Teaching Quality and Academic Research

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Abstract

This paper studies the relationship between teaching quality measures and research productivity using a detailed database for students of Business Administration, Economics, and Finance & Accounting at the University Carlos III of Madrid. We employ measures based on the value-added methodology traditionally used in non-university studies. We report a positive and significant relation between high levels of research and teaching quality. This finding is not contaminated by the potential negotiating power of full professors strategically choosing the best performing groups. Moreover, we argue that teaching effectiveness measures based on the evaluations of students using anonymous questionnaires are questionable.

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1. Introduction

Universities around the world emphasize teaching and research as their main performing tasks. Consequently, the relation between academic research and teaching quality is one of the most fundamental issues of higher education. This paper investigates this relationship employing not only student evaluations but also measures of teacher value-added effectiveness.

Although policy arguments take as given that teaching is a key determinant to a student´s academic formation and transition into the labour market, it is much less clearer how to estimate teacher contribution to student learning. This is unfortunate not only because the empirical studies analyzing the relation between teaching quality and research will potentially be subject to founded critiques, but also because it makes extremely controversial to include teaching quality considerations into teachers´ promotions and tenure granted positions. Most universities rely on summary statistics of student questionnaires to assess the contribution of teachers to student knowledge. The idea is of course to alleviate agency problems related to the fact that neither the quality of teachers, nor their level of effort can be observed. Watchel (1998) argues that faculty opinions about the reliability of these evaluations are extremely dispersed. If anything, the consensus seems to be rather critical with the use of these questionnaires as a way of hiring and promoting university teachers. Indeed, Carrel and West (2010), and Weinberg, Fleisher, and Hashimoto (2009) find that teachers who give higher grades also receive better evaluations. Even if these evaluation measures were effective, we would still confront the problem of causality. In other words, it is not clear at all that a positive correlation between measures of satisfaction and grades would imply that these teachers positively contribute to student learning.

It is interesting to point out that, although these issues are increasingly receiving more attention in the US university system, they do not seem to be a fundamental concern to university officials. Universities are clearly discriminated at the market level, and general reputational-connected arguments closely related to research activities play a key role in globally determining, at least indirectly, the effectiveness of teachers. Hence, it is not surprising that the academic literature identifying characteristics of teacher effectiveness has been developed for primary and secondary schools. This extensive literature analyzes the relative performance of schools and teachers comparing their value added to student learning. Value-added models measure the importance of teacher quality to educational production generally represented by test scores. In these models, outcomes-scores are the sum of a teacher effect, individual heterogeneity, and a transitory orthogonal error. Two important papers of this literature are Goldhaber and Hansen (2010) who discuss the value-added methodology, showing a statistically significant relationship between teachers' value-added effectiveness measures and the subsequent achievement of students in their class, and Rothstein (2010) who discusses the causality interpretation of the results. He argues that the estimates from value-added models can be interpreted causally only under unverifiable assumptions about the correlation between the assignment of students to teachers and other determinants of test scores. In practice this implies that classroom assignments may not be exogenous conditional on typical controls. Even if the best students do not self-select themselves in the classes of the potentially best teachers, Rothstein (2010) shows that estimators of teacher effectiveness may be substantially biased when selection is mostly driven by unobservable variables. Therefore, even if value-added estimates appear to be correlated with actual teacher effectiveness, it may not be clear that these estimated are unbiased.[1]

This paper extends and applies the value-added models of teaching effectiveness to the university level with the final objective of analyzing the relation between teacher quality and academic research. This is a particularly relevant issue for countries where there is a lack of market discrimination among universities. Policy administrators

[1] See Hanushek and Rivkin (2006, 2010) for a review and discussion of the value-added literature.

should be especially concerned with the budget resources assigned to public universities. This is true for Continental Europe where there is a current debate on whether university funding should be much more strongly related to academic research contribution and less so to the number of students attending a particular school. It is easily understood that the core of this debate relies on the degree in which teaching quality and academic research are interconnected. As discussed by Labini and Zinovyeva (2011), many universities worldwide motivate a complementary view between research and teaching. Teachers at the frontier of knowledge may teach up-to-date material in a more effective way and their courses may better reflect the relevant questions to be taught. On the other hand, teaching and research may also be understood as substitutes given the time and effort required for teaching excellence, and they may even reflect different natural abilities. Ultimately, the relationship between academic research and teaching quality is an empirical issue. In any case, it is important to point out that the incentive schemes designed from public officials or from management at public and private universities respectively to favour teaching versus research may complicate extraordinarily the interpretation of the results from the econometric strategy.

Despite the numerous studies at the primary and secondary schools evaluating teacher effectiveness and the well understood statistical properties of these measures, the available evidence between academic research and teaching quality at the university level is relatively scarce. Data are not available across universities around the world, and not even across different universities for a given country. The lack of publicly accessible data is striking. European public administrators and management of both public and private universities should be especially concerned with the lack of interest shown by universities in developing comparable data sets that may allow potential discrimination among universities due not only to their research productivity but also to the connection between teaching effectiveness and academic research. Therefore, the results we have are specific to a single university, academic disciplines or individual researchers. Data heterogeneity makes difficult to generalize the evidence. Hattie and Marsh (1996) summarize the existing evidence of previous studies in the US to conclude that there is a small but positive correlation between different measures of teaching quality and research, although the results vary a lot across the studies employed in their sample. More recently, Marsh and Hattie (2002) find a basically null relation between both activities, and Stack (2003) shows a positive and significant relation between research and teaching as long as non-linearity is allowed in the econometric tests. Using non-US data, and a value-added methodology to measure teaching effectiveness, Hoffmann and Oreopoulos (2009) employ Canadian data to conclude that there is not a strong correlation between research-focused and teaching-focused college instructors since they have effective and non-effective teachers within each group. Their results suggest that, at the margin, instructors do not make a large difference to student achievement. Regarding European data, Braga, Paccagnella and Pellizzari (2011) employ data from Bocconi University in Italy for students entering in the 1998/1999 academic year in programs of Management, Economics, and Law and Management. Using a value-added approach, they conclude that professors who are more productive in research seem to be less efficient as teachers when research quality is measured by the H-index, a research contribution measure based on individual citations. The sign is reversed when they employ yearly citations but the evidence is not statistically significant. However, the effect of teaching effectiveness is relatively important. The average difference in subsequent performance between students who were assigned to the best and worst teacher is approximately 5.6% of the average grade. García, Georgantzis, Martín, and Pérez (2011) employ data of 604 individual university professors at the University Jaume I in Castellón, Spain from a variety of disciplines for the period 2002-2006. They find a significant non-linear positive effect between teacher quality and research performance where teacher effectiveness is measured by students´

evaluations of teaching. Finally, the most exhaustive study relating academic research and teacher quality is due to Labini and Zinovyeva (2011) who employ a very rich data set from Italian universities. Their data cover around 26 % of the total population of Italian university graduates from 2001 to 2004. The data include outcomes in the labour market and in professional qualification exams, and it is combined with official statistical data about research quality and different measures of the research output. They find that measures of students´ teaching satisfaction are positively correlated with department-level indicators of academic research quality. Moreover, and more importantly, they also show that department-level variation of research productivity over time is positively correlated with cross-cohort variation in graduates´ labour market outcomes. These outcomes are a very reasonable proxy for teaching quality and their result suggest the importance of systematically collect these data from universities trying to distinguish themselves from potential competitors. This is a common approach followed by top Business Schools around the world but it is much more difficult to find these statistics in either public or private European universities.

This paper studies the relationship between teacher quality and academic research for three degree programs on Business Administration, Economics, and Finance & Accounting offered by one of the (internationally) best well known Spanish Universities, the University Carlos III of Madrid from 2008 to 2011. We find a positive and significant (non-linear) relation between high levels of academic research and teaching quality but a weak and non-significant relation between publications in top scientific journals and teaching effectiveness. It is important to point out that our findings cannot be attributed to strategic actions from full professors choosing the best performing groups. Additionally, we show that value-added-based measures of teaching quality do not seem to be related to overall satisfaction as captured by students´ questionnaires.

Limitations of our study are obvious. Although, our data are very rich, and university officials have provided us with all necessary details to pursue this research, we must recognize that our data only cover the School of Law, Business and Economics from only one Spanish university. The positive point is that the University Carlos III has a specific and well defined system of incentives for both teaching and research that makes reasonable to use data from this particular university, but it is also true that it is very difficult to generalize our results to other areas of knowledge, and to other Spanish universities. However, the key motivation of our study is to make a public call for the creation of comparable data sets across Spanish universities that allow researchers, students, and public official to discriminate among programs, schools, departments and universities. At least, top Spanish universities should systematically develop data sets that allow for well defined questions and answers about the relative importance of teaching and research. They should understand that an investment on this direction is a key strategic tool to discriminate themselves from other universities as a way of alleviating adverse selection problems.

From a more general perspective, studies of this sort with public data sets allowing for discrimination on teacher quality, academic research productivity, employment conditions and salary levels of recent graduates and so on should be a fundamental part of the obligations that Spanish universities have with society. Any society must be able to ask for responsibilities when enormous amounts of resources are invested in higher education. One of the obvious prerequisites is to have enough data to make the necessary comparisons, and to penalize those who do not create enough value in either teaching or research productivity.

The paper is organized as follows. Section 2 describes our data regarding relevant institutional details while in Section 3 we discuss data describing students and teacher characteristics related to their research and teaching activities. Section 4 explores the relation between academic research and teaching quality employing a value-added methodology. Section 5 discusses the measures of teaching effectiveness across degree programs, departments, and category of professors, and in Section 6 we analyze teacher evaluations using student questionnaires. Section 7 concludes with summary and final remarks.

2. Data and Institutional Information

The University Carlos III is a public Spanish university located in Madrid. It is a relatively recently founded university for the standards of other more traditional Spanish universities. The university started in the 1989-90 academic year offering only a bachelor degree on Law. During the 2012-13 academic year, the university has slightly more than 18,000 students enrolled in a full variety of degrees in most areas of knowledge. We have data from 2,923 students enrolled in the four-year degrees of Business Administration, Economics, and Finance & Accounting. Table 1 reports the list of compulsory courses in each degree program. Our data includes academic years 2008-09 to 2011-12 corresponding to a complete promotion of the first students enrolled under the Bologna process.[2] These degree programs are taught in two different campuses located in the suburbs of Madrid. The main campus and larger campus is located in Getafe, but the students may also choose the smaller campus of Colmenarejo. Students have the opportunity of choosing a group which is taught in English. We have data for 66 compulsory courses and for 398 professors from four different categories, external teachers who are industry-related professionals with teaching responsibilities on courses for which they have a specialized level of expertise, tenure-track professors, associate professors, and full professors.[3]

[2] The Bologna process started with the declaration of Lisbon made by the European Union in 2000. At that point, the Executive European Council formally declared the will of the European Union to become "the most competitive knowledge-based economy in the world".

[3] By courses, we mean subjects of study for which all students receive a grade like Mathematics for Economics I, Financial Economics, Econometrics, Financial Statement Analysis, Macroeconomics, International Trade, and so on.

Table 2 contains the distribution of the teaching categories among the three degree programs for which we have data. Almost 55% of the students are from Business Administration, 28% from Economics, and 17% from Finance & Accounting. Interestingly, given the usual standards of the traditional Spanish universities, practically 59% of the students are taught by external teachers, and 30% by tenure-track professors. This implies that approximately only 11% of the students are taught by consolidated teachers with a guaranteed academic position at the university. This asymmetric distribution is maintained throughout all three degree programs. The teachers belong to five departments namely Business, Economics, Statistics, Economic History, and the Business Management Division (BMD) from the Mechanical Engineering department.[4]

The academic year at Carlos III consists of two terms (fall and spring), and four exam periods. Exams corresponding to the first term take place in January, and exams for the second term in are taken in June. Students that failed in this first opportunity can take the exams again at the end of the academic year during the months of June and July. We employ data from grades obtained exclusively for the first exam opportunity for both January and June of each academic year.

The number of students entering initially in the degree programs is 360, 190 and 110 for Business Administration, Economics, and Finance & Accounting respectively.[5] Students of a given degree are allocated to different groups. Students in different groups have the same compulsory courses but they usually have different timetables and teachers. However, regardless of the specific group to which students are assigned, they are all taught the same material, and all teachers follow the same syllabus. Additionally, all exams across groups contain the same questions. Students are allocated to a group

[4] Given the different views on how to interpret research productivity from teachers in the Law department, we do not include either Law courses taught in the Business, Economics, and Finance & Accounting degree programs, or Law professors in our sample.

[5] These numbers are exact for the 2012-2013 academic year. During our sample period, this number varies slightly during the first years, and we should also take into account that we have new students coming from other degree programs or universities.

based on their last-family name, and they are not allowed to change groups except for very strict reasons when their schedule is not compatible with work. All requests for changes must be clearly justified with the corresponding documentation to the vice-dean of each of the three degree programs. This procedure generates an indirect random allocation process of students to different teachers. The university does not follow any particular rule to assign the first letter of the last name of the students to a particular category of teachers or to teachers with either Ph.D. or not.

Table 3 contains descriptive statistics that summarize the distributions of compulsory courses and their groups across quarters and degree programs. The average class size is very similar for Finance & Accounting and Economics. The most relevant statistic of Table 3 is that the average class size of the Business program is consistently higher than for the other two programs. On average, the class size is 36% and 44% greater than for Economics and Finance & Accounting respectively. This is an important characteristic given the evidence by Pinto and Vera (2011) who employ data from student enrolled in the first year compulsory courses of the Business degree at the University Carlos III for the years 2000-2001 to 2006-2006. They find that class size affects negatively only the medium ability students. Overall, they show that the medium ability students seem to be the most sensitive to class and peer effects relative to high or low ability students.

3. Data on Students and Teacher Research and Teaching Performance

We have data covering the entire academic history of the students in the three degree programs. We have all grades obtained by these students in all compulsory courses taken in their four years at the university. Additionally, we know their overall personal and demographic characteristics. Thus, for each student attending the programs, we have gender, age, and average entry test grade, place of residence before coming to the university, whether they come from a regular high school or a professional formation degree.[6] We also know to which group each student is assigned for each of the courses taken during their studies at the university. Table 4 reports descriptive statistics for the students in our data for all three degree programs. Economics is the only program with slightly more male than female students, while the highest average entry score are for the students entering in the Business program. Finance & Accounting is the less successful degree program in attracting students from outside Madrid,[7] and it is the program with the largest percentage of students coming from non-academic high schools. Unfortunately, we do not have data about the initial labor market conditions of the students in our data. The availability of these data may facilitate the analysis of teaching effectiveness as in Labini and Zinovyeva (2011).

We also have data regarding students´ evaluations of teachers. Before ending the term, and always before observing their final grade, students are asked to evaluate their teachers through the use of standard questionnaires. These evaluations are anonymous but we are able to identify the name of the course, the group identifier and the name of the professor. We have answers for the overall evaluation or satisfaction with the teacher and also responses about the opinion in the methodology employed to evaluate the course by the teacher. Table 5 contains the average results for departments and years. For each item in the questionnaire the students are asked to answer on a scale from 0 (very negative) to 5 (very positive). The overall satisfaction on average does not seem to contain well-defined patters throughout years or departments. If anything, it may be argued that teachers from the Business and Economic History departments tend to obtain slightly better evaluations than teachers from Economics, Statistics and the BMD division from the Mechanical Engineering department. This seems to be

[6] The average entry score is a weighted average of the high school overall degrees and the grade obtained in the general admission test that all students in Spain must take before being admitted into any university. This exam is the same for all students all over the country.

[7] We must point out that this was the first time that a degree on Finance & Accounting was offered by any Spanish University. The fact that this degree was relatively unknown at that time may explain this characteristic.

particularly true for statistical courses taken during the last two years of studies, although we do not intend to make formal statistical inferences.

Regarding data on teachers, our sample contains individual data on age, gender, whether they have a Ph.D or not, category and official university indices on research productivity and teaching activities. Every year, the university makes an internal official competition that ranks each professor with a doctoral degree in terms of research activities, top publications, and teaching activities. The university administrators pursue to incentive the necessary effort and dedication to both research and teaching. An additional economic retribution is obtained depending upon the position reached in the ranking. The research activity includes the officially recognized research periods by the Spanish Government both recognized periods and relative periods, the number of supervised doctoral dissertations, and the competitive research projects obtained as a principal researcher.[8] The publication activity counts the number of publications in journals listed in the Journal of Citation Report (JCR) where the points obtained depend upon the quartile in which the Journal appears in the JCR report. Every article published in the first, second, third, and fourth quartile receives 8, 4, 2, and 1 point respectively. It is important to point out that only permanent Associate and Full Professors are allowed to participate in the research activities evaluation. In our sample, 157 groups are taught by teachers who have the option to participate but only 88 groups have professors who have actually been evaluated throughout the years spanned by our research.[9] Finally, the teaching activity is composed of the overall satisfaction obtained from the students´ evaluations, the time employed to correct exams and give the final grades of the

[8] Every university teacher in Spain has the opportunity to be evaluated every six years in terms of their research contributions. There is a non-anonymous committee that evaluates the five most relevant publications of every teacher in a six-year period. Teachers from both public and private universities can compete in similar basis. The number of recognized periods is simply the number of the six-year period that every professor has, while the relative period is the ratio of recognized periods to the maximum possible number of periods that the professor may have obtained in his academic career.

[9] In the empirical analysis below, we assign zero points to any professor who is allowed to be evaluated but has declined the opportunity.

courses, the activities directed toward innovative projects regarding teaching, the elaboration of teaching material, and the coordination of courses within the department.

Table 6 contains the descriptive statistics and the range of all variables employed in this research for degree programs, students and teachers.

4. The Estimation of Teacher Quality and the Relationship between Academic Research and Teaching Effectiveness

We first estimate a measure of teacher effectiveness or quality obtaining the conditional mean of future grades in compulsory courses given that a course c_0 has been taught by a particular professor.[10] As pointed out above, we have data on three different degree programs, Business Administration, Economics, and Financial & Accounting denoted by $d = 1,2,3$. Each student $i = 1,\ldots,I_d$, in one of the three degree programs, attends a given sequence compulsory courses $c = 1,\ldots,C_d$ where C_d is the total number of compulsory courses in degree *d*. In each of these courses, every student is allocated to a class or group $g = 1,\ldots,G$, where G_c denotes the total number of groups for all courses *c* in each program *d*, according to the first letter of the student´s surname. For a given group *g* taught by a particular (identified) professor, we run the following panel regression where the dimensions of the panel are the individuals and the future courses taken by the individuals:

$$Y_{ic}^{g} = \alpha^{g} + X_{i}^{g}\beta + \varepsilon_{ic}^{g}, \qquad (1)$$

where Y_{ic}^{g} is the grade obtained by student *i* in course *c*, where *c* is a compulsory course, different from a course c_0, which is taken by the student in any future quarter following the specific quarter in which course c_0 was taken. The grades across

[10] This is the value-added methodology adopted to university teaching as discussed by Braga, Paccagnella and Pellizzari (2011)

courses, Y_{ic}^{g}, are standardized at the group level in order to control for potential differences in the grade distribution. The explanatory (control) variables, given by the components of X_{i}^{g}, are student characteristics that include entry test score, a gender dummy, a dummy for the geographic origin of the student (outside Madrid or not), age, and temporal dummies. The estimated alphas can be interpreted as the conditional means of the future grades of students in group *g*. In other words, high (low) values of $\hat{\alpha}^{g}$ suggest that, on average, students attending course c_0 in group *g* (or, similarly. taking the course c_0 with professor $j = 1,\ldots,G$), obtained a better (worse) grade in subsequent courses than students attending course c_0 in a different group (with a different professor).[11] Assuming that the students are effectively randomly allocated across groups, we can interpret the estimated intercepts of the previous panel regression as exogenous group fixed effects. We estimate the panel by the standard random effects procedure with the Swamy-Arora (1972) estimator of the variance of the individual and the purely random components. We estimate 1,345 fixed effects running therefore 1,345 panel regressions with random effects.

It is important to note that estimates of the intercepts (alphas) can be contaminated by the characteristics of the specific group in which a professor is teaching. Therefore, we must purge the previously estimated intercepts/alphas from group characteristic that may influence the future performance of students but that cannot be attributable to teachers. Thus, we consider the degree program, the location of the degree (whether the group is taught in Getafe or Colmenarejo), the language in which the group is taught (Spanish or English), the average entry score of the students attending that group, the percentage of women in the group, the proportion of students entering the university from other ways than the usual selectivity process of the Spanish universities, the size of the group, the proportion of students coming from outside Madrid, and the average

[11] We eliminate the few groups for which the same group was taught by two or more different professors.

age of the students in the group may all potentially impact the estimated alphas over and beyond the abilities of the corresponding professor. For this reason, in a second step we perform the following heteroscedasticity-robust OLS regression of the estimated alphas on the group characteristics:

$$\hat{\alpha}_{adj}^{g} = X^{g}\beta + u^{g} \ , \qquad (2)$$

where $\hat{\alpha}_{adj}^{g}$ is the 1,345-dimensional vector of the estimated alphas in equation (1) adjusted by the inverse of the standard errors of the corresponding alpha coefficients. and X^{g} is the vector of group characteristics included in the list mentioned above. We divide the estimated alphas by their standard errors of regression (1) to take into account the differences in the precision with which the alphas are estimated.

After these controls, the remaining factor explaining the cross-sectional variation of the estimated alphas should be associated with teaching effectiveness. This suggests that the residuals from regression (2) can be interpreted as the unobservable teaching quality. The residuals denoted by u^{g} will therefore be the measure of teaching quality employed in this paper.

Finally, in order to study the relation between teacher quality and academic research productivity, we run the following heteroscedasticity-robust OLS regression of the 1,345 estimated adjusted alphas on the group characteristics and also on teacher characteristics,

$$\hat{\alpha}_{adj}^{g} = X^{g,t}\beta + v^{g} \ , \qquad (3)$$

where $X^{g,t}$ now contains not only the previously discussed group characteristics but also teacher characteristics age, category, research, top publications, and teaching activities.

Column 1 in Table 7.a contains the evidence from regression (2), and columns 2 and 3 correspond to the results from regression (3) where in the second case, we allow for non-linear relations between estimated alphas and research, publications, and teaching activities. The residuals of the results reported in the first column of Table 7.a are our measures of teaching quality, while in columns 2 and 3 we report the results regarding the relation between teaching quality and academic research.[12]

The empirical evidence contained in the first column of Table 7.a shows that, without controlling for teacher characteristics, the conditional means of future grades are statistically higher when students are enrolled in groups taught in Colmenarejo rather than in Getafe.[13] The language in which students are taught does not seem to explain significantly future grades, although the positive sign of the estimated coefficient favors teaching in English. Surprisingly, the average entry score is negatively correlated with conditional means of future grades. The estimated coefficient is not statistically significant in column 1, but it remains to be negative when it is estimated with higher precision in the next columns.[14] The proportion of females in each group and the class size are two key characteristics explaining future grades. Both relations are estimated with high precision, whereas the proportion of females increases significantly the conditional mean of future grades, but class size reduces significantly future grades. As expected, the proportion of students coming from non-academic high schools is negatively correlated with future grades, and the average age of the students in the groups decreases future grades but only when we do not control for teacher characteristics. Finally, the fact that the student is from Madrid or not do not seem to have any statistical significance on future grades.

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[12] The reported results in Table 7.a are from regressions without intercept. The qualitative final results regarding teaching quality and the relation between academic research and teaching effectiveness are very similar when we employ the results from the same regressions with an intercept. Results are available from the authors upon request.

[13] It should also be noticed that Colmenarejo only offers the degree in Business Administration. Moreover, the statistical significance of the location disappears once we control for teacher characteristics. In any case, all results remain qualitative the same when we run the regressions without Colmenarejo.

[14] This is an intriguing result. It would be interesting to check systematically the relation between grades obtained during the university degrees and the average degree reported by the high schools during the admission process of the students.

As pointed out above, columns 2 and 3 of Table 7.a report the relation between academic research and teaching quality. As before, even after controlling for teacher characteristics, the proportion of females, the class size, and the proportion of students coming from non-academic high schools seems to be significant determinants of future grades. The important point is now to analyze how teacher characteristics influence future performance of the students in our sample. In column 2, we estimate simple linear relations. To hold a Ph.D. seems to be a positive factor in explaining future student performance. On the contrary, to be full professor relative to other categories explains negatively and significantly the conditional mean of future grades. The teaching activities developed by the professors, and their top publications do not explain conditional future performance. If anything, it seems that research activities are able to positively impact teaching quality with a *t*-statistic of 1.52. The most relevant results may be the ones reported in column 3 of Table 7.a. Once we control for student and group characteristics, teaching quality, measured by the conditional mean of future grades, seems to be positively related to academic research as long as teachers are heavily involved in research activities. The *t*-statistic associated with the square of research is 2.92. It may be that at the beginning of the research career, research activities negatively impact future grades, but once the teacher has developed enough research, this additional research effort has a positive and significant relation with teacher quality.[15] However, we argue below that this non-linear relation is due to the group of teachers who voluntarily decide not to participate in the evaluation of their research given their low productivity. It is precisely this group of permanent teachers who reduces the positive relation between teaching quality and research making the relationship even negative for low levels of research. Therefore, we conclude that there is a positive and significance relation between teacher quality and academic research

[15] The results are practically identical whether we standardized the data on research activity, top publications and teaching activity or not.

activity as long as the amount of research activity is large enough. Surprisingly, top publications do not explain teacher effectiveness even if we allow for a non-linear relation, and teaching effort seems to positively affect teaching quality as long as the professor does not dedicate too much time to these teaching activities. Note that this effect is precisely the opposite effect we obtain with research activities. It seems that an intensive and productive effort dedicated to research activities, not necessarily measured by publications listed in JCRs, is a key factor in explaining teaching quality as measured by a value-added approximation.

In Table 7.b, rather than controlling for professor category (external, tenure-track, associate or full professor) as in Table 7.a, we control for permanent versus non-permanent teachers. The first column displays the results using the linear specification as in column 2 of Table 7.a. The research activity coefficient is positive with a *t*-statistic of 1.74. Column 2 contains the non-linear specification. Once again, higher levels of research have a positive relation with teaching quality with a *t*-statistic of 2.89, while the linear coefficient is now positive with a *t*-statistic of 2.12. This is explained by the negative coefficient of the interaction term multiplying the permanent teacher dummy and the research activity. This term has a negative *t*-statistic of -2.29 suggesting that the permanent teachers, who reject the opportunity to be evaluated, have a negative impact on future grades. The last column includes not only the interaction term, but also the permanent related dummy by itself. The results are very similar to the ones displayed in column 2.

In order to clarify the relationship between research and teaching quality, we calculate the fitted value of the relation given the coefficients reported in columns 3 and 2 of Tables 7.a and 7.b respectively. For example, when we control for teacher categories, we calculate the fitted values of teacher quality as

$$FTQ(C) = -0.0225 \times R + 0.000505 \times R^2,$$

and when we control for permanent versus non-permanent teachers, we calculate

$$FTQ(P) = 0.451 \times R + 0.000509 \times R^2 - 0.478 \times R,$$

where R takes the value from 1 to 80, which is the research index used at the university. The results are given in Figure 1 for both cases. We observe that for levels of the research index higher than 45 and 54 for category and permanent controls respectively, the impact of research on teaching quality becomes positive.

We repeat the analysis using only the 88 groups that are being taught by professor who have been evaluated by their research activities. The estimated coefficient associated with research activities in the linear specification is positive and equal to 0.0401. Moreover, it is significantly different from zero with a t-statistic of 2.21. Again, research is positively related to teaching quality. The quadratic specification presents very similar results to the ones reported in the third column of Table 7.a, although the quadratic coefficient is now estimated with slightly less precision. The analysis of the fitted values of the regression shows that the effect on teaching quality for low levels of research is practically zero, and it becomes positive for levels of research higher than 23. It is also interesting to point that the use of groups with professors evaluated by their research activities reduces the significance of the proportion of females and the class size. On the other hand, the coefficients associated with groups taught in English and the age of the teacher become now statistically different from zero.

Finally, regarding teaching activities, the results reported in both Tables 7.a and 7.b show that low levels of teaching activities have a positive and significant impact of the quality of teaching. However, and contrary to the case of research, a lot of time dedicated to teaching activities seems to have a negative impact. A similar calculations as the one reported above shows that the impact of teaching activities becomes negative only for extremely high levels of teaching activity.

We must recognize that our positive and significant relation between teaching quality and academic research may be contaminated if the allocation of teachers to groups is not random. This is a key point before we are able to interpret our evidence as a causality relation rather than just as a simple correlation due to the negotiating power of full professors choosing strategically the best performing groups.

In order to formally test whether the allocation of teachers to alternative groups is random, we perform a seemingly unrelated simultaneous equations system where we regress teachers´ observable characteristics on groups´ observable characteristics. In particular, we estimate 8 seemingly unrelated simultaneous equations, where the observations are the 1345 available groups for compulsory courses. The dependent variables are the 8 teachers´ characteristics given by research, top publications, teaching activities, age, to hold a Ph.D. or not, and their category (professor, associate professor or tenure-track teacher). The explanatory variables are the groups´ characteristic given by location of the program, language, average entry score, proportion of females, proportion from outside Madrid, class size and years of study.

Table 8 contains the empirical results. The reported *F*-statistic of Panel A tests the null hypothesis that the coefficients on each group characteristic are all jointly equal to zero in each equation of the system. The last row of Panel A tests the null hypothesis that the coefficients on all independent variables are all jointly zero in all equations of the system.

Overall, the results show that we are able to reject the random allocation of teachers among groups.[16] For the location of the program, language, entry score, and the dummy associated with the first year of the program, the correlation with teachers´ characteristics is statistically significant. However, this finding does not invalidate our conclusion regarding the positive relation between teaching quality and academic research. Our concern is that full professors may choose strategically the best

[16] Braga, Paccagnella, and Pellizzari (2011) find the opposite result using data from Bocconi University.

performing groups. In other words, the key point is to analyze the statistical significance of the groups′ characteristics with respect to the teachers′ characteristics affecting the positive relation between research levels and teaching quality. In Panel B of Table 8, we show *t*-statistics of the independent variables from individual equations of the seemingly unrelated system. We may think that either full professors or teachers with high levels of research indexes choose groups taught in English that are usually composed of good performing students, groups with particularly high average entry scores, or classes offered during the last years of the degree programs. The reported results in Panel B show that research is not statistically related to language, entry score or the third year of the program. On the contrary, if anything, teachers with high levels of research tend to teach in groups with low average entry scores. Similar results are found for full professors.[17] In both cases, the location of the program is statistically significant, but it should be recalled that teaching quality is not significantly related to the location of the group. The overall rejection of the random allocation of teachers is mainly explained by the allocation of tenure-track professors to groups taught in English. This result is totally unrelated to the positive association between research and teaching quality. To conclude, we show that the positive relation reported in Table 7, showing a positive and statistically significant relation between high levels of research and teaching quality, is not contaminated by the strategic decisions of full professors (or professors with strong levels of research) with enough negotiating power choosing the most convenient groups, or groups with the best performing students.

[17] For example, the average entry score of groups taught by full professors is 7.2 (out of 10) while tenure-track professors teach groups with an average score of 7.9. Additionally, only 35% of the total number of full professors teaches groups taught in English, which means that 3.7% of these groups are taught by full professors and 6.8% are taught by associate professors. Finally, the percentage of full professors teaching during the first, second and third year of the programs is 39%, 48%, and 13% respectively.

5. A Discussion on Teaching Effectiveness across Degree Programs, Category of Professors and Departments

As discussed in the previous section, our measure of teaching quality is given by the residuals of regression (2) where the conditional means of future grades are purged from student and group characteristics. This means that what we have left is attributable to the teacher ability to influence the future performance of the students.

Table 9 presents our proposed metric for teaching quality, and alternative descriptive statistics for the residuals of regression (2) without constant. These statistics are given for the overall data in our sample, and by degree programs, category of professor, year of studies, and departments.

A common way of measuring teaching effectiveness in the value-added literature consists of using as a metric the standard deviation of the estimates of teacher effects from our models. These standard deviations are a measure of how much teachers vary in their effects on performance or, as in our case, in future performance. However, it seems reasonable to argue that the effect captured through the standard deviation may have either a positive or a negative effect on students's performance. As the final metric of teaching quality, we propose to employ the ratio of the upside standard deviation to the corresponding downside standard deviation. The upside deviation captures how much teachers positively vary in their effects on future performance, while downside standard deviation reflects the negative impact variation on future grades. Specifically, the upside and downside standard deviations of the residuals from regression (2), are given by,

$$Upside\,SD = \left\{E\left[\left(u - E[u]\right)^2 \times 1_{\{u>E[u]\}}\right]\right\}^{1/2}$$

$$1_{\{u>E[u]\}} = \begin{cases} 1 \; if \; u > E[u] \\ 0 \quad otherwise \end{cases} \tag{4}$$

$$Downside\ \ SD = \left\{ E\left[\left(u - E[u]\right)^2 \times I_{\{u \le E[u]\}} \right] \right\}^{1/2}$$

$$I_{\{u \le E[u]\}} = \begin{cases} 1\ if\ u \le E[u] \\ 0 \quad otherwise \end{cases} , \qquad (5)$$

where u represents the residuals capturing teaching effectiveness. The final metric to define teacher quality is given by,

$$TQ = \frac{Upside\ SD}{Downside\ SD} \qquad (6)$$

Overall, we observe that the variability on future performance due to the average professor is more influenced by the downside than by the upside. This is also true in all degree programs, where the *TQ* ratio is similar across Finance & Accounting and Business Administration, and slightly higher for Economics. Regarding the professor category, although the stronger impact of the downside standard deviation dominates in all cases, the *TQ* ratio for tenure-track teachers presents the better influence on future performance among the four categories analyzed in our data. It may be the case, that this type of teachers makes a particularly strong teaching effort during their promotional period where they do not seem to concentrate their efforts only on research. On the other hand, the *TQ* ratio for associate professors is the lowest among all categories. It may suggest that, once they are appointed with a permanent teaching position, the effort on teaching performance tends to disappears. On the other hand, it is very important to point out that a common policy is to require from associate professors to accept administrative duties. These responsibilities tend to be new in their careers and may easily explain the negative impact on teaching performance.[18] The results obtained for individual years seem to indicate that the effects of teaching on future conditional performance improve over the years of university. Finally, the results across departments show that teachers who belong to the Business, History and BMD

[18] Unfortunately, we do not have data on administrative responsibilities among teachers.

departments have a higher *TQ* ratio relative to teachers in either the Economics or Statistics departments.

Panel A of Table 10.a shows the empirical results when we employ the residuals from regression (3), and we do not allow for non-linear relations with respect to research, publications, and teaching activities. Panel B of Table 10.a contains the result from regression (3) when we allow for non-linear relations. Therefore, in these cases we also control for teacher characteristics, and we should not interpret these residuals as teacher effectiveness. However, it is useful to compare these results with respect to the evidence presented in Table 9. A reduction in the *TQ* ratio from Table 9 to Table 10.a suggests that the recognition of teachers on future performance is particularly important. In other words, given that once we control for their characteristic these effects disappear, by dividing the *TQ* ratios of Table 9 by the *TQ* ratios of Panel B of Table 10.a, we observe a direct incremental influence of the professors by programs, category of teachers, years and departments. A reduction in the *TQ* ratios both for Panels A and B of Table 10.a are obtained for Economics, Tenure-track teachers, and professors of the Business Administration, History and BMD departments. This should be interpreted as a positive influence of teachers. The opposite is obtained for full professors and teachers on the Economics and Statistics departments. These positive and negative incremental effects are graphically represented in Figure 2 when using the non-linear case. Note that, once we control for the effects of research and teaching activities, the contribution of full professor to the future performance of students decreases substantially. This Figure also represents the contributions of each category using the upside and downside standard deviations. Overall, the conclusions seem to be reinforced. There is a positive incremental effect using the upside standard deviation for tenure-track teachers, and professor from the Business, History and BMD Engineering department that is not accompanied by an increase of downside standard deviations in the cases of tenure-track teachers and the BMD department. Similarly, there is a negative incremental impact using the upside standard deviation for full professors, and teachers from the Economics and Statistics departments supported by the corresponding increase of their downside standard deviations.

Table 10.b reports similar evidence when we employ the residuals from column 2 of Table 7.b. Note that we now control for permanent versus non-permanent teachers rather than by teacher categories. The results are practically identical in both tables except for the case of full professors who now present a lower *TQ* ratio, although they still get a higher *TQ* ratio than associate professors.

6. Teacher Quality and Student Evaluations through Questionnaires

In this section we investigate the determinants of the overall students´ satisfaction from the evaluations all professors receive from their students, as well as the correlations between previous measures of teaching effectiveness and the satisfaction from the questionnaires. As discussed in Section 3, the standard evaluation used by the university evaluates teachers on a scale between 0 and 5. From these questionnaires, we collect data on the overall satisfaction with the teacher, and on the agreement with the way teachers evaluate the students.

Table 11 contains the results from a fixed effects panel data model where the dependent variable is the overall satisfaction of the students. We also estimate a Generalized Least Squares random effects panel data model using the same data. It turns out that the Hausman (1978) test rejects the null correlation between individual effects and regressors, so we report the results from the fixed effect specification. The first two columns of Table 11 reports the results using directly the standardized grades received by the students as one of the independent variables, where the second column controls for non-linear effects on research, publications, and teaching activities. The third and fourth columns employ the residuals of the standardized grades as one of the independent variable where these residuals are obtained from a previous regression of the standardized grades on the degree program, location of the degree, evaluation year, group on which the student is assigned, entry score, gender, age and origin of the student, and whether the teaching language is English or not.

All columns show a positive and significant relation between the overall satisfaction and the grades obtained by the students. As we may expect, the higher the grade obtained in the course, the higher the satisfaction of the student with the professor. Additionally, Business and Economics courses seem to be evaluated better than Finance & Accounting; groups receiving the education in English give better evaluations to their teachers, the younger the professor the more satisfied the students are, and professors with Ph.D. obtain on average worse evaluations from students. The variable estimated with the highest precision is the method employed to grade the students. This variable is strongly and positively correlated with the overall level of satisfaction. We also find that full professors receive high evaluations from students, and the Business and Economic History obtain high satisfaction levels relative to the Statistic department.

Regarding the results relating overall satisfaction with research, top publications, and teaching activities we find very different results from the ones reported using value-added teaching effectiveness. It turns out that, once we allow for non-linear relations, high levels of research activity are negatively associated with satisfaction. This is precisely the opposite result we reported using valued-added teaching quality. However, we now find that professors with a high number of top publications obtain good evaluations from students, and the same result is observed for teaching activities. This suggests that students perceived very differently what they are really learning relative to the apparently satisfaction they obtained from professors. It seems that the grade they get and, very importantly, how they are graded is a key point reflected in the students´ questionnaires.

As mentioned previously, our measure of teaching effectiveness is given by the residuals of regression (2),

$$\hat{\alpha}^{g}_{adj} = X^{g}\beta + u^{g}$$

Table 12 contains the correlation coefficients between the overall level of satisfaction obtained from the questionnaires and the residuals reflecting teaching quality. The overall correlation between both measures is 0.011. The correlations for degree programs, category of professors, years of study, and departments are also strikingly low. In particular, they are small but positive for the degree in Economics, external teachers, groups taught during the first year, and for the Economics and Statistic departments. These are the worse departments according to the measures employed as value-added quality, and they also get lower levels of satisfaction relative to other departments in the panel regressions reported in Table 11. Note that the highest correlations are reported for the BMD Engineering department whose professors obtain relatively good results using value-added performance, but relatively bad results in Table 11. This may suggest that the correlation in Table 12 should be negative. Note, however, that this does not have to be necessarily the case since the performance of Table 11 is measured with respect to the Statistics department. The relative performance with respect to other departments involved in the calculation of the correlations in Table 12 may well explain this result. Finally, it is particularly relevant the case of full professors. When we employ the evaluations from students shown in Table 11 they obtain high levels of satisfactions. However, they obtain poor results in terms of teaching effectiveness. This is captured by the relatively high and negative correlation coefficient reported for them in Table 12. To conclude, given these low levels of correlations between teaching quality measures and overall satisfaction, University officials may take with extremely care the results reflected in the questionnaires from students.

7. Conclusions

The relation between teaching quality and academic research is a very complex issue. European universities, especially public-based university systems like the case of Spain, should be involved in developing detailed databases that allow comparable analysis across universities. The results reported in this paper suggest that teaching quality measured by students´ questionnaires may be contaminated by the grade the students obtained, by the procedures employed to evaluate them, and by the age and category of teachers.

We propose measures of teaching quality based on the value-added methodology traditionally employed in non-university studies. We use conditional means of future grades received by students as the basic measure to evaluate teaching quality. Then, we purge these conditional means by the individual characteristics of students and the characteristics of the groups to which they are assigned. Whatever is left should be attributable to teacher quality. Using data from the University Carlos III of Madrid, we find that tenure-track professors, and teachers from the Business, Economic History and BMD Engineering departments obtain higher levels of teaching effectiveness relative to other categories of professors, and to teachers from the Economics and Statistic departments. Overall, these measures of teaching quality are positively and significantly related to high levels of research, although we do not find a significant relation with respect to top publications. The positive relation between academic research and teaching quality does not seem to be contaminated by the potential strategic negotiating power of full professors choosing the best performing groups. A positive relation is also found for reasonable levels of teaching activities. The knowledge and experience obtained in the subject being taught through accumulated experience in relevant research contributes positively to the learning process of students at the University Carlos III.

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Table 1
List of compulsory courses by degree programs

Finance & Accounting	Economics	Business Administration
Year 1 – Term 1		
Economic History		
Introduction to Business Administration	Introduction to Business Administration	Introduction to Business Administration
Principles of Economics	Principles of Economics	Principles of Economics
Mathematics for Economics	Mathematics for Economics I	Mathematics for Economics I
Year 1 – Term 2		
Financial Mathematics	Mathematics for Economics II	Mathematics for Economics II
Microeconomics	Microeconomics	Microeconomics
Introduction of Accounting	Accounting I	Introduction of Accounting
Statistics I	Economic History	Economic History
	Statistics I	Statistics I
Year 2 – Term 1		
Financial Economics	Macroeconomics	Macroeconomics
Statistics II	Statistics II	Statistics II
Organization and Management	Game Theory	Game Theory
	Microeconomics Theory	Management Accounting
Year 2 – Term 2		
Econometrics I	Econometrics	Econometrics
Financial Accounting I	Financial Economics	Financial Economics
Fixed Income and Derivatives	Dynamic Macroeconomics	Organizational Behavior
Financial Management	Industrial Organization	
Year 3– Term 1		
Financial Accounting II	Econometric Techniques	Marketing
Econometrics II	Public Economics	Organizational Economics
Cost Management	Markets and Environment	
Financial Institution System		
Year 3 – Term 2		
Financial Statement Analysis	Applied Economics	Marketing Management
Financial Risk Management	International Trade	Financial Management
Management Control		
Year 4 – Term 1		
Auditing Financial Statements		Strategic Management
Corporate Management and Social Responsibility		Operations Management

Table 2
Percentage of students being taught by professor categories and degree programs

Degree Program	External	Tenure-track	Associate	Professor	%Students
Finance & Accounting	9.56 (16.24)	4.40 (14.86)	2.69 (29.69)	0.25 (10.16)	16.90
Economics	16.38 (27.82)	9.24 (31.22)	1.0 (11.15)	1.65 (67.07)	28.28
Business Administration	32.94 (55.94)	15.96 (53.92)	5.36 (59.16)	0.56 (22.77)	54.82
Total	58.88	29.60	9.06	2.46	100

Note: In parentheses, we report the percentages in the different degree programs given a particular category of teacher.

Table 3
Descriptive statistics of Degree Programs

	Finance & Accounting			Economics			Business Administration		
	# Courses	# Groups	Class Size (Average)	# Courses	# Groups	Class Size (Average)	# Courses	# Groups	Class Size (Average)
2008									
1st Term	4	17	26	3	20	24	3	37	30
2nd Term	4	17	24	5	34	25	5	67	34
2009									
1st Term	7	30	19	7	47	23	7	90	33
2nd Term	8	35	16	9	65	22	8	92	29
2010									
1st Term	11	43	19	10	61	21	9	109	28
2nd Term	10	36	21	11	60	21	10	115	28
2011									
1st Term	13	42	23	10	60	21	11	113	31
2nd Term	11	37	20	11	55	21	10	63	29

Table 4

Descriptive statistics of students by Degree Programs

	Finance & Accounting	Economics	Business Administration	Total
Female students (%)	52.5	48.6	53.4	51.9
Students from outside Madrid (%)	16.3	22.1	21.0	20.5
Students entering from standard nation-wide examination (%)	84.8	95.6	92.4	92.0
Average entry score	7.011 (1.444)	7.536 (1.559)	8.136 (1.490)	7.780 (1.563)

Note: Standard deviation in parentheses

Table 5
Overall satisfaction by departments and years

	Year 1				Year 2			Year 3		Year 4
	2008	**2009**	**2010**	**2011**	**2009**	**2010**	**2011**	**2010**	**2011**	**2011**
Business	3.855	3.730	3.981	3.773	3.585	3.523	3.525	3.615	3.785	3.841
Economics	3.504	3.680	3.595	3.639	3.535	3.690	3.983	3.569	3.889	-
Statistics	3.486	4.129	3.621	3.957	3.836	3.781	3.410	3.296	2.904	-
Econ. History	4.288	4.029	3.863	3.775	-	-	-	-	-	-
Engineering: BMD	3.629	3.226	4.106	3.422	-	3.800	-	1.625	-	4.541

Note: These numbers are based on the questionnaires used by the university to evaluate the overall satisfaction with teachers on a scale between 0 (very negative) and 5 (very positive).

Table 6

Variable description and descriptive statistics of the main variables employed in the regressions

Variable Description	Mean	Standard Deviation	Min	Max
Finance & Accounting: it is a dummy variable that indicates whether the group belongs to this degree program.	0.191	0.393	0	1
Business Administration: it is a dummy variable that indicates whether the group belongs to this degree program.	0.510	0.500	0	1
Location of the program: it is a variable that takes the value 1 if the campus is located in Getafe and 0 otherwise	0.873	0.332	0	1
Teaching language: English: it is a dummy variable that indicates whether the course is taught in English or not.	0.204	0.403	0	1
Ph.D: it is a dummy variable for each teacher in a given group.	0.442	0.497	0	1
Average entry test score: the average score in each group. The highest value this variable can take is 14.	7.725	1.101	5.806	10.534
Proportion Females: in each group.	0.510	0.124	0	1
Proportion of Non-academic Schools: in each group.	0.086	0.090	0	0.5
Class Size: average number of students in each group.	23.541	8.894	6	76
Proportion from outside Madrid: average number of students in each group.	0.206	0.098	0	0.75
Average Age of the Group: for students	11.153	0.414	10.055	12.233
Age: for teachers, where the larger this number the younger the teacher is.	25623.04	2770.70	16766	30714
Research: points obtained in research activity by the teacher of each group. The highest value this variable can take is 80. Only Associate Professors and Full Professors can access to this ranking.	3.837	12.004	0	80
Top Publications: points obtained for top publications. The highest value this variable can take is 40. All teachers holding a Ph.D. can access to this ranking.	1.784	3.052	0	29.340
Teaching activities: points obtained for teaching activities. The highest value this variable can take is 50. All teachers holding a Ph.D. can access to this ranking.	5.579	11.093	0	45.570
Permanent: it is a dummy variable that indicates whether the teacher has a permanent position in the university (they have to be either Associate or Full Professor). It is equal to zero if the teacher is either External or Tenure-track.	0.116	0.321	0	1
Permanent*Research: multiplicative interaction between the Permanent and Research variables.	3.005	12.205	0	80

Table 7.a
Determinants of conditional means of future grades of students in all available groups across all degree programs controlling by group and professor characteristics

Independent Variables	*Estimated Coefficients (t –statistic)*	*Estimated Coefficients (t –statistic)*	*Estimated Coefficients (t –statistic)*
Finance & Accounting	0.0243	-0.0978	-0.0909
	(0.15)	(-0.57)	(-0.53)
Business Administration	-0.0174	0.193	0.198
	(-0.13)	(1.36)	(1.39)
Location of the program	-0.367*	-0.172	-0.184
	(-2.21)	(-0.98)	(-1.04)
Teaching language: English	0.114	0.121	0.115
	(0.78)	(0.81)	(0.77)
Average entry test score	0.0653	-0.203*	-0.204*
	(1.03)	(-2-19)	(-2.19)
Proportion of females	1.291***	1.461***	1.464***
	(3.49)	(3.83)	(3.82)
Proportion from non-academic high schools	-1.615**	-1.581**	-1.529*
	(-2.59)	(-2.60)	(-2.53)
Class size	-0.0188**	-0.0209***	-0.0204***
	(-3.12)	(-3.43)	(-3.36)
Proportion from outside Madrid	-0.115	-0.136	-0.111
	(-0.22)	(-0.27)	(-0.22)
Average age of the group	-0.106*	0.0931	0.100
	(-2.37)	(0.76)	(0.82)
If holds a Ph.D.	-	0.431**	0.427**
		(2.59)	(2.58)
Age	-	0.0000136	0.0000109
		(0.66)	(0.53)
Research	-	0.00912	-0.0225+
		(1.52)	(-1.78)
Top publications	-	-0.00606	0.00392
		(-0.29)	(0.10)
Teaching activities	-	0.00755	0.0502
		(1.28)	(1.75)
Professor category	-	-0.283*	-0.285*
		(-2.09)	(-2.08)
Term dummies	-	Yes	Yes
Department dummies	-	Yes	Yes
Research squared	-	-	0.000505**
			(2.92)
Top publications squared	-	-	-0.000324
			(-0.14)
Teaching activities squared	-	-	-0.00118
			(-1.43)
Number of observations	1345	1345	1345
R-squared	0.221	0.250	0.252
Root MSE	1.804	1.770	1.768
Log-likelihood function	-2697.4	-2662.1	-2658.9
F	44.86	17.87	16.67
(p-values)	(0.000)	(0.000)	(0.000)

Note: This table contains the empirical results from an OLS heterocedastic-robust standard error regression of conditional means of future grades on group and professor characteristics. The results now include dummies for different degree programs. The observations of the dependent variable are weighted by the inverse of the standard error of the estimated alphas in the panel regression given by equation (1). Statistical significance by p-values: + p-value < 0.10; * p-value < 0.05; ** p-value < 0.01; *** p-value < 0.001.

Table 7.b

Determinants of conditional means of future grades of students in all available groups across all degree programs controlling by group and professor (permanent vs. non-permanent) characteristics

Independent Variables	*Estimated Coefficients (t –statistic)*	*Estimated Coefficients (t –statistic)*	*Estimated Coefficients (t –statistic)*
Finance & Accounting	-0.0786	-0.0715	-0.0670
	(-0.45)	(-0.41)	(-0.39)
Business Administation	0.200	0.205	0.209
	(1.40)	(1.44)	(1.47)
Location of the program	-0.188	-0.196	-0.192
	(-1.07)	(-1.12)	(-1.09)
Teaching language: English	0.0876	0.0727	0.0655
	(0.59)	(0.49)	(0.44)
Average entry test score	-0.192*	-0.188*	-0.193*
	(-2.06)	(-2.01)	(-2.04)
Proportion of females	1.438***	1.434***	1.435***
	(3.78)	(3.75)	(3.75)
Proportion from non-academic high schools	-1.628**	-1.582**	-1.565**
	(-2.67)	(-2.61)	(-2.58)
Class size	-0.0214***	-0.0209***	-0.0207***
	(-3.51)	(-3.43)	(-3.39)
Proportion from outside Madrid	-0.0998	-0.0702	-0.0862
	(-0.20)	(-0.14)	(-0.17)
Average age of the group	0.0534	0.0506	0.0695
	(0.43)	(0.41)	(0.55)
If holds a Ph.D.	0.249+	0.257*	0.261*
	(1.95)	(2.03)	(2.05)
Age	0.0000053	0.0000012	0.0000005
	(0.25)	(0.06)	(0.03)
Research	0.353+	0.451*	0.260
	(1.74)	(2.12)	(0.84)
Top publications	-0.0175	-0.0247	-0.0101
	(-0.79)	(-0.60)	(-0.22)
Teaching activities	0.0118+	0.0735*	0.0634+
	(1.78)	(2.40)	(1.93)
Permanent * research	-0.349+	-0.478*	-0.280
	(-1.74)	(-2.29)	(-0.90)
Permanent			-0.272
			(-0.80)
Term dummies	Yes	Yes	Yes
Department dummies	Yes	Yes	Yes
Research squared	-	0.000509**	0.000434*
		(2.89)	(2.36)
Top publications squared	-	0.000678	0.000211
		(0.29)	(0.09)
Teaching activities squared	-	-0.00167+	-0.00146
		(-1.93)	(-1.62)
Number of observations	1345	1345	1345
R-squared	0.249	0.252	0.252
Root MSE	1.771	1.768	1.768
Log-likelihoodfunction	-2662.7	-2658.5	-2658.3
F	17.79	16.70	16.20
(p-values)	(0.000)	(0.000)	(0.000)

Note:This table contains the empirical results from an OLSheterocedastic-robust standard error regression of conditional means of future grades on group and professor characteristics. The observations of the dependent variable are weighted by the inverse of the standard error of the estimated alphas in the panel regression given by equation (1). Statistical significance by p-values: + p-value < 0.10; * p-value < 0.05; ** p-value < 0.01; *** p-value < 0.001

Table 8
Random allocation tests for teachers: regressions of teachers' observable characteristics on groups' characteristics

Panel A	F-Statistic	p-value
Location of the program	2.31	0.02
Teaching language: English	30.99	0.00
Average entry test score	4.33	0.00
Proportion of females	0.94	0.48
Proportion from outside Madrid	0.89	0.52
Class size	1.86	0.06
First year	7.14	0.00
Third year	1.48	0.16
Overall joint significance	6.73	0.00

Note: The reported statistics are derived from a system of 8 seemingly unrelated simultaneous equations, where each observation is a group in a compulsory course for a total of 1345 observations. The dependent variables are therefore 8 teachers´ characteristics (research, top publications, teaching, age, to hold a Ph.D or not, and dummies for categories of teachers), and the independent variables are the 8 group characteristics that generate perverse incentives among teachers when choosing a group. The reported F-statistics test the null hypothesis that the coefficients on each group characteristic are all jointly equal to zero in each equation of the system. The last row tests the null hypothesis that the coefficients on all independent variables are all jointly zero in all equations. All tests are distributed as a F(8, 10688), and the F-test of the last row is distributed as F(64, 10688).

Panel B	t-statistics							
	Research	Top papers	Teaching	Age	If holds a Ph.D.	Professor	Associate Professor	Tenure-track
Location	2.08	2.83	3.12	-0.63	2.78	2.32	1.31	1.84
English	0.12	0.26	0.78	5.06	11.22	1.65	-1.65	14.59
Entry score	-1.66	2.40	1.54	0.50	-0.27	-1.99	-1.33	-0.20
Females	-0.44	-0.01	1.35	0.20	1.93	-0.20	-0.18	2.08
Outside Madrid	-1.80	-1.53	-1.12	1.00	0.68	-2.21	-0.42	1.41
Class size	-1.16	0.02	-1.31	-0.29	-2.19	0.10	0.41	-1.55
First year	-0.84	-3.18	-4.02	-4.23	-5.54	-0.92	0.38	-5.43
Third year	0.32	0.47	-0.61	-1.04	-2.39	-0.11	-0.17	-2.97
Intercept	3.11	0.23	0.35	41.31	3.21	2.43	2.35	1.72

Note: The reported t-statistics are derived from the 8 individual regressions that are part of the seemingly unrelated system of simultaneous equations.

Table 9

Estimates of teaching quality controlling by student and group characteristic

	Min	Max	Mean	Median	SD	Upside	Down-side	TQ Ratio	N
Overall	-8.626	6.793	-0.005	0.124	1.798	0.969	1.196	0.810	1345
Degree Programs									
Fin. & Acc.	-8.626	6.259	-0.000	0.152	1.827	0.943	1.211	0.779	257
Economics	-7.379	6.375	-0.016	0.131	1.683	0.953	1.083	0.880	402
Bus. Admin.	-8.590	6.793	-0.000	0.106	1.854	0.986	1.254	0.786	686
Professor Category									
External	-8.626	6.793	-0.091	0.376	1.787	0.950	1.197	0.793	787
Tenure-track	-8.491	6.375	0.207	0.372	1.865	1.043	1.229	0.849	401
Associate	-5.807	4.391	-0.156	0.066	1.664	0.833	1.134	0.734	126
Professor	-2.912	2.530	0.078	0.361	1.538	0.796	0.981	0.811	31
Year									
1st year	-8.626	6.793	-0.219	-0.013	1.953	0.986	1.373	0.718	719
2nd year	-7.378	5.869	0.144	0.235	1.536	0.875	0.960	0.911	502
3dr year	-4.570	4.391	0.633	0.591	1.638	1.135	0.771	1.472	124
Department									
Business	-8.626	5.562	0.193	0.373	1.850	1.102	1.203	0.916	462
Economics	-8.590	6.375	-0.153	0.005	1.726	0.876	1.202	0.728	569
Statistics	-8.043	5.391	-0.159	0.040	1.815	0.903	1.267	0.713	186
Economic History	-5.533	6.793	0.056	0.153	1.750	1.041	1.072	0.971	89
Engineering: BMD	-4.342	6.256	0.356	0.411	1.994	1.373	1.028	1.335	30

Note: This table contains descriptive statistics of the residuals from regression (2) whose results are shown in the first column of Table 7.a. These residuals are interpreted as our measure of teaching quality. As the final metric of teaching quality we employ the ratio of the upside standard deviation to the downside standard deviation of the residuals.

Table 10.a

Panel A: Future grade residuals controlling by student, group, and teacher (categories) characteristics for the linear specification

	Min	Max	Mean	Median	SD	Upside	Down-side	TQ Ratio	N
Overall	-7.999	6.599	-0.001	0.120	1.751	0.956	1.150	0.831	1345
Degree Programs									
Fin.&Acc.	-7.999	6.334	0.000	0.141	1.728	0.953	1.102	0.865	257
Economics	-7.643	6.185	-0.005	0.148	1.676	0.938	1.078	0.870	402
Bus. Admin.	-7.957	6.599	0.000	0.641	1.806	0.968	1.208	0.801	686
Professor Category									
External	-7.999	6.599	-0.016	0.067	1.742	0.960	1.132	0.848	787
Tenure-track	-7.957	6.334	0.062	0.198	1.840	0.998	1.229	0.812	401
Associate	-5.135	4.190	-0.171	-0.232	1.602	0.820	1.067	0.768	126
Professor	-2.428	2.974	0.218	0.592	1.398	0.783	0.811	0.965	31
Year									
1st year	-7.999	6.599	-0.095	0.011	1.911	1.011	1.291	0.783	719
2nd year	-7.642	5.010	0.065	0.223	1.516	0.847	0.963	0.879	502
3dr year	-5.327	4.190	0.274	0.252	1.641	1.031	0.901	1.144	124
Department									
Business	-7.999	5.141	0.000	0.155	1.776	0.939	1.193	0.787	462
Economics	-7.643	6.334	0.000	0.066	1.716	0.940	1.125	0.835	569
Statistics	-7.725	5.226	0.000	0.147	1.792	0.944	1.191	0.793	186
Economic History	-5.703	6.599	0.000	0.176	1.692	0.997	1.041	0.958	89
Engineering: BMD	-4.328	5.479	0.000	0.003	1.940	1.239	1.139	1.088	30

Panel B: Future grades residuals controlling by student, group, and teacher (categories) characteristics for the non-linear specification

	Min	Max	Mean	Median	SD	Upside	Down-side	TQ Ratio	N
Overall	-7.989	6.597	-0.002	0.108	1.748	0.955	1.149	0.8311	1345
Degree Programs									
Fin.&Acc.	-7.989	6.383	0.000	0.128	1.723	0.951	1.105	0.861	257
Economics	-7.633	6.186	-0.005	0.128	1.672	0.944	1.073	0.879	402
Bus. Admin.	-7.921	6.597	0.000	0.081	1.801	0.964	1.207	0.798	686
Professor Category									
External	-7.989	6.597	-0.013	0.055	1.740	0.961	1.131	0.849	787
Tenure-track	-7.921	6.383	0.041	0.216	1.841	0.992	1.236	0.803	401
Associate	-5.318	4.114	-0.080	-0.103	1.577	0.819	1.047	0.782	126
Professor	-2.704	2.709	0.062	0.106	1.350	0.838	0.777	1.078	31
Year									
1st year	-7.989	6.597	-0.094	0.018	1.907	1.012	1.290	0.784	719
2nd year	-7.633	5.012	0.067	0.195	1.515	0.847	0.964	0.878	502
3dr year	-5.312	4.114	0.255	0.205	1.626	1.020	0.896	1.138	124
Department									
Business	-7.989	5.169	0.000	0.158	1.770	0.932	1.194	0.781	462
Economics	-7.633	6.383	0.000	0.043	1.712	0.944	1.119	0.844	569
Statistics	-7.721	5.116	0.000	0.161	1.788	0.941	1.191	0.790	186
Economic History	-5.708	6.597	0.000	0.130	1.692	0.996	1.044	0.954	89
Engineering: BMD	-4.286	5.499	0.000	-0.014	1.957	1.247	1.158	1.076	30

Note: Panels A and B of this table report statistical descriptors obtained from the residuals of the regressions of conditional futures grades on students, groups, and teacher characteristics (controlling for professor category) using equation (3). The difference between the two panels is due to the inclusion of a non-linear relation between futures grades and research, top publications, and teaching activities.

Table 10.b

Panel A: Future grade residuals controlling by student, group, and teacher (permanent) characteristics for the linear specification

	Min	Max	Mean	Median	SD	Upside	Down-side	TQ Ratio	N
Overall	-8.011	6.622	-0.002	0.112	1.753	0.957	1.150	0.832	1345
				Degree Programs					
Fin. & Acc.	-7.977	6.251	0.000	0.112	1.733	0.955	1.105	0.865	257
Economics	-7.664	6.153	-0.006	0.138	1.676	0.940	1.078	0.872	402
Bus. Admin.	-8.011	6.622	0.000	0.083	1.806	0.969	1.208	0.802	686
				Professor Category					
External	-7.977	6.622	0.002	0.097	1.742	0.966	1.128	0.856	787
Tenure-track	-8.011	6.251	0.038	0.210	1.840	0.992	1.235	0.803	401
Associate	-5.197	4.122	-0.186	-0.265	1.605	0.822	1.068	0.770	126
Professor	-2.569	2.871	0.138	0.580	1.452	0.761	0.889	0.856	31
				Year					
1st year	-8.011	6.622	-0.095	0.044	1.914	1.013	1.292	0.784	719
2nd year	-7.664	5.065	0.064	0.208	1.518	0.851	0.963	0.883	502
3dr year	-5.261	4.122	0.270	0.284	1.631	1.021	0.897	1.138	124
				Department					
Business	-8.011	5.135	0.000	0.136	1.775	0.941	1.190	0.791	462
Economics	-7.664	6.251	0.000	0.099	1.716	0.940	1.126	0.835	569
Statistics	-7.754	5.208	0.000	0.126	1.800	0.946	1.197	0.790	186
Economic History	-5.714	6.622	0.000	0.235	1.698	1.002	1.042	0.961	89
Engineering: BMD	-4.359	5.534	0.000	-0.018	1.930	1.233	1.128	1.094	30

Panel B: Future grades residuals controlling by student, group, and teacher (permanent) characteristics for the non-linear specification

	Min	Max	Mean	Median	SD	Upside	Down-side	TQ Ratio	N
Overall	-7.990	6.624	-0.002	0.101	1.747	0.955	1.149	0.831	1345
				Degree Programs					
Fin. & Acc.	-7.983	6.302	0.000	0.103	1.723	0.948	1.106	0.857	257
Economics	-7.648	6.159	-0.006	0.136	1.669	0.945	1.068	0.884	402
Bus. Admin.	-7.990	6.624	0.000	0.059	1.803	0.964	1.210	0.796	686
				Professor Category					
External	-7.983	6.624	0.001	0.082	1.741	0.966	1.128	0.856	787
Tenure-track	-7.990	6.302	0.006	0.198	1.838	0.980	1.245	0.787	401
Associate	-5.420	4.145	-0.044	0.013	1.577	0.833	1.035	0.805	126
Professor	-2.745	2.709	-0.008	0.131	1.389	0.831	0.819	1.016	31
				Year					
1st year	-7.990	6.624	-0.092	0.031	1.909	1.013	1.291	0.785	719
2nd year	-7.648	5.033	0.066	0.201	1.514	0.848	0.964	0.879	502
3dr year	-5.241	4.145	0.247	0.239	1.616	1.011	0.894	1.130	124
				Department					
Business	-7.990	5.155	0.000	0.148	1.769	0.932	1.194	0.780	462
Economics	-7.648	6.302	0.000	0.070	1.711	0.944	1.119	0.844	569
Statistics	-7.758	5.049	0.000	0.130	1.790	0.940	1.195	0.787	186
Economic History	-5.738	6.624	0.000	0.067	1.700	1.002	1.047	0.957	89
Engineering: BMD	-4.314	5.573	0.000	0.000	1.947	1.243	1.147	1.083	30

Note: Panels A and B of this table report statistical descriptors obtained from the residuals of the regressions of conditional futures grades on students, groups, and teacher characteristics (controlling for permanent versus non-permanent professors) using equation (3). The difference between the two panels is due to the inclusion of a non-linear relation between futures grades and research, top publications, and teaching activities.

Table 11

Determinants of students satisfaction measured by questionnaire reports evaluating overall teaching quality

Independent Variables	*Estimated Coefficients (t –statistic)*	*Estimated Coefficients (t –statistic)*	*Estimated Coefficients (t –statistic)*	*Estimated Coefficients (t –statistic)*
Constant	-0.00728	0.0130	0.0126	0.0330
	(-0.13)	(0.23)	(0.22)	(0.58)
Standardized grades	0.00453*	0.00455*	-	-
	(2.29)	(2.31)		
Residual standardized grades	-	-	0.00475*	0.00476*
			(2.41)	(2.41)
Program: Business	0.162*	0.157*	0.165*	0.160*
	(2.43)	(2.39)	(2.47)	(2.43)
Program: Economics	0.173**	0.167**	0.173**	0.167**
	(3.26)	(3.19)	(3.26)	(3.19)
Location Program (Getafe)	0.0855	0.0964	0.0826	0.0936
	(0.67)	(0.79)	(0.65)	(0.76)
Evaluation Year	0.0121	0.0154	0.0132	0.0165
	(0.87)	(1.11)	(0.95)	(1.19)
Teaching language: English	0.0403*	0.0427*	0.0403*	0.0426*
	(1.98)	(2.08)	(1.98)	(2.08)
If holds a Ph.D.	-0.105***	-0.119***	-0.105***	-0.119***
	(-5.46)	(-6.25)	(-5.46)	(-6.26)
Age	0.0000278***	0.0000280***	0.000027***	0.0000280***
	(17.97)	(18.05)	(17.97)	(18.05)
Satisfaction evaluation employed	0.848***	0.842***	0.848***	0.842***
	(143.29)	(140.52)	(143.23)	(140.46)
Research	0.000590	0.0132***	0.000590	0.0132***
	(1.20)	(10.38)	(1.20)	(10.38)
Top publications	-0.00970***	-0.0197***	-0.00970***	-0.0197***
	(-5.13)	(-7.40)	(-5.13)	(-7.40)
Teaching activities	0.00238***	-0.0281***	0.00238***	-0.0281***
	(5.41)	(-12.96)	(5.41)	(-12.96)
Research squared	-	-0.000216***	-	-0.000216***
		(-10.29)		(-10.29)
Top publications squared	-	0.000303**	-	0.000304**
		(3.10)		(3.10)
Teaching activities squared	-	0.000864***	-	0.000864***
		(13.71)		(13.71)
Tenure-track	0.0507*	0.0859***	0.0507*	0.0860***
	(2.35)	(4.03)	(2.35)	(4.03)
Associate	0.0231	0.0379+	0.0231	0.0379+
	(1.09)	(1.77)	(1.09)	(1.77)
Professor	0.289***	0.418***	0.289***	0.418***
	(7.27)	(11.28)	(7.27)	(11.28)
Business Administration	0.0930***	0.109***	0.0930***	0.109***
	(8.08)	(9.57)	(8.08)	(9.57)
Economics	-0.0226+	-0.0105	-0.0225+	-0.0103
	(-1.96)	(-0.90)	(-1.95)	(-0.89)
Economic History	0.292***	0.284***	0.292***	0.284***
	(17.80)	(17.39)	(17.79)	(17.38)
Engineering: BMD	-0.0375+	-0.0174	-0.0376+	-0.0174
	(-1.67)	(-0.79)	(-1.67)	(-0.79)
Term dummies	Yes	Yes	Yes	Yes
Observations	33508	33508	33508	33508
Number of groups	2923	2923	2923	2923
Overall R-squared	0.437	0.442	0.437	0.442
F	1127.96	1080.04	1127.90	1079.92
(p-value)	(0.000)	(0.000)	(0.000)	(0.000)

Note: This table contains the results of the regression of the overall satisfaction of students on a number of controls. Statistical significance by p-values: + p-value < 0.10; * p-value < 0.05; ** p-value < 0.01; *** p-value < 0.001

Table 12

Correlation coefficients between the overall satisfaction from questionnaires and the measure of teaching quality by degree programs, category of teachers, years, and departments

	Correlation Coefficient
Overall	0.011
Finance & Accounting	-0.003
Economics	0.055
Bus. Admin.	-0.007
External	0.004
Tenure Track	-0.037
Associate	-0.027
Professor	-0.195
First Year	0.008
Second Year	-0.091
Third Year	-0.106
Business	-0.032
Economics	0.024
Statistics	0.043
Economic History	-0.056
Engineering: BMD	0.322

Note: Teaching quality is measured by the residuals from regression (2)

Figure 1

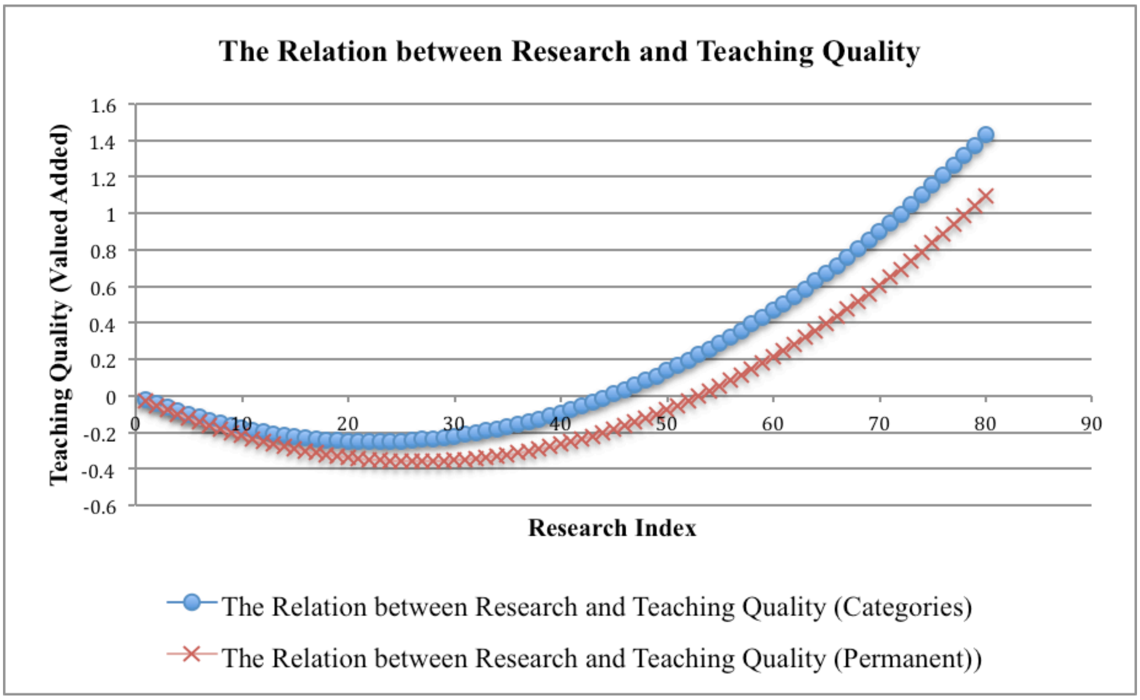
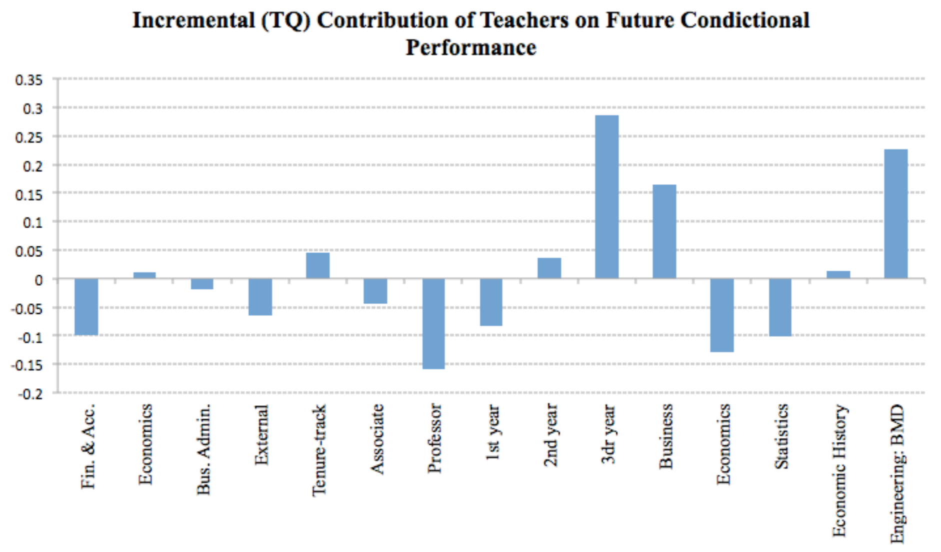
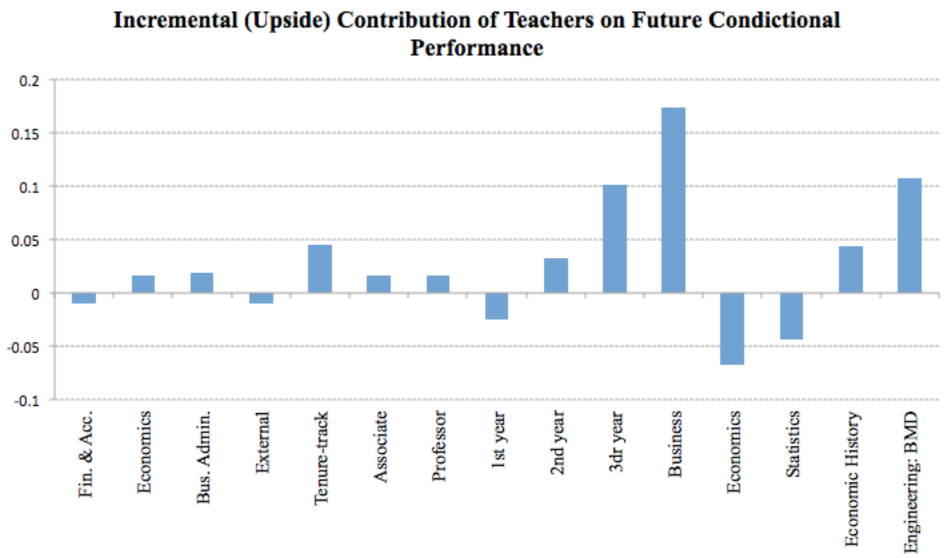
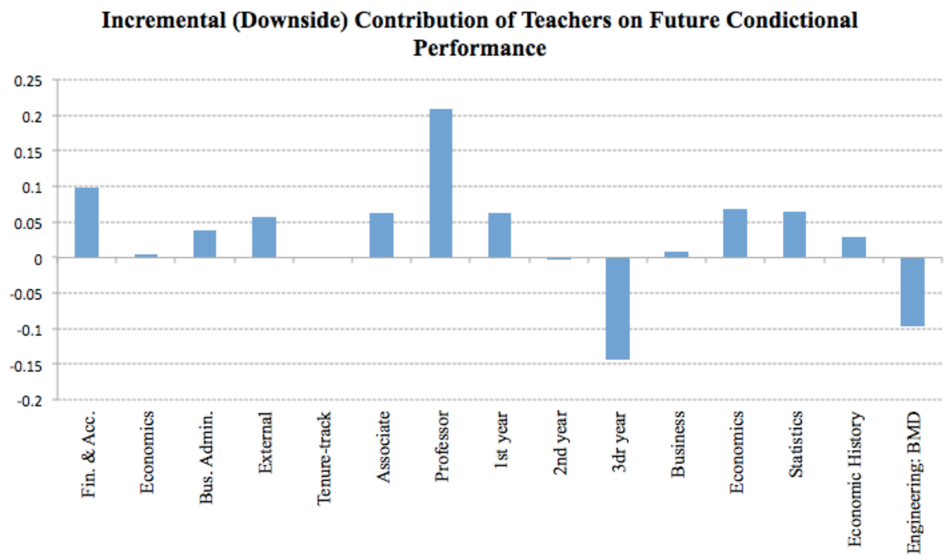

The Relation between Research and Teaching Quality
Teaching Quality (Valued Added)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
0
10
20
30
40
50
60
70
80
90
Research Index
The Relation between Research and Teaching Quality (Categories)
The Relation between Research and Teaching Quality (Permanent))

Figure 2


Incremental (TQ) Contribution of Teachers on Future Condictional Performance
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
Fin. & Acc.
Economics
Bus. Admin.
External
Tenure-track
Associate
Professor
1st year
2nd year
3dr year
Business
Economics
Statistics
Economic History
Engineering: BMD


Incremental (Upside) Contribution of Teachers on Future Condictional Performance
0.2
0.15
0.1
0.05
0
-0.05
-0.1
Fin. & Acc.
Economics
Bus. Admin.
External
Tenure-track
Associate
Professor
1st year
2nd year
3dr year
Business
Economics
Statistics
Economic History
Engineering: BMD


Incremental (Downside) Contribution of Teachers on Future Condictional Performance
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
Fin. & Acc.
Economics
Bus. Admin.
External
Tenure-track
Associate
Professor
1st year
2nd year
3dr year
Business
Economics
Statistics
Economic History
Engineering: BMD