Budget Uncertainty and Faculty Contracts: A Dynamic Framework for Comparative Analysis[*]

Irina Khovanskaya

Higher School of Economics

Konstantin Sonin[†]

New Economic School

Maria Yudkevich

Higher School of Economics

December 2007

Abstract

We study hiring decisions made by competing universities in a dynamic framework, focusing on the structure of university finance. Universities with annual state-approved financing under-invest in high-quality faculty, while universities that receive a significant part of their annual income from returns on endowments hire fewer but better faculty and provide long-term contracts. If university financing is linked to the number of students, there is additional pressure to hire low-quality short-term staff. An increase in the university's budget might force the university to switch its priorities from 'research' to 'teaching' in equilibrium. We employ our model to discuss the necessity for state-financed endowments, and investigate the political economics of competition between universities, path-dependence in the development of the university system, and higher-education reform in emerging market economies.

1 Introduction

Worldwide, there is an enormous heterogeneity in the ways universities hire their faculty. While a significant number of universities around the globe opt for the US-type system with a relatively low teaching load and a tenure system, the majority of universities discount the research activities of their faculty. In many countries, it was not until very recently that governments set themselves the task of creating research universities (Altbach, 2007). However, such reforms require not only sufficient resources, but also a clear understanding of the links between organizational structure and incentives for conducting research activity. For example, the Chinese government has recently unveiled a 15-year Medium to Long-Term Science and Technology Development Plan, which, among other things, envisages a 90% increase of the share of GDP spent on R&D over the period. While the plan has already succeeded in starting major modern research programs (*Science*, April 2006), the fact that institutional arrangements do not allow for an inflow of money that would be outside government control, e.g., by via endowing certain departments or programs, makes the whole plan dependent upon the high growth rates of the Chinese economy.

Many studies in the literature have been devoted to the personal incentives for academicians (e.g., Carmichael, 1988, Chatterjee and Marshall, 2001). However, with the notable exception of Alchian (1959), these incentives are typically separated from the budgetary issues a modern university faces. In this paper, we study the relationship between universities that are competing for good students, and their professors using a dynamic framework. The way universities are budgeted plays an important role: universities with annual state-approved financing hire professors short-term, while universities that receive a significant part of their annual income from royalty on their endowments provide faculty with tenure contracts. Budget uncertainties might stem from rising costs; in 2006, Trinity College at Hartford, USA, had to lay-off more than 20 faculty members as a result of a 62% rise in utility expenses and a 22% rise in health costs. As the price elasticity of demand for education in any particular college is arguably high, private universities relying primarily on tuition cannot maintain their faculty during low budget periods.

Rising costs are not the only source of budget uncertainty. While in the US the state financing of universities is a relatively stable source of income (though still more volatile than endowment financing, as many university budgets are subject to approval by state legislature on an annual basis), in other countries the government might be the primary source of budget uncertainty. In 1995, the Japanese government – perhaps as a result of budget difficulties – initiated a large-scale initiative to promote new hiring rules for foreign academics, and the standard term for a typical

contract was one academic year. The fact that "few institutions except in the United States and Japan have endowment funds that support research" (Altbach, 2007) makes the role of endowments in the development of research universities a focal point for discussion, especially for countries with governments that have only limited commitment power. Even in the US, budget shocks affect the every-day life of researchers. Termination of the Dallas Superconducting Super Collider project in 1993 resulted not only in a write-off of $2 billion, but also in an abrupt change in the lives of 1000+ research-related employees only.[1]

If university financing is linked to the number of students (either directly through government money, as is standard in developed European countries and US state universities, or indirectly from graduates' donations, as in private US universities), there is additional pressure to hire low-quality short-term professors. Furthermore, budget uncertainty might force competing universities to hire low-quality professors in a dynamic equilibrium even if a higher level of high-ability faculty is optimal for any of the possible budget outcomes in the one-shot game. The primary source of this dynamic inefficiency is the commitment problem (see e.g., Acemoglu and Robinson, 2001, Acemoglu, 2008 for the modern perspective of the commitment problem). In a Markov perfect equilibrium, budget uncertainty prevents universities from providing tenure; without providing tenure to high-quality professors, universities cannot provide them with first-best incentives.

There is an important caveat to our work: the economics of education is a topic which has often been much too specific for comparative analysis. Most of the discussion on the subject is devoted entirely to US-specific problems, while the most urgent problems outside the US are not addressed. Our model is consistent with existing evidence on university structure in both the US and the world in general, and also provides direct policy implications for university-building strategies in developing countries such as China and Russia. For example, our model predicts that a private university will be more likely to concentrate most of its resources in a few selected departments. Nevertheless, even semantic differences can create difficulties. In France, the educational institutions that correspond to what we call a 'high-standard' (research) university are called Ecoles as opposed to Universities, with l'Ecole Normale and l'Ecole Polytechnique being the most prominent examples.

In modelling the different strategies that universities might pursue – either high-standard ("research university") or standard ("teaching university")[2] – we focus on the hiring decisions. Indeed,

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[1] "10 years after SSC: Scientists Are Long Gone, But Bitter Memories Remain", *Science*, October 2003, 302: 40-41.

[2] While the distinction between "teaching" and "research" universities is clear in the US and UK, it is much less so in a larger context. In most countries, the terms "high-standard" and "standard" ("normal") seem to be more

faculty selection might be the most important way of controlling the standard of quality. For example, the preamble to the "Principles Governing Research at Harvard" states: "The primary means for controlling the quality of the scholarly activities of this Faculty is through the rigorous academic standard applied in selecting its members."

The difference in university funding across different countries is huge. In Germany, less than 10% of total funding for university education is private (The Economist, September 25, 2004). Recently, there have been several attempts to link strategies that universities pursue to funding structure. Beath, Poyago-Theotoky, and Ulph (2005) attempt to assess the ways in which university funding affects the research vs. teaching trade-off. The budget constraint plays a crucial role in their model. Criticizing an attempt by Del Rey (2001) to model static university competition, they note that research quality need not be directly incorporated into a university budget constraint. In contrast with our model, Beath et al (2005) address neither the competition between universities, nor possible student heterogeneity. Thus, their main findings are dependent not upon the market environment a university might operate in, but on the existence of a centralized system for funding universities. If quality research is targeted to be rewarded, the result might be the "binary divide" of universities into a small elite of "research universities" and a large group of "teaching universities" (pre-1992 UK is cited as a classic example). Our model highlights, in particular, the role of commitment by the central authority to provide funding. Vanhaeht and Pauwels (2005) model universities competing for heterogenous students; the university budgets are state-financed and include a fixed sum and a per-student allowance. One result is the existence of an asymmetric equilibrium, with only one university pursuing a high-standard. We extend this result to a dynamic environment: a higher budget volatility hurts the "upper end" of the binary divide.

One important instance of the US perspective being different from that of the rest of the world is the tenure issue. There are two classic economic explanations for why universities may opt for the tenure system (see, e.g. Morton and Shapiro, 1999, for a survey; also, Finkin, 1996, Menard, 1996, Benjamin and Wagner, 1994). First, it provides young faculty with an incentive to pursue their first-best efforts (Holmstrom, 1982), while for risk-neutral universities this is an efficient way to pay highly risk-averse academics. Second, a tenure system provides good incentives for senior (tenured) faculty to hire the best of young scholars as the already-tenured faculty do not feel competitive pressure from their younger colleagues (Carmichael, 1988). Waldman (1990) argue that if young faculty have no tenure prospects, then they will have inferior incentives to invest in their human capital. Another explanation links tenure issues to optimal-risk sharing (e.g., Freeman,
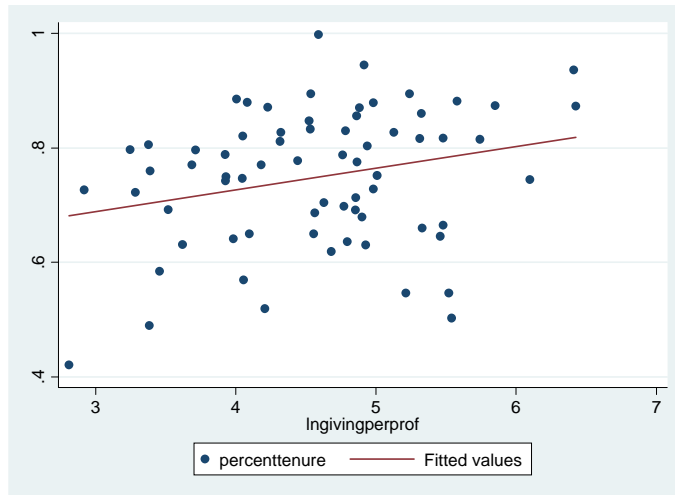
appropriate.

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Figure 1: Percentage of faculty on tenure line and annual donations per employee for private universities in US top-50.

1977). In our model, the returns to a research project are delayed, as we focus on dynamic issues; incorporating uncertainty about the outcome of a research project here is straightforward. Finally, the variance of unobserved productivity parameters of a university professor over time might make tenure an optimal arrangement (Siow, 1998). In emerging countries such as China, India, Brazil, or Russia, the tenure system that assumes competitive pay for faculty is largely absent. (Nevertheless, a typical professor in a Brazilian public university has life-long employment, Schwartzman, 2007.). We do not attempt to offer a new explanation of why tenure is important: here, our analysis is based on the premise that long-term contracts are beneficial.[3]

While the governments of developing nations pay increasing attention to endowment-type financing of research universities and to the tenure-based faculty system, US universities are moving in another direction. Shuster and Finkelstein (American Faculty, 2006) write, "...the transformation is remarkable: from 1969 to 1998, a decline by one-half in faculty members occupying tenure-eligible positions and sevenfold increase in faculty reporting non-tenure-eligible appointments." (Barnes and O'Hara, 1999, observe the same trend in UK universities). On November 20, 2007, The New York Times reported that the American Federation of Teachers estimate that nearly 70% of US profes-

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[3]As we focus exclusively on (dis)incentives provided by budget uncertainty, we do not survey relevant contract theory literature (see e.g., Bolton and Dewatripont, 2005 for a general survey; and Chatterjee and Marshal for contract theory issues related to academic research). The paper by Guriev and Kvasov (2004) is especially relevant as it explicitly studies negotiation over the contract expiration time.

sors are "adjuncts", i.e. either part-timers or full-timers not on a tenure-track, the primary reason for this being an insufficient amount of stable funds. In universities, the share of faculty that were not eligible for tenure rose from 3.4% to 16.4%. Masten (2006) cites a study of the tenure-granting process in the US in the 1970s: the process was fully faculty-managed in 5.8% of universities, while in 29.9% it was jointly managed by faculty and administration. The same study showed that the administration-managed tenure-granting process was more typical for state universities, rather than for private ones. This supports one of the predictions of our model: universities with annually-approved budgets retain more administrative control over hiring decisions.

In a largely overlooked paper, Armen Alchian wrote, "The reason for the general acceptance of tenure is not that the search for truth has some special characteristics which distinguish it from other products, but that, instead, its acceptance springs from the special ownership arrangement and financial structure of our colleges" (Alchian, 1959: page 179). Alchian (1959) predicts that the proportion of tenured faculty is positively correlated with the share of the annual budget from endowment proceeds. (Figure 1 illustrates the relationship between the percentage of faculty on tenure track and annual donations per employee for private universities in the top-50 US universities.) Another prediction is that a commercial university, which is a residual claimant of employees' efforts, is expected to use tenure contracts less often. Our model is the simplest possible way to assess these issues in a dynamic perspective. Basing his observations on empirical data from the academic labor market, Ehrenberg (2003) notes, "A major reason for the growing use of part-time and non-tenure-track faculty is that the ability of a large fraction of American higher education institutions to generate the revenues necessary to pay for higher salaries for tenure track faculty is greatly limited." While certainly plausible, this explanation runs somewhat contrary to the fact that the budgets of most universities in per student terms has been increasing over time.

The rest of the paper is organized as follows. Section 2 sets up the model, and Section 3 contains its analysis. In Section 4, we discuss the policy implications of the formal model, drawing examples from the recent experience of emerging research universities. Section 5 concludes.

2   Setup

There are two infinitely-lived universities who hire professors with heterogenous ability, and heterogenous students who choose a university for their studies.

Faculty and Students

There are two types of professors, able $\theta = \theta_H$ and mediocre $\theta = \theta_L$. This parameter captures both the personal endowment of human capital, i.e. the ability of a professor to teach or do joint research with students,[4] and his outside option. That is, a university needs to pay a professor of type θ at least $w(\theta) = \theta$. In total, there are n_H able and n_L mediocre professors in the university. Each professor needs to apply costly efforts to be productive; for simplicity, we assume that the cost of efforts is small, i.e. the professor does not apply any effort if she is indifferent.

Students have heterogeneous abilities as well: they can also be either able or mediocre, $s \in \{s_H, s_L\}$. A student who has ability s, if matched with a professor of ability θ, gets from this matching $s\theta$. However, a student cannot tell one from the other *ex-ante*.

Suppose that a student meets m professors during her studies. The number of able professors a student i meets, m_i, is random; the distribution of m_i is hypergeometric with parameters $(m, n_H + n_L, n_H)$. Let $p(k) = \Pr(m_i = k)$.[5] Under these assumptions, the expected skills a student i accumulates is

$$Eu_i(s) = \sum_k \left(k\theta_H + (m-k)\theta_L\right) sp(k) = s\frac{m}{n_H + n_L}\left(n_H\theta_H + n_L\theta_L\right).^6$$

To graduate from university, a student needs to exert costly efforts; we assume that $c_H = 0$, while $c_L > 0$. Each student i chooses a university to maximize her expected skills minus this cost: $Eu_i(s) - c_i$.

Universities

Each period, a university has to allocate a budget B to hire a mix of two types of professors, (n_H, n_L). The balance condition is $B = n_H w_H + n_L w_L$, where $w(\theta)$ is the salary of a professor of type θ.

Let M_H denote the number of high-ability students, and M_L be the number of normal-abilty students. Each university maximizes the following function:

$$U = s_H M_H \frac{Bm}{n_H + n_L} + s_L M_L \frac{Bm}{n_H + n_L} + \mu\left(M_H + M_L\right).$$

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[4] Glaeser (2002) observes, "In 1900, students didn't care whether or not faculty members were researchers. In 2000, they do."

[5] If a random variable X has a hypergeometric distrubution with parameters (a, b, c), then the probability of getting exactly k successes is $f(k, a, b, c) = \frac{\binom{b}{k}\binom{a-b}{c-k}}{\binom{a}{c}}$.

[6] For a random variable X that has a hypergeometric distrubution with parameters (a, b, c), $EX = \frac{ac}{b}$.

The first and the second terms give the expected output given the composition of faculty and students, and the third term reflects the fact that the university's budget depends on the size of the student body. If θ is the outside option for a professor of type θ, the balance condition is $B = n_H\theta_H + n_L\theta_L$.

There are two assumptions worth discussing. First, we assume that the professor-student ratio is fixed; $M_H + M_L = \lambda(n_H + n_L)$. Though this assumption might seem overly rigid – especially for private US universities, which operate under no formal pressure to maintain a fixed ratio – it might be derived from first principles, if professors have a quasi-linear utility function of the form $u(w,t) = w - \rho d(t)$, where $w = w(t)$ is the optimal compensation for t hours of teaching (Tirole, 1988). Second, an interesting extension would be to analyze the case of universities competing for star professors, i.e. allow the wage of high-ability professors, $w = w(\theta_H)$, to be determined by the market.

In each period t, the budget of each university $B_i = B^t$, $i = 1, 2$, is equal to B_B with probability p, and to B_S with probability $q = 1 - p$, $B_B > B_S$. If a university wants to fire some professors in period t, it has bear a cost. The cost of firing a mediocre professor is normalized to zero: one can think of these professors as having year-long contracts. Firing an able professor costs the university $C > 0$. This is probably the most natural way to model tenure: the higher the cost C, the more secure the professor's position.

We shall start with analyzing the stage game of our dynamic setup as a static game. In the dynamic game, we assume that a professor enjoys the return on her research efforts only if she remains as faculty in the next period. For students, we assume that their studies take more than one period, but they make their decision only once.

Timing of the stage game in the dynamic game

1. Universities simultaneously and independently learn and allocate their budgets, and make hiring/firing decisions.

2. Payoffs from the research efforts of the faculty who remained are received.

3. New students enter the university of their choice, if there is enough capacity.

4. Students are matched to professors, and one-period payoffs are received. The period ends.

We focus on symmetric Markov perfect equilibria (Maskin and Tirole, 2001). To simplify matters, we assume that able students make their choice before the rest of the students: this

corresponds to entrance exams, which is practiced, e.g., in all Russian universities. In France, high-standard Ecoles have entrance exams, while other (standard) universities have virtually free admission. Also, we assume that students' strategies are stationary: there is a fixed percentage of students that enter universities to spend a number of years there.

3 Analysis

3.1 Static Analysis

We start with the analysis of a one-shot game between universities, which will serve as our basis for the dynamic model. In the static game, universities start by simultaneously and independently allocating their budgets on either high-ability or mediocre faculty. Students then enter the university of their choice, and faculty members exert their first-best efforts.[7] Finally, students are randomly matched to professors, and payoffs are received.

First, we observe that in equilibrium able students would always prefer to go to the university with a stronger faculty. Each university maximizes

$$U = s_H M_H \frac{Bm}{n_H + n_L} + s_L M_L \frac{Bm}{n_H + n_L} + \mu (M_H + M_L).$$

Given the budget, the total number of professors, $n = n_H + n_L$, satisfies $\frac{B}{\theta_H} \leq n \leq \frac{B}{\theta_L}$. Substituting n_L for n_H from the budget constraint, we obtain U as a convex function of n_H. Thus, U is maximized when either $n_H = \frac{B}{\theta_H}$ or $n_H = 0$.

If

$$(s_H M_H^m + s_L M_L^m) \theta_L + \mu \lambda \frac{B}{\theta_L} < (s_H M_H^a + s_L M_L^a) \theta_H + \mu \lambda \frac{B}{\theta_H},$$

where M_H^m and M_L^m is the respective number of high- and low-ability students if the university choose the normal strategy, and M_H^a and M_L^a is the respective number of high- and low-ability students if the university choose the high-standard strategy, the university spends its budget on high-ability professors. Otherwise, $n_H = 0$.

Without loss of generality, we shall assume that $s_L = 0$.[8]

Let T be the total number of all able students, and let $\overline{T}_H$ be the minimum number of able students that would induce a university to pursue a high-standard strategy, given that the other uni-

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[7] In a one-period game faculty have no incentives to vary effort depending on the prospects of retaining their position; thus, we simply fix the level of efforts.

[8] This is without loss of generality, since the university maximand includes the size of the student body; thus, it is $s_H - s_L$ that matters and s_L can be normalized to zero.

versity is also pursuing a high-standard strategy (if the other university pursues a normal strategy, this number of able students still makes a high-standard strategy the best choice):

$$s_H \overline{T}_H \theta_H + \mu\lambda\frac{B}{\theta_H} = s_H \left(\overline{T}_H - \lambda\frac{B}{\theta_H}\right)\theta_L + \mu\lambda\frac{B}{\theta_L}$$

Now, let $\overline{T}_L$ be the maximum number of able students that induce a university to pursue a normal strategy given that the other university has also chosen a normal strategy:

$$s_H \min\left\{T, \lambda\frac{B}{\theta_H}\right\}\theta_H + \mu\lambda\frac{B}{\theta_H} = s_H \overline{T}_L \theta_L + \mu\lambda\frac{B}{\theta_L}.$$

The following Proposition summarizes the above discussion.

Proposition 1 *(i) Suppose that $T > 2\overline{T}_H$. For any pair (T_1, T_2) such that $T = T_1 + T_2$ and $T_1, T_2 \geq \overline{T}_H$, the following strategies constitute an equilibrium: $(n_H^i, n_L^i) = \left(\frac{B}{\theta_H}, 0\right)$, T_i high-ability students enter university i, $i = 1, 2$.*

(ii) If $T < 2\overline{T}_H$, there cannot be more that one high-standard university in equilibrium.

(iii) Suppose that $\overline{T}_L < T$. For any pair (T_1, T_2) such that $T = T_1 + T_2$ and $T_i \geq \overline{T}_L$ for some $i \in \{1, 2\}$, the following strategies constitute an equilibrium: $(n_H^i, n_L^i) = \left(\frac{B}{\theta_H}, 0\right)$, $(n_H^{-i}, n_L^{-i}) = \left(0, \frac{B}{\theta_L}\right)$; $\min\left\{T, \lambda\frac{B}{\theta_H}\right\}$ high-ability students enter university i, while the rest of the high-ability students enter $-i$. If both universities choose a normal strategy, T_i students enter university i.

For the sake of clarity, this proposition does not include students' equilibrium responses to off-equilibrium-path strategies of universities. For example, (i) requires the specification that if the universities' strategies differ, then all able students enter the high-standard university; if both universities opt for a normal-standard strategy, then any decision the able students make is a best response. Similarly, (iii) requires the specification of what students do if universities choose a different strategy profile. If only one of the two conditions $S_1 \geq \overline{T}_H$ and $S_2 \geq \overline{T}$, where $T = S_1 + S_2$, is fulfilled, then S_1 students opt for university 1, while S_2 students opt for university 2, provided that both universities are high-standard.

Budget

Initially, we assumed that the two universities have equal budgets. Now we relax this assumption. Let B_i be the budget available for university i. We focus on the most interesting case, when there is only one high-standard university. Thus, there is no competition for able students: $T \geqslant \lambda\frac{B_1}{\theta_H}$, $T > \overline{T}_L$. Fix a pair (T_1, T_2) such that $T = T_1 + T_2$ and without loss of generality assume that $T_1 \geq \overline{T}_L$. By

Proposition 1, the following strategies constitute the equilibrium of interest. $(n_H^1, n_L^1) = \left(\frac{B_1}{\theta_H}, 0\right)$, $(n_H^2, n_L^2) = \left(0, \frac{B_2}{\theta_L}\right)$. As above, we do not explicitly specify equilibrium responses for off-equilibrium moves.

University 1 maintains high standard as long as $U\left(\frac{B_1}{\theta_H}\right) - U\left(\frac{B_1}{\theta_L}\right) > 0$ or, equivalently,

$$\mu\lambda B_1 \left(\frac{1}{\theta_L} - \frac{1}{\theta_H}\right) < s_H \left(M_H^a \theta_H - M_H^m \theta_L\right), \tag{1}$$

where M_H^m and M_H^a are the number of able students who enter university 1, depending on whether it is high-standard or normal, respectively. Since students care only about the quality of faculty, but not the university budget per se, an increase in B_1 does not affect students' choice if condition (1) is satisfied. When (1) fails, the high standard is no longer the equilibrium choice of university 1, that is, $(n_H^1, n_L^1) = \left(0, \frac{B_1}{\theta_L}\right)$.

We shall demonstrate that there exists a certain threshold $\overline{B}_1$ such that (1) is satisfied in equilibrium if and only if $B_1 < \overline{B}_1$. Note that this cannot be proved by setting $\overline{B}_1 = \frac{1}{\mu\lambda} s_H \left(\frac{1}{\theta_L} - \frac{1}{\theta_H}\right)^{-1} \left(M_H^a \theta_H - M_H^m \theta_L\right)$, since the right-hand side of (1) depends on the equilibrium response of students. Denote $f(B_1) = s_H \left(M_H^a \theta_H - M_H^m \theta_L\right) - \mu\lambda \left(\frac{1}{\theta_L} - \frac{1}{\theta_H}\right) B_1$, since $\theta_H > \theta_L$, $f(B_1)$ decreases with B_1. Recall that the number of able students that enter university 1 when it pursues a high-standard strategy, M_H^m, does not change with B_1.

For $B_1 \leq \frac{T}{\lambda}\theta_H$, the number of able students who enter university 1 when the latter pursues a normal-standard strategy is $M_H^a = \lambda \frac{B_1}{\theta_H}$. Therefore, when $B_1 \leq \frac{T}{\lambda}\theta_H$, $f(B_1) = s_H \left(\lambda \frac{B_1}{\theta_H}\theta_H - M_H^m \theta_L\right) - \mu\lambda \left(\frac{1}{\theta_L} - \frac{1}{\theta_H}\right) B_1$, which is linear in B_1. For $B_1 > \frac{T}{\lambda}\theta_H$, $M_H^a = T$, $f(B_1) = s_H \left(T\theta_H - M_H^m \theta_L\right) - \mu\lambda \left(\frac{1}{\theta_L} - \frac{1}{\theta_H}\right) B_1$, which is also linear in B_1, and decreasing with B_1.

In sum, $f(B_1)$ is piecewise-linear in B_1, $f(0) > 0$ and $f(B_1)$ is decreasing when $B_1 > \frac{T}{\lambda}\theta_H$. This completes the proof of the following Proposition.

Proposition 2 *Suppose that $T \geqslant \lambda\frac{B_1}{\theta_H}$, $T > \overline{T}_L$, and fix a pair (T_1, T_2) such that $T = T_1 + T_2$, $T_1 \geq \overline{T}_L$. Then there exists a threshold $\overline{B}_1$, such that the equilibrium is $(n_H^1, n_L^1) = \left(\frac{B_1}{\theta_H}, 0\right)$, $(n_H^2, n_L^2) = \left(0, \frac{B_2}{\theta_L}\right)$ if $B_1 < \overline{B}_1$, and $(n_H^1, n_L^1) = \left(0, \frac{B_1}{\theta_L}\right)$, $(n_H^2, n_L^2) = \left(0, \frac{B_2}{\theta_L}\right)$, otherwise.*

The most striking implication of Proposition 2 is that an increase in a university's budget might actually force it to abandon the high standard. The intuition is that when the student quality becomes a binding constraint, the university cannot gain by attracting able students and concentrates on increasing the overall number of students. This can be most easily achieved by

hiring relatively cheap, mediocre faculty. The comparative statics are again natural: an increase in the price of high-quality faculty, or, alternatively, an increase in the difference in the quality of faculty shift the threshold $\overline{B}_1$ down; that is, such changes make normal-quality faculty the most preferred choice of the university for a wider range of parameters. One example might be illustrative. In the US, recent difficulties with academic standard (the government-measured graduation rates are 16 percent, which is bleak compared to the national average of 55) drew attention to the University of Phoenix, a huge for-profit university with 300,000 students on campuses in 39 states and online, with 95 percent of faculty working part-time (compared with an average of 47 percent nation-wide).[9] While the common explanation for the reported erosion in quality of faculty is rising market pressure, the increasing availability of federal funds might be another explanation. The University of Phoenix gets more than any other university in federal student financial aid; in the 2004-05 academic year alone, it received 1.8 billion dollars in such aid.

There are some other practical implications of Proposition 2. Of course, this argument does not necessarily imply that there might not exist a large state-financed university with excellent faculty. However, the argument implies that a good department needs to have special arrangements within the university. A real university, top-tier and low-tier alike, typically has more than one department teaching essentially the same subject. For example, Harvard has the Department of Government and the Kennedy School of Government (KSG), two completely separate entities with overlapping curricula and the research agenda. There are also at least three distinct ways to earn a Ph.D. in economics at Harvard: at the Economics Department, KSG, and the Harvard Business School. In Erasmus University of Rotterdam, there are several ways to get a (largely the same) degree in business or financial administration: at the Economics Department, and in the School of Business. Proposition 2 suggests a rationale for why a university may chose to have two departments, a high-standard and a normal one. Suppose that when the budget is equal to some $B > 0$, the university prefers to maintain high standard, and let $B' > B$ be large enough so that the university prefers normal standard when the budget is B'. Then the university is better off splitting its program into departments with budgets B (high-standard) and $B'' = B' - B$ (normal), rather than staying normal with budget B'. Indeed, a normal university receives

$$U\left(B'\right) = s_H M_H^m \theta_L + \mu\lambda\frac{B'}{\theta_L} = \left(s_H M_H^m \theta_L + \mu\lambda\frac{B}{\theta_L}\right) + \mu\lambda\frac{B''}{\theta_L}.$$

The assumption that a budget of B makes the university high-standard yields that

$$s_H M_H^m \theta_L + \mu\lambda\frac{B}{\theta_L} < s_H M_H^a \theta_H + \mu\lambda\frac{B}{\theta_H}.$$

Therefore,

$$U\left(B'\right) = \left(s_H M_H^m \theta_L + \mu\lambda\frac{B}{\theta_L}\right) + \mu\lambda\frac{B''}{\theta_L} < s_H M_H^a \theta_H + \mu\lambda\frac{B}{\theta_H} + \mu\lambda\frac{B''}{\theta_L} = U\left(B\right) + U\left(B''\right).$$

The same argument demonstrates that there might be more than one high-standard department inside one big university.

Peter Howitt, discussing the economics of science and the future of universities (Howitt, 2003), attributed the recent breakthroughs in information and biological technology to a large extent to the ability of American universities to form computer science and chemical engineering departments well before any European university. Our model highlights the pressure that per-student state financing puts on universities to switch to a predominantly teaching mode, rather than to open a new high-quality research department.

Student-teacher ratio, funding, etc

A decrease in the student-teacher ratio makes high standard more likely. Indeed, fix all the parameters of the model, except λ, the student-teacher ratio.[10] The number of professors a student meets, m, is fixed; thus λ is essentially the average size of the class.

$$U = s_H M_H \frac{Bm}{n_H + n_L} + \mu\lambda\left(n_H + n_L\right)$$

Proposition 3 *(i) Suppose that $\lambda_1 < \lambda_2$. For any equilibrium in the game $\Gamma\left(B, m, \mu, \theta_L, \theta_H, \lambda_2\right)$ with at least one university pursuing a high-standard strategy, there exists an equilibrium in the game $\Gamma\left(B, m, \mu, \theta_L, \theta_H, \lambda_1\right)$ where the universities pursue the same strategies.*

(ii) For any set of parameters $(B, m, \mu, \theta_L, \theta_H, \lambda)$ such that there exists an equilibrium with at least one high-standard university, there exist thresholds $\lambda_K < \lambda_N$ such that for any $\lambda > \lambda_K$, any equilibrium of $\Gamma\left(B, m, \mu, \theta_L, \theta_H, \lambda\right)$ has less universities with high-standard strategies, and for any $\lambda > \lambda_N$, the game $\Gamma\left(B, m, \mu, \theta_L, \theta_H, \mu, \lambda\right)$ has no equilibria with high-standard universities.

Now fix all the parameters but μ, the amount of funding associated with each student.

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[10]Throughout the comparative statics analysis, we assume that the strategies of high-quality students are fixed.

Proposition 4 *(i) Suppose that $\mu_1 < \mu_2$. For any equilibrium in the game $\Gamma\left(B, m, \mu_2, \theta_L, \theta_H, \lambda\right)$ with at least one university pursuing a high-standard strategy, there exists an equilibrium in the game $\Gamma\left(B, m, \mu_1, \theta_L, \theta_H, \lambda\right)$ where the universities pursue the same strategies.*

(ii) For any set of parameters $(B, m, \mu, \theta_L, \theta_H, \lambda)$ such that there exists an equilibrium with at least one high-standard university, there exist thresholds $\mu_K < \mu_N$ such that for any $\mu > \mu_K$, any equilibrium of $\Gamma\left(B, m, \mu, \theta_L, \theta_H, \lambda\right)$ has less universities pursuing high-standard strategies, and for any $\mu > \mu_N$, the game $\Gamma\left(B, m, \mu, \theta_L, \theta_H, \lambda\right)$ has no equilibria with high-standard universities.

Similar comparative statics results may be obtained for m, the number of professors a student expects to meet during the time she spends in the university. Along with the proportion of the high-quality professors and their professional quality θ_H, m is a proxy for the overall quality of the university. With either m or θ_H increasing, the range of parameters for which high-standard equilibria exist increases. This highlights an important policy trade-off that the governments of developing countries face: easing access to university for students (e.g., by making any public university tuition-free as it was via a constitutional provision in Brazil in 1988, Schwartzman, 2007) increases the pressure on the university to pursue a normal-quality strategy.

3.2 Dynamics

We now apply our model to the main issue: the dynamic effects of budget uncertainty on the nature of faculty contracts. Suppose that the budget of each university, B_i, may have one of two values, $B_i \in \{B_B, B_S\}$, with $B_B > B_S$. We focus on the case in which the total number of able students does not exceed the maximum number of students that a high-standard university with budget B_H can admit, $\lambda\frac{B_S}{\theta_H} < \frac{1}{2}T < \lambda\frac{B_H}{\theta_H}$, but is larger than the number of able students needed for a normal university. (Other cases may be analyzed in a similar way.) If both universities are of high standard, able students split equally. Furthermore, we assume that university budgets are perfectly correlated: for the state-funded universities, this might be the result of an adverse macroeconomic shock. For both public and private universities, a common budget shock might follow an economy-wide recession. When $B_1 = B_2 = B_B$, both universities choose the high-standard equilibrium.

Recall that in each period t, $B^t = B_1 = B_2$ is equal to B_B with probability p, and to B_S with probability $q = 1 - p$; the cost of firing a mediocre professor is normalized to zero, while firing an able professor costs the university $C > 0$.

Informally, the strategy of university i determines the number of able professors that the university hires in period t as a function of B^t, the budget for period t, and the existing composition

of faculty. (We relegate all formal details, including a description of histories of the game, and strategies conditioned upon histories, to the Appendix. Herein, we omit the time subscript whenever doing so does not lead to confusion.) Once the number of able professors, $n_H^i \left(B, n_{H*}^i \right)$, is determined, the remainder of the budget, $n_L^i \left(B, n_{H*}^i \right) = \frac{B - n_H^i \left(B, n_{H*}^i \right) \theta_H}{\theta_L}$, is spent on professors hired on a temporary basis. Thus, the strategy of university i is

$$\left(n_H^i \left(B, n_{H*}^i \right), n_L^i \left(B, n_{H*}^i \right) \right) = \left(n_H^i \left(B, n_{H*}^i \right), \frac{B - n_H^i \left(B, n_{H*} \right) \theta_H}{\theta_L} \right),$$

where n_{H*}^i is the number of professors who already have tenure in period t. The number of able professors at t is $n_H^i \left(B, n_{H*}^i \right)$; thus, the net number of those who were hired in period t is $n_H^i \left(B, n_{H*}^i \right) - n_{H*}^i$.

The first observation is that if research efforts pay off with a one-period delay, no able professor will exert any efforts until she expects to retain her position in the next period.

If both universities pursue the same standard in this period, $n_H^i \left(B, n_{H*}^i \right) = n_H^{-i} \left(B, n_{H*}^{-i} \right)$, then the expected one-period utility of university i is

$$
\begin{aligned}
U_0 \left(B, n_{H*}^i \right) &= s_H \frac{T_*}{2} \frac{Bm}{n_H^i \left(B, n_{H*}^i \right) + n_L^i \left(B, n_{H*}^i \right)} + \mu \lambda \left(n_H^i \left(B, n_{H*}^i \right) + n_L \left(B, n_{H*}^i \right) \right) \\
&\quad - C \max \left\{ \left(n_{H*}^i - n_H^i \left(B, n_{H*}^i \right) \right), 0 \right\},
\end{aligned}
$$

where T_* is the number of able students. $T_* = T$ if the budget is large, and $T_* = 2 \frac{Bs}{\theta_H} \lambda$ when the budget is small.

If $n_H^i \left(B, n_{H*}^i \right) > n_H^{-i} \left(B, n_{H*}^{-i} \right)$, then the expected one-period utility of university i is

$$
\begin{aligned}
U_0 \left(B, n_{H*}^i \right) &= s_H \frac{T_*}{2} \frac{Bm}{n_H^i \left(B, n_{H*}^i \right) + n_L^i \left(B, n_{H*}^i \right)} + \mu \lambda \left(n_H^i \left(B, n_{H*}^i \right) + n_L \left(B, n_{H*}^i \right) \right) \\
&\quad - C \max \left\{ \left(n_{H*}^i - n_H^i \left(B, n_{H*}^i \right) \right), 0 \right\}.
\end{aligned}
$$

Finally, if $n_H^i \left(B, n_{H*}^i \right) < n_H^{-i} \left(B, n_{H*}^{-i} \right)$, then the expected one-period utility of university i is

$$U_0 \left(B, n_{H*}^i \right) = \mu \lambda \left(n_H^i \left(B, n_{H*}^i \right) + n_L \left(B, n_{H*}^i \right) \right) - C \max \left\{ \left(n_{H*}^i - n_H^i \left(B, n_{H*}^i \right) \right), 0 \right\}.$$

We focus on symmetric Markov perfect equilibria, so that universities make the same choice in the same circumstances. Thus, the expected life-time utility of using strategy $\left(n_H \left(B, n_{H*} \right), \frac{B - n_H \left(B, n_{H*} \right) \theta_H}{\theta_L} \right)$ is equal to

$$U \left(n_H \left(B, n_{H*} \right) \right) = U_0 \left(B, n_{H*} \right) + \frac{\delta}{1 - \delta} \left[p U \left(n_H \left(B_B, n_H \left(B, n_{H*} \right) \right) \right) + q U \left(n_H \left(B_S, n_H \left(B, n_{H*} \right) \right) \right) \right].$$

$$(2)$$

This is a standard Bellman-type equation used for solving Markov games. Essentially, (2) is a system of non-linear equations which, under fairly mild restrictions on parameters, has a unique symmetric solution.

Budget Uncertainty and Tenure Contracts

Our next goal is to study the conditions that determine the equilibrium choice of faculty by the university. For the sake of simplicity, we make no distinction between tenure and long-term contract: at the cost of additional technicalities the model might be modified to deal with fixed-length long-term contracts.

Lemma 1 *There exists some $C_0 = C_0(B_B, B_S)$ such that if the cost of firing a tenured professor, C, exceeds C_0, then a university does not spend its entire budget B_B on high-quality professors.*

Proof. With probability q, the next-period budget is normal, $B = B_S$. Thus, the university will be forced to default on obligations to (some) of its tenured professors. When C is sufficiently high, the university prefers not to hire those whom they would not be able to afford with the low budget.∎

Now assume that $C \geq C_0$, and thus no tenured professor is fired in equilibrium. In this situation, universities hire either a minimal, or maximum number of high-ability professors. The intuition is that the budget uncertainty presents a disincentive for faculty to pursue research efforts, thus forcing universities to put more emphasis on less expensive low-quality faculty. Thus, a decrease in firing costs help to hire high-quality professors, but does not help in providing them with the proper incentives.

We shall start with some less-interesting cases, when one strategy is preferred under all circumstances. First, suppose that $U_0\left(B_B, \frac{B_B}{\theta_H}\right) > U_0\left(B_B, 0\right)$. In this case, in both good and bad times, a high-standard strategy is preferred to a normal strategy given that the other university pursues a high-standard strategy. Second, suppose that $U_0\left(B_S, \frac{B_S}{\theta_H}\right) > U_0\left(B_B, 0\right)$. In this case, the bad-times budget is spent on high-quality faculty no matter whether the other university is high-standard or normal.

Now we turn to our main case, $U_0\left(B_B, \frac{B_S}{\theta_H}\right) < U_0\left(B_B, 0\right)$. Given that the other university pursues a normal-standard strategy, a university prefers to spend its entire good-times budget on normal-quality faculty rather than to hire as much high-quality faculty as the low budget would allow. If at the same time

$$qU_0\left(B_S, 0\right) + pU_0\left(B_B, 0\right) > qU_0\left(B_B, \frac{B_B}{\theta_H}\right) + pU_0\left(B_B, \frac{B_B}{\theta_H}\right),$$

there will be no high-quality professors hired in equilibrium.

Suppose that in a one-period game with a small budget, the sub-game perfect equilibrium is such that able professors are not hired. Then hiring mediocre faculty is a dominant strategy in any state of nature of the Markov game. Thus, it is plausible to concentrate on the situation when the one-period equilibrium strategy given a small budget involves the hiring of able professors.

Proposition 5 *Suppose that a university prefers to have as many able professors when the budget is large as the small budget would allow to hire, rather than spend the whole large budget on mediocre faculty,*

$$S_H \frac{T_*}{2} \frac{B_1 m}{\frac{B_2}{\theta_H} + \frac{B_1 - B_2}{\theta_L}} + \lambda \mu \left(\frac{B_2}{\theta_H} + \frac{B_1 - B_2}{\theta_L} \right) > \lambda \mu \frac{B_1}{\theta_L}. \tag{3}$$

Then there exists a unique Markov-perfect equilibrium. In this equilibrium, the whole small budget is spent on able professors.

While condition (3) can be used to conduct extensive comparative static analysis, which we leave for the next section, the analysis can be refined even further.

Let define the instantaneous payoffs in different cases as follows:

$$U_{aa}^1 = S_H \frac{T_*}{2} \frac{B_1 m}{\frac{B_2}{\theta_H} + \frac{B_1 - B_2}{\theta_L}} + \lambda \mu \left(\frac{B_2}{\theta_H} + \frac{B_1 - B_2}{\theta_L} \right),$$

$$U_{aa}^2 = S_H \frac{T_*}{2} \frac{B_2 m}{\frac{B_2}{\theta_H}} + \lambda \mu \frac{B_2}{\theta_H} = S_H \frac{T_*}{2} \theta_H m + \lambda \mu \frac{B_2}{\theta_H},$$

$$U_{ma}^1 = \lambda \mu \frac{B_1}{\theta_L},$$

$$U_{ma}^2 = \lambda \mu \frac{B_2}{\theta_L},$$

$$U_{am}^1 = S_H T_* \frac{B_1 m}{\frac{B_2}{\theta_H} + \frac{B_1 - B_2}{\theta_L}} + \lambda \mu \left(\frac{B_2}{\theta_H} + \frac{B_1 - B_2}{\theta_L} \right),$$

$$U_{am}^2 = S_H T_* \frac{B_2 m}{\frac{B_2}{\theta_H}} + \lambda \mu \frac{B_2}{\theta_H} = S_H T_* \theta_H m + \lambda \mu \frac{B_2}{\theta_H}$$

$$U_{mm}^1 = S_H \frac{T_*}{2} \frac{B_1 m}{\frac{B_1}{\theta_L}} + \lambda \mu \frac{B_1}{\theta_L} = S_H \frac{T_*}{2} \theta_L m + \lambda \mu \frac{B_1}{\theta_L},$$

$$U_{mm}^2 = S_H \frac{T_*}{2} \frac{B_2 m}{\frac{B_2}{\theta_L}} + \lambda \mu \frac{B_2}{\theta_L} = S_H \frac{T_*}{2} \theta_L m + \lambda \mu \frac{B_2}{\theta_L}$$

First, suppose that the other university is of high standard. Then U_{aa}^1 is the utility a university derives from employing the maximum feasible (i.e., compatible with the small budget) number of able professors in good times, U_{aa}^2 is the utility a university derives from employing the same

number of able professors in bad times, U_{ma}^1 is the utility of spending the whole budget on mediocre faculty in good times, and U_{ma}^2 is the utility of spending the whole budget on mediocre faculty in bad times. Now, suppose that the other university is normal. Then U_{am}^1 is the utility of the high-standard university in good times, U_{am}^2 is the utility of the high–standard university in bad times, U_{mm}^1 is the utility of the normal university in good times, and U_{mm}^2 is the utility of the normal university in bad times.

In the long-run, the condition for a university to prefer to be high-standard when times are good is

$$U_{aa}^1 + \frac{\delta}{1-\delta}\left(pU_{aa}^1 + qU_{aa}^2\right) > U_{ma}^1 + \frac{\delta}{1-\delta}\left(pU_{ma}^1 + qU_{ma}^2\right)$$

The analysis of the one-shot game demonstrated that if this condition is fulfilled, than this university prefers to be of high standard in bad times as well. Re-writing this inequality (see the Appendix) yields the existence condition for a symmetric Markov-perfect equilibrium with both universities pursuing a high-standard strategy.

$$\frac{1}{\lambda\mu}s_H T_* > 2\frac{B_2\left(1-\frac{\theta_L}{\theta_H}\right)\left(\frac{\theta_L}{\theta_H}\frac{B_2}{B_1} + \left(1-\frac{B_2}{B_1}\right)\right)}{\theta_L m\theta_H\left(\frac{\theta_L}{\theta_H}\left(\frac{B_2}{B_1}\delta q + (1-\delta q)\right) + \delta q\left(1-\frac{B_2}{B_1}\right)\right)}. \tag{4}$$

Now, suppose that hiring mediocre faculty is preferred, from the one-period perspective, in good times: $U_{am}^1 < U_{mm}^1$. Furthermore, suppose that the long-term prospects of hiring mediocrities in bad times are better than the alternative:

$$U_{mm}^2 + \frac{\delta}{1-\delta}\left(pU_{mm}^1 + qU_{mm}^2\right) > U_{am}^2 + \frac{\delta}{1-\delta}\left(pU_{am}^1 + qU_{am}^2\right).$$

Again, the static analysis implies that the bad-times condition yields the corresponding condition for good times. After a series of transformations (which are relegated to the Appendix), we find the following existence condition for a symmetric Markov-perfect equilibrium when both universities are normal:

$$\frac{1}{\lambda\mu}s_H T_* > 2\frac{B_1\left(\frac{B_2}{B_1}\frac{\theta_L}{\theta_H} - \frac{B_2}{B_1}\right)\left(\frac{B_2}{B_1}\frac{\theta_L}{\theta_H} + \left(1-\frac{B_2}{B_1}\right)\right)}{\theta_H\theta_L m\left(2\left(\frac{B_2}{B_1}-1\right)(1-p\delta) + \frac{\theta_L}{\theta_H}\left((1-2p\delta) - \frac{B_2}{B_1}(3-2p\delta)\right) + \left(\frac{\theta_L}{\theta_H}\right)^2\frac{B_2}{B_1}\right)}. \tag{5}$$

In this equilibrium, there is no room for research.

For a range of parameters, the uncertainty of the budget forces universities to hire normal-quality professors in a dynamic equilibrium, even if a higher level of high-ability faculty is optimal for any possible budget. This happens because an increase in the university budget leads to a switch in the optimal mode of operation from a high-standard small university to a normal large

university. This effect is especially strong if the university cannot spend more than the low-budget allowance on high-quality professors as firing costs are high. However, if the difference in utility between high- and normal-standard is relatively small, the university pursues a normal-standard strategy. For this to happen, the underlying parameters need to satisfy the following inequality:

$$\frac{1}{\lambda\mu}s_H T_* < \frac{2B_2}{m\theta_H\theta_L}\left(1 - \frac{\theta_L}{\theta_H}\right)\min\left\{1, \left(\frac{B_2}{B_1}\left(1 - \frac{\theta_H}{\theta_L}\right) + \frac{\theta_H}{\theta_L}\right)\right\} \qquad (6)$$

The following Proposition summarizes the above discussion.

Proposition 6 *(i) Suppose that the parameters of the model satisfy condition (6). Then there will be no high-quality tenured professors in any symmetric Markov perfect equilibrium.*

(ii) The range of parameters for which there is no dynamic equilibrium with tenure, i.e., for which condition (6) is satisfied, is larger when the quality of able students, s_H, is low, the professor-student ratio, λ, is low, the size of bad-times (good-times, resp.) budget, B_2 (B_1, resp.) is low (high, resp.), and the amount of money per student, μ, is low.

(iii) When both conditions (5) and (6) are satisfied, though a high-standard policy may be pursued in a one-period game, there is no dynamic (Markov perfect) equilibrium in which universities would pursue high standard.

A formal proof is relegated to the Appendix. The intuition for (iii) is as follows. When the university's budget rises, the difference in utility for high standard and normal standard decreases. Suppose that this difference, d, is small. If the university cannot hire enough high-standard faculty in good times as the cost of firing them in bad times is prohibitive, a normal-standard university would be better. When the bad-times difference in utility between high-standard and normal universities exceeds d, there is no reason to hire an able professor for a tenure position in any state of the world.

4   Discussion

The Dynamic Effect of Budget Uncertainty

While the advantages of having an endowment are taken for granted by US university administrators, it is a point of contention outside the US (e.g., in discussing strategies for building world-class universities in India, Indiresan (2007) argues against endowment money for universities). In economies with a large state sector, politicians and government bureaucrats are hostile to the idea of granting government money as an endowment, as this would strip them of control over these

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funds. Our argument emphasizes what is lost when both faculty and university administrators have to operate on an annual budget. If it is possible to operate on annual budget financing in the social sciences and mathematics, the situation is different in areas such as experimental physics, chemical engineering, and biology, where the success of many research projects is conditional upon the ability of the university to make long-term financial commitments.

Formally, we define the index of budget volatility as follows:

$$\omega = \omega(B_H, B_L) = (B_H - B_L)\, p.$$

Since a proper measure of budget volatility needs to reflect both the difference in absolute values between budgets in good and bad times, and the probability with which the corresponding budgets occur, taking the standard variance as a measure of volatility is inappropriate. Now, when ω is small, the discrepancy between one-shot game equilibrium strategies and one-period strategies in a dynamic equilibrium is small, while larger values of ω correspond to larger volatility.

Proposition 7 *(i) For any discount rate $\delta > 0$, there exists ω_0 such that for any $\omega < \omega_0$, the unique equilibrium in the Markovian game is determined by the one-shot game with the small budget.*

(ii) The higher the budget volatility ω, the smaller the range of parameters for which there exists a symmetric Markov perfect equilibrium with some tenured faculty.

Ehrenberg (2003) reports a growing discrepancy in average faculty salary depending upon the size of endowment in both private and public universities, and attributes this to a higher rate of return on endowments, and not on tuition. However, this argument alone, even if coupled with the plausible assumption that the majority of universities do not generate revenues to pay higher salaries, cannot explain why these universities would opt for teaching-only faculty, rather than a mix of able and mediocre faculty members. Our model is consistent with Ehrenberg's (2003) findings; it demonstrates how the desire to enroll more students forces a university to have no high-ability professors. These findings are also consistent with our results on the impact of budget uncertainty: it might not be the lack of money per se, but the expectations of a possibly low budget in some period in the future. In fact, the very idea of a university, department, or chair financed by the annual royalty from a safe endowment was initially aimed at eliminating any uncertainty related to various sources of financing. Alchian (1959) specifically makes this point in a discussion of institutional arrangements in universities. Altbach (2007) observes: "fluctuating budgets can damage [the newly emerging research] institutions."

Still, there is no doubt that the sheer amount of resources available for a not-for-profit organization matters significantly. Glaeser (2002) writes: "Of course, the other ingredient that made tenure

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possible was growing university resources,"and then quotes from Metzger, who writes, "...helped by enormous largesse from the states, steep rises in federal support, the seed millions of the Ford Foundation, the success of innumerable alumni fund drives, and public willingness to pay the tuition and other college attendance costs . . . the fortunes of judicial tenure rode high []." This makes the governments concerned with the quality of their universities willing to allocate substantial amounts of money to targeted universities. However, they are typically unwilling to provide money as endowments as this strips them of control. Another problem is that state involvement and low inequality crowd out potential donors of university endowments. So, paradoxically, the successful development of a research university in an emerging economy might be more probable in a country where the government has a tight budget constraint, rather than in, e.g., oil-exporters such as Saudi Arabia or Russia. Indeed, an important example of a successful university in an environment that has known no such institutions is the private Bilkent University (the name is an acronym for the "city of science and knowledge" in Turkish). Founded in 1984, it is now the highest ranking Turkish university, both in terms of teaching and research. The crucial feature of this university's development was a development strategy built around the expansion of the initial endowment. The creation of Bilkent University was then followed by the creation of Koc University and Sabanchi University, which are pursuing similar development strategies.

The Political Economy of Higher Education

Our model highlights the implications of university competition when there is a scarcity of talented students. One result is that the equilibrium allocation of students has a significant effect on the relative returns of pursuing either a high-standard or normal strategy for a university. Thus, the emergence of a high-standard private university puts pressure on large state universities. The New York Times, reporting on the development of Turkish private universities, observes that "administrators at some public universities see the upstarts, with their big budgets and the flexibility to shift spending in response to the education market, as a threat." The public bureaucracy response included a number of restrictions that were effectively aimed at compromising the competitive advantages of the emerging institutions.

The problem with the equilibrium entrapment is not unique for developing nations. Altbach (2007) asserts that "Germany, for example, considers all of its universities as research institutions, and as a result is unable to provide adequate funding to any of them, although a few German universities have been recognized for their research quality and are being given enhanced funding to compete globally." This calls for "a differentiated system [that] has academic institutions with

diverse missions, structures and patterns of funding."

However, as Proposition 2 demonstrates, focusing entirely on the government budget constraint might be highly misleading. Altbach (2007) notes that "many countries have just one or two research universities because of their cost and the resources available. Even in fairly large countries, the number of research universities is often small; the United Kingdom has perhaps 20 institutions and Japan has a similar number. China is aiming to establish well over 20, and Brazil has five. Some countries may have more research universities than they can afford; Sweden and the Netherlands are examples." Thus, discussion typically focuses on the lack of means rather on the institutions that facilitate the development of research universities. However, Proposition 2 shows that an increase in the budget available to the university depresses the relative benefits of the high-standard strategy.

Path-dependence in University Development

Combining the main insights from the static case (Proposition 1) and the dynamic analysis (Proposition 6) helps achieve an understanding of the path-dependence in the development of a university. A university that starts as a 'teaching university' with a large number of students and no research-oriented faculty is unlikely to switch to the "research mode" if its expansion depends on the increase of the number of students, as is the case for many government-financed programs. Similarly, a university that starts as a small research-oriented unit is likely to expand and retain its orientation. The following pair of examples—two institutions created from scratch in 1992—illustrates the point.

After decades of virtual non-existence of modern economic research and education under the communist regime,[11] two new institutions were founded in 1992. In 1992, the private New Economic School, a two-year MA program, accepted its first students; the State University—Higher School of Economics started up a year later, in the fall of 1993. By 2007, both schools claimed major successes, offering undisputed top programs in economics (NES as an MA-granting program, HSE as a BA-granting program). However, the paths of institutional development were drastically different. In the New Economic School, up to 90% of the economics curricula was primarily taught by visitors from top Western economics departments for the first seven years, 1992-1999. In 1999, the first Assistant Professor was hired for a tenure-track position, followed by one more in 2000 and two in 2001. By 2007, three of them have been promoted to tenure (in addition to two "founding fathers" who got the position from the start), and there are 10 tenure-track Assistant

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[11]Mathematical economics was an internationally competitive branch of Soviet economics, which boasts one Nobel prize winner and several fellows of the Econometric Society. However, in the Soviet academic realm it was more a part of mathematics than a social science. (See Alexeev, Gaddy, and Leitzel, 1992, for details.)

Professors. The number of graduates increased from 30 in 1992 to 70 in 2007; the annual cost of education per student is \$16,000. By (admittedly raw) RePEC publication and citation rankings, the New Economic School is among the 200 top economics departments in Europe (no other Russian department is in the top 500), and among the top 5 in Eastern Europe.

In contrast, the Higher School of Economics, a state university relying heavily on government support from its inception (initital funds were provided in part by the European Union), started with less than 1,000 students in 1993 and now has more than 10,000. In 2006, HSE employed more than 400 faculty members with Ph.D.s or equivalent (with 300 more such faculty members working part-time). In perfect accordance with the predictions of our model (see Proposition 2 and the following formal discussion of incentives to create additional departments or "centers of excellence"), instead of increasing overall standard, the Higher School of Economics has initiated the formation of several internal institutions aimed at improving its world-wide research standing. One of these, ICEF, hired its first tenure-track Assistant Professor in 2005, and one other institution, the Center for Advanced Studies, plans to start hiring in 2008.

5   Conclusion

We consider a university's development strategy in a dynamic competitive environment. Universities choose whether or not to hire high-quality, expensive professors in order to attract able students; pursuing a low-standard strategy results in a large "teaching university". In the static environment, a surprising result is that with a fixed teacher-student ratio, an increase in the budget of a university might result in switching from a high-standard to a low-standard strategy. In a dynamic environment, in the presence of budget uncertainty, universities might prefer to hire inexpensive, mediocre professors in the short-term even if they would have hired high-quality professors in either states of the world.

Using the theoretical model, we derive a number of policy implications for governments outside the US. First, the allocation of large sums of money is not enough to provide a solid foundation for the emergence of world-class research universities. The crucial element of a successful structuring of incentives is long-term commitment. Second, the amount of money provided for day-to-day university operations should be separated from the size of the student body. Controlling for the size of the student/teacher ratio also makes hiring high-quality faculty a more attractive strategy for a university.

The results of our formal analysis rest upon certain technical assumptions. In particular, the

whole equilibrium analysis rests upon the ability of universities to screen, maybe non-perfectly, the students' quality. Relaxing this assumption has straightforward implications: the pressure on universities to pursue a low-standard, large-university strategy will be higher. In the dynamic game, we assumed a perfect correlation between the budgets of two competing universities. This is plausible since a significant part of university endowments is in the form of low-risk investments, with returns often co-moving with the markets; the amount of new donations is also typically related to macroeconomic shocks. Though we do not expect that a relaxation of this assumption would significantly alter the qualitative results of the analysis, it would require a substantial increase in the complexity of the model, and is left for future research.

References

Altbach, Philip (2007) "Peripheries and Centres: Research Universities in Developing Countries," Higher Education Management and Policy 19, no. 2.

Alchian, Armen (1959) "Private Property and the Relative Cost of Tenure", in Bradley, Ph.D., ed., The Public Stake in Union Power, Chapter 16, Charlottesville: University of Virginia Press, 350–371.

Alexeev, Michael, Clifford Gaddy, and James Leitzel (1992) "Economics in the Former Soviet Union," *Journal of Economic Perspectives* 6:137-148.

Barnes, N., O'Hara (1999). Managing Academics on Short-Term Contracts. Higher Education Quarterly, Vol. 53, No. 3, P. 229-239.

Beath, J., Poyato-Theotoky, J. and Ulph, D. "University Funding Systems and their impact on Research and Teachng: A general Frameworks", Paper Presented at the Conference on Higher Education, Multijurisdictionality and Globalisation, Mons (Belgium), December 2005.

Benjamin, E. and Wagner, R.W. "Academic Freedom: An Everyday Concern", Jossey-Bass, San Francisco CA, 1994.

Bess, J. L. "Contract Systems, Bureaucracies, and Faculty Motivation: The Probable Effects of a No-Tenure Policy" // The Journal of Higher Education, Vol. 69, N. 1, January – February 1998, pp. 1-22

Carmichael, H. L. (1988). Incentives in Academics: Why Is There Tenure? Journal of Political Economy, 96(3), 453-72.

Chatterjee, Kalyan and Robert Marshall (2001) A Model of Academic Tenure, mimeo.

De Fraja, G. and Iossa, E. "Competition among Universities and the emergence of the elite institutions", Bulletin of Economic Research, 2002, Vol. 54, N 3.

Del Rey, E. "Teaching versus research, a model of State University Competition"// Journal of Urban Economics, 2001, Vol. 49.

Del Rey, E. and Romero, L. "Competition between public and private universities: quality prices and exams", Working Paper, Universidad Carlos III, 2004.

Ehrenberg, G. R. "Studying ourselves: The academic labor market"// Journal of Labor Economics, April 2003, Vol. 21, N 2.

Finkin, M.W. (ed.). "The Case for tenure", Cornell University Press, 1996.

Freeman, S. "Wage Trends as Performance Displays Productive Potential: A Model and Application to Academic Early Retirement"// The Bell Journal of Economics, Autumn 1977, Vol. 8, N 2, pp. 419-443.

Glaeser, Edward (2002) The Governance of Non-for-Profit Firms, mimeo.

Guriev, Sergei and Kvasov, Dmitri (2004) "Contracting On Time", American Economic Review.

Howitt, Peter (2003) The Economics of Science and the Future of Universities, The Timlin Lecture, U. Saskatchewan.

Jongbloed, B. "Performance-based Funding in Higher Education: an international survey", Monash University – Acer Centre For The Economics of Education and Training, Working Paper N 35, March 2001.

Hansmann, H. "Why Do Universities Have Endowments?"// The Journal of Legal Studies, Vol. 19, N 1, January 1990, pp. 3-42.

Hashimoto, M. and Raisian, J. "Employment Tenure and Earnings Profiles in Japan and the U.S."// American Economic Review, September 1985,Vol. 75, N 4, pp. 721-735.

Holmstrom, B. (1982) "Managerial Incentive Problems–A Dynamic Perspective." Republished in Review of Economic Studies 66 (1999): 169-82.

Kasten, K. L. "Tenure and Merit Pay as Rewards for Research, Teaching, and Service at a Research University"// The Journal of Higher Education, Vol. 55, N 4, July - August 1984, pp. 500-514.

Maskin, E. and Tirole, J. "Markov Perfect Equilibrium I. Observable Actions"// Journal of Economic Theory, October 2001, Vol. 100, N 2, pp. 191-219.

Masten, S. E. "Authority and Commitment: Why Universities, Like Legislatures, Are Not Organized as Firms"// Journal of Economics and Management Strategy, Fall 2006, Vol. 15, N. 3, pp. 649-684.

McPherson, M.S. and Schapiro, M. O. "Tenure Issues in Higher Education"// The Journal of Economic Perspectives, Winter 1999, Vol. 13, N 1, pp. 85-98.

McPherson, M. S., and Whinston, G. C. (1983). The Economics of Academic Tenure: A Rational Perspective. A Journal of Economic Behavior and Organization, 4(2-3), 163-84.

Menand, L. "The Limits of Academic Freedom" in: Menand, L. (Ed.), The Future of Academic Freedom, 1996.

McPherson, M. S. and Gordon, C. W. "The Economics of Academic Tenure: A Relational Perspective" in "The Case for Tenure", ed. Finkin, M. W., Ithaca, NY: Cornell University Press, 1996.

Pencavel, J. "The Response of Employees to Severance Incentives: The University of California

Faculty, 1991-94"// Journal of Human Resources, Winter 2001, Vol. 36, pp. 58-84.

Ramey, Garey, and Joel Watson. 1997. "Contractual Fragility, Job Destruction, and Business Cycles." Quarterly Journal of Economics 112:873-911.

Ruch, Richard S. (2001). Higher Ed, Inc. The Rise of the For-Profit University. Baltimore and London: The Johns Hopkins University Press.

Schuster, J. and Finkelstein, M. (2006) "*The American Faculty*", Baltimore, MD: Johns Hopkins University Press.

Schwartzman, S. (2007) "Brazil's Leading University: Original Ideas and Contemporary Goals", in "World Class Worldwide", Altbach, P. and J.Balan, eds. Baltimore, MD: Johns Hopkins University Press.

Siow, A. (1984) "Occupational Choice under Uncertainty"// Econometrica, Vol. 52, pp. 631-45.

Siow, A. (1998). Tenure and other Unusual Personnel Practices in Academia. Journal of Law Economics and Organization, 14(1), 152-73.

Vanhaecht, E. and Pauwels, W. (2005) "University competition: symmetric or asymmetric quality choices", University of Antwerp, mimeo..

Waldman, M. (1990) "Up-or-Out Contracts: A Signaling Perspective"// *Journal of Labor Economics*, Vol. 8, N 2, pp. 230-250.

Wilson, R. (2001) "Proportion of Part-Time Faculty Members Leveled Off from 1992 to 1998, Data Shows"// *Chronicle of Higher Education*, p. A17.