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Reducing Rents from Energy Technology Adoption Programs by Exploiting Observable Information

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Abstract

In this paper, we study how regulators may improve upon the efficiency of their energy technology adoption programs by exploiting readily observable information to limit rent extraction by firms. Using panel data on 862 investment decisions in the Netherlands, we find that rent extraction is closely linked not only to technology characteristics, but also to the firm's capital budgetting technique. In particular, we find that firms are more likely to extract rent when either the technology's pay-back period or its required investment is lower, but less likely if they do not use a formal capital budgeting technique. Standard firm characteristics, such as size and sector, correlate with firms' use of capital budgeting techniques, thereby partly resolving the regulator's asymmetric information problem.

Keywords: rent extraction; tagging; tax expenditure programs; technology adoption subsidies; investment decisions; bivariate probit model.

JEL Codes: D22; H25; H32; O33; Q48.

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1 Introduction[†]

Energy efficiency is quickly becoming a key ingredient of the energy and environmental policy mix (Convery, 2011). For that reason, many governments have brought in investment subsidies to stimulate the adoption of new technologies, such as hybrid vehicles, solar panels or energy saving equipment. The effectiveness of such subsidies is, however, widely challenged (International Energy Agency, 2011). For example, any attempt by regulators to 'green' investment decisions towards technologies with low energy use must - according to standard principal-agent theory - be bristling with pitfalls. Along this line of thought, every energy technology adoption (ETA) program must suffer heavily from rent extraction, which has its roots in the regulator's imperfect observation of the agent's behavior in response to the program. For instance, Wirl in a series of papers (Wirl, 1995, 1999 and 2000) argues that ETA programs, such as those under the US Demand Side Management (DSM) program, typically only reach those agents that are already inclined to invest, giving rise to adverse selection, or induce agents to conceal their type, leading to moral hazard.

However, by using information that is both *observable* and *correlated* with the probability of the agent obtaining a rent from the ETA program, regulators might tighten the eligibility for their ETA programs and, accordingly, design so-called 'tagged' incentive schemes (Akerlof, 1978). Basically, tagged incentive schemes use observable information on agents' decisions as a screening device.[1] This decreases rent extraction arising from either adverse selection or moral hazard by enabling regulators to exploit the existing heterogeneity between seemingly homogeneous (investment) decisions.

For example, within the context of energy technology investments by firms, the regulator might use the information that is implicitly revealed by the firm's choice of technology. Consider a firm investing in a heat pump and applying for a subsidy. The information revealed by this particular investment is that the firm has a demand for heat. As a consequence, the regulator knows that the alternative investment for this firm would have been - depending on the availability of natural gas - either a less efficient heat pump or a boiler. The firm, therefore, cannot credibly mimic

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[1]The advantages of 'tagging' are well documented, for instance in the context of welfare programs (Parsons, 1996) and in health economics (Zivin and Zilberman, 2002).

being of another type, because the regulator can use market shares of alternative investments as a screening device. For example, if the firm were to pretend to invest in a very inefficient heating technology with a low market share, the regulator would be able, at least with some probability, to 'expose' the firm.

To the best of our knowledge, the question of whether and how regulators might exploit observable information to reduce rents in the context of firms' investment decisions is hardly studied in the literature. In particular, we know of no empirical analysis that has studied which information might be useful in reducing rent extraction by firms.[2] In this paper, we study this question in the context of two Dutch ETA programs.

The most obvious candidates for observable and correlated information in our context are technology and firm characteristics. Using engineering studies or other technical analyses, technology characteristics can usually be quite easily observed, including an assessment of the potential financial profitability of a technology based on some imputed (bottom-up) analysis. More difficulties arise when finding an appropriate screening device for firm characteristics. From DeCanio and Watkins' (1998) study of firms' participation decisions in the voluntary Green Lights program of the US Environmental Protection Agency, we know that the decision to join the Green Lights program is associated systematically with firm characteristics, such as size (number of employees), sector and profitability (earnings per share, expected future earnings growth).[3] In addition, this study also observes that internal characteristics of firms seem to influence decision-making by firms in ways not measured by conventional investment analysis, in particular those focusing on the cost of capital and the standard net present value calculations.[4]

We believe, however, that it is hardly surprising that firm-specific characteristics matter. In particular, internal financial decision-making procedures vary largely across firms. As Graham and Harvey (2001) report, firms typically vary as to how

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[2]For instance, previous empirical work on the DSM program has focused exclusively on household decision-making and has not accounted for the role of observable information in relation to free riding (e.g., Malm, 1996; Haugland, 1996; Loughran and Kulick, 2004). The same holds for recent work on tax rebates for hybrid vehicles (Chandra et al., 2010; and Gallagher and Muehlegger, 2011).

[3]DeCanio and Watkins (1998) test the conventional theory that is based on the conjecture that financial analysis of the potential profitability of Green Lights investment should not vary across firms, so 'the presence of these firm-specific influences is evidence that the conventional model of investment decision-making is inadequate in this case.'(p. 106).

[4]The study also recognizes the opportunity for regulators to exploit this heterogeneity by an improvement of information dissemination, but provides no concrete suggestions.

they make (i.e., frame) their investment decisions. Whereas large firms rely heavily on present-value techniques and the capital asset pricing model (CAPM), small firms are more likely to use the pay-back criterion - if they use capital budgeting techniques at all. Such differences will have an effect on how firms evaluate energy efficiency investment opportunites, which, in turn, is likely to have an impact on rent extraction as well.[5] However, such characteristics are notoriously difficult to observe, in particular if internal decision-making procedures are responsible for the observed differences. Such procedures are typically unobservable and pose a serious challenge to regulatory agencies when designing effective and efficient ETA programs.

To study whether and how observable and correlated information might be helpful for improving the design of such programs, we collected data on 862 investment decisions by both profit and not-for-profit firms participating in one of two 'tagged' Dutch ETA programs. Both programs aim to increase the adoption and penetration of innovative energy-saving technologies by partially compensating firms for their investment-cost differential. Under these programs, the regulator restricts compensation of the investment-cost differential to technologies whose market share is 'small' and whose energy-saving potential is 'large'.[6] Using information from the regulatory agency on both programs, we compiled a unique data set covering 20 different energy-saving technologies across 75 four-digit sectors. For all investment decisions in our data set, we not only know the technologies' economic and physical characteristics, but also the actual decision-making procedure used by the firms and whether - according to their own judgement - their investment decision changed in response to the ETA program. We use this data set to evaluate whether and how free riding is related to any of the observable information in our data set. Regulators may use such information to minimize rent extraction by firms in the Dutch ETA programs by assigning to every firm a probability that it is free riding their program. Alternatively, regulators may restrict the eligibility criteria by either dropping technologies or restricting access for certain types of firms.[7]

Our results are based on a bivariate probit model and confirm, first of all, the

[5]Recall Hausman's (1979) finding that there is remarkable heterogeneity among households, as revealed by their (imputed) discount rates in making energy investment decisions in durables.

[6]These eligibility criteria, i.e., what is considered to be 'small' and 'large', are updated on a yearly basis.

[7]We want to stress that the nature of our data set does not allow us to extend our results to firms outside our sample, i.e., to firms that did not adopt these technologies at all or to firms that adopted these technologies but did not file an application under either one of the Dutch ETA programs.

importance of firm characteristics in the rent distribution. In particular, we find that the framing of investment decisions by firms is strongly correlated with the probability of being a free rider. In addition, we find that the way in which firms frame their investment decisions is correlated with observable characteristics such as the size of the firm and the sector in which it is active. In our sample of firms, about half claim *not* to use any capital budgeting technique to evaluate investment decisions[8] and the other half compute the economic consequences of an investment project explicitly but mainly through the simplest of capital budgeting techniques, viz. the pay-back period (PBP). We find that larger firms are more likely to use the pay-back period as a capital budgeting technique and that the use of the pay-back period differs substantially across sectors. Compared with horticultural firms, both agricultural and transport firms are much less likely to use a capital budgeting technique. In addition, we find clear evidence of the importance of technology characteristics in the rent distribution. Firms investing in technologies with long pay-back periods are less likely to be free riders than firms investing in technologies with short pay-back periods. Also, firms investing in expensive technologies are less likely to be free-riders than firms investing in cheap technologies. This confirms our conjecture that the regulator may use both firm and technology characteristics as a screening device for reducing rent extraction.

This paper proceeds as follows. Section 2 provides background information on the two ETA programs in the Netherlands that form the basis for our analysis. Section 3 presents our empirical model, while Section 4 presents the results. We conclude in Section 5.

2 Background and Data

This section provides background information on the characteristics of the two ETA programs that we evaluate, the so-called energy investment tax credit program (EIA) targeted at for-profit firms and the energy investment subsidy program (EINP) targeted at not-for-profit firms.[9] These ETA programs aim to stimulate the adoption of technologies with desirable characteristics from a social perspective, such as a reduction of CO_2 emissions. Examples of such technologies are wind turbines, high-

[8]This effect does not hinge on whether the firm is a for-profit firm or a not-for-profit firm.

[9]We use the Dutch Acronyms EIA ('energie-investeringsaftrek') and EINP ('subsidieregeling energievoorzieningen in de non-profit en bijzondere sectoren') to denote this tax credit and subsidy program respectively.

efficiency glass and insulation.

Under both programs, firms investing in energy-saving or renewable technologies receive a partial compensation for their investment costs. The EIA compensation is a tax deduction, whereas the EINP compensation is a subsidy. Under both programs, the advantage for firms varies with the level of investment and does so at a decreasing rate.[10] Under the EIA, the compensation is determined by the product of the tax credit and the firm's marginal tax rate. In our sample, the net advantage varies between 14% and 33% of the amount invested.[11] For-profit firms may backwards (three years) or forwards (seven years) any net operating losses, which in most instances will allow them to cash the tax deduction up to any present value considerations. Under the EINP, not-for-profit firms may obtain a subsidy between 14.5% and 18.5% of the amount invested. Typically, the number of EINP applications has been about 10% of the number of EIA applications.[12]

Both ETA programs use the so-called Energy List to determine upfront which technologies and firms are eligible for compensation and which are not.[13] In the 1997-2005 period, the Energy List contained between 80 and 110 technologies. In a typical year, the enforcement agency Senter renews, usually tightening, the eligibility criteria of around 30% of the technologies present on the Energy-List. Criteria for inclusion of technologies on the Energy List are that: (i) the use of the technology should result in a substantial reduction in energy use or emissions; and (ii) the technology is not common. Only a small number of technologies, such as insulation, energy-efficient lighting systems and frequency converters, appear (or have appeared) on both lists.

Table 1 presents information from the regulatory agency Senter on the number and size of applications for the EIA between 1997 and 2003.[14] Since 1997, the number of applications has grown steadily until, in September 2002, the EIA pro-

[10] In 1997, the tax deduction granted under the EIA varied between 52% for investments up to €2̃9,000 and 40% for investments larger than €2̃24,000. The investment figures are updated yearly with the consumer price index. As of 2002, the tax deduction is 55% irrespective of the size of the investment.

[11] For the time period covered by our sample, Dutch tax rates were 35% for limited liability companies and varied between 33% and 60% for other firms, such as partnerships and one-man businesses.

[12] The EINP was terminated in 2001.

[13] The current Energy List can be downloaded from http://regelingen.agentschapnl.nl/content/energie-investeringsaftrek-eia (in Dutch).

[14] Unfortunately, comparable information is not available for the EINP.

gram was temporarily suspended because of oversubscription.[15] To prevent future oversubscription, Senter tightened the criteria for eligibility as of 2003. Over the years, around 90% of EIA applications have been submitted by small companies, i.e., companies with a maximum of 100 employees. The share of investments by small companies has risen from 32% in 1998 to 87% in 2003. Furthermore, every application under the EIA or EINP is checked by Senter to prevent fraudulent claims; such checks may include company visits to detect whether the technology filed has indeed been installed. On average, Senter approves 80-85% of the amount claimed. Moreover, a small number of applications are withdrawn voluntarily, representing around 3-6% of the amount claimed.

[INSERT TABLE 1]

To determine the degree to which the use of observable characteristics may reduce the rent-incentive trade-off, we compiled a micro panel data set with information from Senter, which was supplemented with field data obtained from a survey among firms that were granted the subsidy between 1997 and 1999. Using the Senter database, we selected 20 technologies (see Table 2) on the basis of the following criteria. First, each of the selected technologies had to have been continuously on the Energy List between 1997 and 1999 in order to avoid strategic behavior by firms. Second, technologies for which there were fewer than 20 successful applications were excluded from our sample. Finally, we selected the top-20 technologies as measured by the sum of the firms' individual investment costs. Of the 20 selected technologies, 10 belonged to the EIA program only, seven to the EINP program only, and the remaining three to both the EIA and EINP programs.

Based on the selection procedure described in the previous paragraph, we obtained 4,967 and 513 records from Senter for the EIA and EINP, respectively.[16] After corrections for partnership firms as well as for applicants applying for more than one technology, we sent our questionnaire to 2,353 EIA-applicants and all 513 EINP applicants. From the response of 776 surveys (33.0%) for the EIA and 237 surveys (46.2%) for the EINP, 673 and 189 surveys, respectively, proved to be

[15] This was due to a small number of extremely large applications, which would have nearly doubled the 2002 expenditure under the program.

[16] Under the EIA program, partnership firms are required to submit separate applications for all partners corresponding to their share in the partnership. For our purposes, we considered these partners as a homogeneous agent when making their investment decision. This reduced the EIA database from 14,837 to 4,967 observations. Note that under Dutch law, partnership firms cannot be not-for-profit firms.

useful in that they were completely filled out. Response rates were representative across the technologies except for some minor under-representation of insulation and energy-conserving cooling and of freezing equipment, type B.

From the Senter database, we obtained information on the type of technology, the level of investment, the year in which the application was submitted and the sector in which the firm operated. Senter also provided us with the reference technologies, i.e., the technologies that firms would have invested in otherwise. Senter determined these reference technologies, their costs and energy use on the basis of a 1999 survey and expert opinion. For 12 of the 20 technologies investigated, the reference technology is characterized by 'no investment'.

We used these reference technologies together with information on sectoral energy prices supplied by the CPB Netherlands Bureau for Economic Policy Analysis to compute firm-specific pay-back periods, both in years and in euro per TJ.[17] These sectoral energy prices are a good proxy for the energy prices paid by individual firms in our sample, because most firms in our sample paid advertised tariffs until January 2002.[18] Table 2 provides further details on the characteristics of the technologies analyzed in our sample, such as the investment costs of the (reference) technology, the EIA tax credit or EINP subsidy measured as a percentage of the additional investment cost, the pay-back period and number of observations. Note that all information in Table 2 is based on firm-specific numbers.

[INSERT TABLE 2]

The questionnaire supplemented the Senter database with information reported by the firms about their background characteristics, such as turnover and legal

[17]Pay-back periods measured in years were obtained by dividing the additional investment of the energy-saving technology by its yearly energy saving in euros. Pay-back periods in euros per TJ, which we will refer to as physical pay-back periods, were obtained by dividing the additional investment of the energy-saving technology by its yearly energy saving in TJ.

[18]The Dutch electricity market was liberalized for large users on 1 January, 1999, followed by medium users on 1 January , 2002. The corresponding dates for the gas market are 1 January, 2001 for large users and 1 January, 2002 for medium users. Using Senter's information on firms' turnover and number of employees, we conclude that, prior to 2001, a maximum of 3.1% of the firms in our sample was able to buy electricity or gas on a liberalized market, implying that their (negotiated) prices would substantially deviate from the sectoral energy prices. After 2001, liberalization might have affected most, if not all, energy prices. However, competition in the Dutch electricity market lacked contestability in the early stages (Newbery, 2002), and was virtually absent on natural gas market as witnessed by the market share (78%) of GasTerra, the Dutch incumbent, in 2004 (GasTerra, 2008).

form.[19] Furthermore, it provided detailed information on the firms' internal decision-making processes, i.e., the financial method they used for evaluating this specific investment project, such as internal rate of return, pay-back period, or none. In addition, the firms provided us with the critical values used in their evaluation, i.e., minimum internal rate of return or critical pay-back period. To evaluate whether firms had changed their investment as a result of the ETA program, we asked them whether the investment would also have been made without delay, had the firm not been eligible for compensation. Firms also reported on the level of other subsidies, if any, obtained for the technology in question, the information set of the firm just prior to the time of investment (when did they learn about the technology and the ETA program), and the prime motive for investing in the technology. To reduce hypothetical bias, the questionnaire was accompanied by a letter signed by the Minister that explicitly told respondents that their answers would be used by the government to improve the ETA program in the future. This may partially explain the high response rates relative to other surveys.

Table 3 reports sample statistics for our data set. Average investment costs in our sample are at €$\tilde{7}$8,600 higher than the EIA average (see Table 1), and range from €$\tilde{2}$5,700 to €$\tilde{3}$,118,000. Only 36% of all investments in our sample have a reference technology, whose cost varies between €$\tilde{1}$,100 and €$\tilde{2}$,650,000. Furthermore, the mean value of the annual energy-cost savings measured in monetary terms is €$\tilde{1}$2,500 (or 16% of the mean investment cost in our sample), which is considerable. Note also that the variation in pay-back periods is substantial: whereas the average pay-back period in our sample is 9.8 years, for some technologies it is less than a year and for others it exceeds 40 years.[20]

[INSERT TABLE 3]

3 Estimation Model

A key element in the design of our two ETA programs is the Energy List. On the one hand, this list reflects the regulator's current judgement about which technologies are eligible for subsidy under either of the two ETA programs. For example, the regulator may use some (objective) characteristics of the technology, such as the amount of energy saved per euro invested, to determine whether the technology

[19] See Appendix B for the complete (translated) questionnaire.

[20] Note that the reported pay-back periods would have been only marginally lower if we included the other subsidies that were obtained by the respondents in the calculation of the pay-back period.

should be eligible. On the other hand, the list is a reference point for firms to evaluate their investment opportunities. Firms screen the technologies on this list using their own, firm-specific *internal* decision-making procedure. To illustrate, suppose that firms rank potential investments in energy technologies according to the investments' net present value (NPV). Standard economic theory suggests that any rational firm should invest in the most profitable technology, provided that its NPV is larger than zero. This should be the case irrespective of the type of firm involved (profit or not-for-profit) or the risk class to which the firm belongs. So if a technology on the Energy List passes the criterion laid down in the firm's decision-making procedure, the firm should adopt it.

As explained in the introduction, DeCanio and Watkins (1998) have shown that for a similar type of investment (energy-efficient lighting), 'exogenous' characteristics of firms do matter, even after controlling for differences in risk between firms. Their analysis took the firms' internal decision-making process for granted, however, whereas there is evidence that firms differ in the way they 'frame' their investment decisions. For instance, Graham and Harvey (2001) found that large firms rely heavily on present-value techniques and the capital asset pricing model, whereas small firms are more likely to use the (critical) pay-back criterion (CPBP).

We also find that there is a large variation as to how firms frame their investment decisions. On the question of which method the firm used to evaluate this specific investment, 41% of the firms in our sample indicated that they used the CPBP, 4% used the internal rate of return,[21] and 43% claimed not to use any explicit method for the evaluation of their investments at all.[22] Particularly interesting in our sample is the large number of firms that claims *not* to use *any* kind of (simple) financial evaluation method. To us, it seems unlikely that the observed heterogeneity regarding firms' internal decision-making procedures would not systematically affect the decisions taken by firms and, thereby, the rent distribution across firms in our sample. If this is indeed the case, the question of whether the regulator can observe (correlated) information regarding firm-specific characteristics, such as the internal

[21] Note that the internal rate of return and the CPBP are strongly related (see Sarnat and Levy, 1969). The CPBP can be replaced by a 'pseudo critical pay-back period', which is equal to $(1-(1+r)^{-n})/r$, where r is the internal rate of return and n is the economic lifetime of the technology.

[22] The remaining 12% did not know whether their firm used a criterion or what it was; we added them to the category of not using any method. Note also that the high percentage of firms that claim not to use any method is not due to the presence of not-for-profit firms, because the percentages are more or less the same for profit and not-for-profit firms.

decision-making procedure, is even more important for our purpose.

When do we expect that a firm is likely to be free riding? This, first of all, depends on whether the ETA program changes the firm's behavior. For example, if an ETA program lowers the cost of a technology to the firm, we expect that the technology will be adopted more often, or earlier in time, even if firms differ in (the stringency of) their internal decision-making procedures.[23] We also expect to see this if firms do not evaluate investments according to financial methods.[24] Furthermore, we expect that a firm is more likely to be free riding if it uses a less stringent criterion, e.g., a higher CPBP. We also expect technology characteristics to matter. We hypothesize that if a firm is investing in more profitable technologies, i.e., in technologies with a shorter pay-back period, it is more likely to be free riding. Finally, we expect that, due to the possibility of a firm being liquidity constrained, firms making expensive investments are less likely to be free riding.

Given the large number of firms not using any capital budgeting technique in our sample, we use a bivariate probit model to explain, first, whether a firm is likely to use a capital budgeting technique (in our sample, the CPBP) and, second, whether the firm was free riding on the ETA program when making the investment.[25] Accordingly, we estimate a bivariate probit model in which the first equation explains whether a firm with certain observable characteristics, such as turnover, number of employees and sector, uses a capital budgeting technique, $y_{i1} = 1$, or not, $y_{i1} = 0$, and the second equation explains whether a firm is free riding, $y_{i2} = 1$, or not, $y_{i2} = 0$. Subsequently, we refer to these equations as the 'capital budgeting equation' and the 'rent equation', respectively. Formally,

$$\begin{aligned} y_{i1} &= 1\left(\frac{X_{i1}'\beta_1}{\sigma_{i1}} + \varepsilon_{i1} > 0\right), \\ y_{i2} &= 1\left(X_2'(y_{i1}, z_i)\beta_2 + \varepsilon_{i2} > 0\right), \end{aligned} \tag{1}$$

where $\sigma_{i1} = z_i + \lambda(1 - z_i)$

[23]Even though option value theory has stressed the importance of uncertainty with respect to future costs and benefits for the adoption decision (Pindyck, 1991), there is no additional effect on the relative attractiveness of investment options related to subsidization.

[24]Our expectation is based on experimental evidence reported by Aalbers et al. (2009).

[25]We have restricted the first probit to only those firms that claim to use a pay-back period. The very few firms using an internal rate of return are taken together with firms that claim not to use any method. Deleting these firms from our sample has no influence on our results, which are available upon request.

$$\text{and } X_2'(y_{i1}, z_i) = \begin{bmatrix} [X_2^{1\prime} \quad X_2'], & y_{i1} = 1, & z_i = 1 \\ [X_2^{2\prime} \quad X_2'], & y_{i1} = 0, & z_i = 1 \\ [X_2^{3\prime} \quad X_2'], & y_{i1} = 0 \text{ or } y_{i1} = 1, & z_i = 0 \end{bmatrix}.$$

Here, β_1 and β_2 are the regression coefficients of the explanatory variables of the first and second probit equation, respectively. Moreover, $\beta_2 = [\beta_2^1, \beta_2^2, \beta_2^3, \beta_2]$,[26] z_i is a dummy indicating whether the firm is for-profit, $z_i = 1$, or not-for-profit, $z_i = 0$, while λ captures any differences in variance between the for-profit and not-for-profit firms. Finally, $(\varepsilon_{i1}, \varepsilon_{i2})$ is independently and identically distributed as a bivariate normal with correlation coefficient ρ.

We estimate both a pooled and a non-pooled version of the model. In the pooled version, we have $\beta_2^1 = \beta_2^2 = \beta_2^3 = 0$. In the non-pooled version, we split our sample into three groups: (i) rational for-profit firms, i.e., for-profit firms claiming to use a capital budget technique, such as CPBP; (ii) quasi-rational for-profit firms, i.e., for-profit firms claiming not to use a capital budgeting technique; and (iii) not-for-profit firms.[27] Note that our model is a recursive simultaneous-equations model with an endogenous set of (interacted) variables in the second probit equation where the endogenous nature of the variables on the right-hand side of the second equation can be ignored in formulating the log-likelihood (cf. Greene and Hensher, 2009, p. 78). This specification allows us to capture any correlation between unobserved variables in both equations.

4 Results

4.1 Pooled sample

Tables 4 (capital budgeting equation) and 5 (rent equation) together present the estimation results for our sample. We start, for the sake of reference, with the estimation results for the pooled sample (see Model (1) in both tables). According to our pooled estimates of the capital budgeting equation based on the bivariate probit, firms with a (relatively) large turnover in our sample are significantly more likely to use capital budgeting techniques than firms with smaller turnovers. This finding is

[26] We use the subscripts $_1$ and $_2$ to denote whether the variables for β and X appear in the first or second probit equation, respectively. We use the superscripts ^{1}, ^{2} and ^{3} to denote whether or not a specific variable belongs only in a specific subgroup (explained later in more detail). If a variable belongs to all subgroups, we use no superscript.

[27] Unfortunately, in the non-pooled model, data limitations prevent us from splitting the not-for-profit firms into rational and quasi-rational firms.

- in spirit - consistent with the survey by Graham and Harvey (2001). They found that larger firms use more sophisticated capital budgeting techniques. Even though our sample falls more or less entirely within their ‘very small firms’ category, we also find that large firms use more sophisticated capital budgeting techniques. Furthermore, the probability of using capital budgeting techniques differs significantly across sectors (after correction for size). Compared with horticulture, firms in other sectors, especially the transport sector, are significantly less likely to use capital budgeting techniques. The high percentage of firms using capital budgeting techniques in horticulture is not surprising, as the horticulture sector in the Netherlands is internationally very competitive, exporting over 80% of its production.

[INSERT TABLE 4]

Looking at the results that explain whether a specific firm is more likely to obtain a rent (Table 5), the probability of the firm being a free rider decreases with the pay-back period (PBP) of the technology, which is as predicted. Without support from ETA programs, firms are less likely to invest in technologies with long pay-back periods, simply because they are less profitable, thereby decreasing the probability that such firms are free riding. Moreover, the probability of a firm being a free rider *decreases* with investment size, as shown by the negative coefficient of INVESTMENT, which is again as predicted. According to this pooled model, a higher CPBP has a positive effect on the probability of being a free rider, which is also as predicted. Its coefficient is, however, statistically insignificant.

[INSERT TABLE 5]

Furthermore, note that the correlation of the unobserved factors between the first and second equations (ρ) is -0.33 and highly statistically significant. The variance of the unobserved factors for the capital budgeting equation is smaller for not-for-profit firms than for for-profit firms; the coefficient in the all but last row of Table 4 in the column of Model (1) is smaller than one. A possible explanation for this result is that the not-for-profit sample is more homogeneous than the for-profit sample, because these firms are predominantly found in the non-commercial services sector.[28] This illustrates that consistent estimation of the rent equation indeed requires our bivariate procedure.

[28]In total we have 189 not-for-profit firms in our sample, of which 140 are active in the non-commercial services sector and 49 in the commercial services sector.

4.2 Non-pooled sample

One possibility why the variable CPBP is not significant in the pooled model is that only a subset of firms use this capital budgeting technique. Therefore, we explicitly allow for variation in behavior between different types of firms and estimate a non-pooled version of our model. Given our data limitations, we obtain the best results if we divide our sample into the three separate groups mentioned in section 3: (i) rational for-profit firms using CPBP; (ii) quasi rational for-profit firms not using CPBP; and (iii) not-for-profit firms.[29] Models (2) and (3) in Tables 4 and 5 present the results of two specifications for the non-pooled estimation.

The results of the capital budgeting equation are self explanatory because they are almost identical for the pooled and the non-pooled models. The rent equation now produces results in accordance with our hypotheses, although interesting differences exist between the subgroups. In particular, the first observation is that the rational for-profit firms are, on average, more likely to free ride than the other two groups. This is reflected in the constant, which is positive and statistically significant for the rational for-profit firms, but insignificant for the other two groups.

Furthermore, as in the pooled model, rational for-profit firms are less likely to obtain rents when they invest in technologies with longer pay-back periods (PBP). However, we do not find these results for for-profit firms that frame their investment decision without using a capital budgeting technique. For this subgroup, PBP remains statistically insignificant (results are available on request). However, when we allow for a different 'rule of thumb' for decision making, i.e., a pay-back period expressed in euros per TJ, we again obtain a significant coefficient of the right sign (see Model (2)). This measure reflects the investment-cost differential with the reference technology relative to the (physical) units of energy saved. One might consider this to be a much simpler 'rule of thumb' that requires only very limited information to evaluate the relative performance of the subsidized technology. With this specification, we obtain the same result as for the rational for-profit firms: longer pay-back periods still matter, but the probability of free riding for those firms depends on what we label the PHYSICAL PBP. This finding justifies our label 'quasi-rational'.

The results for our INVESTMENT variable are also remarkably different across our subsample. Whereas the investment level has almost no explanatory power for

[29] We also estimated our sample for two (rational versus quasi-rational firms) as well as for four (rational versus quasi-rational in for-profit and not-for-profit firms) separate groups. In all cases, the results are less convincing (e.g., all results for the not-for-profit firms turned out to be statistically insignificant). Results available on request.

the rational for-profit firms (remember that these firms are already more likely to be free riders in general), high investment levels reduce the likelihood of free riding for the quasi-rational for-profit firms as well as for the not-for-profit firms, although the effect is not statistically significant for the latter group. This is consistent with our hypothesis and might be explained by the much simpler 'rule of thumb' applied in investment decisions by quasi-rational firms. In particular, the likelihood that they are liquidity constrained is likely to increase with larger investments.

Finally, note that the variable CPBP is still not statistically significant in Model (2) even though it is of the expected sign and its explanatory power is strongly improved relative to the pooled model. One reason could be that the effect of the CPBP on the probability of free riding interacts with the economic lifetime of a technology.[30] A longer CPBP might raise the probability that a firm is free riding, but only for investments with a comparable economic lifetime. Interacting the CPBP reported by these firms with dummy variables indicating the economic lifetime of the investment (ELT10, ELT15 and ELT50 for technologies with a lifetime of respectively 10, 15 or 50 years), confirms again our expectation (see Model (3) in Table 5). Now the coefficient of the CPBP term shows up statistically significant for two out of the three categories.

The results for the not-for profit sector are statistically insignificant. We suspect that the insignificance is due to data limitations because there are relatively few not-for-profit firms in our sample. Finally, note that the correlation of the unobserved factors between the first and second probits (ρ) in the non-pooled model is 0.61, which is much higher than in the pooled model.

4.3 Robustness

Surveys in general may suffer from policy response bias, i.e., respondents could anticipate potential negative effects of their answers on future policy decisions. In our case, firms might be inclined to answer that they have changed their decision to buy the energy-saving technology because of the ETA programs, i.e., that they are not free riding. Otherwise, the regulator might constrain future possibilities of obtaining rents.

We have several reasons to believe that the potential impact of such a response bias in our sample is limited. First, and most important, is the observation that, on

[30] The economic lifetime of a technology is taken to be similar to the depreciation period allowed under Dutch accounting law.

average, half of our sample by no means answered strategically in this way, simply 'admitting' that they are free riding. In addition, the percentage of firms that admit to free riding varies enormously between technologies (see Table 2). For example, only 17% of the firms investing in a wind turbine admit that they are free riding compared with 69% of the firms investing in energy blinds. Other technologies with high levels of free riding are heat registration systems (67%), energy-conserving cooling and freezing equipment, type A (64%), and frequency converters (64%). The high level of truthful firms and the large variation across technologies suggest that policy response bias is not a major issue in our sample. Moreover, we do not expect that strategically-responding firms would 'admit' that their prime reason for investing in the energy-saving technology was to obtain the subsidy or tax-credit. Still, 14% of our firms mentioned this as their prime reason for investment and, what is more, this subsample also relatively more often claimed (72% versus 45%) that their decision had been changed due to the ETA program.[31]

Second, we believe that our use of a letter on behalf of the Minister by the regulatory agency, mentioning explicitly that this research would be used for future improvements of the subsidy scheme in the Netherlands, is very likely to have reduced response bias. This use of consequentialism requires trust in the regulatory agency, which we believe exists. One indication is the response rate, which is far above what is common for surveys among firms.[32] Another sign is that many respondents used the last empty field in the survey to provide us with advice and comments on the ETA programs in the Netherlands. This is consistent with other observations that trust in the government was quite widespread in Dutch society at the time of our research.[33]

Third, the main interest in our analysis is not to establish the *absolute* level of rent extraction by firms. More general inferences on the potential efficiency gains of using observable information to reduce rent extraction would require data on a control group of firms not subject to either of the ETA programs. Instead, our main interest is in whether and how these stated responses vary systematically across different types of firms that have filed an application under either of the ETA

[31] Other possible answers about the main reason were an upgrade of a previous similar investment (25%), an upgrade of the entire production process (22%), a cleaner environment (8%), regulation (3%), a better reputation (2%), and other reason (26%).

[32] For example, Campbell and Kamlani (1997), Freeman and Kleiner (2000), and Graham and Harvey report response rates of 19%, 11%, and 9%, respectively.

[33] Source: http://www.europeansocialsurvey.org.

programs.[34] Indeed, our aim is to illuminate the role that observable information can play in reducing rent extraction within the current ETA programs, by linking this observable information to free-riding behavior. Moreover, if response bias differed systematically between our three subgroups, this would already be captured by the fixed effects for each group.

Finally, we checked whether our results are driven by firms that have larger stakes in not answering truthfully. Clearly, these stakes are highest for those firms that invested most, because under the existing ETA programs the largest investments generate the largest advantage. Model (4) in Table 6 shows that our results are not affected by excluding the top 10% of investments from our sample, except for the INVESTMENT variable, which - although retaining the right sign - becomes insignificant. A possible explanation is that firms undertaking large investments are especially likely to be liquidity constrained.

[INSERT TABLE 6]

As a further check on the robustness of our results, we explored whether the ETA programs had an effect on the information set of the firms. The inclusion of a technology on the Energy List of an ETA program may signal its importance to firms and accordingly stimulate learning about it (Wene, 2000; Jaffe et al., 2003). We would expect firms thatlearned about the ETA program only after they invested to be more likely to be free riding than firms that already knew of the ETA program. We tested this hypothesis by asking firms whether they obtained their knowledge about the ETA program before, during or after the time of the investment decision. Firms answering 'after' received no attention value from the ETA program. Our results indeed confirm that these firms are more likely to be free riding (see Model (5) in Table 6).[35]

[34] This leaves two possibilities in the absence of the scheme, i.e., (i) the firms would have canceled the investment or (ii) they would have postponed the investment. In the estimation, we make no distinction between postponement and cancellation. Results, available on request, are not affected when this distinction is made.

[35] A possible explanation for this result is that companies that knew about the ETA program may have 'discovered' their investments by looking at the Energy List. These investments may then have received more support during the decision process or may be - on average - more profitable. Such companies would be inclined to state that the ETA program did change their decision, i.e., that they are not free riding.

4.4 Policy implications

Selection bias might be a serious shortcoming if the investment behavior of firms in our sample is not representative for small to medium sized firms in general. Indeed, the firms in our sample have all invested in these technologies with subsidy, so we cannot compare their behavior with that of firms that have invested in these technologies without subsidy or have not invested at all. It should be noted, however, that our results are useful for a regulator interested in improving the design of ETA programs even if our sample is not representative for small firms in general. Specifically, our results show that the choice of technologies on the Energy List indeed matters for the effectiveness (as well as the efficiency) of the ETA program. The effectiveness of the subsidy program may be even further increased by specifically targeting (groups of) firms.

To illustrate the economic significance of our effects, we computed the marginal effects of all right-hand-side variables in Model (3) on the probability of free riding (see Table 7).[36] According to our estimates an increase of the PBP by 1 year reduces the probability that a rational for-profit firm is free riding by 0.007, whereas an increase in the PHYSICAL PBP by €1̃ per TJ reduces the probability that a quasi-rational for-profit firm is free riding by 0.004. Moreover, an increase in the investment by €1̃000 reduces the probability of free riding of a quasi-rational for-profit firm by 0.11, of a not-for-profit firm by 0.19 (not significant), but increases the probability of free riding of a rational for-profit firm by 0.023 (not significant).

[INSERT TABLE 7]

Regarding firm characteristics, we find that firms using capital budgeting techniques have a 0.073 higher probability of free riding (compared with firms not using capital budgeting techniques). Although regulators cannot observe the type of firm (rational or not), they might use observable correlated information, such as the size and sector of the firm, to improve the effectiveness of their ETA program. For example, firms with a large (medium) turnover have a 0.017 (0.008) higher probability of free riding than firms with a small turnover. Moreover, firms active in the horticulture sector have a 0.015 to 0.029 higher probability of free riding than firms in other sectors. Hence, we conclude that the regulator might improve the effectiveness of the Dutch ETA programs by using observable information on both technologies and firms to decrease the percentage of firms that are free riding. In addition, the

[36] See Appendix A for more details. Probabilities are measured on a scale between 0 and 1.

regulator might use information that is correlated with non-observable information, such as the use of (specific) capital budgeting techniques.

5 Conclusion

In this paper, we show that adoption decisions regarding subsidized technologies differ markedly between different types of firms and across technologies. Specifically, we contribute to the existing empirical literature by shedding new light on why firms invest in certain technologies, and how those decisions are affected by the use of a tax credit or subsidy. Using a unique micro data set on individual investments in energy-saving technologies, we find clear evidence to support our conjecture that the probability that a firm obtains a rent from a subsidy program depends on both firm- and technology-specific characteristics. Interestingly, these characteristics are either directly observable or correlated with other observable information, and could therefore be exploited by the regulator to improve its energy technology adoption program by restricting eligibility.

One remarkable finding of our empirical study is the systematic difference between firms in how they frame their investment decisions. In our sample, about half of the firms claim *not* to use any capital budgeting technique to evaluate investment decisions. The other half do indeed compute the economic consequences of an investment project, but mainly through the simplest of techniques, i.e., the pay-back period. These differences in behavior, however, are nicely correlated with observable characteristics such as the size of a firm and the sector in which it is active. Agricultural and transport firms are much less likely to use a capital budgeting technique than horticulture firms, for example.

The other remarkable finding is that this distinction in subgroups also matters for rent extraction from the ETA programs that we evaluated. First of all, firms using capital budgeting techniques are more likely to obtain such rents than firms not using capital budgeting techniques. Second, rents are typically larger for both types of firms when they invest in technologies with shorter pay-back periods. Apparently, firms not using capital budgeting techniques still evaluate their investment in a systematic way. Our results suggest that they trade off the additional investment against the amount of energy saved, instead of the value of energy saved. That is, they behave *as if* they are using a physical pay-back period. Third, these quasi-rational firms are also more likely to be free riders if they invest smaller amounts. Taken together, these findings clearly show that, in our sample, framing affects investment, i.e., the investment decision taken by a firm depends on the capital budgeting technique it uses. We believe that this observation may be representative for a much wider class of investments.

These findings show the importance of observable information for screening technologies and firms that are eligible for subsidization. Restricting eligibility to technologies with long(er) pay-back periods is one example in this respect. On the other hand, the regulator may select technologies that are typically bought by quasi-rational firms, which are usually small firms. In this way, the regulator reduces the probability that firms will be free riding. Thus we find clear indications that such 'tagging' is a useful and productive strategy for regulators if they aim to stimulate the penetration of certain energy-efficient technologies. This is not surprising, as the advantages of tagging are well known in other areas. What impact tagging may have in the context of energy technology adoption programs in general remains a topic for further research as we are unable to generalize our conclusions beyond our sample.

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Tables and Figures

Table 1: Number and size of applications under the EIA

Year	Number of applications	Amount claimed (m €)	Average investment (€)
1997	10,366	430	41,500
1998	14,145	656	46,400
1999	17,408	587	33,700
2000	25,815	695	26,900
2001	28,139	1,058	37,600
2002	17,228	1,344	78,000
2003	15,518	834	53,700

Table 2: Technology characteristics

	N	Investment	Reference	Saving	Subsidy[1]	PBP[2]	Free rider
		1,000 €	1,000 €	1,000 €	%	year	%
Combined heat and power	61	224	0	51	18	4.2	48
Condenser	50	37	19	13	42	1.4	49
Draught sealing	5	39	0	1.1	18	36.6	60
Energy blinds	68	38	0	7.5	22	4.9	69
Energy conserving cooling and freezing equipment, type A	11	22	18	2.2	115	2.1	64
Energy conserving cooling and freezing equipment, type B	58	39	31	1.5	106	4.9	60
Energy efficient lighting	30	45	30	2.5	54	6.0	30
Frequency converter	66	17	0	5.3	20	3.8	64
Generic construction techniques	27	45	0	13	21	3.6	55
Generic equipment, process techn.	26	215	0	131	17	1.8	61
Heat buffer	51	44	0	5.6	21	7.8	59
Heat pump	7	29	9.6	6.0	27	3.3	43
Heat recovery from ventilation air	10	59	0	17	18	3.4	40
Heat registration system	6	11	0	0.4	19	27.3	67
High-efficiency boiler	93	51	34	2.0	54	7.9	58
High-efficiency glass	8	128	105	1.6	93	14.5	61
Insulation	207	27	0	1.2	21	23.0	41
Lightweight semi-trailer	53	323	274	7.9	117	6.1	36
Weather-dependent optimizer of non-residential heating	7	25	0	4.7	18	5.3	42
Wind turbine	18	324	0	43	18	7.6	17

[1]Compensation as a percentage of additional investment costs.

[2]Mean PBP (measured in years) calculated by dividing additional investment of technology by its yearly energy saving (in euros) using sector-specific energy prices in 1999.

Table 3: Descriptive statistics[1]

Variable	Unit	Mean	SD	Minimum	Maximum
Decision not altered by subsidy	dummy	0.51	n.a.	0	1
Investment cost	1,000 €	78.6	221.6	25.7	3,118
Investment cost reference technology[2]	1,000 €	26.1	150.8	1.1	2,650
Energy saved per year:					
- monetary	1,000 €	12.5	51.2	1.47	1,131
- non-monetary	TJ	1.91	6.54	0.00	100.3
Price of electricity	€	7.7	1.2	3.4	12.0
Price of gas	€	17.0	5.5	8.4	28.7
Pay-back period (PBP)	years	9.8	9.1	0.8	41.7
PHYSICAL PBP	€ /TJ	149.7	120.7	15.0	445.0
EIA or EINP subsidy as % of investment	%	19.9	3.3	13.7	26.4
PBP including EIA or EINP subsidy	years	9.4	9.6	-66.5	41.7
Estimated Economic lifetime	years	22.1	16.5	10.0	50.0
Critical pay-back period (CPBP)[3]	years	3.13	4.3	0.0	31.4
Obtained VAMIL subsidy	dummy	0.18	0.39	0	1
Obtained other subsidies	dummy	0.11	0.31	0	1
No attention value	dummy	0.39	0.49	0	1
Small to medium company[4]	dummy	0.25	0.43	0	1
Medium company[4]	dummy	0.42	0.49	0	1
Large company[4]	dummy	0.22	0.42	0	1

[1]Summary statistics apply to 862 observations over the three-year period 1997-1999.
[2]Reference technology applies to 310 observations.
[3]Critical pay-back period applies to 384 observations.
[4]Turnover: small to medium companies below € 0.45m; medium companies between € 0.45m and € 4.5m; large companies more than € 4.5m.

Table 4: Results capital budgeting equation

	Model (1)	Model (2)	Model (3)
	Pooled	Non-pooled	Non-pooled
MEDIUM TURNOVER	0.25**	0.21**	0.20**
	(2.36)	(2.08)	(2.07)
LARGE TURNOVER	0.51***	0.49***	0.49***
	(3.51)	(3.50)	(3.53)
INDUSTRY	-0.41**	-0.39**	-0.38**
	(2.31)	(2.31)	(2.27)
COMMERCIAL TRADE	-0.47***	-0.42***	-0.43***
	(2.80)	(2.59)	(2.67)
TRANSPORT	-0.68***	-0.63***	-0.65***
	(3.43)	(3.32)	(3.43)
COMMERCIAL SERVICES	-0.46***	-0.41***	-0.39***
	(2.81)	(2.68)	(2.62)
NON-COMMERCIAL SERVICES	-0.37***	-0.36***	-0.37***
	(2.93)	(2.91)	(2.93)
FOOD	-0.40*	-0.41**	-0.42**
	(1.82)	(2.01)	(2.07)
AGRICULTURE	-0.44***	-0.41***	-0.41***
	(4.08)	(3.96)	(4.00)
HORTICULTURE	-0.06	-0.06	-0.04
	(0.57)	(0.53)	(0.42)
Variance not-for-profit firms	0.60**	0.61**	0.62**
	(2.45)	(2.49)	(2.48)

Notes: Dependent variable is USES CAPITAL BUDGETING TECHNIQUE.
This equation is estimated jointly with the rent equation (see Table 5).
***[**](*) denotes significance at 1[5](10) percent level.
t-statistics within parentheses.

Table 5: Results rent equation

	Model (1)	Model (2)	Model (3)
	Pooled	Non-pooled	Non-pooled
Rational for-profit firms			
Constant		0.48***	0.51***
		(3.89)	(3.50)
PBP		-0.03***	-0.03**
		(2.88)	(2.51)
INVESTMENT		0.06	0.11
		(0.43)	(0.75)
CPBP		0.02	
		(1.28)	
CPBP*ELT10			0.04*
			(1.75)
CPBP*ELT15			0.00
			(0.13)
CPBP*ELT50			0.03*
			(1.73)
Quasi-rational for-profit firms			
Constant		-0.01	-0.04
		(0.09)	(0.28)
PHYSICAL PBP		-0.02***	-0.02**
		(2.62)	(2.52)
INVESTMENT		-0.47**	-0.47**
		(2.25)	(2.26)
Not-for-profit firms			
Constant		0.06	0.06
		(0.39)	(0.36)
PBP		0.00	0.00
		(0.05)	(0.12)
INVESTMENT		-0.87	-0.82
		(1.44)	(1.34)
All firms			
Constant	0.17**		
	(2.06)		
PBP	-0.02***		
	(3.30)		
INVESTMENT	-0.16*		
	(1.83)		
CPBP	0.01		
	(0.76)		
Rho	-0.33***	-0.61***	-0.63***
	(3.76)	(5.68)	(5.89)
Log-Likelihood	-586.0	-575.7	-573.7

Notes: dependent variable is WOULD HAVE MADE INVESTMENT WITHOUT SUBSIDY.
This equation is estimated jointly with the capital budgeting equation (see Table 4).
Number of observations is 862 for all models.
***[**](*) denotes significance at the 1[5](10) percent level.
t-statistics within parentheses.

Table 6: Results rent equation

	Model (4)	Model (5)
	Excl. 10% highest investment	No attention value
Rational for-profit firms		
Constant	0.66***	0.43***
	(3.86)	(2.91)
PBP	-0.03**	-0.03***
	(2.50)	(2.61)
INVESTMENT	-0.87	0.14
	(1.06)	(0.94)
CPBP*ELT10	0.04*	0.04*
	(1.75)	(1.72)
CPBP*ELT15	-0.01	0.00
	(0.46	(0.12)
CPBP*ELT50	0.03*	0.03
	(1.72)	(1.59)
Quasi-rational for-profit firms		
Constant	-0.04	-0.13
	(0.23)	(0.84)
PHYSICAL PBP	-0.02***	-0.02***
	(2.60)	(2.62)
INVESTMENT	-1.17	-0.42**
	(1.39)	(2.08)
Not-for-profit firms		
Constant	0.02	-0.02
	(0.09)	(0.11)
PBP	-0.00	-0.00
	(0.02)	(0.13)
INVESTMENT	-0.03	-0.83
	(0.02)	(1.39)
All firms		
NO ATTENTION VALUE		0.22***
		(2.74)
Rho	-0.64***	-0.62***
	(5.98)	(5.66)
Log L	-515.1	-569.2

Notes: dependent variable is WOULD HAVE MADE INVESTMENT WITHOUT SUBSIDY; This equation is estimated jointly with the Capital Budgeting Equation (not reported); Number of observations is 776 for Model (4) and 862 for Model (5). ***[**](*) denotes significance at the 1[5](10) percent level; t-statistics within parenthesis.

Table 7: Marginal effects of the bivariate probit on $E\{y_2|X_1, X_2\}$

Capital budgeting equation		**Rent equation**	
Dummy variables		Dummy variables	
MEDIUM TURNOVER	0.008*	FOR PROFIT	0.001
LARGE TURNOVER	0.017*	USES CPBP	0.073**
INDUSTRY	-0.018**	Cont. variables - rational for-profit	
COMMERCIAL TRADE	-0.019**	PBP (in years)	-0.007**
TRANSPORT	-0.029**	INVESTMENT (in 1,000 €)	0.023
COMMERCIAL SERVICES	-0.018**	CPBP*ELT10 (in years)	0.008*
NON-COMMERCIAL SERVICES	-0.015**	CPBP*ELT15 (in years)	0.001
FOOD	-0.019**	CPBP*ELT50 (in years)	0.005*
AGRICULTURE	-0.019**	Cont. variables - quasi-rational for-profit	
HORTICULTURE	-0.002	PHYSICAL PBP (in €/TJ)	-0.004**
		INVESTMENT (in 1,000 €)	-0.113**
		Cont. variables - not-for-profit	
		PBP (in years)	0.000
		INVESTMENT (in 1,000 €)	-0.190

Notes: **(*) denotes significance at the 5 (10) percent level.
See Appendix A for computational details.

Appendix A Marginal Effects

We are interested in the effect of (observable) firm and technology characteristics on the probability of free-riding. The conditional mean is

$$\begin{aligned} E\{y_2|X_1, X_2\} &= P\{y_1 = 1\}\, E\{y_2|y_1 = 1, X_1, X_2\} \\ &\quad + P\{y_1 = 0\}\, E\{y_2|y_1 = 0, X_1, X_2\} \\ &= \Phi(X_1'\beta_1, X_2'\beta_2, \rho) + \Phi(X_1'\beta_1, -X_2'\beta_2, -\rho). \end{aligned}$$

Marginal effects are calculated as in Greene (2004, p. 716). For continuous variables, this conditional mean function is differentiated to calculate the marginal effects. For binary variables, the conditional mean function is computed with the variable in question set to 1 and 0. The marginal effect is the difference between these values. Finally, the marginal effect of using a pay-back period on the decision (not) to buy is calculated as $P\{y_2 = 1|y_1 = 1, X_1, X_2\} - P\{y_2 = 1|y_1 = 0, X_1, X_2\}$. Standard errors for the estimated marginal effects are calculated by using a Monte Carlo procedure. For each marginal effect, 5,000 draws were taken from the bivariate normal distribution using the Choloski transformation (see Train, 2003). For each of these draws, we computed the marginal effect. Finally, we took the 95% confidence interval of the resulting distribution.

Appendix B Questionnaire (for EIA only)

Question 1: What is the legal form of your company?

O PLC
O Cooperative society
O Limited partnership
O Partnership
O Firm
O Association
O Foundation
O One-man business
O Mutual insurance company
O Cooperation
O European Economic Cooperation

Question 2: What was your company's total turnover in the year 1999?

O Less than 250,000 guilders
O Between 250,000 and 1 million guilders
O Between 1 and 10 million guilders
O More than 10 million guilders

Question 3: Could you please give us a clear description of your position within the company?

Question 4: In general, which person takes the investment decisions within your company?

O The person answering this questionnaire
O Someone else within the company
O Other: ....

Question 5: Which person deals with your company's taxes and, especially, tax deduction?

O The person answering this questionnaire
O Someone else within the company
O Some person from outside the company (accountant / tax office)

Question 6: In which year and month was the investment decision taken?

O Month: ....

O Year: ....

Question 7: When was your company informed of the existence of this specific capital equipment?

O Before the decision making regarding the investment

O During the decision making regarding the investment

O After the decision making regarding the investment

O Unknown

Question 8: When was your company informed of the existence of the EIA deduction option for this specific capital equipment?

O Before the decision making regarding the investment

O During the decision making regarding the investment

O After the decision making regarding the investment

O Unknown

Question 9: What has been the main reason for your company to invest in this specific capital equipment? (Please choose one answer.)

O The environment

O The tax deduction

O Regulation (e.g., covenant, permit)

O Company image

O Innovation of the production process

O Superior capital equipment

O Other: ....

Question 10: Does your company employ a critical pay-back period or an internal rate of return for investments; that is, does your company either require investment costs to be recovered within a certain amount of time or use a minimum required rate of return on investment?

O	Yes, a critical pay-back period	go to question 11
O	Yes, an internal rate of return	go to question 12
O	No, a critical pay-back period nor an internal rate of return	go to question 13
O	Do not know	go to question 13

Question 11: What is this critical pay-back period in your company?

O 1 year
O 2 years
O 3 years
O 4 years
O 5 years
O 6 years
O 7 years
O 8 years
O 9 years
O 10 years
O More than 10 years, namely . . . . . . years

Go to question 13

Question 12: What is this internal rate of return in your company?

O Less than 5 percent
O 5 percent
O 6 percent
O 7 percent
O 8 percent
O 9 percent
O 10 percent
O 11 percent
O 12 percent
O 13 percent
O 14 percent
O 15 percent
O More than 15 percent, namely . . . . . . percent

Question 13: With which statement do you agree most?

- O Without EIA deduction the investment in this specific capital equipment would not have been made at all
- O Without EIA deduction the investment would have been made in a different piece of capital equipment
- O Without EIA deduction the investment in this specific capital equipment would have been made at the same point in time
- O Without EIA deduction the investment in this specific capital equipment would have been postponed

Question 14: How large was your company's advantage obtained from the EIA deduction (for this investment)? In other words: how large were your tax savings?

Question 15: Within what period of time has your company recovered, or does it expect to recover, the investment for which EIA deduction has been granted?

- O 1 year
- O 2 years
- O 3 years
- O 4 years
- O 5 years
- O 6 years
- O 7 years
- O 8 years
- O 9 years
- O 10 years
- O More than 10 years, namely ...... years
- O Unknown

Question 16: Has your company used other deduction or subsidy schemes to finance the investment in this specific capital equipment?

- O Yes, the VAMIL tax deduction
- O Yes, another deduction option or subsidy   go to question 17
- O No

Question 17: Which other subsidy or deduction scheme has your company used for this specific capital equipment?

O	Name of scheme:	Amount: .... Guilders
O	Name of scheme:	Amount: .... Guilders
O	Name of scheme:	Amount: .... Guilders

IF YOU HAVE FURTHER COMMENTS ABOUT THE EIA INVESTMENT DEDUCTION OR ABOUT THIS QUESTIONNAIRE, YOU ARE WELCOME TO WRITE THEM BELOW.