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Jingrun Chen and Junmin Wan

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Center for Advanced Economic Study
Fukuoka University
(CAES)

8-19-1 Nanakuma, Jonan-ku, Fukuoka,
JAPAN 814-0180
+81-92-871-6631

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Jingrun Chen and Junmin Wan[2]

Graduate School of Economics, Fukuoka University, Japan

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Correspondence: Nanakuma 8-19-1, Jounan Ward, Fukuoka City, Fukuoka 8140180, Japan; (e-mail) Wan: wan@fukuoka-u.ac.jp; (tel) +81-92-871-6631(ext.4208); (fax) +81-92-864-2904.

Highlights

1. Using panel data on the 122 listed construction firms active in China during 2002–2021, this paper estimates the Marginal *q* and Average *q*, and finds that the former is significantly higher than the latter.

2. A high Marginal *q* moves together with a low investment rate, explained by a demand-driven theory which reveals indirect impacts of real estate bubbles on the construction industry.

3. The response of investment to the Marginal *q* is more sensitive than that to the Average *q*. This implies that overinvestment may be in play, because *q* features bubble profits attributable to housing oversupply.

Abstract

Using individual panel data on 122 Chinese construction firms listed from 2002–2021, this paper connects both the housing and stock markets with real investments and empirically tests whether Tobin's q theory reflects corporate investment decisions. We estimate the Marginal q and the Average q, and find that the former is significantly higher than the latter. Furthermore, an excessively high Marginal q moves together with a low investment rate. These two facts contradict traditional q theory, but are explained by the transmission mechanism of demand-driven theory associated with indirect impacts of real estate bubbles on the construction industry. We then regress q on investments, and find that the effect of investment on the Marginal q is more sensitive than that on the Average q. These empirical results imply that overinvestment may be in play because q features bubble profits attributable to housing oversupply.

JEL classification: E13, E22, D24

Keywords: Average q, China, listed construction firm, Marginal q, investment

1. Introduction

Wan and Qiu (2023) found that the explosive growth of housing prices in China induced significant overinvestment in real estate-related industries. As the construction industry functions upstream of the real estate industry, construction firms could be more severely impacted than the sectors explored in Wan and Qiu (2023). It is thus important to explore the possible impact of strongly increasing housing prices on construction firms. This study uses Tobin's Marginal *q* and Average *q* to analyze investment by the construction industry. It is hoped that this work will serve as a useful link in the chain of evidence showing transmission of housing bubbles among related sectors.

1.1 Real estate and construction sectors of China

Chinese real estate has long been considered to be an integrated value system with important financial attributes linked to household registration, school districts, and other resources (Wu 2021). Bank branch deregulation has increased loans to firms and households, triggering overinvestment (Wan 2018). Real estate readily absorbs excessive money. Figure 1 shows the real estate market of Beijing over time; the average house price has doubled since 2005, but the construction market fell into recession after peaking in 2015. Since 2021, when the largest Chinese real estate firm, Evergrande Real Estate Group, experienced a debt crisis, the real estate market has been in rapid decline from January to July 2022. Commercial property sales fell 28.8% year-on-year.[3] Residential property vacancy rates in 28 major Chinese cities averaged 12%.

3 For details see East-money: https://finance.eastmoney.com/a/202208152479905182.html

Since June 2022, many house-buyers have suspended mortgage payments to protest construction delays on homes they have already paid for, placing developers' future sales at risk and pausing an important source of cash flow.[4] Many construction firms have gone bankrupt and left the market.[5] The impact of the housing slump on the construction industry is thus clear.

Given the explosive growth in house price growth and the high housing vacancy rates, we believe that the construction market is oversupplied, driven by housing demand. Following Wan and Qiu (2023), we assume that the house price explosion is an exogenous shock experienced by that market, and would thus be expected to disturb quantity and price equilibria (Figure 2). To meet the excess demand for housing, it is essential to increase construction industry capacity, which may trigger overinvestment. Firm profits and the Tobin's Marginal *q* should be affected both directly and indirectly.

1.2 The housing bubble and transmission thereof

Wan (2015) used the bubble of Phillips et al. (2012) to derive the ratio of monthly house prices to rents for the first time, and believed that house price growth significantly increased the savings rates of Chinese households. Guerrieri and Uhlig (2016) considered that investors purchased assets in an irrational manner. Wan (2018a, 2018b) and Wan and Qiu (2020) confirmed the existence of housing bubbles. Exploding house prices in major cities have created many new vacant homes, thus oversupplies. The real

4 For details see CNBC: https://www.cnbc.com/2022/08/12/heres-where-chinas-real-estate-troubles-could-spill-over-.html

5 For details see Tencent News: https://new.qq.com/rain/a/20220921A033EV00

estate bubble increased the proportion of non-performing loans (Wan 2018b) and greatly impacted the overall economy (Wan 2021b). Wan (2018a) found a significant negative correlation between housing and land prices, and the consumer price index (CPI), during the bubble economy periods of China and Japan. Wan and Qiu (2023) confirmed that the Chinese real estate bubble induced Granger-like changes in the producer price index (PPI). Using input-output table methods, Cook (2018) and Rogoff and Yang (2021) found that housing bubbles increase investment and prices in housing-related sectors (crowding-in effects) and reduce investment and prices in non-housing sectors (crowding-out effects).

1.3 Contributions of this research

This study has three characteristics. First, compared to industries, households, and banks, real estate firms and the construction industry are more deeply affected by the Chinese real estate bubble. Qiu and Wan (2021b) used macro data and Marginal *q* theory to confirm overinvestment in the Chinese construction industry from 2006 to 2019. Given the limitations of the macro data, the cited authors did not combine real estate investments with financial information. This paper first uses the micro data of all listed construction firms to analyze the impact of the real estate bubble on such firms employing demand-side drive theory. When the micro- and macro-empirical results were compared, both studies came to the same conclusion. This constitutes concrete evidence of construction sector overinvestment associated with the housing bubble.

Second, although Gugler and Yurtoglu (2003), Wiberg (2008), and Berglund (2011) considered that estimation of Marginal *q* was difficult, Ogawa (2003) derived a method presented in an important quantitative research paper on the impact of financial distress in the 1990s on Japanese corporate investment. This study is the first attempt of the use of the same methodology to process data from Chinese construction firms. We identify the individual balance sheet items of listed Chinese listed firms by the nature of the enterprises, and use these data to calculate the Marginal *q*.

Third, we use data from 2002 to 2021 on 122 listed Chinese construction firms (90% of the total, 122/137) to estimate their depreciation rates and the before- and after-tax Marginal *q* and Average *q*. The Marginal *q* is close to that of the Japanese construction industry in the 1980s (3.8475) [Ogawa (1994)] but the Average *q* is larger than that of US listed firms (0.808) [Furstenberg et al. (1977)]. The before-tax Marginal *q* is higher than the after-tax Marginal *q* and the after-tax Marginal *q* higher than the Average *q*. Our findings are similar to those reported by Ogawa et al. (1994) for Japan in the 1980s, and by Qiu and Wan (2021b) for China from 2006–2019, but different from those reported by Chirinko and Schaller (2001) for Japan in the 1980s. The difference between our data and those of Chirinko and Schaller (2001) may reflect a different interpretation of the Marginal *q*, because the Marginal *q* contains bubble profit (Wan 2021c).

1.4 Organization of the paper

This paper is organized as follows. The research questions and hypotheses are detailed in Section 2. Section 3 describes the data sources for the depreciation rates and specifies how the Marginal *q*, Average *q*, and the investment function are derived. Section 4 summarizes the empirical results and Section 5 contains the conclusions and policy implications.

2 Research question and hypotheses

2.1 Overinvestment and the housing bubble

According to Rogoff and Yang (2021), 28.7% of China's GDP is attributable to the construction industry, which thus plays a major role in the national economy and is key when studying the transmission of real estate bubbles to the real estate sector. Wan and Qiu (2020, 2023) used Granger causality tests to confirm that a transmission hypothesis derived using demand-driven theory explained the relationship between Chinese housing prices and the Producer Price Index (PPI). Wan (2021b) found that an input-output table method combined with neoclassical theory could be used to analyze transmission of the real estate bubble to the construction industry, affording new insight into how housing bubbles affect various sectors. Although a connection between the housing bubble and the construction industry may be obvious, this does not eliminate the need for concrete evidence derived via empirical analysis.

The Chinese real estate market has experienced an unprecedented boom; house prices have been rising rapidly since 2008 despite low rental growth (Jiang et al. 2022). Chen et al. (2020) studied the impact of the Chinese 2009 monetary stimulus program on infrastructure spending and credit allocation. Wan (2015, 2018a) empirically analyzed annual price-to-rent ratios, and performed bubble tests; these empirically identified house price bubbles in 36 major Chinese cities. Excessive increases in house prices readily generate distorted demand information that affects the expectations of developers and consumers. An excessive supply caused by distorted demand creates a backlog of vacant real estate. Wan (2018b) found that, if a housing market is strictly regulated, overinvestment in real estate and related industries suppressed corporate profits, in turn increasing bank non-performing loans (NPLs) and compromising the stability and efficiency of the financial system. Wan (2021d) explained that branch deregulation encouraged banks to loan excessively to firms, inducing overinvestment.

2.2 Investment in the construction industry

Wan (2021b) argued that high housing prices increased the demand and supply of steel, coal, and other materials. According to the China Household Finance Survey and Research Center, the housing vacancy rate in Chinese urban areas attained an astonishing 21.4% in 2017.[6] Thus, it is necessary to study the impact of real estate market overheating on other industries, especially the (very important) construction industry. Here, we analyze overcapacity from the perspective of overinvestment caused by excessive house-building. Qiu and Wan (2021a, b) proposed the concept of a "bubble Marginal *q*." The cited authors found that the Marginal *q* of the Chinese construction industry macro data was significantly higher than the Average *q*, possibly attributable

[6] For the details see: https://chfs.swufe.edu.cn/__local/D/65/2B/57D2F2A832F77C8F3C1DDC4926E_ADF9EA0C_121D6C.pdf

to large profits generated by the real estate bubble. It was predicted that the bubble *q* might still be less than 1 after the bubble burst; a *q* value less than 1 at that time would indicate continued overinvestment. We employ the *q* method of Wan and Qiu (2023) to analyze the impact of housing bubbles on investment in the construction industry. Overinvestment and excess growth capacity can trigger capital underutilization and increase average fixed costs. In the sluggish real estate market of today, if supply continues to rise, a decline in profitability and a rise in NPLs are inevitable, increasing the risk of a financial crisis.

2.3 Depreciation rates of listed construction industries

When estimating the Marginal *q*, it is accepted that the profit and interest rates are important, but opinions differ in terms of the depreciation rate. Wan and Qiu (2022) defined the total value of fixed assets (TVFA) as an imputed value, based on economic depreciation theory by Wan (2019). Wan and Qiu (2022) explored the impacts of two depreciation methods, the perpetual inventory method (PIM) and depreciation expense as an accounting item (DEAI), on the asset values of 36 Chinese industrial sectors.

2.4 Hypotheses

The investment literature is dominated by two theories, the neoclassical theory of Jorgenson (1963) and the *q* theory of Tobin (1969). Hayashi (1982) discussed the Tobin conjecture that investment was a function of Marginal *q*, thus equivalent to calculation of optimal capital accumulation by firms with adjustment costs. However, we found that, in recent years, although the Chinese real estate market has slumped and investment in the construction industry has decreased year-by-year, the Marginal *q* remains high. This leads to a very counter-intuitive conclusion: A high Marginal *q* is not a symptom of underinvestment, and may in fact indicate overinvestment. We explore this further by studying listed Chinese construction firms. We consider two possibilities based on the empirical specifications of the investment function as presented by Abel (1980), Chirinko (1993), Ogawa et al. (1994, 2019), and Wan (2019).

Hypothesis 1: If the Marginal *q* is greater than the Average *q*, overinvestment in the Chinese construction industry is in play (Wan 2021c).

Hypothesis 2: The investment behavior of the Chinese construction industry is explained by *q* theory. Thus, corporate investment is significantly positively correlated with the Marginal *q* and Average *q*. These *q* values may include abnormal profits from bubbles (Wan 2021c, Wan and Qiu 2023).

In China, Wan and Qiu (2023) considered that 36 industrial sectors were market-oriented; construction was not included. If our empirical results support the hypotheses above, this will constitute evidence that the real estate bubble is transmitted to the construction sector and that the Chinese construction industry is thus also market-oriented.

3 Data and methods

3.1 Panel data on 122 listed construction firms

We obtained 1,373 annual observations on 122 listed construction firms from 2002 to 2021. The "China Engineering Construction Industry Development Report (2021)"[7] compiled by the China Association of Construction Enterprise Management identifies engineering construction as "National Economic Industry Classification (GB/T 4754-2017)" in the construction industry sector (E). That sector includes four major categories: Housing construction (E47); civil engineering construction (E48); building installation (E49); and building decoration and "other" (E50). Based on these definitions, we found 137 listed firms. Excluding those that re-aligned their endeavors in recent years, and those for which annual financial reports were lacking, 122 firms were finally selected. We manually collected balance sheet data from the official homepages. We manually retrieved average annual share prices (https://cn.investing.com). The descriptive statistics are shown in Table 2.

3.2 Sample characteristics

The 122 firms account for approximately 90% of all listed firms. The "China Statistical Yearbook on Construction 2021"[8] released by the National Bureau of Statistics in 2020 reported 116,722 construction firms with total assets of 28.3 trillion Yuan. The 122 firms that we studied have total assets of 11.7 trillion Yuan,[9] thus 37.7%

7 https://xueshu.baidu.com/usercenter/paper/show?paperid=161100m0812202t0ct170ph0av215800&site=xueshu_se
8 https://data.cnki.net/Trade/yearbook/single/N2021120002?zcode=Z005
9 We simply summed the 2020 data for the full sample.

of the total. Most Chinese construction firms are not public; listed firms account for about 38% of all assets; larger firms are more likely to go public.

Our calculated q-values and investment rates contained some outliers, defined as values that deviated from the mean by more than three standard deviations. These were excluded because they may reflect (often unobservable) changes in accounting rules, cost capitalizations, or changes in fair value. Fixed asset utilization efficiency does not fluctuate outside the normal range; there are no outliers.

3.3 Depreciation rate

Assuming that profits come from resources owned by the firm, such as leases, real estate investments, and land use rights, the stock of fixed assets in a balance sheet does fully reflect how profits are generated. Therefore, fixed assets must be redefined to satisfy the assumptions of q theory. Our total value of fixed assets (TVFA) estimation is based on the method of Wan and Qiu (2022, 2023). The benchmark capital stock used is based on the value at the end of the current period:

$$TVFA_{it} = OVFA_{it} - DFA_{it} + Errors_{it}, \tag{1}$$

where:

$TVFA_{it}$: Total value of fixed assets of construction firm *i* at time *t*;

$OVFA_{it}$: Original value of fixed assets of construction firm *i* at time *t*;

DFA_{it}: Depreciation of fixed assets of construction firm *i* at time *t*;

$Errors_{mt}$: Error item. This indicates principally the individual deviation of any enterprise in terms of fixed asset valuation, accumulated depreciation, and/or provision for impairment of existing conditions.

Note that fixed assets (TVFA) do not include inventories, but do include land, unlike the estimate of Qiu and Wan (2021a) for the real estate industry and that of Ogawa (1999) for Japanese firms. This is attributable to the nature of the construction industry, which can be considered to be primarily housing manufacture. The inventories are largely raw materials and the work-in-progress required to deliver houses; the inventories do not directly produce additional value. The balance sheets show that the sizes of construction firm fixed assets (about 4% of total assets) are close to that of investment properties (also about 4%). Construction firms hold real estate to earn rent or appreciate capital while building houses. In a balance sheet, investment properties may be depreciated as are fixed assets.

We use both the PIM and the DEAI method of Wan and Qiu (2022) to estimate the depreciation rates of construction firms. The depreciation rates are very similar. Although PIM contains more information on investment intermediation and asset revaluation (Wan and Qiu 2022), this is filtered out in the balance sheet. Therefore, to simplify the analysis and to improve the accuracy of the information, we use only the DEAI method to estimate depreciation. We control for inflation using the average Price Index of Investment in Fixed Assets (PIIFA). The DEAI of a construction firm is estimated as follows:

$$\delta_{DEAI-it} = \frac{(AD_{it} - AD_{it-1})/PIIFA_t}{TVFA_{it-1}}, \quad (2)$$

where:

$\delta_{DEAI-it}$: The DEAI depreciation rate of construction firm *i* at time *t*;

AD_{it}: The accumulated depreciation of construction firm *i* at time *t*;

$PIIFA_t$: The average PIIFA;

$TVFA_{it-1}$: Total fixed assets value of construction firm *i* at time *t-1*.

To estimate the Marginal q, we obtain the annual industry median by calculating the depreciation and interest rates. We use the industry median to replace the individual firm depreciation and interest rates in the following calculations. This reduces the effect of endogeneity on the investment function and compensates for bias imposed by outliers on the overall estimations. Figure 3 shows the median annual depreciation and interest rates of the 122 construction firms.

3.4 Estimation of Tobin's Average *q* and Marginal *q*

To estimate the Average q, we adapt the definition of q by Tobin (1963, 1969), and refer to the methods of Ogawa (1999) and Qiu and Wan (2021a) when deriving the following formula:

$$Aq_{it} = \frac{EMV_{it}+TD_{it}}{TA_{it-1}}, \quad (3)$$

where:

Aq_{it}: Average q of construction firm *i* at time *t*;

EMV_{it}: Equity market value of construction firm *i* at time *t*;

TD_{it}: Total book value of debt of construction firm *i* at time *t*;

TA_{it}: Total book value of assets of construction firm *i* at time *t-1*.

We estimate the equity market value (EMV) by multiplying the current value of the stock by the share capital. Here, the equity capital includes domestically listed common stocks (A shares)[10] and domestically listed foreign stocks (B shares).[11] We use the total assets at the end of the previous period to reduce the effect of endogeneity. The trend in the annual Average q of the listed construction firms is shown in Figure 4. The trends for the top 10 listed firms are shown in Figures 6–15.[12]

As our data are obtained from the annual statements of listed firms, we chose the improved Marginal q assessment method of Ogawa (2003) [which matches that of Hayashi (1982)]. We employed the simple specification of Wan and Qiu (2023) when deriving the following equation:

$$Mq_{it} = \frac{\pi_{it}}{P_{it}^{I}} \frac{1+r_{it}}{r_{it}+\delta_{it}}, \tag{4}$$

where:

Mq_{it}: Before- and after-tax Marginal q of construction firm *i* at time t;

π_{it}: Ratio of total profit before- and after-tax of construction firm *i* at time t;

P_{it}^{I}: Investment of construction firm *i* at time *t*;

δ_{it}: Average depreciation rate (DEAI) of construction firm *i* at time *t*;

r_{it}: Average interest payments of construction firm *i* at time *t*.

We calculated the annual median depreciation and interest rates of the sample and used them as proxies for the depreciation and interest rates in the above equation. We retained only one individual firm characteristic, thus profitability. Figure 3 shows the

10 A shares: RMB ordinary shares issued by companies incorporated in China and denominated in RMB in China for subscription and trading by domestic institutions, organizations, or individuals (excluding Taiwan, Hong Kong, and Macau investors) in RMB.

11 B shares: RMB-denominated shares subscribed and traded in foreign currencies that are listed and traded in China (Shanghai and Shenzhen), where the place of registrations and listing of B-share companies lie in China.

12 The top 10-ranked firms are those of the top 10 total assets at the end of 2021.

median annual depreciation and interest rates of the 122 firms. The trend in the annual Marginal q is shown in Figure 4. The trends in the Marginal q values of the top 10 firms are shown in Figures 6–15.

3.5 Empirical specifications

Following Ogawa et al. (1994, 2019), Qiu and Wan (2021b), and Wan and Qiu (2023), we used the following empirical specification of the investment function:

$$\frac{I_{it}}{K_{it-1}} = \zeta_0 + \zeta_1 q_{it} + \mu_i + \gamma_t + \varepsilon_{it}, \quad (5)$$

where:

I_{it}: Fixed assets investment of construction firm *i* at time *t*;

K_{it-1}: TVFA of construction firm *i* at time *t-1*;

q_{it}: Before-tax Marginal q, after-tax Marginal q, and Average q of construction firm *i* at time *t*;

ζ_1 is a coefficient; and ζ_0, μ_i, γ_t, and ε_{it} constant firm-specific and time effects, and random errors, respectively.

Following Chirinko (1993), Ogawa et al. (1994, 2019), Qiu and Wan (2021a, b), and Wan and Qiu (2023), we derived a structural form of the adjustment cost model for Marginal q and Average q:

$$\frac{I_{it}}{K_{it-1}} = \tau + \frac{1}{a}(q_{it} - 1)P_{it}^{I} + \mu_i + \gamma_t + \varepsilon_{it}, \quad (6)$$

where:

a and τ are parameters of the quadratic adjustment cost function.

We used panel estimation methods with fixed effects and robust standard errors to analyze all observations in the dataset.

4 Empirical results

4.1 Depreciation rate

Figure 3 shows the median depreciation and interest rates as revealed by DEAI from 2002–2021. Wan and Qiu (2023) examined the impacts of different depreciation methods on the values of industry assets. We used the same methods and found that the PIM- and DEAI-estimated depreciation rates were identical (0.074). Although, in theory, the PIM data are richer than the DEAI data, the methods are equivalent under certain conditions [Wan and Qiu (2022)]. To eliminate the effects of fixed asset devaluation and up-valuation, we thus used the DEAI method; the average depreciation rate was 0.0980, close to that (0.092) of the construction industry [Wan and Qiu (2022)]; the 0.080 of the 36 Chinese industrial sectors [Wan and Qiu (2023)]; and the value (0.080) reported by Bond et al. (2003) for the Belgian, French, German, and UK industries (0.080). The average interest rate (0.042) is close to the average U.S. lending rate (0.045) for 2001–2021.[13]

4.2 Tobin's Average *q* and Marginal *q*

We calculated the before- and after-tax Marginal q and Average q for the 122 firms. Figure 4 shows the average investment rates versus the Marginal q and Average q. The before- and after-tax Marginal q and Average q values of the top 10 listed firms

13 Authors' projection based on World Bank data: https://data.worldbank.org/indicator/FR.INR.LEND?locations=US

in terms of asset size are shown in Table 1 and Figures 6–15, respectively. To reduce the effect of outliers, we used the medians as estimates of the before- and after-tax Marginal *q* and Average *q*; the values were 3.205 (before-tax Marginal *q*), 2.499 (after-tax Marginal *q*), and 1.541 (Average *q*), respectively, thus larger than the mean Average *q* and Marginal *q* of Japanese firms in 1970–1990 (1.590 and 1.163, respectively) [Ogawa (1999)] but close to that (3.846) of the after-tax Marginal *q* of the Japanese construction sector during the 1980s [Ogawa (1994)]. The average *q* is greater than that (0.808) of the United States from 1952–1976 [Furstenberg (1977)].[14] The Marginal *q* of the Chinese construction firms was somewhat greater than the Average *q* and clearly higher than the figures for the U.S. and Japan.

Wan (2021c) suggested that Tobin's Marginal *q* may also exceed Tobin's Average *q* when bubble profits are considered when choosing real estate investments. West (1987) argued that bubbles interfere with stock prices by linking present values to future dividends. Thus, bubbles in the Tobin's Marginal *q* and Average *q* may trigger overinvestment in the real estate sector.

4.3 Investment equations using Tobin's *q* theory

Figure 4 depicts the trends in investment rate versus the Marginal *q* and Average *q*. Figure 5 shows that the ratio of fixed to total assets of construction firms trended

[14] When deriving obtaining quarterly series, von Fustenberg et al. (1977) took the moving average of the Average *q* at the end of two consecutive quarters. In this article, we take the simple average for 1952–1976.

down since 2005, perhaps because firms reduced their fixed asset occupancy via leasing to increase liquidity (Qiu and Wan 2021b).

Table 3 shows the empirical results yielded by the reduced form of Equation (5) and the structured investment of Equation (6) that considers adjustment costs. Investment is significantly affected by the before-tax Margin *q*. These results support *Hypothesis 2,* suggesting that investment behavior can be explained by Tobin's Marginal *q* theory. This result is also consistent with data on the Chinese construction industry and real estate sectors reported by Wan and Qiu (2021a, b).

Table 4 shows the t-test comparisons of the differences between the after-tax Marginal *q* and Average *q*. These support *Hypothesis 1*; the Marginal *q* is significantly larger than the Average *q*. Qiu and Wan (2021b) found that an excessive Marginal q was common in the construction industry.

5. Conclusions and policy implications

We analyzed the investment behaviors of 122 listed Chinese construction firms from 2002 to 2021 based on Tobin's Marginal *q* and Average *q* theory, and found that overinvestment was in play. The estimated Marginal *q* was significantly higher than the estimated Average *q*, and the high Marginal *q* moved together with a low investment rate. These two (initially puzzling) facts are explained by indirect impacts of real estate bubbles on the construction industry. Furthermore, the response to investment of the Marginal *q* was more sensitive than that of the Average *q*, because the Marginal *q* contains more direct bubble profits attributable to housing oversupply. If construction firms profit from demand-pull in the real estate sector, the industry engages in overinvestment and acquires overcapacity.

We offer robust evidence of transmission of bubble effects from the real estate sector (Qiu and Wan 2021a; Huang and Wan 2022) to the construction sector (Qiu and Wan 2021b; Wan 2021a). To address overinvestment by the construction industry, we must first address overinvestment in the real estate sector. This stems from excessive saving; this enhances real estate bubbles as suggested by the speculative saving hypothesis of Wan (2015). Therefore, to reduce overinvestment and overcapacity in the construction and industrial sectors, the real estate market must be stabilized. Wan (2018a, 2021b) suggested that governments could achieve a soft landing by imposing a land appreciation or capital gains tax.

In future, we plan to explore the possible underestimation of fixed assets caused by the large rise in leasing and possible profit overestimation when multiple profit sources are in play. We will seek to improve the accuracy of the Marginal q. We will also use the micro data of non-listed firms to analyze the impact of real estate bubbles on housing-related industries.

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Table 1a: After-tax Marginal q, before-tax Marginal q and Average q of the top 10 construction firms

Year	**China State Construction Engineering Group Co., Ltd.**			**China Railway Engineering Group Limited**			**China Railway Construction Corporation Limited**			**China Communications Construction Co., Ltd.**			**Power Construction Corporation of China**		
	Average q	After-tax Marginal q	Before-tax Marginal q	Average q	After-tax Marginal q	Before-tax Marginal q	Average q	After-tax Marginal q	Before-tax Marginal q	Average q	After-tax Marginal q	Before-tax Marginal q	Average q	After-tax Marginal q	Before-tax Marginal q
2008				1.4239	0.6783	0.9143	1.8847	2.1308	2.6267						
2009	1.6939	7.9882	11.3410	1.5058	3.2172	3.7542	1.5524	3.2376	3.9954						
2010	1.3565	8.7491	11.6774	1.3075	2.6236	3.3231	1.3273	1.3666	1.9277						
2011	1.1941	8.0020	10.7695	1.1329	1.7214	2.2827	1.1537	1.7953	2.2904						
2012	1.2438	8.6344	11.4337	1.1241	1.7819	2.3491	1.1342	1.7502	2.2381	1.1756	1.9761	2.6234	1.1233	0.9276	1.1732
2013	1.0948	8.1753	10.8133	1.0686	2.1663	2.9049	1.0965	2.1654	2.7048	1.1009	1.8443	2.4414	1.2099	0.9999	1.2251
2014	1.2000	6.9639	9.0963	1.2290	2.1183	3.0383	1.2701	2.2333	2.8858	1.3955	2.1324	2.7211	1.3808	0.9704	1.2410
2015	1.1167	6.4000	8.4929	1.2060	2.1592	2.9874	1.2161	2.7408	3.5069	1.2348	2.5584	3.1464	1.5547	1.0352	1.3889
2016	1.2715	6.2288	7.8839	1.1318	2.1168	2.9450	1.1105	2.9366	3.7511	1.1767	2.5165	3.2476	1.2698	0.8455	1.0894
2017	1.0631	6.2558	8.0998	1.1478	2.2472	3.0921	1.0463	3.2177	4.0424	1.0622	3.1442	3.9162	1.1347	0.7727	1.0466
2018	1.0780	5.2491	6.8081	1.0428	2.5839	3.3656	1.0439	3.4451	4.3598	1.0620	3.7429	4.6938	1.1194	0.9154	1.1761
2019	0.9499	5.4963	7.0844	1.0148	3.4395	4.2464	1.0428	3.6436	4.5138	1.0122	3.6986	4.5700	0.9620	0.9948	1.2843
2020	0.8964	6.2812	8.3475	0.9623	3.7060	4.5402	0.9586	4.5751	5.6041	0.9494	3.7563	4.9407	0.8878	1.2553	1.5974
2021	0.8933	6.2108	8.0607	0.9546	4.1197	5.0819	0.8951	5.0017	5.9975	0.8727	4.7373	5.7954	0.9559	1.4275	1.7766
Avg.	1.1799	7.0353	9.3206	1.1767	2.3507	3.0572	1.2182	2.7106	3.4190	1.1299	2.8189	3.5889	1.1825	0.9685	1.2469

Source: Authors' estimations based on data from the balance sheets.

Table 1b: After-tax Marginal q , before-tax Marginal q and Average q of the top 10 construction firms (cont.)

Year	**Metallurgical Corporation of China Ltd.**			**Shanghai Construction Group Co., Ltd.**			**Shaanxi Construction Engineering Group Corporation Limited**			**China National Chemical Engineering Co., Ltd.**			**Jiangsu Zhongnan Construction Group Co., Ltd.**		
	Average q	After-tax Marginal q	Before-tax Marginal q	Average q	After-tax Marginal q	Before-tax Marginal q	Average q	After-tax Marginal q	Before-tax Marginal q	Average q	After-tax Marginal q	Before-tax Marginal q	Average q	After-tax Marginal q	Before-tax Marginal q
2009				1.5716	1.1402	1.4268	3.0943	9.5001	11.4045						
2010	1.3426	2.7295	3.7673	2.4022	3.9549	5.1050	3.2530	7.6372	9.5954	1.5618	5.3732	6.6872	1.8791	7.6128	10.0056
2011	1.1252	1.2244	2.0298	1.3646	2.5918	3.2435	1.9540	6.6122	7.8632	1.6941	5.7770	7.1057	1.5127	8.6622	12.2600
2012	0.9535	-3.0296	-2.3008	1.2890	2.2707	2.8479	1.8695	3.3099	3.8556	1.7633	6.4212	7.7033	1.6582	4.1833	6.2364
2013	0.9235	0.6733	1.1587	1.1928	2.2685	2.9454	1.6118	3.3715	4.1869	1.4964	5.5529	6.7341	1.3270	5.2293	7.8772
2014	1.1288	0.9711	1.4999	1.4263	2.4053	3.1110	1.7844	3.9188	4.6246	1.4380	5.3080	6.3464	1.3424	3.3043	5.1962
2015	1.1892	1.2214	1.7630	1.3708	2.4678	3.2387	1.6875	2.3070	2.8675	1.0795	3.1467	3.8337	1.1992	1.0797	1.5370
2016	1.1154	1.5378	1.9701	1.2823	2.1732	3.0472	1.5648	1.7279	2.0591	1.0776	1.8237	2.2546	1.4506	0.8841	1.4107
2017	1.1061	1.7978	2.4039	1.1381	2.4498	3.2372	1.3174	4.4185	5.1746	1.0755	1.7020	2.4243	1.5553	1.5330	2.6252
2018	0.9665	2.0538	2.5838	1.0608	2.7753	3.5246	1.2611	4.2792	5.0788	1.0110	1.9005	2.5293	1.3538	3.7015	4.8817
2019	0.9105	2.0982	2.7089	1.1700	3.1412	4.1401	1.1443	4.0800	4.8280	1.1342	2.7834	3.3101	1.2872	5.7612	7.6712
2020	0.9217	2.9660	3.7673	1.1826	2.5294	3.4646	21.2991	12.2658	14.6434	1.0723	3.8089	4.5045	1.1861	10.2339	13.7912
2021	0.9310	4.1667	5.0301	1.0401	3.1116	4.0609	1.2300	10.9308	12.7236	1.4610	4.4362	5.3559	0.9493	-3.7496	-3.1477
Avg.	1.0621	1.2949	1.9411	1.3709	2.5140	3.2777	3.5224	4.9026	5.8888	1.3094	3.8224	4.6746	1.3377	3.9659	5.6238

Source: Authors' estimations based on data from the balance sheets.

Table 2: Summary statistics of the 122 listed construction firms

Variable	Obs	Median	Mean	Std. Dev.	Min	Max
After-tax Marginal $q_{(t)}$	1353	2.4989	4.0510	8.6719	-44.5124	47.7282
Before-tax Marginal $q_{(t)}$	1353	3.2049	5.2223	9.7780	-44.8468	47.8536
Average $q_{(t)}$	1369	1.5413	2.3865	3.4342	0.6804	48.2903
[After-tax Marginal $q_{(t)}$ - 1]*Price Index for Investment in Fixed Assets	1353	1.4989	3.0510	8.6719	-45.5124	46.7282
[Before-tax Marginal $q_{(t)}$ - 1]*Price Index for Investment in Fixed Assets	1353	2.2040	4.1838	9.8764	-44.8468	46.8536
[Average $q_{(t)}$ - 1]*Price Index for Investment in Fixed Assets	1369	0.5413	1.3865	3.4342	-0.3196	47.2903
Investment in Fixed Assets$_{(t)}$/ Net Value of Fixed Assets $_{(t-1)}$	1371	0.2088	0.4438	0.7085	0.0000	6.9436
After-tax Profit on Fixed Assets $_{(t)}$ / Net Value of Fixed Assets$_{(t-1)}$	1372	0.2857	0.4315	1.3259	-12.7705	10.7804
Before-tax Profit on Fixed Assets $_{(t)}$ / Net Value of Fixed Assets$_{(t-1)}$	1373	0.3678	0.5682	1.5767	-14.8715	16.7690
Year	2440	2011	2011.5	5.7675	2002	2021

Source: Authors' estimations based on data from the balance sheets.

Table 3a: Determinants of investments in the 122 listed construction firms (reduced form and adjustment cost model)

(Panel estimation with fixed effect and robust standard errors (FE))

Independent Variables	Dependent variable = Investment in Fixed Assets $_{(t)}$ / Net Value of Fixed Assets $_{(t-1)}$			
Average $q_{(t)}$	0.018 ***	0.0203 ***		
	(0.0058)	(0.0064)		
[Average $q_{(t)}$ - 1]*Price Index for Investment in Fixed Assets			0.018 ***	0.0203 ***
			(0.0058)	(0.0064)
Constant	43.4175 ***	0.6495 **	43.4356 ***	0.6697 **
	(13.2028)	(0.2705)	(13.2039)	(0.2699)
Year	-0.0214 ***		-0.0214 ***	
	(0.0066)		(0.0066)	
Year 2002 (Dropped)				
Year 2003		-0.1018		-0.1018
		(0.1877)		(0.1877)
Year 2004		-0.1244		-0.1244
		(0.3035)		(0.3035)
Year 2005		-0.0119		-0.0119
		(0.3327)		(0.3327)
Year 2006		-0.1816		-0.1816
		(0.2961)		(0.2961)
Year 2007		0.0265		0.0265
		(0.3021)		(0.3021)
Year 2008		0.0466		0.0466
		(0.2996)		(0.2996)
Year 2009		0.0099		0.0099
		(0.2994)		(0.2994)
Year 2010		-0.1334		-0.1334
		(0.2702)		(0.2702)
Year 2011		-0.1993		-0.1993
		(0.2721)		(0.2721)
Year 2012		-0.2226		-0.2226
		(0.2736)		(0.2736)
Year 2013		-0.3024		-0.3024
		(0.2749)		(0.2749)
Year 2014		-0.2961		-0.2961
		(0.2714)		(0.2714)
Year 2015		-0.4255		-0.4255
		(0.2763)		(0.2763)
Year 2016		-0.3397		-0.3397
		(0.2829)		(0.2829)
Year 2017		-0.2665		-0.2665
		(0.2828)		(0.2828)
Year 2018		-0.2302		-0.2302
		(0.2817)		(0.2817)
Year 2019		-0.3620		-0.3620
		(0.2807)		(0.2807)
Year 2020		-0.3620		-0.3620
		(0.2838)		(0.2838)
Year 2021		-0.3691		-0.3691
		(0.2828)		(0.2828)
Observations	1,366	1,366	1,366	1,366
R-squared	0.0263	0.0421	0.0263	0.0421
Number of firms	122	122	122	122

Note: Robust standard errors in parentheses (FE), *** p<0.01, ** p<0.05, * p<0.1.

Table 3b: Determinants of investments in the 122 listed construction firms (reduced form and adjustment cost model)

(Panel estimation with fixed effect and robust standard errors (FE))

Independent Variables	Dependent variable = Investment in Fixed Assets $_{(t)}$ / Net Value of Fixed Assets $_{(t-1)}$			
After-tax Marginal $q_{(t)}$	0.0233 ***	0.0244 ***		
	(0.0044)	(0.0045)		
[After-tax Marginal $q_{(t)}$ - 1]*Price Index for Investment in Fixed Assets			0.0233 ***	0.0244 ***
			(0.0044)	(0.0045)
Constant	37.1287 ***	0.5969 **	37.152 ***	0.6213 **
	(12.1157)	(0.2593)	(12.1159)	(0.2591)
Year	-0.0183 ***		-0.0183 ***	
	(0.0060)		(0.0060)	
Year 2002 (Dropped)				
Year 2003		-0.0741		-0.0741
		(0.1890)		(0.1890)
Year 2004		-0.0810		-0.0810
		(0.2890)		(0.2890)
Year 2005		0.0036		0.0036
		(0.3206)		(0.3206)
Year 2006		-0.1522		-0.1522
		(0.2866)		(0.2866)
Year 2007		0.0382		0.0382
		(0.2887)		(0.2887)
Year 2008		0.0319		0.0319
		(0.2917)		(0.2917)
Year 2009		-0.1034		-0.1034
		(0.2652)		(0.2652)
Year 2010		-0.1383		-0.1383
		(0.2564)		(0.2564)
Year 2011		-0.2131		-0.2131
		(0.2634)		(0.2634)
Year 2012		-0.2347		-0.2347
		(0.2647)		(0.2647)
Year 2013		-0.3374		-0.3374
		(0.2621)		(0.2621)
Year 2014		-0.3053		-0.3053
		(0.2587)		(0.2587)
Year 2015		-0.4292		-0.4292
		(0.2646)		(0.2646)
Year 2016		-0.3443		-0.3443
		(0.2690)		(0.2690)
Year 2017		-0.3163		-0.3163
		(0.2707)		(0.2707)
Year 2018		-0.2639		-0.2639
		(0.2703)		(0.2703)
Year 2019		-0.3519		-0.3519
		(0.2700)		(0.2700)
Year 2020		-0.3320		-0.3320
		(0.2718)		(0.2718)
Year 2021		-0.2551		-0.2551
		(0.2703)		(0.2703)
Observations	1,355	1,355	1,355	1,355
R-squared	0.1091	0.1276	0.1091	0.1276
Number of firms	122	122	122	122

Note: Robust standard errors in parentheses (FE), *** p<0.01, ** p<0.05, * p<0.1.

Table 3c: Determinants of investments in the 122 listed construction firms (reduced form and adjustment cost model)

(Panel estimation with fixed effect and robust standard errors (FE))

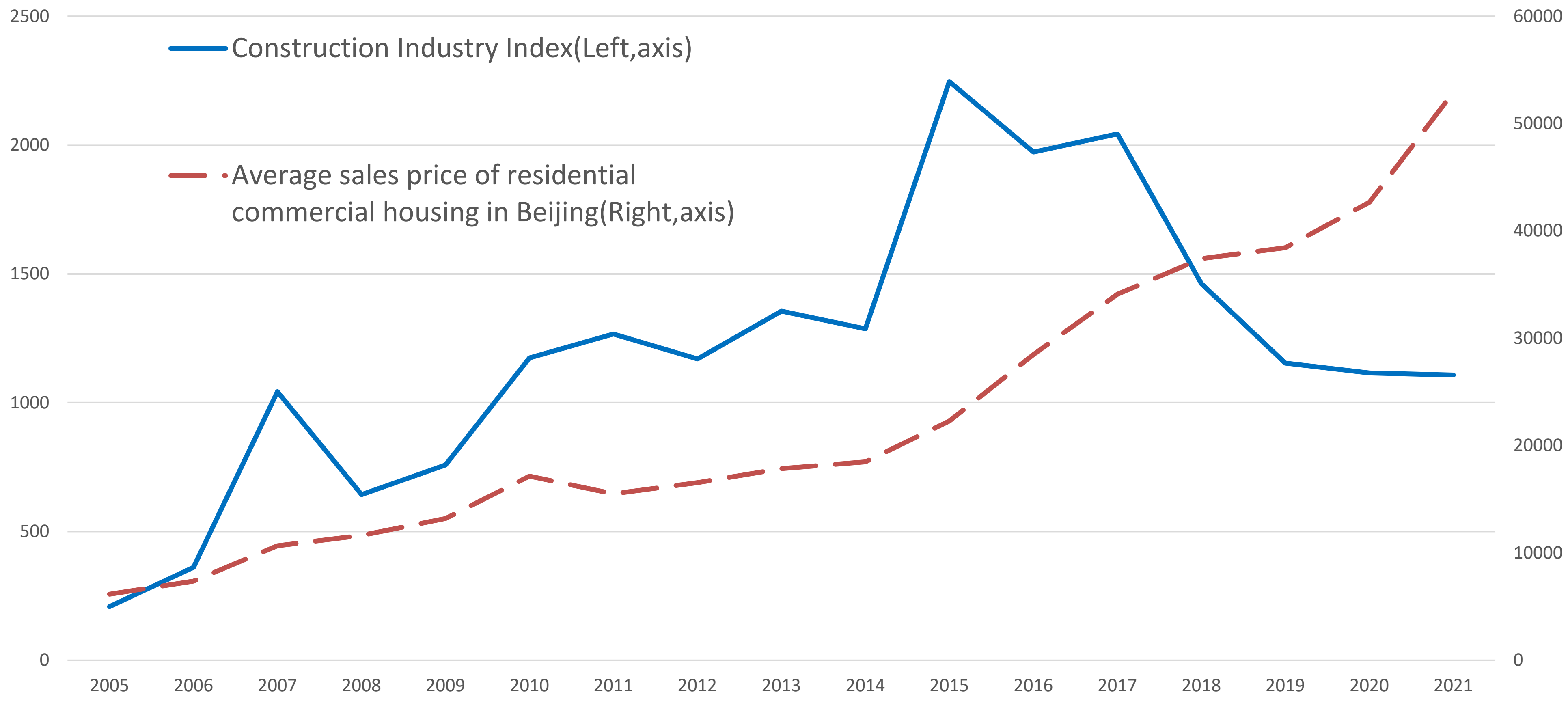
Independent Variables	Dependent variable = Investment in Fixed Assets $_{(t)}$ / Net Value of Fixed Assets $_{(t-1)}$			
Before-tax Marginal $q_{(t)}$	0.0235 ***	0.0247 ***		
	(0.0041)	(0.0041)		
[Before-tax Marginal $q_{(t)}$ - 1]*Price Index for Investment in Fixed Assets			0.0232 ***	0.0243 ***
			(0.0040)	(0.0040)
Constant	37.0102 ***	0.5715 **	36.9932 ***	0.5981 **
	(11.9899)	(0.2580)	(11.9923)	(0.2579)
Year	-0.0182 ***		-0.0182 ***	
	(0.0060)		(0.0060)	
Year 2002 (Dropped)				
Year 2003		-0.0654		-0.0659
		(0.1883)		(0.1882)
Year 2004		-0.0781		-0.0789
		(0.2868)		(0.2870)
Year 2005		0.0012		0.0008
		(0.3177)		(0.3179)
Year 2006		-0.1500		-0.1505
		(0.2855)		(0.2857)
Year 2007		0.0223		0.0228
		(0.2842)		(0.2845)
Year 2008		0.0603		0.0600
		(0.2894)		(0.2896)
Year 2009		-0.1053		-0.1053
		(0.2642)		(0.2643)
Year 2010		-0.1485		-0.1479
		(0.2552)		(0.2553)
Year 2011		-0.2176		-0.2172
		(0.2617)		(0.2618)
Year 2012		-0.2465		-0.2459
		(0.2633)		(0.2635)
Year 2013		-0.3502		-0.3494
		(0.2608)		(0.2610)
Year 2014		-0.3150		-0.3145
		(0.2573)		(0.2574)
Year 2015		-0.4220		-0.4216
		(0.2628)		(0.2630)
Year 2016		-0.3596		-0.3589
		(0.2672)		(0.2674)
Year 2017		-0.3314		-0.3305
		(0.2695)		(0.2696)
Year 2018		-0.2648		-0.2660
		(0.2687)		(0.2689)
Year 2019		-0.3560		-0.3576
		(0.2686)		(0.2687)
Year 2020		-0.3251		-0.3276
		(0.2703)		(0.2705)
Year 2021		-0.2564		-0.2522
		(0.2689)		(0.2691)
Observations	1,351	1,351	1,352	1,352
R-squared	0.1312	0.1509	0.1306	0.1503
Number of firms	122	122	122	122

Note: Robust standard errors in parentheses (FE), *** p<0.01, ** p<0.05, * p<0.1.

Table 4 : T test for the difference between after-tax Marginal *q* and Average *q*

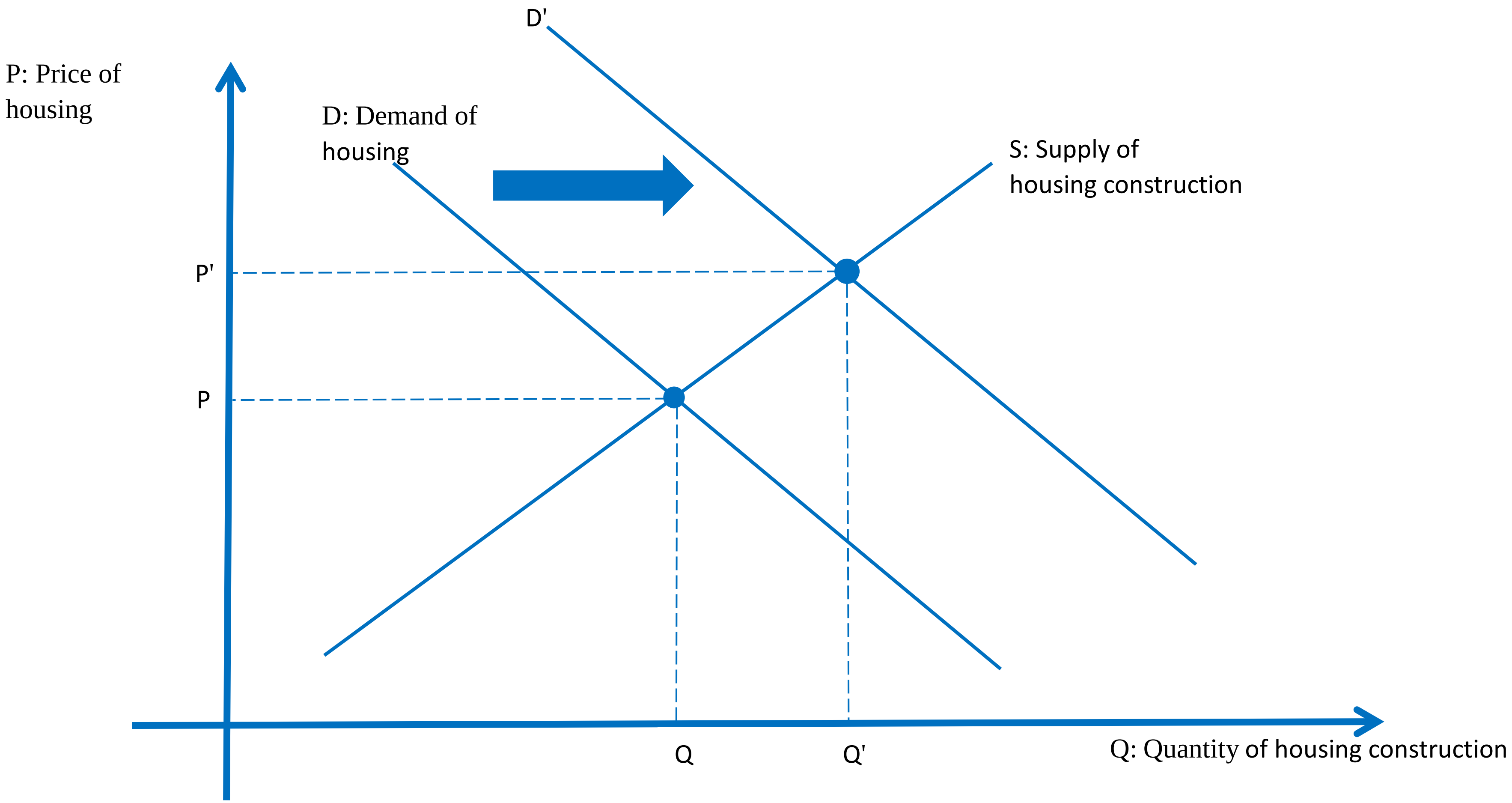
mean (diff) = mean (Marginal *q* - Average *q*)		t = 6.9905
H_0: mean (diff) = 0		degrees of freedom = 1352
H_a: mean (diff) < 0	H_a: mean (diff) ! = 0	Ha: mean (diff) > 0
Pr (T < t) = 1.0000	Pr (| T | > | t |) = 0.0000	Pr (T > t) = 0.0000

Figure 1: Housing prices (unit: Yuan/m^2) and construction industry share prices (base year:1991=100) by year



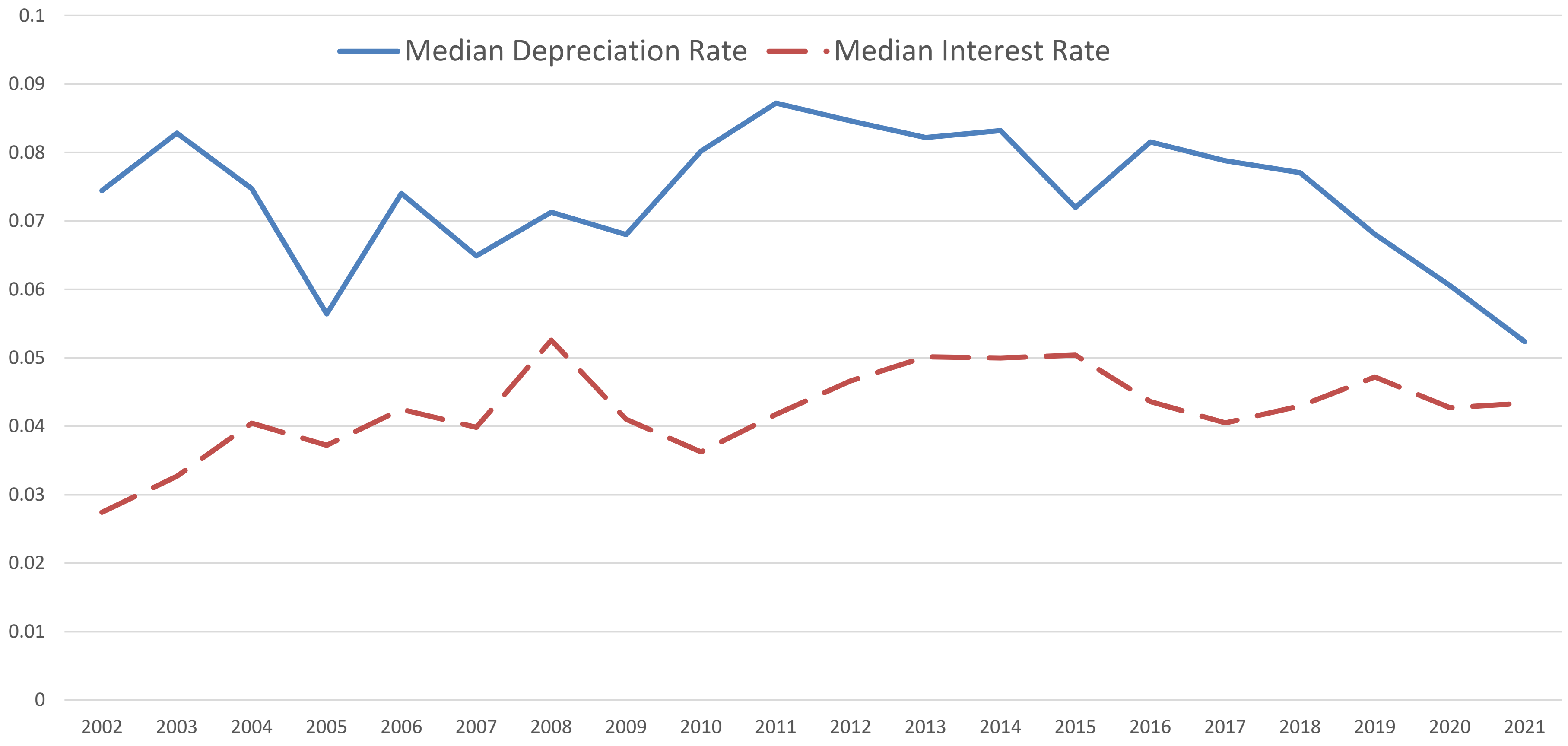
Source: China National Bureau of Statistics and Shenzhen Stock Exchange (Construction Commodity Selection Index)

Figure 2: Demand and supply of housing construction market



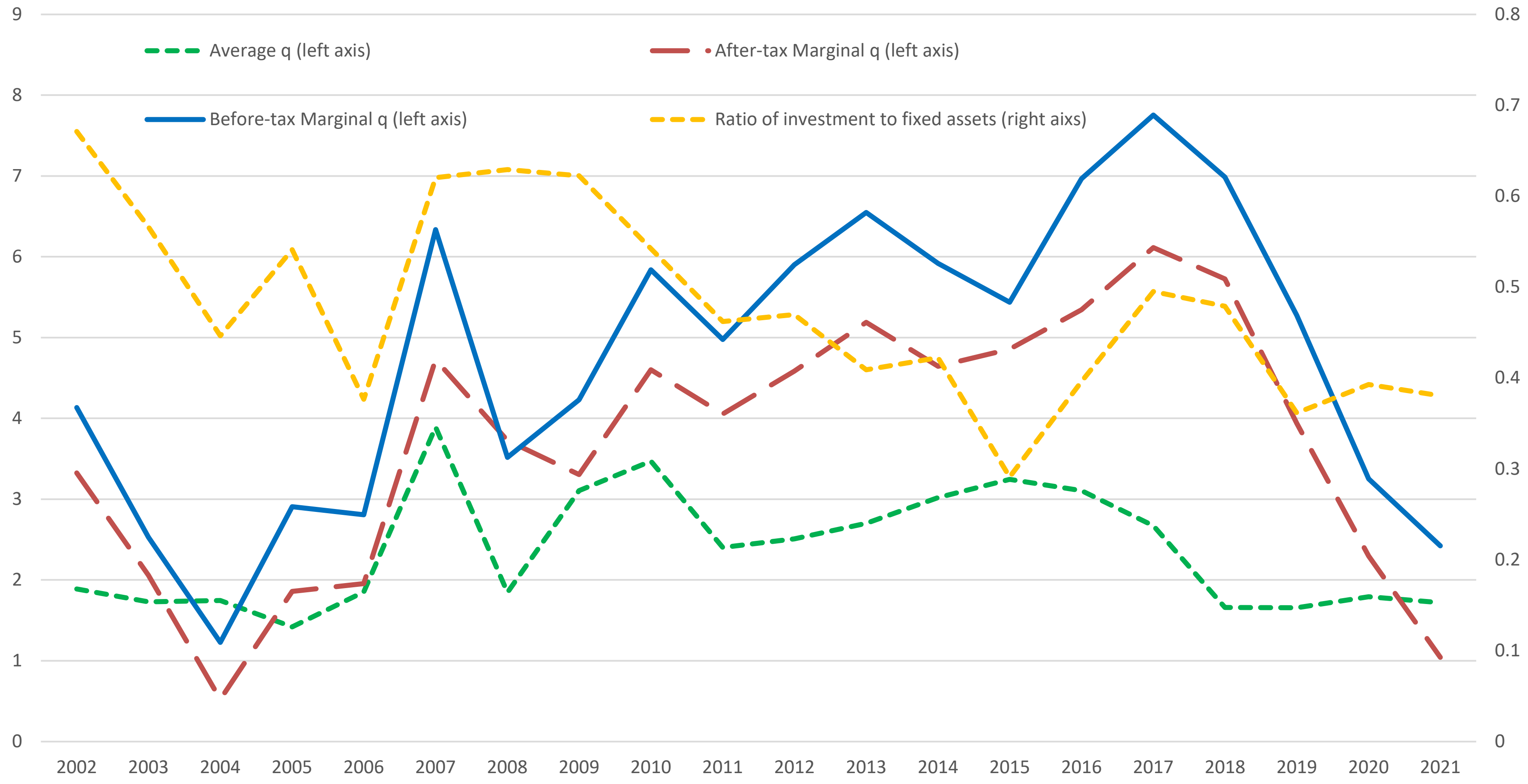
Source: Drawn by the authors.

Figure 3: Median value of depreciation rate and interest rate of the 122 listed construction firms by year



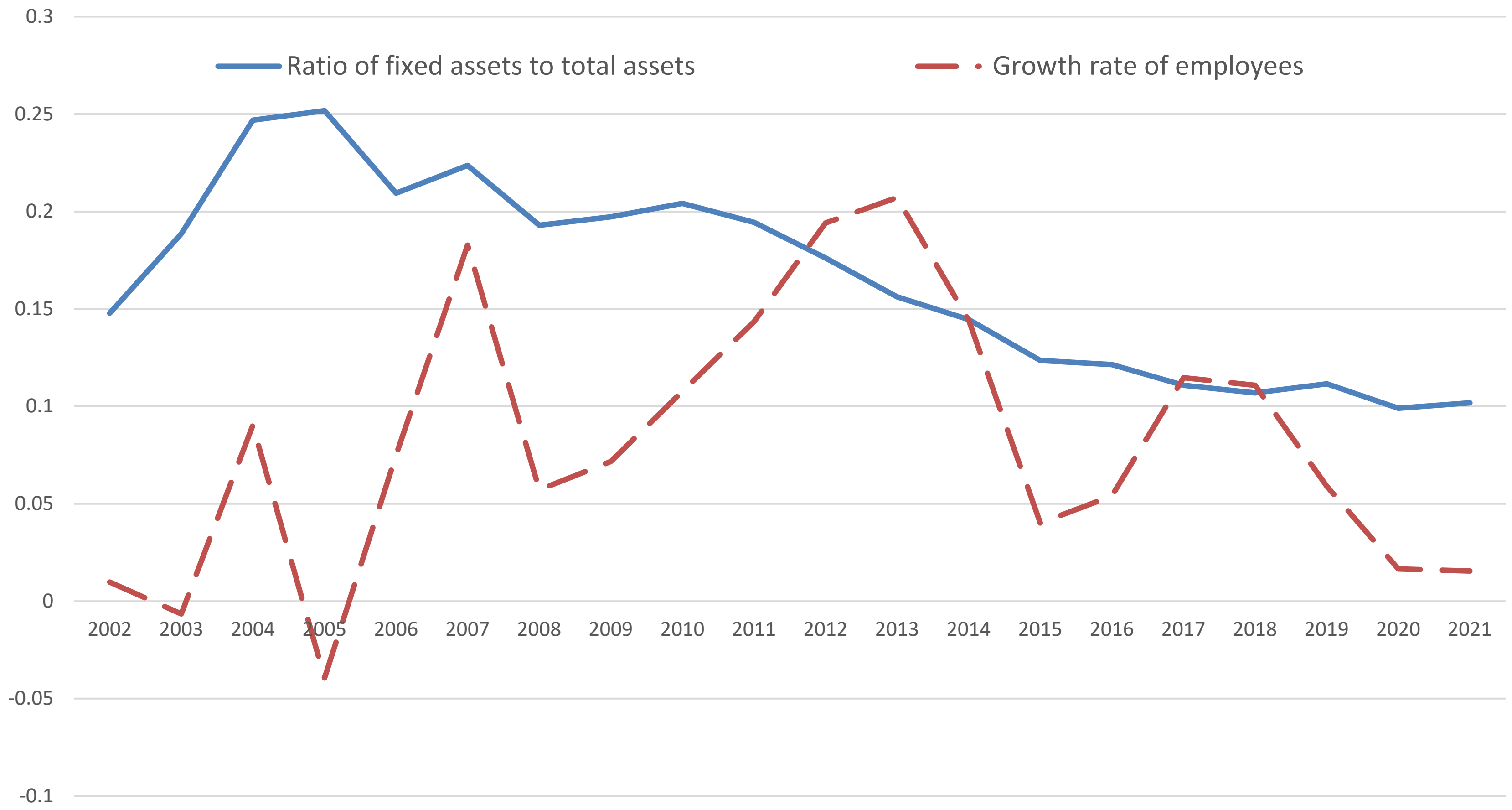
Source: Authors' estimations based on data from the balance sheets.

Figure 4: Average value of Marginal *q*, Average *q* and ratio of investment to fixed assets of the 122 listed construction firms by year



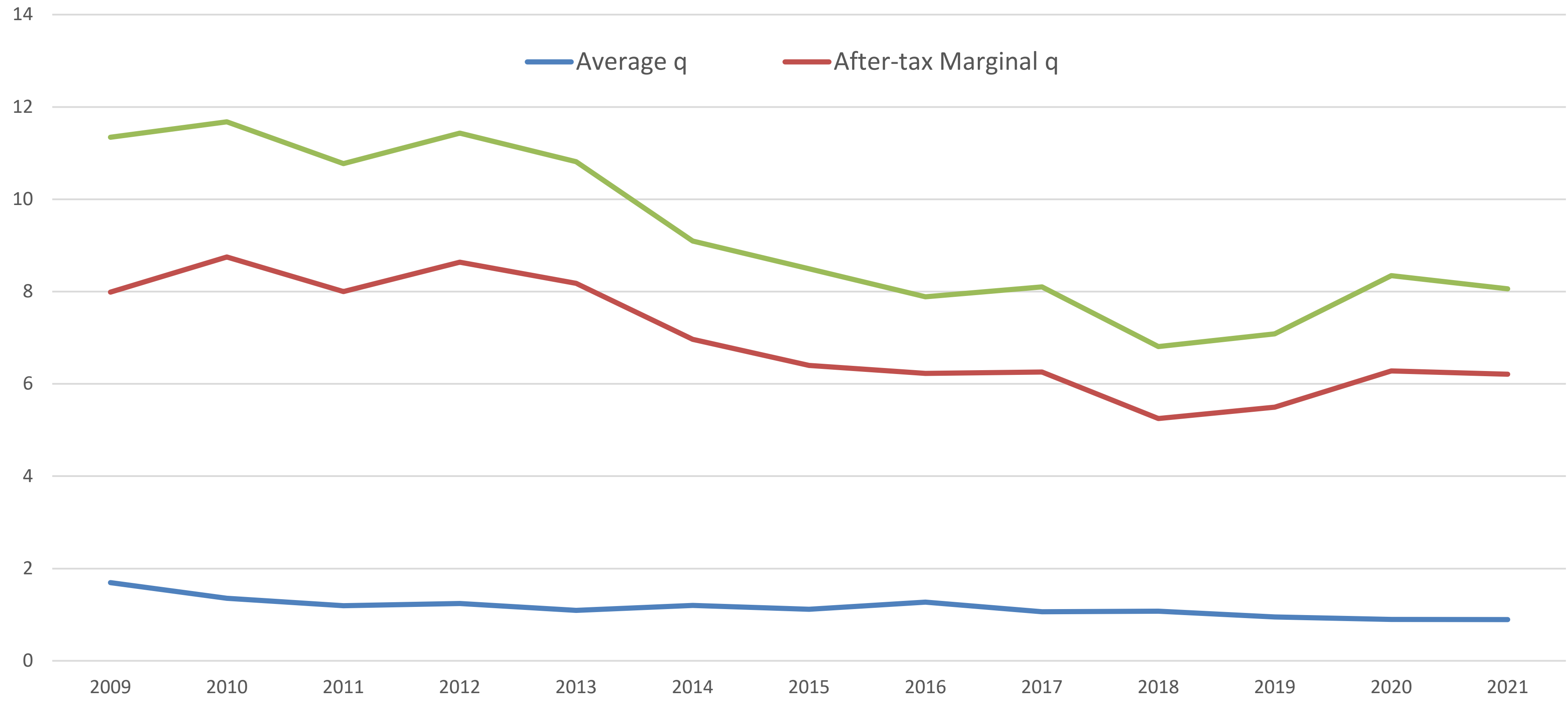
Source: Authors' estimations based on data from the balance sheets.

Figure 5: Average value of growth rates of employees and ratio of fixed assets to total assets by year



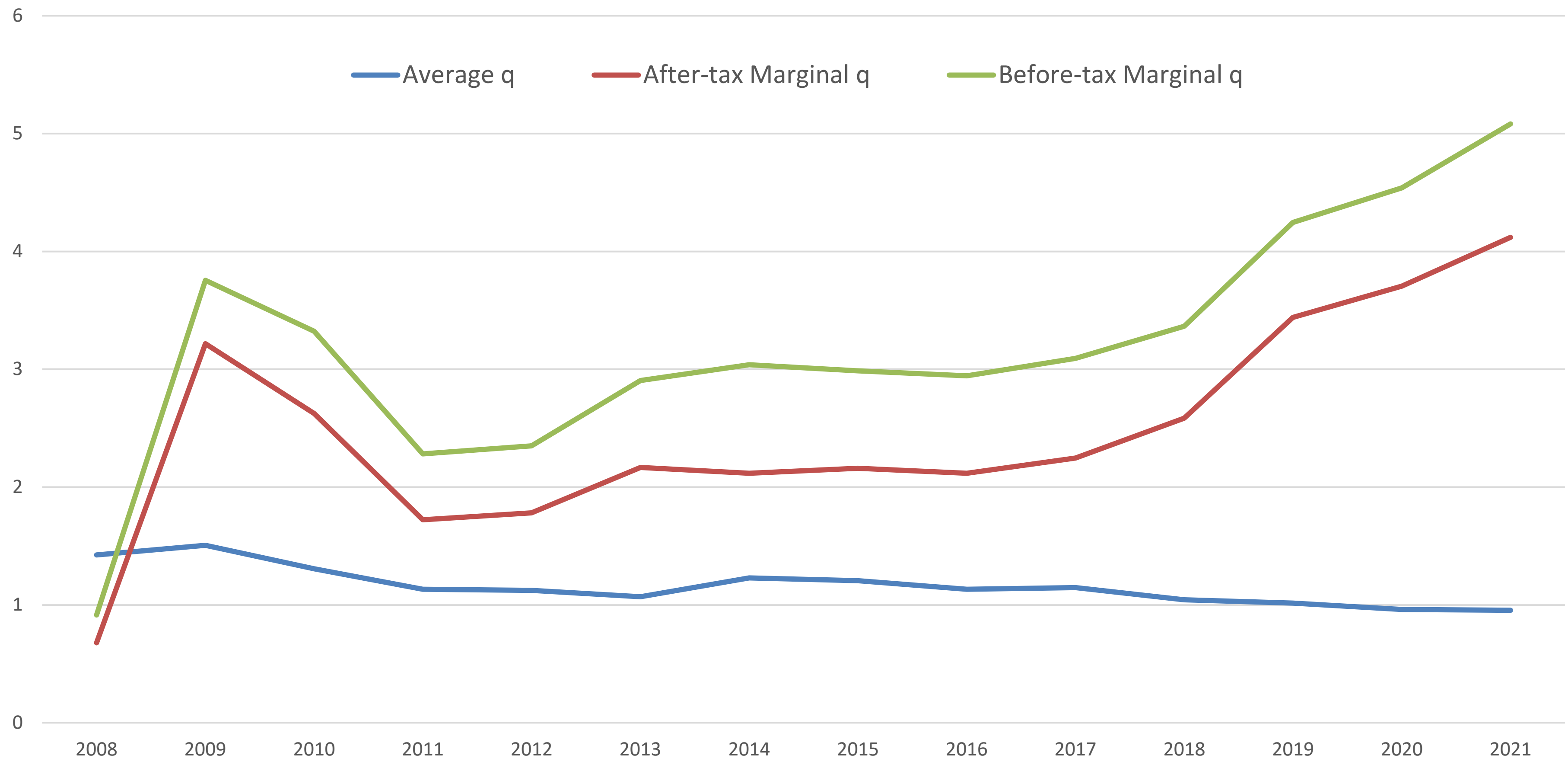
Source: Authors' estimations based on data from the balance sheets.

Figure 6: After-tax Marginal *q*, before-tax Marginal *q* and Average *q* of China State Construction Engineering Group Co., Ltd. for the period 2009-2021



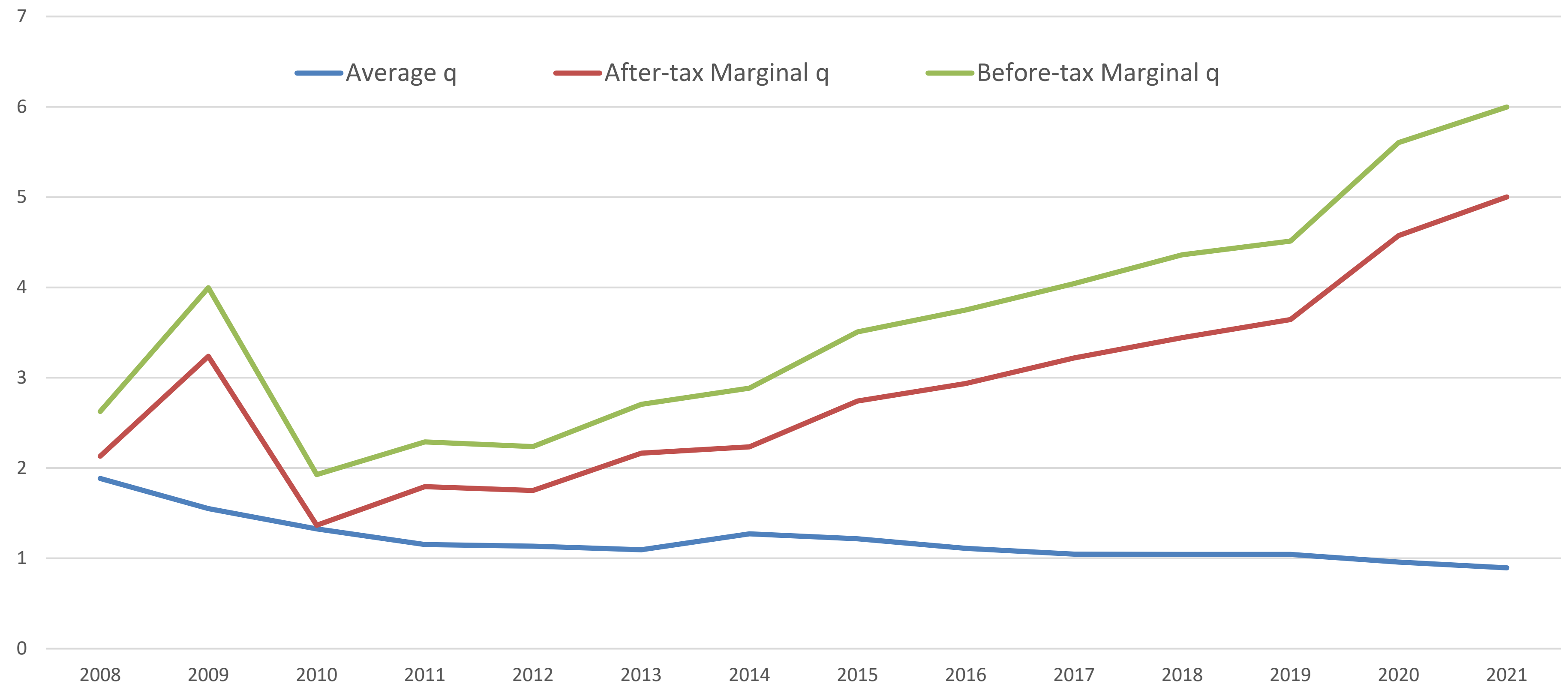
Source: Authors' estimations based on data from the balance sheets.

Figure 7: After-tax Marginal *q*, before-tax Marginal *q* and Average *q* of China Railway Engineering Group Limited for the period 2008-2021



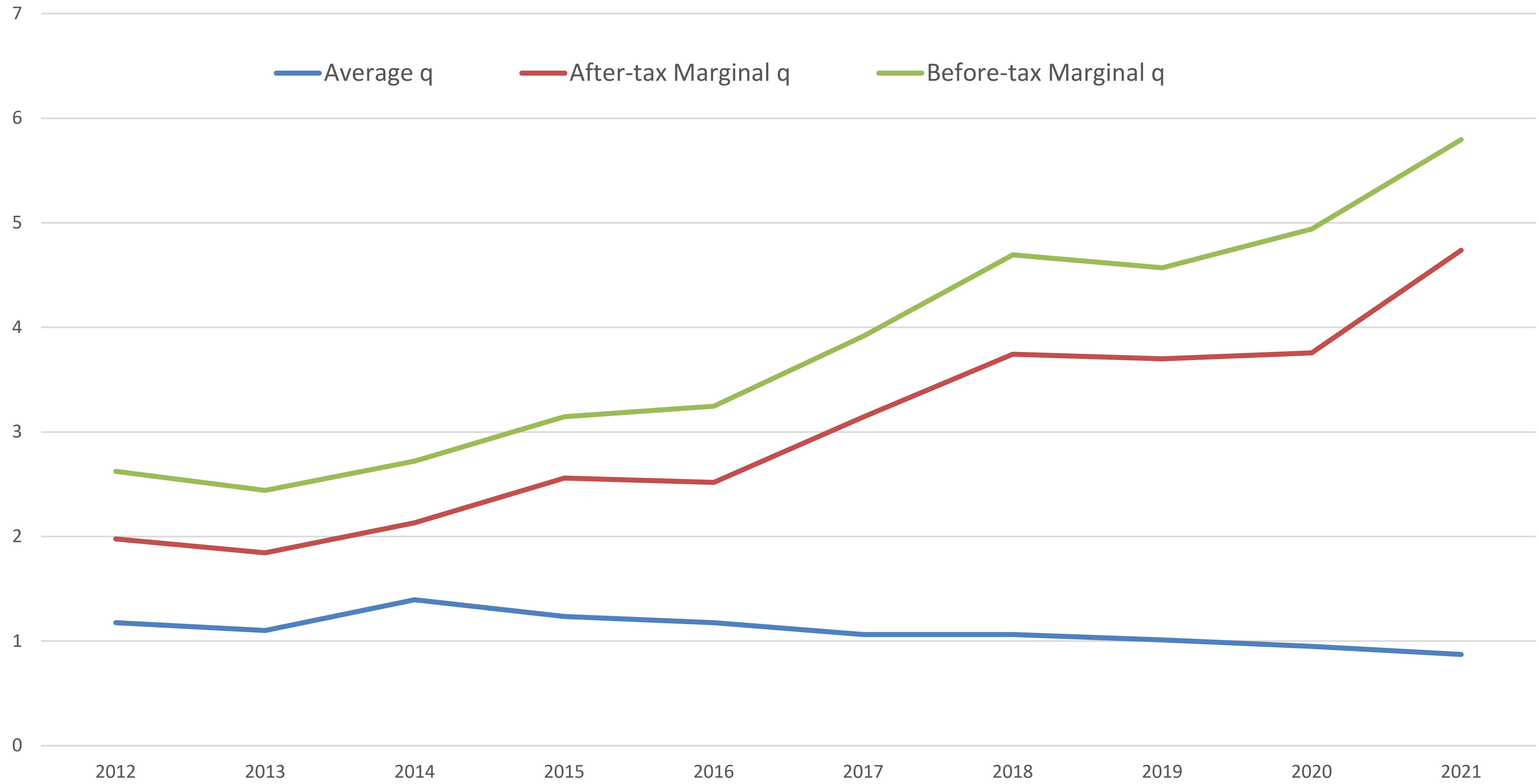
Source: Authors' estimations based on data from the balance sheets.

Figure 8: After-tax Marginal *q*, before-tax Marginal *q* and Average *q* of China Railway Construction Corporation Limited for the period 2008-2021



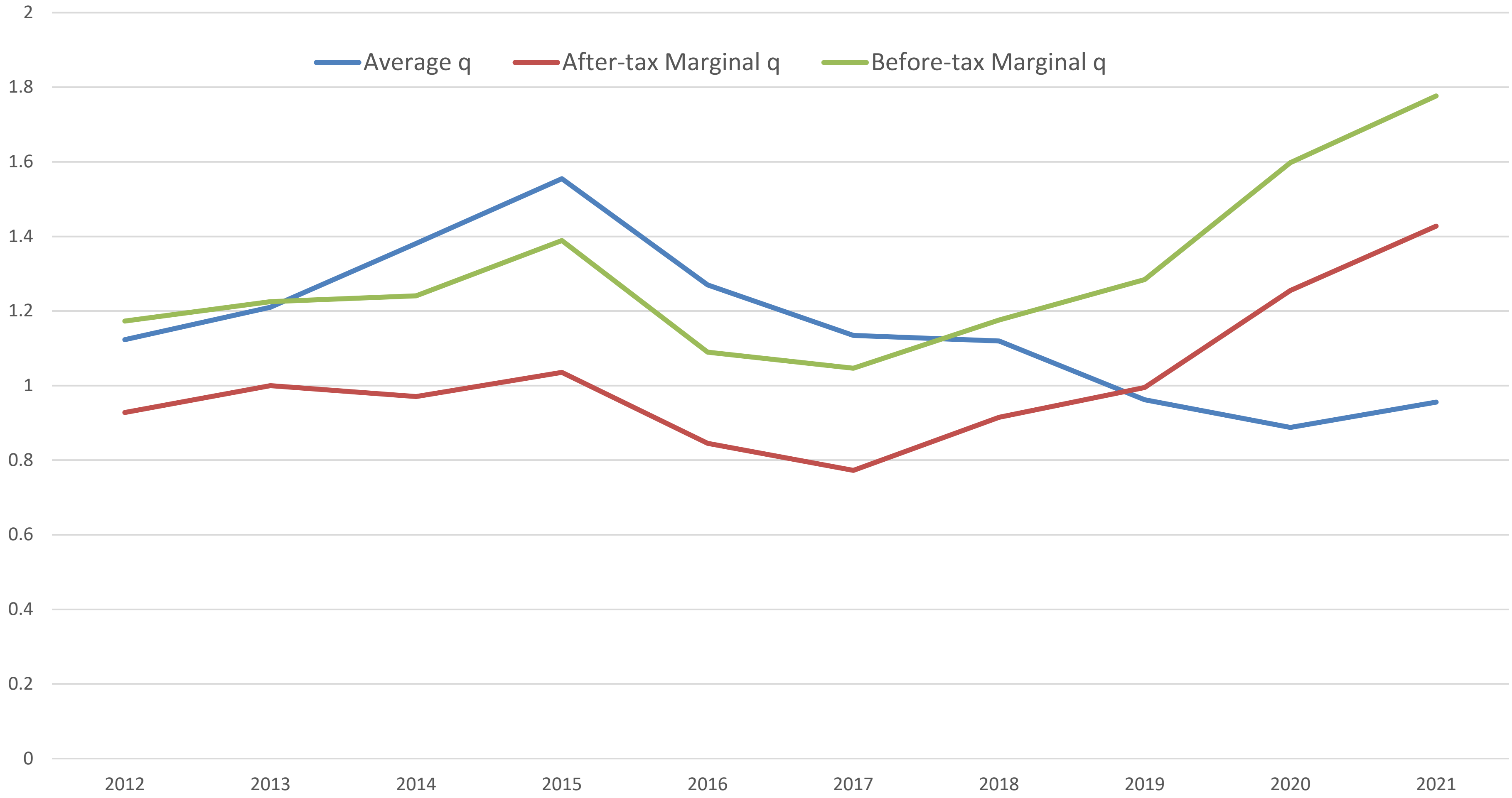
Source: Authors' estimations based on data from the balance sheets.

Figure 9: After-tax Marginal *q*, before-tax Marginal *q* and Average *q* of China Communications Construction Co., Ltd. for the period 2012-2021



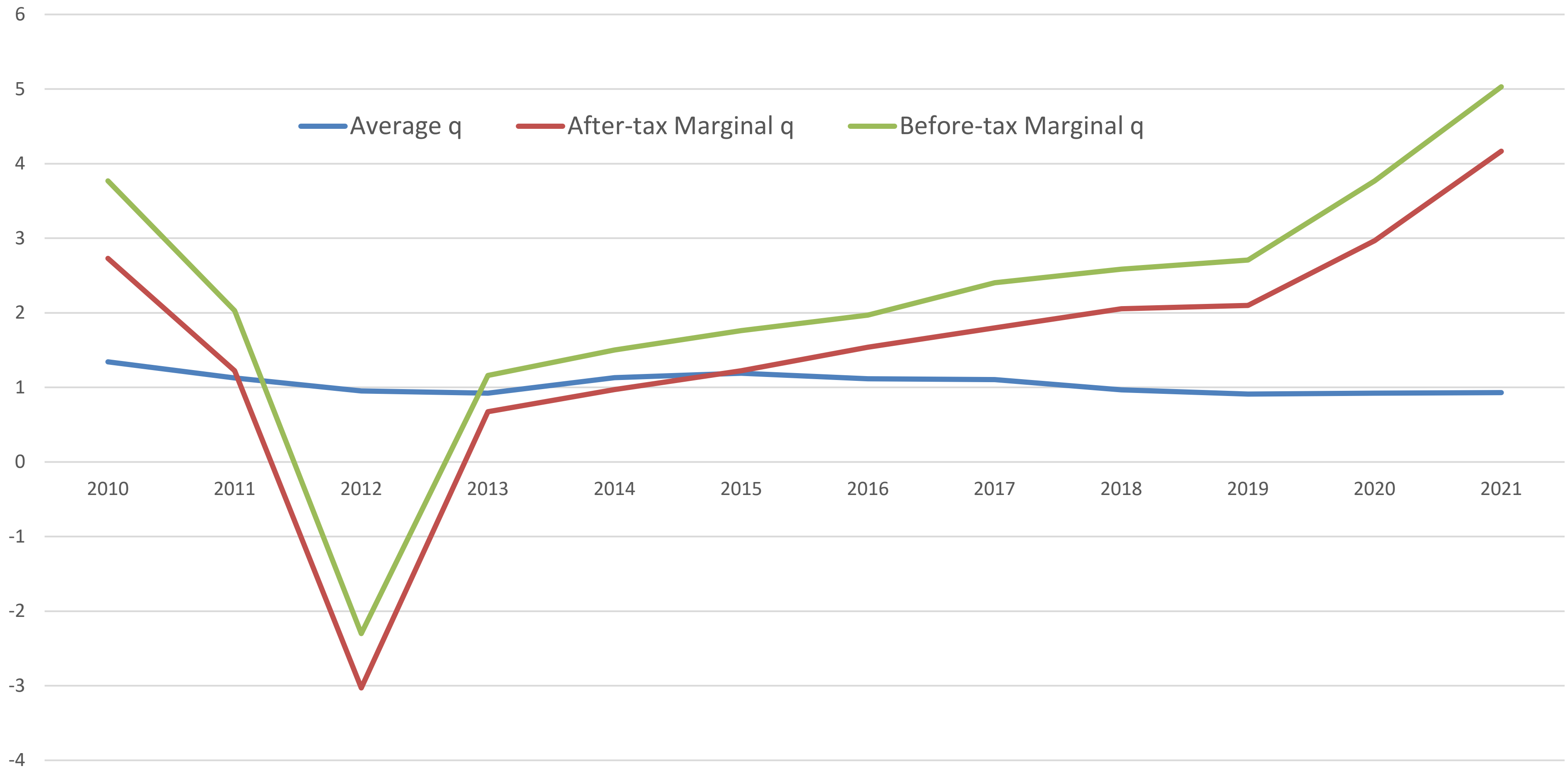
Source: Authors' estimations based on data from the balance sheets.

Figure 10: After-tax Marginal *q*, before-tax Marginal *q* and Average *q* of Power Construction Corporation of China for the period 2012-2021



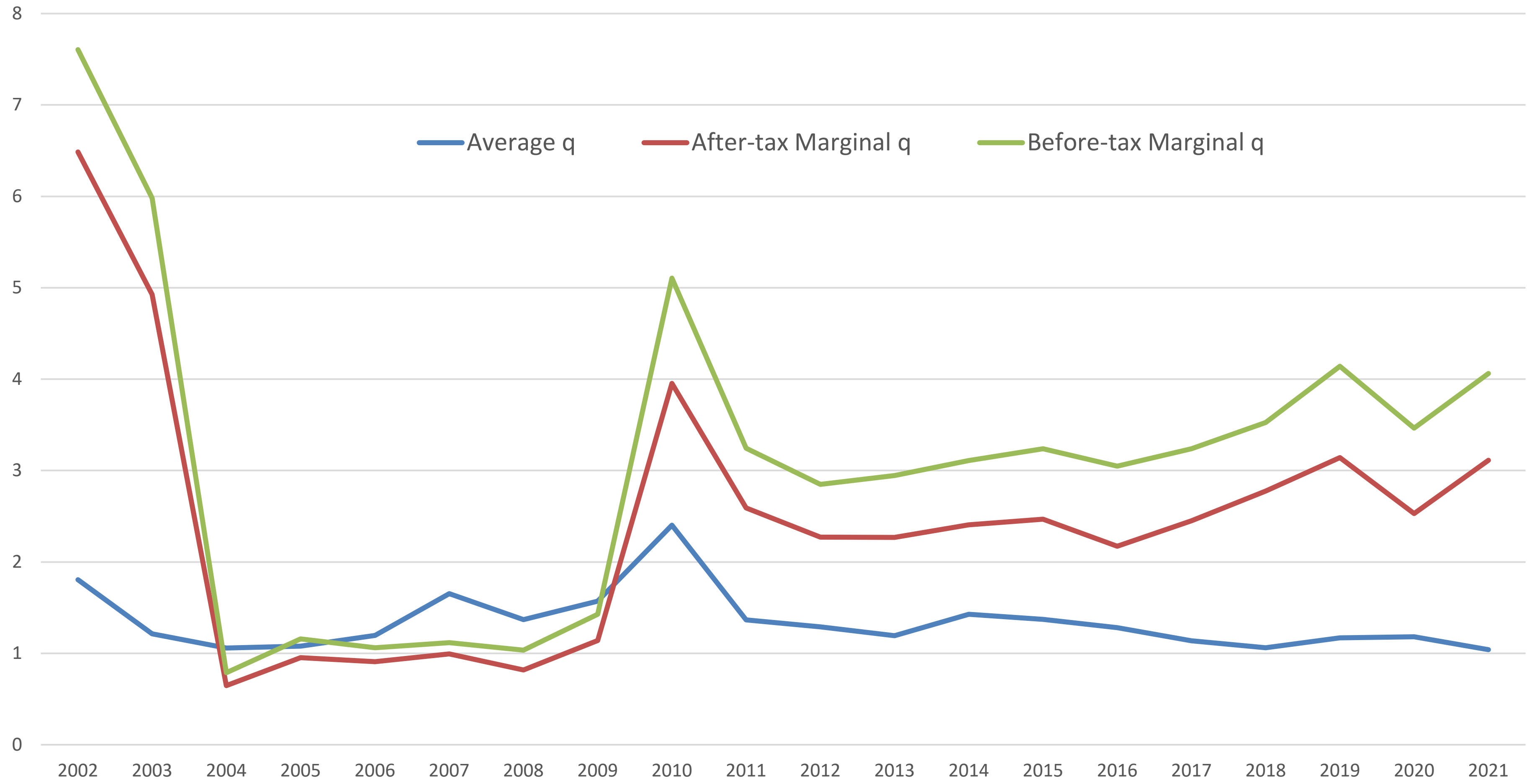
Source: Authors' estimations based on data from the balance sheets.

Figure 11: After-tax Marginal *q*, before-tax Marginal *q* and Average *q* of Metallurgical Corporation of China Ltd. for the period 2010-2021



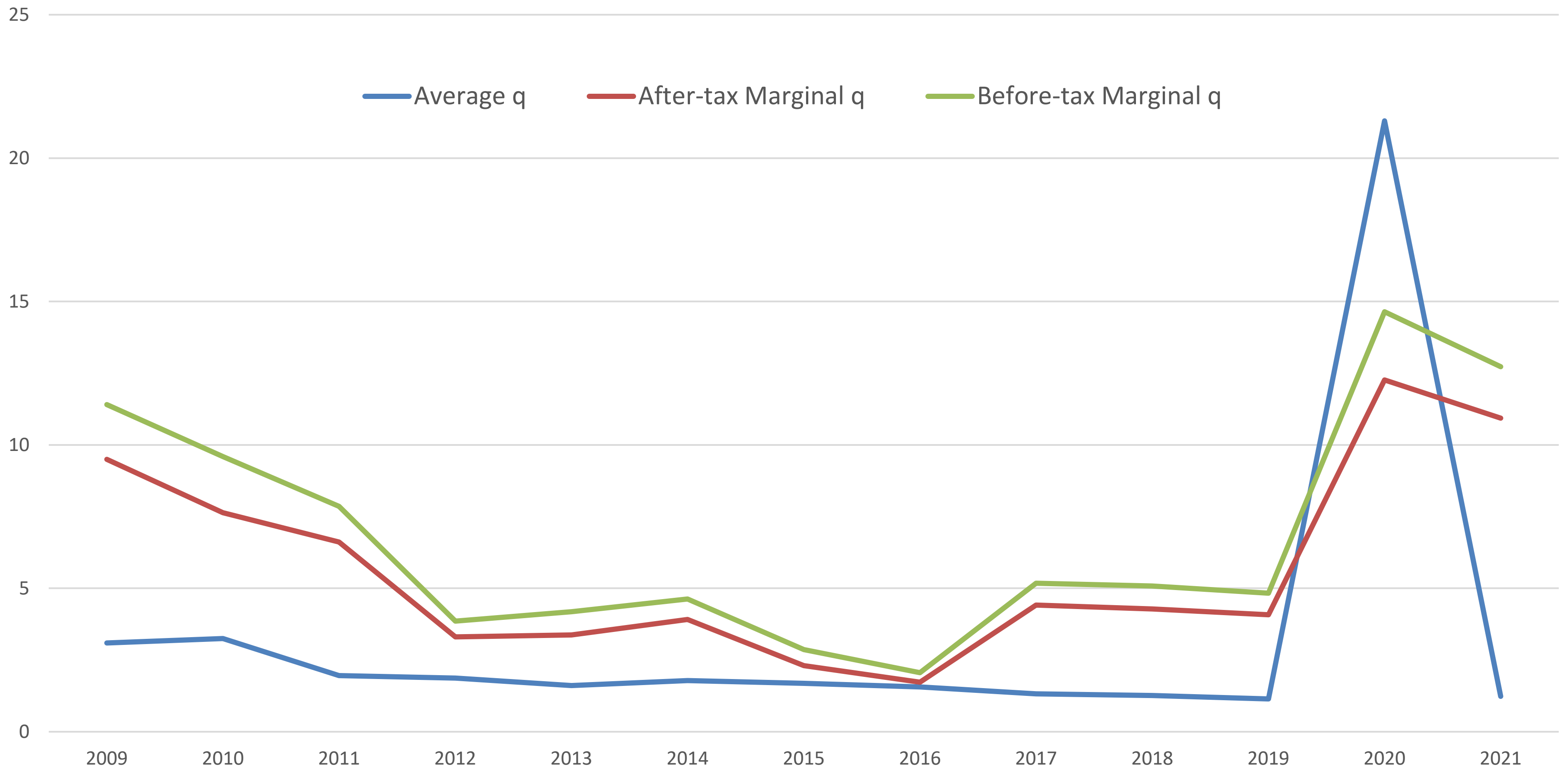
Source: Authors' estimations based on data from the balance sheets.

Figure 12: After-tax Marginal *q*, before-tax Marginal *q* and Average *q* of Shanghai Construction Group Co., Ltd. for the period 2002-2021



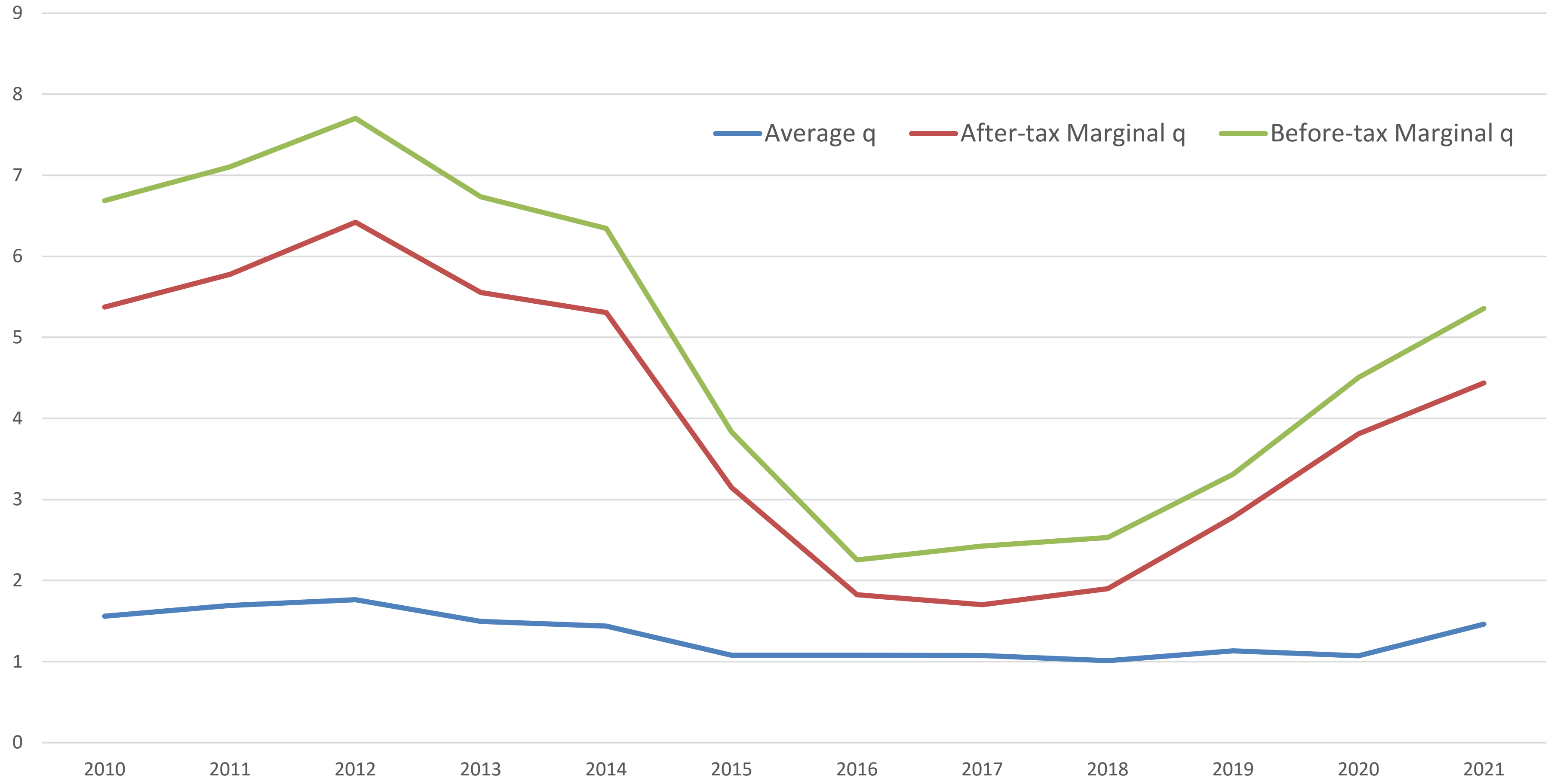
Source: Authors' estimations based on data from the balance sheets.

Figure 13: After-tax Marginal *q*, before-tax Marginal *q* and Average *q* of Shaanxi Construction Engineering Group Corporation Limited for the period 2009-2021



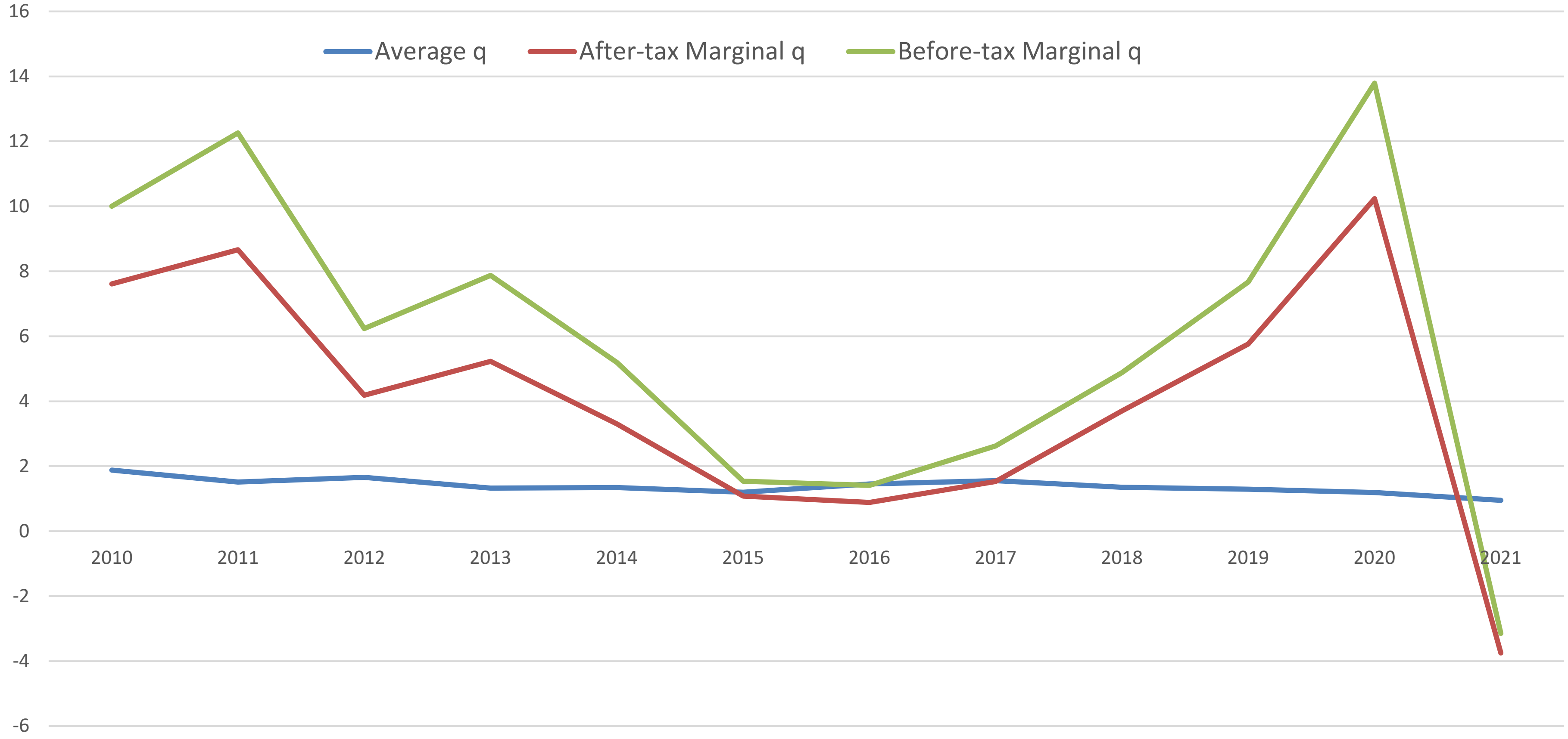
Source: Authors' estimations based on data from the balance sheet.

Figure 14: After-tax Marginal *q*, before-tax Marginal *q* and Average *q* of China National Chemical Engineering Co., Ltd. for the period 2010-2021



Source: Authors' estimations based on data from the balance sheet.

Figure 15: After-tax Marginal *q*, before-tax Marginal *q* and Average *q* of Jiangsu Zhongnan Construction Group Co., Ltd. for the period 2010-2021



Source: Authors' estimations based on data from the balance sheet.