University Expansion in the BRIC Countries and the Global Information Economy

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> **Can the BRIC university systems greatly increase the quantity of graduates in these developing countries and simultaneously achieve high enough quality to compete successfully at the higher end of the global knowledge economy?**

Massive higher education expansion in the world's four largest developing economies—Brazil, Russia, India, and China, known as the BRIC countries—is having a significant impact on the world supply of university graduates, including greatly increasing available cadres of engineers and computer scientists. This expansion may change the locus of future development in the global knowledge economy. If the BRICs can train large numbers of highly qualified engineers and scientists, the poles of technological innovation could shift away from the United States, Europe, and Japan—or, at the least, become increasingly shared between these old centers and the new.

The level and nature of such a change depends on how successful the BRIC governments are at raising the quality of university education as they rapidly expand access to it. Can the BRIC university systems greatly increase the quantity of graduates in these developing countries and simultaneously achieve high enough quality to compete successfully at the higher end of the global knowledge economy?

We spent almost three years in the BRICs studying their increases in undergraduate enrollments, collecting data on how much governments and families spend on baccalaureate education, interviewing university administrators and faculty, and surveying thousands of final-year engineering and computer science students in almost 100 BRIC higher education institutions. We dug deeply into the forces driving the expansion, how it was being financed, and how well students were being trained in the STEM disciplines and technical fields of study.

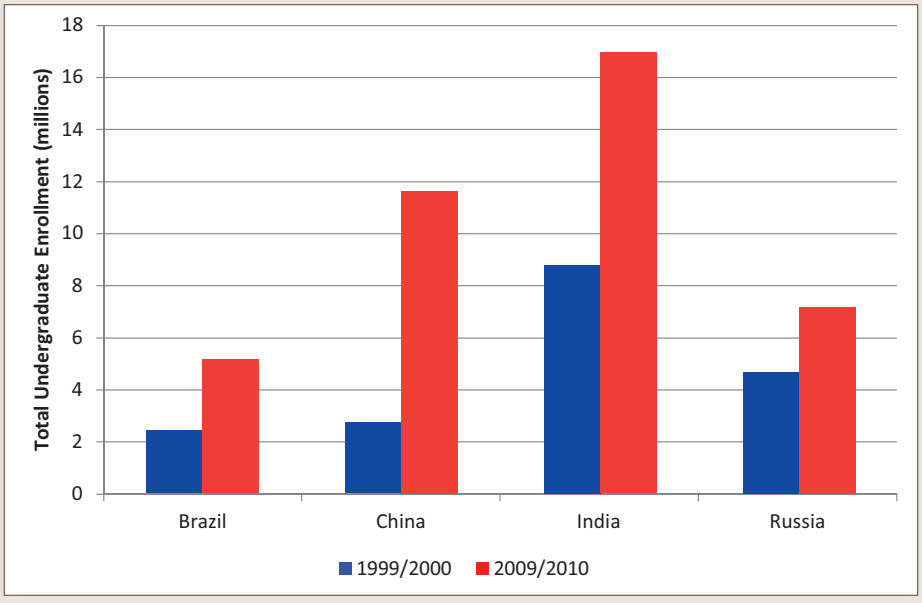
Our results should raise concerns—mainly in the BRICs, but also in the United States.

BRIC Enrollment Expansion

Enrollments in BRIC undergraduate education in the first decade of the 21st century increased from about 19 million in 1999/2000 to more than 40 million in 2009/2010 (see Figure 1). By far the largest increase was in China, which went from less than 3 million to almost 12 million students during that ten-year period.

In Russia, about three-quarters of the college-age population is enrolled in higher education (one of the highest percentages in the world). But that country is an exception. The proportion of college-age youth attending four-year institutions is still a low 15 to 20 percent in China and India and about 30 to 35 percent in Brazil.

Figure 1. BRIC Countries: Undergraduate Enrollment Growth, 1999–2009



> Elite Chinese universities now graduate more engineers and computer scientists than the total annual output from US universities.

China plans to raise this figure to about 25 percent by 2020, and it should have no trouble achieving that level of access because of a rapidly declining youth population. (Editor's note: See Arthur Hauptman's article in the May/June 2013 issue of *Change* for a discussion of the relationship between demographics and college attainment statistics.) India and Brazil's enrollments also continue to rise faster than population growth.

A very high proportion of this enrollment increase has been in relatively low-cost second- and third-tier (i.e., non-elite) institutions. In 2009, such mass institutions graduated about 2.1 million of the 2.5 million total bachelor's graduates in China, 2.2 million of the 2.3 million graduates in India, 1 million of the 1.14 million graduates in Russia, and 0.7 million of the 0.8 million graduates in Brazil. Access to elite institutions has been limited, and the number of graduates they produce has grown very slowly.

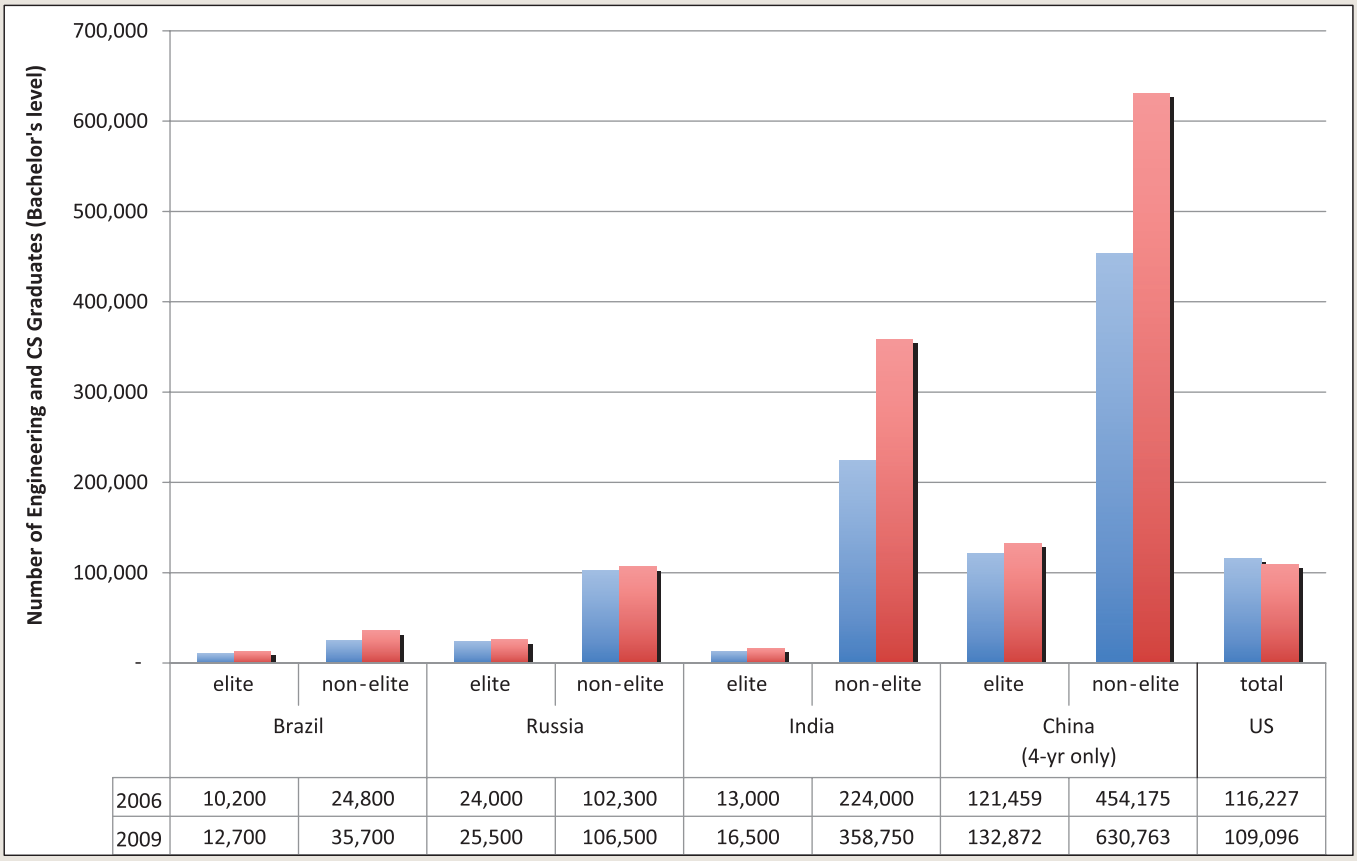
The pattern among engineering and computer science majors is similar. Few graduate from elite institutions—almost all the increase results from the expansion of enrollment in non-elite, second- and third-tier universities (see Figure 2). That said, because such a high fraction of Chinese students are engineering and computer science majors, elite Chinese universities now graduate more engineers and computer scientists than the total annual output from US universities.

The Centrality of the State

One of the main insights we drew from the study is that the state—that is, the political system as instantiated in governmental organization and policies—is key to explaining higher education development in the BRICs. The role of the state vis-à-vis higher education is determined, first, by history: How that relationship developed in the past in each of these countries carries over to different degrees into the present university structures and affects the possibilities for making change.

For example, the structure of the university system developed in the Soviet Union (and the faculty and administration of those universities) is the core of Russian higher education to this day. Although the post-Soviet government has cre-

Figure 2. BRIC Countries: Engineering and Computer Science Graduates, Elite and Non-Elite Four-Year Institutions, 2006–2009



	Brazil		Russia		India		China (4-yr only)		US
	elite	non-elite	elite	non-elite	elite	non-elite	elite	non-elite	total
2006	10,200	24,800	24,000	102,300	13,000	224,000	121,459	454,175	116,227
2009	12,700	35,700	25,500	106,500	16,500	358,750	132,872	630,763	109,096

ated a few new universities and combined others in regional federal institutions, most universities in Russia today retain the core departments and functions assigned to them in the Communist command economy.

Second, current national political environments heavily influence how the state shapes the university system in response to various economic and political pressures. University expansion in the BRICs plays an important role in legitimizing the political system and particular governments.

The BRIC governments must negotiate complex political demands at home, including ensuring domestic economic growth, social mobility, and political participation. Because the public sees more and better higher education as positively associated with all these elements of a developed society, the governments' focus on their university systems has become an important part of their domestic economic and social policy.

These states face domestic pressure to greatly expand their higher education systems in part because economic globalization (and in China and Russia, the transition to a market economy) has helped increase the economic payoff to more highly educated labor (Carnoy et al, 2013), both for the countries and for individual citizens. The identification of higher education with social mobility and better employment increasingly ties state legitimacy to its provision of access to higher education.

Globalization also increases competition among states for "global legitimacy" (Meyer, Ramirez, and Soysal, 1992; Meyer, Ramirez, et al, 2005). In the case of higher education, this has emerged in the form of both competing to expand the proportion of college-age youth that graduates from college and to improve institutional quality—hence the drive by China and Russia to create "world-class" universities that are ranked alongside the best in the US and Europe.

The four states' higher education policies are also shaped in part by institutional actors who represent the large and growing higher education "industry." But these actors, as we learned in our interviews, are hardly monolithic. They represent different kinds of institutions, and they react quite differently to the states' attempts to find new ways to finance or rationalize the system.

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Financing Higher Education in the BRICs

Although China and Russia's higher education expansion has been largely in public institutions, their financing has shifted from direct public funding to cost sharing with families though tuition payments. Brazil and India have shifted much of the cost of expansion to students who pay tuition in unsubsidized private institutions.

In China, all students in public universities pay tuition, and about 20 percent of them attend higher-tuition private universities. In Russia, the central government still finances a certain number of students in the public universities. But thanks to an amendment of the education law in the early 1990s, universities are allowed to charge tuition to students who do not qualify for these budgeted places. Today, more than half of Russian students in public institutions are tuition paying, and another 17 percent attend hundreds of small private institutions.

In Brazil, public universities do not charge fees, but almost three-quarters of students attend full-fee private institutions. In India, students pay (low) tuition in public institutions, but private unaided colleges charging higher fees have absorbed much of the increase in enrollment over the past 10 years. In 2012, about 55 to 60 percent of baccalaureate-seeking Indian students enrolled in private institutions.

Some analysts have argued that states allow for the expansion of private provision because they recognize their own inefficiency in providing social services. They postulate that deregulating higher education so that more private providers can enter the higher education "market" is allocatively and technically more efficient than expanding enrollment in publicly run universities (World Bank, 2000).

The rapid expansion of private higher education may indeed result from inadequate state capacity to deliver high-quality education (and other social services; James, 1993). A "weak" state is also likely to have greater difficulty getting its wealthier citizens to pay taxes and thereby generate the revenue needed to support higher education with government funds. Among others, Latin American countries have traditionally faced this problem, and now even US federal and state governments seem unable to raise needed tax revenues for the country's higher education system.

However, increased private provision of higher education may also be a strategic political choice. As in the US, the state may rely increasingly on private higher education or implement cost sharing by charging fees in public universities because, as previously mentioned, private economic

returns to university degrees are high (and increasing).

In the BRICs, the economic payoff is especially high for some fields of study, such as business/economics, law, medicine, engineering, and computer science. Governments have been able to decrease their direct public funding of university expansion because the payoff has become high enough to induce many more students and their families to pay tuition, especially for study in the high-return fields.

US medical and business schools have long charged higher tuition than other schools precisely because of high private returns to graduates in those fields. In the current budget crisis, some institutions and states are proposing to do the same for undergraduate programs. Such proposals are engendering considerable pushback, however.

Despite the increase in cost sharing, though, ultimately the states see higher education as a matter of strategic importance. Hence they tightly control admissions rules, tuition fees (in India, Russia, and China—much less in Brazil), curriculum (in India, Russia, and Brazil—less in China), and even examinations in private colleges and universities (in India and Brazil) or for fee-paying students in public universities (in Russia).

Increasing Differentiation between Elite and Mass Universities

One way to gain insights into how the BRIC governments use higher education to meet their political goals is to analyze how many resources they allocate to different tiers of the higher education system.

BRIC countries devote fewer public and private financial resources than developed countries to train the average student entering an undergraduate program. In 2008, the total public and private spending per student in the US averaged $30,000 and in the OECD about $PPP13,700 (prices converted to allow for comparisons between the United States and other countries are called PPP dollars). In recent years, spending per student (when costs per student in private institutions are averaged in) was about $PPP5,000 in Brazil, $PPP5,500 in Russia, $PPP4,300 in China, and $PPP1,300 in India.

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Beyond these average costs, a key feature of enrollment expansion in the BRICs is the increased differentiation in cost per student between elite institutions—which China and Russia in particular are trying to build into "world-class" universities—and the mass institutions that are attended by 80–90 percent of undergraduates.

In China in 2010, for instance, elite institutions spent an average of about $PPP10,000 per student, whereas non-elite ones spent about $PPP4,000. The ratio is 2.5:1, whereas twelve years earlier it was 1.5:1.

In Russia, spending per student in elite institutions today is roughly double that in non-elite ones; just a few years ago it was only 1.2:1. In Brazil, current spending per student in elite institutions is about three times as high as in non-elite universities, yet less than a decade ago it was 1.5:1.

From our institutional surveys in India, we estimate that elite technical institutions there spend about $PPP12,500 per student, whereas non-elite technical institutions spend about $PPP2,500—a ratio of about 5:1. Although this is the largest elite-mass spending difference, the good news is that does not appear to be increasing. Rather than investing more per student in existing elite institutions, India has expanded its very limited elite enrollment by building more Indian Institutes of Technology and Indian Institutes of Management.

The Chinese government appears to be the most aggressive in developing elite institutions. It has greatly expanded both undergraduate and graduate enrollments, markedly increased funding for elite institutions. Since more than 30 percent of Chinese undergraduates major in engineering and computer science, China produces a much larger quantity of elite STEM enrollments and graduates than the other BRICs.

Much of this support of the elite institutions is targeted at research. China has both increased research funding and created quasi-market incentives for university administrators and faculty to improve both institutional rankings and research productivity.

The other three BRIC countries are, to different degrees, making similar efforts to advance elite higher education. In recent years, the Russian government has begun providing strategic support to a small number of research universities. These universities compete fiercely, under the stimulus of policy-based incentives, to produce high-quality graduates and research, even though research productivity and financial support for research are still well below those of China and Brazil.

The Brazilian government has also taken steps to expand elite enrollments fairly rapidly during the last decade. It can

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rely on an established base of public (and a few private) institutions that have strong faculty, research, and graduate education.

India too has its famous elite institutions, such as the Indian Institutes of Technology (IITs), but it differs from the other BRICs in its disproportionately lower elite enrollments and graduates (despite having absolute numbers comparable to Brazil and Russia). India's elite institutions have also received less research funding from the government and have had greater difficulty than the other three countries in finding qualified faculty to staff these institutions because of a very low number of PhD graduates in technical fields.

Although instructional costs per student are much higher in elite universities, only part of the increasing gap between elite and non-elite institutions is spending on instruction. Especially in China and Brazil, research monies going to elite universities have been rising, and these play an important role in expanding the per-student resource distance between elite and mass institutions. Nevertheless, as in other countries, research funding at universities helps build better facilities that benefit undergraduate education.

A government strategy that increasingly invests in high-cost institutions while educating ever more students in low-cost ones suggests that BRIC states believe in the very great spin-off effects (externalities) of the elite universities—of the highly skilled labor they train and the research they produce. They seem to have bought into the idea that US dominance in information technology resulted from investments in science and engineering programs and research at places like Stanford, UC Berkeley, Caltech, and MIT, as well as from leading business schools.

This widely held notion fails to recognize that the US success in technology and business has also depended on high-quality education and training at a range of universities whose spending per student may have been lower than that at elite public and private research universities but whose quality has been a major concern of state governments and of the institutions themselves.

The focus on elite institutions suggests that BRIC governments are not very concerned with the possible impact that their strategy may have on social inequality. Most of the students at these institutions come from highly educated families and the most elite pre-tertiary schools. When they attend elite universities, their private contribution is a very small fraction of the total cost of their education.

On the other hand, BRIC students attending lower-cost public or private institutions (in Brazil and India, many or most of them are also from highly educated families) pay a high fraction of the costs of their education. Like in the US, both India and Brazil have implemented major affirmative action programs in higher education, but our research shows that this offsets only a small part of the of underlying inequity of university financing in these countries.

Incentives to Improve the Quality of Higher Education

Varying levels of inputs into elite and non-elite institutions reflect the role that BRIC governments play in shaping the quality of higher education. Policymakers in each of the BRICs have heavily regulated the number and types of students who can get in to elite engineering programs by instituting highly selective entrance exams.

Policymakers in Russia and China, especially, use special funding to motivate elite institutions to be competitive with the leading research institutions in developed countries. In all four countries, policymakers also grant elite institutions much more autonomy than non-elite institutions.

By contrast, until recently, policymakers have offered few incentives, financial or otherwise, to non-elite institutions to improve quality. In Russia, our interviews suggest that until now, most non-elite institutions have had little pressure or motivation to either improve quality or reduce costs, since the central government has been increasing spending per student and allowing institutions to open fee-paying programs to augment their revenues, regardless of quality.

In theory, such programs should increase competition among non-elite institutions. But until now, most have relied on high demand and local monopolies rather than better quality to attract fee-paying students.

Our interviews in India and the available institutional studies in Brazil suggest that in the non-elite (mostly private) institutions where a high percentage of engineering and computer science students get their education, cutting costs is a higher priority than quality improvements. The situation is largely the same in China, except that the most selective non-elite institutions are encouraged to improve educational quality by vying with each other for higher rankings and associated increases in funding.

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Policymakers have at times legislated minimum standards of quality for non-elite higher education institutions or provided incentives for them to improve. In China, local policymakers arrange for outside expert assessments of the quality of instruction in non-elite institutions. They also regularly identify and recognize outstanding instructors and classes.

In Brazil, the government has tried to increase competition among non-elites by mandating that institutions publish their graduating students' test scores. It is possible to get the average entrance-exam scores of incoming students at Russian and Chinese universities as well.

India has encouraged more attention to quality in non-elite institutions—mainly private colleges, which must be affiliated with a supervising public university—with offers of greater autonomy from such supervision if they meet higher curriculum standards and initiate graduate programs.

Despite taking measures to ensure a minimum level of quality in mass institutions, on the whole BRIC governments appear to be much more focused on responding to the increasing demand for higher education places at low cost than on raising quality in these institutions. Russia is an exception, because most of the university-age population is in universities, and the number of secondary school graduates is declining. The other three BRICs face constant pressure to expand access.

Thus, mass institutions in the BRICs tend to organize their departments, curricula, and faculty hiring to be reasonably efficient at maximizing the number of students they can process while maintaining demand for their "brands." For most mass institutions, especially the private ones (which comprise the vast majority of non-elite institutions in Brazil and India), this means keeping a tight rein on costs per student, lobbying governments to be less stringent in applying regulations, and competing for students with advertising that may have little to do with academic quality.

Are the BRICs Producing the Technical Cadres That Will Change the World?

In 2009, the total number of engineering computer science graduates in China and India combined was much larger—760,000 and 370,000, respectively—than the almost 500,000 graduates produced annually in developed countries such as the US (see Figure 2). When we add the 130,000 graduates in Russia and the 50,000 more in Brazil, the total output of engineers and computer scientists in the BRICs is about two and a half times as many as in the developed countries as a whole.

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Yet only a small percentage of these graduates is trained to the same level of competence as engineers and computer science undergraduates in the United States, Europe, or Japan.

We employed a series of indirect indicators to measure the overall quality of engineering and computer science education in the four BRICs. These included input indicators, such as the probable average performance in mathematics of high school students entering into technical universities as measured by international assessments (PISA and TIMSS), the availability of qualified faculty as indicated by the percentage of faculty with PhDs, the amount of R&D funding, and student educational experiences based on answers to our student survey.

We also used output indicators of quality—namely, faculty publications and citations (research output) and graduates' type of employment and expected salaries. We were even able to estimate the value added in engineering and computer science programs for Brazil using first- and final-year scores on a government-administered test of university students called the Exame Nacional de Desempenho de Estudantes (ENADE).

We concluded that the examination process to enter the BRICs' elite engineering and computer science programs selects very high-ability students who would compete successfully in US engineering schools. Essentially all students who enter such elite programs graduate in China, India, and Russia. In Brazil about 65 percent of them complete within six years.

Our research suggests that the quality of the elite engineering and computer science programs they attend is good. Such programs are characterized by relatively generous per-student expenditures and better-paid and more qualified faculty.

Government policymakers in each country help elite institutions (to varying degrees) by providing substantial funding, mandating improvements in curricula and instructional practices, and encouraging faculty to concentrate more on research. The relatively greater student learning gains in elite institutions than in non-elites suggested by our Brazilian value-added estimates, as well as the greater quantity and quality of research publications from BRIC elite engineering departments, also indicate that relatively high-quality faculty teach in those institutions.

But 85 percent of BRIC technical students are in non-elite institutions, where the level of quality is dubious. Entrants into BRIC non-elite technical institutions are much less well prepared on average than those in the elites. This is especially true in India and Brazil, where mathematics preparation in a typical high school is poor, as reflected in very low international test (PISA) scores.

Based on our interviews, observations of engineering classes (China and India), and our estimated comparative

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student outcomes using the final-year ENADE test (in Brazil), we concluded that almost all non-elite institutions in these countries also provide rather poor education for these less-prepared students, with few meaningful practical experiences for students and no opportunities to engage with faculty in research. This is not surprising, given their low levels of funding and qualified faculty.

Nevertheless, given the resources and attention the BRIC governments have lavished on their elite institutions in recent years, the top half of elite universities' engineering graduates in the BRICs are, at the very least, probably as well prepared technically as the top half of the engineering graduates in developed countries. It is therefore safe to say that annually, about 100,000 engineering and computer science graduates from elite programs in the BRIC countries (this figure is from 2009—by the end of 2013, the number will be much larger) are comparable to the top 50,000 engineers and computer science graduates receiving bachelor's degrees from US colleges and universities, the top 150,000 engineering first degrees awarded in the European Union, and the top 50,000 engineering first degrees in Japan.

The large supply of qualified engineering graduates from the BRIC countries has already had a large impact on BRIC domestic high-technology production. As the supply of elite engineering and computer science program graduates from the BRICs continues to grow, BRIC graduates could, in the not-too-distant future, become a huge factor in the developed countries' information-technology job markets. C

Resources

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