Heterogeneity Assessment of the Effect of Academic Achievement and Identification of Its Transmission Mechanism: A Survey of Undergraduates from Nanjing University of Finance and Economics

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Abstract—In the new era, China advocates the strategy of "Invigorating the country through science, technology and education & reinvigorating China through human resource development". Analyzing the development status of contemporary college students' academics in the context of the times is the most important aspect of our strategy. In response to the national call, this project uses the survey data of undergraduates of Nanjing University of Finance and Economics as a sample to study the relationship between the surrounding environment and academic performance, identify the internal mechanism of the effect of infection and study whether the transmission effect of the learning transmission mechanism on the results will be The heterogeneity of subject and object varies. Finally, the peer effect is found to have an important impact on undergraduate grades, and lower grade students are more susceptible to peer effects. Students with good grades are more susceptible to couples and friends, while students with poor grades are more easily affected by roommates. Self-study and mutual learning are important transmission mechanisms of mutual influence, but sharing learning with couples can promote academic achievement more than self-study together.

Keywords—*academic achievement, contagion mechanism, heterogeneity*

I. INTRODUCTION

As the old saying goes, *Keep good men company and you shall be of the number*. This sentence points out the important influence of the environment on the growth of students. The academic performance of college students is influenced by many aspects of environmental factors such as learning attitude, study habits and family background. Among them, the influence of learning attitude on performance is particularly prominent. Correct learning attitude can reduce students' burnout and improve their learning efficiency [1,2]. The peer effect has a great influence on the learning attitude. And the peer effect refers to the corresponding influence of peers' behavior on the subject.

The better the undergraduates' grades are, the more training and learning opportunities are available. Although the academic performance can not fully reflect the students' ability, it can reflect the students' learning attitude and learning ability to a certain extent [3]. Academic achievement is of great importance to the further study and employment of undergraduate students. Therefore, the study of the relationship between environment and undergraduate students' academic achievement can help the relevant departments and universities to improve the quality of talents, and then improve the social productivity.

II. LITERATURE REVIEW AND ANALYSIS

In recent years, many scholars have carried out

multi-angle analysis of the influencing factors of students' academic achievement, and obtained many excellent results. For example, Zhang Wenhong and Han Yu (2018) analyzed the unequal allocation of resources among schools in different regions and the resulting inequality in access to education [4]. Liang Yaoming (2017) found that the interaction between peers in dormitory had an important influence on college students [5]. However, the research on peer effect of academic achievement is relatively lacking in the existing literature.

From the perspective of self-factors, students' will, attitude and interest play a decisive role in academic performance, and personal factors are more important than external environmental factors [6]. Wen hongying (2016) found that there were significant differences between male and female students in learning interest, learning will, learning attitude, learning motivation, non-intellectual factors and learning performance, but no significant differences in learning self-discipline and learning efficacy [7].

Learning attitude is an important factor affecting academic performance. Correct learning attitude and scientific learning attitude can effectively improve academic performance [1,2,8]. Li Li and Zhang Wei (2004) also believe that academic performance depends mainly on personal efforts [9]. Intelligence factors are related to academic achievement to a certain extent, and non-intellectual factors play a decisive role. It is found that with the increase of age, the difference of non-intellectual factors will lead to more obvious differences in academic performance [10]. In recent years, many foreign scholars have done a lot of research on the relationship between homework time and academic achievement. Based on the Carroll model (Carrol, 1963), Bloom model (Bloom, 1976), Willie and Hannis Ferg model (Wiley & Harnischfeger, 1974, 1976), it is concluded that there is a certain correlation between learning time and academic achievement. However, Li Guanghai and Cui Qun-fa (2004) proposed that there was no significant correlation between academic performance and learning time in general, but higher academic performance necessarily required a certain amount of learning time [11].

In addition to the self-factor of student, the family environment and the external social environment will also have an impact on students' values, learning motivation, career choices [12], which indirectly affects college students' academic performance. For example, Sacerdote (2011) found that roommates' GPA had a significant effect on individual GPA by means of the dormitory allots the peer formation mechanism, which is exogenous [13]. Zheng Lei (2015) reviewed and verified the community effect and peer effect in education from the perspective of multidisciplinary research [14].

It has been studied by scholars about the heterogeneity between peers and the differential transmission effect on academic performance. Cao Yan (2013) found that low-ability local students were more likely to be affected by the positive influence of immigrant peers, while high-ability local students were also affected by the second generation of immigrant peers [15]. Yang Po (2009) studied the peer effect at the class level. He believed that peer competence had no significant positive and non-linear effect on individual learning performance. At the same time, he found that students' grade would be reduced by the expansion of peer competence differences [16]. However, there are few studies on college students' peer effects and the intrinsic transmission mechanism of academic achievement, so this project will make a further study on this part.

III. EMPIRICAL ANALYSIS

A. Data sources

The data of this project comes from the random sample survey of undergraduates of Nanjing University of Finance and Economics. The data collected in the same university avoids the errors caused by the different GPA algorithms of each university. In the process of collecting data, students in the sophomore year and above are mainly surveyed. Because of their long school time, stable relationship, and significant changes in the GPA, the results are more reliable. However, the freshman is in the stage of relational network construction, who we do not choose it as the research object.

B. General variable description

Individual factors include gender, parents' level of education and self-study (significant increase = 2, general increase = 1, no change = 0, decreased = 1). In the part of the source place of students, this project is classified into the following three groups according to the education level and the difficulty coefficient of college entrance examination: the first group includes Yunnan, Guangxi, Guizhou, Sichuan, Tibet; the second group includes Gansu, Qinghai, Inner Mongolia, Heilongjiang, Jilin, Liaoning, Ningxia, Xinjiang, Shaanxi, Chongqing, Beijing, Tianjin, Hainan; the third group includes Fujian, Henan, Hebei, Jiangxi, Hubei, Hunan, Guangdong, Anhui, Shandong, Shanghai, Zhejiang, Jiangsu. In order to facilitate the calculation and regression analysis, this study divides the cost of living into the following categories: below 1000, 1000-2000, 2000-3000, 3000 and above are recorded as 1000, 1500, 2500 and 3000 respectively. The GPA is divided into the following categories: below 3.0, 3.0-3.5, 3.5-4.0, and 4.0-5.0 are recorded as 3.0, 3.25, 3.75, and 4.5, respectively.

The research of peer effect mainly includes comparing with the GPA of roommates, couples and good friends (I'm much better than others = -2, I'm a little better than others = -1, equal to each other = 0, he's a little better than me = 1, he's much better than me = 2), comparison of self-study frequency (I am higher = -1, almost = 0, higher than me = 1), self-study frequency changes in roommates, couples, and friends (decreased a lot = -2, decreased = -1, no change = 0, some increases = 1, significant increases = 2, unknown = 0), the frequency of self-study with roommates, couples

and friends (never = 1, occasionally = 2, often = 3); the frequency of learning with roommates, couples and friends (never = 1, occasionally = 2, often = 3), the frequency of self-study with roommates, couples and friends (never = 1, occasionally = 2, often = 3) and the frequency of learning with roommates, couples and friends (never = 1, occasionally = 2, often = 3).

C. The impact on the GPA range

TABLE I. THE IMPACT OF PERSONAL FACTOR ON GPA

	(1)
Variable	**GPA**
Male[1]	-0.0671***
	(0.0256)
Whether the father is senior (1= yes, 0= not)	-0.0609*
	(0.0313)
Whether the father is undergraduate (1= yes, 0= not)	-0.00197
	(0.0327)
Whether the father is postgraduate (1= yes, 0= not)	0.0654
	(0.0642)
Whether the mother is senior (1= yes, 0= not)	0.0432
	(0.0279)
Whether the mother is undergraduate (1= yes, 0= not)	0.0595*
	(0.0321)
Whether the mother is postgraduate (1= yes, 0= not)	0.312***
	(0.102)
Student source	0.0799***
	(0.0194)
Monthly living expenses	-5.69e-05**
	(2.64e-05)
Constant	3.285***
	(0.0687)
Observations	1,163
R-squared	0.045

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

1 indicates that female as a reference.

The education level of parents is based on junior high school and below.

The results show that the educational background of their parents and the student resource has a positive significant relationship with GPA.

Family background has an impact on students' thinking and awareness background. Parents with high education level generally pay more attention to children's learning ability and academic achievement. It is not difficult to find that parents with higher education level have a greater influence on students' academic performance. And the influence of mother's education level on student achievement is more significant than that of father. The student source reflects the previous education level of the student. The education level in the developed area is relatively high, so the students' learning ability is stronger. Due to the continuity of learning, it's to say the learning habits developed before still play a role in university study, so the student source has a significant impact on student achievement. Ailian Zhang (2001) found that girls'

enthusiasm for learning is higher than that of boys when she did a survey about the characteristics of college students' learning motivation. So students with high enthusiasm have high motivation [17].

The results showed that women's scores were 0.067 higher than men's grades, indicating that women pay more attention to learning at the university level and have stronger self-control. The monthly living expenses reflecting the family's economic conditions have no significant impact on academic performance. Although the family economic situation can provide different learning resources and learning environment, the resources of colleges are enough for undergraduates, and the choice of whether to learn is determined by one's own more. The learning environment is also determined by one's own decision rather than the family situation.

D. The impact on the change of GPA

1) Personal factor

TABLE II. THE IMPACT OF PERSONAL REASON ON THE CHANGE OF GPA

Variable	GPA Change
The change of self-study frequency	0.0678***
	(0.00702)
There is something impacts GPA[2]	0.00618
	(0.0180)
Having plans for academic or work[3]	0.0128
	(0.0149)
Constant	0.0404***
	(0.0129)
Observations	1,163
R-squared	0.078

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

2 indicates that nothing affects learning as a reference

3 indicates that there is no plans for academic or work as a reference.

The student's academic performance is constantly changing. Personal factors can make the student's academic performance change significantly over a period of time. Students' learning attitudes are closely related to their academic performance. Individual plans and recent events may also have an impact on academic performance. Table 2 reports the changes in the attitude of learning, the impact of events on learning, and the impact of plans for academic or work on learning performance. Changes in self-learning attitudes have a positive and significant impact on academic performance at a significant 1% level. Changes in learning attitudes affect students' various learning behaviors, improve their learning attitudes, and prolong their study time. So their academic performance will increase. We found that 82.6% of students have no major events affecting learning in the near future, while the rest of the students are often influenced by indulging in games or love. But on the whole, this one has little impact on academic performance. The study found that an individual's academic or work program has a positive impact on student achievement, and that students have a clear academic or work plan that encourages students to work hard.

2) Peer impact

To empirically test the impact of peer effects on academic performance, we use the least squares (OLS) method to estimate roommates, couples, and friends. List (1) in Table 3 reports on the impact of roommates on academic performance. The regression results show that the score of the roommate is positively affecting the student's academic performance at the level of 1%. For each roommate's score, the student's grade (GPA) is increased

by 0.019. According to statistics, it is found that the roommates and their own performances are normally distributed. The scores of the roommates equal to me is 35.8% of the total. If we take the scores not much different into consideration, the proportion will reach 72.5%. The roommates get along with each other for a long time, which forms a subtle influence and makes the students in the same dormitory have similarities.

TABLE III. THE IMPACT OF THE PEER EFFECT ON THE OVERALL SAMPLE

Variable	(1) GPA change	(2) GPA change	(3) GPA change	(4) GPA change
The change of self-study frequency	0.0566***	0.0694***	0.0615***	0.0654***
	(0.00746)	(0.0137)	(0.00718)	(0.0147)
Something impacts GPA[2]	0.00311	0.0431	0.0107	0.0649*
	(0.0178)	(0.0347)	(0.0178)	(0.0346)
Having plans for academic or work[3]	0.0141	0.000267	0.00634	-0.00940
	(0.0147)	(0.0313)	(0.0147)	(0.0303)
Compared with the roommates' GPA	0.0190***			0.00974
	(0.00701)			(0.0148)
Compared with the roommates' self-study frequency	0.00363			0.0479**
	(0.0120)			(0.0209)
The change of self-study frequency on roommates	0.0216**			-0.00412
	(0.00855)			(0.0179)
Frequency of self-study with roommates	0.0297**			0.0514**
	(0.0116)			(0.0248)
Frequency of communicating study with roommates	0.0472***			0.0865***
	(0.0140)			(0.0263)
Compared with the couple's GPA		-0.0103		0.00695
		(0.0139)		(0.0137)
Compared with the couple's self-study frequency		0.0284		0.0177
		(0.0223)		(0.0213)
The change of self-study frequency on couple		0.0461***		0.0467***
		(0.0154)		(0.0158)
Frequency of self-study with couple		-0.0422**		-0.0259
		(0.0183)		(0.0183)
Frequency of communicating study with couple		0.0687***		0.0487***
		(0.0161)		(0.0159)
Compared with the friends' GPA			-0.00268	-0.000199
			(0.00652)	(0.0132)
Compared with the friends' self-study frequency			0.0264**	-0.0185
			(0.0108)	(0.0206)
The change of self-study frequency on friends			0.0173*	-0.00186
			(0.00929)	(0.0171)
Frequency of self-study with friends			0.0544***	0.0181
			(0.0113)	(0.0229)
Frequency of communicating study with friends			0.000804	-0.00554
			(0.0124)	(0.0249)
Constant	-0.130***	-0.0179	-0.0605**	-0.322***
	(0.0308)	(0.0491)	(0.0262)	(0.0801)
Observations	1,163	254	1,163	254
R-squared	0.122	0.234	0.111	0.347

Standard errors in parentheses*** $p<0.01$, ** $p<0.05$, * $p<0.1$

2 indicates that nothing affects learning as a reference

3 indicates that there is no plans for academic or work as a reference.

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The frequency of self-study on the roommates appears to have a positive and significant impact on student achievement at the 5% level. The learning behavior of the roommates will lead us to learning with other people in the same room, which will change the academic performance. List (2) and list (3) report the impact of couples and friends on student achievement. We found that couples and friends have similar effects on students' academic performance. Their GPA is normally distributed. GPA has a little difference with couple's is 70.5%. GPA has a little

difference with friends is 78.6%. Whether it is a roommate, a couple or a friend, we can find that the frequency changes of the self-study will have a positive and significant impact on the student's academic performance, while the friend's part will have a positive affect at the 10% level. The behavior of peers is often motivated. One student increases his interest in learning and the self-study frequency. It often motivates students accompanied to study together, and it also creates a sense of urgency for students around.

TABLE IV. THE INFLUENCE OF PEER EFFECTS IN DIFFERENT GRADES

Variable	Sophomore GPA change	Junior GPA change	Senior GPA change
The change of self-study frequency	0.0424*	0.127**	0.120***
	(0.0230)	(0.0498)	(0.0379)
Something impacts GPA[2]	0.0575	0.116*	0.325***
	(0.0479)	(0.0587)	(0.0959)
Having plans for academic or work[3]	-0.0447	0.0443	-0.123
	(0.0405)	(0.0468)	(0.154)
Compared with the roommates' GPA	0.00146	0.0604	-0.00890
	(0.0195)	(0.0369)	(0.0298)
Compared with the roommates' self-study frequency	0.0788**	-0.0123	0.0139
	(0.0315)	(0.0411)	(0.0548)
The change of self-study frequency on roommates	-0.0102	-0.0122	0.0713*
	(0.0266)	(0.0430)	(0.0371)
Frequency of self-study with roommates	0.102***	0.179**	-0.170***
	(0.0342)	(0.0753)	(0.0607)
Frequency of communicating study with roommates	0.0889***	-0.167*	0.177**
	(0.0338)	(0.0867)	(0.0669)
Compared with the couple's GPA	0.00403	0.126***	-0.0750**
	(0.0200)	(0.0339)	(0.0320)
Compared with the couple's self-study frequency	0.0309	-0.129***	0.0991*
	(0.0332)	(0.0322)	(0.0549)
The change of self-study frequency on couple	0.0712***	0.0742**	-0.0535*
	(0.0234)	(0.0293)	(0.0305)
Frequency of self-study with couple	-0.00991	-0.0381	0.0767
	(0.0290)	(0.0343)	(0.0664)
Frequency of communicating study with couple	0.0486**	-0.00245	0.0953
	(0.0224)	(0.0242)	(0.0571)
Compared with the friends' GPA	0.00681	-0.0683*	0.0275
	(0.0210)	(0.0338)	(0.0204)
Compared with the friends' self-study frequency	-0.0498*	0.00806	-0.0239
	(0.0298)	(0.0478)	(0.0410)
The change of self-study frequency on friends	-0.0172	0.0181	-0.00470
	(0.0265)	(0.0264)	(0.0402)
Frequency of self-study with friends	0.0134	0.0122	0.0202
	(0.0354)	(0.0348)	(0.0525)
Frequency of communicating study with friends	-0.00179	0.00751	-0.0294
	(0.0353)	(0.0533)	(0.0795)
Constant	-0.462***	-0.00354	-0.242
	(0.113)	(0.165)	(0.220)
Observations	148	48	57
R-squared	0.388	0.828	0.611

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

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3 indicates that there is no plans for academic or work as a reference

3) Host-object heterogeneity analysis

TABLE V. THE INFLUENCE OF PEER ON THE HETEROGENEITY OF STUDENTS WITH DIFFERENT ACHIEVEMENT LEVELS

Variable	A	B
	GPA change	GPA change
The change of self-study frequency	0.105***	0.0320*
	(0.0223)	(0.0178)
Something impacts GPA[2]	-0.0851	0.0567
	(0.0680)	(0.0391)
Having plans for academic or work[3]	-0.122**	0.0710*
	(0.0461)	(0.0373)
Compared with the roommates' GPA	0.00644	0.0117
	(0.0365)	(0.0170)
Compared with the roommates' self-study frequency	0.0111	0.0799***
	(0.0357)	(0.0239)
The change of self-study frequency on roommates	-0.0923***	0.0412**
	(0.0307)	(0.0205)
Frequency of self-study with roommates	0.0936**	0.130***
	(0.0384)	(0.0310)
Frequency of communicating study with roommates	0.0511	0.0593*
	(0.0391)	(0.0344)
Compared with the couple's GPA	0.0393	-0.0111
	(0.0252)	(0.0153)
Compared with the couple's self-study frequency	-0.0208	0.0357
	(0.0340)	(0.0243)
The change of self-study frequency on couple	0.0678**	0.0603***
	(0.0259)	(0.0203)
Frequency of self-study with couple	-0.0304	-0.00925
	(0.0272)	(0.0223)
Frequency of communicating study with couple	0.0358	0.0537***
	(0.0294)	(0.0185)
Compared with the friends' GPA	0.0753***	-0.0308**
	(0.0244)	(0.0151)
Compared with the friends' self-study frequency	-0.0648*	-0.0101
	(0.0371)	(0.0240)
The change of self-study frequency on friends	-0.00445	-0.0429*
	(0.0281)	(0.0220)
Frequency of self-study with friends	-0.00817	0.0488
	(0.0302)	(0.0301)
Frequency of communicating study friends	0.00764	-0.00436
	(0.0434)	(0.0296)
Constant	-0.224*	-0.539***
	(0.121)	(0.0957)
Observations	93	161
R-squared	0.565	0.492

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

2 indicates that nothing affects learning as a reference

3 indicates that there is no plans for academic or work as a reference.

The role of the peer effect at different stages may be different, so we analyze each of three grades. From the regression results, sophomores are more likely to be influenced by their peers, while the effect of the third-grade and the senior peers is relatively weak. The results of the sophomore and third-grade roommates and couples have similar personal influences, but the reason why the seniors peers' effect are not significant may be that students have their own development direction and plans at this stage and have fewer connections with their peers. The third-grade and the senior peers' have something in common with their roommates in self-study. The students in these two stages tend to study with their roommates and entertain themselves with their couples. Senior students are more inclined to study with their couples. This is in line with expectations. The sophomore student relationship network has been established, but learning is in a transitional period. Learning habits and methods are formed during university period, so some learning attitudes and behaviors of peers will have a certain degree of influence on their own learning. Juniors have basically had their own future plans, and they have formed their own study habits and learning styles when they are in freshman and sophomore. So the influence of their peers is not obvious. Senior students are mainly in postgraduate and employment situations. Students who take the postgraduate exams are actively preparing for the exam, while those who choose to work directly after graduation may be internships and more concerned with work rather than learning.

In the heterogeneity analysis, we divide students into two categories. Class A is a student with a GPA of 3.5 or higher, and Class B is a student with a GPA of less than 3.5. Table 5 reports the impact of peers on students with different levels of achievement. It can be found that students with better academic performance are more susceptible to couples and friends. When forming their own relationship network, friends and couples are chosen by the students themselves, while the roommates are not independent choices. Students with good grades are often more willing to communicate with people who are better than themselves, so they tend to be friends and couples who share their interests in the same choice of. For students with lower grades, their grades are more susceptible to roommates, and they are more likely to be entertaining with their couples and friends. In the process of getting along, the learning behaviors and attitudes of friends and couples have little effect on them. And the roommates have a common dormitory life, mutual understanding of each other's learning status, so the frequency of self-study on the roommates' changes, the roommates and their learning exchanges have a significant impact on their performance.

4) Analysis of transmission mechanism

Co-learning between peers has an important impact on students' performance. In order to further study the mechanism of transmission of learning achievement, we analyze self-study and discussion together with our peers. Finally, it is found that in getting along with roommates, both have significant positive effects on students ' academic performance. In the university, roommates get along with each other, study together and learn from each other will improve the academic performance of all the members of the dormitory. The learning attitudes and habits of a student in the dormitory can influence his roommates together

through self-study and mutual communication, thus improving the learning atmosphere of the entire dormitory. In the contact with couples, communication learning is an important factor in mutual influence. Learning to study with friends is better than communicating with friends to make a difference in performance.

TABLE VI. TEST OF THE CONDUCTION MECHANISM OF PEER EFFECTS

Variable	The change of GPA
The change of self-study frequency	0.0685***
	(0.0127)
Something impacts GPA[2]	0.0750**
	(0.0333)
Having plans for academic or work[3]	0.0145
	(0.0296)
Frequency of self-study with roommates	0.0693***
	(0.0237)
Frequency of communicating study with roommates	0.0681***
	(0.0258)
Frequency of self-study with couples	-0.0203
	(0.0180)
Frequency of communicating study with couples	0.0562***
	(0.0154)
Frequency of self-study with friends	0.0199
	(0.0226)
Frequency of communicating study with friends	-0.00264
	(0.0247)
Constant	-0.339***
	(0.0781)
Observations	254
R-squared	0.283

Standard errors in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$

2 indicates that nothing affects learning as a reference

3 indicates that there is no plans for academic or work as a reference

IV. CONCLUSION

In an era of increasing demand for talent, people are constantly looking for ways to improve the quality of their talents, and the education sector is paying more and more attention to curriculum development and education methods in primary and secondary schools and universities. Through this study, it is found that academic achievement is affected by many factors, in the process of undergraduate individual learning skills, learning attitudes, work starting point formation, peer influence is an important factor in addition to their own efforts and teacher teaching, and the lower grade students are more susceptible to peer influence, outstanding students are more susceptible to the influence of partners and friends, and students with poor grades are more affected by their roommates. Studying together and communicating with each other are important transmission mechanisms that interact with each other, but communication and learning with couples in joint learning can promote the improvement of academic performance more than self-study.

The peer effect is an important factor affecting the performance of undergraduates, so this effect can be used to improve the undergraduate academic performance. On the road of study, practice, research and examination of the road, expand the platform for students to learn from others, so that like-minded people more communicate with each other in order to improve their ability. Expand the number of data samples and the scope of sampled, select more representative regions or universities to collect data samples; adjust the data sample structure; refine and analyze different school, professional, and regional student data samples, which can be used as follow-up research directions for this project. In order to further optimize the personnel training program, improve the quality of personnel training, to help the all-round development of sophisticated talent, it will contribute to the all-round development of highly sophisticated talents.

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