Do Peer Influences have an Impact on Academic Success: an Investigation into Peer Effects amongst Home Students at The University of Warwick[1]

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Abstract: Using a cross sectional data set obtained through random sampling from the University of Warwick, this project presents an analysis of peer effects amongst home students living in the university halls of residence. An empirical strategy is employed whereby the existence of peer effects upon a student's final first year mark are identified using data regarding the ability of his/her peers, as measured by their A-level achievements. The investigation employs both linear and non-linear peer effect models, to establish the nature of the peer effects. This has allowed identification of whether peer effects are more prevalent amongst low, average and high ability students. Furthermore the non-linear peer effects model identifies whether students of various abilities have their academic success impacted by low, average or high ability peers. The results from this investigation suggest that peer effects are non-linear, and have a significant effect upon the academic success of high and average ability students. In particular, high ability students witness a substantial decrease in results when placed with a low ability peer. These results justify the selective admissions policies commonly used by higher education institutions.

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[2] Word Count excludes figures, tables, appendices and headings.

Contents

1. Introduction

Higher education organizations, particularly those considered to be of 'high quality', are in a position where there is sufficient demand for their offerings that they are able to be selective in the students they choose. As a result of this, these institutes select students they believe to have a good chance of attaining a high level of academic success[3], due to a belief in peer effects (Goethals 2001), more specifically the belief that certain types of, or more able students encourage the same qualities in their peers. A central question posed in this study is whether this approach is justified. Does being placed with students of a certain quality really provide a stronger rooting towards academic success at university?

There is limited work that has been conducted on peer effects[4] in higher education although there is a vast range of literature covering peer effects in schools (such as Epple and Romano 1998). Furthermore, empirical evidence supporting the existence of peer effects in higher education is for the most part limited to US institutions. No empirical study had been published applicable to a UK university at the time of commencement of this study.[5] I conduct an empirical analysis to measure peer effects at Warwick University using data relevant to students in campus accommodation and the people they live with. There has been no similar research method to measure peer effects for a UK university[6], making this study an interesting topic for investigation.

[3] In this study academic success is considered to be success in exam grades, translated through a higher grade. This point is assumed throughout the study.
[4] This study will discuss peer effects with regard to their impact on academic success (an assumption carried throughout) as opposed to peer influences on factors such as the amount a student drinks, gambles etc. Although these may all be endogenous parts of peer effects that affect exam results, they are not the key concern in this investigation.
[5] A discussion paper by Martins and Walker touching on the issue of peer effects in a UK university was published by the working paper series, IZA in December 2006, following my commitment to the project from October 2006.
[6] There may be further publications relevant to empirical evidence for peer effects for the UK, but none to my knowledge.

There are numerous reasons why institutions, and students alike should care for the study of peer effects.

On the institution level, the existence of peer effects may have serious implications for the optimal strategy with regard to admissions policy. Taking into account the time and costs spent in attracting a certain type of student in the name of peer quality, it is difficult to justify why an institution would go through such lengths in the absence of peer effects. Furthermore, there is an opportunity cost associated with offering places to only high ability students (for example through scholarships), as there is the forgone chance to serve a greater number and a wider range of students. If however, peer effects are found to be a significant factor impacting upon academic success, selective admissions policies and ability grouping measures are warranted. For students applying to higher education institutions this translates into increased competitiveness for places, where admitted students are simultaneously indicators of, and contributors to the quality of the learning environment.

The study begins with the economic theory underlying peer effects in Section 2. Section 3 reviews previous works related to the study of peer effects. In Sections 4 and 5 is presented the data, and the empirical technique used to analyse it. The results obtained are shown in Section 6. Section 7 concludes the study and provides suggestions for further research on the topic.

2. The Economics of Higher Education and Peer Effects

Peers enter the education production function as a 'customer input production technology' (Rothschild and White 1995). In this function, by attending an institution, students are consuming the quality that the institution provides, whilst simultaneously contributing to it. Therefore, from a student perspective, through attending a certain institution they are investing in their own human capital, a key input to which may be social capital, in other words the quality created between them and their peers (Burt 1997).

One approach to evaluate the extent to which quality is created between a student and his/her peers can be explained by considering a student's attitude towards education.[7] A peer can influence the student's own production (with regard to performance) in two ways central to the discussion posed in this study. The first it to alter their ability to perform (e.g. efficiency of study time), thus influencing the student's own production function. The second is to change the student's utility for education (comprising of factors such as how much the student enjoys studying compared to participating in other activities). The central theme of this investigation is to establish whether these peer effects, if they exist, work positively or negatively in terms of the academic success of the student.

Winston and Zimmerman (2003) indicate that the interaction between students can be shown as:

Equation 1

$$B_1 = f(B_2, C_2, X)$$

[7] Using a Becker 'household production' framework (Winston 1987 cf. Goethals et al. 1999)

Where for two students, Student 1's observed behaviour (B_1) depends on the behaviour (B_2) and characteristics (C_2) of Student 2 as well as other factors (X) that may affect Student 1's behaviour. If the partial derivatives for the observed behaviour between students are not zero then peer effects are shown to exist.

Peer effects, when they exist, can have important implications for higher education institutions. These implications will be dependent upon the nature of the peer effects. The effects could be linear or non-linear (for example, pairing high ability students with those of lower ability may have a positive effect on grades for the lower ability student, yet may or may not have negative implications for the high ability student). This leads to the issue of the extent of symmetry of peer effects if they are non-linear; whether the negative peer effects upon strong students by being placed with weak students outweighs the benefit that weak students gain from being paired with strong students. If the peer effect is non linear, the derivatives in equation 1 will differ when mixing groups of different abilities.

The peer effects[8], which arise as spatial externalities[9], are something institutions can seek to influence. This can be done through control of the admissions process as well as grouping students to form the optimal allocation of students with regard to obtaining academic success for the student, and an enhanced reputation for the University, as a provider of educational quality.

[8] If they exist

[9] These spatial externalities can be considered as the environment in which the student is placed.

3. Literature Survey

Much of the literature[10] acknowledges that the measurement of peer effects can prove to be difficult. In an academic context, student performance depends on a variety of factors, and isolating the peer influences is a challenging task. This issue can have important implications for the approach employed when researching peer effects.

Furthermore, problems in identifying peer effects arise as 'people typically choose with whom they associate' (Zimmerman 2003). Hence this is a factor which needs to be considered when investigating peer effects at the University of Warwick, as students have partially made a decision about the peers they wish to associate with in their choice of which university to study at.

Particularly interesting are the methodologies used to measure peer effects adopted by Zimmerman (2003) in comparison to controlled experiments constructed by Falk and Ichino (2006). I shall now proceed to discuss the relative merits and limitations of these methods, as well as how they could be applied to my investigation.

In order to address the issues of confounding local and personal factors on peer effects, Falk and Ichino (2006) use a controlled experiment to isolate the peer factor effects on work output for randomly selected subjects. Through elimination of other performance influencing factors, which could be confused with peer effects, the results put forward by this study provided 'clean evidence for the existence of peer effects on work behaviour'. In the experiment, randomly recruited subjects were placed in identical environments and asked to perform a simple

[10] Hanushek et. al (2003), Falk and Ichino (2006), Zimmerman (2003).

envelope-stuffing task, requiring no prior knowledge or skill. Subjects were placed in pairs to monitor the work output effects that peers may have had on each other. Single subject settings were used as a control to compare with the paired settings for the experiment. This allowed an assessment of whether or not peer effects did in fact exist, through comparing the outputs of each setting, and individual productivity performance in each setting. If peer effects are not related to productivity performance then the ‘distributions of output’ in both settings should have been the same. The study concludes that peers can be relevant in influencing performance, particularly in improving the performance of a low-end performer when placed with a high-end performer.

In application to a possible study at Warwick University, Falk and Ichino’s method may be difficult to implement. A controlled experiment, although it allows focus on peer effects, would not yield results that would be meaningful with regard to academic success, therefore would be of little use in policy implementation.

In contrast to the controlled experiment strategy, Zimmerman (2003) adopts a natural experiment methodology. Zimmerman uses data, from an American university college, on students’ grades, SAT scores and the SAT scores of peers in order to measure the differences in final grades of students with a variety of SAT scores, when living with high, low and medium SAT performing peers. Differentiating from previous work that has been done to investigate peer effects in higher education, Zimmerman concentrates on the effects roommates (as peers) can have on a student’s grades in randomly allocated dorms. The study concludes that peer effects are significant in university residential areas, although the magnitude of their effect is fairly small. A technique such as this, used to measure peer effects is a possibility at Warwick

University, since students are randomly allocated to halls in their first year, therefore students do not choose whom they live with[11].

A great degree of consideration needs to be given to how peer effects will be measured within a higher education setting. Martins and Walker (2006) use class student grade averages as a proxy with which to measure an individual students' own grade (and therefore ability) within the class. However, due to my limitations as a student, it is not possible for me to obtain data at this level. A survey of residential students, regarding high school achievements as a measure of ability (as conducted by Zimmerman) is more feasible.

The importance of separating other factors from peer factors is one that is highly stressed by Hanushek et. al (2003). Using controls for observable characteristics[12], alongside other controls for fixed effects in terms of the individual and school effects, 'permits the clearest identification of peer effects'. Although this method allows for a more reliable representation of peer effects, it has its limitations in that the characteristics of peers are still not known. This paper does however try and find measures for three commonly cited peer traits; achievement, race and socio-economic status. Again, the final conclusion of this paper was that 'peer achievement has a positive effect on achievement growth', in contrast to the earlier paper by Hanushek (1992), which found no such relation.

As exam success is the dependent factor in this study, it is necessary to be aware of the factors other than peer effects that may have an influence on it. Anderson, Benjamin and Fuss (1994) use a sample of approximately six thousand students from the University of Toronto to

[11] Which hall a student lives in may be dependent on income; this factor means that income effects will need to be controlled for in the empirical analysis at the University of Warwick.
[12] Such as gender, race and parental income.

identify the determinants of success in an introductory university level economics course. The results from their analysis identify that secondary education performance, gender and prior background are all significant in the effect on students' grades. Betts and Morell (1999) also identify these factors as significant in their study of five thousand undergraduate students at the University of California. In addition they also find ethnicity, parental income, neighbourhood effects, and socio-economic environment all have a significant relationship with university grades. Interestingly, in the Betts and Morell study, there was found to be no significant effect of teacher pupil ratios and teachers' educational level on student performance.

The aim of my research is to adopt a method, similar to the natural experiment method employed by Zimmerman (2003), to produce a model of factors affecting exam performance, and thus determine whether or not peer effects exist in Warwick University. As the literature has shown, a high degree of detail will need to be adopted when separating peer effects from other confounding effects on academic performance. This can be done using control factors for the other variables, aside from the peer affect variables, as identified by Hanushek et. al (2003). Moreover, it will be important to ensure that all relevant variables affecting exam performance are included in order to lower the risk of obtaining a biased model that exaggerates the importance of peers.

4. Data

4.1 Data Source

I obtained a cross sectional data set by surveying 196 home students from Warwick University, who lived in campus accommodation[13] during the first year of their course. The means of collecting the data was the use of an online networking site[14], inviting students to complete a questionnaire, through which data was captured. A sample of the questionnaire filled out by students is shown in Appendix 1.

In using the website to target student response, it is necessary to be aware of the selection bias that may occur in the results, due to the fact that results are only obtained by students who have access to the website. However, advantages of using the website include that it ensured strict confidentiality of results, which in theory would lead to more honest responses with which to extrapolate results. This was necessary when dealing with sensitive information about respondents. Furthermore, the website enabled access to a wide range of students.

A main feature required of the data was its attention to combating the selection bias problems typically associated with measuring peer effects (Falk and Ichino 2006). For this reason, data was collected from students regarding their first year. University halls are guaranteed and allocated randomly[15] only in the first year of a student's degree. Students are expected to find their own means of accommodation in subsequent years, which means they also select the people with whom they live, which means that peer effects could not be distinguished. This is

[13] Zimmerman (2003) used a similar data collection method, collecting data relevant for students living in college accommodation.
[14] The website used was www.facebook.com
[15] The method used to sort accommodation applications for students is random with regard to factors such as ethnicity, gender or background that may affect a student's measure of ability, as used in this study. It is therefore appropriate to use these students, randomly allocated in terms of ability, in order to investigate the impact of mixing students of different abilities on academic success at university.

because in choosing the peers with whom they live, students may assemble with those of similar abilities. Therefore, instead of seeing peer effects, we may simply be seeing similar students grouping together (Zimmerman 2003).

Data could not be obtained from current first years however, as during the time of data collection they would not have had any measure of academic success at university, having been at university only 5 months. Current second, third and fourth years (corresponding to entry years 2005, 2004 and 2003 respectively) were therefore surveyed instead, about information relevant to their first year at university.

4.2 Description of Variables

Dependant variable:

MARK: As a measure of academic success, students were asked to state their final overall mark (to the nearest percentage) obtained at the end of their first year in university.

Main Explanatory/Independent variables:

ABILITY: Students were surveyed regarding the A-level grades they obtained upon leaving high school. These grades were then converted into points using the standard UCAS tariff point system[16], in order that they take a quantitative value. My model assumes that A-level grades are a suitable measure of academic ability.

[16] Where A= 120 points, B= 100 points, C=80 points, D=60 points and E=40 points.

PEER: Using the same measure of ABILITY as for the student, this variable is a measure of the peer's ability, again based on high school UCAS points. In the context of this study a peer is defined as the peer who lived adjacent to the student during their first year in university accommodation[17].

Both abilities i.e. for students and for the peers will be separated into low, medium and high performers for the purposes of the empirical analysis presented in section 6. The boundaries into which I will split these segments are discussed in section 4.3.

Other Explanatory/Control variables:

The following variables have been included to ensure that other factors, which may have an effect on MARK, are included in the model so that the effect of PEER is not upwardly biased. Controlling for potentially confounding variables is the main empirical challenge (Hanushek et. al 2003). I have therefore taken care not to include variables such as the amount of alcohol a student drinks, as the peers a student interacts with may simultaneously determine this.

COHORT: This is the year in which the student commenced their degree course. The cohorts have been split into entry years 2003, 2004 and 2005 (corresponding to current 4th, 3rd and 2nd years respectively). This variable ensures there is a control for changes in MARK over time.

GENDER: The gender of the student, split into male and female.

[17] In order to focus on peer effects amongst home student, only students who lived adjacent to another home student were surveyed.

ETHNICITY: The student's ethnic origin, split into White, Asian, Black, Mixed or Other backgrounds.

PARENT: The student's parental income, split into below average, average and above average incomes. This variable also controls for differences in distribution amongst halls due to income differences.

DEPARTMENT: Students studying a range of courses were surveyed. I have broken these down into departments for simplicity, namely Social Studies, Science, Arts and Medicine.

4.3 Descriptive Statistics

In order to ensure that the data set collected was representative of the targeted student body, students from a wide range of academic disciplines and socio economic backgrounds were surveyed. The use of the networking website to obtain data helped fulfil this objective due to the variety of students who were available to access on it. Figure 1 displays the proportions of students surveyed, broken down into their gender, department of study, parental income and ethnicity. I have shown the various proportions over the whole sample, covering the entry years 2003-2005 inclusive, which comprised of 196 surveyed students, as well as proportions for each individual cohort (entry years 2003, 2004 and 2005) to show changes in proportions over time.

The gender gap in the sample is extremely small, with a slightly greater proportion of males in the sample. Over the cohorts sampled, this decreases progressively from 55% males in 2003 to 50.6% males by 2005, which may reflect an admissions policy geared towards equality of the sexes.

Cohort (observations)	2003-2005 (196)	2003 (20)	2004 (93)	2005 (83)
Variable	%	%	%	%
GENDER				
Male	51.53	55.00	51.60	50.60
Female	48.47	45.00	48.39	49.40
DEPARTMENT				
Social Studies	45.41	40.00	44.09	48.19
Science	33.16	40.00	38.71	25.30
Art	15.31	20.00	7.53	22.89
Medicine	6.12	0.00	9.68	3.61
PARENT INCOME				
Below average	8.16	5.00	13.98	2.41
Average	47.96	70.00	43.01	48.19
Above average	43.88	25.00	43.01	49.40
ETHNICITY				
White	47.96	35.00	39.78	60.24
Asian	37.76	45.00	46.24	26.51
Black	5.10	5.00	6.45	3.61
Mixed	6.63	10.00	6.45	6.02
Other	2.55	5.00	1.08	3.61

Figure 1: Representative Proportions in Sample

Other trends that are apparent in the sample, include the increasing proportion of students with above average parental income, which comprises 25% of the sample in 2003 and rises to almost half the sample by 2005. The only missing observations in the data set are for medical year entrants in 2003. However, this is due to the fact that medical students form a relatively small proportion of the Warwick student body (6.12% of the sample), as do fourth year students.

Figure 2 displays the summary statistics for the main focus variables (MARK, ABILITY and PEER) of the dataset. In the sample the mean final year mark was 63.11%, with a maximum of 87% and a minimum of 42%. The main notable trend in marks over the three cohorts is that the standard deviation of marks is progressively decreasing.

The data shows no major difference in the distribution of ability between students and peers. Both hold a maximum value of 480 UCAS points, and students and peers have minimums of 240 and 260 respectively.

The mean average student ability is 366.84 UCAS points, and the mean peer ability is 359.49 UCAS points. The UCAS points obtained in the sample are high[18], indicating that Warwick is an extremely selective institution.

The graphs in Appendix 2 show that all of mark, ability and peer follow an approximately normal distribution, and confirm there are no outliers in the data set.

[18] Compared to the national average.

Cohort (observations) / Statistic	2003-2005 (196)	2003 (20)	2004 (93)	2005 (83)
	MARK	MARK	MARK	MARK
Mean	63.11	65.50	61.59	64.24
Maximum	87.00	87.00	85.00	83.00
Minimum	42.00	45.00	42.00	50.00
Std. Dev.	7.28	8.68	7.72	6.04
	ABILITY	ABILITY	ABILITY	ABILITY
Mean	366.84	367.00	369.68	363.61
Maximum	480.00	480.00	480.00	480.00
Minimum	240.00	240.00	260.00	240.00
Std. Dev.	53.32	56.30	54.50	51.72
	PEER	PEER	PEER	PEER
Mean	359.49	359.00	353.33	366.51
Maximum	480.00	480.00	480.00	480.00
Minimum	260.00	300.00	260.00	280.00
Std. Dev.	45.36	51.29	45.24	43.52

Figure 2: Summary Statistics: Mark, Ability and Peer

For the purposes of the empirical analysis students will be split into segments of high, average and low abilities, and the same will be done for their peers. From the graphs in Appendix 2 it can be seen that the lower end of abilities for both peers and students is a UCAS score of 320 or less, and high performers are approximately 420 and above. The boundaries I have therefore used in this study to separate the groups are as follows:

Low ability: UCAS points of 320 or less.

Average ability: Above 320 UCAS points and below 420 UCAS points.

High ability: UCAS points of 420 or more.

Figure 3 shows final year overall mark graphed against peer ability. On the outset, from looking at this graph we can already see there may be a small positive correlation between a student's first year grades and his/her peer's ability.

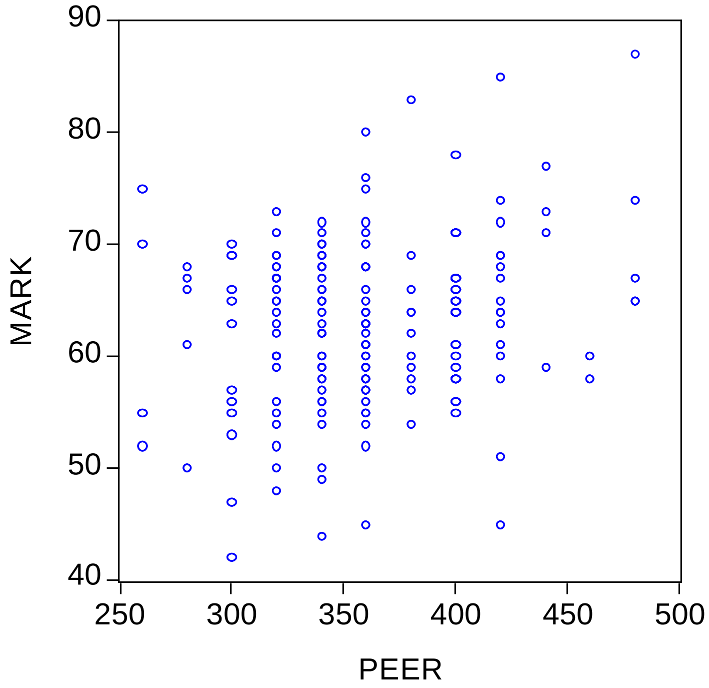

Figure 3: Final Year Overall Mark and Peer Ability

5. Methodology

5.1 Statistical Procedure

In the cross sectional data set obtained through the random sampling method described in section 4.1 the main variables in the data set, (mark, ability and peer) are quantitative. As the correlogram in Figure 4 shows, there is no perfect collinearity between the independent quantitative variables (ability and peer). The model is initially assumed to be linear in parameters, therefore the model can be estimated by Ordinary Least Squares (Wooldridge 2003). Furthermore, as we have seen in section 4.3 these variables form a strongly normal distribution[19]. Normal distribution of residuals can therefore be assumed. As a result of this an appropriate model choice is that of Ordinary Least Squares (OLS).

	MARK	ABILITY	PEER
MARK	1.000	0.195	0.187
ABILITY	0.195	1.000	0.081
PEER	0.187	0.081	1.000

Figure 4: Correlogram for Mark, Peer and Ability

The main issues arising from using this method to run regressions are the violations to the OLS assumptions and the Gauss-Markov theorem, which may arise. This would lead to biased estimates. In order to check the robustness of the models proposed, they should all be tested for heteroskedasticity to ensure constancy in the variance of the error term. Additionally, to test the validity of the models through ensuring there is no misspecification due to omitted relevant variables, included irrelevant variables or incorrect functional form, Ramsey's RESET test will be run on all regressions. In data collection I have been extremely careful to ensure factors

[19] Also refer to Appendix 2.

affecting final first year grade have been included, so as not to give extra weight to the importance of the peer effect or ability effect on final first year grades, which would lead to an upwardly biased model.

Adopting the method used by Zimmerman (2003). I will consider two broad models, discussed below, when evaluating the peer effect upon final year grades. All regressions will be tested for joint significance[20] of included variables, and in particular the significance[21] of a student's ability and peer effects upon academic success will be focussed on.

5.2 Model 1

The first model will allow the peer effect to be linear. That is, the model will estimate the effect of an increase in peer ability on final first year grades[22]. The equation estimated is shown below. X_i corresponds to the other control factors that have been included in the model, which may impact upon $mark_i$.

Equation 2

$$mark_i = c + \beta_1 ability_i + \beta_2 peer_i + \beta_3 X_i + \varepsilon_i$$

5.3 Model 2

This model will build upon the regression estimated in model 1, by allowing the peer effect to be non-linear. This will be by accomplished by splitting the peer abilities into weak, average

[20] Using an F-test (Wooldridge 2003).
[21] Using an T-test (Wooldridge 2003).
[22] Holding all else constant. The ceteris paribus assumption is applied to interpretations of all regressions from hereon. Although it will not be stated, this fact is assumed.

and high performing peers[23], achieved by adding dummies for these abilities into the model. This will allow the effect of mixing groups of students e.g. strong performing students with weak performing peers to be seen.

Equation 3

$$mark_i = c + \beta_1 ability_i + \beta_2 peer\_low_i + \beta_3 peer\_ave_i + \beta_4 X_i + \varepsilon_i$$

In Equation 3, the dummy variables for low ability and average ability peers are included, with which to compare the effect of a student being placed with a high ability peer. An explanation of dummy variables is provided in Appendix 3a.

Construction of the models as outlined above will enable identification of the extent to which peer effects exist in the data set and will also form the basis of comparison of peer effects in my study compared to previous works.

6. Results

All regression outputs are included in Appendix 3, along with their respective tests for robustness, as discussed in Section 5. An explanation of the dummy variables used in the regression is also included in this appendix. All tests have been carried out at a 5% significance level unless otherwise stated. Control variables, as outlined in section 4.2 were included where they contributed to the overall significance of the model. In this section I present only the aspects of results important to the central discussion of peer effects.

[23] The boundaries for segmenting students were discussed in Section 4.3

In order to make data interpretation more meaningful, I divided the UCAS point measurement by twenty for both for the student's ability and the peer's ability. This is due to the fact that a twenty point increase corresponds to a one grade improvement in A-levels e.g. in moving one B grade to an A grade, a candidate incurs twenty more UCAS points. When analysing regression results therefore, a unit increase in any ability equals a twenty-point increase in UCAS points.

6.1 Results for Model 1

The regressions for this model allowed the peer effect to be linear. Figure 5 shows the coefficients for the effect of a student's own ability and peer's ability upon first year grades.

	Model			
	All Students	Low Ability	Average Ability	High Ability
ability	0.483*	1.662*	-0.315	1.968*
peer	0.447*	0.089	0.345	1.651*
* significant at 5% level				

Figure 5: Coefficients for Model 1, Linear Peer Effect Model

In the overall model, taking into account students of all abilities, the results show that amongst the sample there is a small peer effect present. A twenty-point increase in the peer's ability corresponds to a 0.447% increase in first year mark. In order to test a peer affect amongst students of varying abilities, students were split into low, average, and high abilities (as explained in Section 4.3). The results indicated a significant peer effect amongst only high ability students where a 20-point increase in a peer's UCAS points corresponds to a 1.651% increase in first year mark. This linear model for average ability students, it is interesting to note, fails the RESET test at the 5% significance level[24]. This may be due to the incorrect functional form of the peer effect, an issue that is tackled using Model 2.

These linear peer-effect results differ from those of Zimmerman (2003) in that here peer effects are only found to be significant for high ability students, whereas Zimmerman finds a relatively small significant peer effect amongst only average ability students.

6.2 Results for Model 2:

This model, which allowed peer effects to be non-linear, was carried out upon the student's sampled, again segmented into their own low, average and high abilities. The coefficients for the effect of a student's own ability, and the effect of being placed with a low ability or average ability peer as opposed to a high ability peer are shown in Figure 6.

	Model		
	Low Ability	Average Ability	High Ability
ability	1.687*	-0.335	1.588*
peer_low	-0.347	-2.177	-11.042*
peer_ave	-3.586	-2.513**	-2.788
* significant at 5% level			
**significant at 10% level			

Figure 6: Coefficients for Model 2, Non-Linear Peer Effect Model

[24] See Appendix 3e

The results show there are no significant peer effects active amongst students of low ability. Average ability students sampled however, show a 2.513% decrease in first year mark when placed with a student of similar ability rather than a high ability peer. This regression now passes the RESET test[25] indicating the non-linear peer effect model as a better fit. The peer effect is most dramatic amongst high ability students, where there is evidence that if they are placed with a low ability student rather than a high ability student, it corresponds to an 11.042% decrease in their first year mark. The R^2 for the high ability student is slightly larger for the non-linear peer effects model (R^2= 0.448) than for the linear model (R^2= 0.430). The same trend is true for the low ability and average ability linear/non-linear models, suggesting that the non-linear peer effects are better fit. These results are conclusive with those of Zimmerman (2003), who also finds average ability students have lower grades when not placed with a high ability student. However, we have found, in addition, that high ability students are affected by significant peer effects; a conclusion that Zimmerman did not draw[26].

	Model			
	Male		Female	
	Average Ability	High Ability	Average Ability	High Ability
ability	-0.716	1.074	0.441	2.469*
peer_low	-6.113*	-16.11*	1.571	-2.090
peer_ave	-3.229	-7.480*	-3.191*	-2.824
* significant at 5% level				

Figure 7: Male and Female Coefficients for Model 2, Non-Linear Peer Effect Model

[25] See Appendix 3f
[26] The reasons for the possible difference in results are discussed in the critique in Section 6.3.

Figure 7 displays the sample split into males and females in order to see the nature of non-linear peer effects among either group, using average and high ability students who I have thus far shown to display sensitivity to peer effects.

Amongst students of average ability males show a significant peer effect, corresponding to a decrease in first year mark when placed with a low ability peer rather than a high ability peer. The same is true for average ability females, however when they are placed with an average ability peer rather than a high ability peer. In the high ability proportion of students, females are not affected by any significant peer effects, however males show a dramatic decrease in first year mark when placed with either a low ability or an average ability (16.11% and 7.48% decrease respectively) rather than a peer of similar ability. From this we can see that males tend to be more significantly affected by peers than females amongst high ability students.

6.3 Critique

Although the central aim of this study has been to investigate the existence of peer effects at Warwick University, there is a problem with studying only Warwick students to investigate peer effects. As seen in Section 4.3, Warwick is an institution that has attracted and retained very able students. In choosing to attend such a selective institution students have already, to some extent, chosen their peers. This has led to a certain degree of selection bias in the results.

Furthermore, due to the limitations on grades available on current first years, current second, third and fourth years were instead questioned regarding first year grades. This again brings about the problem of selection bias within the data set. To progress beyond first year it is necessary for students to pass the year. The sample therefore only consists of students who did sufficiently well to pass their first year. This means the abilities of failed students, or peer influences that could have assisted ‘academic failure’ will not have been noted in the results.

At Warwick a student’s first year does not count towards or counts for relatively little towards the final degree classification. This means a student’s own motivation factors, or susceptibility to lower end peer influences may be increased. This perhaps explains why high ability students show a receptivity to peer effects. Perhaps in different circumstances, such as in second or final years the effect of peers would be different as the implications of final results are more serious.

The data set is small, due to the time constraints of this study. This may mean that peer effects are significant in the sample, but the effects could disappear over a larger sample, or the nature of the effects (i.e. which ability groups are affected) could change.

Another factor affecting the validity of results are that when comparing the coefficients of significant peer effects it is difficult to find a comparison measure, as SAT scores are used in the America, whereas I have used A-level UCAS points. This system of scoring student’s abilities is only comparable with students who are scored the same way. The results of this study would be more reliable if a suitable comparison was available.

7. Conclusion and Further Research

The more robust results from this investigation show peer effects to be non-linear, in particular that high ability students are most influenced by the ability of their peers, with an increasingly negative influence on their academic success as a peer's ability decreases. Students of average ability are also found to be affected by their peers, although to a lesser extent than high ability students.

These results are only applicable to a setting such as that provided in Warwick University, where the institution is of a high standard, and already attracts a high calibre of quality (in terms of the ability of students).[27] The same method of analysis could be extended to cover other UK universities in order to see if the trends in peer effects that I have identified are also a factor for them. This will also allow the identification of whether or not there are comparable optimal admissions policies related to peer effects for universities other than Warwick University.

Considering the findings of this investigation, it becomes apparent that the selective admissions policies at Warwick University and the competition for places for high ability students are justified. This is because low ability students bring down those more able than them to a greater extent than high ability students are able to positively influence the lower end. Being even further selective will have the effect of influencing the atmosphere on campus as well as allowing a greater degree of focus upon achieving a greater level of academic success in the institution. The case for selective admission is particularly strong for males, who are more susceptible towards peer effects than females, from the findings of this research.

Further implications of the study could include proposed reforms for Warwick, in terms of the segmentation of students based on ability. This could be done through the accommodation process, influencing student interaction times in classes as well as funnelling these groups into

[27] The non-linearity observed therefore may not be applicable in other contexts, such as when moving a high ability student from Warwick into a comparably low standard institution or moving a low ability student from a low standard institution into Warwick.

those of more homogeneous ability. These measures would influence the grouping of students and in turn the peer influences.

In order to further validate the findings of this research more students could be surveyed to see if the effects upon academic success of interaction of students of heterogeneous abilities changes, or the peer effects found in this study diminish among a greater representative sample. Furthermore this study has only focussed upon the peer effects within home students. The survey could be extended to cover international students as well in order to see if the same relationships found hold true.

Another interesting extension to the study of peer effects is to include more peer characteristics, other than ability, into the empirical equations, such as the amount of alcohol they consume, and monitor the effect that traits such as these have on a student's exam results.

The ideas discussed here are a limited few of possible further research into peer effects. As they demonstrate, there is still huge possibility to learn more about the influences that peers can have in an academic context.

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Appendix 1: Sample Survey

Only fill in this questionnaire
-If you are a home student at Warwick University
-Lived in Halls of Residence at Warwick University in the first year of your current degree course
-If you lived adjacent to another home student during your first year in University

Please be ensured all answers are strictly confidential.

1. What was your overall mark (to the nearest percentage) at the end of the first year of your degree course?

2. What grades did you achieve at A-level (e.g. ABB)? Do not include AS-level grades.

3. What grades did a fellow student who lived next to you in halls in first year achieve at A-level (e.g. ABB)? Do not include AS-level grades.

4. In which year did you commence your current degree course? (Highlight the relevant option)
-2003 -2004 -2005

5. What is your gender? (Highlight the relevant option)
-Male -Female

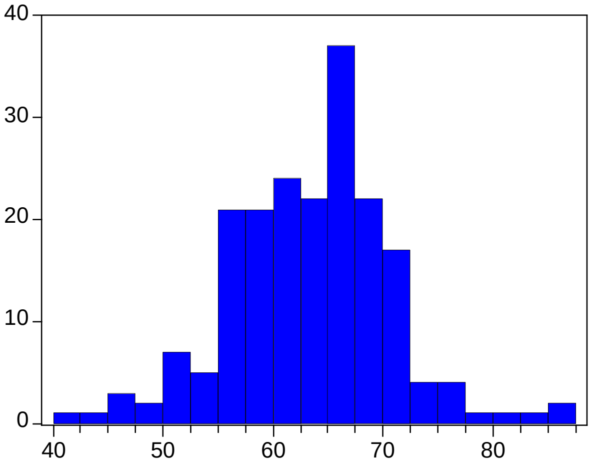
6. What is your ethnic origin? (Highlight the relevant option)
-White Background
-Asian Background
-Black Background
-Mixed Background
-Other Background

7. How would you best describe your parents' income? (Highlight the relevant option)
-Below Average
-Average
-Above Average

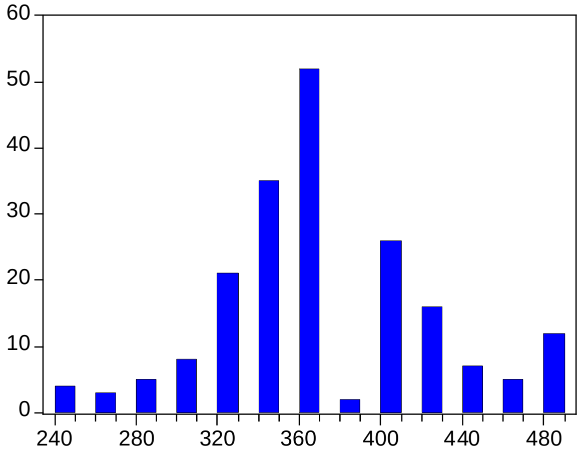
8. In which department does your degree course belong? (Highlight the relevant option)
-Social Studies
-Science
-Arts
-Medicine

Thank you for taking the time to complete this survey.

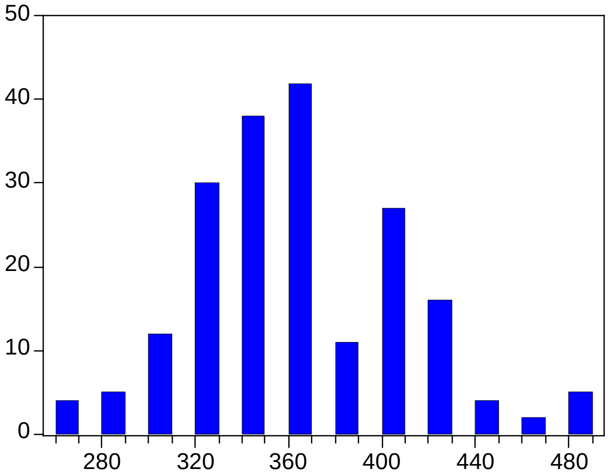
Appendix 2: Distribution of Variables



Series: MARK	
Sample 1 196	
Observations 196	
Mean	63.11224
Median	64.00000
Maximum	87.00000
Minimum	42.00000
Std. Dev.	7.282410
Skewness	-0.007729
Kurtosis	3.756536
Jarque-Bera	4.676112
Probability	0.096515



Series: ABILITY	
Sample 1 196	
Observations 196	
Mean	366.8367
Median	360.0000
Maximum	480.0000
Minimum	240.0000
Std. Dev.	53.32238
Skewness	0.244086
Kurtosis	2.992775
Jarque-Bera	1.946635
Probability	0.377828



Series: PEER	
Sample 1 196	
Observations 196	
Mean	359.4898
Median	360.0000
Maximum	480.0000
Minimum	260.0000
Std. Dev.	45.35608
Skewness	0.396628
Kurtosis	3.089004
Jarque-Bera	5.203605
Probability	0.074140

Appendix 3: Regression Outputs

3a Explanation of Variables

3b Model 1, Linear Peer Effect Model, All Students

3c Model 1, Linear Peer Effect Model, Low Ability Students

3d Model 2, Non-Linear Peer Effect Model, Low Ability Students

3e Model 1, Linear Peer Effect Model, Average Ability Students

3f Model 2, Non-Linear Peer Effect Model, Average Ability Students

3g Model 1, Linear Peer Effect Model, High Ability Students

3h Model 2, Non-Linear Peer Effect Model, High Ability Students

3i Model 2, Non-Linear Peer Effect Model, Average Ability Male Students

3j Model 2, Non-Linear Peer Effect Model, Average Ability Female Students

3k Model 2, Non-Linear Peer Effect Model, High Ability Male Students

3l Model 2, Non-Linear Peer Effect Model, High Ability Female Students

3a Explanation of Variables

mark: Student's final first year mark

ability: Student's A-level UCAS points (divided by 20 in regressions)

peer: Peer's A-level UCAS points (divided by 20 in regressions)

peer_low: 1 if peer ability is low (less than or equal to 320 UCAS points), 0 if average or high
peer_ave: 1 if peer ability is average (greater than 320 points and less than 420 UCAS points), 0 if low or high

gender: 1 if gender is female, 0 if male

par_low: 1 if parental income is below average, 0 if average or above average
par_ave: 1 if parental income is average, 0 if below average or above average
par_high: 1 if parental income is above average, 0 if below average or average

eth_asiblk: 1 if ethnicity is Asian or Black, 0 if White, Mixed or Other
eth_mixoth: 1 if ethnicity is Mixed or Other, 0 if White, Asian or Black

dep_sci: 1 if department is science, 0 if social studies, art or medicine
dep_art: 1 if department is art, 0 if social studies, science or medicine
dep_med: 1 if department is medicine, 0 if social studies, science or art

coh_2004: 1 if entry year is 2004, 0 if 2003 or 2005
coh_2005: 1 if entry year is 2005, 0 if 2003 or 2004

3b Model 1, Linear Peer Effect Model, All Students

Dependent Variable: MARK
Method: Least Squares
Date: 04/09/07 Time: 11:44
Sample: 1 196
Included observations: 196

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	51.31516	5.399406	9.503853	0.0000
ABILITY	0.483221	0.186007	2.597865	0.0101
PEER	0.447142	0.219359	2.038402	0.0429
COH_2004	-3.685329	1.722769	-2.139190	0.0337
COH_2005	-1.849959	1.729934	-1.069382	0.2863
DEP_ART	1.491855	1.533733	0.972695	0.3320
DEP_MED	0.942271	2.169378	0.434351	0.6645
DEP_SCI	0.526740	1.167776	0.451062	0.6525
ETH_ASIBLK	-0.514814	1.124429	-0.457845	0.6476
ETH_MIXOTH	-0.521437	1.773676	-0.293986	0.7691
GENDER	-3.121662	1.031201	-3.027210	0.0028
PAR_LOW	-5.029270	1.941383	-2.590560	0.0104
PAR_AVE	-1.750977	1.062606	-1.647814	0.1011

R-squared	0.189983	Mean dependent var	63.11224
Adjusted R-squared	0.136867	S.D. dependent var	7.282410
S.E. of regression	6.765717	Akaike info criterion	6.725638
Sum squared resid	8376.813	Schwarz criterion	6.943064
Log likelihood	-646.1125	F-statistic	3.576772
Durbin-Watson stat	0.309909	Prob(F-statistic)	0.000084

F critical value 5% significance level: 1.79

White Heteroskedasticity Test:

F-statistic	1.460065	Probability	0.032739
Obs*R-squared	90.32093	Probability	0.071036

Ramsey RESET Test:

F-statistic	1.622364	Probability	0.200289
Log likelihood ratio	3.482506	Probability	0.175301

3c Model 1, Linear Peer Effect Model, Low Ability Students

Dependent Variable: MARK
Method: Least Squares
Date: 04/09/07 Time: 12:02
Sample: 1 196 IF ABILITY<16.5
Included observations: 41

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	33.10009	13.23341	2.501251	0.0169
ABILITY	1.661848	0.707513	2.348858	0.0243
PEER	0.088934	0.454352	0.195739	0.8459
COH_2005	3.751030	1.950595	1.923018	0.0622

R-squared	0.188361	Mean dependent var	61.02439
Adjusted R-squared	0.122552	S.D. dependent var	6.463311
S.E. of regression	6.054326	Akaike info criterion	6.531891
Sum squared resid	1356.230	Schwarz criterion	6.699069
Log likelihood	-129.9038	F-statistic	2.862247
Durbin-Watson stat	0.128012	Prob(F-statistic)	0.049810

F critical value 5% significance level: 2.85

White Heteroskedasticity Test:

F-statistic	0.459334	Probability	0.875220
Obs*R-squared	4.223211	Probability	0.836444

Ramsey RESET Test:

F-statistic	1.036518	Probability	0.365320
Log likelihood ratio	2.359217	Probability	0.307399

3d Model 2, Non-Linear Peer Effect Model, Low Ability Students

Dependent Variable: MARK
Method: Least Squares
Date: 04/09/07 Time: 12:00
Sample: 1 196 IF ABILITY<16.5
Included observations: 41

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	36.71118	10.70132	3.430529	0.0015
ABILITY	1.687068	0.688855	2.449089	0.0193
PEER_LOW	-0.347085	3.324274	-0.104409	0.9174
PEER_AVE	-3.586348	2.899898	-1.236715	0.2242
COH_2005	3.914014	1.916538	2.042231	0.0485

R-squared	0.249940	Mean dependent var	61.02439
Adjusted R-squared	0.166600	S.D. dependent var	6.463311
S.E. of regression	5.900404	Akaike info criterion	6.501768
Sum squared resid	1253.332	Schwarz criterion	6.710740
Log likelihood	-128.2862	F-statistic	2.999044
Durbin-Watson stat	0.168960	Prob(F-statistic)	0.031046

F critical value 5% significance level: 2.64

White Heteroskedasticity Test:

F-statistic	0.812463	Probability	0.618962
Obs*R-squared	8.737388	Probability	0.557195

Ramsey RESET Test:

F-statistic	0.362051	Probability	0.698899
Log likelihood ratio	0.864013	Probability	0.649205

3e Model 1, Linear Peer Effect Model, Average Ability Students

Dependent Variable: MARK
Method: Least Squares
Date: 04/09/07 Time: 12:15
Sample: 1 196 IF ABILITY>16.5 AND ABILITY<20.5
Included observations: 115

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	68.98126	11.21296	6.151924	0.0000
ABILITY	-0.314999	0.571018	-0.551645	0.5823
PEER	0.345037	0.276268	1.248922	0.2144
COH_2004	-5.073257	2.039503	-2.487497	0.0144
COH_2005	-3.005865	2.042541	-1.471630	0.1440
GENDER	-5.101411	1.249344	-4.083272	0.0001

R-squared	0.190742	Mean dependent var	63.44348
Adjusted R-squared	0.153620	S.D. dependent var	7.092362
S.E. of regression	6.524895	Akaike info criterion	6.639891
Sum squared resid	4640.594	Schwarz criterion	6.783104
Log likelihood	-375.7937	F-statistic	5.138260
Durbin-Watson stat	0.436066	Prob(F-statistic)	0.000286

F critical value 5% significance level: 2.29

White Heteroskedasticity Test:

F-statistic	1.793689	Probability	0.095888
Obs*R-squared	12.07737	Probability	0.098043

Ramsey RESET Test:

F-statistic	4.461098	Probability	0.013776
Log likelihood ratio	9.210396	Probability	0.010000

3f Model 2, Non-Linear Peer Effect Model, Average Ability Students

Dependent Variable: MARK
Method: Least Squares
Date: 04/09/07 Time: 12:17
Sample: 1 196 IF ABILITY>16.5 AND ABILITY<20.5
Included observations: 115

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	77.33500	10.99972	7.030636	0.0000
ABILITY	-0.334832	0.574386	-0.582939	0.5611
PEER_LOW	-2.176712	2.125453	-1.024117	0.3081
PEER_AVE	-2.513012	1.901763	-1.321412	0.1892
COH_2004	-4.897455	2.070862	-2.364935	0.0198
COH_2005	-2.582963	2.116551	-1.220364	0.2250
GENDER	-5.197227	1.260909	-4.121811	0.0001

R-squared	0.192265	Mean dependent var	63.44348
Adjusted R-squared	0.147391	S.D. dependent var	7.092362
S.E. of regression	6.548862	Akaike info criterion	6.655398
Sum squared resid	4631.860	Schwarz criterion	6.822481
Log likelihood	-375.6854	F-statistic	4.284545
Durbin-Watson stat	0.415363	Prob(F-statistic)	0.000651

F critical value 5% significance level: 2.18

White Heteroskedasticity Test:

F-statistic	1.515300	Probability	0.169772
Obs*R-squared	10.37196	Probability	0.168456

Ramsey RESET Test:

F-statistic	1.170936	Probability	0.314055
Log likelihood ratio	2.513051	Probability	0.284641

3g Model 1, Linear Peer Effect Model, High Ability Students

Dependent Variable: MARK
Method: Least Squares
Date: 04/09/07 Time: 12:34
Sample: 1 196 IF ABILITY>20.5
Included observations: 40

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-10.18604	19.45623	-0.523536	0.6039
ABILITY	1.967930	0.880209	2.235752	0.0318
PEER	1.651147	0.482422	3.422620	0.0016
DEP_SCI	4.534685	2.342281	1.936013	0.0610
GENDER	-2.443921	2.328386	-1.049620	0.3011

R-squared	0.430592	Mean dependent var	64.30000
Adjusted R-squared	0.365517	S.D. dependent var	8.302610
S.E. of regression	6.613398	Akaike info criterion	6.732541
Sum squared resid	1530.796	Schwarz criterion	6.943651
Log likelihood	-129.6508	F-statistic	6.616840
Durbin-Watson stat	1.123167	Prob(F-statistic)	0.000448

F critical value 5% significance level: 2.64

White Heteroskedasticity Test:

F-statistic	0.535146	Probability	0.872450
Obs*R-squared	7.685713	Probability	0.809183

Ramsey RESET Test:

F-statistic	1.720904	Probability	0.194572
Log likelihood ratio	3.968365	Probability	0.137493

3h Model 2, Non-Linear Peer Effect Model, High Ability Students

Dependent Variable: MARK
Method: Least Squares
Date: 04/09/07 Time: 12:33
Sample: 1 196 IF ABILITY>20.5
Included observations: 40

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	33.52232	20.41907	1.641717	0.1099
ABILITY	1.587948	0.906842	1.751075	0.0890
PEER_LOW	-11.04159	3.455565	-3.195307	0.0030
PEER_AVE	-2.787571	3.101027	-0.898919	0.3750
DEP_SCI	4.608397	2.459955	1.873366	0.0696
GENDER	-3.286808	2.327375	-1.412238	0.1670

R-squared	0.447815	Mean dependent var	64.30000
Adjusted R-squared	0.366611	S.D. dependent var	8.302610
S.E. of regression	6.607693	Akaike info criterion	6.751827
Sum squared resid	1484.495	Schwarz criterion	7.005159
Log likelihood	-129.0365	F-statistic	5.514710
Durbin-Watson stat	1.021340	Prob(F-statistic)	0.000802

F critical value 5% significance level: 2.49

White Heteroskedasticity Test:

F-statistic	0.417838	Probability	0.861793
Obs*R-squared	2.824261	Probability	0.830559

Ramsey RESET Test:

F-statistic	0.709075	Probability	0.499668
Log likelihood ratio	1.734531	Probability	0.420099

3i Model 2, Non-Linear Peer Effect Model, Average Ability Male Students

Dependent Variable: MARK
Method: Least Squares
Date: 04/09/07 Time: 13:44
Sample: 1 196 IF ABILITY<20.5 AND ABILITY>16.5 AND GENDER=0
Included observations: 61

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	84.36317	15.59657	5.409083	0.0000
ABILITY	-0.715403	0.831302	-0.860581	0.3932
PEER_LOW	-6.113383	3.567139	-1.713806	0.0922
PEER_AVE	-3.228997	3.349540	-0.964012	0.3393
PAR_LOW	-11.72366	4.460914	-2.628085	0.0111
PAR_AVE	-2.610782	2.028895	-1.286800	0.2036

R-squared	0.182530	Mean dependent var	65.73770
Adjusted R-squared	0.108214	S.D. dependent var	7.790810
S.E. of regression	7.357205	Akaike info criterion	6.922418
Sum squared resid	2977.065	Schwarz criterion	7.130045
Log likelihood	-205.1337	F-statistic	2.456149
Durbin-Watson stat	0.305829	Prob(F-statistic)	0.044365

F critical value 5% significance level: 2.38

White Heteroskedasticity Test:

F-statistic	1.958723	Probability	0.087887
Obs*R-squared	10.90292	Probability	0.091423

Ramsey RESET Test:

F-statistic	2.476235	Probability	0.093735
Log likelihood ratio	5.449209	Probability	0.065572

3j Model 2, Non-Linear Peer Effect Model, Average Ability Female Students

Dependent Variable: MARK
Method: Least Squares
Date: 04/09/07 Time: 13:47
Sample: 1 196 IF ABILITY<20.5 AND ABILITY>16.5 AND GENDER=1
Included observations: 54

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	54.96108	12.66380	4.340014	0.0001
ABILITY	0.441447	0.683896	0.645488	0.5217
PEER_LOW	1.570949	2.046340	0.767688	0.4464
PEER_AVE	-3.191024	1.874171	-1.702633	0.0951
PAR_LOW	-4.597089	2.624889	-1.751346	0.0863
PAR_AVE	-0.682345	1.432478	-0.476339	0.6360

R-squared	0.235279	Mean dependent var	60.85185
Adjusted R-squared	0.155620	S.D. dependent var	5.155716
S.E. of regression	4.737595	Akaike info criterion	6.053376
Sum squared resid	1077.351	Schwarz criterion	6.274374
Log likelihood	-157.4411	F-statistic	2.953592
Durbin-Watson stat	0.471475	Prob(F-statistic)	0.021024

F critical value 5% significance level: 2.41

White Heteroskedasticity Test:

F-statistic	1.278434	Probability	0.285448
Obs*R-squared	7.576513	Probability	0.270799

Ramsey RESET Test:

F-statistic	1.820921	Probability	0.173352
Log likelihood ratio	4.114405	Probability	0.127811

3k Model 2, Non-Linear Peer Effect Model, High Ability Male Students

Dependent Variable: MARK
Method: Least Squares
Date: 04/09/07 Time: 13:41
Sample: 1 196 IF ABILITY>20.5 AND GENDER=0
Included observations: 18

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	50.33530	32.90154	1.529877	0.1483
ABILITY	1.074317	1.462168	0.734743	0.4746
PEER_LOW	-16.11082	4.758228	-3.385887	0.0044
PEER_AVE	-7.479563	4.006980	-1.866633	0.0830

R-squared	0.534798	Mean dependent var	66.11111
Adjusted R-squared	0.435112	S.D. dependent var	9.304578
S.E. of regression	6.993230	Akaike info criterion	6.920892
Sum squared resid	684.6737	Schwarz criterion	7.118752
Log likelihood	-58.28803	F-statistic	5.364822
Durbin-Watson stat	1.332764	Prob(F-statistic)	0.011398

F critical value 5% significance level: 3.34

White Heteroskedasticity Test:

F-statistic	0.411050	Probability	0.856869
Obs*R-squared	3.296632	Probability	0.770800

Ramsey RESET Test:

F-statistic	0.903930	Probability	0.430853
Log likelihood ratio	2.525965	Probability	0.282809

3I Model 2, Non-Linear Peer Effect Model, High Ability Female Students

Dependent Variable: MARK
Method: Least Squares
Date: 04/09/07 Time: 13:31
Sample: 1 196 IF ABILITY>20.5 AND GENDER=1
Included observations: 22

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.478781	28.39836	0.192926	0.8492
ABILITY	2.468988	1.192024	2.071258	0.0530
PEER_LOW	-2.090316	5.733291	-0.364593	0.7197
PEER_AVE	2.824157	5.064815	0.557603	0.5840

R-squared	0.293685	Mean dependent var	62.81818
Adjusted R-squared	0.175966	S.D. dependent var	7.267910
S.E. of regression	6.597540	Akaike info criterion	6.774236
Sum squared resid	783.4955	Schwarz criterion	6.972608
Log likelihood	-70.51660	F-statistic	2.494798
Durbin-Watson stat	0.294862	Prob(F-statistic)	0.092732

F critical value 10% significance level: 2.42

White Heteroskedasticity Test:

F-statistic	2.425566	Probability	0.076799
Obs*R-squared	10.83377	Probability	0.093652

Ramsey RESET Test:

F-statistic	1.060583	Probability	0.369378
Log likelihood ratio	2.738824	Probability	0.254256