Estimation of the Static Corporate Sustainability Interactions Model

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Abstract

There is a large amount of empirical literature focused on the relationship between corporate sustainability and corporate financial performance. Given the mixed results it is hard to evaluate whether sustainability investments have a positive impact on financial performance or companies with good financial position invest in sustainability initiatives to acquire consumer and regulatory goodwill. Furthermore, the literature considers firm specific aspects affecting the link but generally omits the influence of the competition. However, companies, which decide to invest in sustainability, do not make this decision based solely on their own expected returns, but they have to consider the actions of their competitors as well. We view the sustainability decisions of companies as strategic decisions and evaluate the effect of competition and spillovers on sustainability in a static market entry game. We find that strategic motives, typically ignored in the empirical literature, appear to be an important factor in sustainability related decisions. The static entry game we considered is a generalization of a discrete choice model (multinomial logit) that allows the actions of group of firms to be interdependent. We estimate the parameters of the discrete choice model using the social performance ratings from MSCI KLD 400 Social Index and financial information from Wharton Research Data Services' COMPUSTAT dataset. Although the interdependence of discrete entry decisions can pose identification and estimation problems in general, after carefully taking those aspects into consideration, we provide empirical evidence that the effect of competition on the likelihood of entry into the sustainability market dominates the effect of spillover. Furthermore, this finding is more profound for first time entrants.

Key Words: Corporate sustainability, strategic interactions, market entry, MSCI KLD 400 Social Index ratings

1. Introduction

Much of the existing empirical literature in sustainability research studies the link between sustainability and financial performance (Molina et al., 2009, Lu et al., 2014) and presents empirical evidence on the link (ideally causal) between corporate sustainability and financial performance. A limitation of this literature is that sustainability is endogenous with respect to financial performance, i.e., a company's decision to adopt sustainability initiatives is likely correlate with unobservable firm characteristics that may also affect financial performance. Most rigorous quantitative evaluations of sustainability policies use a two-stage approach- the first stage controls for the self-selection of sustainability adoption of the firm through an instrumental variable or matching approach, while the second stage compares the sustainability performance of adopting firms against non-adopting firms.

Eccles et al. (2014) report that high sustainability companies outperform the low sustainability ones in terms of both stock market and accounting measures. Companies investing in sustainability especially in environmental sustainability gain competitive advantage (Golicic and Smith, 2013, Yadav et al., 2017). Further evidence comes from Unruh (2016); organizations that have made a sustainability related business model change are twice likely to report profit from sustainability than those that haven't. One can argue that sustainability initiatives lead to producer surplus.

Sustainability research uses MSCI KLD 400 Social Index dataset[1], CSRHUB[2], GRI (Global Reporting Initiative)[3], Dow Jones Sustainability Index[4] or similar datasets for analyzing the sustainability efforts and ratings of the firms. There is a fairly sizable empirical literature on the determinants of the sustainability score of the firms using MSCI KLD 400 Social Index. When the MSCI KLD 400 Social Index data is investigated, it is mostly assumed that the companies in the dataset in a particular year are in the dataset just because of the fundamental economic/sustainable actions that they have taken in the year before. A framework based on this assumption lacks the consideration for competitive factors affecting sustainability decisions and the possibility of strategic interactions between the firms.

We consider that this might be an important oversight when the sustainability initiatives are being taken by the firms. The single firm's entrance (which in our case refers to the situation that the firm performs considerable amount of sustainability related activities) to the sustainability market (which we will refer to the "competitive" environment that can award or penalize firms according to whether or not they take sustainable actions) is highly valued by the stakeholders: it can reduce production cost, improve workplace productivity, and potentially increases the financial returns (if the returns to sustainability is positive). But the firm's collection of the returns from the sustainability efforts depends on whether the competitor/fellow firms also took same/similar or different sustainable actions. Therefore, the

[1] https://www.msci.com/documents/10199/904492e6-527e-4d64-9904-c710bf1533c6
[2] http://www.csrhub.com/
[3] www.globalreporting.org
[4] http://www.sustainability-indices.com/

sustainability return of the single firm in a particular year is a function of the other firms' sustainability decisions. Or in the language of the market entry literature, a single firm's entry decision to the sustainability market is a function of the entry decisions of the other firms.

Competitors' sustainability decisions like any other strategic decision affect the financial outcomes of the company. To clarify, if the entry decision of company *j* changes the expectation of stakeholders from company *i* (a sustainable version of the product or a lower price) then the net benefit of company *i* will decrease. Company *i* either does not change her product offering regarding sustainability or price and loses demand and market share or decides to adapt to the shifting expectations of stakeholders and incurs new costs. Either way the net benefits of company *i* will decrease. Thus the entry of company *j* into the sustainability market will negatively influence the net profit of company *i*. We expect that if the goods or services of the competitor companies are substitutable i.e. the level of competition is high (low industry concentration), the negative effect of sustainability competition will be even more profound. This implies that the likelihood of undertaking more sustainability initiatives is related negatively to the level of competition in the industry.

If a company imitates the competitors' sustainability initiatives, the implementation cost for that company will be lower compared to the competitors' costs. The follower benefits from the spillovers without bearing the full cost of the investments and free rides the sustainability efforts of her competitors. If the sustainability efforts of company *j* lead to an improved stakeholder perception of the whole industry, there may be sustainability spillovers and company *i* somewhat free rides the sustainability efforts of company *j*. Thus the likelihood of undertaking sustainability initiatives is influenced positively by sustainability spillovers.

The influence of the competitor's entry into the virtual market of sustainability should be approached cautiously. For sustainability interactions the influence of competition depends both on the competition level and the spillover rate. Thus there is a need to consider the sustainability decisions of companies as strategic interactions and the estimation of the sign of the coefficient of the effect of competitors becomes an important question. The rest of the paper proceeds as follows: Section 2 presents a brief theoretical base on the sustainability adoption. Section 3 lays out the estimation framework and introduces the econometric model which allows the sustainability decisions to be interdependent among the firms. Section 4 describes the dataset and the variables. Section 5 discusses the results and their implications. Section 6 concludes with future research opportunities.

2. Theory and Main Hypothesis

Abrahamson and Lorenkopf (1993) describe diffusion processes as bandwagons, where companies invest in an innovation because of the number of organizations that have already adopted this innovation instead of the expected returns of the innovation. Several innovations have become the norm over the course of time because of the companies' aspiration to gain competitive advantage and producer surplus (Christensen, 1997).

Since sustainability initiatives should be considered similar to other innovations, it is safe to presume that at some future time, the majority of the companies operating in a particular industry will decide to invest in sustainability. Companies have diverse motivations for adopting sustainability initiatives such as moral or value-based motivations, legitimacy concerns, managerial-agency-based motivation, institutional motivations, responsiveness to activists and strategic motivations (Caroll et al., 2016). Most importantly, companies that observe their competitors obtain positive returns by undertaking sustainability initiatives are inclined to invest in sustainability to exploit the producer surplus as well. Thus the remaining companies are likely to invest in sustainability to be able to compete with the sustainability pioneers.

Sustainability research has delivered not only anecdotal evidence but also empirical evidence on diffusion of sustainability practices. In his Harvard Business Review article Unruh (2010) presents anecdotal evidence of companies investing in sustainability because industry peers already invested in sustainability and names industry-wide sustainability pressures as the green domino effect. (Unruh, 2010). Matisoff (2015) claims that the sustainability behavior of industry leaders change the sustainability behavior of followers for the better and draws attention to the evidence supporting dissemination of best practices across the industry in the sustainability literature. The general upward trend for the MSCI KLD scores of S&P 500/Domini firms documented by Carroll et al. (2016) supports the same view.

In goods markets both revenues and costs decrease if more competitors adopt the same pricing strategy (Ellickson and Misra, 2012). On the one hand, with increased sustainability competition a decrease in revenues may be expected, which in turn will decrease the likelihood of investing in sustainability. As more companies adopt sustainability initiatives, companies which are not sustainable won't be capable to compete with their sustainable counterparts. With sustainability becoming the norm, even more companies invest in sustainability. However, with more companies offering sustainability, consumers won't be willing to pay a price premium for a sustainable product or choose a brand/product over a competing brand/product because of their sustainability. The value stakeholders assign to sustainability will decrease if almost all firms supply sustainability and the demand for sustainability will not suffice, which will reflect negatively on sustainability revenues. On the other hand increased sustainability competition may increase revenues due to spillovers. If the sustainability efforts of a company lead to an improved stakeholder perception of the whole industry, the total market revenue may increase and companies which didn't invest in sustainability may benefit from increased total market revenue. Company *i* free rides the sustainability efforts of company *j* and may even gain the second mover advantage, if consumers do not differentiate between companies due to homogeneous goods assumption.

Spillovers not only occur in form of increased revenues but also as decreased costs. Similar to pricing strategy cost of sustainability might decrease if more competitors adopt the same sustainability initiatives. If a company imitates the competitors' sustainability initiatives, the initial implementation cost for that company will be lower compared to the competitors' costs. The follower gains second mover advantage without bearing the full cost of the investments and the company free rides the sustainability efforts of her competitors.

Companies that invest in innovations before their competitors gain the first-mover advantage (Gaimon, 1989). In the presence of sustainability spillovers the leader's position can be challenged by new comers. When firms make their entry decisions sequentially, it is well known that early movers can preempt subsequent potential entrants (Bresnahan and Reiss,1991a,1991b). Sirsly and Lamertz (2008) discuss the conditions under which the sustainability leader can maintain the first-mover advantage.

The new comers not only suffer from market entry barriers in the form of incumbent firms' forestalling the entry of new competitors but also due to resistance within the company. Birkinshaw and Ridderstrale (1999) propose the corporate immune system as an analogy to model the resistance to advancement of creation-oriented activities such as sustainability initiatives. Similarly to the immune system acting to prevent alien substances from affecting the body in a harmful way, existing power bases within the company view new initiatives as harmful. Furthermore, Eccles et al., 2014 document that established companies lag in adapting sustainability initiatives which can be beneficial in the long run and debate whether the cause is corporate inertia[5].

Flammer (2015) advocates that in the initial stages of sustainability companies harvest the low-hanging fruits. She finds that the value gains are larger for companies with relatively low levels of sustainability, which indicates that the sustainability–financial relationship is concave. Likewise, we build our models on diminishing returns from additional sustainability initiatives. Flammer studies companies who already decided to invest into sustainability and have already committed to a minimum threshold of sustainability. We study whether companies decide to invest or not and expect that initial implementation of sustainability is costly.

The decision on sustainability adoption in an oligopolistic market has not been modeled. Yet similar problem formulations have been suggested in a wide variety of settings such as decision on market entry (Berry, 1992), labor force participation (Bjorn and Vuong, 1984, Keane and Wolpin, 1997), long-term

[5] Corporate inertia is a term used to describe established companies' lag in adapting business models, operating conditions, and making strategic decisions which can be beneficial in the long run.

care and family bargaining (Stern et al ,1999, Stern et al. 2002), auctions (Bajari and Hortacsu, 2003, Athey et al. 2008), technology adoption (Ryan and Tucker, 2012). We draw parallels with the research stream of market entry and technology adoption models and adapt the framework by Bajari et. al (2010) to the sustainability context.

3. The Estimation Framework

Sustainability decisions are strategic decisions which can be approached as discrete choices and should involve the consideration of demand, cost, and the competitive factors. The interrelatedness of firm decisions and the game theoretic nature of the framework complicate the discrete choice estimation (Draganska et al, 2008). The nested fixed point method has been widely used in the estimation of discrete choice models in the context of static games (see, e.g., Seim 2006; Orhun 2013). However, the key econometric problem is that, there is at least one fixed point (equilibrium), which has to be solved at each iteration of the likelihood estimation. Moreover, if there is more than one fixed point, an equilibrium selection rule has to be prescribed. Due to computational cost of the nested fixed-point algorithm, alternative methods have been developed, such as the two-step approach of Hotz and Miller (1993) and Bajari et al. (2010), which we will adapt to estimate the strategic sustainability interactions.

The estimation framework is based on the following idea. Since the equilibrium of sustainability decisions depends on the observable state variables, in the first stage the competitive effects (strategic interactions) are not incorporated into the estimation and firms' choices are modeled as a function of observable state variables. Thereby consistent estimates of the probabilities are obtained. These first-stage probabilities are estimates of the beliefs companies have about their competitors' actions. The recovered probabilities are then plugged into a second—stage model which incorporates strategic interactions.

In the model proposed by Bajari et al. (2010), a company obtains zero net benefit if it chooses not to enter the market. This might be a reasonable assumption for new market entries and it is well known that the effect of entering into a market can be identified only relative to not entering in the estimation of market entry games (Bresnahan and Reiss, 1991a). In our setting, however, the company still obtains net benefits if it chooses not to enter the sustainability market, since it will continue to operate in its primary line of business. The non-adopter operates in the primary line of business and the decision of the competitor on sustainability can affect the non-adopters' return negatively as well as positively. A company, which chooses not to enter the market, is still affected by the actions of its competitors.

Ideally, the model should be able to identify the level of sustainability influence on net benefits separately. However, empirically we won't be able to identify the net benefits from adopting sustainable practices and the net benefits from not adopting sustainable practices separately. We can only identify the difference between the net benefit of investing in sustainable practices as opposed to not investing and recover the difference nonparametrically by inverting the equilibrium choice probabilities. Thus, we assume that the difference in net benefits among adopters and non-adopters stems only from their sustainable practices and control for all other firm characteristics that may lead to differences in net benefits.

3.1. The Model

Since companies are assumed to be rational decision makers, in each period they make sustainability decisions, which maximize their expected net benefits. There are alternative ways to conceptualize sustainability decisions. On the one hand, we can model companies' sustainability decisions as the level of investment put into sustainability initiatives. On the other hand we can model companies' sustainability decisions as a discrete choice— whether companies decide to invest into sustainability or not. As researchers, we don't know whether companies approach sustainability decisions as continuous or one shot decisions.

If the sustainability decisions are defined as continuous sustainability investments w_i for company i, then the set of all possible decisions of the focal company and competitors becomes infinitely big and the estimation becomes computationally costly. Thus we develop the following discrete choice model[6], where each player simultaneously chooses an action $x_i \epsilon \{0,1\}$.

$$x_i = \begin{cases} 1 \text{ if } w_i > 0 \\ 0 \text{ otherwise,} \end{cases} \tag{1}$$

We assume that there are a finite number of companies (players); N=$\{1, \ldots, i, \ldots, n\}$. Let $\boldsymbol{x}_N = (x_1, \ldots, x_i, \ldots, x_n)$ denote the vector of actions taken by all players. Player i choses an action x_i by taking the actions of competitors into account. $\boldsymbol{x}_{N/i} = (x_1, \ldots, x_{i-1,} x_{i+1}, \ldots, x_n)$ denotes the vector of actions for all players, excluding player i. Let $S_i = (s_1, \ldots, s_k)$ denote the vector of k state variables for player i and $s_l \in S_i$ denote the l^{th} state variable for player i. The state variables in S_i may include variables such as firm size, firm age, leverage, R&D intensity and advertisement intensity as well as past sustainability decisions of the players, which are the variables that may affect the current decision on sustainability besides the strategic interaction. $\boldsymbol{S} = (S_1, \ldots, S_n)$ denotes the vector of state variables for all n players. $\boldsymbol{\vartheta}$ is a (n_x1) vector of parameters measuring the impact of $\boldsymbol{S}$ on the expected total net benefit.

We assume that $\boldsymbol{S}$ is common knowledge to all players in the game as well as observable to the analyst. For each player there is also a $k+1^{th}$ state variable labeled $\varepsilon_i(x_i)$, which is private information for the player and unobservable to the analyst. Thus each player is subject to a stochastic preference shock $\varepsilon_i(x_i)$ for each possible action x_i. These state variables are assumed as distributed identically and

[6] In this model a company is considered as an entrant into the sustainability market if $w_i > 0$. The model can be extended to companies, which have taken substantial sustainability initiatives to enter the sustainability market. Then a company will be considered as an entrant, if the sustainability investments w_i exceed a threshold value.

independently (iid) across all players and actions. Player i's vector of stochastic preference shock $\varepsilon_i = (\varepsilon_{i0}, \varepsilon_{i1})$ is distributed according to a joint distribution with some general density function, $f_i(\varepsilon_i)$. Furthermore, $\boldsymbol{\varepsilon_{N/i}} = (\varepsilon_1, \dots., \varepsilon_{i-1,}\varepsilon_{i+1}, \dots, \varepsilon_n)$ denotes the vector of stochastic preference shock for all players, excluding player i.

The player i's problem is to maximize the expected net benefits subject to the competitors' actions in each period. $\pi_i(x_i, \boldsymbol{x}_{N/i}, \boldsymbol{S};\ \boldsymbol{\vartheta})$ defines the total net benefit of company i given $\boldsymbol{S}$. The player i solves

$$\max_{x_i} \left\{E\left(\pi_i(x_i, \boldsymbol{x}_{N/i}, \boldsymbol{S};\ \boldsymbol{\vartheta}) + \varepsilon_i(x_i)\right)\right\} \qquad (2)$$

Since $\boldsymbol{\varepsilon_{N/i}}$ are private information of other players and not observable by the player i, the decision of player i does not depend on these shocks. Thus player i's decision rule a_i is a function of $(\boldsymbol{S}, \varepsilon_i)$ only.

Define $P_i(x_i|\boldsymbol{S})$ as

$$P_i(x_i = 1|\boldsymbol{S}) = \int 1\{a_i(\boldsymbol{S}, \varepsilon_i) = 1\} f(\,\varepsilon_i(x_i)\,) d\varepsilon_i \qquad (3)$$

where $1\{a_i(\boldsymbol{S}, \varepsilon_i) = 1\}$ is the indicator function that player i's decision is 1 given the vector of state variables and stochastic preference shock $(\boldsymbol{S}, \varepsilon_i)$. $P_i(x_i = 1|\boldsymbol{S})$ is the probability that player i' s decision is to invest in sustainability conditional on the state variables $\boldsymbol{S}$, which are public information. We define the distribution of $\boldsymbol{x_N}$ given $\boldsymbol{S}$ as $P(\boldsymbol{x_N}|\boldsymbol{S}) = \prod_{i=1}^{n} P(x_i|\boldsymbol{S})$.

Next we define $V_i(x_i, \boldsymbol{x}_{N/i}, \boldsymbol{S};\ \boldsymbol{\vartheta})$ as the net benefit for player i for choosing action x_i over all possible actions of other players and the preference shock received by player i by choosing that particular action.

$$V_i(x_i, \boldsymbol{x}_{N/i}, \boldsymbol{S}; \boldsymbol{\vartheta}\,) = \sum_{\boldsymbol{x}_{N/i}} \pi_i(x_i, \boldsymbol{x}_{N/i}, \boldsymbol{S}; \boldsymbol{\vartheta}\,)\, P_{N/i}(\boldsymbol{x}_{N/i}|\boldsymbol{S}) + \varepsilon_i(x_i), \qquad (4)$$

where $P_{N/i}(\boldsymbol{x}_{N/i}|\boldsymbol{S}) = \prod_{j \neq i} P_j(x_j|\boldsymbol{S})$. Since player i does not observe the private information shocks, ε_j for $(j \neq i)$, player i's beliefs about her opponents sustainability actions are captured by $P_{N/i}(\boldsymbol{x}_{N/i}|\boldsymbol{S})$. Since all possible actions of other players are accounted for, the following relation represents the choice specific net benefit function, which is the deterministic part[7] of the expected net benefit function:

$$\Pi_i(x_i, \boldsymbol{S}; \boldsymbol{\vartheta}) = \sum_{\boldsymbol{x}_{N/i}} \pi_i(\,x_i, \boldsymbol{x}_{N/i}, \boldsymbol{S}; \boldsymbol{\vartheta})\, P_{N/i}(\boldsymbol{x}_{N/i}|\boldsymbol{S}) \qquad (5)$$

Player i chooses action $x_i = 1$ over action $x_i = 0$, if the summation of choice specific net benefit function and the preference shock from choosing action $x_i = 1$ exceeds the summation of choice specific net benefit function and the preference shock from choosing action $x_i = 0$. For player i to invest in sustainability is optimal, if the following condition is satisfied:

$$P_i(x_i = 1|\boldsymbol{S}) = Prob\{\varepsilon_i | \Pi_i(x_i = 1, \boldsymbol{S}; \boldsymbol{\vartheta}) + \varepsilon_i(x_i = 1) > \Pi_i(x_i = 0, \boldsymbol{S}; \boldsymbol{\vartheta}) + \varepsilon_i(x_i = 0)\} \qquad (6)$$

[7] The net benefit of player i depending on each possible action taken by the competitors is multiplied by its probability of occurring, and the resulting products are summed to produce the expected value. Thus the expected value of the random variable net benefit $\Pi_i(x_i, \boldsymbol{S}; \boldsymbol{\vartheta})$ can be calculated.

3.2. Parametrization of the Net Benefit Function

We consider a static entry game, where the net benefit function of entering into the sustainability market subject to the competitors' sustainability decisions is composed of two parts. In the first term in (7) $\boldsymbol{\vartheta}$ measures the influence of state variables $\boldsymbol{S}'$on the total net benefit $\pi_i(x_i, \boldsymbol{x}_{N/i}, \boldsymbol{S})$ -the conditions that lead the company to adopt sustainability, while the term δ captures the influence of other companies' choices on the entry decision.[8]

$$\pi_i(x_i, \boldsymbol{x}_{N/i}, \boldsymbol{S}; \boldsymbol{\vartheta}) = \begin{cases} \boldsymbol{\vartheta S}' + \delta\left(\sum_{i\neq j}^{n} 1\{x_j = 1\}\right) & \text{if } x_i = 1 \\ 0 & \text{if } x_i = 0 \end{cases} \tag{7}$$

According to Bajari et al. (2010) δ <0, since entry of a competitor into the market decreases the net benefit of the focal company i. However, for sustainability interactions the parameter δ in (7) depends on both the competition level and the spillover rate.

The random error terms $\varepsilon_i(x_i)$ in the net benefit function (4) capture the preference shock to the net benefit from choosing action x_i, which are private information to player i. Player i's error vector $\varepsilon_i = (\varepsilon_{i0}, \varepsilon_{i1})$ is distributed jointly with a density function $f_i(\varepsilon_i)$ and the random error terms are assumed to be independent and identically distributed (iid). We assume that the error terms are distributed extreme value. If $f_i(\varepsilon_i)$ has an extreme value type-I distribution and the ε_{il}'s are independent, then $P_i(x_i = 1|\boldsymbol{S})$ has an analytical solution, which represents the probability of choosing $x_i = 1$.

The type-I extreme value distribution has common applications in the study of discrete choice behavior due to its analytical properties[9] and empirical implications[10] (McFadden, 1984) and the following relation is well developed and conventionally used as the analytical solution to $P_i(x_i = 1|\boldsymbol{S})$

$$P_i(x_i = 1|\boldsymbol{S}) = \frac{\exp(\boldsymbol{\vartheta S}' + \delta \sum_{i\neq j} P_j(x_j = 1|\boldsymbol{S}))}{1+\exp((\boldsymbol{\vartheta S}' + \delta \sum_{i\neq j} P_j(x_j = 1|\boldsymbol{S}))} = \Gamma_i(\boldsymbol{\vartheta}, \delta, P_j(1|\boldsymbol{S}), \forall j). \tag{8}$$

If we use equation (8) in equation (5), we get $\Pi_i(x_i, \boldsymbol{S}; \boldsymbol{\vartheta}) = \vartheta\boldsymbol{S}' + \delta \sum_{i\neq j} P_j(x_j = 1|\boldsymbol{S})$. Since, the error terms are distributed extreme value, from equation (6), we infer that the choice probabilities $P_i(x_i = 1|\boldsymbol{S})$ take a form similar to a single agent multinomial logit model. Since better actions are more likely to be chosen than worse actions, the statistical reaction function $\Gamma_i(\boldsymbol{\vartheta}, \delta, P_j(1|\boldsymbol{S}), \forall j)$ orders the probability of different actions by their expected net benefits. Thus the reaction function is continuous

[8]While $\boldsymbol{S}$ denotes the vector of state variables in the first stage, $\boldsymbol{S}'$ denotes the vector of state variables $\boldsymbol{S}$ with the inclusion of a market- specific component in the second stage.

[9] The limiting distributions for the minimum or the maximum of a very large collection of random observations from the same arbitrary distribution can only be described by generalized extreme value distributions models - specifically, the Gumbel, Fréchet, and Weibull distributions also known as type I, II and III extreme value distributions.

[10]The difference of two type-I extreme value-distributed variables follows a logistic distribution, of which the logit function is the quantile function.

and monotonically increasing in the choice specific net benefit function Π_i. Since the error terms ε_i have density function $f_i(\varepsilon_i)$ and P_i is continous in Π_i, according to Brouwer's fixed point theorem there is an equilibrium to this model for any finite $\boldsymbol{S}$ (McKelvey and Palfrey, 1995). We will use the equilibrium in equation (8) in the econometric analysis.

We suppose that t=1,…,T repetitions of the game are observable and denote the sustainability decision of firm i in repetition t as x_{it}. Furthermore, we use $\boldsymbol{S}_{it}$ for the values state variables take in period t such that $\boldsymbol{S}_t = \{S_{1t} \dots S_{nt}\}$ and follow a two stage estimation strategy. In the first stage, we estimate the binary response x_{it} conditional on a given set of covarites, S_{it}. By observing the sustainability decisions of a large number of companies, we can obtain a consistent estimate $\hat{P}_i(x_i = 1|\boldsymbol{S})$ of $P_i(x_i = 1|\boldsymbol{S})$ for all i. A probit model suffices to estimate the choice probabilities in the first stage.

In the second stage, we estimate the structural parameters of net benefit function $\boldsymbol{\vartheta}$ and δ. Given the first stage estimates $\hat{P}_i(x_i = 1|\boldsymbol{S})$**,** we maximize a pseudo-likelihood function $\Gamma_i\big(\boldsymbol{\vartheta}, \delta, P_j(1|\boldsymbol{S}), \forall j\big)$ and obtain estimates of $\boldsymbol{\vartheta}$ and δ applying a logit model. On the one hand, this two stage estimation strategy has advantages in terms of computational burden, since we have to estimate a probit model in the first stage and a logit model in the second stage. On the other hand, a collinearity problem may arise when estimating $\boldsymbol{\vartheta}$ and δ, since both the first stage estimates $\hat{P}_i(x_i = 1|\boldsymbol{S})$ and $\vartheta\boldsymbol{S}'$ depend on the vector of state variables $\boldsymbol{S}$. In many settings, an exclusion restriction is imposed to overcome the collinearity problem. In this setting, the sustainability decisions of other firms do not directly affect company i's net benefits. The endogenously determined actions of competitors indirectly enter the net benefit function of company i. If we exclude the shocks caused by other firms' actions from the term $\boldsymbol{\vartheta}\boldsymbol{S}'$, we will be able to eliminate collinearity.

3.3. Identification

We can identify the deterministic part of the net benefits, without imposing any assumptions on its functional form. Suppose we consider $\boldsymbol{\vartheta}$ to be completely nonparametric, and hereinafter write $\pi_i\big(x_i, \boldsymbol{x}_{N/i}, \boldsymbol{S}\big)$ instead of $\pi_i\big(x_i, \boldsymbol{x}_{N/i}, \boldsymbol{S}; \boldsymbol{\vartheta}\big)$, and we denote the probability that the response is equal to one in the data conditional on $\boldsymbol{S}$ as $P_i(x_i = 1|\boldsymbol{S})$, which corresponds to the probability of company i choosing to invest in sustainability. Similarly, we denote the probability that the response is equal to zero in the data conditional on $\boldsymbol{S}$ as $P_i(x_i = 0|\boldsymbol{S})$, which corresponds to the probability of company i choosing not to invest in sustainability. Since even a single agent discrete choice model is not identified without independence and a parametric form assumption on the error term, we will assume that the error terms are distributed iid with a known distribution function and the error terms $\varepsilon_i(x_i)$ are distributed iid across actions x_i and players i. Moreover, the parametric form of the distribution, F, comes from a known family. We define $\Pi_i(x_i = 0|\boldsymbol{S}) = 0$ and $\Pi_i(x_i = 1|\boldsymbol{S}) = F^{-1}(P_i(x_i = 1|\boldsymbol{S}))$, where F^{-1} denotes the cumulative distribution function (cdf). Analogous to the notation in the previous section, we define the deterministic part of the expected net benefit function as the choice specific net benefit function $\Pi_i(x_i = 1|\boldsymbol{S})$=$\sum_{\boldsymbol{x}_{N/i}} \pi_i(x_i = 1, \boldsymbol{x}_{N/i}, \boldsymbol{S})\, P_{N/i}(\boldsymbol{x}_{N/i}|\boldsymbol{S})$.

Company i chooses action $x_i = 1$ if and only if the choice specific net benefit and the error term associated with this action is greater than the choice specific net benefit and the error term associated with action $x_i = 0$. Thus the equilibrium in this model satisfies player i's decision rule $a_i(\boldsymbol{S}, \varepsilon_i) = 1$ if and only if

$$\Pi_i(x_i = 1|\boldsymbol{S}) + \varepsilon_i(x_i = 1) > \Pi_i(x_i = 0|\boldsymbol{S}) + \varepsilon_i(x_i = 0) \quad (9)$$

Furthermore, the equilibrium choice probabilities $P_i(x_i|\boldsymbol{S})$ have to satisfy:

$$P_i(x_i|\boldsymbol{S}) = Pr\{\Pi_i(x_i = 1|\boldsymbol{S}) - \Pi_i(x_i = 0|\boldsymbol{S}) > \varepsilon_i(x_i = 0) - \varepsilon_i(x_i = 1)\} \quad (10)$$

From Equation (10) we can infer that the equilibrium choice probabilities $P_i(x_i|\boldsymbol{S})$ have a one-to-one relationship to the choice specific net benefit functions, $\Pi_i(x_i = 1|\boldsymbol{S}) - \Pi_i(x_i = 0|\boldsymbol{S})$. Since we assume that $\varepsilon_i(x_i)$ are distributed iid and the distribution comes from a known family, one-to-one mapping is possible. We denote the map from general form choice specific value functions to choice probabilities as: $\Gamma: \{0,1\}\ x\ \boldsymbol{S} \rightarrow [0,1]$.

$$P_i(x_i|\boldsymbol{S}) = \Gamma_i(\Pi_i(x_i = 1|\boldsymbol{S}) - \Pi_i(x_i = 0|\boldsymbol{S})) \quad (11)$$

We denote the inverse mapping as Γ^{-1}:

$$\Pi_i(x_i = 1|\boldsymbol{S}) - \Pi_i(x_i = 0|\boldsymbol{S}) = \Gamma_i^{-1}(P_i(x_i|\boldsymbol{S})) \quad (12)$$

We can recover $\Pi_i(x_i = 1|\boldsymbol{S}) - \Pi_i(x_i = 0|\boldsymbol{S})$ nonparametrically by inverting the equilibrium choice probabilities. We identify the difference between the net benefit of investing in sustainability as opposed to not investing. We won't be able to identify $\Pi_i(x_i = 1|\boldsymbol{S})$ and $\Pi_i(x_i = 0|\boldsymbol{S})$ separately. Thus, we will assume that the net benefit of not investing in sustainability is equal to zero. Formally written for all i and $\boldsymbol{x}_{N/i}$ and $\boldsymbol{S}$, $\Pi_i(x_i = 0,\ \boldsymbol{x}_{N/i},\ \boldsymbol{S})$=0.

Based on this assumption using the mapping given in equation (13) we can recover $\Pi_i(x_i|\boldsymbol{S})$ for all i, x_i and $\boldsymbol{S}$. Recall that the definition of choice specific net benefit $\Pi_i(x_i, \boldsymbol{S}; \boldsymbol{\vartheta})$ from (5) implies that

$$\Pi_i(x_i|\boldsymbol{S}) = \sum_{\boldsymbol{x}_{N/i}} \pi_i(x_i, \boldsymbol{x}_{N/i}, \boldsymbol{S})\, P_{N/i}(\boldsymbol{x}_{N/i}|\boldsymbol{S})\ \forall i = 1, \dots, n,\ x_i = 0{,}1 \quad (13)$$

However, even if we knew $\Pi_i(x_i|\boldsymbol{S})$ and $P_{N/i}(\boldsymbol{x}_{N/i}|\boldsymbol{S})$ we would not be able to invert this system and identify the total net benefit $\pi_i(x_i, \boldsymbol{x}_{N/i}, \boldsymbol{S})$. For the identification we follow Bajari et al. (2010) and introduce exclusion restrictions. Basically, we partition the state variables as: $\boldsymbol{S} = (S_i, \boldsymbol{S}_{N/i})$, which makes sense in terms of the conceptual model as well, since players have different state variables. As stated in Theorem 1 by Bajari et. al (2010) identification is achieved under the stated conditions therein. For details of the identification see Appendix A1

We will use the empirical analog of (13) to form an estimate of the total net benefit $\pi_i(x_i,\ \boldsymbol{x}_{N/i}, S_i)$. If there is a nonparametric inversion between choice probabilities and the choice specific net benefit function, we can recover the estimates of the choice probabilities $\hat{P}_i\ (x_i = 1|\boldsymbol{S})$ and of the choice specific net benefit function $\widehat{\Pi}_i(x_i = 1|\boldsymbol{S})$. The structural parameters of the model can be identified, if appropriate exclusion restrictions are imposed on the net benefits. In the next section, we describe the data and econometric specifications used to analyze the sustainability decisions of companies.

4. Data and Variables

4.1. Data

We have collected annual company data on corporate sustainability and corporate financial performance for years 1991–2014. We used social performance ratings from MSCI KLD 400 Social Index database as the sustainability measure. [11] MSCI KLD 400 Social Index considers large, mid and small cap companies in the MSCI US IMI Index. It excludes companies which are involved in sectors such as Nuclear Power, Tobacco, Alcohol, Gambling, Military Weapons, Civilian Firearms, GMOs and Adult Entertainment. They rate eligible companies on regarding their strengths and failures (concerns) in seven categories: Community (Com-), Corporate Governance (Cgov-), Diversity (Div-), Employee Relations (Emp-), Environment (Env-), Human Rights (Hum-), Product (Pro-). Companies are excluded from the index if (i) they are deleted from the MSCI USA IMI Index, (ii) they fail the exclusion screens, (iii) their ratings fall below minimum standards. We obtained 40,485 firm-year observations. Moreover, we extracted sustainability ratings of 4613 companies between 1991 and 2013.

We collected company financial information from the Wharton Research Data Services' COMPUSTAT dataset. We focused on the North American sample of COMPUSTAT. We obtained 12,458 firm-year observations, after the companies with revenues less than 50 million USD are dropped. We extracted total assets; total stockholders' equity, revenue, net sales, net income and market value for 2,371 companies between the fiscal years 1991 and 2013.

Out of 2371 companies 657 companies are both in the COMPUSTAT and the MSCI KLD 400 Social Index data sets. Thus we obtained an unbalanced panel of 657 companies over the years 1991-2014.

COMPUSTAT provides Standard Industrial Classification (SIC) code information on the primary line of business for each firm. We restricted the sample to manufacturing firms and operationalized subindustry by using the two digit SIC codes. Furthermore, we excluded companies with $roa \leq -10$ and $roa \geq 10$ so that outliers do not contaminate the results. We restricted the sample between the years 1999-2014 to ensure the continuity of the time series[12]. The restricted sample consists of 6704 (458 firms) firm-year observations. We obtained a balanced panel of 419 manufacturing companies over the

[11] https://www.msci.com/resources/factsheets/index_fact_sheet/msci-kld-400-social-index.pdf
[12] MSCI USA IMI Index has been compiled from a variety of sources, which may have followed different index calculation methodologies in some instances.

years 1999-2014. Since the data for the independent and dependent variables are collected from two completely different sources, common method bias does not affect the analysis.

4.2 Variables

We need to evaluate the influence of competition and spillover on the likelihood of entering the sustainability market. We assume that companies which are graded by MSCI KLD 400 Social Index have decided to enter the sustainability market and construct a binary variable, which is denoted as *entry* and is the empirical equivalent of x_i.

Since not all sustainability initiatives are independent from the industry characteristics, we can deduce that competition level regarding sustainability might be influenced indirectly by the competition level in the goods or/ and services market. We operationalize the sustainability competition as the number of companies in MSCI KLD 400 Social Index for given industry and year, whereas the company itself is excluded. We denote the variable as *number_of_competitors*, which corresponds to $\boldsymbol{x}_{N/i}$ in the empirical model.

Since past sustainability decisions, firm size, financial performance, R&D intensity and advertising intensity can influence the sustainability decisions of the companies, we consider them as control variables. These control variables are the empirical counter part of the set of k state variables, $S_i = (s_1, \dots\dots, s_k), \forall i = 1, \dots, n$. We incorporate past years' sustainability decision and denote the variable as *past_entry*. Furthermore we control whether or not a company enters the sustainability market for the first time. We denote the related variable as *first_time_entry*.

We also include company size into the analysis as a control variable. To be able to compare companies which are in labor intensive versus capital/technology intensive industries, we consider the variables; number of employees and total assets in million dollars. Due to missing values in the data, adding the control variable, natural logarithm of the number of employees into the analysis decreases the sample size and does not improve model fit. Thus we omit this control variable from the final analysis. Since the total assets are skewed to right, we use the natural logarithm and denote the variable as *ln_asset*.

There is a reciprocal relationship between sustainability performance and financial performance. While RBV and stakeholder theory advocate that sustainability performance affects financial performance positively, the slack resources theory supports the recursive relationship (Waddock and Graves, 1997). Firms that financially outperform their industry average have slack resources to invest in corporate sustainability activities (Surroca et al., 2010). To isolate the influence of slack resources and and control for financial performance we employ leverage and return on assets as indicators of financial performance. Leverage is the ratio of debt to total assets and the related variable is denoted as *leverage*. Return on assets is the ratio of net income to total assets and the variable is denoted as *roa*.

Furthermore, since we aim to evaluate the influence of sustainability on financial performance from the stakeholder theory channel, we isolate the effect of advertisement on stakeholder returns and include advertising intensity as a control variable. The advertising intensity is calculated as the ratio of advertising expenses to net sales.

In the context of sustainability research, RBV suggests that corporate sustainability initiatives are intangible resources of the firm, which promote efficiency and lead to better financial performance. To isolate sustainability from other intangible resources of the firm we control for R&D intensity, as an intangible resource. R&D intensity is calculated as the ratio of R&D expenses to net sales.

Due to missing values in the data adding the control variables advertising intensity and R&D intensity into the analysis decreases the sample size. Furthermore, it does not help much for improving the model fit. Since qualitatively similar results were found for this data set, we do not report these results in the interest of brevity and exclude the control variables advertising intensity and R&D intensity from the final analysis reported in Section 5.

5. Results and Discussion

Table 1 displays the summary statistics for entry into sustainability market (*entry*), past entry into sustainability market (*past_entry*), first time entry into sustainability market (*first_time_entry*) , financial performance (*roa*, *leverage*), firm size (*ln_asset*), market share of the company (*marketshare*) and market size of the industry (*ln_total_market_revenue*). About 52.6 % of the companies in our dataset are identified as invested in sustainability at least once between 1999 and 2014. 37.9 % of the companies are first time entrants into the sustainability market. The average roa is -1,262%. Thus financially good companies are not overrepresented in the sample, which might have prompted misleading results. The average market share in the data is 0,168%, which indicates that the market is highly fragmented. We can infer that the sustainability market is a highly competitive market.

5.1. Evidence for Causality

Since the dependent variable *entry* take only two values, "1" and "0", which represent outcomes invest/ not invest in sustainability initiatives, we assume that the net benefits come from a binary logit model, where the probability of a particular outcome is determined as follows:

$$P_i(\boldsymbol{x}_i = 1) = \Gamma_i\left(\boldsymbol{\vartheta}S_i + \delta E\left(\boldsymbol{x}_{N/i}\middle|\,\boldsymbol{S}_{N/i}\right)\right) \tag{15}$$

$$P_i(\boldsymbol{x}_i = 0) = 1 - \Gamma_i\left(\boldsymbol{\vartheta}S_i + \delta E\left(\boldsymbol{x}_{N/i}\middle|\,\boldsymbol{S}_{N/i}\right)\right)$$

In all the estimations in Table 2, the dependent variable *entry* indicates whether a company has entered the sustainability market or not. The explanatory variable *number_of_competitors* is calculated as the number of companies that entered the sustainability market, whereas the focal company is excluded. In

Model 1, we include the control variables *past entry, roa, ln_asset, leverage, market share, first time entry* and *ln_total_market_revenue.* In Model 2, we control for the time trend effects by incorporating time variant variables in addition to the full set of controls. We calculate *trend* as the difference between the year of observation and 1998. We include the variable $trend^2$, the squared *trend*, thereby allowing a nonlinear relationship between time trend effects and *entry*. In Model 3, we run a random effects model, since the differences across companies might have some influence on the dependent variable *entry*. We incorporate the full set of controls as well as *trend* and $trend^2$. Thereby we control both for individual and time trend effects. In Model 4, we restrict the sample to companies that enter the sustainability market for the first time and control for *roa, ln_asset, leverage, market share* and *ln_total_market_revenue.*

Table 1: Summary Statistics

	Mean	Standard deviation	Min	Max
entry	0.526	0.499	0	1
past_entry	0.479	0.499	0	1
first_time_entry	0.379	0.485	0	1
roa	-0.013	0.334	-9.20	4.83
ln_asset	6.844	2.035	0.16	13.08
leverage	0.203	0.261	0	7.44
marketshare	0.0017	0.006	0	0.09
ln_total_market_revenue	15.19	0.248	14.71	15.48
total_market_revenue*	40.78	9.442	24.43	52.91
Observations	6,704			

* in 100K dollars

For all specifications, we can infer that if more competitors enter the sustainability market the likelihood of the focal company entering the sustainability market will increase. This finding suggests that the spillover effects dominate the competition effect. However, it is not clear whether the spillover effects stem from the demand or supply side. As discussed in Section 2, spillovers may occur in form of improved stakeholder perception of the whole industry and all players in the industry benefit from increased demand or the implementation cost is lower for companies that imitate the competitors' sustainability initiatives. Either way the companies benefit from the spillovers without bearing the full cost of the investments, thus the likelihood of entering in the sustainability market increases compared to the likelihood of entering in a sustainability market, where no spillovers exists.

Table 2: Logit estimates of the effect of competition

	Model 1	Model 2	Model 3	Model 4
number_of_competitors	0.0132***	0.0159***	0.0164***	0.0156***
	(0.0009)	(0.001)	(0.001)	(0.002)
past_entry	1.881***	1.907***	0.016***	-
	(0.088)	(0.089)	(0.001)	
trend		-0.329***	-0.305***	
		(0.076)	(0.077)	
$trend^2$		0.0095***	0.0087***	
		(0.0028)	(0.0029)	
roa	0.428***	0.396***	0.392**	0.169
	(0.148)	(0.148)	(0.160)	(0.185)
ln_asset	0.282***	0.283***	0.323***	0.169***
	(0.022)	(0.022)	(0.028)	(0.038)
leverage	-0.086	-0.100	-0.157	-0.116
	(0.147)	(0.148)	(0.168)	(0.325)
marketshare	-24.41***	-24.62***	-25.93***	-53.04***
	(5.92)	(5.94)	(7.40)	(20.73)
first_time_entry	-1.188***	-1.230***	-1.167***	
	(0.099)	(0.100)	(0.112)	
ln_total_market_revenue	-3.262***	-1.136**	-1.159**	-2.071***
	(0.329)	(0.519)	(0.531)	(0.795)
cons	44.11***	13.05*	12.95*	25.21**
	(4.82)	(7.58)	(7.76)	(11.55)
Fixed effects	None	time trend	individual& time trend	first time entry
Log likelihood	-2801.16	-2787.71	-2778.18	-894.56
Pseudo- R^2	0.396	0.399		0.124
Observations	6,704	6,704	6,704	2,543

*Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1*

Nonetheless, this finding suggests that companies are more likely to invest into sustainability if they observe that their competitors invest into sustainability and supports that sustainability becomes the norm over course of time like any other innovation or disruptive technology. We need to assure that *number_of_competitors* is an unbiased estimator of sustainability competition, to be certain that we have empirical support for the green domino effect (Unruh, 2010) or sustainability dissemination (Matisoff, 2015).

5.2. Correcting for Endogeneity Bias with IV Model

The analysis in Table 2 does not indicate a causal relationship. In other words; we do not observe the likelihood of a company entering the sustainability market, if all else being equal, N+1 companies compete in the sustainability market instead of N companies. Thus the models in Table 2 do not provide a measure of the causal effect of competition on the entry decision into the sustainability market. They rather exhibit an association between the number of competitors and the likelihood of entry in the sustainability market.

To control for the endogeneity in the relationship, the IV method can be used. If there is an observable instrument, that affects sustainability decisions of competitors, but is uncorrelated with the unobserved factor affecting the sustainability decision of the focal company, then an IV estimator based on this instrument will yield a consistent estimate of the number of competitors on the likelihood of entering into the sustainability market. Assuming the number of competitors in the market is fixed, an increase in the industry size would increase the expected revenue, which makes the entry of the focal company into the market more likely. Bresnahan and Reiss (1991a, 1991b) note that market size is highly correlated with the number of firms in a market. Berry and Waldfogel (1999) use market size as an instrument for the number of firms. We employ the natural logarithm of total market revenue (*total_market_revenue*) as a measure of industry size and use it as an instrument. This IV measure, though may not be the ideal instrument, still has the potential to correct some of the endogeneity in the relationship.[13]

Since the focal company makes the entry decision conditional on the actions of its competitors, if the unobserved factor affects the sustainability decision of the focal company as well as the sustainability decisions of its competitors positively, then the coefficient of the *number_of_competitors* will be upward biased. As seen in Table 3, when the IV approach is implemented[14], the coefficient of the explanatory variable, which is significant and positive in Model 2, becomes negative and significant at the 5 percent level of significance. We interpret this result as an evidence of endogeneity in the OLS results and therefore the true coefficient can be in fact negative. Compared to Model 2 in Table 3, the IV result indicates that the coefficient has a negative sign as the literature would suggest about the effect of competition. To further investigate the endogeneity in the estimation we therefore need to incorporate the strategic interaction into the analysis.

5.3. Correcting for Endogeneity Bias with Static Model of Strategic Interaction

We assume static competition and employ the two stage analysis described in Section 3. We take the estimates of the equilibrium choice probabilities $\hat{P}_i(x_i|\boldsymbol{S})$ from the first stage as given and form an estimate of the choice specific net benefit function $\hat{\Pi}_i(x_i = 1|\boldsymbol{S}) - \hat{\Pi}_i(x_i = 0|\boldsymbol{S})$. This can be done by evaluating equation (10) using $\hat{P}_i(x_i|\boldsymbol{S})$ instead of $P_i(x_i|\boldsymbol{S})$. In the case of the binary logit model the inversion follows as:

[13] The first stage of the IV estimates indicates a significant association between the number of competitors and the market size variables. The corresponding F-statistics is significantly high. Also, the Wald test of exogeneity employed produces 4.95 for the chi-squared (1) with the corresponding p-value of 0.026.
[14] In Stata IV-probit is implemented where the variable number_of_competitors is instrumented with the market revenue.

$$\widehat{\Pi}_i(x_i = 1|\boldsymbol{S}) - \widehat{\Pi}_i(x_i = 0|\boldsymbol{S}) = \log(\hat{P}_i(x_i = 1|\boldsymbol{S})) - \log(\hat{P}_i(x_i = 0|\boldsymbol{S})) \tag{16}$$

under the assumption that the preference shock has an extreme value type I distribution. We need covariates that influence the net benefits of one particular company, but not other companies.[15] The covariates include financial performance (*roa*, *leverage*), firm size (*ln_assets*), past sustainability performance (*past_entry*, *first_time_entry*).

Table 3: Probit model with endogenous regressors

Variable	Model 2	Model 2 IV
number_of_competitors	0.0159***	-0.0166**
	(0.001)	(0.008)
past_entry	1.907***	0.639**
	(0.089)	(0.262)
Trend	-0.3297***	0.740**
	(0.076)	(0.306)
$trend^2$	0.0095***	-0.0247**
	(0.003)	(0.009)
Roa	0.396***	0.223***
	(0.148)	(0.067)
ln_asset	0.283***	0.109***
	(0.022)	(0.034)
Leverage	-0.1003	-0.036
	(0.148)	(0.071)
Marketshare	-24.62***	-9.663**
	(5.94)	(4.032)
first_time_entry	-1.23***	-0.697***
	(0.100)	(0.099)
ln_total_market_revenue	-1.19**	
	(0.519)	
cons	13.046*	-0.605
	(7.576)	(0.657)
Fixed effects	time trend	time trend
Log likelihood	-2787.71	-35120
Pseudo- R^2	0.40	
Observations	6,704	6,704

*Robust standard errors in brackets, *** p<0.01, ** p<0.05, **

[15] In general, this is not required for the model identification but incorporating an extra variable into the estimation, that supplies independent variation for each company will make the identification easier. Otherwise the model should be identified depending on a functional form.

We obtain consistent estimates of the probabilities in the first stage. After recovering the estimate of $\hat{P}_i(x_i|\boldsymbol{S})$ and estimate of choice specific net benefit function $\widehat{\Pi}_i(x_i = 0|\boldsymbol{S})$, we use the empirical analog of equation (11) to form an estimate of $\Pi_i(x_i,\ \boldsymbol{x}_{N/i}, S_i)$ and recover structural parameters. The identification depends crucially on applying appropriate exclusion restrictions. The recovered probabilities are plugged into a second-stage model which incorporates competitive interaction which is operationalized as *market share*. Thereby, we estimate the causal effect of competition on the likelihood of entry in the sustainability market consistently.

As discussed in Section 2 increasing competition decreases the likelihood of investing in sustainability and will manifest itself as a negative and significant coefficient. However, due to the spillovers, the effect of increasing competition on net benefits is not that clear. Spillovers occur in the form of 1) decreased initial investment costs due to imitability of sustainability investments, which are generally not protected by patents and 2) improved stakeholder perception towards the whole industry, which results in increased revenues. Regardless of the channel -revenue increase or cost reduction- spillovers increase the expected net benefits, which in turn increases the likelihood of entry. If the spillover effect dominates the competition effect, we expect to obtain positive and significant coefficients.

In Table 4, results of the two-stage estimation are presented. We control for unobserved heterogeneity in several ways. First, in all specifications, we include a full set of firm and year fixed effects to control for factors that remain fixed in a year that influence sustainability decisions of companies. Second, we control for unobserved heterogeneity using both fixed effects and random effects specifications. When we substitute the recovered probabilities into the second-stage, we observe that the coefficient of the explanatory variable is negative and significant. Recall that, it is positive and significant in the logit estimation (Table 2) and negative and insignificant in the IV estimation (Table 3). While the IV estimation corrects for the endogeneity bias to some extent, incorporating strategic interactions yield unbiased results. The negative and significant relationship between the likelihood of entry and number of competitors indicates that the effect of competition dominates spillover effects.

As proposed in Section 2, competition increases the cost of market entry, while spillover effects decrease these costs. Since sustainability initiatives, which are easy to implement are prone to disseminate to all market participants, we would observe the effect of spillovers if it were substantial. The comparison of Table 4 to Table 2 verifies that employing *number_of_competitors* as explanatory variable leads to upward biased results. Thus considering the effect of competition and spillovers as ex ante measures of market entry becomes important.

According to the bandwagon effect companies see sustainability investments as necessity due to market share even though they might not benefit financially in the short term. Lourenco et al. (2012) present empirical evidence that if firms with a lower level of sustainability are profitable, market penalizes larger firms more. Managerial implication of this finding is that companies do not invest in sustainability out of necessity. Cassimnon et al. (2016) point out that companies relying solely on the net present value or cost-benefit approach, which ignore the strategic value of sustainability investments, often decide not to invest into sustainability. We observe a negative effect of number of competitors on the likelihood of entry only when controlled for strategic interactions and infer that for sustainability innovations the bandwagon effect is supported.

Table 4: Logit estimates of the effect of strategic interactions (parametric first stage)

Variable	Model 1	Model 2	Model 3	Model 4
prob_competitors_entry	-0.0030**	-0.0256***	-0.0253***	-0.0084**
	(0.0014)	(0.0028)	(0.0028)	(0.0038)
past_entry	1.718***	1.837***	1.738***	
	(0.0847)	(0.088)	(0.096)	
Trend		1.135***	1.135***	
		(0.112)	(0.113)	
$trend^2$		-0.0391***	-0.0391***	
		(0.004)	(0.004)	
Roa	0.448***	0.504***	0.521***	0.159
	(0.147)	(0.152)	(0.161)	(0.19)
ln_asset	0.2676***	0.2660***	0.2879***	0.1621***
	(0.022)	(0.022)	(0.026)	(0.038)
Leverage	-0.1517	-0.1416	-0.1870	-0.2213
	(0.149)	(0.115)	(0.164)	(0.326)
Marketshare	-23.58***	-22.84***	-23.63***	-52.07***
	(5.91)	(6.02)	(6.92)	(20.50)
first_time_entry	-1.364***	-1.337***	-1.315***	
	(0.099)	(0.101)	(0.107)	
ln_total_market_revenue	1.949***	0.988	0.999	6.195***
	(0.498)	(0.539)	(0.548)	(1.340)
cons	-30.90***	-17.33**	-17.71**	-94.59***
	(7.28)	(7.88)	(8.01)	(19.54)
Fixed effects	none	time trend	individual & time trend	first time entry
Log likelihood	-2905.51	-2851.98	-2848.25	-920.45
Pseudo- R^2	0.37	0.38		0.10
Observations	6,704	6,704	6,704	2,543

*Robust standard errors in brackets, *** p<0.01, ** p<0.05*

We document that market share influences the likelihood of entry into the sustainability market negatively. According to Hofer et al (2012) more productive companies see less a need to invest in sustainability in order to gain superior financial performance. Soytaş et al. (2015) present empirical evidence that more productive firms have higher marginal costs of sustainability and point out it is more costly for productive companies to change, since the way operate is well established. Similarly, companies which have established market share are likely to see less a need to invest in sustainability.

Table 5: Logit estimates of the effect of strategic interactions (semiparametric first stage)

Variable	Model 1	Model 2	Model 3	Model 4
prob_competitors_entry	-0.0015	-0.0234***	-0.0227***	-0.0005
	(0.0015)	(0.0029)	(0.0030)	(0.0035)
past_entry	1.707***	1.822***	1.716***	
	(0.085)	(0.088)	(0.096)	
trend		1.047***	1.047***	
		(0.116)	(0.118)	
$trend^2$		-0.036***	-0.036***	
		(0.004)	(0.004)	
roa	0.4500***	0.5011***	0.5182***	0.1671
	(0.147)	(0.151)	(0.160)	(0.188)
ln_asset	0.268***	0.265***	0.289***	0.161***
	(0.022)	(0.022)	(0.026)	(0.038)
leverage	-0.1450	-0.1311	-0.1788	-0.1889
	(0.148)	(0.150)	(0.164)	(0.325)
marketshare	-23.57***	-22.97***	-23.86***	-52.06***
	(5.899)	(5.970)	(6.935)	(20.596)
first_time_entry	-1.355***	-1.311***	-1.286***	
	(0.099)	(0.099)	(0.107)	
ln_total_market_revenue	1.433***	0.827	0.827	3.478***
	(0.513)	(0.545)	(0.554)	(1.246)
cons	-23.402***	-14.968*	-15.217*	-55.02***
	(7.503)	(7.973)	(8.104)	(18.183)
Fixed effects	none	time trend	individual& time trend	first time entry
Log likelihood	-2907.28	-2865.68	-2865.68	-923.04
Pseudo- R^2	0.37	0.38		0.10
Observations	6,704	6,704	6,704	2,543

*Robust standard errors in brackets, *** p<0.01, ** p<0.05*

We document that first time entry into sustainability decreases the likelihood of entry, hence we infer that initial sustainability investments are costly due to competition. As seen in Model 1, Model 2 and Model 3 the variable *past_entry* increases the likelihood of entry, whereas the variable *first_time_ entry* decreases the likelihood of entry. Moreover, we refine our analysis by restricting our sample to the companies which enter for the first time. The change in the coefficient in Model 4 reveals that the first time entry of a company decreases the likelihood of entry drastically, which suggests that initial investments are costly and act as market entry barriers. This finding it is consistent with the corporate immune system concept in corporate entrepreneurship literature (Birkinshaw and Ridderstrale, 1999) and Eccles et al.'s (2014) remark on corporate inertia in the strategy literature.

Entry decision into the sustainability market is a strategic decision and creates selection bias. As seen in Table 2 due to selection bias, the results are biased upwards and overestimate the true relationship between number of competitors and likelihood of entry. The two- stage models intent to correct the selection bias and we document that the number of competitors affect the likelihood of entry negatively. However, a limitation two- stage models is that he researchers might be over-controlling for differences across firms by controlling for the likelihood to invest into sustainability and then only examining within-firm changes over time, which might lead to incorrect negative or insignificant findings (Matisoff, 2015). In order to show that over-controlling is not a concern, we perform robustness check.

5.4. Robustness

We allow for a more flexible first stage, to evaluate whether the presence of competition effect is robust. We replicate the estimations in Model1 to Model4 in Table 4, using the probabilities recovered from a semiparametric first stage instead of the parametric first stage used in the main estimation and estimate the same effect for the specifications in Table 5. The results indicate a robust negative relationship between competition and the likelihood of entry into the sustainability market.

6. Conclusion

Our goal was to illustrate how a game-theoretic framework can aid in the construction and estimation of interrelated choice models in the corporate sustainability context. We presented a coherent econometric model that incorporates the possibility of the competitors' actions having an impact on the decision of the focal company. Similar to classical Industrial Organization research, we have explored how the number of firms in the sustainability market, firms' sizes, their financial positions and potential competitors affect market entry.

When strategic interaction is not accounted for, we find that the increasing number of competitors increases the likelihood of sustainability investments, seemingly shows the spillover effect dominates the competition. However, when we control for the strategic interaction of sustainability through an instrumental variable, the relationship between number of competitors and the likelihood of entry into the sustainability market becomes negative yet insignificant. Further when, we apply the two stage approach which incorporates competitive interaction, we document that competition hurts the likelihood of entry into the sustainability market. Combined with the finding that as the number of competitors increase, the more likely the firm is to enter, these results can be interpreted as that despite the negative effect of competition companies invest in sustainability in anticipation of future net benefits (or loss due to not participating) or in a way not to fall short of the market's current practice (as if presenting their existence in the market for instance, since they might have already invested in sustainability in the past). This being said, however our analysis demonstrates, using the number of competitors as a measure for competition in a model without controlling for the strategic interactions does not necessarily mean that it is the pure competition effect that leads to this positive association. The endogeneity due to the strategic motive will shadow the coefficient estimate of competition and will produce an upward biased coefficient if one does not control for it in the model. This "causal" effect of competition in the sustainability market is in line with the conventional effect of competition on market entry which has been established by industrial organization literature for a long time.

Although the interdependence of discrete entry decisions can pose identification and estimation problems, we are able to provide empirical evidence that the effect of competition on the likelihood of entry into the sustainability market dominates the effect of spillover. Furthermore, this finding is more profound for the first time entrants. This result has substantial regulatory policy implications. Public policy makers should give incentives to new entrants in order to compensate the negative influence of competition on the total sustainability outcome of the market.

Companies' sustainability decisions are not only based on the cost benefit analysis but also on the sustainability decisions of competitor companies. Firms might decide to invest in sustainability to gain competitive advantage in the long-run regardless the financial return in the short-term. Future research questions arise such as the formalization of sustainability interactions in a multi period model, since investments in sustainability are likely to have dynamic effects over time which the static model does not capture. Moreover, the decomposition of latent profits into revenue and costs components would provide a better understanding of how strategic interactions influence the sustainability decisions.

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Appendix A1

We aim to invert the following system

$$\Pi_i(x_i|\boldsymbol{S}) = \sum_{x_{N/i}} \pi_i(x_i, \boldsymbol{x}_{N/i}, \boldsymbol{S})\, P_{N/i}\left(\boldsymbol{x}_{N/i}\middle|\boldsymbol{S}\right) \forall i = 1, \dots, n,\ x_i = 0{,}1 \qquad (13)$$

There are *n* players who choose an action from the set *l*={0, 1} and their benefit depends on the 2^{n-1} possible actions of other players. Thus we have to solve for $n\ x\ 2^{n-1}$ unknowns. However, the Left Hand Side (LHS) contains information on *n x 2* scalars. The system is solvable, if there are cross-equation restrictions across either players or actions (*i* or *l*). Thus we introduce exclusion restrictions. We partition the state variables as: $\boldsymbol{S} = (S_i, \boldsymbol{S}_{N/i})$, which makes sense in terms of the conceptual model as well, since players have different state variables. We suppose $\pi_i(x_i, \boldsymbol{x}_{N/i}, \boldsymbol{S}) = \pi_i(x_i, \boldsymbol{x}_{N/i}, S_i)$ based on the assumption, that the profit of firm *i* depends on the investment decision of other players but does not depend on the firm characteristics represented as state variables $\boldsymbol{S}_{N/i}$. If such an exclusion restriction can be imposed, we can rewrite equation (13) as:

$$\Pi_i\left(x_i|S_i,\ \boldsymbol{S}_{N/i}\right) = \sum_{x_{N/i}} P_{N/i}\left(\boldsymbol{x}_{N/i}\middle|S_i, \boldsymbol{S}_{N/i}\right) \pi_i(x_i,\ \boldsymbol{x}_{N/i}, S_i) \qquad (14)$$

As stated in Teorem 1 by Bajari et. al (2010): "Suppose that the assumptions of error terms being distributed iid with a known distribution function and the net benefit of not investing in sustainability is equal to zero hold. The necessary order condition for identifying choice specific net benefit function $\Pi_i\left(x_i, \boldsymbol{x}_{N/i}, S_i\right)$ is that for almost all S_i, there exists 2^{n-1} points in the support of the conditional distribution of $\boldsymbol{S}_{N/i}$ given S_i. A sufficient rank condition for identification is that for almost all values of S_i, the conditional second moment matrix of $E\left[\ P_{N/i}\left(\ \boldsymbol{x}_{N/i}\middle|S_i\ ,\ \boldsymbol{S}_{N/i}\right)\ P_{N/i}\left(\ \boldsymbol{x}_{N/i}\middle|S_i\ ,\ \boldsymbol{S}_{N/i}\right)'|S_i\right]$ is nonsingular"

The rank condition holds for both discrete and continuous regressors and can be verified from the data, since the rank condition is stated in terms of the observable reduced form choice probabilities. Moreover, it is analogous to the standard rank condition in a linear regression model. However, it differs from the linear regression model, since the regressors, $P_{N/i}\left(\boldsymbol{x}_{N/i}\middle|\ S_i,\ \boldsymbol{S}_{N/i}\right)$ have to be estimated from the data in the first stage. To identify the strategic interaction models in which net benefits depend on the expected actions of other players, the reduced form choice probabilities have to depend on the states of other players $\boldsymbol{S}_{N/i}$. In the single-agent model with no strategic interactions, the LHS of equation (14) does not depend on $\boldsymbol{S}_{N/i}$ and the RHS does not depend on $\boldsymbol{x}_{N/i}$. The probabilities $P_{N/i}\left(\boldsymbol{x}_{N/i}\middle|S_i\ ,\ \boldsymbol{S}_{N/i}\right)$ sum up to 1 and equation (14) becomes an identity.

Since the system of equations obtained by varying the values of $\boldsymbol{S}_{N/i}$ is nonsingular and invertible, for almost all S_i, the sufficient rank condition for identification is satisfied. The necessary order condition for identification -for each S_i there exists 2^{n-1} points in the support of the conditional distribution of

$\boldsymbol{S}_{N/i}$ given S_i- holds, as long as $\boldsymbol{S}_{N/i}$ contains a continuously distributed variable with $\Pi_i(x_i, \boldsymbol{x}_{N/i}, S_i)$ sufficiently variable (Bajari, 2010).