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Highlights

1 We show that triple bubbles of a single firm can occur when a listed firm has a tradable asset, a tradable share, and a tradable corporate bond in the different asset markets with a sufficient number of risk-neutral speculative investors.

2 When the bubble profits are considered in the decision of real investment, Tobin's Marginal q could exceed Tobin's Average q, even with linear production technology, and short sale constraints enlarge this imbalance.

3 Tobin's Marginal q and Average q with bubbles are likely to induce overinvestment in the real sector; hence, prevention of bubbles by imposing taxes or introducing short sales in the three asset markets could reduce overinvestment.

Abstract

Here, we attempt to show theoretically why there can be triple bubbles in a listed single firm. A firm like China Evergrande Group has a tradable asset (e.g., housing), a tradable share, and a tradable corporate bond. If there are a sufficient number of risk-neutral speculative investors in the three aforementioned asset markets, then three rational bubbles with different default risks occur as these markets attempt to achieve the different bubble premiums. Consequently, when the bubble profits are considered in the decision of real investment, Tobin's Marginal q could exceed Tobin's Average q, even with linear production technology. Furthermore, short sale constraints enlarge the imbalance of Tobin's Marginal q and Average q, with overinvestment as a likely outcome. Hence, prevention of the bubble formations through taxation or the introduction of short sales in the three asset markets could reduce overinvestment in real sector.

JEL classification: G12, D21

Keywords: Bubble premium, Overinvestment, Rational bubble, Tobin's Average q, Tobin's Marginal q

1 Introduction

As reported by Qiu and Wan (2021a), the stock price and the bond price of the China Evergrande Group crashed in Shanghai, Hong Kong, and New York financial markets under the ongoing housing price bubble in mainland China (Wan 2015, 2018b). Moreover, Qiu and Wan (2021a) reported that Tobin's Marginal q was significantly higher than Tobin's Average q for the listed residential firms, and that overinvestments of these firms were significantly oriented by the bubbly q. Overinvestment in the housing sector has caused overinvestments in housing-related sectors, such as construction (Qiu and Wan 2021b) and materials (Wan and Qiu 2020) and under-investments in other sectors (Wan 2021b); this has resulted in a higher number of non-performing loans in China's banking sectors (Wan 2018b, 2021d). Consequently, China's economy has suffered recession in the real sector and instability in the financial sector, and the correspondent policies are emergent (Wan 2021a). However, little is known as to why there are so many bubbles in asset and debt markets and why overinvestments in real sectors are induced by bubbles in the financial markets. In this paper, we explore several explanations based on the bubble theory according to Wan (2018a, 2021c) and the q theory proposed by Tobin (1969).

Despite the extensive literature on the financial markets (e.g., Merton 1973, Shiller 1981, Tirole 1982, Abreu and Brunnermeier 2003, Fama 2014, Martin et al.

2021), corporate finance (Miller and Modigliani 1961), and real investments (Jorgenson 1963, Abel 1980), questions remain as to how financial bubbles are theoretically linked with real investment. As an exception, Chirinko and Schaller (2001) used the positive difference between Tobin's Average q and Tobin's Marginal q of listed firms in Japan as a bubble (≡ Tobin's Average q −Tobin's Marginal q) to estimate the overinvesments of these firms by assuming a no-bubble scenario for Tobin's Marginal q. This assumption would not be supported by both theory and the real economy, because Tobin's Marginal q could include a rational bubble.

Here we provide a theoretical explaination as to why Tobin's Marginal q could be higher than Tobin's Average q; hence, their difference cannot capture the exact size of a bubble in the market. We also show that there are triple bubbles for a single firm, and further show that Tobin's Marginal q could be higher than Tobin's Average q, even with linear production technology. The key points used to obtain these theoretical results is that there are a sufficient number of risk-neutral investors and that bubble premiums caused by the default risks of bubbles are introduced into the triple markets. Bubble profits in Tobin's Marginal and Average q are likely to induce overinvestments in real sectors. Hence, efforts to reduce or exclude these bubbles in the triple markets could take the form of imposed taxes, as argued by Stiglitz (1989) and Wan (2018a,

2021c), or the introduction of short sales to reduce overinvestments in real sectors.

This paper is organized as follows. Section 2 presents a theoretical framework to show that there are triple bubbles of a single firm. Section 3 theoretically shows that Tobin's Marginal q could be higher than Tobin's Average q, even with linear production technology under the triple bubbles of a single firm, and Section 4 summarizes our findings and potential policy implications, as well as issues from both theoretical and empirical sides left for future research.

2 The Model

2.1 Rational Bubbles

2.1.1 Bubble in the Asset Price

In an asset market in the framework of Blanchard (1979) and Blanchard and Watson (1982), we assume that there are many risk-neutral investors who freely choose to invest in a risk-free or risky asset. A risk asset such as housing (A in Figure 1) depreciates at a positive constant rate δ whereas it produces profit (e.g., rent) at a constant rate α (≥ 0) over time. For a positive and constant risk-free rate r, the discounted value (F_A) of the profit sequence of asset A for the infinite horizon is as follows:

$$F_A = \frac{\alpha}{r+\delta} A, and \;\; f_A = \frac{F_A}{A} = \frac{\alpha}{r+\delta}. \quad (1)$$

Following *Assumption 1* in Wan (2021c), we assume that the bubble premium, γ_A, is strictly positive over zero time. The bubble premium over strictly zero time γ_A is attributable to trading; there is no default or crash if there is no trade. Under an intra-temporal (or inter-investor) no-arbitrage condition, the following equation should be satisfied when the market is in equilibrium and the investor is a sequential trader:

$$1 = \frac{E_n[p_{n+1}]}{p_n} - \gamma_A E_n\left[\frac{p_n - f_A}{p_n}\right], \quad (2)$$

where E_n is the expectation operator of the *n-th* investor. When the asset is sold to the *m-th* investor, we obtain

$$p_n = f_A + \lim_{m\to\infty} E_n\left[\frac{p_{n+m}}{(1+\gamma_A)^m}\right], \quad (3)$$

for $1 \leq m < \infty$.

Hence, at equilibrium under the no-arbitrage condition, the price of asset *A* under rational expectations will have a rational bubble b_A ($\equiv \lim_{m\to\infty} E_n\left[\frac{p_{n+m}}{(1+\gamma_A)^m}\right] > 0$):

$$p_A = f_A + b_A. \quad (4)$$

2.1.2 Bubble in the Share Price

Assume that the manager of the firm issues new shares (*S>0*) in the stock market to make a new real investment in *A*, as shown in Figure 1. The manager puts rent

plus a portion ($0 < \beta < \frac{S+B}{S}$) of b_A as dividends to stock investors. Using a similar mechanism on the asset side, the fundamental value of a new share is given by

$$f_S = \frac{\alpha}{r+\delta} + \beta b_A, \tag{5}$$

and the market price (p_S) of the new share (S) will form a new rational bubble ($b_S > 0$ with strictly positive bubble premium γ_S) via turnover. Then the price is expressed as

$$p_S = f_S + b_S = \left(\frac{\alpha}{r+\delta} + \beta b_A\right) + b_S = \frac{\alpha}{r+\delta} + (\beta b_A + b_S). \tag{6}$$

Note here that $0 < \beta < \frac{S+B}{S}$ is from $b_A A = b_A(S+B) = b_A S + b_A B$. The manager of the firm can allocate total volume of bubble profit from the asset side ($b_A A$) to share or bond investors as follows:

$$\beta b_A S + \left[1 - (\beta - 1)\frac{S}{B}\right] b_A B = b_A S + b_A B = b_A A. \tag{7}$$

2.1.3 Bubble in the Bond Price

Also assume that the manager of the firm issues a new bond ($B>0$) in the bond market to make a new real investment in A, as shown in Figure 1. The manager puts rent plus a portion ($0 < \beta' \equiv 1 - (\beta - 1)\frac{S}{B} < \frac{S+B}{B}$) of b_A as dividends to a bond investor. Under a similar mechanism on the asset side, the fundamental value of the new bond is as follows:

$$f_B = \frac{\alpha}{r+\delta} + \beta' b_A, \tag{8}$$

and the market price (p_B) of the new bond (B) will form a new rational bubble ($b_B > 0$ with strictly positive bubble premium γ_B) by turnover. Then the price is given by

$$p_B = f_B + b_B = \left(\frac{\alpha}{r+\delta} + \beta' b_A\right) + b_B = \frac{\alpha}{r+\delta} + (\beta' b_A + b_B). \quad (9)$$

2.2 Triple Bubbles of a Single Firm

Because the assets, shares, and bonds of a firm are traded in different asset markets, different rational bubbles can form among the investor groups and bubble premiums from different default risks, thus leading to our first theorem.

Theorem 1:

Under no-arbitrage conditions and rational expectations, a listed firm can potentially create triple rational bubbles in asset, share, and bond markets, respectively.

Proof:

Equations (1)–(9) prove Theorem 1. ***Q.E.D.***

If some new investors have different beliefs and they can short sell the share

or bond for a sufficient price with sufficient volume, the bubbles in the share and bond markets would be likely to crash. Consequently, short sale constraints on the asset side would be likely to postpone the crash of a bubble (Xiong 2013). In the case of the China Evergrande Group, short sale constraint exists in the housing market (asset side of the firm), but does not exist in the share and bond markets. Hence, a bubble component on the asset side could persist longer and be larger than those of share and bond markets.

3 Tobin's Marginal *q* and Average *q* with Triple Bubbles

If there are no bubbles in the three markets, Tobin's Marginal *q* should be equal to Tobin's Average *q* under the assumption of a linear production function (Hayashi 1982). We know there are different institutions and different investors in housing, share, and bond markets; therefore, there are different rational bubbles with different bubble premiums in these markets following ***Theorem 1.*** This leads us to the second theorem.

Theorem 2:

Tobin's Marginal *q* can be equal to, lower than, or higher than Tobin's Average *q* depending on the sizes of rational bubbles on both the asset side and liability side of a

listed firm with a linear production technology.

Proof:

Without bubbles in the three asset markets, by Eqs. (1), (4), and (6) we have

$$\text{Tobin's Marginal } q = \frac{\partial F_A}{\partial A} = \frac{\alpha}{r+\delta}, \tag{10}$$

$$\text{Tobin's Average } q = \frac{p_S * S}{S} = \frac{\alpha}{r+\delta}, \tag{11}$$

such that Tobin's Marginal q = Tobin's Average $q = \frac{\alpha}{r+\delta}$. This result is the same as those of Hayashi (1982) and Wan (2019).

When bubbles exist in one, two, or all of the three markets,

$$\text{Tobin's Marginal } q = \frac{\partial F_A}{\partial A} = p_A = f_A + b_A = \frac{\alpha}{r+\delta} + b_A, \tag{12}$$

$$\text{Tobin's Average } q = \frac{p_S * S}{S} = p_S = \frac{\alpha}{r+\delta} + (\beta b_A + b_S). \tag{13}$$

Thus, Tobin's Marginal $q \lesseqgtr$ Tobin's Average q

$$\textit{iff } b_A \lesseqgtr \beta b_A + b_S. \tag{14}$$

In the special case with $b_S = 0$ caused by short sale or other policy tools,

Tobin's Marginal q > Tobin's Average q,

$$b_A > \beta b_A \quad \text{for} \quad 0 < \beta < 1. \tag{15}$$

Q.E.D

Qiu and Wan (2021a) determined that Tobin's Marginal q was significantly higher than Tobin's Average q for the listed residential firms in China, such as the China Evergrande Group. This fact is well explained by ***Theorem 2*** using the framework of rational bubbles.

4 Conclusions and policy implications

We developed a model to show the triple bubbles of a listed single firm. The triple bubble scenario occurs because the firm has tradable assets, tradable shares, and corporate bonds, and these assets and debts are turned over by a sufficient number of risk-neutral speculative investors and bubble premiums. When the bubble profits by producing new assets or by issuing new shares, and bonds are considered in the decision of a real investment of a firm, Tobin's Marginal q could potentially be higher than Tobin's Average q, even with linear production technology; under this scenario, short sale constraints would enlarge this imbalance. Moreover, bubble profit is likely to induce overinvestment; thus, prevention of bubble formations via taxes or the introduction of a short sale in the three asset markets could reduce overinvestment in real sector.

The issue left for future research is the introduction of a time horizon to the

analytical model. Additionally, the transition of a real investment before bubble occurrence, during the bubble period, and after the bubble crash should be analyzed explicitly. Furthermore, more detailed empirical studies based on listed firms in China, Japan, the U.S. and the other developing or developed countries are necessary to test the theoretical predictions in this paper.

5 References

Abel, Andrew B (1980) Empirical Investment Functions: An Integrative Framework. *Carnegie Conference Series on Public Policy*, Vol. 12, pp. 39-91.

Abreu, Dilip, and Markus Brunnermeier (2003) Bubbles and Crashes. *Econometrica*, Vol. 71, pp. 173–204.

Blanchard, Olivier Jean (1979) Speculative Bubbles, Crashes and Rational Expectations. *Economic Letters*, Vol. 3, pp. 387-389.

Blanchard, Olivier Jean, and Mark W. Watson (1982) Bubbles, Rational Expectations and Financial Markets. *NBER Working Paper Series*, No. 945.

Chirinko, Robert S. and Huntley Schaller (2001) Business Fixed Investment and Bubbles: The Japanese Case. *American Economic Review*, Vol. 91, pp. 663-679.

Fama, Eugene F. (2014) Two Pillars of Asset Pricing. *American Economic Review*, Vol. 104, pp. 1467-1485.

Hayashi, Fumio (1982) Tobin's Marginal *q* and Average *q*: A Neoclassical Interpretation. *Econometrica*, Vol. 50(1), pp. 213-224.

Jorgenson, Dale W. (1963) Capital Theory and Investment Behavior. *American Economic Review*, Vol. 53, pp. 247-259.

Martin, Alberto, Enrique Moral-Benito, and Tom Schmitz (2021) The Financial Transmission of Housing Booms: Evidence from Spain. *American Economic Review*, Vol. 111(3), pp. 1013-1153.

Merton, Robert C. (1973) An Intertemporal Capital Asset Pricing Model. *Econometrica*, Vol. 41, pp.867-887.

Miller, Merton H., and Franco Modigliani (1961) Dividend Policy, Growth, and the Valuation of Shares. *The Journal of Business*, Vol. 34(4), pp. 411-433.

Qiu, Qiqi and Junmin Wan (2021a) Residential Investments and Housing Prices in China. *CAES Working Paper Series*, WP-2021-012, Center for Advanced Economic Study, Fukuoka University, September 30, pp.1-54. http://www.econ.fukuoka-u.ac.jp/researchcenter/workingpapers/WP-2021-012.pdf

Qiu, Qiqi and Junmin Wan (2021b) Construction Investments and Housing Prices in China. *CAES Working Paper Series*, WP-2021-013, Center for Advanced Economic Study, Fukuoka University, October 1, pp.1-34. http://www.econ.fukuoka-u.ac.jp/researchcenter/workingpapers/WP-2021-013.pdf

Shiller, Robert J. (1981) Do Stock Prices Move Too Much to be Justified by Subsequent Changes in Dividends? *American Economic Review*, Vol. 71, pp. 421-436.

Stiglitz, Joseph E. (1989) Using Tax Policy to Curb Speculative Short-Term Trading. *Journal of Financial Service Research*, Vol. 3, pp. 101-115.

Tirole, Jean (1982) On the Possibility of Speculation under Rational Expectations. *Econometrica*, Vol. 50(5), pp. 1163-1181.

Tobin, James (1969) A General Equilibrium Approach to Monetary Theory. *Journal of Money, Credit and Banking*, Vol. 1(1), pp. 15-29.

Wan, Junmin (2015) Household Savings and Housing Prices in China. *The World Economy*, Vol. 38, pp. 172-192.

Wan, Junmin (2018a) Prevention and Landing of Bubble. *International Review of Economics and Finance*, Vol. 56, pp. 190-204.

Wan, Junmin (2018b) Non-performing Loans and Housing Prices in China. *International Review of Economics and Finance,* Vol. 57, pp. 26-42.

Wan, Junmin (2019) The Effective Life and Value of Capital. *CAES Working Paper Series*, WP-2019-016, Center for Advanced Economic Study, Fukuoka University, December 2, pp. 1-40.
http://www.econ.fukuoka-u.ac.jp/researchcenter/workingpapers/WP-2019-016.pdf

Wan, Junmin (2021a) US-China Trade War: Speculative Saving Perspective. *The Chinese Economy*, March, Vol. 54(2), pp. 107-123.
https://doi.org/10.1080/10971475.2020.1830230

Wan, Junmin (2021b) Transmission of Housing Bubbles among Industrial Sectors. *CAES Working Paper Series*, WP-2021-006, Center of Advanced Economic Studies, Fukuoka University, March 24, pp. 1-25.
http://www.econ.fukuoka-u.ac.jp/researchcenter/workingpapers/WP-2021-006.pdf

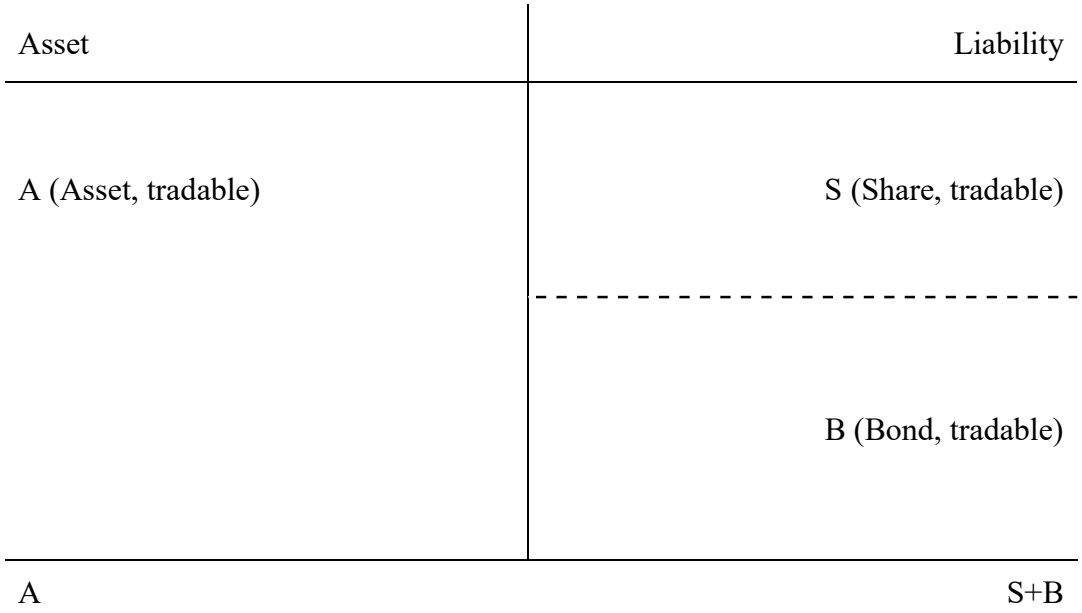
Wan, Junmin (2021c) Bubble Occurrence and Landing. *CAES Working Paper Series*, WP-2021-009, Center for Advanced Economic Study, Fukuoka University, July 8, pp.1-36.
http://www.econ.fukuoka-u.ac.jp/researchcenter/workingpapers/WP-2021-009.pdf

Wan, Junmin (2021d) Non-performing Loans and Branch Deregulation. *CAES Working Paper Series*, WP-2021-018, Center for Advanced Economic Study, Fukuoka University, December 26, pp.1-53.
http://www.econ.fukuoka-u.ac.jp/researchcenter/workingpapers/WP-2021-018.pdf

Wan, Junmin, and Qiqi Qiu (2020) The Impact of Housing Bubbles on Industrial Investments in China. *CAES Working Paper Series*, WP-2020-006, Center of Advanced Economic Studies, Fukuoka University, pp. 1-38.
http://www.econ.fukuoka-u.ac.jp/researchcenter/workingpapers/WP-2020-006.pdf

Xiong, Wei (2013) Bubbles, Crises, and Heterogeneous Beliefs. *Handbook for Systemic Risk*, edited by Jean-Pierre Fouque and Joseph A. Langsam, Cambridge University Press, pp. 663-713.

Figure 1: Balance sheet of a listed firm



Source: Drawn by the author.