China Economic Review 73 (2022) 101789

Contents lists available at ScienceDirect

China Economic Review

journal homepage: www.elsevier.com/locate/chieco

The value of higher education to entrepreneurial performance: Evidence from higher education expansion in China

Yanxiang Feng [1], Xinyang Tan [1], Ruixin Wang [1,*]

School of Economics and Management, Harbin Institute of Technology (Shenzhen), Shenzhen, China

ARTICLE INFO

JEL code:
I25
L26
D24

Keywords:
Higher education
Entrepreneurship
Productivity

ABSTRACT

Using the Enterprise Survey for Innovation and Entrepreneurship in China (ESIEC) 2018 database, we estimate the effect of the higher education of entrepreneur on firm performance. The expansion of higher education in China that began in 1999 is considered as an exogenous shock to identify causal effects. We find (1) that college education of entrepreneur significantly increases the total factor productivity of firms; (2) that college education of entrepreneur significantly increases the probability of innovation; and (3) that college education of entrepreneur significantly increases the likelihood that firms will gain policy supports from governments. The estimation results suggest that the increasing human capital of entrepreneurs is an important driving force for productivity growth in China. The study has policy implications for both higher education expansion and entrepreneurship.

1. Introduction

China's recent economic growth is characterized by a significant rise of productivity (Beerli, Weiss, Zilibotti, & Zweimüller, 2020). Fast productivity growth proceeds from the reallocation through selection of more productive firms (Acemoglu, Aghion, & Zilibotti, 2006; Hsieh & Song, 2015; Song, Storesletten, & Zilibotti, 2011). Meanwhile, China has activated the engine of innovation-led growth by investing in R&D and technology adoption (Acemoglu, Gancia, & Zilibotti, 2015; Holmes, McGrattan, & Prescott, 2015; Zilibotti, 2017). "Its spending on R&D accounts for around 20 percent of the world total, second only to the United States. Its number of patents granted annually for inventions has been the highest in the world" (World Bank, 2019).

China's growing human capital is also an important driving force for productivity growth. "China runs one of the world's largest education systems, with more than 7 million students graduating from its universities (in 2017), of whom more than 40 percent are in science, technology, engineering, and mathematics" (World Bank, 2019). Prior studies have shown that an increase in skilled labors allows firms to adopt new and more productive technologies (Fleisher, Li, & Zhao, 2010), and that the effect is stronger in human-capital intensive industries (Che & Zhang, 2018). In this paper, we show that the human capital of entrepreneurs also plays a critical role in productivity growth.

This research is motivated by the patterns observed in the field study we conducted in 6 provinces in 2018. Enhanced human capital of entrepreneurs, particularly that represented by higher education, improves productivity, for two main reasons. First, study and training in college provide entrepreneurs with a deeper understanding of the technologies in their business, so that they usually know

* Corresponding author.
E-mail address: wangruixin@hit.edu.cn (R. Wang).
[1] Authors equally share the first authorship.

https://doi.org/10.1016/j.chieco.2022.101789
Received 2 September 2021; Received in revised form 28 January 2022; Accepted 24 March 2022
Available online 28 March 2022
1043-951X/

better how to turn ideas into new products or services, put people together in particular ways and combine them with physical capital and other factors. Second, college education, as a signal of capability, can help entrepreneurs to obtain supports from governments and financial institutions.

We investigate the impact of the higher education of entrepreneur on total factor productivity (TFP) and the underlying mechanisms by taking advantage of a unique natural experiment in China that expanded college access for high-school graduates with effect from 1999 and thus generated a surge in college-educated entrepreneurs from 2003. Following Che and Zhang (2018), we adopt a difference-in-differences (DID) model to identify the impact of this increase in entrepreneurial human capital on productivity. We estimate the impact using a unique dataset of small and medium enterprises from the Enterprise Survey for Innovation and Entrepreneurship in China (ESIEC). The survey covers small and medium-sized enterprises (SMEs) in 6 provinces, collecting information related to start-up history, performance, innovation, and the overall business environment, which allows us to link the education background of entrepreneurs and firm performance.

The estimation results confirm that the expansion of higher education significantly increased the incidence of entrepreneurs graduating from college. Considering this expansion as an exogenous shock, we examine the impact of college education on entrepreneurial performance. We find that college-educated entrepreneurs run more productive firms than those with no higher education background. We further explore the underlying mechanisms of the impact. We find that college-educated entrepreneurs are more likely to develop new products or services than those with no college degree, and their innovation, on average, creates more value. College-educated entrepreneurs are more likely to hire college-educated employees and provide on-the-job training for their employees. We also find that college-educated entrepreneurs are more likely to obtain government subsidies that nurture start-up firms and to receive any type of policy supports from governments.

This study contributes to the empirical literature on the role of human capital in entrepreneurial selection and performance. Van der Sluis, Van Praag, and Vijverberg (2008) and Unger, Rauch, Frese, and Rosenbusch (2011) have summarized the literature on the relationship between education and entrepreneurial entry and outcomes. Most prior studies have revealed that even though the relationship between education and selection into entrepreneurship is ambiguous, the relationship between education and entrepreneurial performance is significantly positive, irrespective of the performance measure used (such as survival, profit, firm growth, or income). This paper focuses on the impact of the higher education of entrepreneur on firm productivity, highlighting how college education helps them to innovate and win government support. The paper also speaks to the literature studying the impact of human capital on economic growth. The lack of human capital poses a major barrier to productivity growth and economic development (Acemoglu & Zilibotti, 2001). By examining plant-level data, Moretti (2004) finds that local human capital positively influences productivity. Fleisher, Hu, Li, and Kim (2011), using a panel of firm-level data from China, find that education level improves worker productivity and the total factor productivity of firms, and that higher education of CEOs increases TFP for firms with foreign investment. This paper extends this strand of literature by investigating the effect of human capital of entrepreneurs, rather than workers, on firm productivity. Also, this paper is closely related to a new stream of literature on the impact of higher education expansion. Using China's education reform that began in 1999, a series of papers have estimated the impacts of the expansion of higher education on employment (Knight, Deng, & Li, 2017; Li, Whalley, & Xing, 2014; Xing, Yang, & Li, 2018), total factor productivity (Che & Zhang, 2018) and entrepreneurial selection (Huang, Tani, & Zhu, 2021). Following their methodology, we explore the impact of the higher education of entrepreneur on firm performance. The results have clear implications for education reform and productivity growth in China.

The rest of this article is organized as follows. In Section 2, we present the theory underlying the empirical analysis and derive testable hypotheses. The third section briefly summarizes the higher education reform and describes empirical strategy. Section 4 describes data sources and summary statistics, and Section 5 presents estimation results. Section 6 concludes.

2. Conceptual framework

Entrepreneurship, as defined by Lazear (2005), is "the process of assembling necessary factors of production consisting of human, physical, and information resources and doing so in an efficient manner." Therefore, entrepreneurs must be jacks-of-all-trades, meaning they should have knowledge, at least on a basic level, of numerous business areas. However, in a highly specialized economy, converting ideas into reality tends to require entrepreneurs to have specialized knowledge of their business, particularly the technologies in that business. In other words, pure generalists may have no particular advantage in entrepreneurship. The development of new products or services pays off in the market when specialization is combined with general knowledge about the tasks needed for production. Therefore, an ideal entrepreneur has both general knowledge and knowledge of an area of specialization (Kacperczyk & Younkin, 2017).

In general, higher education provides entrepreneurs with knowledge and training in one or a few specialized areas and can thus improve entrepreneurial performance for two reasons. First, higher education increases entrepreneurs' capability to perform the generic tasks of discovering and exploiting business opportunities (Shane & Venkataraman, 2007; Unger et al., 2011). For example, it may increase owners' entrepreneurial alertness (cf. Westhead, Ucbasaran, & Wright, 2005), preparing them to identify specific opportunities that are not visible to other people (Shane, 2000) and affecting their approaches to the exploitation of opportunities (Chandler & Hanks, 1994; Shane, 2000). Higher education also prepares entrepreneurs for further learning and aids the accumulation of new knowledge and skills. Second, following Arrow (1973), by functioning as a filter or screening, higher education is helpful for acquiring other useful resources such as financial and physical capital (Brush, Greene, & Hart, 2001) and can compensate in part for a lack of financial capital, a constraint for many entrepreneurial firms (Bates, 1990; Chandler & Hanks, 1998). In China, both central and local governments spend heavily to nurture start-up companies. Most of these subsidy programs require entrepreneurs to have a

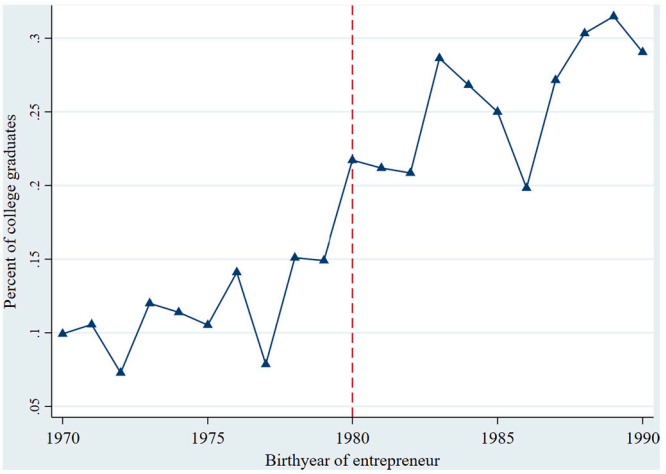

Fig. 1. Percentage of college-educated entrepreneurs over birth cohorts. (Source: drawn by authors based on ESIEC 2018 survey)

vocational college degree or above, so college-educated entrepreneurs have an advantage in winning supports from governments or financial institutions.

Based on the discussion on higher education and entrepreneurial performance, we derive the following testable hypotheses.

Hypothesis 1. College education of entrepreneur increases firm productivity.

To explore the underlying mechanism of the impact, we attempt to examine the following two hypotheses.

Hypothesis 2. College education of entrepreneur increases the probability of innovation.

Hypothesis 3. College education of entrepreneur increases the probability of the firm to obtain policy supports from governments.

3. Empirical strategy

3.1. Background: Higher education expansion since 1999

During the 1997 Asian financial crisis the Chinese government faced both economic downturn and rise in unemployment that was resulted from the reforms of the state-owned enterprises. To stimulate domestic demand for educational services and hence investment in construction, services and other related industries and to postpone high school graduates' entry into the labor market, in January 1999 the Ministry of Education (MOE) announced an admission plan of 1.3 million for three and four-year college programs, a 20% increase over 1998. The following June it revised the admission plan to 1.56 million, an unprecedented increase of 44% over the previous year (Che & Zhang, 2018).

Colleges and universities in China are predominately publicly funded, so the annual college admission growth on average was only 4.7% between 1995 and 1998. By contrast, college admissions grew annually by more than 40% in both 1999 and 2000, and by about 20% over the next five years. This took everyone by surprise. According to Che and Zhang (2018), the gross college enrolment rate increased from 9.8% in 1998 to 24.2% in 2009. As a consequence, more college-educated individuals engaged in entrepreneurship. As shown in Fig. 1, the percentage of college-educated entrepreneurs in the cohorts who were born in 1970s and thus reached college age before the expansion of higher education since 1999 is less than 15%. However, the percentage strikingly increases to 22% for the cohort who was born in 1980 and thus was exposed to the expansion. For most of the following cohorts, the percentage is above 25%.

3.2. Identification strategy

We identify the impact of the higher education of entrepreneur on firm performance using instrumental variable (IV) approach. The exogenous variation of the education level of entrepreneur is created by the expansion of higher education since 1999. Because the goal of the higher education expansion is to stimulate aggregate demand and is not targeted at any particular industry, the surge in college graduates in entrepreneurs is exogenous to the growth trend of any particular industry or firm and allows us to identify the causal relationship between higher education of entrepreneur and firm performance.

Specifically, in the first stage of IV estimation, we follow Che and Zhang (2018), identifying the effect of higher education expansion on the education level of entrepreneurs in a DID framework, in which we compare changes in percentage of college-educated entrepreneurs of firms in more human-capital intensive industries before and after the higher education expansion to that of firms in less human-capital intensive industries. The intuition behind the identification strategy is that, starting a firm tends to require entrepreneurs to have specialized knowledge of their business. Particularly in the more human-capital intensive industries, it usually needs entrepreneurs to have deep understanding of the technologies used in their business when developing new products or

services and organizing production. In this sense, college-educated entrepreneurs have advantages over those who have no college education background in more human-capital intensive industries, as higher education can equip entrepreneurs with knowledge of an area of specialization. By contrast, college-educated entrepreneurs are not so advantageous in less human-capital intensive industries, which usually requires entrepreneurs to have less technological knowledge. Therefore, percentage of college-educated entrepreneurs may increase in both industries after the higher education expansion, but the increase is larger in more human-capital intensive industries. In short, the DID method can estimate the extra increase in the probability of an entrepreneur to have college education background in more human-capital intensive industries after the higher education expansion relative to that in less human-capital intensive industries. Hence, we use the following specification to estimate the impact of the higher education expansion on the education level of entrepreneurs:

$$College_{i,j,n} = \beta_0 + \beta_1 HCI_j \times Cohort_i + X'_{i,j,n}\gamma + \varepsilon_{i,j,n} \quad (1)$$

where $College_{i,j,n}$ is a dummy variable that indicates whether entrepreneur i in industry j in city n has a college degree or above by the survey year. HCI_j is a dummy variable that indicates whether industry j is a more human-capital intensive industry. Following Che and Zhang (2018), human-capital intensity is defined as the percentage of college-educated labor force using data from economic census in 2008. So, HCI_j equals to one if the human-capital intensity of an industry is above the median, and zero otherwise.[2] $Cohort_i$ is a dummy variable that indicates whether the entrepreneur reached college age on or after 1999. Most Chinese students start primary school when they are six or seven years old, as required by the Law of Compulsory Education. Therefore, we assume that the first cohort that was exposed to the higher education expansion in 1999 is those born in 1980. In the DID framework, the interaction term between HCI_j and $Cohort_i$ captures the causal effect of the higher education expansion on percentage of college-educated entrepreneurs in more human-capital intensive industries relative to that in less human-capital intensive industries, given that both industry fixed effects and birth cohort fixed effects are controlled, and parallel trend assumption is satisfied. $X_{i,j,n}$ is a vector of control variables include parents' education levels and firm characteristics such as initial investment. The likelihood of college-educated entrepreneur may systematically vary over year and across regions, so we further control for fixed effects of firm registration time and city fixed effects. To control for the heterogeneity of time (cohort) trend across industries, we also include industry specific time (cohort) trends.

Taking Eq. (1) as the first stage of IV estimation, we examine the impact of the higher education of entrepreneur on firm performance in the following equation in the second stage.

$$Y_{i,j,n} = \alpha_0 + \alpha_1 \widehat{College}_{i,j,n} + X'_{i,j,n}\phi + \mu_{i,j,n} \quad (2)$$

where $Y_{i,j,n}$ is the entrepreneurial performance of firm i in industry j in city n on 2017. $\widehat{College}_{i,j,n}$ is the predicted probability of entrepreneur i in industry j to have college education background based on the first stage estimation. Given that our firm-level data are cross-sectional, and all the firms were established on or after 2010, the higher education expansion in 1999 is not correlated with the other determinants of entrepreneurial performance, e.g., education level of labor force. To guarantee the exogeneity of the instrumental variable, we also need to control for the differences in human-capital intensity across industries, so we include industry fixed effects into the estimation. $X_{i,j,n}$ is a vector of control variables including parents' education level and firm characteristics such as initial investment.[3] Considering that the likelihood of college-educated entrepreneur may change over cohorts, we also control for cohort fixed effects and industry specific time (cohort) trends. Furthermore, firm registration time fixed effects, and city fixed effects are also controlled.

To examine Hypothesis 1, we measure firm productivity by total factor productivity, which is estimated using OLS model.[4] We expect that college education of entrepreneur positively affects firm TFP.

The underlying mechanism is also explored by estimating Eq. (2) with different dependent variables. To examine Hypothesis 2, we estimate the impacts of the higher education of entrepreneur on a series of variables that measure innovation outcomes, including a dummy variable that indicates whether the firm developed new products or services in the survey year, the value created by new products or services as well as the percentage of sales value from new products or service. We also estimate the effects on innovation efforts, specifically we employ two dependent variables, percentage of college-educated labor force in the firm and a dummy variable that indicates whether the firm provides on-the-job training for employees. The intuition is that first, the specialized knowledge of college-educated employees, such as technical drawing, circuit design and properties of various materials, enables them to efficiently convert new ideas into technical designs and prototypes; second, on-the-job training fosters capacity of employees to master advanced technologies and develop new products or services. We expect the effects on innovation outcomes and efforts are all positive and statistically significant.

Similarly, to examine Hypothesis 3, we estimate the impacts of the higher education of entrepreneur on two dummy variables that

[2] The classification is robust if we use the data of industry human-capital intensity in the US in 1980 from Ciccone and Papaioannou (2009).

[3] In our main results, the control variables of firm characteristics only include initial investment, since introducing firm variables results in data attrition problem. Instead, we control for more fixed effects that are relevant to firm performance, such as industry fixed effects, firm registration time fixed effects and city fixed effects. In Appendix Table A4, we include more firm characteristics, including number of employees, value of fixed assets and percent of engineers and technicians. The estimation results are robust.

[4] To ensure that our results are robust to outliers, we drop the top and bottom 5% of estimated TFP. As the data about firm performance are cross-sectional, we do not adopt other methods to estimate TFP, such as Levinsohn and Petrin (2003).

Table 1
Summary statistics of key variables.

Variables	(1)	(2)	(3)	(4)	(5)
	Obs	Mean	S.D.	Min	Max
Industry HC intensity	1886	0.128	0.109	0.034	0.426
College-educated entrepreneur	1886	0.196	0.397	0.000	1.000
Age	1886	35.94	6.402	25.000	48.000
Educational attainment of father	1886	8.186	3.911	0.000	16.000
Educational attainment of mother	1886	6.463	4.107	0.000	18.000
Log value of initial investment	1886	12.050	2.177	0.000	18.171
TFP	853	0.209	1.330	−3.349	7.795
New product or service	1276	0.415	0.493	0.000	1.000
Percent of new product/service in sales	1161	0.092	0.189	0.000	1.000
Log value of new product/service	1161	5.618	7.980	0.000	24.818
Percent of college-educated employees	1362	0.309	0.386	0.000	1.000
On-the-job training	1360	0.608	0.488	0.000	1.000
Entrepreneurship subsidy	1272	0.072	0.258	0.000	1.000
Supportive policy	1875	0.123	0.328	0.000	1.000

indicate whether a firm received subsidy for entrepreneurship and any type of policy supports from governments respectively by the survey year. We expect that the college-educated entrepreneurs are more likely to gain policy supports from governments.

4. Data and summary statistics

We draw our sample from the Enterprise Survey for Innovation and Entrepreneurship in China (ESIEC) 2018 database. ESIEC is a field survey of Chinese private enterprises led by the Center for Enterprise Research of Peking University. In 2018, ESIEC successfully interviewed more than 6000 self-employed businesses and private enterprises, collecting information related to start-up history, performance, innovation activities, and the overall business environment. The survey in 2018 covered 6 provinces—Henan, Guangdong, Zhejiang, Shanghai, Gansu, and Liaoning. It used a stratified sampling strategy in these provinces. First, it randomly sampled 16–25 counties in each province. In total, 117 counties were selected. In each county, the survey randomly selected private enterprises and self-owned businesses established in the period of 2010–2017 from the China National Business Registration Database.[5] To examine the role of the higher education of entrepreneur on firm performance, we delete the sample firms of which the respondents in ESIEC are not entrepreneurs but rather managers. On average, the sampled entrepreneurs are 36 years old, ranging from 25 to 48 in age. We show the age structure of entrepreneurs in Fig. A1. Since we adopt the higher education expansion since 1999 as an exogenous shock to identify the causal effect, we further narrow our focus to the sample firms whose founders were born on or after 1970. Then, to limit the heterogeneity of the working sample, we restrict our sample to the first-time entrepreneurs.

Table 1 presents the summary statistics of a few key variables. Following Ciccone and Papaioannou (2009), we measure human-capital intensity as the percentage of college-educated workers using data from China Economic Census Yearbook of 2008. In the surveyed sample, around 20% of entrepreneurs have college education background. The education levels of entrepreneur's parents are measured by their school years, which on average are less than 9 years, suggesting most of them did not complete high school education. We show the percentage of college-educated entrepreneurs by industry in detail in Table A2 in Appendix: in more human-capital intensive industries, such as information technology, scientific research or business services, the percentage of college-educated entrepreneurs is also high, reaching around 40%; in contrast, the percentage is around 10% in less human-capital intensive industries, such as manufacturing, trade or residential services.

The value of TFP varies from −3.349 to 7.795. When estimating TFP, the number of observations is reduced to 853 due to data attrition. Usually, the response rates to the questions about firm operation, such as revenue, capital stock, labor, investment and so on, are relatively lower than other questions for privacy concerns.

In our sample, 41.5% of firms provided new products or services in 2017, and the sales value created by these new products or services accounts for 9.16% of the total value. The percent of college-educated employees is 30.9% in labor force, 60.8% of the sample firms provide on-the-job training for their employees. Among the sample firms, 7.2% are covered by government subsidy to promote entrepreneurship, and 12.3% are covered by any type of supportive policies.

[5] The China National Business Registration Database is from the State Administration of Industry and Commerce (SAIC), and contains the registration information for all the firms and self-employed businesses, including registration dates, locations, contact information, business operation scope, and type of industry. The sampling probability for the retail and wholesale sector was set to a quarter of the actual probability, considering the high degree of homogeneity within the sector and its sheer size. In the same vein, the survey reduced the number of self-employed businesses in our sample by setting the sampling ratio of self-employed businesses to incorporated enterprises at one to four.

Table 2
Treatment effects on entrepreneurs' higher education (first stage).

Variables	(1)	(2)
	College	College
HC intensive industry × Reach college age after 1999	0.156**	0.154**
	(0.058)	(0.062)
Controls	No	Yes
Industry FE	Yes	Yes
Registration time FE	Yes	Yes
Cohort FE	Yes	Yes
City FE	Yes	Yes
Industry specific time trend	Yes	Yes
R-squared	0.226	0.268
Observations	1886	1886

Note: 1. Dependent variable is a dummy variable that indicates whether an entrepreneur has college education background. 2. Control variables include parents' educational attainment and log value of initial investment. 3. A linear probability model is adopted. 4. Standard errors are clustered at industry level and reported in parentheses. 5. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

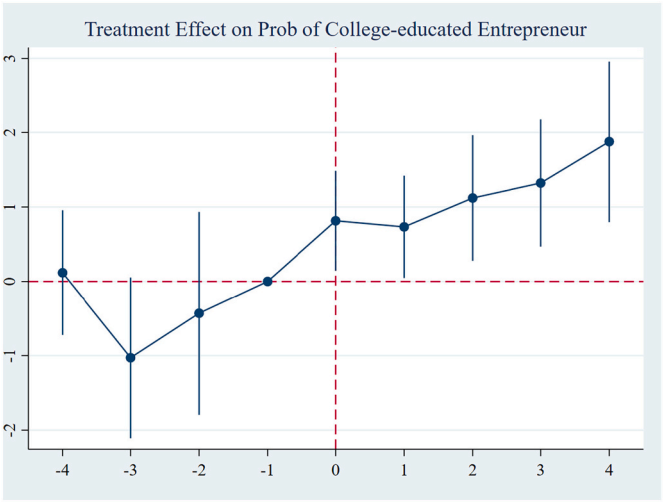

Fig. 2. Event study on the treatment effect of higher education expansion on probability of college-educated entrepreneurs.

5. Estimation results

5.1. First stage of IV estimation

Table 2 reports the results for the first stage of IV estimation, examining the impact of higher education expansion on entrepreneurs' education level. We identify the causal effect in a DID framework, in which we compare changes in percentage of the college-educated entrepreneurs before and after the higher education expansion of firms in more human-capital intensive industries to that of firms in less human-capital intensive industries. The coefficient of the interactive term between *HCI* (HC intensive industry) and *Cohort* (Reach college age after 1999) captures the exogenous variation resulted from the higher education expansion since 1999. As a benchmark result, we run a regression that only controls fixed effects in Column (1). The coefficient of the interaction term is 0.156 and statistically significant at 5% level. After introducing a set of control variables, including parents' educational attainment and log value of initial investment, as shown in Column (2), the estimated coefficient is 0.154 and significant at 5% level. Thus, relative to the firms in less human-capital intensive industries, the higher education expansion increases the percentage of college-educated entrepreneurs of the firms in more human-capital intensive industries by 15.4 percentage points. As a robustness check, we use the interaction term between *Cohort* and the value of human-capital intensity as an alternative treatment variable, implementing the DID estimation again. The estimation results, as shown in Table A3, are robust to the above findings.

To guarantee that the expansion of higher education exogenously affects the probability of entrepreneurs to have college education background, we should examine if parallel trend assumption is satisfied. We conduct an event study to detect the difference in trends of percentage of the college-educated entrepreneurs between firms in more human-capital intensive industries and those in less human-capital intensive industries. As we show in Fig. 2, difference in trends between the two industries is not significantly different from zero at conventional level prior to the higher education expansion, so we are unable to reject that the parallel trend assumption is satisfied.

Table 3
Effects of higher education of entrepreneur on TFP.

Variables	(1)	(2)
	OLS	IV
	TFP	TFP
College	0.543***	1.769***
	(0.145)	(0.625)
Controls	Yes	Yes
Industry FE	Yes	Yes
Registration time FE	Yes	Yes
Cohort FE	Yes	Yes
City FE	Yes	Yes
Industry specific time trend	Yes	Yes
First-stage F-stat	–	14.228
Observations	853	853

Note: 1. Dependent variable is total factor productivity. 2. An OLS model is adopted in Column (1). 3. An IV model is adopted in Column (2). We take HC intensive industry × Reach college age after 1999 as the instrumental variable for the dummy variable that indicates whether the entrepreneur has college education background. 4. Control variable includes log value of initial investment. 5. Standard errors are clustered at industry level and reported in parentheses. 6. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 4
Effects of higher education of entrepreneur on innovation outcome.

Variables	(1)	(2)	(3)
	New product or service	Share of new product/Service in sales	Value of new product/Service
College	0.310*	0.115*	5.358**
	(0.161)	(0.063)	(2.200)
Controls	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Registration time FE	Yes	Yes	Yes
Cohort FE	Yes	Yes	Yes
City FE	Yes	Yes	Yes
Industry specific time trend	Yes	Yes	Yes
First-stage F-stat	20.755	16.947	16.947
Observations	1276	1161	1161

Note: 1. Dependent variables are dummy variables that indicate whether to produce new products or services in Column (1), the share of sales value from new products or services in Column (2), and the log form of the value of new products or services in Column (3). 2. We take HC intensive industry × Reach college age after 1999 as the instrumental variable for the dummy variable that indicates whether the entrepreneur has college education background. 3. Control variable includes log value of initial investment. 4. Standard errors are clustered at industry level and reported in parentheses. 5. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

In contrast, we can observe that difference between the two industries is significantly enlarged after the higher education expansion.

Moreover, we perform a placebo test and assume that the higher education expansion had been implemented one to five years earlier than the actual reform year. We construct the “placebo” variable in a similar manner as our main treatment measure and estimate the Eq. (1). As shown in Table A1, most of the coefficients of “placebo” variables are insignificantly different from zero, so the parallel trend assumption is further confirmed. Based on the results of the first stage, we can identify the impact of the higher education of entrepreneur on firm performance using the predicted probability of an entrepreneur to have college education background.

5.2. Second stage of IV estimation

By estimating Eq. (2), we examine the three hypotheses regarding the impact of the higher education of entrepreneur on firm performance and the underlying mechanisms.

Table 5
Effects of higher education of entrepreneur on innovation efforts.

Variables	(1)	(2)
	Percent of college-educated employees	On-the-job training
College	0.601***	0.401***
	(0.051)	(0.134)
Controls	Yes	Yes
Industry FE	Yes	Yes
Registration time FE	Yes	Yes
Cohort FE	Yes	Yes
City FE	Yes	Yes
Industry specific time trend	Yes	Yes
First-stage F-stat	24.230	24.836
Observations	1362	1360

Note: 1. Dependent variables are percent of college-educated employees in Column (1), and a dummy variable that indicates whether to provide on-the-job training in Column (2). 2. We take HC intensive industry × Reach college age after 1999 as the instrumental variable for the dummy variable that indicates whether the entrepreneur has college education background. 3. Control variable includes log value of initial investment. 4. Standard errors are clustered at industry level and reported in parentheses. 5. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

5.2.1. *Hypothesis 1*

To test Hypothesis 1, we take TFP as a measure of firm productivity and perform our empirical analysis by running the second stage of IV estimation. Table 3 reports the estimation results. We show the OLS results in Column (1), the coefficient of *College* is 0.543 and significant at 1% level. The results of IV estimation are shown in Column (2), the coefficient of *College* is 1.769 and significant at 1% level.[6] The estimation results suggest that compared with those without college education, college-educated entrepreneurs can raise firm productivity by 1.330 units of standard deviation (SD = 1.330). As the higher education expansion increases the percentage of college-educated entrepreneurs by 15.4 percentage points (0.388 unit of standard deviation), on average it improves firm productivity by 0.205 unit of standard deviation. The first-stage F-statistic is 14.228, indicating the relevance condition of instrument variable is fulfilled. In Table A3, we perform robustness check using the value of human-capital intensity to construct instrumental variable. The results are robust to the above findings.

5.2.2. *Hypothesis 2*

Then we explore the underlying mechanisms by examining Hypothesis 2 and Hypothesis 3. Higher education of entrepreneur improves firm productivity for two main reasons, first, college-educated entrepreneurs are more likely to innovate, e.g., develop new products or services (Hypothesis 2); second, the firm of college-educated entrepreneur is more likely to obtain policy supports from governments (Hypothesis 3). We report the impacts of the higher education of entrepreneur on innovation outcomes and efforts in Tables 4 and 5.

As shown in Table 4, we estimate the impact on probability of developing new products or services in Column (1), the coefficient of *College* is 0.310 and significant at 10% level, indicating that the higher education of entrepreneur increases the probability of innovation by 31.0 percentage points.[7] We examine the impacts on percentage of the sales value from new products or service as well as the value created by new products or services in Columns (2) and (3). The coefficients of *College* are 0.115 and 5.358 respectively and are both statistically significant at conventional level. In short, higher education helps entrepreneurs with developing new products or services, and their innovation, on average, creates more value.

In Table 5, we further examine Hypothesis 2 by estimating the impacts of the higher education of entrepreneur on innovation efforts. Specifically, we examine the effect on the percentage of college-educated employees in Column (1). The coefficient of *College* is 0.601 and significant at 1% level, indicating that the higher education of entrepreneur increases the percentage of college-educated employees by 60.1 percentage points. In Column (2) we estimate the impact on whether to provide on-the-job training for employees, the coefficient of *College* is 0.401 and significant at 1% level. So, the likelihood that college-educated entrepreneurs conduct on-the-job training is 40.1 percentage points higher than that of those who have no college background. The estimation results above provide evidence for Hypothesis 2, highlighting the unique value of college education to entrepreneurs relative to basic education. The specialized knowledge and training of college-education enables entrepreneurs to efficiently exploit business opportunities, organize innovation activities and convert new ideas into innovative products and services, then improve firm productivity. All these results

[6] It is noteworthy that the coefficient to *College* in IV estimation is more than three times as large as that in OLS estimation. The results suggest that the coefficient is underestimated in OLS estimation due to omitted variable bias or selection problem. An interpretation is that in OLS model, college graduates may be negatively selected into the sample of entrepreneurs, since "higher levels of education may generate better outside options (i.e., more lucrative wage employment under better working conditions) and thus decrease the likelihood of entrepreneurship as the preferred choice" (Van der Sluis et al., 2008). Consequently, the performance of college-educated entrepreneurs may be underestimated using this selected sample. By taking advantage of the supply shock of college graduates, IV estimation can help to mitigate the concerns over the selection problem as the wage employment becomes less attractive when there is excess supply of college graduates in labor market.

[7] We adopt a linear probability model (LPM), and the results are robust to Probit model.

Table 6
Effects of higher education of entrepreneur on government support.

Variables	(1)	(2)
	Entrepreneurship subsidy	Supportive policy
College	0.245***	0.266***
	(0.085)	(0.074)
Controls	Yes	Yes
Industry FE	Yes	Yes
Registration time FE	Yes	Yes
Cohort FE	Yes	Yes
City FE	Yes	Yes
Industry specific time trend	Yes	Yes
First-stage F-stat	20.748	31.863
Observations	1272	1875

Note: 1. Dependent variables are dummy variables that indicate whether the firm received entrepreneurship subsidy in Column (1), and whether the firm received any supportive policy in Column (2). 2. We take HC intensive industry × Reach college age after 1999 as the instrumental variable for the dummy variable that indicates whether the entrepreneur has college education background. 3. Control variable includes log value of initial investment. 4. Standard errors are clustered at industry level and reported in parentheses. 5. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

pass weak instrument test, and are robust, as shown in Table A3, when adopting an alternative treatment variable as an IV.

5.2.3. *Hypothesis 3*

The estimation results to Hypothesis 3 are reported in Table 6. We show the impact on whether the firm received subsidy for entrepreneurship in Column (1) and whether the firm received any type of policy supports from government in Column (2). The coefficients of *College* are 0.245 and 0.266 respectively and are both statistically significant at 1 percent level, indicating that the college-educated entrepreneurs' probability of winning government supports is around 25 percentage points higher than that of those who have no college degree or above, then confirming the prediction of Hypothesis 3. The estimation results suggest that higher education, as a signal of capability, may help entrepreneurs to obtain policy supports from government. The results pass weak instrument test, and are robust, as shown in Table A3.

6. Conclusions

Using ESIEC 2018 database, we estimate the effect of the higher education of entrepreneur on firm performance. The higher education expansion in China starting in 1999 is adopted as an exogenous shock to identify causal effects. We find (1) that college education of entrepreneur significantly increases total factor productivity. By exploring the underlying mechanism of the impact, we find (2) that college education of entrepreneur significantly increases the probability of innovation; (3) that college education of entrepreneur significantly increases the probability of firm to win policy supports from governments.

Our paper provides a complementary interpretation to the productivity growth in China from the perspective of the human capital of entrepreneur. Currently, China is still in its transition from investment-led to innovation-led growth, the empirical results in our paper highlight the role of the higher education of entrepreneur in igniting the engine of innovation and productivity growth, thus the policies that foster human capital and encourage entrepreneurship among college graduates may be particularly important for the structural change and growth of Chinese economy.

Acknowledgements

We are grateful for support from a special grant for studying the impact of COVID-19 from Department of Education of Guangdong (2020KZDZX1225); National Natural Science Foundation of China (# 71874051). We would like to appreciate the insightful comments from both the editor and two anonymous reviewers. We would also like to thank the helpful comments from Yu Zhu and all seminar participants in Beijing Normal University at Zhuhai and the 21st China Economics Annual Conference. All errors are our own.

Appendix. Appendix

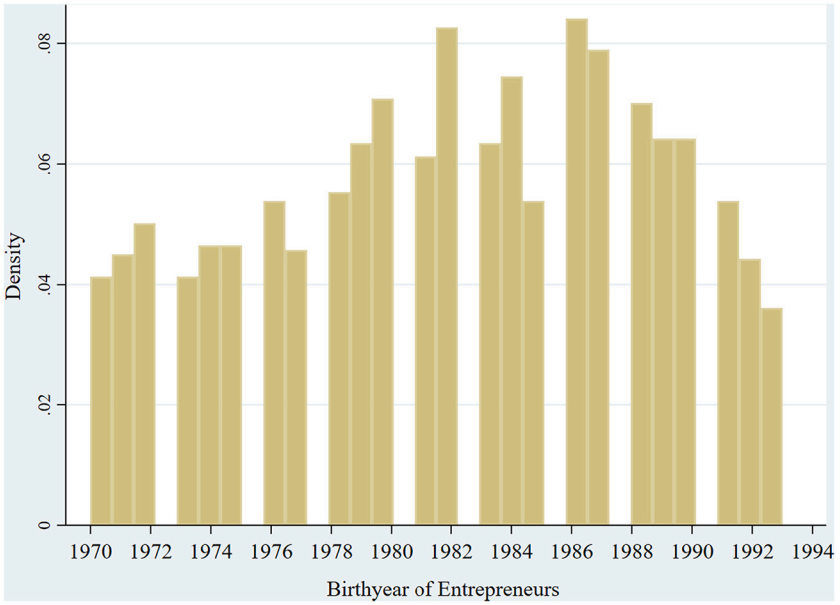

Fig. A1. Age structure of entrepreneurs (Source: drawn by authors based on ESIEC 2018 survey).

Table A1
Treatment effects on entrepreneurs' higher education (Placebo test).

Variables	(1)	(2)
	College	College
HC intensive industry × Reach college age after 1998	0.171**	0.156*
	(0.079)	(0.083)
R-squared	0.226	0.268
HC intensive industry × Reach college age after 1997	0.153	0.124
	(0.094)	(0.105)
R-squared	0.226	0.267
HC intensive industry × Reach college age after 1996	0.017	0.017
	(0.086)	(0.088)
R-squared	0.224	0.266
HC intensive industry × Reach college age after 1995	0.017	0.013
	(0.052)	(0.058)
R-squared	0.224	0.266
HC intensive industry × Reach college age after 1994	−0.079	−0.083*
	(0.047)	(0.043)
R-squared	0.225	0.266
Controls	No	Yes
Industry FE	Yes	Yes
Registration time FE	Yes	Yes
Cohort FE	Yes	Yes
City FE	Yes	Yes
Industry specific time trend	Yes	Yes
Observations	1886	1886

Note: 1. Dependent variable is a dummy variable that indicates whether an entrepreneur has college education background. 2. Control variables include parents' educational attainment and log value of initial investment. 3. A linear probability model is adopted. 4. Standard errors are clustered at industry level and reported in parentheses. 5. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A2
Education level of entrepreneurs and employees by industry.

Industry	Number of entrepreneurs	Percentage of college-educated entrepreneurs	Percentage of college-educated employees (China, 2008)
More human-capital intensive industry	532	38.72%	
Business services	217	36.41%	21.00%
Information technology	102	35.29%	39.30%
Scientific research	80	50.00%	38.00%

(*continued on next page*)

Table A2 (*continued*)

Industry	Number of entrepreneurs	Percentage of college-educated entrepreneurs	Percentage of college-educated employees (China, 2008)
Less human-capital intensive industry	1354	12.04%	
Manufacturing	279	13.26%	5.30%
Trade	348	14.94%	11.70%
Hospitality	234	9.83%	4.60%
Residential services	211	8.53%	6.70%

Table A3
Effects of higher education on entrepreneurial performance (Robustness check: Alternative treatment variable).

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	College	TFP	New product or service	Share of new product/ Service in sales	Value of new product/ Service	Percent of college-educated employees	On-the-job training	Entrepreneurship subsidy	Supportive policy
HC intensity × Reach college age after 1999	0.548*								
	(0.285)								
College		1.938***	0.305*	0.105*	5.171**	0.581***	0.417***	0.252***	0.270***
		(0.666)	(0.181)	(0.061)	(2.363)	(0.047)	(0.137)	(0.092)	(0.080)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Registration time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry specific time trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
First-stage F-stat	–	13.540	19.821	16.590	16.590	22.752	23.208	18.770	30.664
Observations	1886	853	1276	1161	1161	1362	1360	1272	1875

Note: 1. A linear probability model is adopted in Column (1). An IV model is adopted in Columns (2)–(9). We use *HC intensity*, instead of *HC Intensive Industry*, to construct the instrumental variable for *College*, the dummy variable that indicates whether the entrepreneur has college education background. 2. Dependent variable in Column (1) is a dummy variable that indicates whether an entrepreneur has college education background. Dependent variables in Columns (2)–(9) are total factor productivity, dummy variable that indicates whether to produce new products or services, percent of sales value from new products or services, log form of the value of new products or services, proportion of college-educated employees, dummy variable that indicates whether to provide on-the-job training, and dummy variables that indicate whether the firm received entrepreneurship subsidy and whether the firm received any supportive policy, respectively. 3. Control variables include parents' educational attainment and log value of initial investment in Column (1), and include log value of initial investment in Columns (2)-(9). 4. Standard errors are clustered at industry level and reported in parentheses. 5. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A4
Effects of higher education on entrepreneurial performance (Robustness check: More control variables).

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	College	TFP	New product or service	Share of new product/ Service in sales	Value of new product/ Service	Percent of college-educated employees	On-the-job training	Entrepreneurship subsidy	Supportive policy
HC intensive industry × Reach college age after 1999	0.266***								
	(0.080)								
College		1.310**	0.128	0.107*	2.308	0.651***	0.222**	0.208***	0.188***
		(0.571)	(0.166)	(0.056)	(2.661)	(0.080)	(0.109)	(0.063)	(0.058)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Registration time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

(*continued on next page*)

Table A4 (*continued*)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	College	TFP	New product or service	Share of new product/ Service in sales	Value of new product/ Service	Percent of college-educated employees	On-the-job training	Entrepreneurship subsidy	Supportive policy
Industry specific time trend									
First-stage F-stat	–	10.792	13.504	10.246	10.246	20.785	21.026	17.095	21.103
Observations	1027	667	787	719	719	1025	1026	756	1025

Note: 1. A linear probability model is adopted in Column (1). An IV model is adopted in Columns (2)–(9). We take HC intensive industry × Reach college age after 1999 as the instrumental variable for the dummy variable that indicates whether the entrepreneur has college education background. 2. Dependent variable in Column (1) is a dummy variable that indicates whether an entrepreneur has college education background. Dependent variables in Columns (2)–(9) are total factor productivity, dummy variable that indicates whether to produce new products or services, percent of sales value from new products or services, log form of the value of new products or services, proportion of college-educated employees, dummy variable that indicates whether to provide on-the-job training, and dummy variables that indicate whether the firm received entrepreneurship subsidy and whether the firm received any supportive policy, respectively. 3. Control variables basically include parents' educational attainment and log value of initial investment in Column (1), and include log value of initial investment in Columns (2)–(9). More control variables, such as number of employees, value of fixed assets and percent of engineers and technicians, are introduced in all columns. 4. Standard errors are clustered at industry level and reported in parentheses. 5. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

References

Acemoglu, D., Aghion, P., & Zilibotti, F. (2006). Distance to frontier, selection, and economic growth. *Journal of the European Economic Association, 4*(1), 37–74.

Acemoglu, D., Gancia, G., & Zilibotti, F. (2015). Offshoring and directed technical change. *American Economic Journal: Macroeconomics, 7*(3), 84–122.

Acemoglu, D., & Zilibotti, F. (2001). Productivity differences. *The Quarterly Journal of Economics, 116*(2), 563–606.

Arrow, K. J. (1973). Higher education as a filter. *Journal of Public Economics, 2*(3), 193–216.

Bates, T. (1990). Entrepreneur human capital inputs and small business longevity. *The Review of Economics and Statistics, 72*(4), 551–559.

Beerli, A., Weiss, F. J., Zilibotti, F., & Zweimüller, J. (2020). Demand forces of technical change evidence from the Chinese manufacturing industry. *China Economic Review, 60*(C).

Brush, C. G., Greene, P. G., & Hart, M. M. (2001). From initial idea to unique advantage: The entrepreneurial challenge of constructing a resource base. *Academy of Management Executive, 15*, 64–78.

Chandler, G. N., & Hanks, S. H. (1994). Founder competence, the environment, and venture performance. *Entrepreneurship Theory and Practice, 18*(3), 77–89.

Chandler, G. N., & Hanks, S. H. (1998). An examination of the substitutability of founders human and financial capital in emerging business ventures. *Journal of Business Venturing, 13*(5), 353–369.

Che, Y., & Zhang, L. (2018). Human capital, technology adoption and firm performance: Impacts of China's higher education expansion in the late 1990s. *Economic Journal, 128*(614), 2282–2320.

Ciccone, A., & Papaioannou, E. (2009). Human capital, the structure of production, and growth. *The Review of Economics and Statistics, 91*(1), 66–82.

Fleisher, B. M., Hu, Y., Li, H., & Kim, S. (2011). Economic transition, higher education and worker productivity in China. *Journal of Development Economics, 94*(1), 86–94.

Fleisher, B. M., Li, H., & Zhao, M. (2010). Human capital, economic growth, and regional inequality in China. *Journal of Development Economics, 92*(2), 215–231.

Holmes, T. J., McGrattan, E. R., & Prescott, E. C. (2015). Quid pro quo: Technology capital transfers for market access in China. *Review of Economic Studies, 82*(3), 1154–1193.

Hsieh, C., & Song, Z. (2015). Grasp the large, let go of the small: The transformation of the state sector in China. *Brookings Papers on Economic Activity, 46*(1), 295–366.

Huang, B., Tani, M., & Zhu, Y. (2021). Does higher education make you more entrepreneurial? Causal evidence from China. In *IZA Discussion Papers* (p. 14310).

Kacperczyk, A., & Younkin, P. (2017). The paradox of breadth: The tension between experience and legitimacy in the transition to entrepreneurship. *Administrative Science Quarterly, 62*(4), 731–764.

Knight, J., Deng, Q., & Li, S. (2017). China's expansion of higher education: The labour market consequences of a supply shock. *China Economic Review, 43*(C), 127–141.

Lazear, E. (2005). Entrepreneurship. *Journal of Labor Economics, 23*(4), 649–680.

Levinsohn, J., & Petrin, A. (2003). Estimating production functions using inputs to control for unobservables. *Review of Economic Studies, 70*(2), 317–341.

Li, S., Whalley, J., & Xing, C. (2014). China's higher education expansion and unemployment of college graduates. *China Economic Review, 30*, 567–582.

Moretti, E. (2004). Workers' education, spillovers, and productivity: Evidence from plant-level production functions. *American Economic Review, 94*(3), 656–690.

Shane, S. (2000). Prior knowledge and the discovery of entrepreneurial opportunities. *Organization Science, 11*, 448–469.

Shane, S., & Venkataraman, S. (2007). The promise of entrepreneurship as a field of research. In Á. Cuervo, D. Ribeiro, & S. Roig (Eds.), *Springer Books* (pp. 171–184). Entrepreneurship.

Song, Z. M., Storesletten, K., & Zilibotti, F. (2011). Growing like China. *American Economic Review, 101*(1), 196–233.

Unger, J. M., Rauch, A., Frese, M., & Rosenbusch, N. (2011). Human capital and entrepreneurial success: A meta-analytical review. *Journal of Business Venturing, 26*(3), 341–358.

Van der Sluis, J., Van Praag, M., & Vijverberg, W. (2008). Education and entrepreneurship selection and performance: A review of the empirical literature. *Journal of Economic Surveys, 22*(5), 795–841.

Westhead, P., Ucbasaran, D., & Wright, M. (2005). Decisions, actions, and performance: Do novice, serial, and portfolio entrepreneurs differ? *Journal of Small Business Management, 43*, 393–417.

World Bank Group, & The People's Republic of China Development Research Center of the State Council. (2019). Innovative China. *World Bank Publications, 32351*.

Xing, C., Yang, P., & Li, Z. (2018). The medium-run effect of China's higher education expansion on the unemployment of college graduates. *China Economic Review, 51*, 181–193.

Zilibotti, F. (2017). Growing and slowing down like China. *Journal of the European Economic Association, 15*(5), 943–988.