THE SHORT-TERM AND LONG-TERM TRADE-OFFS OF SUSTAINABLE ENTREPRENEURSHIP

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Abstract

We use game theory concepts and tools to model the technology choices of firms that face a trade-off between the short-term profits from "dirty" technologies and the long-term benefits of a clean environment. When the nominal costs from adopting environmentally friendly technologies are "high enough," then choosing "dirty" technologies is a dominant strategy. However, when firms' objectives change due to taxes, subsidies, or demand shifts, the optimal strategies of firms can lead to a socially desirable sustainable equilibrium. A simple version of the model is adapted into a classroom activity that allows students to discover the main results of the model via simulations of corporate decision making.

Key Words: game theory, sustainability, classroom experiment

JEL Classification: A20, C70, Q55

Introduction

One of the hottest topics on today's college campuses, in media, and in politics is sustainability. Ironically, many different definitions of "sustainable" are currently circulating in the ongoing evolution of a more ethical, humane, and environmentally-friendly way of conducting business. We focus on a single definition from the World Commission on the Environment and Development (WCED) 1987: economic development is sustainable if it fulfills the present-generation's needs without jeopardizing the quality of life and economy of future generations. Sustainability is a complex, multi-faceted concept that encompasses ecological, economic, and social dimensions. It requires the efficient use of the environment and natural resources as well as socially responsible decision-makers.

Some sustainable practices involve improvements in efficiency or elimination of waste that may have previously been unrecognized. As in the use of more efficient lighting technologies, these changes likely entail up-front cost, but lower resource consumption and costs over time. More recently, improving technologies and productive efficiency have been re-cast as a sustainability issue, these choices are part and parcel of every business, regardless of its management's view of sustainability as a guiding business principle.

Since environmentally friendly and/or socially conscious production processes may be more limiting than the alternatives, the adoption of some sustainable technologies may be more costly to firms in both the short-term and long-term. For example, a manager of a restaurant may use inputs that are produced locally to reduce the carbon emissions released as a result of added transport. However, in opting for locally produced inputs, the manager is providing a

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differentiated product that may be attractive to customers willing to pay extra for dishes produced with a lower carbon cost.

In either case, whether efficiency-improving or society-improving, sustainable business practices have the potential to increase a firm's profits and long-term viability. As a result of the growing awareness of sustainable practices, their impact on costs, and the potential for improving a company's reputation among its customers, many business owners are incorporating sustainability considerations into their decision-making processes. In effect, as firms commit to sustainable business practices they move from a competitive market with negative externalities to a monopolistically competitive market where sustainable practices become an embedded characteristic of firms product lines, differentiating them from other similar (or even otherwise identical) products. If successfully marketed, the firm can convert the benefits that would otherwise accrue to society into private profits. If production process characteristics are viewed as components of a good, then "Green" can be marketed as a normal-good characteristic, whereas, "Brown" would become an inferior characteristic. The existence of otherwise identical products differentiated by production processes alone is an indication of the potential profitability of green over brown technologies.

An example of this can be found in green energy. Some publically traded energy providers have added power generation and fuel sources that are more environmentally friendly than those based on fossil fuels. According to the company's website, Georgia Power offers a "green energy" program on a voluntary basis, allowing interested customers to purchase renewable energy, but at an increased price. Keep in mind that, to the end user, the sources used for electricity generation are indistinguishable from each other, but in selling green energy, Georgia Power is guaranteeing the buyer that the purchased amount of green energy is generated and supplied using solar, wind, or some other source generally regarded as green. This option has been available from Georgia Power since 2003. Green energy can, in turn, be used in the production of other sustainable goods and services.

It should be noted that the regulatory environment (i.e., governmental and industry-wide policies) that a business faces will likely influence the adoption of sustainable practices as well. Legislation, tax policy, and industry standards can have the effect of changing the costs and benefits of sustainable business practices, and the timing of related decisions.

We model the short-term and long-term trade-offs that businesses face when choosing between sustainable and unsustainable technologies. Using game theory, we identify firms' dominant strategies both with and without government regulation. We describe an adaptation of the model that college instructors can use to demonstrate to students the inherent trade-offs managers face when trying to balance their various stakeholders' interests. Finally, we develop a game that can effectively engage students and guide them to discover the results of the model via first-hand experiences. The classroom presentation and experiment are appropriate for introductory business and economics courses.

The rest of the paper is organized as follows: in the next section we review the relevant literature, followed by a couple of examples that instructors can use to introduce the model in class. We then describe a simple version of the model for use in the classroom, followed by a classroom experiment and suggested classroom discussion questions. A more general version of the model is presented in the appendix. At last we conclude.

Literature

Heyes (2000), Lawn (2003), Harris and Codur (2004), and Razmi (2012), incorporate sustainability elements into well-known economic theories. Heyes (2000) and Lawn (2003) add an environmental equilibrium curve to the traditional IS-LM model, while Razmi (2012) models emission permits as a short-run stabilization policy tool. Harris and Codur (2004) develop a teaching module that introduces the environment to traditional macroeconomic models. For instance, they include the biosphere in the Circular Flow Diagram and discuss the role of pollution, natural resources, and recycling in the macroeconomy. They also discuss the limitations of GDP as a measure of well-being and add an alternative measure called environmentally-adjusted GDP.

These papers all use traditional macroeconomic models. Unlike them, we use game theory to model the microeconomic strategies of firms and the effect that economic policies can have on them. Moreover, unlike the previous papers, we develop a classroom activity that instructors can use to guide students to discover the potential impact on the environment of different policy tools.

Holt and McDaniel (1998) develop a classroom game that can be adapted to teach sustainability to students. They use red and black playing cards to demonstrate the Prisoner's dilemma in large classrooms. The advantages of this game are that it can be played in any size classroom, students can play individually, and it requires little effort from the instructor as students are asked to keep track of their moves and payoffs themselves. The activity that we present here requires the instructor to develop an Excel spreadsheet, to communicate with students, and to keep track of moves and payoffs of all players. Although more demanding on the instructor, our activity incorporates an added level of realism, the effect of government intervention on the players' decisions, and, it encourages interaction among students by making them work in a group setting.

Interactive classroom methods, including games and experiments, are valuable because they increase student engagement and learning, and they facilitate the realization of abstract, theoretical models in a practical, intuitive way (Holt 1999 and 2003). Moreover, Emerson and Taylor (2004), Ball, Eckel and Rojas (2006), Dickie (2006), and Durham, McKinnon and Schulman (2007), indicate that the use of interactive teaching techniques can improve student performance and grades.

Other Real-World Examples of Green Profits

Green energy is only one example of a more sustainable product leveraged for additional profits. Improvements in lighting technologies have made their way onto the showroom floors of the retail auto industry. Although light emitting diodes (LED) have been used in auto head-lights, tail-lights and interior displays for several years, LED lighting for building interiors, because of its comparatively high initial cost, has taken longer to gain a foothold. A recent auto industry article (Treece, 2016) states that auto dealerships are moving toward lighting their lots with the more sustainable LED lighting. Apparently, there is a "small but growing group of dealers switching to LED lights, particularly for outdoor lighting, because of their low operating costs and natural-looking light." Traditional exterior and interior lighting technologies consume significantly larger amounts of electricity and require more frequent maintenance. Furthermore, LEDs are directional and can be used to "feature" specific units on the lot. The following is an actual cost example taken from the article:

> "Reed Lallier Chevrolet, which sold about 1,200 new and 1,000 used vehicles last year at its eight-acre site, installed the new lights at the end of last year. For the 100 light poles, the total installation cost -- including fixtures, controls, labor and taxes -- came to about $120,000. Utility-bill savings so far are about $2,000 a month. Lallier expects to save another $3,000 a year on maintenance." (Treece 2016).

A similar cost-oriented approach has been adopted in segments of the agricultural sector. Organic farm products have gained market share and become more widely available over the past 25-year period. Haanaes, et al (2013) identified an Egyptian cotton producer as an example of a sustainable farmer who was able to lower farming costs, improve average yields and produce a better, more desirable product by adopting organic and sustainable farming practices. From 2006 until 2011, the year of turmoil known as the "Arab Spring," his business grew at an average rate of 14% annually. This farm and other similar sustainability-focused businesses, like the auto dealers above, have adopted a longer-range view of investing in which initially more-expensive technologies eventually lead to substantially lower short-run costs of production and/or higher productivity per unit of input. Furthermore, the agricultural industry is an example of sustainable practices arising from a broader view of the production process. Rather than attempting to maximize the profits from each agricultural product in a vacuum, the sustainable farmer must understand the potential links and benefits among the various products he or she could potentially produce. In the same way that crop rotation requires a multi-period, multi-crop approach to avoid environmentally costly and chemically-intensive soil maintenance, the pursuit of sustainable business requires an upfront search for system-wide efficiencies which pay off over multiple periods of business activity.

A Simple Model for the Classroom

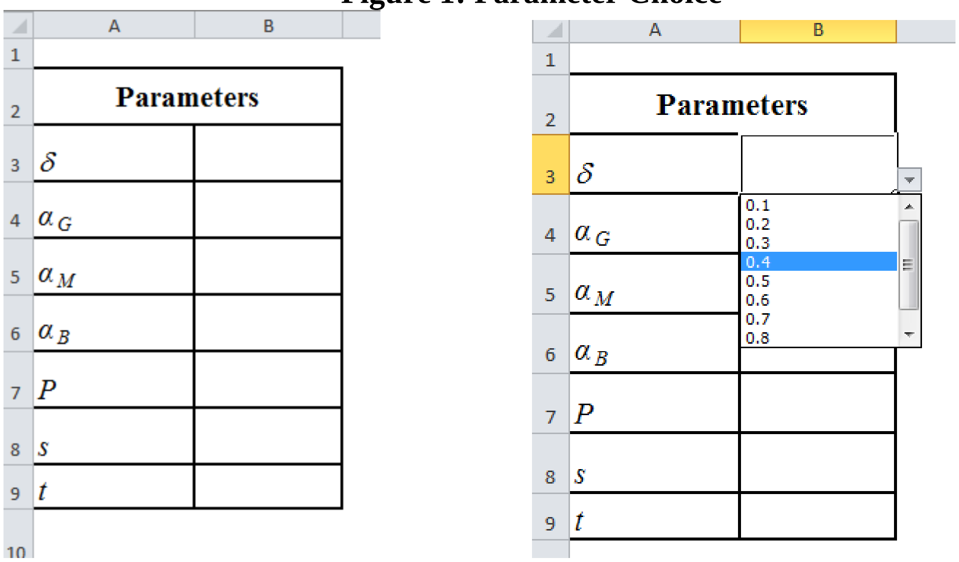
Consider a two-period model with two firms, A and B. The two periods can be thought of as the present (period 1) and the future (period 2). At the beginning of the first period, firms simultaneously invest in a production technology. Technology choices last for two periods. For simplicity, we assume that there are only two technologies (or production functions) available: Green and Brown. The Green technology is environmentally friendly whereas the Brown technology is not.

We assume that period 1 payoffs are higher if the Brown technology is used, and we let $P > 0$ denote the premium short-term profits earned by producing with the Brown technology. However, future payoffs increase if at least one firm decides to adopt the Green technology. That is, we assume that profits grow by a factor $0 < \alpha < 1$ over time, which can be attributed to experience, learning by doing, and to the quality of the environment. Finally, whenever a firm produces using the Brown technology it depletes the environment introducing additional costs in period 2.

Formally, we assume that if both firms choose the Green technology, their profits grow by a factor $0 < \alpha_G < 1$; if both firms invest in the Brown technology, their profits grow by $0 < \alpha_B < 1$; and if one firm chooses Green and one Brown, profits in period 2 grow by $0 < \alpha_M < 1$. To capture the benefits of Green technologies in the environment, we assume that $\alpha_G > \alpha_M > \alpha_B$. We denote the time discount parameter as $0 < \delta < 1$, the tax rate as $0 < t < 1$, and subsidies as $0 < s < 1$.

To find the equilibrium of the game we compare the payoffs of each firm taking the strategy of the other firm as given. The appendix develops the general model and solution. In this section, we present a simple model assuming specific values for α_G, α_M, $\alpha_{B.}$, δ, *t*, *s*, and *P*. Moreover, we develop a Microsoft Excel spreadsheet to facilitate the classroom presentation. Drop boxes are used to restrict parameter selection to satisfy the assumptions of the model: when the user clicks on an empty cell to choose a parameter (e.g., cell B1 in Figure 1), a drop box with a series of options appears; the drop boxes restrict parameter choices to satisfy the inequalities $\alpha_G > \alpha_M > \alpha_B > 0$.

Figure 1: Parameter Choice



The spreadsheet includes a matrix with color-coded payoffs. The payoffs in Figure 2 correspond to an example in which δ=0.8, α_G =0.4, α_M =0.3, α_B =0.2, *t*=0 and *s* =0. Whenever a

Figure 2: Payoff Matrix for δ=0.8, α_G =0.4, α_M =0.3, α_B =0.2, *t*=0 and *s* =0

		Firm B	
		Green Technology	**Brown Technology**
Firm A	**Green Technology**	Firm A's payoffs: ***1.32*** Firm B's payoffs: ***1.32***	Firm A's payoffs: ***1.24*** Firm B's payoffs: ***1.61***
	Brown Technology	Firm A's payoffs: ***1.61*** Firm B's payoffs: ***1.24***	Firm A's payoffs: ***1.51*** Firm B's payoffs: ***1.51***

firm chooses the Green technology, its payoffs are highlighted in green; when a firm chooses the Brown technology, its payoffs are highlighted in brown. For instance, when both firms choose the Green technology, their payoffs are 1.32. If firm A chooses Green while firm B chooses

Brown, A's payoffs are 1.24 while B's payoffs are 1.61. Instructors can change parameters, one at a time, to show students how payoffs change with δ, α_G, α_M, α_B, t and s.

Figure 3: Firm A's Payoffs for Different Tax Rates

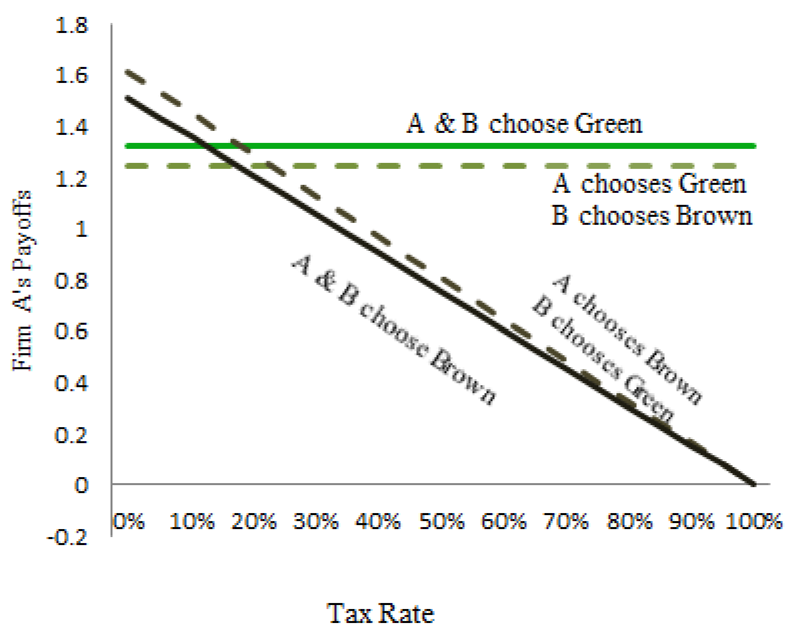
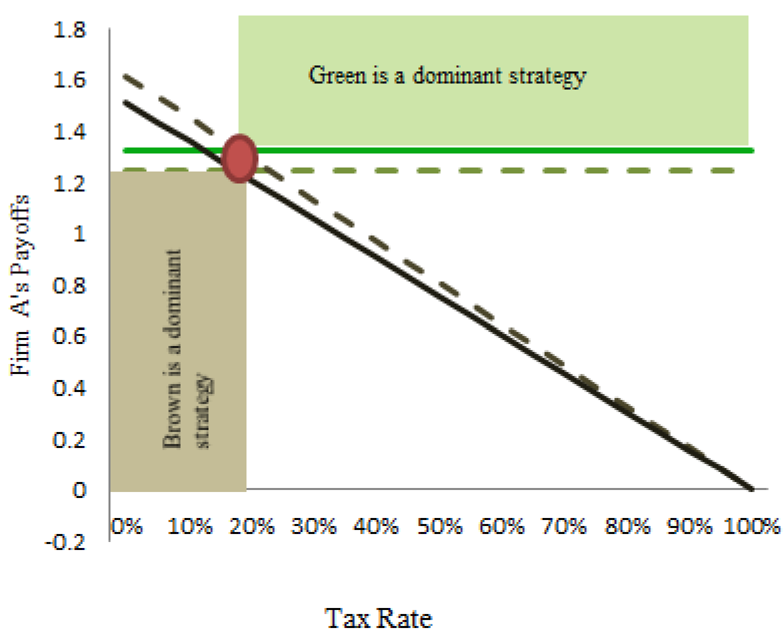


Figure 4: Tax Rates that Incentivize the Adoption of Green Technologies



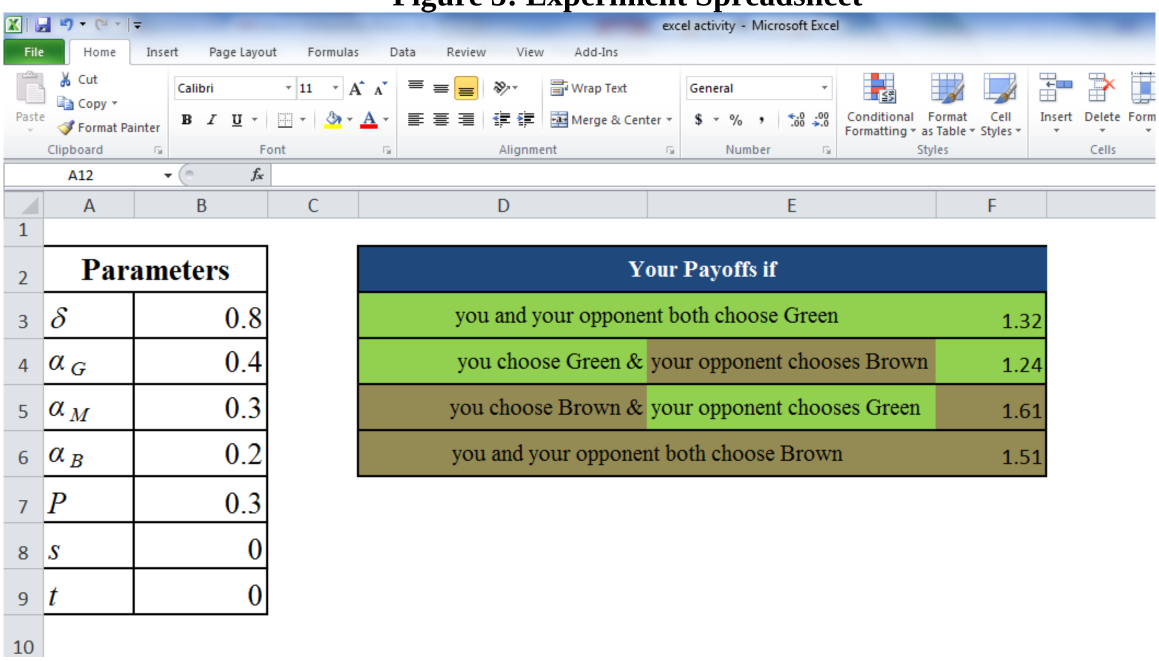
We also develop graphs that show how payoffs and strategies change with parameter values. Figures 3 and 4 show the payoffs of firm A for δ=0.8, α_G =0.4, α_M =0.3, α_B =0.2, s =0 and t between 0 and 1. Figure 4 highlights the areas for which choosing Green is a dominant strategy and identifies the minimum tax rate needed to induce the socially desirable equilibrium in which both firms choose Green. Although these graphs show the dependence of payoffs and strategies on taxes, similar graphs can be made to highlight the impact of subsidies.

Classroom Activity

Instead of presenting the model in class in a lecture format, instructors can allow students to "discover" the results of the model with a classroom experiment. Instructors can carry out the experiment in a computer lab or in a classroom with Wi-Fi access. If the instructor chooses the latter option, he should let students know in advance to bring a computer or tablet to class.

Prior to the day of the experiment, the instructor creates an Excel spreadsheet that allows students to estimate their payoffs. A summary of such a spreadsheet is shown in Figure 5. The first two columns in the spreadsheet show the parameter values and the next few columns show the payoffs.[2]

Figure 5: Experiment Spreadsheet



On the day of the experiment, instructors assign students to groups of two or three. Instructors must choose an even number of groups in order to pair them up to play against each other. Once groups are chosen, the instructor distributes the Excel file to the students by email or by uploading to a course management website. Students are not told who they are matched against, but the instructor keeps track of group pairings and choices. Finally, instructors must

[2] The payoffs are entered as formulas. For example, the payoff when both firms choose Green is $(1+ \delta\alpha_G)(1+s)$, which using the appropriate Excel cells can be written as =(1+(B3*B4))*(1+B8). The payoff when the student playing the game chooses Green and his opponent chooses Brown is $(1 + \delta\alpha_M)(1+s)$, which is equivalent to =(1+(B3*B4))*(1+B8) using Excel formulas, etc.

choose a way to communicate with students during the activity. We prefer two-way online chats between each group and the instructor, but note cards could be used. At the beginning of every round, students communicate their choices to the instructor. The instructor tabulates all responses and sends a message to each group showing its payoff. The round ends when students learn their payoffs.

During the activity, the instructor has an Excel document open with a list of the groups and pairings. For example, suppose there are four groups in the class, labeled A, B, C, and D. (For an added touch of fun, instructors can allow students to choose group names). The instructor keeps track of choices using a file like the one shown in Figure 6. Ideally, the game is played multiple times so that students can discover their optimal strategies. In the example in Figure 6, in round 1 group A plays against group B, and group C against group D. In round 2, group A plays against C, and B against D. The instructor may choose to reassign the pairs randomly after every round. Students, however, never find out who their "opponent" is. To facilitate the calculation of payoffs, the instructor's tracking table (Figure 6) can be embedded with formulas that use *IF* and *AND* statements that automatically calculate the payoffs.[3]

Figure 6: Instructor's Tracking Table

	Group Pairs		Choices	Payoffs
Round 1	A C	B D		
Round 2	A B	C D		
Round 3	A B	D C		
Round 4	A C	B D		
Round 5	B A	D D		
Round 6	A C	B D		

Initially, we recommend setting taxes and subsidies equal to zero, but after a few rounds instructors can announce policy changes and instruct students modify the parameter values in their spreadsheets. For example, the first four or five rounds can be played using the parameter values δ=0.8, α_G =0.4, α_M =0.3, α_B =0.2, t=0, and s =0. Once strategies converge to the dominant strategies, students have discovered the correct solution and the instructor can modify the game. Instructors can ask students to modify taxes by clicking on the appropriate drop box (cell B9 in Figure 5 in our case) and make them 1% or 0.01, for example. After two or three rounds, instructors can change t again, and so on.

[3] An example of an IF statement with multiple conditions can be the following:
=IF(AND(F3="G",G3="G"),(1+(B3*B4))*(1+B8),IF(AND(F3="G",G3="B"),(1+(B3*B5))*(1+B8),IF(AND(F3="B",G3="G"),(1+(B3*B5))*(1+B7)*(1-B9),IF(AND(F3="B",G3="B"),(1+(B3*B6))*(1+B7)*(1-B9),0))))

Talking Points

After several rounds of the game, the instructor can end the activity and begin a classroom discussion. Based on our experience, we have developed talking points for the discussion:

- How did your group decide on which technology to choose? Did your choice change from round to round? Why or why not?

Surprisingly, while most students play the game to maximize their payoffs, there are some students who disregard the highest paying strategies and attach intangible utility to choosing the environmentally friendly technology. That is, even when the initial parameters and payoffs are those depicted in Figure 5, some students still choose the Green technology knowing that their profits would be higher if they chose Brown. Some of them claim to be environmentally conscious such that profits are not the only goal; others attach a probability to the instructor changing the rules midway through the game to punish students who choose the brown technology and try to prevent these losses.

- Did your strategy change when we introduced taxes/subsidies? Why or why not?

For the profit-minded students, taxes/subsidies are always effective in inducing the socially desirable outcome. In our experience, students are very quick at calculating the point at which their strategies change.

- How high do taxes need to be to induce a socially desirable (Green-Green) outcome? Are taxes better or worse than subsidies?

When students are provided with the Excel spreadsheet, they can calculate the exact value of the taxes that will induce the correct strategy. During classroom discussions, they can debate among themselves about what tax is “too high” to pay and whether or not governments should really regulate the environmental choices of firms.

In addition to the classroom discussion, instructors can follow up with a take-home assignment by asking students to research the actual regulations that different countries have put in place to deal with environmental concerns.

Conclusion

Using game theory matrices and the concepts of dominant strategies and Nash equilibrium, we model the decisions of firms faced with the option of depleting the environment for the sake of profits. Our model shows that if environmentally friendly technologies are very expensive, then firms choose “dirty” technologies. However, if the long-term benefits of green technologies are “large enough” firms can be persuaded to abandon “dirty” technologies in favor of sustainable processes. Persuasion can come in the form of government regulation, taxes, or pressure from consumers. We develop a simplified version of the model, Excel spreadsheets, and a classroom activity that allow students to discover these results by simulating corporate decision making. We plan to develop an interface version of the activity that allows students to play against the computer.

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Appendix

In this appendix we generalize the simple model presented in the paper.

Basic Set-Up: A Model without Government

We assume two profit maximizing firms, A and B. At the beginning of the first period, firms choose (simultaneously) between two technologies: Green (environmentally friendly) and Brown. We assume that profits grow by a factor α over time, which can be attributed to experience, learning by doing, or to the quality of the environment. Moreover, whenever a firm produces using the Brown technology it depletes the environment introducing additional costs in period 2. Formally, we assume that if both firms choose the Green technology, their profits grow by a factor α_G; if both firms invest in the Brown technology, their profits grow by α_B; and if one firm chooses Green and one Brown, profits in period 2 grow by α_M. To capture the benefits of Green technologies in the environment, we assume that $\alpha_G > \alpha_M > \alpha_B > 0$.

Letting δ denote the time discount parameter, then the two-period discounted payoffs of firms A and B can be summarized in the matrix depicted in Table 1. If both firms choose the Green technology, they each earn profits G in period 1 and $\delta \alpha_G G$ in period 2. If both firms choose the Brown technology, they both earn $(1 + P)G$ in period 1 and $\delta \alpha_B (1+ P)G$ in period 2, where P denotes the short term savings from using the Brown technology. If one firm chooses the Green technology and the other the Brown technology, the firm that chooses Green receives G in period 1 and $\delta \alpha_M G$ in period 2, while the firm that chooses the Brown technology receives $(1+ P)G$ in period 1 and $\delta \alpha_M (1+ P)G$ in period 2.

To find the equilibrium of the game we compare the payoffs of each firm taking the strategy of the other firm as given. We find that for certain values of the parameters, choosing the Brown technology is always optimal, no matter what the other firm does; for other values, choosing the Green technology is always optimal. We summarize these conditions in Proposition 1.

Proposition 1:

- If $P > \delta(\alpha_M - \alpha_B)/ (1 + \delta \alpha_B)$ and $P > \delta(\alpha_G - \alpha_M)/ (1 + \delta \alpha_M)$, then the unique Nash equilibrium of the game is for both firms to choose the Brown technology.
- If $P < \delta(\alpha_M - \alpha_B)/ (1 + \delta \alpha_B)$ and $P < \delta(\alpha_G - \alpha_M)/ (1 + \delta \alpha_M)$, then the unique Nash equilibrium of the game is for both firms to choose the Green technology.

Table 1: Payoff Matrix

		Firm B	
		Green Technology	**Brown Technology**
Firm A	**Green Technology**	Firm A's payoffs: $(1 + \delta \alpha_G) G$ Firm B's payoffs: $(1 + \delta \alpha_G) G$	Firm A's payoffs: $(1 + \delta \alpha_M) G$ Firm B's payoffs: $(1 + \delta \alpha_M)(1+P) G$
	Brown Technology	Firm A's payoffs: $(1 + \delta \alpha_M)(1+P) G$ Firm B's payoffs: $(1 + \delta \alpha_M) G$	Firm A's payoffs: $(1 + \delta \alpha_B) (1+ P) G$ Firm B's payoffs: $(1 + \delta \alpha_B) (1+ P) G$

According to Proposition 1, if the monetary costs from adopting Green technologies are "high enough," then firms are better off choosing Brown technologies. In the next section we investigate the alternatives of governments or regulatory agencies to change these choices.

Regulations

Assume that P is "large enough" and thus that the unique Nash equilibrium of the game is for both firms to choose the Brown technology. In this section we modify the payoffs of firms by assuming that governments levy a tax, t, on firms that choose the Brown technology. The modified two-period discounted payoffs of firms can be summarized in Table 2.

A comparison of payoffs leads to the conclusion that if taxes t are "large enough," the Green technology becomes a dominant strategy and the unique Nash equilibrium of the game occurs when both firms choose the Green technology. We summarize this in Proposition 2.

Proposition 2: If $t > (\delta(\alpha_M - \alpha_B) - (1+\delta\alpha_B)P)/(1+\delta\alpha_B)(1+P)$ and $t > (\delta(\alpha_G - \alpha_M) - (1+\delta\alpha_M)P)/(1+\delta\alpha_M)(1+P)$, then the unique Nash equilibrium of the game is for both firms to choose the Green technology.

Table 2: Payoffs with Taxes

		Firm B	
		Green Technology	**Brown Technology**
Firm A	**Green Technology**	Firm A's payoffs: $(1 + \delta\alpha_G)G$ Firm B's payoffs: $(1 + \delta\alpha_G)G$	Firm A's payoffs: $(1 + \delta\alpha_M)G$ Firm B's payoffs: $(1 + \delta\alpha_M)(1+P)(1-t)G$
	Brown Technology	Firm A's payoffs: $(1 + \delta\alpha_M)(1+P)(1-t)G$ Firm B's payoffs: $(1 + \delta\alpha_M)G$	Firm A's payoffs: $(1 + \delta\alpha_B)(1+P)(1-t)G$ Firm B's payoffs: $(1 + \delta\alpha_B)(1+P)(1-t)G$

In addition to levying a tax, governments may offer subsidies to firms that choose Green technologies, or a combination of subsidies and taxes. A subsidy s increases the payoffs of Green firms and leaves the payoffs of Brown firms unchanged. Table 3 summarizes the payoffs when both subsidies and taxes are imposed, while Proposition 3 summarizes the conditions under which (Green, Green) is the unique Nash equilibrium.

Proposition 3: If $(1+s)/(1-t) > (1 + \delta\alpha_B)(1+P)/(1+\delta\alpha_B)$ and $(1+s)/(1-t) > (1 + \delta\alpha_M)(1+P)/(1+\delta\alpha_M)$, then the unique Nash equilibrium of the game is for both firms to choose the Green technology.

Changing firms' objectives via taxes or subsidies can lead to a socially desirable outcome: a sustainable equilibrium. Although the model assumes that the variations in payoffs come from government regulations, the payoffs can be interpreted as imposed by consumers. For example, if many consumers decide to patronize only the firms that use sustainable technologies, demand for the products of the firms using Brown technologies decreases. This is akin to a tax on firms using cheaper, yet "dirtier", technologies.

Table 3: Payoffs with Taxes and Subsidies

		Firm B	
		Green Technology	**Brown Technology**
Firm A	**Green Technology**	Firm A's payoffs: $(1 + \delta\alpha_G)(1+s)\ G$ Firm B's payoffs: $(1 + \delta\alpha_G)(1+s)\ G$	Firm A's payoffs: $(1 + \delta\alpha_M)(1+s)\ G$ Firm B's payoffs: $(1 + \delta\alpha_M)(1+P)(1-t)\ G$
	Brown Technology	Firm A's payoffs: $(1 + \delta\alpha_M)(1+P)(1-t)\ G$ Firm B's payoffs: $(1 + \delta\alpha_M)(1+s)\ G$	Firm A's payoffs: $(1 + \delta\alpha_B)(1+ P)(1-t)\ G$ Firm B's payoffs: $(1 + \delta\alpha_B)(1+ P)(1-t)\ G$