Are there complementarities in educational peer effects?

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Abstract

Many recent studies have shown that students benefit in the sense of improved educational outcomes from having high-quality peers around them. A key unknown is whether peer attributes complement or substitute own inputs into education. If they complement own inputs, then assortative matching into learning groups is the optimal outcome both from an individual point of view and from a societal point of view, and would arise from voluntary sorting. If peer inputs substitute for own inputs, then reverse assortative matching into peer groups is optimal even though this would not come about via voluntary sorting. We introduce this issue in a simple model and explore its theoretical implications when utility is a function of both the ability and the effort level of self and peers. We then use students' responses to questionnaires to shed light on this unknown. The empirical evidence strongly points towards social complementarities in educational production, indicating that streaming students according to ability is the optimal design of educational institutions.

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People are people through other people. Xhosa saying.

1 Introduction

The recent literature on peer effects in education has found evidence that high-quality peers make a positive contribution to the educational outcomes of others.[1] While the main effect of peers may be positive, do peer attributes complement or substitute for own inputs into education?

If the peer externality complements own inputs, then the highest aggregate education outcomes are attained when individuals of greatest talent are streamed together and those of lowest talent are also streamed together. Moreover, individuals themselves would sort this way if given the choice. However, if the peer externality is a substitute for own inputs, then the allocation of students that leads to the highest average education outcome is one where the highest ability individuals are matched with individuals of the lowest ability. Yet in this state of the world, if the main effect of peers is increasing in peer ability, high-ability individuals would still prefer to be streamed together rather than grouped with low-ability peers. Hence, an enforced allocation mechanism would be needed to enable the socially optimal negative assortative matching to take place.

While the economic literature has not yet addressed this issue to any great extent, education debates about whether society should aim for positive or negative assortative matching in education have raged for decades. The English comprehensive system deliberately aims to mix abilities at the primary and secondary school levels under the belief that this negative assortative matching is optimal in aggregate. On the other hand, the system of specialized academic and vocational schools in much of mainland Europe, most notably Germany, is predicated on the belief that the aggregate outcome is higher under positive assortative matching. The elementary and secondary schooling system in the United States, whose effective allocation design reflects both parental choice and the choices of individual states and localities, is a mixture of these two extremes.

Only a minority of the population enters tertiary education, which in most countries operates under positive assortative matching by default at the population level, due primarily to ability-based sorting of students across universities with admissions requirements of varying strictness. Even within universities, positive assortative matching is more likely than negative assortative matching at the university-wide level. This is because in countries that do not follow the liberal education system, students enter specific programs of study, each with potentially different entry requirements. Hence, students are likely to find themselves broadly

[1] Recent studies include Hanushek, Kain, Markman & Rivkin (2003), Lefgren (2004),Kang (2007), Ding & Lehrer (2007), Zimmerman (2003), Hoxby & Weingarth (2005) ,Henry & Rickman (2007), Ammermueller & Pischke (2006), Vandenberghe (2002), Betts & Zau (2004), and Entorf & Lauk (2006).

matched by default to program- or cohort-level peers of similar ability. Yet even in this case, where cohort-level student heterogeneity is relatively low, the issue of matching surfaces in the form of how students within a given program or cohort are allocated into tutorial groups.

In this paper, we set up a simple model of educational outcomes to highlight the social choice aspects of the peer externality. In our model, individual students make a choice about effort based on their own talent and on the talent and effort levels of their peers. We label the product of effort and talent the 'net input' into education, which flows from two sources: both self and peers. We then derive the optimal choice of effort for each student given peer ability, and we show which peer matches and resulting levels and distributions of outcomes arise from various social allocation mechanisms of students into peer groups. The mechanisms we consider include voluntary matching in the absence of side payments; voluntary matching with side payments; and enforced random or negative assortative matching via a social planner.

We then introduce a questionnaire we posed to over 500 Australian undergraduate students, wherein we directly queried them about their beliefs regarding whether peer externalities complement or substitute for their own inputs. Students responded with a wide distribution of answers, but the dominant belief is that peer externalities are complements rather than substitutes.

The main novelty of this paper is that we accommodate the possibility that individuals anticipate and react to peer influences by varying their own inputs to education. This responds in a theoretical sense to a widespread concern in the literature for the endogeneity of peer outcomes (e.g., Brock & Durlauf (2001), Brock & Durlauf (2007)). Additionally, we show how student preferences regarding selection into learning environments can result from an educational production function with a social component, and how selection is therefore a public welfare concern. To show this, we offer a new, simple, and economically sensible theoretical framework with which to capture how peers affect learning, and we map this framework to existing achievement models typically used in the peer effects literature. Finally, we map our model to new survey data about peers, inputs, and outcomes in higher education.

The next section introduces the models we use to think about peer effects, and discusses some relevant recent literature using our simple model as a conceptual framework. We then introduce our survey data and present our empirical results in Section 3. Section 5 concludes.

2 Models of peer effects

We begin with a model in which each student receives utility from educational attainment and disutility from effort, an input into educational production. Each individual is endowed with ability and chooses effort. Each student's ability and effort level enter her educational production function directly, and also enter other students' educational production functions.

Utility takes the simple form

$$u_i(e_i, E_i) = e_i - \eta E_i^2 \tag{1}$$

where e_i is the educational attainment of student i, E_i is her effort, and η is assumed positive. We presume that individuals are matched into pairs to learn, with each individual subscripted by i matched to a peer subscripted by j.[2] Once matched to a peer, every student chooses her effort in a one-shot game.

In this simplest model, educational production takes the form

$$e_i = \gamma_0 + \gamma_1(\alpha_i E_i) + \gamma_2(\alpha_j E_j) \tag{2}$$

Here, $\boldsymbol{\alpha}$ is ability, each element of which is drawn independently from a continuous cumulative distribution function $Q(.)$ that is bounded above and below and defined on the positive axis.[3] In line with standard economic thinking about production models in general, this equation allows both peers' effort and ability to influence a given student's educational outcome, rather than only peers' ability.

The term $\gamma_1(\alpha_i E_i)$, where we assume throughout that $\gamma_1 > 0$, captures the individual's net input into her own education and implies that we conceptualize own ability as the marginal productivity of own effort. The term $\alpha_j E_j$ refers to net peer input into own education, such that $\gamma_2(\alpha_j E_j)$ denotes the total contribution of net peer input into creating own educational outcomes. γ_2 represents a pure externality that does not interact with own choices or endowments. We will look later at what happens if we allow for complementarity or substitution between own and peer inputs.

Individuals are matched into peer groups via a first stage procedure. In the next subsection, we consider in detail the consequences of several voluntary and compulsory matching procedures. For every flavor of matching, all individuals are presumed to have full information about the distribution of ability in the group of potential peers, the form of the educational production function for all players, and the matching process.

We solve the model by backward induction, beginning with the second stage of the individual's problem, after matches to peers are made. Conditional on a match, optimal effort can be determined by solving the individual's utility maximization problem. The first-order condition with respect to effort is

$$\frac{d}{dE_i}(u_i(e_i, E_i)) = 0 = \gamma_1 \alpha_i - 2\eta E_i, \tag{3}$$

[2] The assumption that all peer groups contain two students is restrictive, but it enables an exposition of the model's implications using the familiar concept of a marketplace for (peer) services that is populated by individual autonomous agents.

[3] It may help to think of $Q(.)$ as the uniform distribution. γ_0 should be interpreted as not subject to choice, but could contain linear functions of own ability α_i or even peer ability α_j without qualitatively affecting any further results.

so optimal effort is defined by

$$E_i^* = \frac{\alpha_i \gamma_1}{2\eta} \tag{4}$$

which is increasing in own ability. Solving and substituting in for the optimal effort level of student i's peer, maximized utility for student i now equals

$$u_i^*(\alpha_i, \alpha_j) = \gamma_0 + \frac{\gamma_1^2 \alpha_i^2}{4\eta} + \frac{\gamma_1 \gamma_2 \alpha_j^2}{2\eta}$$

In this expression, the term $\frac{\gamma_1 \gamma_2 \alpha_j^2}{2\eta}$ is the own utility value of peers in education, and we will label it the "peer transfer." If $\gamma_2 > 0$, then learning in groups provides more utility than learning alone, and individuals benefit more from high ability peers than from low ability peers. If $\gamma_2 < 0$, then individuals benefit more from low ability peers than from high ability peers, and would be happiest if they could learn alone rather than in groups.

Given this outcome, the preference ordering for peers is completely determined by γ_2. If pairwise matching is required, and if $\gamma_2 > 0$, then all individuals want to match with the individuals of highest ability. The reverse holds if $\gamma_2 < 0$: if they must match to a peer, individuals all want the lowest-ability peer available. It is natural to see $\gamma_2 > 0$ as the generic case—and in Section 4 we provide some empirical support for this proposition—so we focus on the implications of the model when the peer transfer is positive.

2.1 Matching and outcomes in the simple model

We initially consider voluntary matching without side payments as the allocation mechanism used to produce matched pairs of peers. Matching takes place in sequential bidding rounds and is comprehensive, open, and voluntary, in the sense that each individual evaluates all others and is able to announce publicly her preference ordering for peers and to reject proposed partners. Only those pairings where both individuals agree to the match form. Each round, all matched pairs are taken out from the pool over which remaining unmatched individuals announce their preference orderings, until all individuals are matched.

When $\gamma_2 > 0$, the outcome of self-selection under this bid-based sequential matching process is simple: there will be complete positive assortative matching of students based on ability. The two highest-ability individuals remaining in the student pool, who hold the most power in the marketplace for peer services, will match with each other in every round. With sufficient support in the ability distribution, this sequential bid-based matching process will result in each individual being matched with someone of whose ability level is epsilon close to her own ability. Approximating α_j with α_i, realized utility for each individual is then $\gamma_0 + \frac{\gamma_1 \alpha_i^2 (\gamma_1 + 2\gamma_2)}{4\eta}$.

If, alternatively, a social planner were to match individuals into pairs randomly, then each individual would in expectation receive a peer transfer of $\int \frac{\gamma_1 \gamma_2 \alpha_j^2}{2\eta} dQ$. In expectation, this would benefit all those with low ability who would otherwise have ended up with lower peer transfers, and adversely affect all those with high ability who would otherwise have ended up with higher peer transfers. A similar redistributive effect would be seen with respect to education achieved, as the education produced for lower-ability (higher-ability) students would be higher (lower) under forced random matching than under self-selection. The cost of this redistribution could be approximated in either educational or utility terms by subtracting total outcomes under self-selection from total outcomes under forced random matching, but it might be costless or even produce overall utility and education gains, depending on the exact distribution of student ability.

A social planner could alternatively enforce negative assortative matching by pairing the highest ability individual with the lowest ability individual in each matching round, creating another and possibly larger net transfer of utility and education from the high ability to the low ability. Again, this redistributive transfer might be costless, depending on the underlying student ability distribution and the consequent outcome of the counterfactual voluntary matching process.

Finally, a market-based allocation mechanism could be established by allowing for compensating utility transfers between individuals under otherwise perfect market circumstances. In the model above, individual i's willingness to pay for a peer equals the peer transfer term $\frac{\gamma_1\gamma_2\alpha_j^2}{2\eta}$. Under voluntary matching without transfers, student i would expect a peer transfer of $\frac{\gamma_1\gamma_2\alpha_i^2}{2\eta}$, since she expects to match with a peer of ability epsilon close to her own. Thus, student i's willingness to pay for a peer under an enhanced voluntary matching scheme equals the utility she would derive from the proposed peer j less her default expected peer transfer under simple voluntary matching, or $\frac{\gamma_1\gamma_2[\alpha_j^2-\alpha_i^2]}{2\eta}$. For all j such that $\alpha_i < \alpha_j$, such that student i is considering "trading up," this willingness-to-pay is positive. Conversely, student i will only consider "trading down" if she is given a positive utility transfer to compensate her for doing so, as her willingness to pay for this sort of trade is negative. Since the same can be said for all students, then if transfer costs are zero and individuals' resources are sufficient to offer transfers, individuals will be observed to match randomly in expectation. All observed compensating transfers, in the amount $\frac{\gamma_1\gamma_2[\alpha_1^2-\alpha_2^2]}{2\eta}$, will flow from the lower-ability to the higher-ability student in the pair. If resources are constrained, then the actual matches observed will depend upon the distribution of initial resources available with which individuals might compensate partners with higher ability than themselves.[4] In terms of aggregate utility outcomes, any observed match under a compensating transfers scheme leads to identical outcomes as the voluntary matching case, although the distribution of education achieved may differ. Lower-ability individuals will be observed with equal or better educational outcomes depending on their ability and choice to buy high ability peers, and by contrast, higher-ability

[4]If lower-ability individuals face higher costs of borrowing than higher-ability individuals, for example, then we would again observe some degree of assortative matching because lower-ability individuals are outbid for high-ability peers by higher-ability individuals.

individuals will be observed with equal or worse educational outcomes depending on their ability and choice to buy high ability peers.

To summarize, under our simplest model without complementarities or substitution, we observe that a matching algorithm where no utility transfers are possible results in positive assortative matching. Peer-sourced educational benefits flow disproportionately to higher-ability individuals. With transfers, this disproportionality in the distribution of benefits from peers can be potentially eliminated with no net change in utility, but only if lower-ability students can make costless transfers to compensate higher-ability partners. The uncompensated random or negative assortative matching of individuals implemented by a social planner will progressively redistribute the educational benefits of peers and also make higher-ability individuals worse off, and lower-ability individuals better off, in utility terms.[5]

2.2 Previous literature

With our basic modeling framework in place, we now review some recent work in two areas. First, we discuss the modeling approaches used by authors who have empirically estimated peer effects. Second, we review papers whose authors have used social effects models or empirical results to discuss, explicitly or implicitly, the social choice element implied by different group allocation mechanisms.

2.2.1 Peer effects estimation

We can re-write equation (2) as:

$$\begin{aligned} e_i &= \gamma_0(1-\frac{\gamma_2}{\gamma_1}) + (\gamma_1 - \frac{\gamma_2^2}{\gamma_1})(\alpha_i E_i) + \frac{\gamma_2}{\gamma_1} e_j \\ &= \gamma_0^* + \gamma_1^*(\alpha_i E_i) + \gamma_2^* e_j \end{aligned} \tag{5}$$

where the education outcome of individual i is written as a function of own inputs, $\alpha_i E_i$, and the educational outcome (rather than inputs) of the peer, e_j. This "pure endogenous effects" equation has been estimated only rarely in recent economic literature, due primarily to the belief that contextual and/or correlated effects, in the terminology of Manski (1995), are also present in education. As also discussed in Manski (1995), it is impossible to identify all three types of social effects when the identifying variation in peer outcomes is only a function of changes in the mix of fixed student characteristics across groups, and so many researchers have chosen to use their variation to try to identify contextual and/or correlated effects rather than endogenous effects. Even were a researcher to run a pure endogenous effects model such as that shown in equation 5, variation in student effort is conventionally not observed distinct from ability, so $\alpha_i E_i$ would be afflicted by measurement error; and own effort level,

[5]Note that forced random or negative assortative matching would produce a *regressive* redistribution of education and utility were $\gamma 2 < 0$.

which we expect to be correlated with peer outcomes, would be in the error term. In the presence of measurement error in α_i, the issue is further compounded by the probability that students endogenously select themselves into groups, such that the peer outcome is not just correlated with unobserved effort, E_i, but also with α_i, via the relation between peer ability and own ability—a common concern in the peer effects literature (see, amongst many others, Evans, Oates & Schwab (1992), Krauth (2006), and Arcidiacono, Foster, Goodpaster & Kinsler (2007)). Even in the absence of unobserved ability-based self-selection, however, if student effort enters educational production as it does in our model, then even a pure endogenous-effects specification cannot consistently estimate the peer effect without data on effort.

As mentioned above, instead of estimating an endogenous effects model, many authors interested in educational peer effects have opted to estimate a contextual effects specification where only peer background characteristics—not observed outcomes—enter own educational production. This specification has sometimes been thought to yield a lower bound for the "full" effect of peers in own education, under the assumption that self-selection will generally result in correlated and endogenous effects pushing in the same direction as the contextual effect. To generate a contextual effects specification using our model, where students choose effort conditional on peer and own ability, we can substitute optimal effort for self and peers into equation (2) to generate

$$\begin{aligned} e_i &= \gamma_0 + \frac{\gamma_1^2\alpha_i^2}{2\eta} + \frac{\gamma_1\gamma_2\alpha_j^2}{2\eta} \\ &= \gamma_0 + b_1\alpha_i^2 + b_2\alpha_j^2 \end{aligned} \tag{6}$$

Perhaps the most surprising corollary of equation (6) is that endogenous effort in our model can be accommodated by means of including quadratics rather than levels of ability in the estimation of educational outcomes. The squared terms prohibit a representation of this equation as a linear combination of a traditional contextual-effects model—where only levels of peer and own ability appear—and additional terms. It is nonetheless clear that estimating own education as a function of levels rather than squares of own and peer ability will not necessarily yield a lower bound on the effects of peers in own education. If we take the α_i used in previous research to be a noisy measure of α_i^2, then both measurement error and selection concerns afflict the peer effect estimate, even if the actual measurement of ability itself is perfect.[6] If the correlation of α_j with α_i^2, such as would be observed under assortative matching, dominates the measurement error problem, then this specification would yield an overestimate of b_2 and an underestimate of b_1. In the case of random peer matching, α_i and α_j should be uncorrelated, and so here as well as in the case of a weaker influence of selection than of measurement error we should get the classical result of an underestimate of both b_1

[6]See Arcidiacono et al. (2007) for a detailed empirical investigation of these competing influences in peer effects estimation.

and b_2.[7] Although not included in our model, the educational production function may also include correlated effects. While such effects would have no impact on our theoretical results, they form an additional source of bias in the estimation of spillovers if excluded.[8]

Papers trying to estimate equation (6) include large-sample empirical studies on elementary school students (Hanushek et al. 2003, Hoxby 2000, Hoxby & Weingarth 2005, Ammermueller & Pischke 2006, Nechyba & Vigdor 2004), high school students (Ding & Lehrer 2007), undergraduates (Sacerdote 2001, Betts & Morell 1999, Zimmerman 2003, Foster 2006, Lyle 2007), and postgraduate students (Arcidiacono & Nicholson 2005). Using a variety of techniques and measures, these generally find a modest but significantly positive b_2. However, as shown above, a key weakness of all of these studies is that they both fail to measure effort E_i and fail to circumvent the lack of data on effort, which leads to estimation of the wrong functional form.

2.2.2 Allocation as social choice

The most current empirical studies by economists working in the field of social effects have begun to address concerns about optimal grouping mechanisms. In a study of peer effects in a work environment, Mas & Moretti (2006) parenthetically mention the implications for total productivity of different worker grouping mechanisms in the presence of social effects on individual productivity. They interpret their empirical results to imply that in order to maximize total productivity, high- and low-productivity workers should be mixed, such that diversity in worker groups is maximized. Falk & Ichino (2006) find that grouping workers is preferable to having workers work alone, in terms of total productivity on an unskilled task, but they do not compare different worker-grouping paradigms. Drawing on empirical results derived from a Chinese secondary school context, Ding & Lehrer (2007) briefly consider different possible student grouping mechanisms and find that students at the top of the ability distribution would benefit most from streamed (ability-homogeneous) classes, while those at the bottom would benefit most from mixed classes. This result, also found in Kang (2007), implies that optimal student grouping is a concern that demands treatment from a public welfare perspective rather than a production-maximization perspective.

To address the twin possibilities that students of different ability levels may be subject to different peer transfers, and that there may exist a conflict between the individually optimal

[7]It is interesting to note that the estimate of the educational returns to *own* ability as well as the estimated peer effects yielded by this specification are biased. A full exploration of this problem and its consequences for the educational returns literature is beyond the scope of this paper.

[8]A common 'correlated effect' that influences both partners would imply $e_i = \gamma_0 + \gamma_1(\alpha_i E_i) + \gamma_2(\alpha_j E_j) + \gamma_{ij}$ where γ_{ij} is a fixed unpredictable common shock to both e_i and e_j. Because it is a shock, it does not affect choices or transfers and hence does not affect any of the findings in this paper. However, it will matter for empirical estimation because γ_{ij} is by design correlated with e_j though not with α_j. Hence in estimating equations of peers' outcomes on each other, it is important to control for factors involved in producing γ_{ij}.

and socially optimal peer allocation mechanism, we now augment our basic model by allowing for peer and own inputs to education to interact in each student's educational production function.

2.3 Adding interactions between self and peers

The simple model above reflects the dominant assumption in the applied literature that peers affect own educational outcomes in a linear, additive manner. Here, we expand on that framework by looking at what happens if we allow for interaction effects between own and peers' inputs to educational production.

We use an expanded educational production function that includes cross-effects:

$$e_i = \gamma_0 + \gamma_1(\alpha_i E_i) + \gamma_2(\alpha_j E_j) + \gamma_3(\alpha_j E_j)(\alpha_i E_i) \tag{7}$$

Here, the term $\gamma_3(\alpha_j E_j)(\alpha_i E_i)$ denotes the interaction between own net input and the net input of the peer. This function allows for peer inputs to be either substitutes (in which case $\gamma_3 < 0$) or complements (in which case $\gamma_3 > 0$) to own inputs in own educational production.[9]

Optimal effort level expended by i and j then becomes:

$$\begin{aligned} E_i^* &= \frac{\alpha_i(\gamma_1 + \gamma_3(\alpha_j E_j))}{2\eta} \\ E_j^* &= \frac{\alpha_j(\gamma_1 + \gamma_3(\alpha_i E_i))}{2\eta} \end{aligned}$$

which solve to

$$\begin{aligned} E_i^* &= \frac{\alpha_i\gamma_1(2\eta + \alpha_j^2\gamma_3)}{4\eta^2 - \alpha_i^2\alpha_j^2\gamma_3^2} \\ E_j^* &= \frac{\alpha_j\gamma_1(2\eta + \alpha_i^2\gamma_3)}{4\eta^2 - \alpha_i^2\alpha_j^2\gamma_3^2} \end{aligned}$$

These expressions imply that maximized utility equals

$$u_i^*(\alpha_i, \alpha_j, E_j) = \{\gamma_0 + \frac{\gamma_1^2\alpha_i^2}{4\eta}\} + \alpha_j E_j\{\frac{\gamma_1\gamma_3\alpha_i^2}{2\eta} + \gamma_2\} + \alpha_j^2 E_j^2\{\frac{\gamma_3^2\alpha_i^2}{4\eta}\} \tag{8}$$

for any given values of own and peer ability. Linearizing this equation around $\gamma_3 = 0$ and inserting for E_j yields

[9] We think of the term $\gamma_3(\alpha_j E_j)(\alpha_i E_i)$ as a reduced-form effect from a possibly much more complex functional form. While this term in principle allows for education to become decreasing in the net input of the peer (when γ_3 is highly negative), we will in the remainder of the paper think of the term $\gamma_3(\alpha_j E_j)(\alpha_i E_i)$ as 'small' relative to $\gamma_2(\alpha_j E_j)$, such that $\frac{\delta e_i}{\delta(\alpha_j E_j)} > 0$ and $\frac{\delta e_i}{\delta(\alpha_i E_i)} > 0$ for the range of values taken on by $\alpha_i E_i$. This restriction is not really necessary to explain the model, but allows us to focus on the most plausible states of the world.

$$u_i^*(\alpha_i, \alpha_j) \approx \{\gamma_0 + \frac{\gamma_1^2 \alpha_i^2}{4\eta}\} + \gamma_2\{\frac{\gamma_1 \alpha_j^2}{2\eta}\} + \gamma_3\{(\gamma_1 + \gamma_2)\frac{\gamma_1 \alpha_i^2 \alpha_j^2}{4\eta^2}\} \tag{9}$$

Again recalling our assumption that $\gamma_2 > 0$, the key thing to note about this equation is that $\frac{\delta^2 u}{\delta\alpha_j \delta\alpha_i} > 0$ iff $\gamma_3 > 0$. That is, when the input of peers is complementary to own input in educational production, higher ability individuals benefit more in utility terms from higher ability peers. Now, if $\gamma_3 < 0$, such that peer inputs have decreasing returns with own input, then $\frac{\delta^2 u}{\delta\alpha_j \delta\alpha_i} < 0$, implying that high-ability individuals' utility returns to high-ability peers are less than those of lower ability individuals.

In the case that $\gamma_3 > 0$, the positive dependence of own optimal effort on peer effort implies that the process we consider is a supermodular game, as analyzed at length in the game theory literature (Milgrom & Roberts 1990, Shimer & Smith 2000, Vives 2005). The core defining element of such a game is that the returns to behavior for each agent increase in the like behavior of the other (either partner or competing) agent. In many settings, this leads to the theoretical possibility of multiple equilibria. Which equilibrium the system arrives at is strongly dependent upon initial conditions and specific aspects of game context. In our application, however, due to the cross-agent heterogeneity in willingness to pay and matching-market power generated by agents' underlying differences in ability endowments, we can derive one full-information equilibrium per assignment mechanism. We derive these in the next subsection.

2.4 Matching and outcomes with net input interactions

We now consider the amount and distribution of outcomes that are implied if we apply to this expanded model the same set of possible peer allocation mechanisms as we did above using the simple model.

In the case of the voluntary bid-based sequential matching process without transfers, the resulting allocation is complete assortative matching iff $\frac{\delta u}{\delta\alpha_j} > 0$, since in this case all students wish to be matched to the highest-ability peer possible. This first derivative is positive when $\gamma_2\{\frac{\gamma_1\alpha_j}{\eta}\} + \gamma_3\{(\gamma_1+\gamma_2)\frac{\gamma_1\alpha_i^2\alpha_j}{2\eta^2}\} > 0$ which trivially holds when $\gamma_2 > 0$ and γ_3 is positive or small and negative,[10] or in other words when net peer effects are positive. Given the overwhelming evidence from prior literature that net peer effects are positive, this is the case we assume and that we will discuss further.

Given positive assortative matching brought about by voluntary selection without transfers, the net utility of an individual with ability α_i can once again be found by approximating α_j with α_i yielding $u_i^*(\alpha_i, \alpha_i) \approx \gamma_0 + \alpha_i^2 \frac{\gamma_1^2 + 2\gamma_2\gamma_1}{4\eta} + \alpha_i^4 \frac{\gamma_3\gamma_1(\gamma_1+\gamma_2)}{4\eta^2}$. This individual would see net education produced in the amount of $e_i \approx \gamma_0 + \alpha_i^2 \frac{\gamma_1^2 + \gamma_2\gamma_1}{2\eta} + \alpha_i^4 \frac{\gamma_3(2\gamma_1^2 + \gamma_2\gamma_1)}{4\eta^2}$.

[10] This will always be true if both γ_2 and γ_3 are positive. If γ_3 is negative, then this will hold if $|\gamma_3| < \frac{2\eta\gamma_2}{(\gamma_1+\gamma_2)\alpha_i^2}$.

The second matching scheme we consider is forced random matching by a social planner. The actual utility of an individual then depends entirely on the ability of the allocated peer. What we can say in general is that low-ability individuals can expect to gain from random matching since they can expect to be allocated a higher ability peer than otherwise, while high-ability individuals can expect to lose from random matching since they can expect to be allocated a lower ability peer. This general conclusion also held under our simple model, in the absence of interactions between own and peers' inputs. The expected change in utility for any individual, and hence for the population, will again depend on the actual distribution of ability. An individual's expected net benefit from being forced into a random match can be computed as the difference between utility expected under forced random assignment versus that obtainable via voluntary assortative matching:

$$\begin{aligned}\Delta U(\alpha_i) &= \int_{a_{min}}^{a_{max}} u_i^*(\alpha_i, \alpha) dQ(a) - u_i^*(\alpha_i, \alpha_i) \\ &\approx (\sigma_j^2 - \alpha_i^2)\{\frac{\gamma_2\gamma_1}{2\eta} + \frac{\gamma_3(\gamma_1 + \gamma_2)\gamma_1\alpha_i^2}{4\eta^2}\}\end{aligned}$$

where $\sigma_j^2 = \int a^2 dQ(a)$. This expected change will be positive for low α_i individuals and negative for high α_i individuals.

A final issue worth noting with regard to the forced allocation mechanism is that the theoretically optimal allocation depends trivially on γ_3. If $\gamma_3 > 0$, then total utility and education outcomes are clearly maximized under positive assortative matching, which will come about voluntarily. Yet, when $\gamma_3 < 0$, then the exact opposite holds since the effect of having a high-ability peer is then higher for a low-ability person than for a high-ability person. From a social perspective, high-ability peers should be allocated to low-ability individuals in order to produce the most utility and education in aggregate. As a result, despite the fact that all individuals wish to be matched to high-ability peers, and thus that voluntary sorting will yield positive assortative matching, aggregate utility and education are maximized by negative assortative matching. Forced mixing is then one way to achieve this social objective, although it will also produce a regressive redistribution of both utility and education.

The final matching protocol we consider is the voluntary market allocation mechanism with side payments. If $\gamma_3 > 0$, the compensated matching process yields a straightforward outcome: the higher-ability individuals will outbid others to match with other high-ability individuals. The net transfer will be zero, since same-ability types match up in sequential rounds of matching and pay each other the same transfer.

The more complicated case under compensating transfers occurs when $\gamma_3 < 0$, where low-ability types would have an incentive to offer the most appealing peer transfers, because they gain more from having a high-ability peer than other types. The resulting equilibrium is negative assortative matching. In this case, the exact level of the transfers involved is nontrivial to calculate, and has to be solved by backward induction from the resulting equilibrium allocation.

In the last round of matching, individuals with median ability pay each other a zero transfer. In the penultimate round of matching, the remaining population still includes individuals of median ability and individuals with abilities just above and below the median. The individual who is just below the median by ability level ε would be willing to pay to be matched with peer just ε above the median rather than at the median. The amount that an individual at the median would be willing to pay to be matched with a peer ε above the median rather than the median equals $u_i^*(Q^{-1}(0.5), Q^{-1}(0.5)+\varepsilon) - u_i^*(Q^{-1}(0.5), Q^{-1}(0.5))$. Since the lower-ability individual only needs to bid this amount to overbid the median person, this is the transfer that will occur. Simplifying this expression yields

$$u_i^*(Q^{-1}(0.5), Q^{-1}(0.5) + \varepsilon) - u_i^*(Q^{-1}(0.5), Q^{-1}(0.5)) \approx \varepsilon \frac{\delta u_i^{*\prime}(Q^{-1}(0.5), \alpha_j)}{\delta \alpha_j} |^{\alpha_j = Q^{-1}(0.5)}$$

Having solved for the transfer seen in the penultimate round of matching, we can now consider the round immediately before this. If we extend the line of thought above to the individuals with ability 2ε above and below the median, we find the transfer to the former from the latter has to be $\varepsilon u_i^{*\prime}(Q^{-1}(0.5), Q^{-1}(0.5)) + \varepsilon u_i^{*\prime}(Q^{-1}(0.5) - \varepsilon, Q^{-1}(0.5) + \varepsilon)$. Generalizing this, we obtain a formula for the transfer $t(\alpha_i)$ paid by individual with ability $\alpha_i < Q^{-1}(0.5)$ to her peer of ability $\alpha_j = Q^{-1}(1 - Q(\alpha_i))$:

$$t(\alpha_i) = \int_{\alpha_i}^{Q^{-1}(0.5)} \frac{\delta u(\alpha, \alpha_j = Q^{-1}(1 - Q(\alpha)))}{\delta \alpha_j} d\alpha$$

In the case where $Q(.)$ is the uniform distribution, this formula simplifies to $t(\alpha_i) = \int_{\alpha_i}^{Q^{-1}(0.5)} \frac{\delta u(\alpha, 2Q^{-1}(0.5) - \alpha)))}{\delta \alpha} d\alpha$.

In summary, adding an interaction between own and peers' inputs into educational production yields a much more complicated problem, and one where the sign of the interaction is crucial in determining the default matching pattern that the system will produce when individuals match voluntarily. We see that the market mechanism obviates the need for a social planner to force students to match in order to achieve the social optimum, essentially because the peer externality is fully priced by means of side payments. Social allocation mechanisms only appear to be useful when side payments cannot be made and when $\gamma_3 < 0$.

3 Data and survey results

We have survey data on a sub-sample of two large populations of undergraduate students. Selected questions from the survey were specifically designed to shed light on the signs and relative magnitudes of γ_2 and γ_3. The population from which our survey data are drawn is the universe of students enrolled internally in undergraduate programs in the business faculties of two Australian universities: the University of South Australia (UniSA), which is in Adelaide, and the University of Technology Sydney (UTS), during the first semester of 2008.

We designed a battery of survey questions to tap into beliefs about peers as well as on effort expended by respondents on academic work. From an economic theory perspective, students' beliefs about the parameters γ_2 and γ_3, even more than their actual values, are what should matter for choice behavior. Since undergraduate students have usually been in full-time education for 12 consecutive years already, we can furthermore be quite confident that these students will have had ample time to learn about γ_2 and γ_3 from previous peer interactions. This means we can view their opinions about these coefficients as the reasonable, rational estimates of primary producers of education outcomes. Regarding personal effort levels, we asked students how many hours per week they studied, and also asked them to rank themselves relative to other students in terms of how hard they work. We also ask respondents about their self-assessed ability level relative to other students.[11]

The survey was administered to the two population of students at both institutions in April 2008. Due to ethics protocols, we could not offer a particularly strong incentive for students to complete the survey,[12] and hence the response rate to the survey was fairly low. 667 students responded to the survey out of a combined universe of approximately 10,000 students.

3.1 Are peers important?

If peers are economically inconsequential to learning, then even if our model is right, existing models of educational production that exclude or mis-specify the peer effect may still be reliable. The first use to which we put our survey responses is therefore to determine whether or not peers are perceived by students to impact their learning, relative to other influences. To elicit this information, we posed the following question:

> Q4: "Please rank the following as things that help you get good marks in university courses (1 = most important; 8 = least important).

- Putting in a lot of effort
- My raw capabilities
- Having a positive attitude
- Support from family and friends
- Good influences from other students in the course

[11] Note that students are exactly the group we would want to have as survey responders in order to address our research question; the usual reasons for critiquing the use of students in surveys do not apply in our case.

[12] We included respondents' names in a random draw for $200.

- Luck
- Whether I get a good lecturer for a course
- Whether I get a good tutor for a course "

Importantly, this question specifically distinguishes own contributions towards learning from classroom peers' contributions. This implies that any influence on own effort levels, and through them on educational production, that may be brought about by peers could be classified by student respondents as attributable to either self or peers.

In Figure 1 we show the distribution of the respondents' answers to this question, by simply adding up across all respondents the inverse ranks accorded to each option. This figure points to the conclusion that classroom peer influences are low in importance, ranked above only luck, in producing good grades. Personal effort is deemed the most important driver of educational performance, with own ability and positive attitude ranked in a second-tier level of importance. The influence of family and friends and the quality of teaching staff rank next, before peer influence and, lastly, luck.

Figure 2 counts the number of student respondents who ranked each source of influence as first-, second-, or third-most important in producing good grades. The distribution of top-3-ranked influence sources mimics the overall pattern shown using raw rank counts in Figure 1, although using this method, peer influence appears to be perceived as stronger than that of both luck and influence from tutors, and is closest in perceived strength of influence to that of lecturers.

We conclude that peers, in and of themselves, are only modestly important in producing good grades. The mechanism of social influence that may matter economically to educational production is peers' influence on own effort—a phenomenon that has rarely attracted the attention of economists in education.

We now introduce the survey questions that pertain directly to estimating the parameters of our model, including both direct effects and interactions of own and peer inputs.

3.2 Answers on questions pertaining to γ_2 and γ_3

To ascertain whether students believe that they benefit from having high ability peers, we asked the following question:

> Q1: *(response codes 1, Strongly Agree, through 11, Strongly Disagree)* "If a tutorial is full of more capable students, I will learn more than I would if it were full of less capable students."

This question directly addresses the issue of whether individuals benefit from high ability peers or not. In all the variants of the model above, we assumed that this was the case for all levels of own ability. In Figure 3, we show the distribution of answers to this question,

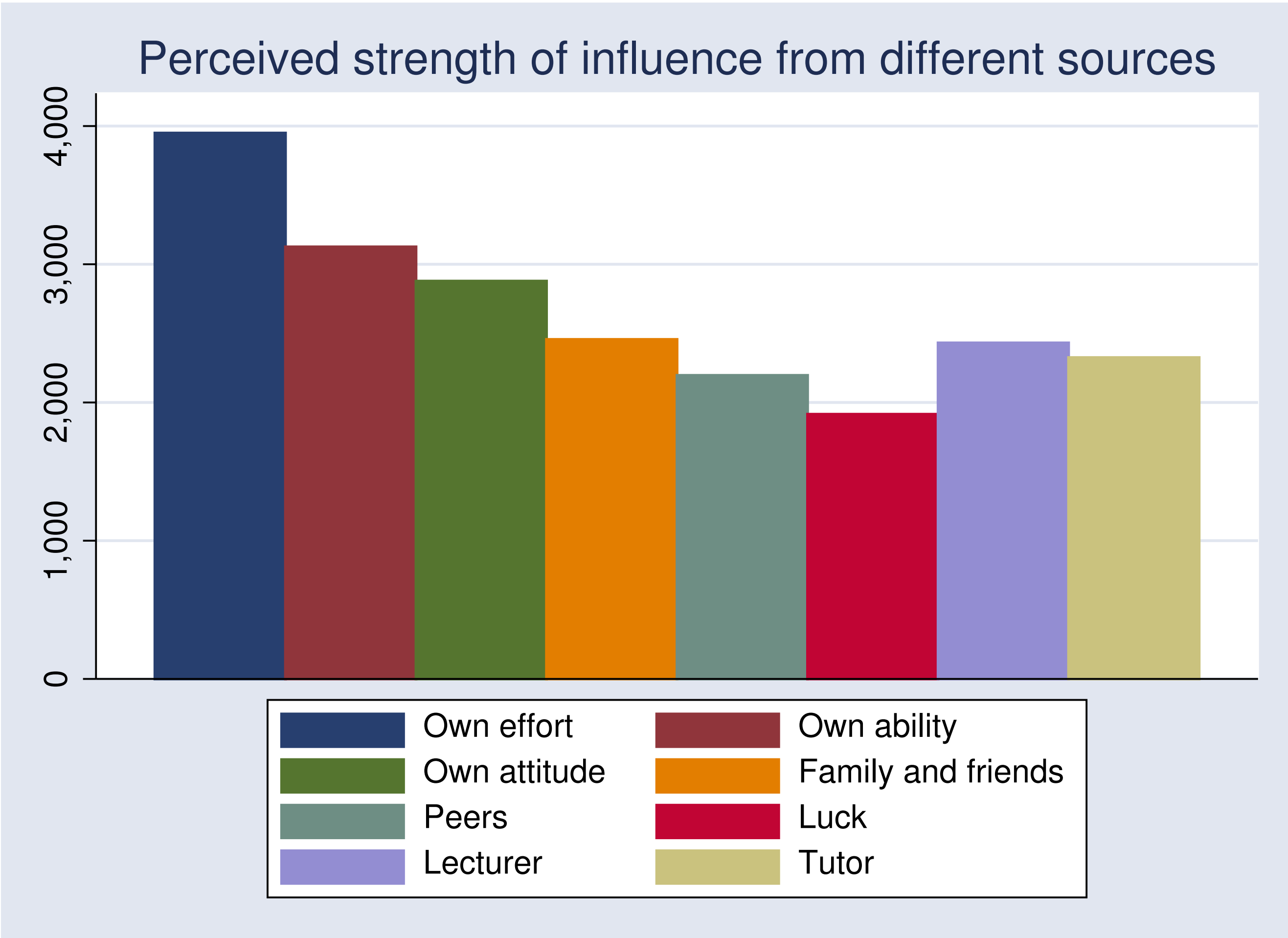

Figure 1: Are peers important? Raw counts of rankings of influence strength.

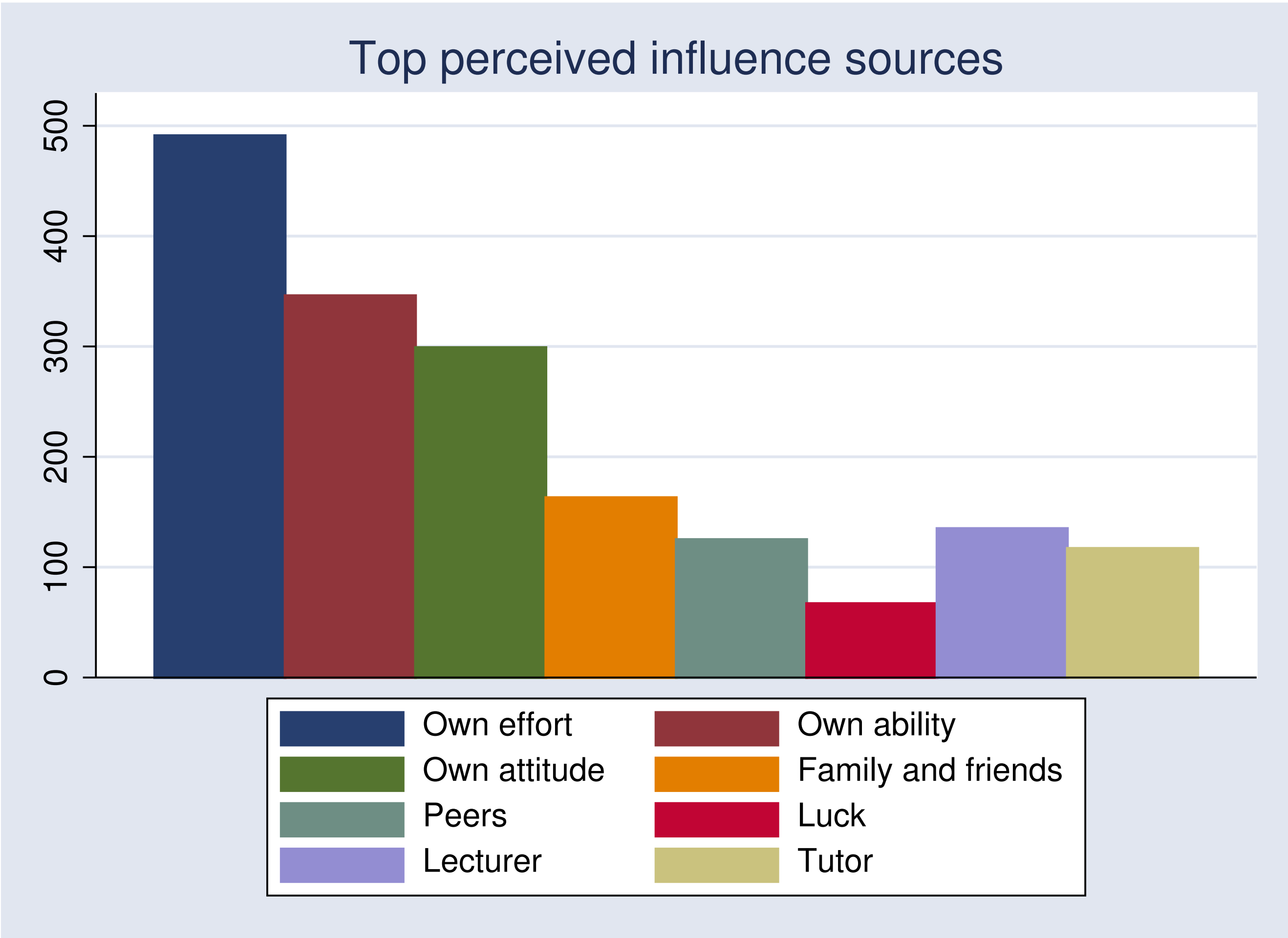

Figure 2: Counts of students responding that each source of influence ranked in the top three.

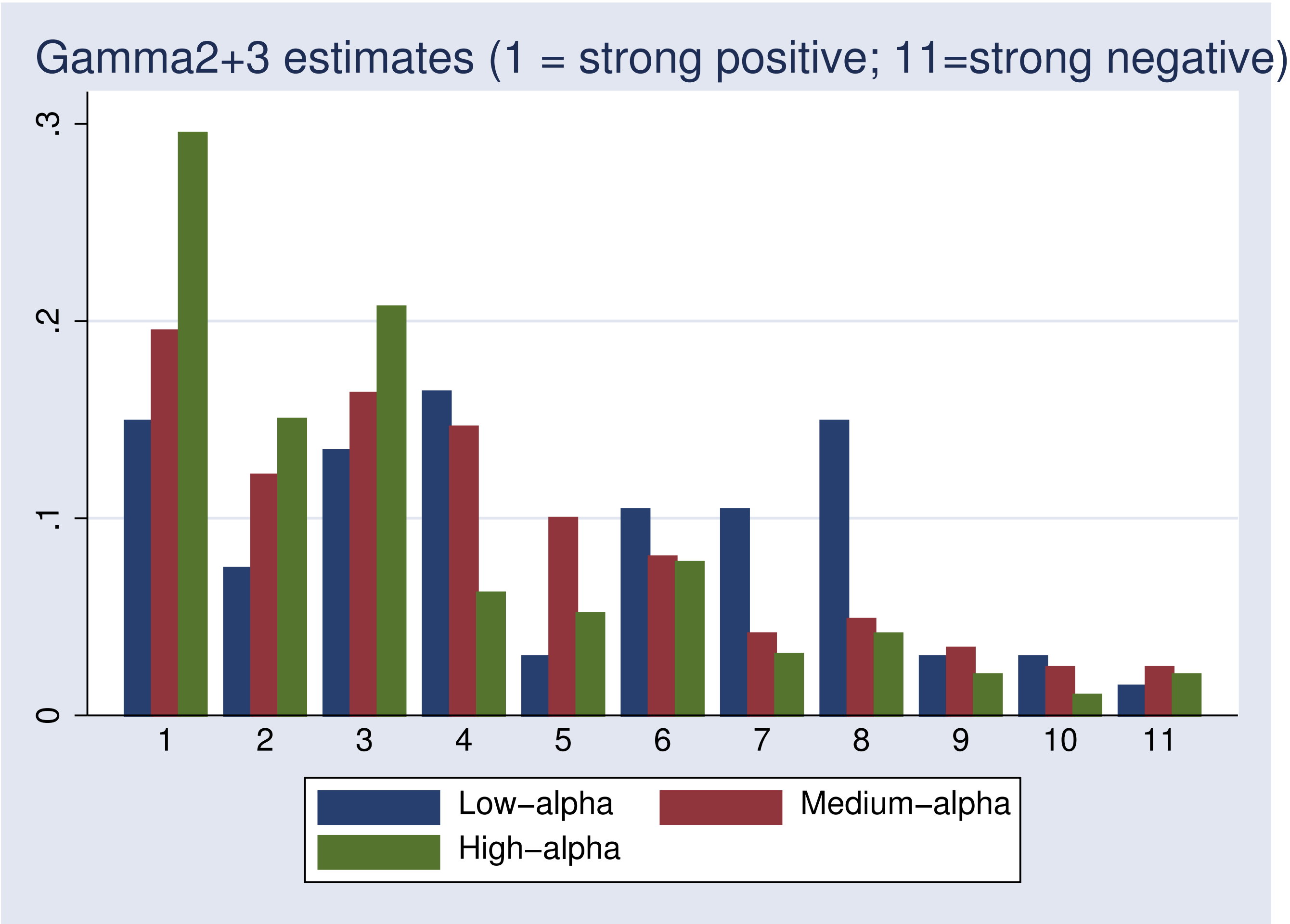

Figure 3: Estimates of $\gamma_2 + \gamma_3$

depending on whether the individual self-reported being in the lowest relative ability category (self-rated as "not as smart/capable" as other students), medium ability category (self-rated as "about as smart/capable" as other students), or highest ability category (self-rated as "more smart/capable" or "much more smart/capable" than other students).

We see, for all ability levels, that the density of individuals who answer this question positively (a 5 or lower) outweighs the density answering negatively, which we take as direct evidence that the combined effect of γ_2 and γ_3 is positive. Interestingly, we see that the question is answered more positively for the higher ability individuals, giving the preliminary suggestion that γ_3 is also positive.

Two additional questions were posed to see whether peer inputs mattered in terms of choice behavior. One question was concerned with peer ability and the other with peer effort:

> Q2: *(response codes 1, Strongly Agree, through 11, Strongly Disagree)* "If other students in a tutorial work hard, it makes me work hard too. "
>
> Q3: *(response codes 1, Strongly Agree, through 11, Strongly Disagree)* "The smarter the other students are in a tutorial, the harder I work in that tutorial. "

The first question pertains to the behavioral response to peer effort, whereas the second asks for the behavioral response to peer ability. Both questions directly identify whether or not γ_3 is positive. From the theoretical model we know that if γ_3 is positive, then the answer to both questions should be positive and identical for both questions. If γ_3 is negative, then the answer to both questions should be negative.

We show the distribution of the answers to these two questions in Figure 4. Once again we see much more density in the positive range or responses (0 to 5), confirming a positive sign overall.[13] We take this as a direct indication that the belief amongst students is that γ_3 is positive.

3.3 Do γ_2 and γ_3 vary over individuals?

We now briefly investigate the determinants of the variance we document above in students' perceptions of peer effects. Peer effects researchers would be interested to know whether peer effect parameters are heterogenous across people, which in our context corresponds to the question of whether γ_2 and γ_3 vary systematically. To this point in the paper we have presumed that they do not, simply because our model of peer effects becomes too hard to solve analytically in terms of peer sorting if one presumes parameter heterogeneity. Yet, the empirical truth might well be that there is parameter heterogeneity.

In order to see whether we should take the variance in responses to the questions above as evidence of actual heterogeneity instead of simply reflecting a single coefficient with measure-

[13] At the respondent level, the Spearman correlation between responses to these two questions is .55 and Kendall's τ-a is .3882.

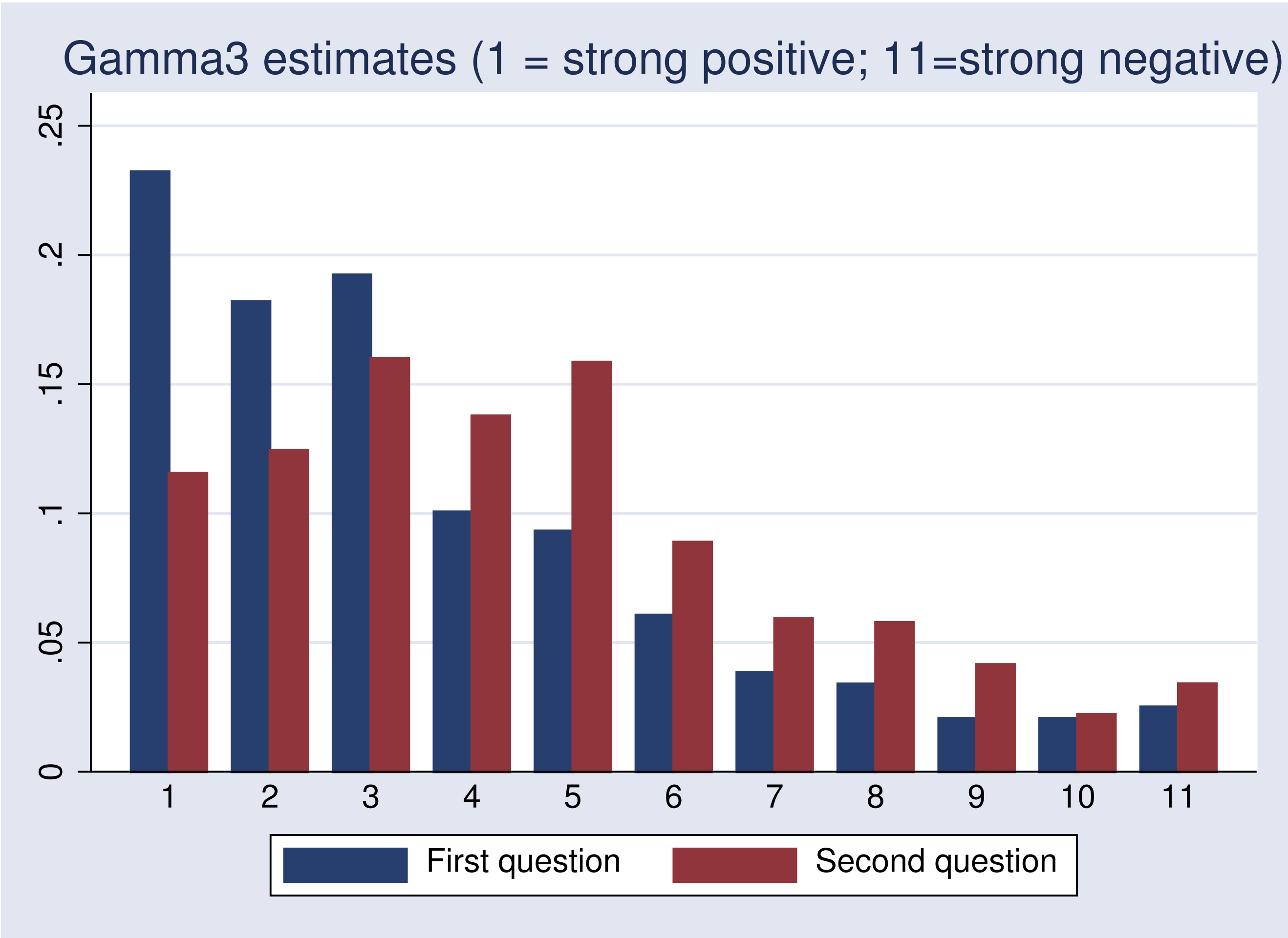

Figure 4: Estimates of γ_3

ment error in the responses, we relate responses to these questions to students' self-reported relative ability, effort levels and outcomes. In the case that there is in actuality a population wide single γ_2 and γ_3 then there should be no valid variation in the responses above and hence they should not predict any outcome, nor should they be predictable on the basis of other student-specific measures.

To address this question, we use responses to the following questions that we asked students regarding their relative ability, relative effort, and expected grades:

Q5: "Overall, with respect to academic work, would you rate yourself as ... (choose one)

- Not as capable as other [UTS/UniSA] students
- About as capable as other [UTS/UniSA] students
- More capable than other [UTS/UniSA] students
- Much more capable than other [UTS/UniSA] students

Q6: "Overall, with respect to academic work, would you rate yourself as ... (choose one)

- Not as hardworking as other [UTS/UniSA] students
- About as hardworking as other [UTS/UniSA] students
- More hardworking than other [UTS/UniSA] students
- Much more hardworking than other [UTS/UniSA] students

Q7: "Please list the courses you are enrolled in at [UTS/UniSA] this semester and the final course marks (percentages out of 100) that you expect in each.

Table 1 shows the results of our investigation into whether the variance in γ_2 and γ_3 reflects actual parameter heterogeneity. The first column of Panel A shows the results of a naive regression of average expected grades (across all courses for which the respondent reported expected grades) onto the three questions above that we use to estimate γ_2 and γ_3. In Column 2, we add own effort and ability measures to the equation, and in Column 3 we add a further array of control variables taken from matched records on survey respondents extracted from university data banks. In Panel B of Table 1, we use a range of independent variables about students to predict students' answers to the questions targeting perceptions of γ_2 and γ_3.

We see in Panel A of this table that the stronger the perception that γ_2 and/or γ_3 are positive—i.e., the lower is a student's coded answer to the three questions eliciting information about these parameters—the higher the student's average expected grades. This relationship is still statistically significant for the peer-ability-based measure of γ_3 even when we control for own effort and own ability in the regression, implying that the heterogeneity in perceived peer influence is not fully captured by either of these presumably first-order influences in education. As expected, both self-reported effort level and self-reported ability are powerfully, positively and significantly associated with expected grades.[14]

Panel B of Table 1 shows that the variance in perceptions of peer effects is systematically predicted by expected grades, own effort, and own ability. In each reported equation, some combination of own effort, ability, and expected outcomes is statistically significantly associated with perceived peer effects, in the expected direction: students who have higher grade expectations and/or who self-rate as more able or more hardworking than their fellow students report perceiving more positive peer effects.

4 Discussion

In this paper we have suggested a new model of peer effects that explicitly incorporates the notion that students choose their effort level depending the peer attributes they encounter in the learning environment. We use this model to show three things. First, we derive the implications of the model for utility and education under a variety of different peer-group sorting mechanisms. When peer and own inputs interact in educational production, we show that voluntary matching is preferable to forced random matching unless the peer-own input interaction is negative—such that peer inputs substitute for, rather than complement, own educational inputs—*and* cost-free compensatory side payments to potential peers are not possible. Since voluntary matching will result in positive assortative matching when peer inputs complement own inputs to education, this result implies that with peer complementarities, ability streaming in education is preferable both individually and socially to ability mixing.

Second, we show new survey-based evidence that undergraduate students in fact believe that the peer-own input interaction term is positive. This provides some empirical support for believing the recommendation above based on the presumption of complements in educational production.

Finally, we show how a model-consistent peer effects specification can be derived and estimated even in the absence of data on own or peer effort in the classroom. This result allows researchers with access only to administrative data, in which effort remains unobserved, to generate peer effect estimates that accommodate the likely possibility that students vary their own effort inputs according to peer inputs.

[14]The excluded ability category is students who self-rate as "Not as smart/capable" as other students, and the excluded effort category is students who self-rate as "Not as hard-working" as other students.

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A Survey instrument

The following survey was administered via email on April 8, 2008, and closed on May 1, 2008. The surveyed population was all students enrolled internally in undergraduate programs within the Division of Business at the University of South Australia or the Faculty of Business at the University of Technology Sydney. To satisfy requirements of the two institutions' Human Research Ethics Committees, participation in the survey was voluntary, although students were offered a chance to win $200 in a random drawing upon completion of the survey. The version shown was sent to UTS students; an analogous survey was sent to UniSA students with "UTS" replaced throughout by "UniSA".

Table 1: Is the variance in perceived peer effects systematic?

Panel A	(1)	(2)	(3)
Dep. Var.: Average expected grade			
Gamma2+gamma3	-0.3227**	-.1749	-.1627
	(0.1140)	(.1093)	(.1153)
Gamma3 (item 1: peer effort)	0.0092	.0050	-.0266
	(0.1378)	(.1309)	(.1365)
Gamma3 (item 2: peer ability)	-.3614**	-.3060*	-.3852**
	(0.1382)	(.1309)	(.1383)
Own effort step 2	-	2.6733**	1.9903*
		(.7206)	(.7663)
Own effort step 3	-	3.8064**	3.0866**
		(.8197)	(.8815)
Own ability step 2	-	3.9606**	4.0008**
		(.9976)	(1.0412)
Own ability step 3	-	6.6535**	6.5511**
		(1.0907)	(1.1535)
Constant	74.9840**	67.4653**	378.0328**
	(0.7024)	(1.2284)	(118.0585)
N	631	631	591
F	7.42	14.79	4.76
Adj R^2	.0297	.1328	.1375
Panel B	(1)	(2)	(3)
Dep. Var.:	$\gamma_2 + \gamma_3$	γ_3 **(item 1)**	γ_3 **(item 2)**
Average expected grade	-.0326*	-.0307*	-.0542**
	(.0154)	(.0148)	(.0147)
Own effort step 2	-.0105	-.7349**	-.6245*
	(.2835)	(.2731)	(.2708)
Own effort step 3	.0575	-.6935*	-.5275
	(.3285)	(.3165)	(.3138)
Own ability step 2	-.6862	.4356	-.2418
	(.3886)	(.3744)	(.3712)
Own ability step 3	-1.1805**	.6381	-.0933
	(.4351)	(.4192)	(.4156)
N	591	591	591
F	1.68	1.33	1.97
Adj R^2	.0257	.0127	.0366

Note: In Panel A, the dependent variable is the average of expected grades in all classes as reported in the survey; in Panel B, the dependent variables used are responses to the questions regarding γ_2 and γ_3, and additional controls in all regressions in Panel B and in Column (3) of Panel A are year and quarter of birth, sex, international student status, time of day and day of week of classes, and institution. 'Own effort step 2' is a dummy set to 1 if the respondent self-reported as 'about as hard-working' as other students, and 0 otherwise; 'Own effort step 3' is a dummy set to 1 if the respondent self-reported as being 'more' or 'much more' hardworking than others, and 0 otherwise. 'Own ability step 2' is a dummy set to 1 if the respondent self-reported as being 'about as smart/capable' as other students, and 0 otherwise; 'Own ability step 3' is a dummy set to 1 if the respondent self-reported as being 'more' or 'much more' smart/capable than others, and 0 otherwise. See text for more detail.

Peer Influence

Thank you for agreeing to participate in the research project entitled, "How do students of different abilities influence one another in business faculty classrooms?" by answering this short survey about peer influence. It should take approximately 15 minutes for you to complete.

Part Two

1. Please write down your family name and UTS student ID number.

2. How many hours per week do you study?(e.g., 0, 10, or other number)

3. How many hours per week do you study with other University of Technology Sydney students? (e.g., 0, 10, or other number)

4. How many hours per week do you study with people other than University of Technology Sydney students? (e.g., 0, 10, or other number)

5. Of the UTS students you usually study with, roughly what percent did you first meet when you were both taking the same course? (e.g., 0%, 50%, 100%, or other percentage)

6. Of the time you spend studying with other UTS students, roughly what percent of the time do you talk about courses that you and they both are enrolled in currently? (e.g., 0%, 50%, 100%, or other percentage)

7. Of the other students in a given tutorial, roughly what percent of them do or say things that affect your learning? (e.g., 0%, 50%, 100%, or other percentage)

8. How many hours per week do you spend time socially with other University of Technology Sydney students? (e.g., 0, 10, or other number)

9. How many hours per week do you work for pay, counting all jobs? (e.g., 0, 10, or other number)

For Questions 10 to 23, please choose one number from 1 to 11, with 1 being 'strongly agree' and 11 being 'strongly disagree'.

10. In general, I feel that other students being in the tutorial classroom helps me perform better in university courses.

- ○ 1 Strongly Agree
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10
- ○ 11 Strongly Disagree

11. In general, I feel that other students being in the tutorial classroom has a positive effect on the effort I exert in university courses.

- ○ 1 Strongly Agree
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10
- ○ 11 Strongly Disagree

12. If other students in a tutorial work hard, it makes me work hard too.

- ○ 1 Strongly Agree
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10
- ○ 11 Strongly Disagree

13. If I think other students in a tutorial are smarter than me, it makes me work harder.

- ○ 1 Strongly Agree
- ○ 2
- ○ 3

○ 4
○ 5
○ 6
○ 7
○ 8
○ 9
○ 10
○ 11 Strongly Disagree

14. If I think I am smarter than other students in a tutorial, it makes me slack off (not work as hard).

○ 1 Strongly Agree
○ 2
○ 3
○ 4
○ 5
○ 6
○ 7
○ 8
○ 9
○ 10
○ 11 Strongly Disagree

15. The smarter the other students are in a tutorial, the harder I work in that tutorial.

○ 1 Strongly Agree
○ 2
○ 3
○ 4
○ 5
○ 6
○ 7
○ 8
○ 9
○ 10
○ 11 Strongly Disagree

16. When I need to make a choice at university, I often follow the advice of fellow students.

○ 1 Strongly Agree
○ 2
○ 3
○ 4
○ 5
○ 6
○ 7
○ 8
○ 9
○ 10
○ 11 Strongly Disagree

17. I don't really care what other students think of me.

○ 1 Strongly Agree
○ 2
○ 3
○ 4
○ 5
○ 6
○ 7
○ 8
○ 9
○ 10
○ 11 Strongly Disagree

18. I try to avoid being in a situation where I am seen by others as "too smart."

○ 1 Strongly Agree
○ 2
○ 3
○ 4
○ 5
○ 6
○ 7
○ 8
○ 9
○ 10
○ 11 Strongly Disagree

19. I try to avoid being in a situation where I am seen by others as "not smart enough."

○ 1 Strongly Agree
○ 2
○ 3
○ 4
○ 5
○ 6
○ 7
○ 8
○ 9
○ 10
○ 11 Strongly Disagree

20. The behavior of students like me matters more to my behavior and my success at university than the behavior of all students as a whole.

○ 1 Strongly Agree
○ 2
○ 3
○ 4
○ 5
○ 6

○ 7
○ 8
○ 9
○ 10
○ 11 Strongly Disagree

21. If a tutorial is full of more capable students, I will learn more than I would if it were full of less capable students.

○ 1 Strongly Agree
○ 2
○ 3
○ 4
○ 5
○ 6
○ 7
○ 8
○ 9
○ 10
○ 11 Strongly Disagree

22. If a tutorial is full of more capable students, I depend less on the tutor to learn the material.

○ 1 Strongly Agree
○ 2
○ 3
○ 4
○ 5
○ 6
○ 7
○ 8
○ 9
○ 10
○ 11 Strongly Disagree

23. If a tutorial is taught by a bad tutor, I depend more on my tutorial classmates to learn the material.

○ 1 Strongly Agree
○ 2
○ 3
○ 4
○ 5
○ 6
○ 7
○ 8
○ 9
○ 10
○ 11 Strongly Disagree

24. Please rank the following characteristics in order of their importance to you when selecting study mates (1 = most important; 6 = least important):

NO TWO OR MORE OPTIONS SHOULD HAVE THE SAME RANKING.

- [ ] That they are physically attractive
- [ ] That they devote effort to their studies
- [ ] That they are smart/capable of doing well
- [ ] That I have things in common with them
- [ ] That I like them as a friend
- [ ] That I knew them before university

25. Please rank the following characteristics in order of their importance to you when selecting tutorials (1 = most important; 4 = least important):

NO TWO OR MORE OPTIONS SHOULD HAVE THE SAME RANKING.

- [ ] That they are conveniently scheduled for me
- [ ] That I know they will be taught by a good tutor
- [ ] That I know capable students will be in that tutorial
- [ ] That I know some of my friends will be in that tutorial

26. Please rank the following as goals you are aiming for in your life right now, in order of their importance to you (1 = most important; 6 = least important):

NO TWO OR MORE OPTIONS SHOULD HAVE THE SAME RANKING.

- [ ] Finding a new long-term partner
- [ ] Making others (e.g., my parents, my country) proud
- [ ] Figuring out what to do with my life
- [ ] Having good times with friends and family
- [ ] Earning high marks in university
- [ ] Earning money

27. Please rank the following as things that might make you withdraw from a course, your program, or the university, in order of their importance to you (1 = most important; 6 = least important):

NO TWO OR MORE OPTIONS SHOULD HAVE THE SAME RANKING.

- [ ] The coursework being too hard for me
- [ ] Not having enough time to devote to academic work
- [ ] Financial problems
- [ ] Logistical or administrative problems (e.g., parking, enrolment, child care)
- [ ] Other students' decisions about whether to withdraw
- [ ] A major personal crisis

28. Please rank the following as things that help you get good marks in university courses (1 = most important; 8 = least important):

NO TWO OR MORE OPTIONS SHOULD HAVE THE SAME RANKING.

- [ ] Putting in a lot of effort
- [ ] My raw capabilities/smarts
- [ ] Having a positive attitude
- [ ] Support from family and friends
- [ ] Good influences from other students in the course
- [ ] Luck

[ ] Whether I get a good lecturer for a course
[ ] Whether I get a good tutor for a course

29. Please rank the following as ways you learn from your fellow students (1 = most important; 6 = least important):

NO TWO OR MORE OPTIONS SHOULD HAVE THE SAME RANKING.

[ ] Directly working together on problems/questions in class
[ ] Discussing course material in class
[ ] Discussing or working together on course material outside of class
[ ] Imitating or copying others' academic work
[ ] Imitating or copying others' attitudes toward academic work
[ ] Interactions completely outside of academic work

30. Overall, with respect to academic work, would you rate yourself as...(choose one)

- ○ Not as smart/capable as other UTS students
- ○ About as smart/capable as other UTS students
- ○ More smart/capable than other UTS students
- ○ Much more smart/capable than other UTS students

31. Overall, with respect to academic work, would you rate yourself as...(choose one)

- ○ Not as hardworking as other UTS students
- ○ About as hardworking as other UTS students
- ○ More hardworking than other UTS students
- ○ Much more hardworking than other UTS students

32. Are you left-handed?

- ○ Yes
- ○ No

33. Please list the courses you are enrolled in at UTS this semester and the final course marks (percentages out of 100) that you expect in each.

Please separate courses with semicolons--for example,
Business Statistics 80; Microeconomics 70;
Financial Accounting 75

34. Is there anything else you'd like to share with us about how strongly you think you're influenced by your fellow students in a classroom, how you choose your study mates, or which particular groups of other students are most influential on you?

Part Three

This final section of the survey asks about how important expectations of the future are to you. We first ask you to imagine two scenarios involving expectations and to tell us your feelings about it, and then we pose a few other, general questions (from Question 39 to Question 46) about the importance of expectations.

PLEASE ONLY CHOOSE ONE OF THE FOLLOWING TWO SCENARIO SETS (EITHER Questions 35 and 36, or Questions 37 and 38):

35. SCENARIO SET 1 (if you prefer sports to performing arts): Imagine the next important game your favourite sports team is going to play. Which of the following would you prefer to experience in the build-up to the game?

○ A) You are told by all commentators and fellow supporters of all the strengths of your team and the many ways in which it is going to play better than the opponents, making you believe your team might well pull off a famous victory over a difficult opponent. During the game in question, the outcome is often close but your team does eventually lose.

○ B) You are told by all commentators and fellow supporters of all the weaknesses of your teams and the many ways in which it is going to be outplayed by the opponents, making you believe your team has no chance of victory. During the game in question, the outcome is often close but your team does eventually lose.

36. Now, suppose the same game is coming up. Which of the following would you prefer to experience in the build-up to the game?

○ A) You are told by all commentators and fellow supporters of all the strengths of your team and the many ways in which it is going to play better than the opponents, making you believe your team might well pull off a famous victory over a difficult opponent. During the game in question, the outcome is often close but your team does eventually win.

○ B) You are told by all commentators and fellow supporters of all the weaknesses of your teams and the many ways in which it is going to be outplayed by the opponents, making you believe your team has no chance of victory. During the game in question, the outcome is often close but your team does eventually win.

37. SCENARIO SET 2 (if you prefer performing arts to sports): Imagine that an important international arts awards ceremony is coming up, and it is possible that your favourite performing artist may get a particular award. Which of the following would you prefer to experience in the build-up to the ceremony?

○ A) You are told by all art lovers and fellow fans of all the strengths of your favourite artist and the many reasons why his or her work is exceptional, making you believe your artist might well succeed in getting the award. During the awards ceremony, many commentators remark about how your artist is a contender for the award, but in the end s/he does not get it.

○ B) You are told by all art lovers and fellow fans of all the weaknesses of your favourite artist and the many reasons why his or her work is not particularly outstanding, making you believe your artist has no chance of getting the award. During the awards ceremony, many commentators remark about how your artist is a contender for the award, but in the end s/he does not get it.

38. Now, suppose the same arts awards ceremony is coming up. Which of the following would you prefer to experience in the build-up to the ceremony?

○ A) You are told by all art lovers and fellow fans of all the strengths of your favourite artist and the many reasons why his or her work is exceptional, making you believe your artist might well succeed in getting the award. During the awards ceremony, many commentators remark about how your artist is a contender for the award, and in the end s/he gets it.

○ B) You are told by all art lovers and fellow fans of all the weaknesses of your favourite artist and the many reasons why his or her work is not particularly outstanding, making you believe your artist has no chance of getting the award. During the awards ceremony, many commentators remark about how your artist is a contender for the award, and in the end s/he gets it.

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39. In general, would you prefer:

○ (a) to be aware in advance of an upcoming bad event, and then experience it; or

○ (b) to believe that an upcoming event will be good, but then when you actually experience it, it is bad?

40. Please rank the following in order of their strength, in your opinion (1 = strongest feeling; 3 = weakest feeling):

NO TWO OR MORE OPTIONS SHOULD HAVE THE SAME RANKING.

[ ] The feeling you get when something good happens.

[ ] The feeling you get when you expect that something good is going to happen.

[ ] The feeling you get when something good happens, when you had expected it to be bad.

For the following questions, please choose one number from 1 to 11, with 1 being 'strongly agree' and 11 being 'strongly disagree'.

41. When I'm in a new and unfamiliar situation, I am always optimistic that things will work out for me (in other words, I feel and think that things will be OK).

○ 1 Strongly Agree
○ 2
○ 3
○ 4
○ 5
○ 6
○ 7
○ 8
○ 9
○ 10
○ 11 Strongly Disagree

42. I often find myself doing things that I know, at the time I choose to do them, I will regret later.

○ 1 Strongly Agree
○ 2

- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10
- ○ 11 Strongly Disagree

43. When I expect that good things are going to happen to me in the future, I feel better about myself.

- ○ 1 Strongly Agree
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10
- ○ 11 Strongly Disagree

44. When I get disappointed about something, it makes me feel that I'm to blame, because I should have known better in the first place and not expected as much.

- ○ 1 Strongly Agree
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10
- ○ 11 Strongly Disagree

45. I always try to be cautious when I approach new and unfamiliar situations, in case something goes wrong.

- ○ 1 Strongly Agree
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9

- ○ 19
- ○ 11 Strongly Disagree

46. I prefer to have low expectations of the future since that way I might be pleasantly surprised, and I'm protected from being disappointed.

- ○ 1 Strongly Agree
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10
- ○ 11 Strongly Disagree

Thank you for your time. Your UTS student ID number will now be entered into a random drawing for $200. The drawing for this prize will be held at noon in Room EM521 at the University of South Australia on 1 May 2008, and the winner of the $200 will be notified by email within four days of the draw.

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