good reasons to buy cars with the new fuel (e.g. hybrid cars).

Since alternative fuel can be cheaper or be made cheaper by a legislation that internalize the costs of pollution and CO2 emission to the different fuels, early car adopters will enjoy a cost advantage with respect to the conventional car users. The wider number of alternative fuel cars increases the profits of stations offering alternative fuel. Since they remain a minority, each one covers a much wider area (consumption basin) which allows a relatively quick increase of sales.

Normal market mechanism will start working, spreading the new fuel in further stations and consumers near to those stations beginning to switch to the new fuel.

The PRODINT mechanism will stay until a satisfactory diffusion of the new distribution infrastructure is achieved. It costed nothing to the policy-maker, who can boast the reduction of CO2 emissions and the trasport costs. Producers of alternative fuel cars will make healthy profits, attracting further producers thus guaranteeing a wider choice of car models.

As the reader will have noticed, we are taking into account not only strictly monetary factors, but also the mentality, the level of information and behavioural inertia of the various actors involved.

4. Some key details: administrative and monitoring costs

Administrative costs of PRODINT are minimal. By leveraging existing technology, one can imagine **a bank account where people pay the tax**, while signalling by email that they adopted the good so as to receive to their bank accounts the share of tax revenue. No bureacracy has to be added.

Monitoring costs can be brought down to very low levels through widespread power of control. For instance, any citizen could be entitled to signal non-adoption and this message is compared with official declaration of the adopter/nonadopter; in case of discrepancy (or a number of signalled discrepancies) a mission to verify is sent; if indeed there is a violation, then a high fine is issued; the citizen(s) having signalled receive(s) a part of the fine.

Many other systems of monitoring and administration can be deviced, while keeping simplicity and low costs being their features.

5. The main advantages of PRODINT

In synthesis, the main advantages of this tax system are the following:

1. totally relying on spontaneous decision, leaving people free to adopt or not;

2. no tax burden for the population as a whole;

3. during the process a large amount of people is better off with the scheme than without; of course, non-adopters would have preferred the absence of the scheme but they become a minority over time; if the wide diffusion triggers the diffusion of a complementary technology (as with the case of cars after the stations) even the "forced" adopters are happy of having done this;

4. the tax levied can be really small in absolute terms.

Additionally, the reaction of the sellers of the good is much better than in presence of a state incentive: they do not change their prices because they do not know how much the adopters might receive from the tax. On the contrary, lump-sum or percentage state-paid incentives to customers are often transferred to extra-profits of the sellers who increase price of that sum, by keeping almost at the same net price the purchaser.

In the sector producing the innovation, this scheme generates a diffusion dinamics that matches reasonable production timetable, with increasing production over time and a relatively long tail, whereas deadlines - which mandate everybody adopting - generate a skyrocketing production before deadlines and zero afterwards, with the necessity of having a large production capacity which ends up to be useless. Capital is piled up, labour is selected in a rush, has no time to learn the job and then is fired because employment goes to zero.

In turn, the smoother dynamics fostered by PRODINT allows incremental improvements of the innovation itself, as for solar panels getting more efficient over time, because the profits from early production can be channeled to R&D, as you can experiment in this interactive model.

Note that in the supplier sector, many firms compete and the consumer has the time to compare the many differentiated versions offered, whereas with deadlines the suppliers are sure to sell and do not care about additional features.

6. Some more advanced cases

6.1. Variable cost of adoption

If the cost C of adopting is not constant but has an observable distribution in the population, then the size of payments to recent adopters might be somewhat adjusted to it. This in particular is relevant when adoption relates to a vertically differentiated good and the policymaker would like to influence not only the mere fact of adoption but also its "quality", by giving more to the boldest adopters of "better" technologies.

6.2. Unknown and extremely variable cost of adoption

A more extreme case is when not only the cost of adoption is different for each agent in the population, but also it cannot be observed from outside (it is a private information of the agent).

In this case, the policymaker can request the agent to write down its estimate of adoption cost (leaving room for opportunistic behaviour) and establish the amount of tax in relation to its distribution. In particular, given a target fraction of the population that one wants to motivate to adopt, one can sum up the declared adoption cost of that fraction, beginning from the lowest estimates. In this way one obtains the lowest total amount to be given to that

fraction so as it to adopt. This amount is divided by the number of non adopters and fixed as their tax. The tax revenue is distributed as a loan to those who promise to adopt in this new period. If they adopt indeed, the loan is cancelled, if not they have to pay it back.

One would expect firms to overshoot, by declaring higher costs than real ones. But those who ask the largest sums will usually end up rather paying than receiving. Those who receive will probably get high profits from the tax, confirming that it is better not to overshoot. In this uncertain scenario one thing is sure: adoption is granted in the requested quantity. Individual profits and losses represent "collateral damage" for meeting the target.

6.3. Adoption of a technology with a stream of costs and revenues over time

Many technologies involve not only a cost C for purchase but also additional costs over time in terms of maintenance, fuel, etc. In particular, a recurrent situation is where a more expensive technology in terms of C has lower variable costs over time (e.g. an efficient engine that requires less fuel but is more expensive at the time of purchase, a solar panel, etc.).

In this case, the adoption is linked to a low discount rate and a long acceptable payback period: the investor compare the present value of the technology by discounting the savings in the future with the higher cost of investment now.

More in general, the technology can involve also revenues flows, with discounting once again being the common way to take decisions of adoption.

This means that the prevailing interest rate on the market is a key determinant in choosing to adopt, with too high interest rates discouraging innovation diffusion.

PRODINT modifies only the cost of purchase, not the stream of costs and revenues afterwards, so it increases the roof for interest rate below which adoption takes place, it reduces the years for payback, so it drastically help adoption for a number of investors. In more technical terms, PRODINT increases both the Net Present Value (NPV) and the Internal Rate of Return (IRR) of the investment, so that a wider number of investors find the decision profitable.

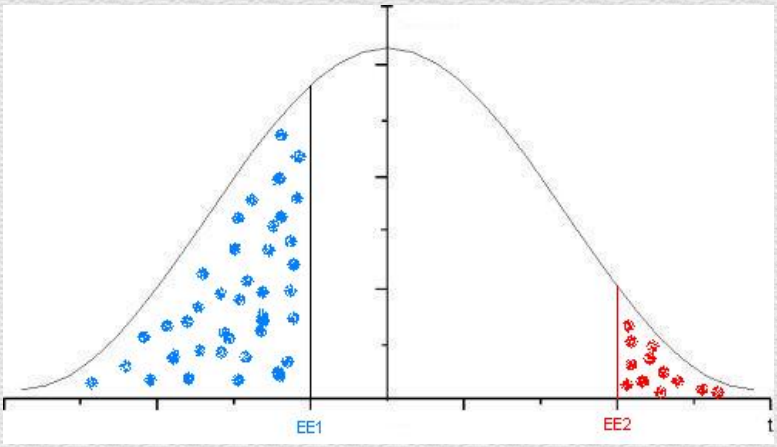
6.4. Meeting performance threshold instead of specific technology diffusion

In certain cases, the policymaker does not know the exact technology that would be necessary to reach its goals (e.g. "lowering greenhouse gases emissions" or "increasing the competitiveness of the industry"). In other cases, technologies are known but there are several of them in competition to each other (e.g. broadband Internet connection delivered by satellite, cable, Wi-Fi, Wi-MAX, x-DSL, etc.) and the policymaker does not want to favour one against the other, possibly because of consensus constraints.

To the extent that performance is measurable, the tax can be levied on the group of agents that does not meet a minimum threshold and the tax revenue given to those exceed a sufficiency threshold.

The two thresholds can converge in one or be separated by a neutral zone, where no payment is made in either direction.

If performance, e.g. energy efficiency, is presently distributed according to a bell curve, the situation can be depicted in the following way:



People and firms using technology whose energy efficiency is below EE1 will pay the tax, whose revenue is transferred to those whose energy efficiency is higher than EE2. Because of the fact that the blue taxed are more numerous than the red receivers, the tax can be small and tolerable, while the incentive will be strong. Since the improvement in the environment resulting from higher average efficiency (the main benefit of the entire strategy) is given to all, the neutral zone can align itself with the recipients and form a political majority.

The thresholds can be established to change over time, e.g. an increase of 2% per year, so to create a clear, stable, and pro-diffusion environment for all the agents.

6.5. Distributive justice: four remarks

In normal conditions, pioneers and early adopters tend to have higher income, higher education, and better social connections than late comers. Thus, PRODINT might be criticized as a redistribution from the poor to the rich.

There are three remarks to contrast this danger, as some would consider it:

1. distributive justice, if felt necessary, can be achieved by other means, e.g. a progressive income taxation with large negative taxes paid to the poor;

2. by acknowledging the existence of PRODINT, a poor could take a loan and adopt the innovation, getting the share in tax revenue; in this way PRODINT opens the opportunity to adopt even to people that would have not afford it;

3. the goal of PRODINT is fast adoption, thus an implicit assumption is that the agent can (afford to) adopt and it's just because of cultural inertia that he does not; accodingly, the universe of taxed agents might be circumscribed to those that can afford the innovation (e.g. SUV + Hybrid electric vehicles could be the universe, with owners of SUV being taxed and owners of HEVs recieving the revenue, fostering people to sell their SUV and buy HEVs instead - the rest of the population enjoying this development from a safely neutral fiscal point of view).

A more radical objection to PRODINT from a "green" point of view is that PRODINT is an incentive to buy something, not to live better with less. There is some truth in this: the implicit assumption is that people have a need and some technology is necessary to satisfy it, with PRODINT channelling adoption to the most environmental friendly one. However, if one can single out which is the "environmental correct" behaviour, then PRODINT could be directed to support those people that follow it, not necessarily own & use some technology.

For instance, if tele-work and car-sharing are seen as a better solution than owning a car at all (SUV, Hybrid,... alike), than PRODINT could be levied on all car owners with the revenues distributed to tele-worker and car-sharing users.

More in general, PRODINT is very flexible and can be used adequatedly in many situations, once the goal of a wider diffusion of a certain technology or a certain behaviour has been judged useful [2].

7. Theoretical justifications

The broad framework of PRODINT is evolutionary economics, that has deeply analysed technology innovation and its diffusion. Economic and non-economic factors have been found to be relevant, in particular not only the amount of information available but also the capability of interpreting it, with ex-ante preferences (e.g. to environmental protection).

In psychological terms, prospect theory by Kahneman and Tverski would underline the importance of providing highly visible reference points for decision; the dichotomization of adoption and non-adoption, with its harshly different treatments and phase-after-phase results (pay vs. receive, denounced by citizen vs. praised,...) are all meant to give decision-makers an extreme incentive to act.

PRODINT implements the principle of "polluter pays" in a new, albeit fully legitimate, way. The non-adopter is the polluter and what is paid is not a fine for the damage but the adoption by non-polluters for a real improvement.

8. Potential areas of application

Climate change mitigation and adaptation strategies will systematically require the adoption of **new behaviours**, **new consumer goods**, **new production technology**.

PRODINT can be implemented at every territorial level (country, sub-national region, a city or village) with visibile results in relatively short amount of time.

A fast and sustainable diffusion is key to effectiveness at global scale. Coordinated efforts will be necessary but countries willing to lead could adopt PRODINT and show to the others its impact.

At the Economics Web Institute we are keen to see its implementation and very glad of every contact you would like to establish with us. Our consulting services are at your disposal for any request.

NOTES

[1] I'd like to thank Lewis Smith for this suggestion.

[2] This section benefited from a conversation with Marco De Luca.

Main page
Essays
More on economic policies...