PRELIMINARY – DO NOT CIRCULATE

Commute Costs and Labor Supply: Evidence from a Satellite Campus*

Abstract

Whether, and how much, increased commute costs decrease labor supply is important in assessing how transport infrastructure investments and traffic congestion policies will affect cities' long-run growth. Yet empirical estimates of commute costs' causal effect are lacking because it is endogenous – residences, job locations, commute modes, and wages may respond. We use the transition from an urban to a suburban campus at a Chinese university to measure teaching hours' response to a longer commute. Exogeneity is ensured because few teachers change residences, nearly all faculty ride a free shuttle bus and we control for wage changes.

Employing a regression discontinuity design and controlling for unobservable factors through teacher and academic-year fixed effects, the 1.0 to 1.5-hour (40-kilometer) increase in round-trip commute time reduces annual teaching by 56 hours or 22%. Teachers value commute time at 47 to 70% of their wage. Consistent with higher per-day commute costs, annual teaching days decrease by 27 while daily teaching hours increase by 0.49. Difference-in-difference estimates using teacher-specific changes in commute costs during the transition years to the new campus corroborate these results ruling out confounding coincident changes.

The university accommodated much of the decreased teaching time by increasing class sizes by an average of 15 students, indirect evidence that teaching quality declined. Teachers substitute toward graduate teaching, a close substitute for undergraduate teaching not affected by the transition, but decrease research output. This has important implications for Chinese higher education since rapid enrollment increases have led to increased use of satellite campuses. We find weak evidence that male assistant professors respond less than female but find no significant gender differences in other positions.

Keywords: commuting; labor supply; satellite campus;
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Shihe Fu
Wang Yanan Institute for Studies in Economics (WISE)
Xiamen University
Xiamen 361005 China
fushihe@xmu.edu.cn
Tel: 86-0592-2188255

V. Brian Viard
Cheung Kong Graduate School of Business
Beijing 100738 China
brianviard@ckgsb.edu.cn
Tel: 86-10-8518-8858

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1. Introduction

If labor supply responds significantly to commute costs then evaluations of transport infrastructure investments and traffic congestion policies should consider labor supply effects. This would also imply that commute costs affect long-run employment levels and the growth of cities. Because commute costs vary with respect to work days but are fixed within a work day, a longer commute can either increase or decrease total work time depending on the relative changes in days worked and daily hours (Cogan, 1981; Parry and Bento, 2001).[1] In what direction, and how much, commute costs affect labor supply is therefore an empirical question.

This is not a new question but it is a hard one. Gibbons and Machin (2006) claim that there is no direct empirical evidence of the causal effect of commute time on labor supply. It is hard because commute costs are endogenous – people consider commute costs when choosing their residence and job locations and firms consider them when setting their wages and locations[2] – and it is difficult to find suitable instruments. For example, workers with high commute-cost sensitivity are likely to choose locations with short commutes while those with low sensitivity are likely to tolerate longer commutes. Estimated naively, commute costs' effect on work time will be understated. Measuring commute costs is also often difficult. Commute costs can include time, monetary costs, and disutility of the commute itself and even commute time and distance are usually not known with precision.

Consequently, most existing evidence on labor supply effects of commute costs is either indirect or subject to endogeneity concerns. The only paper that we are aware of that confronts the endogeneity issue is Gutierrez-i-Puigarnau and van Ommeren (GPVO, 2010). They use employer-induced changes in location and measure the response of employees. To maintain exogeneity, they exclude workers who change residences. While this solves the in-sample endogeneity problem, it understates the out-of-sample effects of commute time because workers who move are those with high commute-cost sensitivity. Their results also involve measurement error in commute distance because transport mode choice and presence of employer-subsidized transport are unknown. GPVO (2010) find small effects from increased commute distance: fifteen fewer work minutes per week from an extra forty kilometers in roundtrip commute distance.

To identify the causal effect of commute costs on work time we examine the addition of a suburban satellite to a main urban campus at a Chinese university. For classes taught at the satellite campus, commute time changes exogenously since virtually no faculty move. Moreover, the increased time (30 to 45 minutes one-way) and distance (20 kilometers one-way) are known and homogeneous across teachers since virtually

[1] Daily work hours could also change as workers adjust their start and end times to avoid particularly congested periods of the day. These "bottleneck" theories are examined in Vickrey (1969), Arnott, de Palma, and Lindsey (1990, 1993), and Arnott, Tilman and Schöb (2005).

[2] Many papers examine these equilibrium changes. Manning (2003) provides empirical evidence on the positive relationship between commute costs and wages and Gin and Sonstelie (1992) on residential location changes due to commute cost changes. Van Ommeren and Rietveld (2005) provide a theoretical relationship between commute time and wages in a job-matching model. White (1988) provides a theoretical model of location choice (and therefore commute costs) with endogenous residence and work locations. Zax (1991) uses data on the relocation of a single company and finds that quits and moves occur more frequently alone than together.

all faculty ride a shuttle bus. The bus is free to faculty so our estimates reflect the effect of commute time and disutility but not monetary costs. The new campus opens in academic year 2004 (throughout the paper we refer to the academic year spanning fall semester of year t to spring semester of $t + 1$ as academic year t and unless otherwise noted a "year" refers to an "academic year") but undergraduate students transition one class level per year until all four levels are taught there in 2007. This incremental transition imposes different levels of commute costs at the individual level during the transition years depending on an individual teacher's course schedule. Salaries were adjusted over this time period but are constant within a year allowing us to control for them with academic-year fixed effects.

Using data on the university's complete undergraduate course schedule from 2000 to 2009, we employ two different approaches to identify the causal effects of commute costs. First, we employ a regression discontinuity design (RDD) that compares work time before (2000 to 2003) versus after (2007 to 2009) the transition of all four class levels to the new campus and controls for unobservable confounding factors by including teacher and academic-year fixed effects. Since this approach relies on aggregate variation it could be subject to confounding factors coinciding with the campus transition. To address this, we employ a second approach that uses individual-level variation in commute costs during the transition years. Commute costs change at different times for different faculty during the transition years depending on their course schedule allowing us to apply a difference-in-differences (DD) analysis. Reassuringly, both approaches yield similar estimates.

In contrast to GPVO (2010), we find a significant labor-supply response to increased commute costs. They estimate an elasticity of -0.009 of work time with respect to commute distance compared to our estimated elasticity of -0.19 of work time with respect to commute time,[3] highlighting the concern with their excluding high commute-cost sensitive workers. We estimate that the 1.0 to 1.5 hour increase in commute time per teaching day reduces annual teaching time by 56 hours, a 22% reduction in the 249 average teaching hours before the transition. Since faculty average 80 teaching days per year before the transition, teachers value commute time at 47 to 70% of their hourly wage.[4]

We offer several pieces of corroborating evidence to supplement the RDD results. During the transition to the new campus, faculty teaching freshmen incur higher commute costs sooner because freshman transition first. Those teaching sophomores incur the higher commute costs next soonest, followed by those teaching juniors, and finally those teaching seniors. Comparing the effect on work time for teachers with differential changes in commute costs using a DD approach is immune to any confounding factors not correlated with individual-level commute costs. Using this

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[3] A decrease of 55.9 annual hours of work time from an average of 248.8 annual hours before the transition due to an increase of 37.5 minutes (the midpoint of 30 to 45 minutes) in one-way commute time to the satellite campus from 10 minutes initially (walking to class on the main campus) using the midpoint method.

[4] Many studies estimate the value of commute time relative to wage. However, this only estimates the equilibrium trade-off between commute and work time in a reduced-form way and does not provide structural parameters for evaluating transport policy or labor market outcomes (Gibbons and Machin, 2006, page 7). This literature has yielded a large range for the value of commute time – from 0.5 to 3 times the wage rate (Small, 1992; Timothy and Wheaton, 2001, Small and Verhoef, 2007). Gibbons and Machin (2006) place the center of these estimates around 50% which is at the low-end of our estimates.

approach we find that work time falls more for teachers exposed to higher commute costs in a given year. Each additional commute day decreases annual work time by 0.66 hours per transition year. Given an average increase of 14.5 commute days per transition year, we estimate a cumulative decrease in annual work time of 38 hours. Since commute costs are endogenous during the transition periods (teachers with high commute-cost sensitivity will work harder to shift away from teaching class levels that transition earlier) this represents a lower bound.[6]

Our other corroborating evidence relies on theoretical predictions from a labor supply model. Commute costs vary with days worked but are fixed with respect to daily hours conditional on working that day. Therefore the increased commute time from the transition to the satellite campus should decrease work days but increase daily hours. Consistent with this, our RDD estimates indicate annual work days fall by 27.2 while daily hours increase by 0.49. Our DD estimates are qualitatively similar but lower in absolute value consistent with endogeneity bias. This aspect of our results has ramifications for how theoretical labor supply models should be constructed.[7] Some assume that work days are fixed and daily hours chosen (Cogan, 1981) while others assume the opposite (Parry and Bento, 2001). Our results imply that both margins respond to increased commute costs.

Besides undergraduate teaching, faculty may also devote work time to graduate teaching, research, and consulting. Since their location is unaffected by the campus transition,[8] these activities become relatively more attractive when commute time for undergraduate teaching increases. However, time spent on these activities might decrease because increased time and fatigue from commuting crowds them out. While we do not observe consulting activities, we have data for graduate teaching hours and research output to test substitution toward these activities. Using the same RDD approach we find graduate teaching increases due to the transition by 27 hours annually per teacher engaged in graduate teaching. This is about 24% of the decrease in undergraduate teaching time. On the other hand, the number of academic research papers produced annually by the faculty decreases by 0.30.

Female labor supply is generally thought to be more responsive to labor market changes. Black, Kolesnikova, and Taylor (2008) find that female work time is more sensitive to commute costs although they acknowledge that their results represent equilibrium not structural relationships. In contrast, we find no significant difference in male and female responses to the campus transition. We also find no significant difference in the response by faculty of different positions (assistant, associate, and full). If we examine differences in gender reactions controlling for position we find weak evidence that male assistant professors respond less than female assistant professors but find no significant gender differences at any other position.

As the teachers in our data have great flexibility on the intensive margin of work time we are cautious in extrapolating our results to workers with less flexibility. However, as the number of “knowledge workers” and telecommuting increase (Florida, 2004),

[6] The same endogeneity problem does not occur in our RDD estimates because they compare before the transition begins to after it is fully completed when there is no means to avoid commute costs for any undergraduate course.
[7] Cogan (1981) comments on the importance of accounting for fixed costs of working in labor force participation.
[8] As described later, a portion of graduate teaching transitioned late in our sample period.

our results indicate that commute costs can have significant effects on labor supply and should be considered in transportation network design, traffic congestion policies, and firm location decisions. These imply that shortening commute times can stimulate labor supply and the long-run employment growth of cities.

There is an extensive theoretical literature discussing the welfare implications of replacing income taxes with congestion taxes (such as highway or peak-traffic tolls) in a revenue-neutral way. A number of these papers emphasize the importance of endogenizing the value of time because the decreased work time from higher commute costs may more than offset the benefits of the income tax reduction (Parry and Bento 2001; De Borger and van Dender, 2003; Mayeres and Proost, 2001). Our results confirm the importance of including labor market distortions from a congestion tax in calibrating these models. Our results also imply that firms, at least those whose employees have flexible work times, can reap great benefits from providing convenient and quick transportation.

Our paper also has implications for higher education quality in China. Total undergraduate enrollment in China increased from 2.0 million in 1998 to 8.7 million in 2010 and the gross enrollment rate (proportion of 18 to 22 year olds enrolled in higher education) has increased from about 3% in 1990 to nearly 27% in 2010.[9] The number of universities has not kept pace leading to higher enrollments per university: from around four thousand students per university in 1997 to fourteen thousand in 2006. Many universities have accommodated this expansion by increasing their campus size. If located in congested downtown areas, this often requires building a satellite campus away from the original. As of 2009, more than sixty universities had established satellite campuses;[10] a move local governments often support to stimulate economic output and boost real estate prices. At the national level the Ministry of Education once encouraged universities to expand enrollments although more recently it has begun to restrict the expansion process.[11]

Although we cannot directly estimate the effect of higher commute costs on academic performance we offer indirect evidence of how the university accommodated the dramatic decline in teaching hours. The student-teacher ratio is approximately the same at the end of our sample period as before the transition ruling out changes in enrollment or faculty size as a major margin of adjustment. We do find that the university dramatically increased class sizes after the transition – accounting for an increase in student-class hours more than three times the reduction due to commute costs. This has implications for teaching quality and students' academic performance because of reduced interaction between students and teachers. A second possible dimension of adjustment is students taking fewer courses. We are unable to assess this possibility but it would also indicate a decline in educational quality. Given this, government policies to promote satellite campuses deserve some scrutiny given their potential effect on educational quality.

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[9] According to Ministry of Education available at http://www.moe.gov.cn/.
[10] "Development Patterns of College Towns in China," Wei Zhou (2009), M.A. Thesis (in Chinese), Zhongshan University. Available online at http://wenku.baidu.com/view/55b71960ddccda38376baf91.html.
[11] "Six Universities Will Build Satellite Campuses in the Satellite Cities," *Beijing Daily*, July 14, 2011

2. Empirical Setting

We examine commute costs introduced by the transition of undergraduate teaching to a newly-opened satellite campus at a well-established Chinese university.[12] The university's main campus is in the city center and the satellite campus is 20 kilometers away in the city suburbs.[13] The process began in calendar year 2000 with a plan to obtain land and a year later the university signed a contract with the city government to buy a parcel. In calendar year 2002 bidding for the campus design was held and later that year a national newspaper announced that the first year of students would enter the new campus in 2003, a date which was later postponed to 2004. This announcement is a key date because it means that prior to late 2002 the faculty was aware of a new campus being built but unaware of how the transition would proceed. This means that any efforts by the faculty to change their teaching schedule away from teaching freshman courses (the first to be taught at the new campus) began in academic year 2003.

The groundbreaking ceremony for the new campus was held in early calendar year 2003 and in academic year 2004 the entering freshman class lived and took courses at the satellite campus. Therefore, in 2004 freshman took courses at the satellite campus while sophomores through seniors took them at the main campus. In 2005, another new class entered at the new campus so that freshman and sophomores took courses at the satellite campus while juniors and seniors took them at the main campus. In 2006 only seniors took courses at the main campus while all three other class levels took them at the satellite campus. From 2007 onward all four class levels took courses at the satellite campus.

Graduate courses remained at the main campus during most of our sample period. Entering Master's students began taking courses at the satellite campus in 2008. Since they generally study for two years one-half of them were at the satellite campus in 2008 and all of them by 2009. Entering Ph.D. students began taking courses at the satellite campus in 2009. Since most Ph.D. students study for three years approximately one-third were taking courses at the satellite campus in 2009.

Few teachers moved to the satellite campus during our sample period. The university continued to provide subsidized housing at the main campus and did not complete construction of faculty housing at the satellite campus until after 2010. The university provided a shuttle bus for faculty to commute between the two campuses and because it was free and convenient virtually all faculty used it. Therefore, our estimates measure the effect of an exogenous increase in commute time but not monetary cost. The shuttle trip takes about thirty minutes in each direction plus ten to fifteen minutes of walking and waiting on each end. Since the time required varies depending on random variation in weather, traffic, and wait times we assume that commute time increased between 1.0 and 1.5 hours per commute day.

[12] For confidentiality reasons we cannot identify the university. For the same reason we do not provide references for the background information on the campus opening all of which were obtained from local newspapers.
[13] Based on "Google Maps" driving distance for the route normally taken by the free shuttle bus.

Our data consists of the complete undergraduate and graduate course schedule for the university from 2000 to 2009.[14] This provides four years before the transition and three years in which all four class levels were taking courses at the satellite campus. For each course we know its academic semester, teacher, class level (freshman, sophomore, junior, or senior), number of students (class size), days and times of meeting,[15] course hours (credits or weekly hours taught), classroom location, and number of weeks. We can identify the class level for each course because in China, unlike the U.S., most courses are taught to a single undergraduate class level. This is important for our estimates using the transition period (2004 to 2007) since it allows us to determine which courses were taught at which campus during these years.

There are three categories of courses that are taught to more than one class level: "sports," "university," and "double degree" classes. "Sports" classes are athletic classes and are offered to any class level. "University" classes are classes that all class levels and are generally related to culture or personal development such as music, foreign languages, movie appreciation, nutrition and health, literature, and painting. In China, courses are also usually taught only to students within a major (which corresponds to a university department). The exceptions to this, "double-degree" courses, are offered to students outside of the major. Since students outside the major may take these courses at a different class level they cannot be allocated to a single class level. Since all undergraduate courses were taught at the new campus after completion of the transition it is unnecessary to allocate these to a class level for our "before-versus-after" RDD estimation.[16] We describe how we handle these in our DD estimation below. As Table 1 shows these courses, grouped together as "other," are a small fraction of courses until 2009.

We use the course hours and number of weeks taught to compute total teaching hours for each course. For co-taught courses, we divide the course teaching hours by the number of co-teachers to obtain teaching hours for each teacher. We then aggregate across all courses in a year to obtain annual teaching hours for each teacher for each year. To determine the number of teaching days for each teacher we use the day of week and semester taught for each course to identify all the dates on which that course is taught during the semester. We then identify any overlap in these dates to obtain the number of unique teaching days for each teacher in each semester. Aggregating across the two semesters we obtain annual teaching days for each teacher. Finally, we compute average daily hours (conditional on teaching that day) taught for each teacher in each year by dividing total hours by number of teaching days.

We perform our estimation based on class "hours." A class "hour" is 50 minutes prior to the transition and 45 minutes after. Therefore, our RDD results will understate decreases in work time by 10% if teaching productivity does not change after the transition. Our DD results are affected by this only in 2007. It is also possible that

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[14] The undergraduate data was obtained from the university's undergraduate education administrative office and the graduate data was obtained from the university's website.

[15] The one exception to this is that for courses taught prior to 2005 and meeting on weekends the day and time is not available. We discuss how we handle this when we discuss our results.

[16] For our DD estimation using the transition years we did not include "other" courses in our calculation of expected commute days because we do not observe the location of these courses. Thus, we may understate expected commute days somewhat.

shirking increases as a substitute for leisure time lost to longer commutes.[17] In this case, measured work time may not fully reflect output. Such effects are likely small in our setting given that teachers have flexible work schedules and work in front of a class. It is also possible that the longer commute time increases absenteeism (GPVO, 2010) but this is unlikely since teachers must make up any missed classes.

Teachers allocate their time between five major activities: undergraduate teaching, graduate teaching, research, consulting, and leisure. The university's total compensation for a faculty member can be represented as $F + B + wH_T$. F is a fixed annual payment based on seniority, position, and administrative duties and is largely based on a nationwide standard and fairly uniform across faculty.[18] B is a bonus paid for research publications and is given on an annual basis. Research also provides non-pecuniary benefits such as prestige, personal satisfaction, and future career advancement. The last component is the linear payment for teaching where w is the hourly wage and H_T is the number of "hours" (50 minutes before the transition and 45 minutes after) taught. The wage increased over time: RMB 20 in 2001 and 2002, RMB 40 in 2003 and 2004, RMB 60 from 2005 to 2007, and RMB 90 from 2008 onward.[19] Since F and B do not change within academic years, we control for them by including academic-year fixed effects in our estimation.

The increase in salaries over time might lead us to understate the effect of commute costs on teaching time. However, since we do not know how the returns to outside activities are changing we do not know how effective wages are changing. Our approach is to control for the value of wages relative to the outside option by including academic-year fixed effects in our estimates. Since wages are constant within an academic year any effects from wage changes will be absorbed by these fixed effects. In an even more demanding specification we allow for teacher-specific time trends. Our transition estimates rely on teacher-specific variation in commute costs which are immune to changes in the aggregate wage.

Subject to a minimum teaching load (there is no maximum) a teacher has great discretion in choosing their teaching hours to maximize their utility given the wage. The general process is the following. Each faculty member submits their teaching preferences to the department staff which figures out course scheduling. The schedule is submitted to a university-wide administrative office that assigns classrooms for each course. Roughly, departments determine courses and schedule while the university determines locations. In the background, department heads may influence the courses taught by individual faculty and different faculty members may have differing levels of power in negotiating. We control for this by including teacher fixed effects in our regressions and check the robustness using a teacher-specific time trend. In other specifications, we control for teacher position since faculty in higher positions may have more leverage.

[17] Ross and Zenou (2008) find evidence for this among highly-supervised blue-collar workers.
[18] Faculty with an overseas Ph.D. and domestic faculty hired since 2006 are hired under three-year contracts. All other domestic faculty have permanent contracts.
[19] We do not believe that wage changes are anticipated by faculty because they are determined by human resources or a university-level committee and only then announced to faculty members. Therefore, we do not believe faculty will change their teaching schedules dynamically in anticipation of wage changes.

The minimum annual teaching load for faculty changed somewhat during our sample period from 240 hours in 2001 to 2004 to 225 hours per year from 2005 onward.[20] Faculty with a foreign Ph.D. had to meet a minimum of only 160 hours per year but these are a small portion of our data since the university only recently began hiring them.[21] Teachers received 1.5 hours of credit for each hour teaching Master's students throughout our sample period.[22] Teachers are paid for courses used to satisfy their minimum teaching load as well as those above.[23]

Ideally, we would directly control for the minimum teaching load by estimating a tobit regression. However, we cannot because teachers may use other activities to fulfill this requirement and we not observe these. These include supervising graduate theses,[24] administrative tasks, and supervising student internships and study trips. Although we cannot control for these, to the extent that the minimum teaching load binds for some faculty it will bias us against finding an effect from the increased commute costs because the locations for these other activities are unaffected by the campus transition. We control for the change in the minimum teaching requirement over time through year fixed effects, flexible time trends, and teacher-specific time trends.[25]

Faculty size, student enrollment, graduation requirements, and class sizes could all affect demand for teaching at the university level. However, for an individual faculty member these demand factors are summarized by the wage which we control for through academic-year fixed effects. There is the possibility of other market-clearing mechanisms. In particular, department heads may put pressure on faculty to teach. We control for the aggregate effect of this in each year by including academic-year fixed effects and at the individual faculty level by including teacher-specific fixed effects. Moreover, this would bias us against finding an effect unless department heads pressured faculty to teach less after the transition. This alternative explanation also does not explain the annual days and daily hours results.

Graduate teaching hours and research output could increase or decrease after the transition. Since their location is unaffected by the transition faculty may substitute toward them. However, the increased commute time and the fatigue it creates may crowd out these activities. We examine the effect on both using our RDD design. We measure graduate teaching hours in the same manner as undergraduate; however, we are unable to decompose the effects into annual days and daily hours because we do not observe the days on which courses are taught. We measure research output using publications in academic journals.

[20] This is for department-specific courses. For "university-wide" and "sports" courses the minimum was 320 hours per year from 2001 to 2004 and 300 from 2005 onward. Faculty in the English, sports, and math departments primarily teach these courses although members of these departments also teach department-specific courses.
[21] We also check the robustness of our results to excluding foreign Ph.D. holders. Foreign Ph.D. holders are defined as faculty holding a Ph.D. from a non-mainland China university
[22] Foreign Ph.D. holders did not receive this discount.
[23] Faculty with a foreign Ph.D. are paid only for hours exceeding the minimum teaching load.
[24] Supervising an M.A. (Ph.D.) student for one year equals 30 (60) undergraduate teaching hours.
[25] The variety of activities available for meeting the minimum teaching load varies by position. For example, only associate and full professors can supervise Master's theses and only full professors can supervise Ph.D. theses. We make sure our results are robust to this by including position controls in some specifications.

3. Theoretical Background

In this section we model the effect of an increase in commute time on daily hours, annual days, and annual hours for workers with discretionary work time.[26] Because additional commute time increases fixed costs per work day workers will concentrate more hours per day in fewer days. Total work time could either increase or decrease. We show this using a modified version of the model by GPVO (2009). They generalize a standard labor supply model with commute costs to allow for the choice of days worked and daily hours rather than just total work hours. We adapt their model in two main ways to reflect our setting. Their model allows for a concave wage function consistent with declining marginal productivity. We instead use a linear wage function but assume a convex effort cost which diminishes the value of leisure. We also zero out the monetary commute costs in GPVO (2009) consistent with the free shuttle service to the satellite campus. Despite these differences, the two models' implications are qualitatively similar.

A teacher's annual utility is $v = V(C, L)$ where C is annual consumption, L is annual leisure time, and V is differentiable and concave.[27] As described earlier, a teacher's annual compensation is $S + wDH$ where $S = F + B$ combines the two components of their fixed annual salary, w is their hourly teaching wage, and we have decomposed annual teaching hours $(H_T = DH)$ into annual days (D) and daily hours (H). A teacher's annual budget constraint is $C = Y + S + wDH$ where Y is annual non-labor income. Annual time is divided between teaching and leisure and each teaching day requires round-trip commute time of t.[28] Each additional daily teaching hour requires effort that decreases utility from daily leisure by $e(H)$ with $e'(H) > 0$ and $e"(H) > 0$ representing fatigue which makes leisure less pleasant. A teacher's annual time constraint is $\bar{T} = L + D(H + t)$ where $\bar{T}$ is total annual hours. Substituting the budget and time constraints and including the effect of the disutility of effort:[29]

(1) $v = V\left(Y + S + wDH, \bar{T} - D\big(H + t + e(H)\big)\right).$

The two first-order conditions are:

(2) $V_Y wD - V_L D\big(1 + e'(H)\big) = 0$, and
(3) $V_Y wH - V_L\big(H + t + e(H)\big) = 0.$

[26] In our empirical setting there are two possible constraints on work time: a minimum teaching requirement and moral suasion from the department head. We do not model these constraints but as discussed above these will both bias us against finding an effect. Either of these might bind differentially across faculty but we include teacher fixed effects in estimation.
[27] That is, $V_{LL} < 0, V_{YY} < 0$, and $V_{LY} > 0$.
[28] As discussed earlier, teachers may have other work obligations besides teaching. For expositional ease, "annual days," "daily hours," and "annual hours" refer to time spent teaching. Thus, time spent on consulting and research is subsumed into leisure. Our model assumes an equal number of hours across days. In our data they are unevenly distributed but this does not qualitatively change the model's implications.
[29] The problem should also include a constraint on the maximum number of daily hours. For simplicity, we assume an interior solution.

Equation (2) says that the marginal utility of consumption from an extra hour of work each day equals the foregone marginal utility of leisure that day including the effect of fatigue. Equation (3) says the same from working an extra day during the year. Combining these two the optimally chosen daily work time fulfills:

(4) $e'(H) = \frac{t+e(H)}{H}$.

The teacher equates the marginal disutility of effort to the average daily disutility of working (including both commute time and effort). That is, the teacher will smooth the hours worked per day across days to avoid the escalating costs that come with working very long days (*i.e.*, it is better to have two ten-hour days than one twenty-hour day). It follows immediately from (4) that an increase in daily commute time increases daily hours worked:

(5) $\frac{\partial H}{\partial t} = \frac{1}{e"(H)H} > 0.$

Given higher daily commute costs, teachers will spend more hours teaching once they arrive at the satellite campus so as to avoid additional trips on other days. In Appendix A we show that an increase in commute time decreases annual days worked. Teachers concentrate their teaching in fewer days to avoid the extra time from commuting each work day. Therefore, an increase in commute time increases daily hours but decreases annual days. In Appendix A we show that an increase in commute time has an ambiguous effect on total hours worked per year (DH). Whether it increases or decreases depends in particular on the curvature of the effort costs. If effort costs do not increase too rapidly with daily hours worked then increased commute costs may increase total work time.

4. Econometric Model

We model the work time for teacher i in academic year $2000 \leq t \leq 2009$ as:

(6) $Y_{it} = \alpha_i + g(t) + \tilde{\beta}_i\left[\bigcup_{c\in Q}(Tr_t^c CD_{it-1}^c)\right] + X_{it} + \tilde{\varepsilon}_{it}$,

where Y_{it} is one of three measures of work time (annual hours, annual days, and daily hours), α_i is a teacher fixed effect which absorbs time-constant unobserved work-time preferences, $g(t)$ is a function of academic years that captures time-specific unobserved factors affecting work time, $Q = \{Fr, So, Ju, Se\}$ is the set of four class levels, CD_{it}^c is the number of days teacher i would have to commute to the satellite campus based on their academic-year t schedule and assuming that level c students had transitioned to the satellite campus, Tr_t^c is a dummy variable set equal to one beginning in the academic year in which level c has transitioned to the satellite campus and zero before, and $\tilde{\varepsilon}_{it} \sim N(0, \sigma_\varepsilon^2)$ independently across teachers and years. We control for teacher-specific characteristics X_{it} such as position. We do not allow for time-varying, university-wide characteristics because they are subsumed in $g(t)$. These include wages, student enrollment, faculty size, class size, curriculum, and graduation course requirements. β_i captures the effect of increased commute time on work time for teacher i.

The model assumes that a teacher's commute costs in year t are proportional to the commute days they would incur based on their year $t-1$ teaching schedule. For example, in 2004 the freshman class transitioned to the satellite campus. We assume that the expected number of commute days for a teacher in 2004 is equal to the number of unique dates that they taught a freshman-level class in 2003. Consider a teacher who taught for twenty weeks in 2003 and taught two freshman classes on Tuesday, one freshman class on a Thursday, and only non-freshman classes all other weekdays. Their expected number of commute days in 2004 would be forty (two unique commute days per week for twenty weeks). We use the union of commute days across all levels that have transitioned to the satellite campus because if a teacher teaches two different class levels that have transitioned to the new campus on the same day then they need only commute once that day.[30]

We consider a teacher's lagged teaching schedule to be the best proxy for their expected commute costs in the current year. A teacher's current schedule is invalid because it is simultaneously determined (if commute costs decrease a teacher's work time they will also decrease their contemporaneous number of commute days). Using the lagged teaching schedule is problematic in that teachers' schedules may change over time for random and non-random reasons. Random reasons such as changes in students' or the teacher's interests will introduce noise and make estimates less precise but are not of major concern since they will make it less likely we find a significant effect. Of more serious concern is that teachers may alter their schedule in non-random ways that introduce endogeneity bias into the estimates. In particular, teachers will attempt to shift away from teaching classes to class levels that impose higher commute costs. For example, between 2003 and 2004 teachers will try to change their schedule to avoid teaching freshman-level classes.

We believe the lagged schedule is still a reasonable proxy because changing teaching schedules is costly for two reasons. First, teachers must convince the department head to allow them to do so and all other faculty have an incentive to make similar appeals. Second, it requires developing a new course which imposes fixed costs on the teacher. Faculty members may also attempt to swap courses to reduce their collective commute time but that requires solving a difficult matching problem.

Our main estimates compare only pre- and post-transition data. This avoids the endogeneity issue because all four class-levels are taught at the satellite campus after the transition and such avoidance behavior is impossible. In fact, we use a transformed model which does not depend on commute days and thereby avoids even the noise due to random changes in schedules. Our secondary estimates that take advantage of individual variation in commute days during the transition years will be

[30] For example, in 2005 both freshman and sophomore class levels have transitioned to the satellite campus. A teacher's commute costs will now be proportional to the number of unique dates they teach either freshman- or sophomore-level classes in 2004. Consider a teacher who taught for thirty weeks in 2004 and taught one freshman- and one sophomore-level class on Monday, two freshman-level classes on Wednesday, and one sophomore-level class on Friday and only junior- and senior level classes on Tuesday and Thursday. Their expected number of commute days in 2005 would be ninety (three commute days per week for thirty weeks).

affected by the endogeneity bias. However, this will bias our estimates toward zero because teachers with higher commute-cost sensitivity will work harder to shift their schedule away from class levels that transition earlier.

We assume that commute-cost sensitivity across consumers is $\tilde{\beta}_i = \tilde{\beta} + \sigma_{i\beta}$ with $\sigma_{i\beta} \sim N(0, \sigma_\beta^2)$ independently across teachers and independently of $\tilde{\varepsilon}_{it}$. Commute-cost sensitivity may vary across teachers because they differ in their schedules for other activities or because of their family situation such as whether they have dependents.

Before versus After (RDD) Model

In our main model we use the "before and "after" years of:

(7) $Y_{it} = \alpha_i + g(t) + \tilde{\beta}_i[D_t x CD_{it-1}^{To}] + \tilde{\varepsilon}_{it};\ t \in \{00, \ldots, 03; 07, \ldots, 09\}$,

where $CD_{it}^{To} = \bigcup_{c \in Q} CD_{it}^c$ is total commute days across all class levels and $D_t = Tr_t^{Fr} \times Tr_t^{So} \times Tr_t^{Ju} \times Tr_t^{Se}$ is a dummy variable set to one after all class levels have moved to the new campus ($t \in \{07, \ldots, 09\}$) and zero before ($t \in \{00, \ldots, 03\}$). Importantly, teacher commute-cost sensitivity $(\tilde{\beta}_i)$ is uncorrelated with the number of commute days since the teachers' schedules are set prior to the university announcing the transition sequence (after academic year 2003 began). To avoid relying on a lagged measure of commute days (which would introduce the endogeneity problems discussed earlier) we transform Equation (7):

(8) $Y_{it} = \alpha_i + g(t) + \beta D_t + \varepsilon_{it};\ t \in \{00, \ldots, 03; 07, \ldots, 09\}$.

Under this formulation, $\beta = \tilde{\beta}\overline{CD}^{To}$ where $\overline{CD}^{To}$ is the average number of commute days across all teachers and years after the full transition to the satellite campus (2007 – 2009). It captures the average effect on the outcome variable Y_{it} of moving all class levels to the satellite campus. This transformed equation can be interpreted as an RDD design which estimates if any pre-existing time trend in the work time variable is altered after the transition conditional on the control variables.

The error structure in Equation (8) is heterosckedatistic and serially correlated within teacher but independent across teachers: $E[\varepsilon_{it}|D_t] = 0$, $E[\varepsilon_{it}^2|D_t] = D_t(\overline{CD}^{To})^2\sigma_\beta^2 + \sigma_\varepsilon^2$, $E[\varepsilon_{it}\varepsilon_{is}|D_t, D_s] = [1 + D_t D_s((\overline{CD}^{To})^2 - 1)]\sigma_\beta^2$, $t \neq s$, and $E\left[\varepsilon_{it}\varepsilon_{js}|D_t, D_s\right] = 0, i \neq j, \forall s, t$. We accommodate this structure by allowing for standard errors clustered by teacher-transition cell and robust to heteroskedasticity.

Transition (DD) Model

Although our RDD model is unlikely to be subject to time-varying confounding factors since we include academic-year fixed effects, we can further rule this out by examining the transition years 2004 to 2007. Here we take advantage of individual variation in commute costs by using the fact that class levels transition one at a time each year to the satellite campus. Work time should be disproportionately affected for those who teach class levels that have transitioned to the satellite campus relative to those who teach class levels that have not transitioned.

Taking first differences using Equation (6), we obtain:

(9) $\Delta Y_{it} = f(t) + \tilde{\beta}\left(\bigcup_{c\in Q} Tr_t^c CD_{it-1}^c - \bigcup_{c\in Q} Tr_{t-1}^c CD_{it-2}^c\right) + \Delta\varepsilon_{it};\ t = 04, \ldots, 07,$

where $f(t)$ is a function of academic years that captures time-specific unobserved factors affecting the change in work time and $\Delta\varepsilon_{it} = \tilde{\varepsilon}_{it} - \tilde{\varepsilon}_{it-1} + \sigma_{i\beta}\left(\bigcup_{c\in Q} CD_{it-1}^c - \bigcup_{c\in Q} CD_{it-2}^c\right)$. The second term arises because beta contains a random component across individuals. This random component is scaled up or down with the change in commute days. This allows for random changes in the distributions of courses across academic years (*i.e.*, CD_{it}^c may differ from CD_{it-1}^c for random reasons) but does not incorporate purposeful changes by teachers to avoid teaching courses with high commute costs. However, endogeneity bias will tend to understate the effects we find. If teachers on average substitute away from teaching classes held on the satellite campus then our lagged measure of commute days will be overstated. This means our regression will attribute too small an effect (in absolute value) of commute days on work time.[31]

We drop X_{it} from the regression because we do not estimate the transition regressions controlling for teacher demographics.[32] The covariance structure is:

$E[\Delta\varepsilon_{it}|CD_{it-1}^c, CD_{it-2}^c] = 0$, $E[\Delta\varepsilon_{it}^2|CD_{it-1}^c, CD_{it-2}^c] = \left(\bigcup_{c\in Q} Tr_t^c CD_{it-1}^c - \bigcup_{c\in Q} Tr_{t-1}^c CD_{it-2}^c\right)^2 \sigma_\beta^2 + 2\sigma_\varepsilon^2$,

$E[\Delta\varepsilon_{it}\Delta\varepsilon_{is}|CD_{it-1}^c, CD_{it-2}^c, CD_{is-1}^c, CD_{is-2}^c] = \left(\bigcup_{c\in Q} Tr_t^c CD_{it-1}^c - \bigcup_{c\in Q} Tr_{t-1}^c CD_{it-2}^c\right)\left(\bigcup_{c\in Q} Tr_s^c CD_{is-1}^c - \bigcup_{c\in Q} Tr_{s-1}^c CD_{is-2}^c\right)\sigma_\beta^2$, $t \neq s$, and

$E\left[\Delta\varepsilon_{it}\Delta\varepsilon_{js}\middle|CD_{it-1}^c, CD_{it-2}^c, CD_{js-1}^c, CD_{js-2}^c\right] = 0, i \neq j, \forall s, t.$

This can be estimated by including academic-year dummies or a flexible time trend and allowing for standard errors clustered by teacher and robust to heteroskedasticity.

5. Data

Table 2 shows descriptive statistics for the data.[33] Panel A1 shows data for the 1,058 teachers present in at least one year before or after the transition. An observation is a

[31] We attempted to estimate a regression using commute days in academic years prior to the announcement of the campus transition as an instrument for lagged commute days in Equation (9). The results were statistically insignificant presumably due to the high level of noise introduced by such a long time lag and a much smaller sample size.

[32] We drop these because gender and foreign Ph.D. status do not change over time and few teachers change positions during the transition years. The results are robust to inclusion of teacher fixed effects.

[33] We must drop some course-year observations from the data because of missing or unclear information: those taught by faculty that appear in only one year and are dropped with teacher fixed effects, those missing a teacher name or with a department or school name as the teacher, those taught by teachers under short-term contracts and are not permanent staff of the university including foreign, retired, rehired (after retirement), and adjunct faculty.

teacher-year. These teachers taught an average of about four years. Annual hours taught average 234 and range from 2 to 1,088. Annual days taught average 65 and daily hours 3.5 (condition on teaching that day). For annual days and daily hours we drop 241 teacher-course observations because we are missing information on day of the week taught. In doing so, we lose 27 teacher-year observations for which there is no day-of-week taught information for any courses. These are not dropped for annual hours because hours are available even if day of week is not. Also, courses taught on weekends are identified beginning only in the second semester of 2005. Prior to this, we cannot distinguish courses taught on weekends from missing values for other reasons. Therefore, our counts of days worked will be understated slightly prior to 2006. This will bias us against finding a decrease in annual days worked after the transition.

There are dramatically fewer teaching hours at the senior level consistent with Chinese universities requiring less course work and more field projects and independent work in that year. More of the observations belong to later academic years because the number of courses increases over time but they are roughly evenly split before versus after the transition because we have four years of data before and three years after. Sixty percent of the teacher-year observations are attributable to male faculty and about three percent have a foreign Ph.D. Positions follow a pyramid structure with 50% of faculty at the assistant level, 32% at the associate, and 18% at the full professor level.[34] Some of our specifications divide faculty into an “early” (joined during or before 2000) and a “late” (joined from 2001 to 2003) cohort. Fifty-six percent are in the early and 19% are in the late cohort. About twenty five percent are in neither category because they joined after 2003.

Panel A2 summarizes data for the 477 teachers who were present in at least one year before and one year after the transition. Since we include teacher fixed effects in our estimation, this is the data that identify the transition effects. Each teacher in the sub-sample taught for about six years. The summary statistics are very similar to those for the full sample except that somewhat fewer occur after the transition and they are more evenly distributed across years consistent with the faculty growth over time. This also implies that a higher proportion come from the early cohort than in the full sample. Even fewer hold foreign Ph.D.’s in this sub-sample, consistent with more such faculty being hired over time.

The raw data exhibits the same patterns that our formal results show later. Annual teaching hours drop by 27.8 hours after the transition while annual teaching days drop by 26.5 and daily hours increase by 0.9. The effects are similar in the sub-sample with a drop of 29.1 hours, a drop of 26.8 days, and an increase of 0.8 hours.

Panel B shows descriptive statistics for the four transition years. On average expected commute days (based on the teachers’ prior year schedules) increased by 14.5, annual hours decreased by 15.1, annual days decreased by 7.4, and daily hours increased by

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We also drop course-year observations with fewer than two hours per semester because these are one-time seminars or lectures rather than courses.

[34] We obtain position, gender, and Ph.D. source from the university website. Gender is based on online photos or name if it uniquely indicates gender. The number of observations for position information is somewhat lower because we were unable to collect this information for some faculty.

0.14 in each transition year.[35] Panel C summarizes the data on class sizes at the teacher-course level. There are 21,314 teacher-course observations, an average of five per faculty member.[36] Different sections of the same course, which we can identify because we know the time and location for each class meeting, are treated as separate courses. This is appropriate for two reasons. First, a teacher is paid separately for each session. Second, to measure quality we care about the number of people in each section not the total number across all sections of the same course. Again the raw data demonstrates the same effects as our formal estimates. Class size is 60.2 students before the transition and increases by 6.5 students after. Panel D shows that annual teaching hours for graduate courses increased by 1.5 after the transition.

We obtain research output data on all faculty from the university's Research Support Office. Because it is important in both determining faculty members' salaries and promotions and establishing the university's reputation we are confident that the data is accurate and comprehensive. During our sample period, China's Ministry of Education attributes research output to a university only if the first author's affiliation is the university. The university applied this same criterion in crediting faculty so we only count papers toward a faculty member if they are the first author. Therefore, we observe first author's name, journal name, journal rank, and publishing date. Based on the journal rank, we designate papers as appearing in either "top" or "non-top" journals.[37] In our research output regressions we use research output per year as our dependent variable. Panel E summarizes the "before and after" data for the 1,075 teachers in our sample.[38] The total number of publications drops by 0.22 per year after the transition. The number of non-top publications drops by 0.24 while the number of top publications increases by 0.02.

Table 1 shows how the distribution of courses by class level has evolved over time. The boxes show the years in which that class level was taught at the satellite campus. The total number of undergraduate courses increases each year except in 2004. Other classes are a fairly stable fraction of total courses until 2009 when they jump dramatically. The total number of class-specific undergraduate courses varies a lot year-by-year with no clear pattern. There is also no obvious pattern in the distribution of courses across the four class levels.

Table 3 shows how student enrollment, teaching hours, and class sizes have evolved over time for each class level and in total. The raw data again demonstrate the effect that our formal tests reveal. Total class-specific teaching hours drop significantly in 2004 when the transition begins and again in 2007 when all four class levels have

[35] As noted earlier, the data only identify weekend teaching days beginning in second semester 2005. Prior to this we have no means to determine whether data is missing due to this or for some other reason. As with our main estimates we include weekend days as a work day after second semester 2005 but drop missing values both prior to and after this time. This will bias us against finding an effect.

[36] In the course-level data we drop 349 courses with less than four students because these likely indicate data errors. These are dropped only from the class-size regressions.

[37] The Research Support Office ranks Chinese journals as A1, A2, B1, B2, or C and English journals as A, B, or C. A1 and A2 Chinese journals are the top general interest and field journals in China. English A journals are top general interest journals and English B journals are top field journals. Since publishing papers in English is difficult, we designate Chinese A1 and A2 and English A and B journals as "top." All other journals we designate as "non-top."

[38] There are more teachers than in our teaching sample because some hold research-only positions, hold administrative positions, only supervise graduate students, or do not teach in any year for some other reason.

transitioned. Prior to the transition teaching hours are increasing. In all other years they are roughly constant except in 2009 when they decline dramatically again. At the class level, teaching hours decline in most years after the transition begins but increase in most years prior. The number of “other” courses is cut in half at the completion of the transition but more than double in the last year of our data.

There is no obvious trend in class size but there does appear to be a distinct increase in class size beginning in 2006. For the graduate teaching data, the most striking aspect is that teaching hours increases dramatically in all of the transition years and this new higher level is maintained until 2009.[39] This is consistent with substitution of teaching time to graduate students once commute costs for undergraduate teaching increase.

6. Results

Our results confirm the theoretical predictions from Section 3. Annual days worked decrease and daily hours increase consistent with a longer commute imposing higher daily fixed costs. Although theoretically the net effect could either be positive or negative we find an overall decrease in work time. Our preferred estimates indicate a decrease of 27.2 annual days, an increase of 0.49 daily hours conditional on working that day, and an overall decrease of 55.9 annual hours. The estimates are also internally consistent. Daily hours worked before the transition was 3.0 so a decline of 27.2 work days implies decreased work time of 81.6 hours. Work days averaged 79.8 before the transition so an increase in daily hours of 0.49 implies an increase of 39.1 annual hours. The net effect is 42.5 – close to our estimate of an overall decline of 55.9 annual hours.

The average teacher in our data would pay RMB 42 – 63 (USD 6.6 – 9.9)[40] to avoid one commute hour given their year 2011 hourly wage of RMB 90 (USD 14.2). Put differently, faculty on average dislike teaching more than commuting and would prefer 1.4 to 2.1 hours commuting to one hour teaching. This is consistent with greater dis-amenity from teaching than commuting (Becker, 1965). A class “hour” was reduced from 50 to 45 minutes after the transition. Therefore, the hourly effects we estimate will be ten percent lower if expressed in class minutes rather than class “hours.” The correct interpretation depends on whether ten percent less effort is expended and knowledge conveyed per class “hour” after the transition.

Annual Hours Worked (RDD Estimates)

Table 4 shows the results of estimating Equation (8) with annual hours as the dependent variable. The OLS regression in the first column replicates the 27.8 drop in annual hours that we saw in the descriptive statistics. Column 2 adds teacher fixed effects to control for unobserved teacher preferences for working that are time-invariant and academic-year fixed effects to control for time-varying unobserved factors. These include wages, faculty size, student enrollment, class size, and

[39] The drop in 2009 may be due to the transition of some graduate students to the satellite campus by that time.
[40] Throughout the paper we use an exchange rate as of August 2012: 6.35 USD:RMB.

graduation requirements since these do not change within an academic year. Controlling for these unobservables has a substantial effect. Annual hours decrease by 55.9 hours due to the transition which is a 22.4% reduction from the 248.9 annual hours before the transition. Since a class "hour" fell from 50 to 45 minutes after the transition this implies a reduction of 20.2% in class minutes of teaching due to the transition. This is our preferred, or baseline, specification.

Since new teachers hired after the transition is announced may be less sensitive to commute costs than those before because they are aware of the transition, in Column 3 we include only teachers who taught in all ten years of our time frame. The results are lower but not statistically different. The desire of individual teachers to work may change over time due to promotions, changes in research productivity, negotiation power to change courses, or changing financial conditions. To accommodate such time-varying individual characteristics we add a quadratic teacher-specific time trend to the balanced-panel regression. Column 4 shows the results which are similar to the balanced panel results.

It is also possible that the incentives of faculty hired prior to the transition changed over time due to a change in faculty composition. To see if this is the case we interact the transition variable with a dummy variable if the teacher was hired during or before 2000 (early cohort) versus from 2001 to 2003 (late cohort). Column 5 shows the results. The drop is somewhat larger for the early cohort but the difference is not statistically significant. Since the contracts for teachers with foreign Ph.D.'s differ from other faculty they may be differentially affected by the transition. Estimates without the few teachers who hold foreign degrees (Column 6) yield results virtually identical to the baseline results.

Other factors such as income effects from secular price appreciation in faculty-owned housing may create a pre-existing time trend prior to the transition. To control for this, Appendix B1 shows results using a flexible time trend rather than academic-year fixed effects.[41] These estimates are greater than the baseline results and not highly dependent on the time trend order. All the point estimates fall between 59.4 and 73.3 fewer annual hours and they are not statistically distinguishable.

Annual Days Worked (RDD Estimates)

Table 5 shows the results of estimating Equation (8) with annual days as the dependent variable. As noted earlier, we lose 27 teacher-year observations in these and the daily hour regressions because we do not observe day of week for these.[42] The first column shows results from an OLS regression which replicates the 26.5-day reduction from the descriptive statistics. Column 2 adds teacher and academic-year

[41] Time trends above 5th-order created collinearity in the annual hours, annual days, and daily hours regressions.
[42] As also noted earlier, the data set only identifies weekend teaching days beginning in the second semester of 2005. Before this, we have no way of determining whether a missing value is due to the class being taught on a weekend or some other reason. To be conservative, we include weekend days taught as a work day after second semester 2005 but drop missing values both prior to and after this. This will bias us against finding a decrease in work days.

fixed effects and is our baseline specification. The results are similar – a drop of 27.2 days or 34.1% of the 79.8 days taught before the transition.

In Column 3 we include only teachers who taught in all ten years of our sample. The effect on number of days worked is slightly higher excluding new hires but the difference is not significant. Column 4 shows the results from including a quadratic teacher-specific time trend in the balanced panel regression to see if time-varying individual preferences are important. The results are close to the balanced panel results. Column 5 allows for differential effects on the early and late cohorts. Although the drop is somewhat larger for the early cohort the difference is not statistically significant, consistent with no significant differences due to faculty composition over time. Column 6 shows the results after removing the few teachers with foreign Ph.D.'s. The results are virtually identical to the baseline results.

Appendix B2 shows results using a flexible time trend. The estimates allowing for a pre-existing time trend are very similar to those using academic-year fixed effects and not highly dependent on the time trend order. All of the point estimates lie between 24.4 and 29.3 fewer work days per year and they are not statistically distinguishable.

Daily Hours Worked (RDD Estimates)

Table 6 shows the results of estimating Equation (8) with daily hours as the dependent variable. This is the number of hours worked conditional on teaching that day consistent with commute costs being incurred only if working that day. The OLS regression in the first column replicates the 0.9 increase in daily hours that we saw in the descriptive statistics. Our baseline specification in Column 2 adds teacher and academic-year fixed effects. Controlling for these unobservables has a substantial effect. Daily hours increase by 0.49 due to the transition which is a 16.1% increase from the 3.0 daily hours prior to the transition. Since a class "hour" fell from 50 to 45 minutes after the transition this implies an increase of 14.5% in class minutes of teaching after the transition.

Column 3 includes only teachers who taught in all ten years of our sample. The effect on daily hours is somewhat greater but is not statistically different. Column 4 includes a quadratic teacher-specific time trend in the balanced-panel regression. The results are not significantly different from the balanced-panel results. In Column 5 we distinguish the early from the late cohort. The increase in daily hours for the later cohort is larger but not statistically different from that for the early cohort. Column 6 shows the results after removing the few teachers who hold foreign Ph.D.'s. The results are virtually identical to the baseline results.

Appendix B3 shows results using a flexible time trend. Adding higher-order time trends has the effect of reducing the estimates although they remain statistically significant. All the point estimates lie between 0.24 and 0.48 more daily hours and they are not statistically distinguishable.

Transition (DD) Analysis

Table 7 shows the results of estimating Equation (9) taking advantage of individual-level variation in commute time during the transition years. The top panel shows results for annual hours, the middle for annual days, and the bottom for daily hours. Column 1 of the top panel includes no time controls and shows that an increase of one additional expected commute day in one transition year decreases annual hours by 0.56. Column 2 adds academic-year fixed effects (our preferred specification) increasing the estimate to -0.66. The remaining three columns show that this result is robust up to a third-order time trend.[43]

Since commute days increase by an average of 14.5 days per transition year, our preferred specification implies a decrease of 9.6 annual work hours per transition year. Multiplying by the number of transition years (four) implies annual hours are reduced by 38.3 hours per teacher from the full transition to the satellite campus. This is below our RDD estimate of 55.9 hours; however, our transition estimates are likely biased toward zero because faculty will attempt to substitute away from teaching class levels that transition earlier and those with the highest commute cost sensitivity will try the hardest to do so. Importantly, these estimates indicate that teachers facing the highest commute costs reduce work time more. This makes confounding factors extremely unlikely – confounding factors coincident with the campus transition must be correlated with commute costs at the individual level.

The columns in the middle and bottom panels are sequenced in the same order as the top. For annual days worked our preferred specification with academic-year fixed effects implies a decrease of 0.20 days per transition year for each additional expected annual commute day in a transition year. This is a somewhat larger estimate than without controlling for time-specific unobservables and is robust to using a time trend instead of dummies. Grossing this up in the same way as for annual hours implies a decrease of 11.3 annual days from the full transition to the satellite campus. This is below our estimate of 27.2 days obtained with our RDD estimates consistent with endogeneity bias toward zero.

The bottom panel shows a decrease of 0.0022 daily hours per transition year for each additional expected commute day in a transition year. These estimates are still significant although less so than for the other two measures of work hours and are robust to using a time trend rather than academic-year dummies. Grossing up these changes over the full transition yields an increase of 0.13 daily hours per day worked. This is again below our RDD estimate of 0.49 consistent with a downward bias. Overall, these results corroborate our RDD estimates and rule out confounding factors not correlated with teacher-specific commute costs.

Effect of Demographics

Table 8 examines the role of faculty demographics in the response of annual hours to commute time. Column 1 provides for a differential effect of the transition on female and male faculty. The effect is nearly the same. This result contrasts with previous

[43] Including higher-order time trends creates collinearities.

evidence that female work time is more sensitive to commute costs,[44] possibly because workers in our sample have significant discretion over their work time. Column 2 controls for the position of each teacher. Outside options to teaching may differ with position for several reasons. Given the importance of titles in China, senior faculty have greater consulting opportunities. Graduate courses are often taught only by associate or full professors and full professors are generally the only faculty position legally allowed to supervise Ph.D. theses. The baseline effect shows no difference between assistant professors (the omitted category) and associate professors. However, full professors teach less consistent with them being the only ones who can fulfill their teaching load through supervising graduate students. The transition has a negative and statistically significant effect on all faculty levels. Full professors respond somewhat more but the difference is not statistically significant.

It is possible that we find no significant difference between female and male faculty because a disproportionate fraction of senior faculty are male and the increased bargaining power that conveys offsets higher commute cost sensitivity among female faculty. Simply controlling for position (Column 3) does not reveal this effect. However, interacting position and gender (Column 4) provides weak evidence that male assistant professors respond less than female professors at the same level. There is no significant difference within the other two levels.

Appendices B4 and B5 decompose the effects on annual days and daily hours by demographic group. Faculty demographics play no significant role in the responsiveness of annual days worked to increased commute time. Assistant and associate professors increase their daily hours while full professors do not. Increases in daily work hours occur at all levels for female faculty but only at the two lower levels for male faculty. The differences in response at the lower two levels are not statistically different. Therefore, there is weak evidence that male full professors do not adjust as much as female full professors.

Possible University Responses

How did the university accommodate the dramatic decrease in per-teacher work time? We cannot fully answer this question but we can offer some evidence. There are four possible margins of adjustment which are not mutually exclusive: 1) hire more teachers, 2) admit fewer students, 3) reduce the number of class hours per student, or 4) increase class sizes. Table 3 shows that although the university added faculty every year from 2000 to 2009 it increased enrollment even faster than this through 2008 so that the student-teacher ratio increased every year through 2008.[45] In 2009 it decreased enrollment and increased faculty such that the student-teacher ratio was roughly the same as it was in 2003 immediately before the transition. Therefore, it

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[44] Blau and Kahn (2007) provide evidence of significant female labor supply changes from 1980 to 2000 but also conclude that female labor supply characteristics converge toward those of males. White (1986) finds evidence that male and female commute times respond differently to income, home ownership, and presence of children.

[45] The table assumes that student attrition rates are zero. While we do not have precise attrition data for each year, it appears to be quite low. For example, 2,598 students were admitted in academic year 2000 and 2,586 graduated four years later implying an attrition rate of 0.5%. Similarly, 2,750 students were admitted in academic year 2001 and 2,718 graduated four years later implying an attrition rate of 1.2%.

appears that little of the per-teacher decrease in teaching time was accommodated by increasing faculty size or lowering student enrollments.

Some of the decreased teaching time may have been accommodated by students taking fewer courses either because the university relaxed the requirements after the transition or students took more courses than necessary before the transition and chose to take fewer after. We are unable to verify whether this took place;[46] however, if it did, then this would decrease educational quality. Finally, the university could offer fewer courses with larger class sizes. We investigate this in the next subsection.

Class Size

A key measure of teaching quality is average class size. Table 9 shows the results of estimating the effect of the transition on class size using our RDD approach. An observation in this regression is a teacher-year-course combination. Column 1 replicates, using an OLS regression, the increase in class size of 6.5 students found in the descriptive statistics. Column 2 introduces teacher and academic-year fixed effects to control for teacher-specific and time-varying unobservables affecting class enrollments. This is our preferred estimate and implies that the transition increased students per class by 15.1 or 25.0% of the 60.2 students per class before the transition.

Column 3 allows the transition to have differential effects on different class levels. Class sizes are smaller for all class-level specific courses than for courses that serve multiple levels (the omitted category). Also, junior and senior classes are somewhat smaller than freshman or sophomore. The transition increases class size at all four class levels (by 13 to 25 students) with senior classes affected somewhat more. If teaching quality differs with faculty experience then it is important to control for faculty position. Column 4 shows that class size increases more for classes taught by full professors than for those taught by faculty in lower positions.

Appendix B6 shows results using a flexible time trend rather than academic-year fixed effects. Controlling for any pre-existing trend in class sizes increases the estimates. The effect increases somewhat as higher-order terms are introduced but all of the point estimates are between 15.4 and 22.4 more students per class after the transition. (We did not estimate class size in transition period and probably don't need to do so, since "one more commute days increases class size by X students" sounds too mechanical)

These results imply a reduction in teaching quality in either of two possible ways. First, there is evidence that larger class sizes decrease learning.[47] Second, the variety

[46] Doing so proved impossible as each major has separate requirements which can change annually and it was not possible to obtain historical handbooks for all majors.

[47] At the university level, Bedard and Kuhn (2008) and Mandel and Süssmuth (2011) find a negative effect of class size on student ratings of teacher effectiveness in economics classes while Cheng (2011) finds a similar effect across a range of disciplines. DeGiorgi, Pellizzari, and Woolston (2010) find a negative relationship between class size and wages at the university level. Raimondo, Esposito, and Gershenberg (1990) find lower student performance in a large compared to a small class for the same course at a university. Arias and Walker (2004) use a controlled field experiment at the university level and find a negative relationship between course performance and class size. At the secondary level, Angrist and Lavy (1999) find a negative effect on test scores from greater class sizes while Dustmann, Rajah, and van Soest (2003) find a negative effect on future wages and the decision to

of courses offered may be lower. A "back-of-the-envelope" calculation indicates that this is a significant margin of adjustment by the university. We estimate that the average faculty member reduced teaching time by 55.9 hours per year. Given 745 faculty members and a student teacher ratio of 15.3 in 2003 implies teaching time fell by 635 thousand student-hours annually. Given 2,517 courses and average hours per course of 52.2 in 2003 implies that the increase in class size (15.1) increases student-hours by 1.98 million annually. The increase in class size is about 3.1 times larger than the decrease in working time.

Graduate Teaching and Research Output

The theoretical effect of the transition on faculty research output and graduate teaching is ambiguous. Effort on either could increase because they are substitute activities for undergraduate teaching and are unaffected by the transition (until late in our sample for graduate teaching). On the other hand, it could decrease if the fatigue from additional commuting infringes on research and graduate teaching time. In this subsection we examine this empirically.

In terms of faculty compensation, a graduate course hour equals 1.5 undergraduate course hours for domestic faculty but 1.0 for those with a foreign Ph.D. These ratios did not change over the time period of our sample so our RDD estimation with academic-year fixed effects will accurately estimate the substitution toward graduate teaching. Column 1 of Table 10 shows that graduate teaching increased by 26.8 hours per year per teacher involved in graduate teaching controlling for teacher-specific and academic-year unobservables. Column 2 controls for any pre-existing time trend using a 5th-order time trend.[48] The point estimate increases to 35.0 but it is not statistically different.

Our data does not indicate whether a graduate course is co-taught. Column 3 re-estimates the regression in Column 1 but assumes that the same course in the same semester taught by teachers in the same department is co-taught. The point estimate decreases to 17.1. Since this may over-count the number of co-taught courses this should be considered a lower-bound effect and the estimate in Column 1 (26.8) an upper bound. Since both Master's and Ph.D. students had fully transitioned to the satellite campus in 2009, Column 4 estimates dropping 2009 data. The results are very similar to those in Column 1.[49] Column 5 estimates using only faculty present before and after the transition. The results are very similar.

Graduate teaching increases by 26.8 hours per teacher and there are 206 teachers involved in graduate teaching prior to the transition for a total increase of 5,514 hours. Undergraduate teaching fell by 55.9 hours per teacher and there are 745 faculty involved in undergraduate teaching prior to the transition for a total decrease of

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continue education. On the other hand, Hoxby (2000) finds no significant effect of class size on student achievement at the primary level. Krueger (2003) provides a survey and argues there are positive economic returns from reducing class sizes at the primary and secondary level.

[48] The point estimates are consistent at 1st-, 2nd-, 3rd-, and 4th-order time trends (23.9, 23.9, 27.6, and 28.0).

[49] We also estimated dropping both 2008 and 2009 since Master's students had begun transitioning in that year. The point estimate for the effect of the transition was 31.2 with a t-statistic of 3.8.

41,618 hours. Therefore, the substitution toward graduate teaching represents about 13% of the decrease in undergraduate teaching.

We estimate the effect on annual research output using our RDD specification. The research output data are available from 2001 to 2009 so that we have three years both before and after the transition. We control for teaching hours because faculty heavily involved in teaching are less likely to be active researchers. We lag teaching hours by one year since we estimate it takes about one year to write and publish a paper in a Chinese journal and most of the publications in our data are in Chinese journals (of the 5,803 articles in our sample only 3.5% are in a foreign language). All of our estimates also include teacher fixed effects. Although we should lag the transition dummy to reflect the time to publish a paper, because our "after" period begins in 2007 and by 2006 since all but senior-level courses have transitioned to the satellite campus in 2006 and senior courses involve few teaching hours.

Column 1 of Table 11 estimates the effect on annual journal publications for each teacher using academic-year fixed effects to control for time-varying unobservables. The results show evidence that commuting "crowds out" research. Journal publications drop by 0.30 or 29.7% of the pre-transition output. Column 2 shows similar results from including a 4^{th}-order time trend rather than time dummies. Column 3 estimates using the sub-sample of faculty with at least one publication from calendar years 2001 to 2009. Since many faculty never produce research papers it is useful to estimate the effect on those actively engaged in research. The effect is somewhat greater – a reduction of 0.38 papers per year on average. Column 4 estimates using a Poisson model and finds a similar effect. Columns 5 and 6 show the results for top publications. Unlike in the raw data, controlling for time-varying and teacher unobservables reveals that the transition decreases annual per-capita top journal publications by 0.016 and the effect is even greater if restricting to teachers with non-zero publications. Columns 7 and 8 estimate for non-top publications and find similar results to those for all publications consistent with most publications being in non-top journals.

7. Conclusion

We find that work time drops significantly for our sample of teachers. Although previous estimates have found little effect of commute costs on work time these did not effectively control for endogeneity. Therefore, these earlier estimates may be smaller because workers compensate by changing their residence, work location, or commute mode or firms adjust wages in response to commute costs change. Our estimates measure the causal effect of commuting on work time and are therefore relevant for policy decisions. Our estimates imply that workers, at least those with discretion over their work time, will decrease their work time fairly significantly in response to longer commutes. Vis-à-vis the previous literature, our results suggest caution in concluding that work time is relatively unresponsiveness to commute costs. These estimates have important ramifications for transportation investment decisions, firm locations, and the efficacy of congestion taxes versus income taxes.

Our estimates imply that investments in transportation infrastructure that result in lower commute times will significantly stimulate work time. Our findings may therefore help explain the positive relationship between transportation investments and employment growth (Hymel, 2008). Our findings suggest that firms can get more work for the same wage by locating close to their employees or making their commute easier (*e.g.*, providing free shuttles).

While our infra-marginal estimates do not directly apply to the extensive margin for those with fixed work schedules, the large effects that we obtain suggest the importance of obtaining estimates on the extensive margin for workers with fixed work schedules. Given that the disutility of commuting depends on the commute mode our results apply to commuting primarily by shuttle bus. Further studies are needed for the effect under other modes.

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PRELIMINARY – DO NOT CIRCULATE

Table 1 Course Structure across Academic Years (2000 – 2009)

Academic Year	Freshman			Sophomore			Junior			Senior			Total Class-Specific		Other[1]		Total Undergraduate	
	# of Courses	% of Total[2]	Change in %	# of Courses	% of Total[2]	Change in %	# of Courses	% of Total[2]	Change in %	# of Courses	% of Total[2]	Change in %	#	Annual Increase	# of Courses	% of Total	#	Annual Increase
2000	539	37.2%		446	30.8%		340	23.5%		123	8.5%		1,448		252	14.8%	1,700	
2001	759	35.8%	-1.4%	712	33.6%	2.8%	491	23.1%	-0.3%	159	7.5%	-1.0%	2,121	46.5%	265	11.1%	2,386	40.4%
2002	808	37.8%	2.0%	700	32.7%	-0.9%	540	25.2%	2.1%	92	4.3%	-3.2%	2,140	0.9%	298	12.2%	2,438	2.2%
2003	838	33.3%	-4.5%	841	33.4%	0.7%	671	26.7%	1.4%	167	6.6%	2.3%	2,517	17.6%	366	12.7%	2,883	18.3%
2004	830	35.9%	2.6%	657	28.4%	-5.0%	666	28.8%	2.2%	157	6.8%	0.2%	2,310	-8.2%	398	14.7%	2,708	-6.1%
2005	885	36.3%	0.4%	734	30.1%	1.7%	630	25.9%	-3.0%	188	7.7%	0.9%	2,437	5.5%	423	14.8%	2,860	5.6%
2006	1,241	44.4%	8.1%	725	26.0%	-4.2%	706	25.3%	-0.6%	121	4.3%	-3.4%	2,793	14.6%	614	18.0%	3,407	19.1%
2007	1,168	38.5%	-6.0%	856	28.2%	2.2%	807	26.6%	1.3%	205	6.8%	2.4%	3,036	8.7%	457	13.1%	3,493	2.5%
2008	1,356	39.1%	0.6%	998	28.8%	0.6%	946	27.3%	0.7%	171	4.9%	-1.8%	3,471	14.3%	554	13.8%	4,025	15.2%
2009	1,119	36.5%	-2.6%	977	31.9%	3.1%	839	27.4%	0.1%	131	4.3%	-0.7%	3,066	-11.7%	1323	30.1%	4,389	9.0%

Academic Year	Graduate Courses	Annual Increase
2000	359	
2001	338	-5.8%
2002	353	4.4%
2003	405	14.7%
2004	550	35.8%
2005	685	24.5%
2006	843	23.1%
2007	917	8.8%
2008	966	5.3%
2009	1,056	9.3%

Data for all courses taught at the university. Boxes indicate class levels taught at the satellite campus. [1] Other courses include university-wide, double degree, and sports classes as described in the text. [2] Percentage of total class-specific undergraduate courses.

PRELIMINARY – DO NOT CIRCULATE

Table 2 Descriptive Statistics

Variable	N	Mean	Std. Dev.	Min	Max	N	Mean	Std. Dev.	Min	Max
PANEL A1: Before and After Sample (2000 - 2003; 2007 - 2009); 1,058 Teachers						*PANEL A2: Subset Present Both Before & After (2000 - 2003; 2007 - 2009); 477 Teachers*				
Hours Taught Per Year	4,227	233.76	169.63	2.00	1,088.00	2,770	256.12	167.61	2.00	1,088.00
Hours Taught Per Year Before Transition	1,934	248.85	163.87	2.00	1,008.00	1,546	268.98	162.83	2.00	1,008.00
Hours Taught Per Year After Transition	2,293	221.03	173.36	3.00	1,088.00	1,224	239.89	172.16	3.00	1,088.00
Freshman Hours Taught Per Year	4,227	76.37	135.44	0.00	1,008.00	2,770	82.57	139.94	0.00	1,008.00
Sophomore Hours Taught Per Year	4,227	71.33	115.39	0.00	720.00	2,770	82.90	122.26	0.00	720.00
Junior Hours Taught Per Year	4,227	48.53	74.01	0.00	656.00	2,770	54.60	79.52	0.00	656.00
Senior Hours Taught Per Year	4,227	9.30	26.92	0.00	258.00	2,770	10.18	28.07	0.00	258.00
Days Taught Per Year	4,200	65.47	38.68	3.00	196.00	2,765	72.41	38.96	3.00	196.00
Days Taught Per Year Before Transition	1,931	79.78	41.21	3.00	196.00	1,543	84.27	40.48	3.00	196.00
Days Taught Per Year After Transition	2,269	53.29	31.65	4.00	186.00	1,222	57.44	31.06	4.00	164.00
Hours Taught Per Day[1]	4,200	3.51	1.49	0.21	9.95	2,765	3.48	1.43	0.21	9.50
Hours Taught Per Day Before Transition1	1,931	3.02	1.17	0.33	9.08	1,543	3.13	1.15	0.48	9.08
Hours Taught Per Day After Transition1	2,269	3.93	1.60	0.21	9.95	1,222	3.92	1.62	0.21	9.50
After Transition	4,227	0.542	0.498	0.000	1.000	2,770	0.442	0.497	0.000	1.000
Academic Year 2000	4,227	0.098	0.297	0.000	1.000	2,770	0.114	0.318	0.000	1.000
Academic Year 2001	4,227	0.115	0.318	0.000	1.000	2,770	0.136	0.343	0.000	1.000
Academic Year 2002	4,227	0.118	0.323	0.000	1.000	2,770	0.145	0.353	0.000	1.000
Academic Year 2003	4,227	0.127	0.333	0.000	1.000	2,770	0.162	0.369	0.000	1.000
Academic Year 2007	4,227	0.170	0.376	0.000	1.000	2,770	0.148	0.355	0.000	1.000
Academic Year 2008	4,227	0.190	0.392	0.000	1.000	2,770	0.149	0.356	0.000	1.000
Academic Year 2009	4,227	0.183	0.386	0.000	1.000	2,770	0.145	0.353	0.000	1.000
Male	4,227	0.599	0.490	0.000	1.000	2,770	0.572	0.495	0.000	1.000
Position - Assistant Professor	3,720	0.498	0.500	0.000	1.000	2,682	0.469	0.499	0.000	1.000
Position - Associate Professor	3,720	0.325	0.469	0.000	1.000	2,682	0.341	0.474	0.000	1.000
Position - Full Professor	3,720	0.177	0.381	0.000	1.000	2,682	0.189	0.392	0.000	1.000
Early Cohort	4,227	0.558	0.497	0.000	1.000	2,770	0.742	0.438	0.000	1.000
Late Cohort	4,227	0.189	0.391	0.000	1.000	2,770	0.258	0.438	0.000	1.000
Foreign PhD	4,227	0.029	0.167	0.000	1.000	2,770	0.003	0.050	0.000	1.000
PANEL B: Transition Sample (2004 - 2007); 615 Teachers										
Change in Expected Commute Days	1,795	14.52	37.70	-132.00	162.00					
Change in Hours Taught Per Year	1,795	-15.12	146.43	-981.00	971.00					
Change in Days Taught Per Year	1,132	-7.44	33.28	-119.00	132.00					
Change in Hours Taught Per Day	1,132	0.14	1.38	-6.20	5.45					
PANEL C: Course-Level Data										
Class Size	21,314	63.83	31.49	4.00	405.00					
Class Size Before Transition	9,407	60.22	26.87	4.00	330.00					
Class Size After Transition	11,907	66.68	34.44	5.00	405.00					
PANEL D: Graduate Course Teaching (2000 - 2003; 2007 - 2009); 520 Teachers										
Hours Taught Per Year	1,856	105.82	73.33	3.00	696.00					
Hours Taught Per Year Before Transition	686	104.87	67.74	28.00	440.00					
Hours Taught Per Year After Transition	1,170	106.38	76.44	3.00	696.00					
PANEL E: Research Output (2001 - 2003; 2007 - 2009); 1,075 Teachers										
Annual Publications	3,516	0.89	1.70	0.00	21.00					
Annual Publications Before Transition	1,406	1.02	1.68	0.00	17.00					
Annual Publications After Transition	2,110	0.80	1.70	0.00	21.00					
Annual Top Publications	3,516	0.02	0.17	0.00	4.00					
Annual Top Publications Before Transition	1,406	0.01	0.10	0.00	1.00					
Annual Top Publications After Transition	2,110	0.03	0.21	0.00	4.00					
Annual Non-Top Publications	3,516	0.86	1.66	0.00	21.00					
Annual Non-Top Publications Before Transition	1,406	1.01	1.66	0.00	16.00					
Annual Non-Top Publications After Transition	2,110	0.76	1.65	0.00	21.00					

[1] Number of observations for days taught per year and hours worked per day is less than 4,227 because some teacher-year observations are missing day-of-week information. Panel A1 includes any teacher with data for at least one year either before or after the transition. Panel A2 includes only faculty with at least one year of data before and one year of data after the transition. Panel B includes any teacher with at least one year of data during the transition years.

PRELIMINARY – DO NOT CIRCULATE

Table 3 Enrollment, Teaching Hours, and Class Size across Academic Years (2000 – 2009)

Academic Year	Freshman # of Students	Freshman Teaching Hours #	Freshman Teaching Hours Change	Freshman Class Size	Sophomore # of Students	Sophomore Teaching Hours #	Sophomore Teaching Hours Change	Sophomore Class Size	Junior # of Students	Junior Teaching Hours #	Junior Teaching Hours Change	Junior Class Size
2000	2,598	24,642		66.6	2,067	23,568		66.8	1,431	14,110		48.3
2001	2,750	32,686	32.6%	63.0	2,598	34,976	48.4%	61.6	2,067	20,243	43.5%	58.4
2002	3,000	37,749	15.5%	55.8	2,750	37,808	8.1%	59.7	2,598	22,832	12.8%	61.8
2003	3,018	39,783	5.4%	47.2	3,000	44,492	17.7%	55.2	2,750	28,183	23.4%	59.6
2004	3,738	34,256	-13.9%	63.7	3,018	38,070	-14.4%	54.0	3,000	26,530	-5.9%	55.9
2005	3,936	36,716	7.2%	66.4	3,738	36,343	-4.5%	67.0	3,018	23,699	-10.7%	49.4
2006	4,201	39,346	7.2%	73.7	3,936	34,353	-5.5%	69.2	3,738	25,912	9.3%	60.1
2007	4,414	32,645	-17.0%	72.3	4,201	29,189	-15.0%	76.2	3,936	22,315	-13.9%	63.5
2008	3,650	32,132	-1.6%	70.9	4,414	31,179	6.8%	67.5	4,201	22,695	1.7%	67.3
2009	3,645	29,081	-9.5%	65.8	3,650	28,410	-8.9%	63.3	4,414	20,872	-8.0%	61.5

Academic Year	Senior # of Students	Senior Teaching Hours #	Senior Teaching Hours Change	Senior Class Size	Total Class-Specific Teaching Hours #	Total Class-Specific Teaching Hours Change	Other1 Teaching Hours #	Other1 Teaching Hours Change	Other1 Class Size	Total Undergraduate # of Students	Total # of Teachers2	Student-Teacher Ratio	Total Undergraduate Teaching Hours #	Total Undergraduate Teaching Hours Change	Total Undergraduate Class Size
2000	1,274	3,193		53.2	65,513		6,938		71.8	7,370	664	11.1	72,451		62.8
2001	1,431	4,930	54.4%	47.3	92,835	41.7%	7,804	12.5%	80.8	8,846	708	12.5	100,639	38.9%	62.6
2002	2,067	3,148	-36.1%	58.0	101,537	9.4%	10,021	28.4%	84.5	10,415	718	14.5	111,558	10.8%	61.8
2003	2,598	6,532	107.5%	56.0	118,990	17.2%	12,199	21.7%	66.5	11,366	745	15.3	131,189	17.6%	55.4
2004	2,750	5,801	-11.2%	58.4	104,657	-12.0%	13,490	10.6%	72.6	12,506	804	15.6	118,147	-9.9%	60.4
2005	3,000	5,697	-1.8%	47.1	102,455	-2.1%	12,664	-6.1%	68.1	13,692	846	16.2	115,119	-2.6%	61.8
2006	3,018	3,614	-36.6%	47.5	103,225	0.8%	13,925	10.0%	67.3	14,893	884	16.8	117,150	1.8%	67.9
2007	3,738	4,353	20.5%	74.5	88,503	-14.3%	7,169	-48.5%	62.1	16,289	872	18.7	95,672	-18.3%	70.0
2008	3,936	3,464	-20.4%	57.3	89,470	1.1%	8,359	16.6%	64.4	16,201	914	17.7	97,829	2.3%	67.5
2009	4,201	2,569	-25.8%	74.9	80,932	-9.5%	19,188	129.5%	60.3	15,910	1,030	15.4	100,120	2.3%	63.3

Academic Year	Graduate # of Masters Students	# of Ph.D. Students	Teaching Hours #	Teaching Hours Change	# of Teachers3	Student-Teacher Ratio
2000	408	83	15,960		168	95.5
2001	536	121	17,201	7.8%	167	103.7
2002	674	135	18,510	7.6%	176	105.9
2003	973	197	20,270	9.5%	206	99.4
2004	1,225	205	28,841	42.3%	245	118.6
2005	1,332	211	34,118	18.3%	286	120.0
2006	1,501	222	38,826	13.8%	335	116.6
2007	1,590	214	40,379	4.0%	392	103.6
2008	1,710	221	43,183	6.9%	430	100.9
2009	1,905	220	40,899	-5.3%	456	90.2

Data for all courses taught at the university. Boxes indicate class levels taught at the satellite campus. Data on number of students assumes no attrition in enrollment by students over time. Data on number of students from the university's Deans of Undergraduate Education office and Baike Baidu [S: How should we describe this??]. Data on number of teachers from the university's Human Resources Department. Number of graduate students includes M.A., Ph.D., EMBA, MBA, MPA, MPAcc. Some of these are not full-time students. 1 Other courses include university-wide, double degree, and sports classes as described in the text. [2] Total number of teachers regardless of whether involved in undergraduate or graduate teaching or not. [3] Number of teachers involved in teaching graduate courses.

PRELIMINARY – DO NOT CIRCULATE

Table 4 Effect of Campus Transition on Annual Hours Worked (2000 – 2003; 2007 – 2009)

	1 No Controls	2 Teacher & Academic-Year Fixed Effects	3 Balanced Panel	4 Individual Quadratic Time Trend	5 Early/ Late Cohort	6 Domestic PhD Only
Constant	248.8490 ***	267.2609 ***	319.5990 ***	217.2975 ***	274.9236 ***	269.6789 ***
	(5.7477)	(5.4029)	(8.4320)	(7.0257)	(5.1319)	(5.3611)
After Transition	-27.8200 ***	-55.8628 ***	-44.7170 ***	-52.6569 ***		-55.4366 ***
	(7.8947)	(7.5075)	(11.1988)	(13.0327)		(7.5253)
Early Cohort*After Transition					-59.0739 ***	
					(8.4328)	
Late Cohort*After Transition					-36.3548 ***	
					(10.4999)	
Teacher Fixed Effects	No	Yes	Yes	Yes	Yes	Yes
Number of Teachers	1,058	1,058	192	192	619	1,008
Academic-Year Fixed Effects	No	Yes	Yes	No	Yes	Yes
N	4,227	4,227	1,344	1,344	3,158	4,106
R^2	0.007	0.691	0.607	0.796	0.645	0.687

Dependent variable is annual hours worked. Standard errors in parentheses. Standard errors allow for clustering within teacher/transition cell and general heteroskedasticity in all regressions. * = 10% significance, ** = 5% significance, *** = 1% significance. The individual time trend model uses a balanced panel. The Early/Late Cohort model includes only teachers who joined the university prior to 2004. The Domestic PhD Only model includes only teachers who received a PhD from a mainland China university.

Table 5 Effect of Campus Transition on Annual Days Worked (2000 – 2003; 2007 – 2009)

	1 No Controls	2 Teacher & Academic-Year Fixed Effects	3 Balanced Panel	4 Individual Quadratic Time Trend	5 Early/ Late Cohort	6 Domestic PhD Only
Constant	79.7784 ***	80.0103 ***	93.4000 ***	80.5098 ***	81.8467 ***	80.5174 ***
	(1.3485)	(1.3770)	(2.1226)	(1.7416)	(1.3220)	(1.3720)
After Transition	-26.4862 ***	-27.1651 ***	-28.7790 ***	-31.3263 ***		-27.1088 ***
	(1.3563)	(1.8294)	(2.7883)	(3.2388)		(1.8351)
Early Cohort*After Transition					-29.0828 ***	
					(2.0577)	
Late Cohort*After Transition					-22.8733 ***	
					(2.6597)	
Teacher Fixed Effects	No	Yes	Yes	Yes	Yes	Yes
Number of Teachers	1,045	1,045	190	190	619	995
Academic-Year Fixed Effects	No	Yes	Yes	No	Yes	Yes
N	4,200	4,200	1,330	1,330	3,153	4,079
R^2	0.117	0.620	0.501	0.735	0.570	0.613

Dependent variable is annual days worked. Standard errors in parentheses. Standard errors allow for clustering within teacher/transition cell and general heteroskedasticity in all regressions. * = 10% significance, ** = 5% significance, *** = 1% significance. The individual time trend model uses a balanced panel. The Early/Late Cohort model includes only teachers who joined the university prior to 2004. The Domestic PhD Only model includes only teachers who received a PhD from a mainland China university.

PRELIMINARY – DO NOT CIRCULATE

Table 6 Effect of Campus Transition on Daily Hours Worked (2000 – 2003; 2007 – 2009)

	1 No Controls	2 Teacher & Academic-Year Fixed Effects	3 Balanced Panel	4 Individual Quadratic Time Trend	5 Early/ Late Cohort	6 Domestic PhD Only
Constant	3.0210 ***	3.2555 ***	3.4249 ***	2.7030 ***	3.2403 ***	3.2594 ***
	(0.0368)	(0.0449)	(0.0659)	(0.0617)	(0.0426)	(0.0446)
After Transition	0.9044 ***	0.4874 ***	0.6953 ***	0.7527 ***		0.4867 ***
	(0.0596)	(0.0701)	(0.0996)	(0.1144)		(0.0704)
Early Cohort*After Transition					0.4836 ***	
					(0.0826)	
Late Cohort*After Transition					0.7401 ***	
					(0.0950)	
Teacher Fixed Effects	No	Yes	Yes	Yes	Yes	Yes
Number of Teachers	1,045	1,045	190	190	619	995
Academic Year Fixed Effects	No	Yes	Yes	No	Yes	Yes
N	4,200	4,200	1,330	1,330	3,153	4,079
R^2	0.092	0.616	0.543	0.766	0.565	0.615

Dependent variable is daily hours worked conditional on teaching that day. Standard errors in parentheses. Standard errors allow for clustering within teacher/transition cell and general heteroskedasticity in all regressions. * = 10% significance, ** = 5% significance, *** = 1% significance. The individual time trend model uses a balanced panel. The Early/Late Cohort model includes only teachers who joined the university prior to 2004. The Domestic PhD Only model includes only teachers who received a PhD from a mainland China university.

PRELIMINARY – DO NOT CIRCULATE

Table 7 Effect of Transition on Annual Hours, Annual Days, and Daily Hours Worked (2004 – 2007)

Annual Hours Worked (# Teachers = 615, N = 1,795)

	1	2	3	4	5
Constant	-6.9749 ***	-2.0312	20.8638 ***	-61.6414 ***	54.3230
	(2.5862)	(6.7991)	(7.9851)	(19.7946)	(70.8167)
Δ Commute Days	-0.5612 ***	-0.6593 ***	-0.6382 ***	-0.6587 ***	-0.6593 ***
	(0.1009)	(0.1019)	(0.1027)	(0.1023)	(0.1019)
Time Trend	None	None	1st	2nd	3rd
Academic-Year Fixed Effects	No	Yes	No	No	No
R^2	0.021	0.044	0.028	0.041	0.044
Prob > F (Time Trend)			0.000	0.000	0.000

Annual Days Worked (# Teachers = 340, N = 1,132)

	1	2	3	4	5
Constant	-4.9138 ***	-3.1840	-0.3250	-7.9655	5.5790
	(0.7260)	(2.1277)	(2.3551)	(5.9766)	(20.2631)
Δ Commute Days	-0.1786 ***	-0.1950 ***	-0.1931 ***	-0.1950 ***	-0.1950 ***
	(0.0269)	(0.0273)	(0.0275)	(0.0274)	(0.0273)
Time Trend	None	None	1st	2nd	3rd
Academic-Year Fixed Effects	No	Yes	No	No	No
R^2	0.038	0.044	0.042	0.044	0.045
Prob > F (Time Trend)			0.029	0.017	0.026

Daily Hours Worked (# Teachers = 340, N = 1,132)

	1	2	3	4	5
Constant	0.1084 ***	-0.0633	-0.0180	-0.8734 ***	1.4242 *
	(0.0282)	(0.0661)	(0.0867)	(0.2029)	(0.8504)
Δ Commute Days	0.0020 *	0.0022 *	0.0024 **	0.0022 *	0.0022 *
	(0.0012)	(0.0012)	(0.0012)	(0.0012)	(0.0012)
Time Trend	None	None	1st	2nd	3rd
Academic-Year Fixed Effects	No	Yes	No	No	No
R^2	0.003	0.033	0.005	0.021	0.033
Prob > F (Time Trend)			0.146	0.000	0.000

Dependent variable is: change in annual hours worked in top panel, change in annual days worked in middle panel, and change in daily hours worked (conditional on teaching that day) in bottom panel. Standard errors in parentheses. Standard errors allow for clustering within teacher and general heteroskedasticity in all regressions. * = 10% significance, ** = 5% significance, *** = 1% significance. The F-test is the p-value for the joint significance level of the time trend variables.

Table 8 Effect of Campus Transition on Annual Hours Worked with Teacher and Academic-Year Fixed Effects (2000 – 2003; 2007 – 2009), Role of Demographics

	Effect of Gender	Effect of Position	Gender Control for Position	Gender-Position Interaction
Constant	79.9646 ***	84.2278 ***	84.3283 ***	84.1227 ***
	(1.3773)	(2.1634)	(1.8450)	(2.1651)
Associate Professor		-0.8255	-2.7748	-0.7971
		(3.2439)	(2.2584)	(3.2421)
Full Professor		-7.3485	-5.6092	-7.0589
		(4.8080)	(3.9632)	(4.8378)
Female*After Transition	-28.7838 ***		-28.8015 ***	
	(2.2172)		(2.2478)	
Male*After Transition	-25.9477 ***		-26.3350 ***	
	(2.0924)		(2.1505)	
Assistant Professor*After Transition		-27.8184 ***		
		(2.3283)		
Associate Professor*After Transition		-29.6775 ***		
		(2.7614)		
Full Professor*After Transition		-23.1779 ***		
		(3.2351)		
Female Assistant Professor*After Transition				-28.6368 ***
				(2.8658)
Male Assistant Professor*After Transition				-26.9228 ***
				(3.1033)
Female Associate Professor*After Transition				-30.8562 ***
				(3.0719)
Male Associate Professor*After Transition				-28.8175 ***
				(3.2065)
Female Full Professor*After Transition				-24.9417 ***
				(4.8362)
Male Full Professor*After Transition				-22.6349 ***
				(3.3536)
Number of Teachers	1,045	837	837	837
N	4,200	3,711	3,711	3,711
R^2	0.620	0.583	0.583	0.583

Dependent variable is annual days worked. Standard errors in parentheses. Standard errors allow for clustering within teacher/transition cell and general heteroskedasticity in all regressions. * = 10% significance, ** = 5% significance, *** = 1% significance. Number of observations for regressions involving position lower due to missing values. All regressions include teacher fixed effects and academic-year fixed effects.

PRELIMINARY – DO NOT CIRCULATE

Table 9 Effect of Campus Transition on Class Size (2000 – 2003; 2007 – 2009)

	No Controls	Teacher & Academic-Year Fixed Effects	Class-Level Controls	Position Effects
Constant	60.2240 ***	54.1965 ***	72.5956 ***	54.1258 ***
	(0.7046)	(0.5950)	(2.2879)	(1.0517)
After Transition	6.4538 ***	15.0587 ***		
	(1.0832)	(1.0417)		
Freshman			-18.3463 ***	
			(2.6681)	
Sophomore			-17.7821 ***	
			(2.6143)	
Junior			-25.5185 ***	
			(2.3885)	
Senior			-30.7622 ***	
			(2.6946)	
Freshman*Transition			18.4723 ***	
			(1.4630)	
Sophomore*Transition			13.2243 ***	
			(1.3914)	
Junior*Transition			17.4320 ***	
			(1.4520)	
Senior*Transition			24.9506 ***	
			(3.1503)	
Other*Transition			-1.6494	
			(2.7677)	
Associate Professor				0.3701
				(1.7249)
Full Professor				1.6964
				(2.9451)
Assistant Professor*After Transition				14.2389 ***
				(1.3258)
Associate Professor*After Transition				13.4614 ***
				(1.6076)
Full Professor*After Transition				20.5935 ***
				(2.1690)
Teacher Fixed Effects	No	Yes	Yes	Yes
Number of Teachers	1,055	1,055	1,055	839
Academic-Year Fixed Effects	No	Yes	Yes	Yes
N	21,314	21,314	21,314	19,444
R^2	0.010	0.304	0.326	0.282

Dependent variable is class size (students per class). Standard errors in parentheses. Standard errors allow for clustering within teacher/transition cell and general heteroskedasticity in all regressions. * = 10% significance, ** = 5% significance, *** = 1% significance. Number of observations is lower for regressions with department or position controls due to missing values.

PRELIMINARY – DO NOT CIRCULATE

Table 10 Effect of Campus Transition on Graduate Teaching Hours Worked (2000 – 2003; 2007 – 2009)

	1 Academic Year Dummies	2 Flexible Time Trend	3 Co-Teaching	4 Drop 2009	5 Present Before & After
Constant	88.7553 ***	148.2810 **	71.6480 ***	90.5170 ***	109.7399 ***
	(4.8265)	(71.1435)	(3.8860)	(4.7226)	(4.8593)
After Transition	26.7651 ***	34.9546 ***	17.1387 ***	28.2413 ***	26.9856 ***
	(6.6848)	(11.0154)	(5.2513)	(7.0954)	(7.0456)
Order Time Trend	None	5th	None	None	None
Teacher Fixed Effects	Yes	Yes	Yes	Yes	Yes
Number of Teachers	520	520	520	517	196
Academic-Year Fixed Effects	Yes	No	Yes	Yes	Yes
N	1,856	1,856	1,856	1,472	1,055
R^2	0.584	0.584	0.592	0.591	0.531

Dependent variable is total annual hours worked. Standard errors in parentheses. Standard errors allow for clustering within teacher/transition cell and general heteroskedasticity in all regressions. * = 10% significance, ** = 5% significance, *** = 1% significance. The Present Before & After model includes only faculty present in at least one year both before and after the transition.

Table 11 Effect of Campus Transition on Faculty Research Output with Teacher Fixed Effects (2001 – 2003; 2007 – 2009)

	1	2	3	4	5	6	7	8
	All Journal Publications				Top Journal Publications		Non-'Top Journal Publications	
	Academic Year Dummies	Flexible Time Trend	Non- Zero Publications	Poisson Model	Academic Year Dummies	Non- Zero Publications	Academic Year Dummies	Non- Zero Publications
Constant	1.3444 ***	4.1266 **	2.0249 ***		0.0261 ***	0.0401 ***	1.3183 ***	1.9848 ***
	(0.0878)	(1.9602)	(0.1174)		(0.0084)	(0.0116)	(0.0865)	(0.1157)
After Transition	-0.3023 ***	-0.3430 **	-0.3763 ***	-0.2666 ***	-0.0160 *	-0.0256 **	-0.2863 ***	-0.3507 ***
	(0.0898)	(0.1588)	(0.1163)	(0.0796)	(0.0094)	(0.0127)	(0.0891)	(0.1153)
Lagged Teaching Hours	-0.0005 *	-0.0005 *	-0.0009 **	-0.0007 **	0.0000	0.0000	-0.0005 *	-0.0008 **
	(0.0002)	(0.0002)	(0.0004)	(0.0003)	(0.0000)	(0.0004)	(0.0002)	(0.0004)
Order Time Trend	None	4th	None	None	None	None	None	None
Number of Teachers	1,075	1,075	548	489	1,075	548	1,075	548
Academic-Year Fixed Effe	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
N	3,516	5,316	2,231	2,131	5,316	2,231	3,516	2,231
R^2	0.671	0.671	0.614	0.614	0.425	0.423	0.660	0.601
Log Pseudo-Likelihood				-1948.5				

in Columns 3 and 4, and total annual non-top journal publications for each teacher in Columns 5 and 6. Standard errors in parentheses. Standard errors allow for clustering within teacher/transition cell and general heteroskedasticity in all regressions except the Poisson model. Standard errors in the Poisson model are robust standard errors. * = 10% significance, ** = 5% significance, *** = 1% significance. All regressions include teacher fixed effects.

Appendix A Theoretical Results

Effect of Commute Time on Days Worked Per Year

The effect of an increase in commute time on days worked per year can be determined by totally differentiating Equation (3) with respect to commute time allowing days and hours worked to vary:

(A1) $$\frac{\partial D}{\partial t} = \frac{V_{LY}wDH + V_L - \frac{\partial H}{\partial T}D\left[V_{YY}w^2H - V_{LY}\left(1+e'(H)+w\left(H+t+e(H)\right)\right) - V_{LL}\left(1+e'(H)\right)\left(H+t+e(H)\right)\right]}{V_{YY}(wH)^2 - 2V_{LY}wH\left(H+t+e(H)\right) + V_{LL}\left(H+t+e(H)\right)^2} < 0$$

To check this we can do the same using Equation (2):

(A2) $$\frac{\partial D}{\partial t} = \frac{D\left(V_{LY}w - V_{LL}\left(1+e'(H)\right)\right) - \frac{\partial H}{\partial T}D\left[V_{YY}w^2D + D\left(1+e'(H)\right)(V_{LL} - 2V_{LY}w) - V_Le"(H)\right]}{V_{YY}w^2H - V_{LY}w\left[D\left(H+t+e(H)\right) - H\left(1+e'(H)\right)\right] + V_{LL}\left(1+e'(H)\right)\left(H+t+e(H)\right)} < 0$$

Effect of Commute Time on Total Hours Worked Per Year

The effect of an increase in commute time on total hours worked per year is given by:

(A3) $$\frac{\partial (DH)}{\partial t} = H\frac{\partial D}{\partial t} + D\frac{\partial H}{\partial t}.$$

Since $\partial D/\partial t < 0$ and $\partial H/\partial t > 0$ the sign of $\partial(DH)/\partial t$ depends on the values of V_{YY}, V_{LY}, and V_{LL}. To show that this can either be negative or positive first expand Equation (A3):

(A4) $$sign\left[\frac{\partial (DH)}{\partial t}\right] = sign\left[H\left(\frac{\partial F_1}{\partial H}\frac{\partial F_2}{\partial t} - \frac{\partial F_2}{\partial H}\frac{\partial F_1}{\partial t}\right) + D\left(\frac{\partial F_2}{\partial D}\frac{\partial F_1}{\partial t} - \frac{\partial F_1}{\partial D}\frac{\partial F_2}{\partial t}\right)\right].$$

Now:

(A5a) $\partial F_1/\partial H = V_{YY}(wD)^2 - 2V_{LY}wD^2\left(1+e'(H)\right) + V_{LL}D^2\left(1+e'(H)\right)^2 - V_LDe"(H) < 0,$

(A5b) $\partial F_2/\partial H = \partial F_1/\partial D = V_{YY}w^2DH - V_{LY}wD\left[H\left(1+e'(H)\right) + \left(H+t+e(H)\right)\right] + V_{LL}D\left(1+e'(H)\right)\left(H+t+e(H)\right) < 0,$

(A5c) $\partial F_2/\partial D = V_{YY}(wH)^2 - 2V_{LY}wH\left(H+t+e(H)\right) + V_{LL}\left(H+t+e(H)\right)^2 < 0,$

and:

(A6a) $\partial F_1/\partial t = -V_{LY}wD^2 + V_{LL}D^2\left(1+e'(H)\right) < 0,$

(A6b) $\partial F_2/\partial t = -V_{LY}wDH + V_{LL}D\big(H + t + e(H)\big) - V_L < 0.$

To show that $\partial(DH)/\partial t$ can be positive consider $V_{LY} = 0$ and V_{LL} close to zero so that it can be ignored. Then:

(A7a) $\partial F_1/\partial H = V_{YY}(wD)^2 - V_L De''(H),$

(A7b) $\partial F_2/\partial H = \partial F_1/\partial D = V_{YY}w^2DH$

(A7c) $\partial F_2/\partial D = V_{YY}(wH)^2,$

and:

(A8a) $\partial F_1/\partial t = 0,$

(A8b) $\partial F_2/\partial t = -V_L.$

In this case:

(A9) $\frac{\partial(DH)}{\partial t} = DHV_L^2e''(H) > 0.$

To show that $\partial(DH)/\partial t$ can be negative consider $V_{LY} = 0$ and V_{YY} close to zero so that it can be ignored. Then:

(A10a) $\partial F_1/\partial H = V_{LL}D^2\big(1 + e'(H)\big)^2 - V_L De''(H),$

(A10b) $\partial F_2/\partial H = \partial F_1/\partial D = V_{LL}D\big(1 + e'(H)\big)\big(H + t + e(H)\big),$

(A10c) $\partial F_2/\partial D = V_{LL}\big(H + t + e(H)\big)^2,$

and:

(A11a) $\partial F_1/\partial t = V_{LL}D^2\big(1 + e'(H)\big),$

(A11b) $\partial F_2/\partial t = V_{LL}D\big(H + t + e(H)\big) - V_L < 0.$

In this case:

(A12) $\frac{\partial(DH)}{\partial t} = -V_{LL}V_LD^2\big[\big(1 + e'(H)\big)\big(He'(H) - t - e(H)\big) + \big(H + t + e(H)\big)e''(H)\big]$
$+V_L^2DHe''(H).$

If $e'(H)$ and $e''(H)$ are sufficiently small relative to $e(H)$ then this is negative.

PRELIMINARY – DO NOT CIRCULATE

Appendix B Empirical Robustness Checks

Appendix B1 Effect of Campus Transition on Annual Hours Worked by 1,058 Teachers – Time Trend Estimates including Teacher Fixed Effects (2000 – 2003; 2007 – 2009), N = 4,227

Constant	251.7510 ***	224.2692 ***	212.7282 ***	200.3304 ***	174.1523 ***	84.2438
	(3.0301)	(6.7803)	(10.9045)	(19.7329)	(31.5883)	(91.5214)
After Transition	-33.1684 ***	-67.3614 ***	-65.0422 ***	-59.4359 ***	-64.3532 ***	-73.3074 ***
	(5.1418)	(8.8072)	(8.7313)	(10.8965)	(11.5448)	(14.7181)
Time Trend		10.3275 ***	17.6440 ***	32.2594	74.1194 *	251.5699
		(2.2225)	(5.5864)	(19.8622)	(43.9466)	(177.0774)
Time Trend^2			-0.9427	-5.3287	-25.9960	-144.5646
			(0.6125)	(5.6733)	(19.9825)	(117.1232)
Time Trend^3				0.3505	4.3048	39.0274
				(0.4481)	(3.6549)	(34.1353)
Time Trend^4					-0.2526	-4.8283
					(0.2298)	(4.4895)
Time Trend^5						0.2227
						(0.2186)
R^2	0.687	0.690	0.690	0.690	0.691	0.691
Prob > F (Time Trend)		0.000	0.000	0.000	0.000	0.001

Dependent variable is annual hours worked. Standard errors in parentheses. Standard errors allow for clustering within teacher/transition cell and general heteroskedasticity in all regressions. * = 10% significance, ** = 5% significance, *** = 1% significance. All regressions include teacher fixed-effects. The F-test is the p-value for the joint significance level of the time trend variables.

Appendix B2 Effect of Campus Transition on Annual Days Worked by 1,045 Teachers – Time Trend Estimates including Teacher Fixed Effects (2000 – 2003; 2007 – 2009), N = 4,200

Constant	79.8779 ***	78.1024 ***	80.4024 ***	72.2781 ***	78.8429 ***	46.7858 *
	(0.6704)	(1.8792)	(3.3103)	(5.8501)	(8.9897)	(26.5166)
After Transition	-26.6705 ***	-28.8808 ***	-29.3466 ***	-25.6813 ***	-24.4426 ***	-27.6360 ***
	(1.1399)	(2.3286)	(2.2209)	(2.7118)	(2.7643)	(3.7813)
Time Trend		0.6676	-0.7912	8.7882	-1.7167	61.5603
		(0.6336)	(1.6744)	(5.5528)	(11.8486)	(50.4089)
Time Trend^2			0.1881	-2.6870 *	2.5032	-39.7843
			(0.1681)	(1.5279)	(5.1669)	(32.9517)
Time Trend^3				0.2298 *	-0.7639	11.6216
				(0.1190)	(0.9135)	(9.5170)
Time Trend^4					0.0635	-1.5688
					(0.0561)	(1.2420)
Time Trend^5						0.0795
						(0.0600)
R^2	0.618	0.618	0.619	0.619	0.619	0.620
Prob > F (Time Trend)		0.292	0.129	0.045	0.032	0.120

Dependent variable is annual days worked. Standard errors in parentheses. Standard errors allow for clustering within teacher/transition cell and general heteroskedasticity in all regressions. * = 10% significance, ** = 5% significance, *** = 1% significance. All regressions include teacher fixed-effects. The F-test is the p-value for the joint significance level of the time trend variables.

PRELIMINARY – DO NOT CIRCULATE

Appendix B3 Effect of Campus Transition on Daily Hours Worked by 1,045 Teachers – Time Trend Estimates including Teacher Fixed Effects (2000 – 2003; 2007 – 2009), N = 4,200

Constant	3.1156 ***	2.8926 ***	2.7520 ***	2.9152 ***	2.1184 ***	1.9281 **
	(0.0288)	(0.0624)	(0.0936)	(0.1905)	(0.3204)	(0.8353)
After Transition	0.7293 ***	0.4517 ***	0.4802 ***	0.4066 ***	0.2563 **	0.2373 *
	(0.0492)	(0.0783)	(0.0813)	(0.1045)	(0.1171)	(0.1298)
Time Trend		0.0838 ***	0.1730 ***	-0.0194	1.2556 ***	1.6314
		(0.0197)	(0.0476)	(0.1955)	(0.4535)	(1.5811)
Time Trend^2			-0.0115 **	0.0462	-0.5837 ***	-0.8348
			(0.0058)	(0.0564)	(0.2106)	(1.0282)
Time Trend^3				-0.0046	0.1160 ***	0.1895
				(0.0045)	(0.0394)	(0.2968)
Time Trend^4					-0.0077 ***	-0.0174
					(0.0025)	(0.0389)
Time Trend^5						0.0005
						(0.0019)
R^2	0.611	0.614	0.614	0.614	0.616	0.616
Prob > F (Time Trend)		0.000	0.000	0.000	0.000	0.000

Dependent variable is daily hours worked conditional on teaching that day. Standard errors in parentheses. Standard errors allow for clustering within teacher/transition cell and general heteroskedasticity in all regressions. * = 10% significance, ** = 5% significance, *** = 1% significance. The F-test is the p-value for the joint significance level of the time trend variables.

PRELIMINARY – DO NOT CIRCULATE

Appendix B4 Effect of Campus Transition on Annual Days Worked with Teacher and Academic-Year Fixed Effects (2000 – 2003; 2007 – 2009), Role of Demographics

	Effect of Gender	Effect of Position	Gender Control for Position	Gender-Position Interaction
Constant	79.9646 ***	84.2278 ***	84.3283 ***	84.1227 ***
	(1.3773)	(2.1634)	(1.8450)	(2.1651)
Associate Professor		-0.8255	-2.7748	-0.7971
		(3.2439)	(2.2584)	(3.2421)
Full Professor		-7.3485	-5.6092	-7.0589
		(4.8080)	(3.9632)	(4.8378)
Female*After Transition	-28.7838 ***		-28.8015 ***	
	(2.2172)		(2.2478)	
Male*After Transition	-25.9477 ***		-26.3350 ***	
	(2.0924)		(2.1505)	
Assistant Professor*After Transition		-27.8184 ***		
		(2.3283)		
Associate Professor*After Transition		-29.6775 ***		
		(2.7614)		
Full Professor*After Transition		-23.1779 ***		
		(3.2351)		
Female Assistant Professor*After Transition				-28.6368 ***
				(2.8658)
Male Assistant Professor*After Transition				-26.9228 ***
				(3.1033)
Female Associate Professor*After Transition				-30.8562 ***
				(3.0719)
Male Associate Professor*After Transition				-28.8175 ***
				(3.2065)
Female Full Professor*After Transition				-24.9417 ***
				(4.8362)
Male Full Professor*After Transition				-22.6349 ***
				(3.3536)
Number of Teachers	1,045	837	837	837
N	4,200	3,711	3,711	3,711
R^2	0.620	0.583	0.583	0.583

Dependent variable is annual days worked. Standard errors in parentheses. Standard errors allow for clustering within teacher/transition cell and general heteroskedasticity in all regressions. * = 10% significance, ** = 5% significance, *** = 1% significance. Number of observations for regressions involving position lower due to missing values. All regressions include teacher fixed effects and academic-year fixed effects.

PRELIMINARY – DO NOT CIRCULATE

Appendix B5 Effect of Campus Transition on Daily Hours Worked with Teacher and Academic-Year Fixed Effects (2000 – 2003; 2007 – 2009), Role of Demographics

	Effect of Gender	Effect of Position	Gender Control for Position	Gender-Position Interaction
Constant	3.2597 ***	3.2669 ***	3.2933 ***	3.2776 ***
	(0.0450)	(0.0734)	(0.0651)	(0.0720)
Associate Professor		-0.0108	0.1289	-0.0035
		(0.1168)	(0.0904)	(0.1147)
Full Professor		-0.0243	-0.2949 *	-0.0806
		(0.1891)	(0.1656)	(0.1822)
Female*After Transition	0.6344 ***		0.7150 ***	
	(0.0891)		(0.0899)	
Male*After Transition	0.3769 ***		0.4489 ***	
	(0.0823)		(0.0851)	
Assistant Professor*After Transition		0.6592 ***		
		(0.0904)		
Associate Professor*After Transition		0.7380 ***		
		(0.1136)		
Full Professor*After Transition		0.0831		
		(0.1257)		
Female Assistant Professor*After Transition				0.5585 ***
				(0.1213)
Male Assistant Professor*After Transition				0.7632 ***
				(0.1194)
Female Associate Professor*After Transition				0.9274 ***
				(0.1346)
Male Associate Professor*After Transition				0.6009 ***
				(0.1300)
Female Full Professor*After Transition				0.5220 ***
				(0.1855)
Male Full Professor*After Transition				-0.0566
				(0.1337)
Number of Teachers	1,045	837	837	837
N	4,200	3,711	3,711	3,711
R^2	0.617	0.598	0.596	0.601

Dependent variable is daily hours worked conditional on teaching that day. Standard errors in parentheses. Standard errors allow for clustering within teacher/transition cell and general heteroskedasticity in all regressions. * = 10% significance, ** = 5% significance, *** = 1% significance. Number of observations for regressions involving position lower due to missing values. All regressions include teacher fixed effects and academic-year fixed effects.

PRELIMINARY – DO NOT CIRCULATE

Appendix B6 Effect of Campus Transition on Class Size for Courses Taught by 1,055 Teachers – Time Trend Estimates including Teacher Fixed Effects (2000 – 2003; 2007 – 2009), N = 21,314

Constant	58.8643 ***	64.4616 ***	64.2453 ***	53.8587 ***	45.7300 ***	88.8244 ***
	(0.5743)	(0.9962)	(1.4411)	(2.7183)	(4.3237)	(11.1390)
After Transition	8.8877 ***	15.4428 ***	15.4809 ***	19.7068 ***	18.2191 ***	22.3806 ***
	(1.0280)	(1.2264)	(1.2942)	(1.4279)	(1.6531)	(1.7670)
Time Trend		-2.0209 ***	-1.8901 **	10.0098 ***	22.8416 ***	-61.9739 ***
		(0.3087)	(0.7399)	(2.6953)	(6.0469)	(21.0175)
Time Trend^2			-0.0164	-3.5330 ***	-9.8279 ***	46.7248 ***
			(0.0942)	(0.7642)	(2.8110)	(13.6787)
Time Trend^3				0.2793 ***	1.4794 ***	-15.0552 ***
				(0.0610)	(0.5292)	(3.9510)
Time Trend^4					-0.0765 **	2.1000 ***
					(0.0340)	(0.5186)
Time Trend^5						-0.1059 ***
						(0.0253)
R^2	0.298	0.302	0.302	0.303	0.303	0.304
Prob > F (Time Trend)		0.000	0.000	0.000	0.000	0.000

Dependent variable is course size (students per class). Standard errors in parentheses. Standard errors allow for clustering within teacher/transition cell and general heteroskedasticity in all regressions. * = 10% significance, ** = 5% significance, *** = 1% significance. The F-test is the p-value for the joint significance level of the time trend variables. All regressions include teacher fixed effects.