Using Economic Experiments to Value Diversity in the Engineering Workforce

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Abstract

Economic experiments are tools economists may use in situations where market prices are not easily obtainable and non-market values of a product or product's attributes are unknown. Both market and behavioral experiments may be employed to value diversity across the workforce and within firms. We discuss using market experiments to increase market efficiency and reveal managerial preferences for diversity. We propose a broad array of behavioral experiments which may be used to measure non-market values of diversity. Such experiments can be used to understand the effect of diversity on transaction costs within and between firms. Behavioral bargaining experiments are discussed in relation to understanding employee motivation and work-group efficiency. The interaction of diversity and incentive design mechanisms is explored with tournament experiments. Public goods experiments are proposed as a method to value cooperation within and between diverse groups. Through this review, we find ample opportunity to develop more informed estimates of diversity's value using economic experiments.

Using Economic Experiments to Value Diversity in the Engineering Workforce

Section I. Introduction

Data incorporating diversity in the engineering market place are hard to obtain or often are not straight forward. As other authors in this project find, general workforce diversity data are available from non-governmental organization, industry group, and ethnic group sources (e.g., Human Rights Campaign's Corporate Equality Index, Fortune's company ratings, and Hispanic Business). However, when these data are available, it is often hard to match general employment statistics with specific hiring and wage information to obtain exact valuation estimates. For instance, while there may be information available about the number of Hispanic engineers at various firms, this does not provide details like the initial hiring wage for a new Hispanic engineer in the firm(s). If wage data is available, they may not contain clear information about what is included in the market price (i.e., does salary reflect non-monetary bonuses and expense account perks?). Due to the thinness of the market for diverse engineering candidates, the timing of the market transaction is important. Many transactions may take place over the course of a few years as the candidate is recruited through internship and education incentives, not just at the time of the initial wage offer.

The 'black box' nature of firms makes the non-market valuation of diversity complex. If we consider the theory of the firm proposed by Coase (1937), one of the main goals of the employer will be to bring down the cost of production within the firm. Firms arise when the costs of transacting with the market to produce a product are greater than those needed within the firm. To truly value diversity in the workforce, we need to not only understand the labor wage rate of diverse individuals in the market place, but also understand the influences of diversity on transaction costs within the firm. Questions related to intra-firm value of diversity include the following: a) How do diverse individuals increase team effectiveness and cooperation within the firm? b) How do diverse employees increase or decrease a firms' ability to effectively negotiation contracts and coordinate resources for production?

Economic experiments provide tools to answer questions related to the market and non-market or intra-firm values of diversity in the engineering workforce. The main objective of this paper is to identify the role economic experiments may play in assessing market and firm-level values of diversity in the engineering workforce. I will do this using the following approach. First, I identify key questions and the types of experiments that may be used to answer these questions. Then, the experiments and types of answers they may provide are described. This synthesis of existing literature and tools will be used to make recommendations on how experiments may be used in future valuation work.

Section II. Key Questions and the Experimental Tools Available to Answer Them

There are several key questions which arise when considering the value of diversity in the engineering labor force. I focus on three questions: 1) What is the true market value of diversity in the engineering workforce? 2) What is the value of diverse individuals in work-place team contexts? and 3) How do diverse individuals affect the efficiency of transaction costs within the firm? These questions, corresponding experimental tools, and the possible outcome of employing these tools are presented in Table 1.

Table 1. Key questions, experimental tools, and outcomes with regard to valuing diversity

Question	Type of Experiment(s)	Possible Outcome(s)
What is the true market value of diversity in the	Market	A better understanding of the market coordination

engineering workforce?		mechanism in the market for new, diverse engineering graduations
	Choice Experiments	Estimate the value of different diverse attributes of engineering candidates holding other attributes constant (especially productivity and quality of degree attributes)
What is the value of diverse individuals in team contexts?	Tournament	Identify how the presence of diverse individuals influence incentive schemes or mechanisms.
	Public Goods	Determine the value of diverse individuals in team cooperation and coordination.
How do diverse individuals affect the efficiency of transaction costs within the firm?	Ultimatum Bargaining and Dictator Games	Measure differences in fairness and generosity expectations based on minority status and/or cultural background.
	Trust Game	Understand differences in trusting behavior across diverse individuals which may affect contractual relationships.

Section. III. A. Determining a the Market Value for Diversity

One of the first places to look for an economic value of diversity is the labor market for engineers. One may begin with the question “What is the market value of new engineering graduates from diverse backgrounds?” This question is easily complicated by scarce data, inconsistent data across individuals and firms, and no central market information sharing mechanism. Given these complications, market experiments may be one way to estimate the market value of engineers with diverse backgrounds.

Section II.A.1. Market Experiments

Throughout the last 30 to 40 years, understanding and improving the efficiency of markets has been one main focus of experimental economists. In the cases where markets operate inefficiently or it is difficult to understand the effects of policy on the behavior of different agents, experimental economic methods can be used. In cases where there are no or missing markets, such as the market environmental goods, experimental methods can be used to design new market institutions. Different parameters can be explored through economic experiments. Market architecture parameters relate to the process through which the terms of contracts among agents can be negotiated (Plott 1994). One aspect of market architecture that is explored extensively in labor markets is matching. Matching concerns who transacts with whom in the market place (Niederle, Roth, and Sonmez Forthcoming). The second set of parameters economic experiments address are those related to background institutions. These determine how quickly transactions may occur (i.e., how quickly money is traded for property rights) and insuring those transactions are consistent with original contract designs (Plott 1994). As alternative market architecture and background institution designs are addressed through experiments, testbed experiments can be conducted in the laboratory determine how new designs may eventually be implemented in the marketplace. Field experiments go beyond testbed experiments and take the adjusted market mechanism out of the laboratory and test it in an actual field situation (Harrison and List 2004).

Basic market experiments consist of two types of agents: buyers and sellers. Each of the buyers is endowed with a reservation price while each seller is assigned a production costs for the good. Each buyer tries to maximize the difference between their reservation price and the price he or she has to pay for the good on the market. Similarly, each seller tries to maximize his or her profit by taking a higher market price than his or her cost of production. Sellers and buyers receive different cost and reservation values, creating overall, step-wise market supply and demand functions. The way in which buyers and sellers coordinate their trades, the timing of trades, and the market information available at the time of trades are a few of the basic parameters which can be adjusted or controlled for and studied in market experiments (Davis and Holt 1993).

Previous work on market efficiency identify three main types of market failures that tend to arise in labor markets for early career candidates: failure to provide thickness, failure to overcome the congestion that thickness may bring, and failure to make the market safe for all of those participating (Niederle, Roth, and Sonmez Forthcoming). Markets fail when they are "thin" or there is not a "thick" set of buyers and/or sellers to transact with each other. A lack of either buyers or sellers can lead to either monopsony or monopoly conditions in which either a small group of buyers or sellers dictate market exchange conditions. On the other hand, markets may become congested when there are an overwhelming number of buyers and sellers trying to transact with each other, especially in a limited time horizon. Finally, markets are safe if all agents feel they can reveal and act on information they have.

Alvin Roth and his colleagues have used economic theory and field experiments to improve the performance of several different labor markets (Niederle, Roth, and Sonmez Forthcoming). They have focused on first-time job markets including those for law clerks, medical residency fellowships, and new economics assistant professors. Each of these markets previously suffered from at least one symptom of market failure. In the case of law clerks, one-sided market thinness was the main problem. There were many applicants with few federal judges accepting clerks. This led judges to hire clerks earlier and earlier in law students' careers until they were hiring students after their first year for placement in the third year. The judges were making decisions based on very little law school performance information and many times this early placement led to poor matches. A similar early hiring situation existed in the market for new doctors until medical schools mandated that new doctors could not be hired until a specified date later in their program. This, however, led to congestion with many hospitals trying to hire from a relatively large pool of applicants at the same time. The market became congested because hospitals did not have time to make a second offer when their first offer was rejected. Hospitals were then forced to start making "exploding offers" or offers to students with very limited decision time (less than 12 hours in some cases).

Clearinghouses are now one solution to the medical market problem. Hospitals submit an ordered list of their top candidates to the clearinghouse. Meanwhile, candidates submit an ordered list of their hospital choices to the clearinghouse. Then, the clearinghouse mechanism matches hospitals to candidates using the ordered list.

While the medical market participants, mainly medical schools, were able to find a workable solution to their market congestion problem, it is often more difficult to get participant buy-in in new market design. Economic field experiments are often used to "fix" market coordinating mechanisms on a smaller-scale, especially when preliminary results may be needed to convince all participants of the merits of improving market design. Economic field experiments are those generally conducted outside of the laboratory environment, but with more control compared to the natural market environment. They typically involve the use of field subjects (people accustomed to consuming a certain commodity or activity), field goods, and are typically in a field or natural context. In the work Roth and others have accomplished in labor markets, field experiments have been employed to improve matching mechanisms and, thus, increase market allocative efficiency. Such experiments have been useful to move theory into the field in the case of the law clerks and non-labor matching markets such as those allocating public school placement (Niederle, Roth, and Sonmez Forthcoming). Kagel and Roth (2000) use a laboratory experiment to test matching mechanism or algorithm to understand the outcome of various matching mechanisms better.

As we look to value diversity in the engineering workforce, it is important to understand how the market for new engineers with diverse backgrounds operates. This is a market which can easily suffer from market thinness on the side of the diverse engineering candidates. Assuming it is desirable to have some diversity in the workforce, there may be many more engineering firms vying for diverse candidates than there are diverse candidates, especially when one compares the proportion of diverse candidates to non-diverse candidates. This thinness may be reflected in the current programs designed to recruit diverse candidates from the time they leave high school and through their college training. While these programs may help the candidates overcome a certain degree of labor market uncertainty, it is not clear that they will efficiently match job candidates to firm needs at graduation time. Further, the money spent to recruit these candidates from an early stage may not be reflected in their initial offer. This causes an inaccurate valuation of the minority or diverse candidates true worth.

Laboratory experiments may be used to understand how current matching occurs in the engineering market and if the matching mechanism may be improved. Field experiments may be conducted to test the effectiveness of such an “improvement” in the natural environment. They may also be then used to identify a true market price for diversity in engineering once the matching mechanism and processes are fully understood.

Section II.A.2. Choice-based Experiments

Even in well-functioning markets, there are certain product attributes which may not easily be valued using the market price. While the market price encapsulates the value of the entire product, it does not reveal the value of separate product attributes. In the case of a new engineering graduate, attributes include the candidate's training, age, gender, socio-economic background, experience, ethnicity, academic aptitude, and etc. If and when data are available on the market value of diverse engineering candidates, it may be challenging to determine how much of a given market price is due to the candidate's diverse background or to other factors related to their potential productivity (e.g., institutional training, general personality and attractiveness, experience, etc.). In a worse case scenario, it may be that the market price of diverse candidates is lower on average than that of non-diverse candidates. One could directly infer that this was due to the non-traditional ethnic or racial background of the candidate. On the other hand, it may be that such an attribute is highly correlated with another attribute, such as quality of training. Choice-based experiments allow us to separate the various attributes and value diversity given the quality of training a candidate has obtained. It may be that diversity is valued, but many diverse individuals are not in high quality programs and, thus, are devalued due to this fact, not their role as a diverse individual.

Choice experiments are designed to value the individual attributes associated with different goods or choice alternatives. While market experiments may be easily used to value a whole commodity or good (e.g., a new engineering graduate), they are limited in their ability to explain what attributes associated with specific choice alternatives make each choice more or less attractive based on the level of the various attributes it includes. Examples of attributes which may cause different product or employee values in the engineering labor market include previous related work experience, quality of educational training, and, of course, gender and ethnicity characteristics.

Much of the theoretical assumptions underlying choice experiments go back to Lancaster's (1991) approach to consumer theory. One of the most useful aspects of this theory is that a good, *per se*, does not give direct utility to the consumer. Rather, it possesses a bundle of characteristics and it is these characteristics which give utility to the consumer. Hensher et al. (2005) characterize the utility derived from each choice alternative as U_i where each choice consists of a number of different attributes or sources of relative utility, V_i. U_i is equal to V_i plus unobserved influences ε_i or $U_i = V_i + \varepsilon_i \ \forall j = i,..., J$ alternatives in a choice set. One of the objectives of choice analysis is to estimate the relative weight identified factors within V_i bear upon the total value of V_i and thus on U_i. V_i is equal to the weighted sum of all of the different attributes associated with a specific choice alternative or $V_i = \beta_{0i} + \beta_{1i} f(x_{1i}) + \beta_{2i}(x_{2i}) + \beta_{3i} f(x_{3i}) + ... + \beta_{ki} f(x_{ki})$ where β_{1i} is the weight (parameter) associated with attribute x_1 and choice alternative i and β_{0i} the choice alternative specific constant. There are some important assumptions that underlie our ability to work within this framework. An important assumption the IID condition. That is, the unobserved components of utility for all alternatives are uncorrelated with the unobserved components of utility for all other alternatives. This also assumes the error terms have the same distribution across alternatives.

Choice experiments are designed to measure the weights or parameters associated with each of the attributes across different choice alternatives. The typical process to construct a choice experiment begins with defining the problem and deciding which attributes are of interest across choice alternatives. Not only do the attributes of interest need to be identified, but the way in which they will be measured or their attributes levels must be identified. The experimental design is then determined based on the number of attributes and choice alternatives. There are two main types of experimental design, full factorial design and fractional factorial design. In the full factorial design, all possible treatment combinations or choice alternatives with all attribute combinations are considered. In a fractional factorial design, a fraction of the full factorial design alternatives are randomly chosen. The design mechanism (typically generated via computer software programs) ensure that all of the attributes across treatment combinations are orthogonally related to maintain the IID assumption (Hensher, Rose, and Greene 2005). After this design process is complete, final choice alternatives can be presented to the subject. This can be done in an experimental lab environment with actual products and purchase opportunities, ensuring incentive compatibility,[1] or through hypothetical survey methods. In the latter presentation, hypothetical bias then becomes a concern and needs to be addressed in the survey mechanism and results analysis.[2] Once subjects complete the choice experiment, making purchase or choice decisions across the different choice alternatives, the data can then be econometrically evaluated to determine the weights associated with different attributes and, using the price parameter, the value of the different attributes to consumers.

Given the overview of choice experiment methodology, I will briefly describe how one may be constructed for the problem at hand. Since are interested in valuing diversity in the engineering workforce, we will focus on attributes associated with new engineering graduates. In this example, we will limit diversity to one's racial identity. This attribute will be considered along with one other attribute, quality of education. One of the first steps in constructing a choice

[1] Experiments are incentive compatible when subjects do not have reason to misrepresent their preferences. In the case of economic experiments, incentive compatibility is typically assured when subjects make decisions with consequences involving real money outcomes.
[2] Hypothetical bias is the difference between subjects' true and state preferences. This often occurs in situations where subjects make decisions without consequence (e.g., may vote to fund a new project, but then will never be asked for an actual financial contribution to that project).

experiment will be to identify how many different attribute levels to consider for each alternative. To keep things simple, consider four levels of racial identity: white, black or African American, Hispanic, and other non-white. Regarding education attribute levels we will consider three attributes based on the following engineering program ranking categories: one to 25, 26 to 50 and below 50. In this case, we assume all other attributes are irrelevant across engineering graduates or, at least, held constant. If we went with a full factorial design, then would be twelve different choice alternatives presented in Table 2. A fractional factorial design could be used to abbreviate the number of choices, but we will continue with the full factorial design.

With a little more refinement and attention (see Hensher, Rose, and Greene 2005) these alternatives may then be presented to potential managers in the engineering workforce to measure their preferences for race compared to the quality of engineering program. Each manager will not choose over the 12 different treatment combinations. Rather, they will be presented with a sub-set of the combinations to make choices over. For example, one manager may state their choice of a white applicant from a top 25 program compared to a black applicant from a top 25 program. He or she may be asked to then make three more similar choices. Then, other managers will make similar decisions over other alternative choices to complete the possible choice set responses. Their data will be compiled to determine how managers value the different attributes across the choice alternatives (see Hensher, Rose, and Greene 2005 for detailed instruction on this process). In order to add an economic value to the managers' preferences, another attribute category needs to be added which includes the salary demanded by the employee. For simplicity, we are omitting this from the current example.

Table 2. Full factorial design of race and education attributes associated with new engineering graduates

Treatment Combination	Race Identity	Engineering Program Ranking
1	White	1 to 25
2	White	26 to 50
3	White	Below 50
4	Black	1 to 25
5	Black	26 to 50
6	Black	Below 50
7	Hispanic	1 to 25
8	Hispanic	26 to 50
9	Hispanic	Below 50
10	Other Non-White	1 to 25
11	Other Non-White	26 to 50
12	Other Non-White	Below 50

The experiment described above would be classified as a stated preference experiment (as opposed to revealed preference). If we were to conduct a similar experiment with a fuller experimental design which includes salary information, we would be able to value diversity as an attribute of new engineering candidates. While the example presented is largely hypothetical, some adjustments could be used to make it more incentive compatible. In addition, instead of using a standard survey or experiment format, this experiment may be more interesting if the attribute information is presented to the managers in the form of a resume or vita where all things are held constant except the main variables of interest.

Section II.B.. Valuing Diversity within the Firm

When the market price of a diverse engineering candidate is non-existent or not accurately reported, the value of diverse engineers within firms is not truly known. Therefore, it is also necessary to consider ways in which clearer, full information about the value of diverse individuals within the firm can be obtained. I first consider two different experiments to examine the role diverse individuals may play in the economic efficiency of work force teams. Tournament experiments and the Voluntary Contribution Mechanism (VCM) or public goods game are considered as tools to understand the effect diverse individuals may have on intra-firm transaction costs.

Section II.B.1. Tournament Experiments

Minority individuals recruited to a firm add diversity to the work teams operating within that firm. When considering what the potential value of a minority or diverse individual is to a firm, one needs a way to measure the value they add to the team environment, not just the value of their individual skills and talents. In a tournament experiment, one or more players are grouped together to accomplish a task. They are typically competing against each other to win a prize or set of prizes. According to the theory of tournaments, the four parameters defining a tournament experiment include 1) a specification of each player's utility function, 2) the production function (as a function of each player's effort or input), 3) the distribution of random shocks which may effect each player's output, and 4) the amount of the prizes available to the winner or group of winners (Schotter and Weigelt 1992). In a simple version of a tournament game each team member has a specified utility function, U_i, that is a function of the benefit of the prize he or she may receive, u(p), and the cost of effort, c(e), to that individual where $U_i(p,e)$

= u(p)-c(e). The effort the each individual expends produces some output, y_i, via a production function which may be specified for each individual so that some individuals are more productive than others or productivity is constant across individuals. In general, $y_i=f(e_i)+\varepsilon_i$ where $f(e_i)$ is a concave production function and ε_i is a random shock. It may be assumed that all agents have similar production functions and make similar decisions. In a simple version of the game with two individuals where i=1 and 2, there may be two rewards to individuals, M>0 if $y_1>y_2+k$ and m<M if $y_1<y_2+k$ where k is a constant. If k is positive, then player 2 is favored in the tournament. If k is negative, then player 1 is favored in the tournament. The probability of winning M for each agent is a function of the random shocks to both agents, the constant k, and productivity of each agent or $\pi^i(e_1 e_2 k)$. This probability relies on the difference between random shocks to individuals relative to differences in the productivity of each individual and the constant k or $\pi^i(e_1 e_2 k)$ is just equal to the probability $(\varepsilon_1-\varepsilon_2)> f(e_1)-f(e_2)+k$ .This is used to derive i's expected payoff $Ez^i(e_1 e_2)=\pi^i(e_1 e_2 k)u(M)+[1-\pi^i(e_1 e_2 k)]u(m)-c(e_i)$. E is the strategy player i will adopt given the set of effort choices and outcomes (Schotter and Weigelt 1992). The Nash Equilibrium outcome for this game depends on the distribution of the random shocks. If there are no random shocks or they are perfectly correlated the difference between $(\varepsilon_1-\varepsilon_2)$ is zero. If this is the case and the value of k is small, then there will not be a Nash Equilibrium. Otherwise, there will be a Nash Equilibrium.

Schotter and Weigelt (1992) develop this theory further to test the effectiveness of equal opportunity and affirmative action programs. To test the effectiveness of equal opportunity programs, they compare the outcomes of a symmetric tournament where one player has a cost advantage to one where one agent is not favored more than another. In the experiment to test the effect of an affirmative action program, one agent again has a cost disadvantage. This agent is given an even chance of winning despite his or her cost disadvantage. They hypothesize this will decrease the equilibrium effort level for both agents, lower profits for the tournament administrator, and increase the probability of winning for the cost disadvantaged. Their findings indicate a tournament with equal opportunity incentives (i.e., both agents have similar probability of winning despite cost differences) increases overall effort from both agents, especially the cost disadvantaged, and the profit to the tournament administrator or manager increases. The results from the affirmative action tournament confirm predictions from the hypothesis. Effort levels decrease for both agents and the tournament administrator's profits decrease as the probability of winning for the cost disadvantaged increases (Schotter and Weigelt 1992).

This experiment was designed to test the differences in performance outcomes from affirmative action and equal opportunity outcomes. This allows definition of the circumstances in which diversity may bring more or less productivity to a firm. In their experiment, the authors do assume that the player with the cost disadvantaged represents some minority or under-represented group in the industry. They demonstrate within the laboratory setting that with equal opportunity incentives, having such an individual in the firm can actually boost overall firm productivity.

Tournament experiments can be used to test the effect of basic parameter changes on subject behavior, such as the prize level or method of prize allocation. This can be used to test the effect of the changes in the competitive circumstances in which minorities compete with non-minority subjects. Gneezy, Niederle, and Rustichini (2003) test the effect of team gender composition and compensation methods on the productivity of men and women solving computerized tasks. Their experiment consists of three treatments. In the baseline treatment, men and women are paid at a fixed piece rate for the number of mazes they solve in a fifteen minute period. In the second treatment, they are placed in gender balanced groups of six (three men and three women). This time, only one person in the group is compensated, the one solving the most mazes. This treatment introduced both uncertainty (it is not known until after the competition who will solve the most mazes) and competition into the incentive scheme. The third treatment removes competition, but maintains compensation uncertainty to test how the two effect production. In this treatment, one person is paid from each mixed gender teams based on a random draw, not the number of puzzles he or she solves. The fourth treatment is like the second, only the teams are same sex instead of mixed gender.

The experiment results reveal male performance increases significantly when they are competing in a mixed sex environment compared to being paid at a piece rate. Women, on the other hand, do display higher productivity from treatment one to treatment two. Further, men out perform women in both treatments. Male and female performance is not different in treatment three than treatment one. This indicates that the change in the competitive environment, not the change in payment uncertainty in experiment two drives the productivity differences in the mixed team tournament compared to the piece rate treatment. The gender differences in productivity do change when men and women are placed in same sex competitive teams. The women become more productive (and competitive) when they are in same sex tournament teams. The men continue to be competitive and more productive in the single sex teams relative to the mixed sex teams (Gneezy, Niederle, and Rustichini 2003).

This experiment may be interpreted for various purposes. As we look to value diversity in the work place, one may see that adding diversity to a team increases the productivity of the existing team members. This could also be said of changing the incentive scheme from a piece rate system to a tournament winning for men. Increasing the minority, in this case women, in the competitive environment increased the productivity of both men and women when they were able to compete within their own groups. Thus, if you are an employer with a few women, perhaps it is worthwhile to build up your female workforce to increase the productivity of those women as well as the men.

Section II. B. 2. Public Goods Experiments

Individuals' ability to cooperate and accomplish work in teams can be very important to increasing the efficiency within and innovative output of firms. One experiment which can be used to understand the role diverse people play in group processes is the Voluntary Contribution Mechanism (VCM). The VCM allows economists to understand when other-regarding behavior trumps self-interested behavior (Ledyard 1995). This experiment, also known as a public goods experiment, was originally designed to measure the degree of free-riding in groups, especially around environmental problems. It has since been adapted to a number of problems, including understanding how cultural values and tendencies affect individuals' cooperative behavior in day-to-day business interactions (Cason, Saijo, and Yamato 2002; Kachelmeier and Shehata 1997). With regard to diversity in the engineering workplace, the VCM may be used to determine which minority groups or individuals are more or less likely to cooperate with others. It may also be used to see how incentives can be adjusted to encourage cooperation when cooperation is lacking between diverse groups within a firm. Such results may then be related to the degree to which minority recruitment will increase or decrease organizational efficiency (i.e., transaction costs) and under what conditions.

In a simple version of the VCM, subjects in groups of two to four are given an endowment which they may either keep or invest into a public account. The experimenter collects the contributions to the group account in an envelope, doubles them, and then equally divides the outcome amongst the group regardless of whether or not they contributed to the public account (Ledyard 1995). The game theoretic prediction of the VCM is that no one will contribute anything to the group account or that everyone will free-ride. On the other hand, the social-psychology prediction is that everyone will contribute everything to the group account and optimize group welfare (Ledyard 1995; Davis and Holt 1993). Past experimental evidence does not support either theory. People tend to contribute 40 to 60 percent of their endowment to the group account in the VCM (Ledyard 1995). This mimics real world situations where individuals are asked to give to public goods. Outside of experiments, there are numerous real world examples of altruistic behavior in which individuals give to a common good. Common examples include donations to the Red Cross, public television, and United Way (Andreoni 1995).

Results from past VCM experiments show how this experiment can be used to measure cooperation rates across genders and cultural groups. Cason et al. (2002) design a version of the VCM to measure how different groups punish free-riders or fellow subjects who are not cooperative in the VCM. They find that Japanese have higher expectations for cooperation and punish subjects who free-ride more than American subjects. Kachelmeier and Shehata (1997) use the VCM to try to understand how auditing effects worker behavior in accounting firms among workers in Canada, China, and Hong Kong. They compare subject contributions to the public account with high and low levels of anonymity. They find that low anonymity increases contributions from workers in China and Hong Kong compared to their Canadian counterparts. This reveals it is more acceptable for Canadians to free-ride. The results regarding gender are not clear, especially since experimental design tends to differ markedly across studies. Neither men or women are decidedly more or less cooperative in VCM games across experimental economic studies (Eckel and Grossman Forthcoming). However, as we look at ways to value diversity in the work place, the VCM may be a tool to see how different types of workers can increase or decrease cooperation within engineering firms. In cases where cooperation is increased, the minority individuals or groups may decrease internal transaction costs within the firm.

Section II.B.3. Dictator, Ultimatum Bargaining, and Trust Experiments

Economic experiments which measure generosity, fairness, and trust preferences or norms may help explain *why* having diversity in the engineering workforce is or is not beneficial. Such social norms are vital to grease the wheels of industry and may effect transaction costs within firms and between firms and individuals in the market place. Past experiments across societies and across cultures within the same society show that individuals from different societal and cultural groups display different expectations and actions around social preferences, especially generosity and fairness expectations (Roth et al. 1991; Henrich et al. 2001; Ferraro and Cummings 2007). Three experiments which may be used to understand the effect diverse individuals have on transaction costs in (and between) engineering firms include the dictator, ultimatum bargaining game experiment, and trust experiments.

In the dictator game, there is a dictator and a recipient. The dictator is endowed with an allocation, x, and decides what portion of x to give the recipient. The Nash Equilibrium prediction is that the dictator will give the recipient nothing. If he or she is truly a self-interested individual (as economic theory predicts), then he or she has no incentive to give anything to the recipient. The standard result rejects the notion of complete self-interest. Rather, the dictator tends to give the recipient at least some small portion of their allocation. This indicates that across subjects, there is some level of altruism compelling individuals to share their riches. The outcome of the dictator game is very dependent on the individual involved and their relationships.

The ultimatum bargaining game is similar to the dictator game, but the recipient has an opportunity to respond to the dictator’s offer. The recipient can either accept or reject the offer made to him or her. The role of the dictator changes to that of a proposer. The Nash Equilibrium prediction is that the proposer will make a very small offer, ε, and the respondent or recipient will accept this offer because it is better than nothing. In general, experimental evidence does not support this Nash Equilibrium prediction. The proposer often offers a substantial portion of the endowment, between 25 and 50 percent, and the respondent demands a similar amount. The amount that is offer and accepted depends on the proposer and respondent’s social and cultural fairness norms. A number of experiments across both developed and developing societies show such norms vary across cultural groups (Roth et al. 1991; Henrich et al. 2001).

In addition to altruistic and fairness expectations, trust plays an important role in the inner workings of firms and organizations. In the standard trust game developed by Berg, Dickhaut, and McCabe (1995), two subjects are given an allocation of $X as a show-up fee for the experiment. Subject B (the trustee) pockets his or her show-up fee. Subject A (the trustor) must decide how much of his or her show-up fee to send to subject B. If A sends money to B, it will be tripled before it reaches subject B. When subject B receives it, he or she may keep it or some portion of it back to A at which time it will be tripled before reaching A. The sub-game perfect prediction is that the trustor or subject A will send nothing. In the event that A sends something, it is then predicted that the trustee or subject B has no incentive to return anything to subject A. These predictions are seldom realized. In the original Berg, Dickhaut, and McCabe paper, less than 10 percent of trustors sent nothing.

Using these laboratory experiments may help to predict or understand why certain diverse individuals are valued more or less in the marketplace based on the interactions within the firm. Previous research shows that different cultural and minority groups do behavior differently with respect to generosity, fairness, and trust norms. Recent work by Hong and Brohnet (2007) shows that individuals from dominant and minority groups have different concerns regarding trust in general. Dominant subjects (e.g., white men) are less likely to trust based on a disdain for betrayal whereas minority subjects were more concerned about treated unfairly or begin worse off than their counterpart in trust situations. Using the ultimatum bargaining game, Ferraro and Cummings (2007) find differences in Navajo and Hispanic fairness expectations. Navajo subjects displayed lower expectations of giving from the Proposer to the Respondent than Hispanic subjects. Expectations of giving changed for both types of subjects when they were in sessions with individuals from the other group. When Navajo (Hispanic) subjects where included in Hispanic (Navajo) sessions, the expectations for giving increased with the increase in number of non-group members. It is not clear what these outcomes mean for transaction costs within firms as the experimental designs do not easily lend themselves to these applications. However, they can tell us a little more about what types of workers may be useful in different situations. If an employer is looking for a worker who will be more concerned with equality issues and less so with betrayal by and competition with other workers, then they may want to look at hiring a non-white female candidate. If they want to bring a less “selfish” worker, then a Navajo may be much more desirable than a Hispanic candidate.

By applying these experiments to engineering problem, one could determine at what point firms benefit from a critical mass for different kinds of diversity. As firms may not be able to meet all of their engineering needs from a dominant labor pool, they inevitably need to start hiring some minority candidates. However, as they do this, it appears that their may be some advantage to going beyond the so-called “token” member of a specific minority group. Rather, to ensure intra-firm harmonization, there may need to be a number of such employees to enable broader ranges of trust and understanding between parties. Also, as firms pursue inter-firm and marketplace interactions, it may become more desirable to employee minority candidates minority involvement increases in the market place (either for firm sourcing or sales interactions).

Section IV. Conclusions and Recommendations

Economic experiments may be used to study the market for diverse engineering candidates and measure dimensions of their value not easily available from other labor market data. It is not clear when market clearing occurs in this market or if the market thickness is ideal of optimal matching. Experimental methodology may be used to first ensure the market for diverse engineering candidates is operating efficiently.

Second, this review points out the important role experiments may play to explain the ‘non-market’ value of diverse engineering candidates. Choice-based experiments offer the ability to value a candidate’s diverse background independently of confounding factors such as quality of educational training, geographical background, experience, and socio-economic background. Tournament and public good (VCM) experiments can be used to value diverse individual’s contributions to group work environments. Trust, ultimatum bargaining, and dictator game experiments may measure differences in social norm expectation between diverse and non-diverse individuals. These experiments may explain how such differences contribute to or decrease the efficiency of economic transactions within and between firms.

The possible avenues for future experimental economic research on the role of diverse individuals in the work place is rich. Priority may be given to those experiments which first explain how the market for such individuals operates. As efficient marketing clearing conditions are recognized, it is then important to explore non-market values of the candidates in addition to market price information from the market place.

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