Anthony Ng

Best Dissertation Prize Winner

MSc Public Administration and Government 2017-8

gov.msc@lse.ac.uk

Can zombies be rational? Investment, policy uncertainty and the role of SOEs in China

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Table of Contents

List of Figures v

List of Tables vi

Abstract 1

CHAPTER 1 Introduction 2

1.1 Introduction 2

1.2 Problem statement 4

CHAPTER 2 Literature Review 7

2.1 Section overview 7

2.2 China's SOEs 7

2.2.1 Institutional context of China's SOEs 13

2.3 Policy Uncertainty, SOE and POE Investment 21

2.3 Hypotheses development 26

CHAPTER 3 Methodology 29

3.1 Data collection 29

3.2 Analytical models 29

CHAPTER 4 Results 33

4.1 Regression results 33

4.2 VAR results and Granger causality 37

4.2.1 Pre-estimation checks for VAR 37

4.2.2 Granger causality results 37

CHAPTER 5 Conclusion 43

5.1 Discussion 43

5.2 Policy recommendations 46

References 49

Appendix 56

Appendix A 56

Appendix A.1 Data Appendix 58

Appendix B Granger causality results 59

Appendix B.1 VAR pre-estimation checks 60

AIC and LR pre-estimation for lag order 60

Stability test 60

Autocorrelation Lagrange Multiplier Test 61

List of Figures

Figure 1: State and Private Industrial Profit growth 10

Figure 2: SOE and SASAC hierarchies 14

Figure 3: Total SOE Leverage 18

Figure 4: Central and Local SOE leverage 18

Figure 5: China Policy Uncertainty index correlation with critical events 24

Figure 6: SOE FAI impulse response on China Policy Uncertainty 40

Figure 7: SH FAI impulse response on China Policy Uncertainty 40

Figure 8: POE FAI impulse response on China Policy Uncertainty 41

List of Tables

Table 1: Entity and firm type 15

Table 2: Number of State Enterprises 16

Table 3: Multivariate regression Log-Linear model 33

Table 4: Log-Linear detrended and Log-Log detrended (dt) 35

Table 5: Granger Causality results 38

Abstract

China's State Owned Enterprises (SOEs) have something of a negative reputation: they are inefficient, bloated enterprises that continue to cause drags on real growth. Many have been so inefficient to be attributed the moniker of "zombie". This thesis seeks to explain the apparent irrationality of SOE behaviours, reconceptualising them as state discretionary stability mechanisms when reframed through a lens of *policy uncertainty*: that is SOEs act as State stability mechanisms that increase investment so as to reduce uncertainty within the domestic economy.

Through preliminary multiple regression models adjusted for time series supported with a basic VAR model, it was identified that SOE and State Held (SH) Fixed Asset Investment (FAI) does appear to reduce uncertainty over the short term. Granger causality also confirms that this significant relationship for SOE and SH FAI is only unidirectional causing reductions in uncertainty. Private Owned Enterprise (POE) FAI was found to have a positive relationship with policy uncertainty in preliminary regressions, with subsequent testing over VAR Granger causality also supporting the direction of causality. Predicted orthogonal impulse response function (oirf) results imply that both SOE and POE FAI shocks can reduce uncertainty over the short term although SH may first cause increases to uncertainty. The overall results shed some light on the durability of SOEs in China's industrial sectors and the stabilising role they may play, partially explaining their continued survival where other evolutionary theories of the firm would have predicted their demise. It also suggests that "zombies" can be perceived to act rationally depending on the perspective you take even if, on first glance, they appear as irrational and inefficient capital allocators.

Key words: China, Macro, SOE, Investment, Policy Uncertainty, Inefficiency, Zombie firms

CHAPTER 1

Introduction

1.1 Introduction

Much has been made regarding the apparent inefficiencies of State Owned Entities (SOEs) in China – they are bloated enterprises and too inefficient given their size and market prevalence (e.g. Freund and Sidhu, 2017). One of the seminal texts by the World Bank in 1995, *Bureaucrats in Business* argued in the vein of the Washington Consensus for a transition away from the *inherent* inefficiencies of state planning (Nolan, 2015). Although one may argue that the Washington Consensus has been somewhat diminished as a result of the Great Financial Crisis (GFC) and subsequent economic lull or even secular stagnation[1] (e.g., Summers, 2013) as well as absence of productivity growth (e.g., Haldane, 2017), the view from the international community on China's SOEs as inefficient enterprises requiring reform continues. The most recent IMF Article IV report (IMF, 2018) goes into much detail regarding the need for SOE reform as a *necessary* precondition for China's rebalancing.

A rebalance is something both the China Communist Party (CCP) and State have suggested is important for their continued economic success as well as social stability (e.g., Pettis, 2013). However, what appears to be "axiomatic" within the Washington Consensus – that SOEs are a net negative – should still be open to honest inquiry. Indeed, they are also incredibly durable and resilient, both in terms of their average life spans and anti-fragile nature when confronted with

[1] The secular stagnation hypothesis was proposed by economist Alvin Hansen (Hansen, 1939) which stressed that a lack of incentive to invest on the demand side would lead to a rise in accumulated savings left unabsorbed (i.e., S > I). This would lead to "sick recoveries which die in their infancy and depressions which feed on themselves" (Hansen, 1939: 4). More recently popularised by Larry Summers (e.g., 2014) as a natural market imperfection derived as a function of monetary policy at the zero bound on the nominal rate leading to levels of output below full employment, both mainstream economists such as Paul Krugman and left leaning economists (e.g., Varoufakis, 2015) have made similar arguments regarding global imbalances and instability.

economic shocks. That they have survived may not necessarily be as pure a function of preferential treatment, soft budget constraints and political connections. That the China model (中国模式 *zhong guo mo shi*) has achieved the economic success that it has within such a limited time horizon (i.e., 40 years as of 2018) has been through the *policies* it has adopted. And this necessarily *includes* its policies over SOEs in addition to the gradualist approach to reforms adopted since the opening up period of 1978.

This gradualist approach China has taken to reform is encapsulated by Naughton's (1995, 2007) phrase "growing out of the plan" or the 1978 reform's architect, Deng Xiao Ping's crossing the river whilst feeling for the stones – to move forward but given the *uncertainties* of the future path(s) you take this should be done with a degree of caution lest you fall into turmoil. This fall and demise is what the CCP fears in the form of 捣乱 (*dao luan*) – chaos or disorder which impacts the CCPs legitimacy. Therefore, there is a premium placed on any mechanism which allows the CCP to maintain stability (维稳 *wei wen*). The implementation of Deng's 1978 strategy was through policies that included adapting SOEs over time in addition to gradual privatisation over Town and Village Enterprises (TVEs) and allowance of the dual track pricing system (e.g., Naughton, 2007; Nolan, 2015; Heilmann, 2017). But gradual reform and privatisation over a longer duration has not led to nor does it necessarily imply the end of the SOE, as legitimacy over CCP rule and stability is maintained through such party mechanisms.

Indeed, the state sector remains relatively strong especially in the promotion of strategic "national champions" (e.g., Nolan, 2001) in the face of calls for faster privatisation from the IMF (2017, 2018), World Bank (2017) and think tanks (e.g., Peterson Institute International Economics).

Hubbard (2016) noted that the degree of concentration of SOEs in key sectors remains relatively high such that in terms of the Herfindhal-Hirschman Index (HHI)[2], with SOE monopolies remaining in energy (i.e., utilities and oil and gas), tobacco and automobiles.

The reasons for the continued resilience of SOEs in spite of their perceived relative inefficiencies and irrational investment decisions is the impetus for the current thesis. Specifically, I will explore the relative differences in SOE and State Holding (SH) compared with Private Owned Enterprises (POE) Fixed Asset Investment (FAI) and their respective impacts on *policy uncertainty*. The details of these variables will be discussed in later sections (see Section I and II for the background and development of hypotheses respectively).

1.2 **Problem statement**

This thesis will seek to reframe how we perceive China's SOEs from irrational zombies to rational risk stabilisers. Practically, uncertainty in the form of the Economic Policy Uncertainty (EPU) metric developed by Baker, Bloom and Davis (2013, 2016) will be used as the main dependent variable. The model specification and main variables can be seen in the Methodology section (see 3.2 Analytical models, p.29).

The consensus view of China's SOEs is that they require significant reform as part of the move to the market based system. However for every reduction in SOE intensity and increase in market private forces, there is a trade-off of reduced state control over uncertainty. This is because SOEs

[2] HHI is a measure of firm concentration in a given industry calculated by squaring the number of firms in a given industry and summing the total, such that if 1 firm had 100% of the market this would = 10,000, the maximum HHI figure and a sum close to 0 would imply perfect competition.

will act where others fear to tread: they will invest to reduce uncertainty whereas private shareholders will reflect on their risk tolerance, adopting a wait and see approach (e.g., Cukierman, 1980; Stokey, 2016) and demand higher risk premiums (i.e., return) for a given investment: that is social stability or political goals are lower priority for rational private investors.

I will therefore seek to address the following themes (see Section II for specific hypotheses):

1) Do SOEs help reduce uncertainty as political and policy tools of the State?
2) Do SOEs relative to POEs reduce uncertainty to a greater degree?
3) What are the other determinants of policy uncertainty in the business cycle and what relative impacts do they have?

To my knowledge no prior research has addressed the positive stabilising influence China's SOEs may have on policy uncertainty and none have addressed SOEs and POEs relative influences on policy uncertainty. Rather, empirical literature has focused on aspects of China investment (in)efficiency (e.g., Guariglia & Yang, 2016) and government influence over China firm level investment *under* "uncertainty" (e.g., Xu et al, 2010) but this has i) predominantly focused at the firm unit level; ii) on closer scrutiny measures risk not true uncertainty and iii) looked at uncertainty or risk as the *independent* variable and its impact on output (including investment). To build upon the literature and provide an original piece of research this thesis i) takes a macro perspective rather than focusing on the firm; ii) assesses uncertainty specifically, not risk and iii) also suggests that FAI can serve to reduce uncertainty, rather than FAI being adjusted as a result of uncertainty.

The remainder of this thesis will take the following structure: Section I will provide a literature review of SOEs, providing an introduction over their varieties, and review over investment and policy uncertainty; Section II will articulate the development of the hypotheses to be tested; Section III discusses the data and methodology used to test these hypotheses; Section IV will present and interpret results and Section V will discuss and provide policy recommendations.

CHAPTER 2

Literature Review

2.1 Section overview

This section will explain the role and characteristics of China's SOEs and how they are currently portrayed. It will include an explanation of SOEs and their role, how and why they appear to underperform leading to their being branded as zombie firms and the literature which supports these views. This review will be followed with exposition over the primary dependent variable, China policy uncertainty and its relationship with the main independent variable, investment, specifically related to China's SOE and POE firms.

2.2 China's SOEs

Current literature and explanations of China SOE performance paints a relatively bleak picture with many attributing constraints on future growth on SOEs and local government profligacy (e.g., Huang, 2017), that SOEs continued existence is a function of political support from the State in the form of subsidies (Lee et al, 2014; Allen, et al, 2005), loans at preferential rates (e.g., Szamosszegi and Kyle, 2011), protection from competitors and political connections (e.g., Chen et al, 2017).

This body of literature revolves around the following characteristics: SOEs occupy second tier status when compared to private enterprises as they inefficiently allocate capital and remain "bloated" enterprises (e.g., Ljungqvist et al, 2015). Other studies have identified a productivity gap between SOEs and private firms (Hsieh and Klenow, 2009) where more efficient allocation of capital would lead to an increase in Total Factor Productivity (TFP) (e.g., Hsieh and Song, 2015).

Bai et al (2016) also suggest that the stimulus package that was filtered through SOEs during the GFC may eventually result in a drag on future growth.

These studies also point to SOEs preferential access to credit (e.g., Su, 2016). China banks – also predominately state owned – prefer to grant credit to SOEs relative to POEs (Wei and Wang, 1997) given the implicit government bailout in any instance of default (see Rodden, 2006). It is also possible that default risk is more readily estimated for an SOE given the underlying state backstop which in turn increases the willingness of China banks to lend to SOEs vis a vis POEs (e.g., Cull and Xu, 2003). This also causes a crowding out effect where credit to SOEs crowds out POEs.

Given SOEs are portrayed to be inefficient and crowd out more efficient private firms, governments from transitional economies including China's have implemented degrees of privatisation as a means to improve efficiency. Empirical findings over how successful this reform has been indicate conflicting results: Jefferson and Su (2006) suggest that an increase in non-state share proportional ownership increases the performance of firms. Similarly, Song and Yao (2005) also found that privatisation improves firm profit margins. However, Zhu et al (2007) found that performance worsened post-privatisation,. Similarly. Liu and Li (2005) measured stock market performance for privatised SOEs both pre and post control rights transfers and found no significant change. Wang et al (2016) found that private benefit of a private controlling shareholder was greater than that of a state-controlling shareholder which in turn reduced future corporate performance. They also found no significant change in performance 3 years after the transfer of controlling rights. Lu and Dranove (2013) Management Buyouts also found privatization via

Management Buyouts over the short term reduced efficiency before regressing upward toward the prior mean. Liu et al (2015) found that *mixed* ownership or partial privatisation was the best performing firm type given returns from synergies between state support and private business acumen.

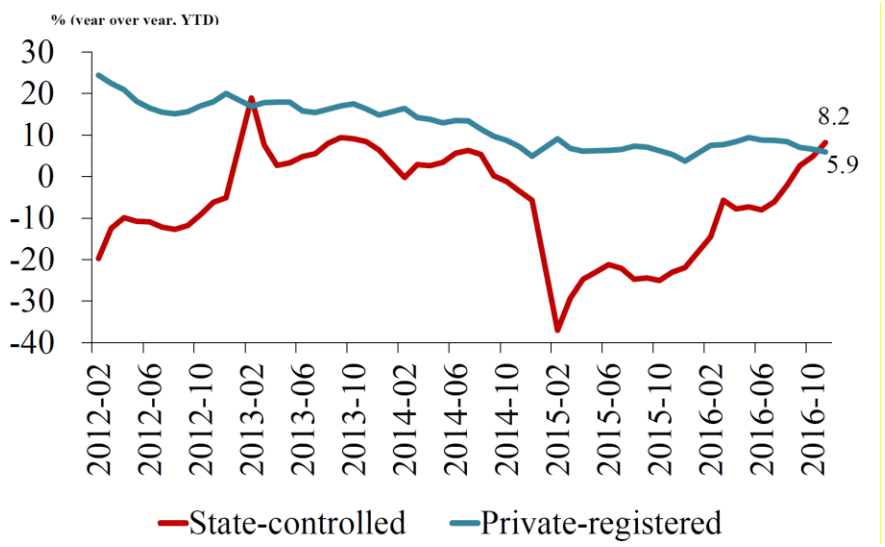
These mixed ownership SOEs are a result of the reform agenda which has taken place in stages with the predominant being Jiang Ze Min's "keep hold of the big and let go of the small" [3] campaign. Loss making SOEs were privatised as larger SOEs were "corporatised" with corporate governance changes to boards, management and shareholders being key components of this process (Wu et al, 2012). Central government also transferred control rights to many local governments where the intention was to improve local economic conditions. This process has slowed with SOEs reducing in number but increasing in size undergoing more merger activity in certain sectors (e.g., Freund, 2017).

Given the conflicting evidence over SOEs, why is there such a consensus view over their negative qualities? There is relatively convincing evidence that China has succeeded in spite of the SOEs rather than as a consequence of them. Nicholas Lardy (2014) in "Markets over Mao" showed that the State had given way to the private market and that the private market – therefore – was at the forefront of the economic boom witnessed throughout the 2000's. This somewhat vindicated the reform agenda and consensus view at that time.

[3] These were instigated in 2003 under 江泽民 (*Jiang Ze Min*) and included the creation of SASACs by the State Council in March 2003 (via decree 378) as well as consolidation of larger more systemically important SOEs – that is in key industries – relative to the smaller. This is perhaps best encapsulated in the 抓大放小 (*zhau da fang xiao* - grab the large and let go of the small) reform.

However, for Lardy's thesis to remain persuasive, it must also be able to explain the inconsistencies in the data that have arisen since publication – that is the apparent *resurgence* of the State relative to the private sector. A resurgence of sorts can be seen in the period since 2014 (see Figures 2 and 3 below). The increase in the percentage of state assets via investment, the relative growth in industrial profits as well as the increase in the share of industrial profits accumulated through the State versus Private registered firms (see Figure 1).

Figure 1: State and Private Industrial Profit growth



Source: China NBS, Lardy (2017)

As of October 2016, the State has had an uptick in their profit growth (8.2%) vs the private sector (5.9%). However, when we look at the base from which the State and Private sector were trending it is apparent that the differential increases are not so stark – that State share of profit growth of 8.2% was from a decline of greater than 20% (in 2015) whereas the private sector growth of 5.9% was off the back of growth of 4%. That is to say given profits were so low within the State sector it is "easier" to outperform (in this case by 2.3%) relative to private firms. Lardy (2017) himself

argues that this resurgence is nothing more than a cyclical change as opposed to any systemic transformation: one which could be as a result of Party emphasis on Xi Jin Ping's thought[4].

Moreover, the share of industrial profits from SOEs (including state-controlled firms) is also 18% vis a vis the 35% in private firms (as of the end of 2016). The data on private controlled – even though it does appear to be trending in a positive direction – is also incomplete as it only includes those private firms that are registered: Limited Liability Companies (LLCs) where the majority or sole shareholder is private are excluded. Factoring in an estimate of profits for these firms would therefore increase the relative share accruing to private controlled firms but would also decline should the majority of these firms be loss making (unlikely but possible if we look only at accounting profits rather than cash flow generation).

A further reason for the pessimistic view of SOEs is due to the negative impacts that they can have on both domestic and international competitiveness. Domestically, MacFarquhar (2017) has suggested that SOEs require reform relative to POEs for the following reasons: i) they are more indebted; ii) less profitable and iii) less productive than their relative private sector peers.

MacFarquar also raises the prospect of SOEs in their current form preventing China's rebalancing: they force up the current account (i.e., trade balance surplus) through increasing overall savings. Pettis (2013) has also made the argument that savings being so high relative to overall investment – by definition – forces up the current account or trade balance (i.e., which in turn increases the

[4] As per the SASAC website published on the 07/18 there was a video meeting convened for both Central and Local SOE officials to study Xi Jin Ping's thought (习近平新时代中国特色社会主义思想) applied to SOE policy http://www.sasac.gov.cn/n2588030/n2588924/c9258344/content.html [accessed on the 01/08/18].

surplus or reduces the deficit) which prevents rebalancing. This is not to say that the CCP or the State Council is not aware of the need to rebalance the economy. In 2007 the much cited announcement by then Premier Wen Jia Bao (温家宝) spoke of the unbalanced, unstable, uncoordinated and unsustainable economy[5].

These distortions are not isolated to the domestic market – they cause reverberations through global trade - which have been most noticeable in the US although through amplification channels can also impact the UK (e.g., see Gilhooly et al, 2018 for estimated spillover and shocks from a China slowdown). MIT economist David Autor (Autor et al, 2013, 2016) has recently identified how these imbalances may have negative economic impacts on certain regions in the US. Indeed, in a more recent paper these same authors along with Majilesi (Autor et al, 2017) identify that the external trade surplus China has with the US may have also had *electoral* consequences in trade-exposed US regions: they found evidence that in presidential elections, counties with greater trade exposure shifted towards the Republican candidate and trade-exposed districts were more likely in congressional elections to vote out a moderate representative in the 2000s.

Freund and Sidhu (2017) identified that between 2006-2014 although global concentration of industrial firms has declined, in industries where China's SOEs dominate concentration has in fact risen. Consistent with the SOE inefficiency hypothesis, Freund and Sidhu also find that China's SOEs are too large and expanding too quickly given their low productivity and this in turn is reducing "global allocative efficiency in some industries" (Freund & Sidhu, 2017: 4). This could be as a consequence of the rationalisation process during the aforementioned SOE reforms: the

[5] In his statement at the NPC in March 2007 Wen Jia Bao was candid when asked about the state of the economy – and his statement would go on to being referenced as the "four un's"

move toward consolidation and privatisation has in fact led to increased inefficiency in terms of capital allocation (production proportional to size) across certain sectors (e.g., Huang, 2008; Hsieh & Zheng, 2016).

These net negative impacts if a function of SOEs and their survival are therefore in part due to the political connections and privileges that SOEs enjoy (e.g., state support; Barbieri et al, 2012) including soft budget constraints (e.g., Qian and Roland, 1998). These prevent consistently loss-making entities from naturally exiting the market which would ordinarily result as a consequence of firms' inability to continue as a going concern. These distortions again impact the private as well as the global markets and these impacts are multiplied as a consequence of the relatively closed capital markets within China. Closing the capital market from a certain perspective does make rational sense if you are trying to prevent flight capital but at the same time the "unnatural" (i.e., when compared to a free market benchmark) way this is coerced via the State ultimately leads to distortions elsewhere.

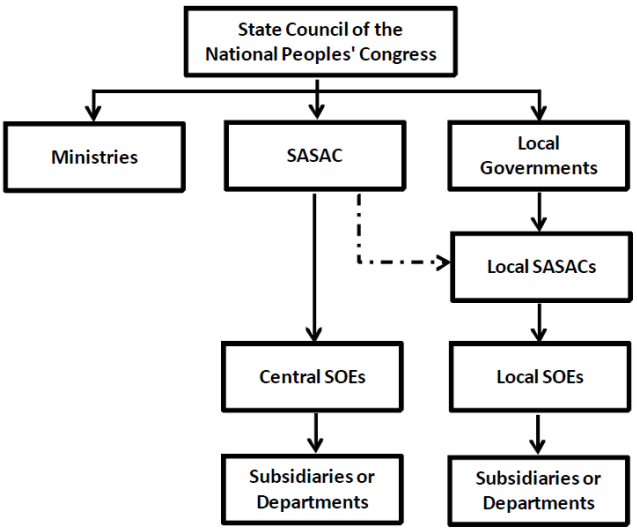
Prior to putting forward the more optimistic argument for SOEs it is important to quantify and define them in relation to their current institutional context, which I do below.

2.2.1 Institutional context of China's SOEs

China's state sector is comprised of SOEs which report to central, provincial and local levels of government. SOEs are either centrally owned or owned by the provincial or local governments. Not all SOEs are created equally: their management is either performed at the Central level

supervised by the State-owned Asset and Supervision Commission (SASAC) and local SOEs are often under local SASACs (see Figure 1). In addition, there are many SOEs that are under the auspices of other ministries or regulators (e.g., the China Banking Regulatory Commission, the China Securities Regulatory Commission etc.). The relative importance and in turn power of SOE influence beginning from the 2008 financial crisis, at a macro level, appears to have been moving towards the Central vis a vis the Local (e.g., Lee, 2009). SASACs are akin to holding companies – that is they hold shares in the SOE rather than the State holding these shares as was the case pre-SOE reform.

Figure 2: SOE and SASAC hierarchies



Source: Deng, Morck and Wu.

As of 2009, amended legislation was passed that stipulated the share-holding structure (i.e., the SASAC entity) would hold the legal assets and liabilities of their respective SOEs on behalf of the State. Definitions of each of these entities can be seen in Table 1.

Table 1: Entity and firm type

Registration Status	**Definition**	
Domestic funded	*Ownership Details*	*Description*
State-Owned Enterprises	100% State ownership	Non-corporate economic entities - all assets are owned by the State
State-Holding enterprises	State ownership > any other single shareholder in firm	Entities where the shareholding of the State > than any other shareholder
Collective-owned enterprises	Public & collective ownership	Economic entities which have collective owners
Cooperative enterprises	employees and outside investment funding	Set up on coop basis. Management decision made by all members
Joint ownership enterprises	>= 2 corporate enterprises own shareholding (not necessarily 50/50)	Established by joint investment capital
Limited Liability Corporations	2-49 investors own share capital	LLCs include state sole funded corporations
Share-holding corporations Ltd.	Total registered capital divided into equal shares	Stock issues on secondary markets
Private enterprises	Natural person serves as controlling or sole shareholder	include: Private LLCs; SHCs; partnership enterprises; sole investment enterprises
Foreign funded	*Ownership Details*	*Description*
Enterprises with funds from HK, Macao, Taiwan	Funds from HK, Macao and/or Taiwan	All types of enterprise with funds from relevant parties as per definition
Foreign funded enterprises	Invested capital from foreign sources	

Source: Adapted from CSY 2016 and US China-Commission, 2011

From Table 1, we can see that the reporting of SOE figures may often be misleading. For the purposes of this thesis, I will adjust the SOE figures to also include those entities that have a controlling or direct shareholding in an entity. Irrespective of its registration status SOEs will always exclude those firms listed as Private enterprises (see Table 1, Domestic Funded no.8), unless otherwise stated.

I also adjust the reported numbers of entities to identify a more accurate estimation of the number of SOEs using the data made available from the China Statistical Yearbook (CSY) from 2016 published by the NBS as follows (see Table 2 below):

Table 2: Number of State Enterprises

Enterprise	*No. of industrial enterprises*	*Calculations or data source*
SOE and SHE	19,022	From NBS CSY 2016
SOE	2,459	From NBS CSY 2016
SHE	16,563	calculated from above (i.e., (SHE+SOE) - SOE = SHE)
State Joint ownership enterprises	10	From NBS CSY 2016
Joint State-collective enterprises	22	From NBS CSY 2016
State sole funded LLCs	3424	From NBS CSY 2016
Unspecified ownership in SOEs	13,107	SHE less others = minimum no. unspecified

Source: NBS CSY 2017, Author calculations

In addition to the industrial enterprises listed in Table 2, many of the listed firms on China stock exchanges are partially owned by the State – and the State is likely to have an oversized influence on the management of the entity even if its shareholding is below 50%. A large proportion of the Non-Tradeable Shares (NTS) of listed firms are also owned by the State. Parsing through this information, although technically possible is not realistic for me to do within the scope of this thesis. However, the CEIC database used for data collection does provide sufficient information around i) the above registration status as per Table 1 (above) and ii) FAI for each of these enterprise types as well as the total FAI from 2004 through to Y/E 2017 on a monthly basis. Therefore, it is possible to make a reasonable estimation of the relative SOE to non-SOE and/or POE FAI quantitative levels.

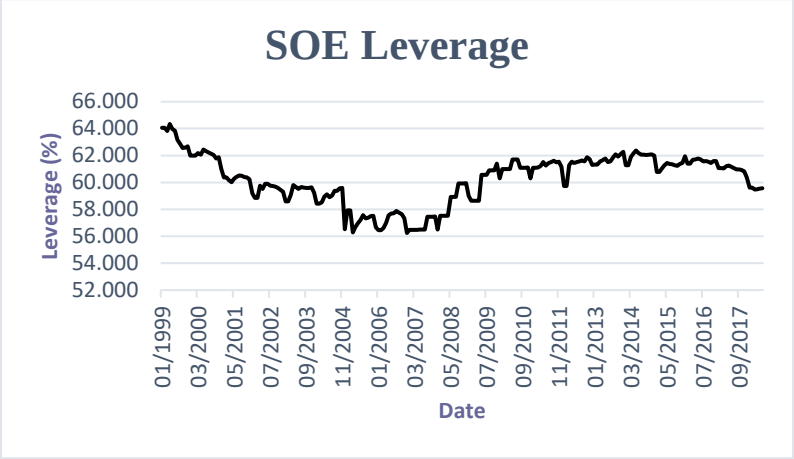
Reforms over the SASAC hierarchies have focused on the adoption of the Singapore Temasek model, with both respected media (e.g., The Economist, 2017, 2018) and research (e.g., Chang and Yin, 2016) suggesting China should seek to further develop this model to increase efficiencies. However, the variation and differences across region and size relative to Singapore makes this more challenging at the tactical level of implementation although strategically (longer term) it may be adopted.

Quantitatively, SOEs and State holding entities still have a very important role in China constituting 40% of assets relative to total assets of all firms. This is a figure worth highlighting given the number of SOEs (see Table 2) has declined as a percentage of the total number of firms. This implies that a smaller number of SOEs have managed to accumulate a larger number of assets over time which lends credence to the aforementioned Freund and Sidhu's (2017) findings on concentration.

Further, SOEs tend to be concentrated in certain sectors as opposed to being allocated across a diversified number of industries. Steel, shipbuilding and heavy machinery are all areas where SOEs appear to be clustered. There also appears to be a significant amount of leverage in SOEs (i.e., total liabilities as a percentage of total assets was 59.56% as of June 2018– see Figure 3).

Figure 3: Total SOE Leverage

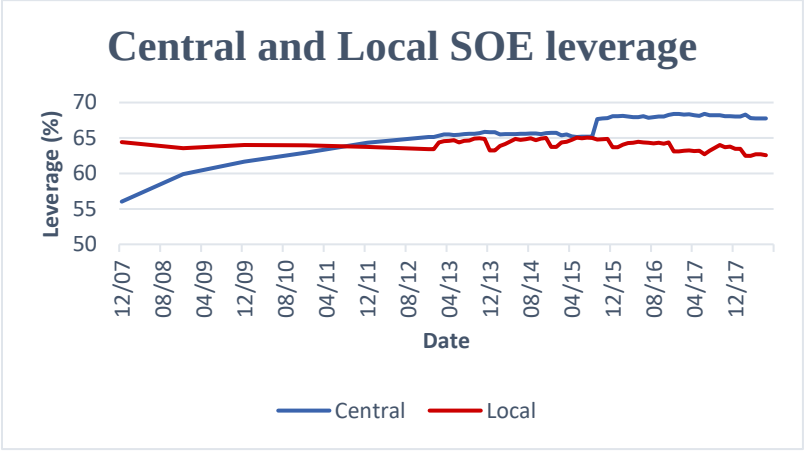
Note: Total leverage is calculated as liabilities/total assets where Total Assets = total liabilities + equity, as per the balance sheet



Source: CEIC data, Author calculations

As Figure 3 (above) shows, leverage has increased since the GFC in 07-08. I also compare relative differences in leverage at the Local and Central level:

Figure 4: Central and Local SOE leverage



Source: CEIC data, Author calculations

Central SOE (CSOE) leverage appears to have expanded relative to Local SOE's and has been above Local SOE (LSOE) leverage as of December 2011, tapering off through to August 2015

prior to expanding relatively rapidly from September 2015 through to the end of 2017. The expansion was as a result of the dramatic fall in the China stock market index that occurred in 2015 (12/06/15) where the State intervened to stabilise the uncertainty in the markets via their most efficient apparatus, the CSOEs given the relative economic decentralisation of China's model (e.g., Qian and Weingast, 1996).

There are two frames of reference to explain SOE increases in leverage: i) SOEs are continuing to act irrationally in their investment decisions leading to a gradual build-up of debt with insufficient cash generation to pay down interest accrued and principal or ii) as the preceding paragraph, this increase in leverage as well as the differential between CSOE and LSOE leverage supports the notion that SOEs can act to stabilise an economy suffering from *uncertainty*. This would make the increase in leverage a "*rational*" trade off if there was also an associated increase in GDP growth (indirectly caused by increases in invested capital via SOEs).

The increase in leverage and SOEs continued existence has led many in both academia and even China's State Council[6] to label several SOEs as *zombies*: entities that are inefficient and only continue as a going concern (in the accounting sense) through "life support" (e.g., from the State or the state owned banks). Moreover, should SOEs ultimately be one of the primary causes of overleverage via an investment led growth model (as per the IMF 2018 Article IV), just as if zombies roamed the earth without constraints, they would eventually destroy the ecosystem from which they derive their sustenance: resources are finite and supply cannot sustain insatiable demand. SOEs, similarly, if they were continue to drain the system of capital with no returns (i.e.,

[6] The State Council defines zombie firms as those firms that have not made a profit for 3 consecutive years

via misallocation) will ultimately cause their own demise as at some stage expanding debt will require interest to be paid down whilst further investment opportunities will contract.

However what the above examination of descriptive data in combination with the relevant literature confirms is there also exists a minority optimistic view which is now easier to elaborate than in the preceding section and forms the central tenet of this thesis (see problem statement on page 4). As per Figure 3, the stock market volatility of 2015 is not the only example of a time the State has stepped in to help stabilise uncertainty – the actions taken during the GFC was to ensure the stability of growth as well as ensuring the government sector continued to operate under conditions of relative uncertainty thereby guaranteeing millions of jobs (e.g., as of the y/e 2017, 60.64m people are employed in State Owned firms; from CEIC and Ministry of Human Resources and Social Security). That is better access to credit serves as the survival function of SOEs (e.g., Song et al, 2011) but also as a stability function to reduce uncertainty. Others (e.g., Chang et al, 2017; Peng et al, 2016) have also identified that SOEs continue to have access to credit relative to POEs in spite of their less efficient business models. Whilst this may appear irrational when viewed through an efficiency paradigm it may in fact serve a rational purpose if viewed through the uncertainty paradigm put forward here.

In summary, two main points come to mind from a review of the literature and historical data: i) under uncertainty and/or higher levels of risk the state banks continue to lend to SOEs so as to ensure continued investment which forms the largest component of GDP growth (e.g., Pettis, 2011, 2013). To have been stalled by the GFC would have potentially been more damaging to the CCP's *legitimacy* given their remit is partly based on continued economic growth (e.g., Heilmann, 2017)

and ii) SOEs' inefficiency at the firm level may be a cost that the CCP and State Council is willing to accept – especially under certain conditions of uncertainty.

I next turn to the literature on uncertainty related specifically to investment and capital allocation decisions – the key relationship explored in the current thesis.

2.3 Policy Uncertainty, SOE and POE Investment

Knight (1921) defined uncertainty as people's inability to forecast the likelihood of something happening – in other words being unable to place a probability estimate and therefore probability distribution of events. Risk, on the other hand, can be assigned a probability and in turn a distribution so as to estimate an expected outcome. The simplest example is a fair coin toss: if a fair coin is flipped there is an equal probability of it landing on heads as tails (i.e., 1 of 2 or 50%). This is a probability estimate of outcomes that can be readily calculated knowing the characteristics of the coin (i.e., it is fair) and the intended action (i.e., the coin flip).

There are many texts on policy under uncertainty, such as those pertaining to the precautionary principle (see Ashford, 2005; Sunstein, 2007) and this thesis will reflect on this principle after the results are analysed. The explicit focus here will be on the interaction between policy uncertainty and SOE investment relative to POE investment.

The literature on investment under uncertainty is rich. Bernanke (1983) identified that firms would have an incentive to refrain from investment where uncertainty was high. That is they would at the very least delay investment and hiring decisions over a time horizon characterised by uncertainty

(e.g., through an investment and hiring freeze). This is under conditions where investment projects are costly, returns difficult to measure with any degree of accuracy and also where workers' employment is risky given they may need to later dismiss them so as to maintain profit margins under tense macroeconomic conditions. Uncertainty also causes precautionary spending reductions and cutbacks from household consumption as well as upward pressure on finance costs (e.g., Gilchrist et al, 2014). Risk aversion also increases and this has been especially well documented in managerial behaviour when making investment and strategic decisions (e.g., Panousi and Papanikolaou, 2012).

Tobin (1958) showed that as the firm or consumer cost of capital increases as a function of increased risk, investment and consumption decline. Investment decisions of firms under uncertainty is generally captured in the net present value (NPV) discounted cash flow (DCF) method at the firm level but in a dynamic business environment, projects can change. This led to more practical adoption of real options theory (Myers, 1977) which McDonald & Siegel (1985) applied to investment decisions whereby the investment decision is a trade-off between waiting (which assumes that uncertainty declines as a function of increasing information availability which itself increases as a function of time to the investment decision) and investing today (i.e., so as not to lose the investment opportunity). As the generation of cash flows becomes less certain the investment is less likely to be made and therefore the real option hypothesis would suggest that investment is negatively related to uncertainty (e.g., Dixit & Pindyck, 1994).

There is also a body of literature specifically on *policy uncertainty* such as monetary, fiscal and regulatory policy uncertainty and the manner in which this impacts the economy (e.g., Friedman,

1968; Rodrik, 1991; Higgs, 1997). Policy uncertainty has also been explored in DSGE[7] models (e.g., Fernandez-Villaverde et al, 2015) and how fluctuations in uncertainty may impact stock market volatility (e.g., Pastor and Veronesi, 2012, 2013). Asset returns have also been found to be negatively related to policy uncertainty (e.g., Brogard and Detzel, 2015).

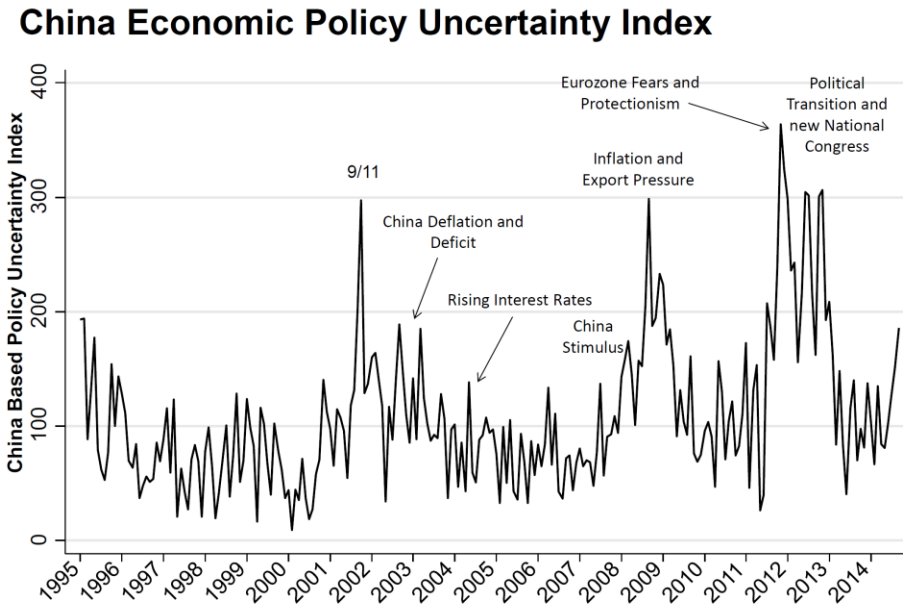
Pastor and Veronesi (2013) predict that political uncertainty commands a risk premium – that is when there are perceived political uncertainties, rational investors will only invest when the predicted returns are sufficient to tolerate the current level of risk and uncertainty. Equity prices will therefore drop as the discount rate increases to factor in this political uncertainty premia. Indeed, in relation to political uncertainty's impact on asset prices in China, Liu et al (2017) identified the impact of exogenous political shocks on asset prices. Using the Bo Xi Lai and Wang Li Jun scandal[8] of 2012 and its impact on asset prices as a natural experiment they found that there was a negative impact to stock prices, especially those that had political connections, and that this was factored into these assets' discount rates (i.e., the political risk had been priced into the discount rate – making it higher - so that the fundamental value was lower than prior to the scandal – where theory suggest investors demanded a higher return for taking on such political risk). They also found that future expected returns for politically connected SOEs were also more volatile (i.e., they showed more variance) than non-SOEs although equity research analysts covering SOE and non-SOE equities and modelling forecasts of said equity prices were not significantly different.
Liu et al (2017) also used Google and Baidu search intensity (on Bo Xi Lai and Wang Li Jun) for measures of political uncertainty related to the Bo Xi Lai scandal as well as Baidu searches for the

[7] Dynamic stochastic general equilibrium models used in econometric studies

[8] In February 2012, Wang Li Jun vice mayor of Chongqing reported to the US consulate on an alleged murder and cover up involving Bo Xi Lai, who was then Chongqing CCP secretary. Bo was charged with corruption and abuse of power and removed from his position.

term “revolution” during the March 2012 Bo scandal. This methodology for assessing political uncertainty is analogous to the metric used in the current study although arguably the *policy uncertainty* metric used here is more valid and reliable (see Figure 5 for relationship between the China index and shocks, including peak periods in 2012 related to the Bo scandal and political transition).

Figure 5: China Policy Uncertainty index correlation with critical events



Source: Bloom, 2015

Xu et al (2010) identify that government control impacts the investment-uncertainty relationship – they identify that for listed companies there is a negative relation between investment and uncertainty but only for private controlled firms. Investment is negatively related to firm-specific uncertainty for private firms, whereas for government controlled firms (i.e., SOEs) there is a positive relationship with market uncertainty. This means that under uncertainty, government controlled firms invest more not less. This is described as government allowing firms to invest to stimulate economic growth. However, this thesis takes a different view: that SOEs increase

investment so as to reduce uncertainty in their role as discretionary stabilisers not that they increase investment as a result of or under uncertainty. I believe the causal mechanism that Xu et al takes to be uncertainty driving relative investment mediated by government/private control to be the obverse: government control (i.e., SOEs) firms invest at the discretion of the state to reduce uncertainty.

Xu et al's paper is important as it uncovers the distinction between firm investment behaviours and how these differ for SOEs and POEs – however the researchers do not assess *uncertainty* but *risk*. They capture this in the CAPM[9] model, which is used to calculate the risk premium of a firm when making capital allocation decisions. I capture the relationship between *policy uncertainty* as captured in the narrative via the news media covering China. Xu et al (2010) state that SOEs are still required to perform macroeconomic control and social welfare functions and explicitly mention the post GFC stimulus program that encouraged investment and infrastructure development – a plan that in Xu et al's words "to a large extent [was] realized through investment by SOEs" (Xu et al, 2010: 137). This was to prevent the global recession from spilling over into China's domestic economy from increased uncertainty. To reduce this *uncertainty* over the future of the economy, China's state-led investment plan using SOEs as mechanisms through which to realise their ambition was successful in that it prevented the recession from reducing China's growth trajectory which appears to support my view of causation.

[9] Capital asset pricing model used in finance to calculate a firm's return on equity based on the current risk free rate and the relationship to the market returns captured in the beta coefficient and the market risk premium.

Regarding the uncertainty metric, text search methods over newspaper archives have led to some significant findings around policy uncertainty (e.g., Boudoukh et al, 2013; Alexopoulos and Cohen, 2015).

Unlike prior studies that have explored social stability and economic goals as incentives that compel SOEs to continue to invest when such investment may not be warranted based on rational expectations of future returns, and prior research on investment behaviours under uncertainty (and risk), I will explore the potential beneficial impact of SOE's Fixed Asset Investment (FAI) relative to Private Owned Entities (POEs) and the relative degree of impact both type of firm has on *policy uncertainty* (Baker et al, 2016).

2.3 Hypotheses development

Given the current thesis seeks to uncover how SOEs investment behaviour may act to attenuate uncertainty, I adopt a measure of uncertainty based on *economic policy uncertainty* (EPU). As previously mentioned this is an index developed by Baker, Bloom and Davis (2016) built out from newspaper coverage frequency. It was first developed for the US and later extended to other countries and economies, including China. The accuracy and reliability of the metric is assessed through robustness checks including firm-level and macro data (see Baker et al, 2016).

Given the exposition above, the relevant data available and the perspectives discussed, this thesis will seek to address the following set of hypotheses:

H_1: there will be a negative relationship between State Owned Entity (SOE) and State Holding (SH) Fixed Asset Investment (FAI) and policy uncertainty whereby increased FAI from state held entities will lead to declines in uncertainty

The general consensus regarding investment and uncertainty in the literature has generally identified that investment declines under uncertainty (e.g., Bernanke, 1983) – this is what we would expect from rational investors who are anticipating continuing declines in the economy as a result of heightened risk and unknown uncertainty. However, State holding and state owned entities, should they as hypothesised be used to ensure stability, may at the discretion of the state invest *more* during periods of uncertainty so as to *reduce* future levels of uncertainty. There will therefore be a negative relationship between SOE and other State-held entity FAI and policy uncertainty controlling for increases in leverage (at both the CSOE and LSOE levels), business cycle indicators and money supply (i.e., M2).

H_2: there will be a significant relationship between Private owned enterprise (POE) FAI and Policy uncertainty where FAI increases will cause associated changes in policy uncertainty

This is predicated on investment under uncertainty and more recently Pastor and Veronesi (2013) and Liu et al's (2017) findings detailed in the literature review. Importantly they suggest that more rational investors would demand a higher risk premium to invest under political and policy uncertainty. Should FAI from SOEs be negatively associated with uncertainty but FAI in China be the proximate cause of instability then, by my own definition non-SOE firms FAI should be positively associated with uncertainty. However, if private investors are more rational in making

capital allocation decisions, then this would also mean that their FAI generates more output leading to reduced uncertainty. As the mechanism is relatively complex I only hypothesise there will be a significant association either way.

Other hypotheses that are included for completeness are as below:

H_3 Increases in real GDP will have a negative relationship with policy uncertainty when holding all other control variables constant

H_4 More accommodative monetary policy will have a negative relationship with policy uncertainty when holding all other control variables constant

H_5 Leverage in SOEs will have a positive relationship with policy uncertainty when holding all other control variables constant

The above hypotheses are subsidiary to the predominant H_1 and H_2. They are premised on prior literature (e.g. Chen et al, 2018) and consistent with the arguments put forward in the hypotheses. Regarding H_5 I will look at both Central and Local SOEs (CSOEs and LSOEs) respective levels of leverage and their impacts on policy uncertainty, although it is hypothesised that they should both have positive relationships with the main DV.

CHAPTER 3

Methodology

3.1 Data collection

I collected and organised raw data (see appendix B.1) from CEIC and the NBS in excel prior to exporting to Stata (v.15). Data was available for FAI for all of the previously named entities (see Table 1). For the purposes of the study I first chose to include State Owned and State Holding; Joint owned where the State was listed as a shareholder; LLCs where the state was the sole shareholder for SOE FAI and Private (only) FAI variables all of which came from CEIC. I also collected the Total FAI data as this was later used to extract the residual FAI after deducting both SOE and POE FAI. I used the monthly data from 2004 (the first year the FAI data was available) through to the end of 2017 (the final month the data was collected).

As this data was in nominal terms, I also adjusted the values into real terms. I used the GDP deflator (monthly) from Higgens at al (2016) available on Autor et al's China shock website[10].

In addition, I also collected the China policy uncertainty dataset (i.e., the DV) from the Baker, Bloom's policyuncertainty.com[11] website (see appendix A for more details).

3.2 Analytical models

As the study involves multivariate statistics over time, it was necessary to utilise a multivariate time series model and VAR model to analyse the data.

[10] http://chinashock.info/ [accessed on the 01/08/18]
[11] www.policyuncertainty.com [accessed on the 31/07/18]

The first series of log-linear models were run using lagged variables to account for t-1 effects as well as the lag of the DV on itself:

$$CPU_t = \alpha + \beta_1 lnCPU_{t-1} + \beta_1 lnGDP_{t-1} + \beta_2 lnSOE_{t-1} + \beta_3 lnSH_{t-1} + \beta_4 lnPO_{t-1} + \beta_{5ln} CSOE_{t-1} + \beta_6 lnLSOE_{t-1} + \beta_7 ln\chi_t + \varepsilon_t \quad [1]$$

Where α is the constant term; CPU refers to China Policy Uncertainty (from Baker et al, 2016); GDP is the logarithm of the real form; SOE refers to SOE Fixed Asset Investment (FAI); SH refers to State Held FAI; PO is Private Owned FAI; CSOE and LSOE are the Central and Local SOE leverage levels and the χ variable contains the remaining control variables (e.g., the natural logarithms of i) CPI; ii) CSI300 – the equity index; iii) M2 that is a broad level of money in the system to express monetary policy). These control variables are also hypothesised to have a relative impact on the dependent variable but these are subsidiary to the main hypotheses. Other variables (i.e., the interaction terms between SOE FAI and leverage) are also added sequentially to the model series in the results section.

The *t* refers to the time period and therefore the *t-1* implies that the period is lagged. The ε refers to the error terms.

The second series of these initial regressions was the same as that in equation [1] with IV's detrended for time and run as both linear-log and log-log models (the model below uses nominal variable names to avoid repetition):

$$CPU_t = \alpha + \beta_1 CPU_{t-1} + \beta_1 GDP_t + \beta_2 SOE_{FAI_t} + \beta_3 SH_{FAI_t} + \beta_4 PO_{FAI_t} + \beta_5 CSOE_{lev_t} + \beta_6 LSOE_{lev_t} + \beta_7 \chi_t + \varepsilon_t \quad [2]$$

General results related to the hypotheses from the series of models will be reported with all results displayed for completeness.

The final series of regressions were run using vector autoregression (VAR). The model used for this analysis is a simplified vector of the prior multiple regression.

$$Y_t = [CPU_t \; GDP_t \; CPI_t \; M2_t \; SOE_{FAI_t} \; POE_{FAI_t} \; SH_{FAI_t} \; CSOE_{leverage_t} LSOE_{leverage_t}]' \quad [3]$$

The vector above contains the standard business cycle indicators such as real GDP, CPI inflation rate and leverage (for CSOE and LSOE) and the change in M2 money supply with the latter indicator which are used by the Bank of England, the Fed and the ECB for monetary expansion (Chen et al, 2018). It also includes the changes in the investment rates but here separated between POE and SOE FAI, where the latter is further subdivided into state held (SH) and state owned (SOE) to be consistent with the analysis and question at hand.

This model, unlike the original regression equation, does not include the CSI300 index but does include a measure of CPI as per PBOC's[12] business cycle models. The exclusion of the other variable was done for the purposes of parsimony and given the model was being used to primarily assess causality on CPU at time *t* (i.e., uncertainty).

[12] People's Bank of China, China's Central Bank

Having assessed for violating assumptions on the VAR and using the appropriate lag (see VAR results for more details), post estimation tests were subsequently run assessing Granger causality to identify whether any of the significant variables were “Granger” causing the postulated dependent variable and not the obverse. Further shocks were applied to assess the predictive value for subsequent months (24 in this dataset) using the modelled VAR, impulse variables and the main DV of policy uncertainty as the response variable.

CHAPTER 4

Results

4.1 Regression results

From initial scatterplots it was noted taking the natural logs of variables would potentially be more meaningful. I reran the scatterplots and from a cursory view could see potential hypothesised relationships could be seen. I then ran a regressions based on equation [1]:

Table 3: Multivariate regression Log-Linear model

DV: Policy uncertainty (t) VARIABLES	(1) Main model	(2) w/ Residual FAI	(3) w/ SOE*LSOE
Policy uncertainty (t-1)	0.582***	0.581***	0.583***
	(0.0707)	(0.0794)	(0.0708)
SOE FAI (t-1)	-187.0*	-262.4*	-245.5*
	(104.8)	(137.7)	(125.1)
SH FAI (t-1)	-167.5**	-200.3**	-153.6**
	(65.58)	(87.94)	(67.62)
POE FAI (t-1)	41.00	92.33	47.48
	(127.4)	(160.0)	(127.8)
CSI300 (t-1)	9.551	11.88	8.863
	(27.39)	(47.87)	(27.43)
M2 (t-1)	2.648	106.2	-52.00
	(313.5)	(420.8)	(320.2)
GDP (t-1)	86.82	-32.55	139.1
	(535.0)	(704.6)	(539.0)
CPI (t-1)	400.9	251.9	357.8
	(396.5)	(523.1)	(400.0)
CSOE leverage (t-1)	-5.608	-3.011	-7.134
	(8.488)	(11.94)	(8.681)
LSOE leverage (t-1)	2.666	-2.443	-10.99
	(6.442)	(9.851)	(17.18)
Total FAI less SO SH POE (t-1)		-298.2	
		(211.0)	
SOE*LSOE leverage (t-1)			1.062
			(1.238)
Constant	-2,732	-2,204	-1,392
	(2,804)	(3,544)	(3,212)
Observations	152	121	152
R-squared	0.686	0.649	0.688
Adjusted R-squared	0.664	0.614	0.663

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

These results show that there seems to be a significant relationship in the hypothesised direction (H_1) between SOE FAI and policy uncertainty ($p < 0.10$) when controlling for leverage (both CSOE and LSOE) and the main control variables (i.e., M2, GDP and CPI). When adding residual FAI in Model 2, SOE FAI remains significant and the negative coefficient increases to explain a larger negative relationship with policy uncertainty although the significance remains the same and standard errors increase. When adjusting for interactive effects between SOE FAI and LSOE, SOE FAI remains significant at the $p < 0.10$ level.

POE FAI does not appear to be significant, that is it is neither positively nor negatively associated with policy uncertainty when holding all other variables constant which does not support H_2. Nevertheless, although POE FAI is not significant, it still appears to have a positive relationship with policy uncertainty when inspecting its coefficient.

State Holding (SH) FAI appears to be significantly related to policy uncertainty in the hypothesised direction (H_1): that is it is negatively associated with policy uncertainty across models 1-3 ($p < 0.05$). These results lend further credence to the main hypothesis that SOE and SH FAI are negatively associated with policy uncertainty.

None of the other variables were found to have significant relationships with policy uncertainty aside from the lagged dependent variable (policy uncertainty; $p < 0.01$).

As this is time series data it was also important to ensure that the *t* variable was included in the model to ensure that the variation seen in the DV was not being explained by trend over time. In

turn, it was also prudent to convert the logged variables to lags (i.e., *t-1*) and then to convert these to variables which had been "detrended" for time (i.e., using Stata's predict and residuals commands). This enables us to ensure that it is not simply time which is causing the IVs to have inflated coefficients and in turn low *p* values (i.e., significant results). This was performed and the below results were obtained for models 4 and 5.

Table 4: Log-Linear detrended and Log-Log detrended (dt)

VARIABLES	(4) DV: Policy uncertainty	(5) DV: lnPolicy uncertainty
Policy uncertainty (t-1)	0.333***	
	(0.0431)	
SOE FAI (dt)	-173.5***	-0.599***
	(45.9)	(0.159)
SH FAI (dt)	0.363	0.00701
	(4.903)	(0.0154)
POE FAI (dt)	1,517***	9.107***
	(207.3)	(0.636)
M2 (dt)	696.0***	5.215***
	(94.22)	(0.298)
GDP (dt)	-1,207***	-7.512***
	(140.2)	(0.417)
CPI (dt)	101.0***	0.667***
	(24.93)	(0.0592)
CSI300 (dt)	55.42***	0.447***
	(10.05)	(0.0318)
CSOE leverage (dt)	5.599	-0.0333**
	(4.172)	(0.0130)
LSOE leverage (dt)	-4.068	0.0355***
	(3.068)	(0.00956)
lnPolicy uncertainty (t-1)		0.147***
		(0.0233)
Constant	-322.3***	0.667***
	(75.67)	(0.220)
Observations	153	153
R-squared	0.884	0.963
Adjusted R-squared	0.877	0.961

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

As can be seen from the results of the time adjusted model, SOE FAI was significant ($p < 0.01$) in the hypothesised direction when controlling for all other variables. POE FAI was also found to have a significant positive relationship with policy uncertainty ($p < 0.01$). However, when time adjusted, SH FAI no longer has a significant relationship with policy uncertainty in the hypothesized direction which does not support the main hypothesis (H_1).

Other significant results which displayed a positive relationship with the DV was the CSI equity index and inflation both at 1% level ($p < 0.01$). Real GDP was also found to have a significant positive relationship in the hypothesised direction with policy uncertainty ($p < 0.01$).

CSOE and LSOE leverage were also both found to be significant at the $p < 0.05$ and $p < 0.01$ levels respectively in the log-log model (5) with CSOE being negatively associated and LSOE being positively associated with policy uncertainty. These findings were not surprising given the news media (which is used to construct the DV metric) tends to highlight China's debt problem and specifically debt at the local government levels as being especially egregious.

Even with the adjustment for trend, the overall model is strongly supportive of the main hypotheses with the complete model also being significant at $p < 0.0001$ (from the results of the F-test; $F(9 , 143) = 660.64$) and adjusted R_2 at 0.877 and 0.961 (i.e., the linear-log and log-log models explain 87.7% and 96.1% of the variance in policy uncertainty respectively).

4.2 VAR results and Granger causality

Given the nature of the data (i.e., multivariate time series), the potential for endogeneity of the variables and in spite of the controls and number of models run, I next perform a VAR and subsequent granger causality to test for the nature of the causal relationship between the hypothesised independent variables and the main DV. This is important as it is entirely plausible that uncertainty could be causing increases in FAI (i.e., in both SH/SOEs and POEs) rather than the obverse as is the hypothesised relationship and significance could be overstated.

4.2.1 Pre-estimation checks for VAR

The results satisfy the assumptions of stability and do not suffer from autocorrelation at lag order 4: the pre-estimation selection order criteria AIC and LR both suggest that a lag 4 model should be used (see Appendix B). They also do not suffer from normal distribution violations as per the Jarque-Bera test.

4.2.2 Granger causality results

Having run the model at lag 4 (see Table 5), the Granger causality wald tests were performed. As hypothesised, SOE FAI and SH FAI were both found to granger cause policy uncertainty being significant in the desired direction and not in the undesired direction where uncertainty causes SOE or SH FAI ($p > 0.10$). This supports H_1.

Note: an "x" indicates that the excluded causal variable Granger causes the equation variable in a unidirectional way. All variables were natural logs.

Equation	Excluded (i.e., causal variable)	F	Prob > F	Causal	Equation	Excluded (i.e., causal variable)	F	Prob > F	Causal	Equation	Excluded (i.e., causal variable)	F	Prob > F
Policy Uncertainty	SOE FAI	1.999	*0.0987*	x	POE FAI	Policy Uncertainty	0.2062	0.9346		M2	Policy Uncertainty	0.635	0.6383
Policy Uncertainty	SH FAI	4.471	*0.0021*	x	POE FAI	SOE FAI	2.0388	0.0928		M2	SOE FAI	4.421	0.0022
Policy Uncertainty	POE FAI	5.028	*0.0009*	x	POE FAI	SH FAI	0.29013	0.8839		M2	SH FAI	0.653	0.626
Policy Uncertainty	rGDP	0.395	0.8122		POE FAI	rGDP	2.0616	0.0897		M2	POE FAI	2.974	0.0218
Policy Uncertainty	CPI	1.037	0.3907		POE FAI	CPI	0.71099	0.5859		M2	rGDP	1.859	0.1216
Policy Uncertainty	M2	0.612	0.6544		POE FAI	M2	10.67	0.0000		M2	CPI	0.596	0.6659
Policy Uncertainty	CSOE leverage	0.368	0.8309		POE FAI	CSOE leverage	1.6006	0.1782		M2	CSOE leverage	0.19	0.9435
Policy Uncertainty	LSOE leverage	0.481	0.7499		POE FAI	LSOE leverage	1.1753	0.3249		M2	LSOE leverage	0.216	0.929
Policy Uncertainty	ALL	1.731	0.0174		POE FAI	ALL	4.276	0.0000		M2	ALL	2.304	0.0006
SOE FAI	Policy Uncertainty	0.55	0.6996		rGDP	Policy Uncertainty	0.62266	0.6472		CSOE leverage	Policy Uncertainty	0.799	0.5278
SOE FAI	SH FAI	33.23	0.0000		rGDP	SOE FAI	2.2682	0.0655		CSOE leverage	SOE FAI	0.142	0.9664
SOE FAI	POE FAI	6.14	0.0002		rGDP	SH FAI	5.9512	*0.0002*	x	CSOE leverage	SH FAI	0.405	0.8047
SOE FAI	rGDP	0.441	0.7784		rGDP	POE FAI	5.6323	0.0003		CSOE leverage	POE FAI	0.416	0.7969
SOE FAI	CPI	1.008	0.406		rGDP	CPI	1.8579	0.1219		CSOE leverage	rGDP	0.557	0.6942
SOE FAI	M2	0.348	0.8447		rGDP	M2	1.8306	0.1269		CSOE leverage	CPI	0.751	0.5591
SOE FAI	CSOE leverage	0.729	0.5737		rGDP	CSOE leverage	1.7838	0.1361		CSOE leverage	M2	0.775	0.5432
SOE FAI	LSOE leverage	0.384	0.8194		rGDP	LSOE leverage	1.4963	0.2072		CSOE leverage	LSOE leverage	0.53	0.7142
SOE FAI	ALL	4871	0.0000		rGDP	ALL	2.1199	0.0017		CSOE leverage	ALL	0.721	0.8584
SH FAI	Policy Uncertainty	0.183	0.9468		CPI	Policy Uncertainty	0.79264	0.532		LSOE leverage	Policy Uncertainty	1.06	0.3793
SH FAI	SOE FAI	2.141	0.0795		CPI	SOE FAI	1.6838	0.1577		LSOE leverage	SOE FAI	0.198	0.9389
SH FAI	POE FAI	1.317	0.2674		CPI	SH FAI	1.8129	0.1303		LSOE leverage	SH FAI	0.164	0.9564
SH FAI	rGDP	1.833	0.1265		CPI	POE FAI	0.66108	0.6202		LSOE leverage	POE FAI	0.346	0.8463
SH FAI	CPI	0.631	0.6416		CPI	rGDP	0.52344	0.7187		LSOE leverage	rGDP	0.155	0.9605
SH FAI	M2	10.62	*0.0000*	x	CPI	M2	0.8346	0.5056		LSOE leverage	CPI	1.432	0.227
SH FAI	CSOE leverage	1.595	0.1798		CPI	CSOE leverage	1.2253	0.3034		LSOE leverage	M2	1.033	0.3929
SH FAI	LSOE leverage	1.156	0.3337		CPI	LSOE leverage	0.37686	0.8248		LSOE leverage	CSOE leverage	0.3	0.8774
SH FAI	ALL	3.282	0.0000		CPI	ALL	1.1695	0.267		LSOE leverage	ALL	0.958	0.5384

Table 5: Granger Causality results

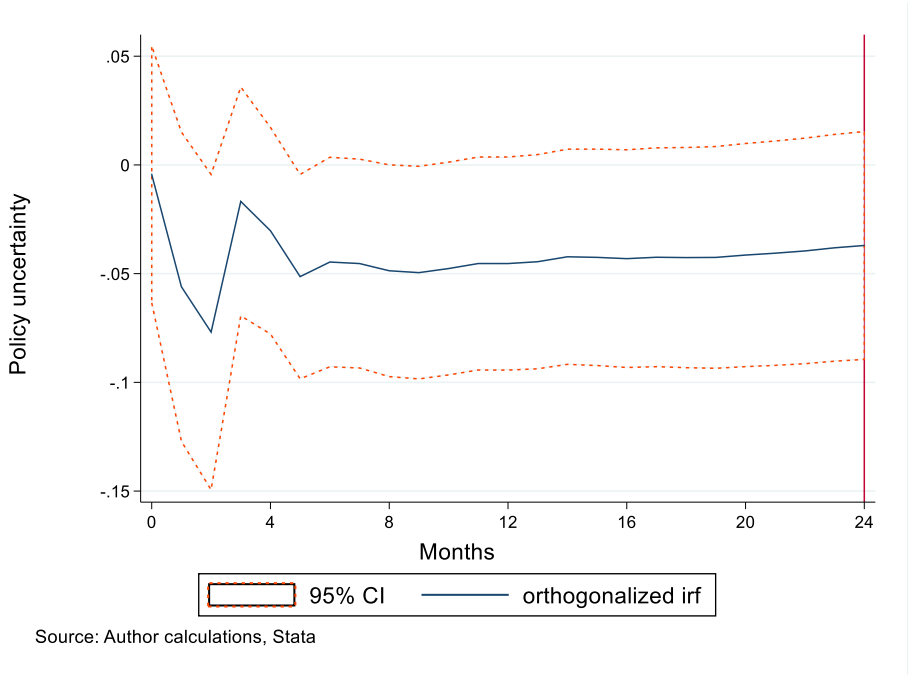
The results also confirm that POE FAI granger causes uncertainty ($p = 0.0009$). These results enhance the persuasiveness of the original regression and enable me to reject the null for H_2.

Interestingly, the results indicate SH FAI is being caused by i) M2 ($p < 0.0001$) and is Granger causing ii) rGDP ($p = 0.0000$). This suggests that SH FAI increases as a consequence of accommodative monetary policy and SH FAI causes real GDP to increase whilst causing uncertainty to decline (from the original multiple regression). However, the sequencing of the causation is not definitive. This would suggest that not only is SH FAI increasing real GDP but it also reduces uncertainty whilst having no causal impact on leverage (as the results also indicate there is no causation between SH FAI and LSOE or CSOE leverage). Further models which can analyse the sequencing of this causal chain would be beneficial for policy making and academics alike.

Subsequent to running these models of granger causality I next assessed the relative impact of some of the predominant variables on policy uncertainty using an impulse-response orthogonal irf (see Figure 6, p.40).

Figure 6: SOE FAI impulse response on China Policy Uncertainty

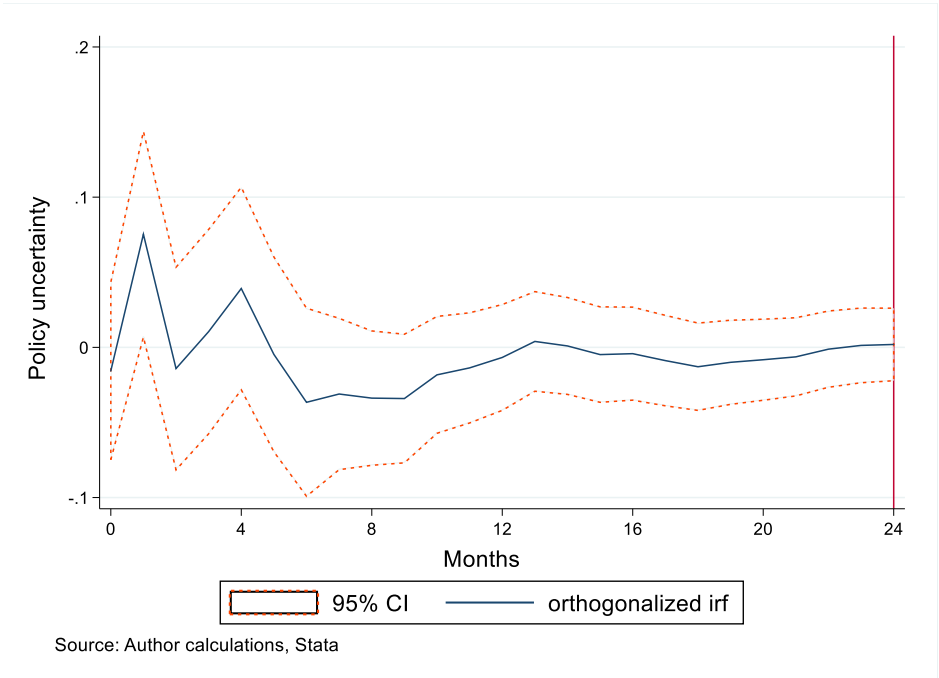
Note: red vertical line at point (24, 0) indicates time period 24, dashed line is the 95% confidence interval



Source: Author calculations, Stata

Figure 7: SH FAI impulse response on China Policy Uncertainty

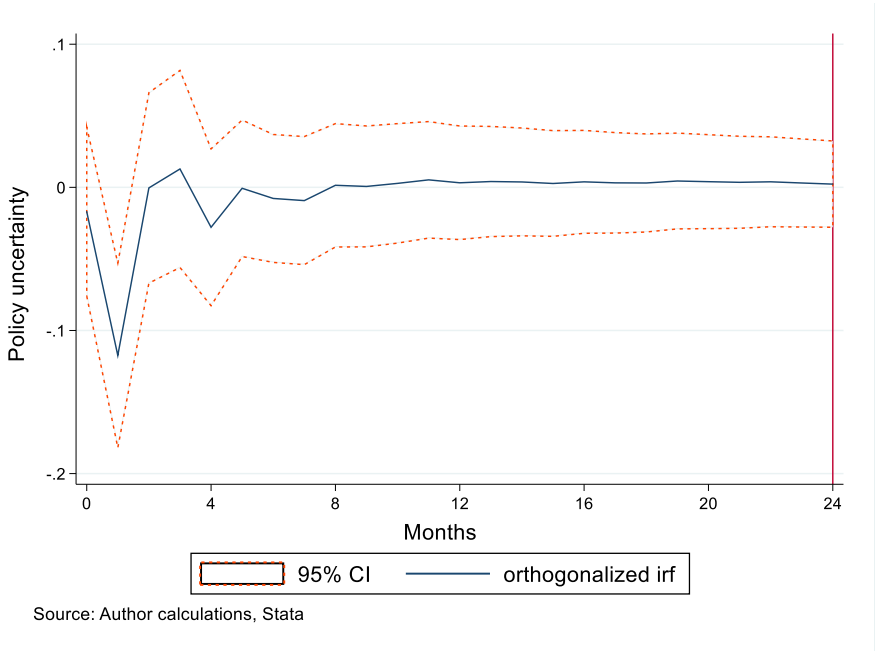
Note: red vertical line at point (24, 0) indicates time period 24, dashed line is the 95% confidence interval



Source: Author calculations, Stata

Figure 8: POE FAI impulse response on China Policy Uncertainty

Note: red vertical line at point (24, 0) indicates time period 24, dashed line is the 95% confidence interval



As can be noted from Figure 6, an impulse shock to SOE FAI on uncertainty leads to a decline in uncertainty which persists over the entire 24 month period at .05 standard deviations (sd) below the mean. Interestingly a shock of POE FAI (see Figure 8) on policy uncertainty leads to a decline over the first 1.5 months (of 1sd) before trending toward 0 deviations by month 6 through to month 24 (i.e., the end of the oirf model time line). A shock from SH FAI (see Figure 7) however leads to an increase in uncertainty over time period 1, a decline below 0 at month 2 before a further increase to 0.25 sd's above the mean by month 4. Between periods 4-6 uncertainty declines to 0.4 standard deviations below the mean for a sustained period of 3 time periods before gradually approaching 0 by time period 13 after which it settles at 0.

These result should be interpreted with some caution although they lend some additional credence to the original hypotheses that increases to SOE FAI will lead to reductions in policy uncertainty

although the increase in SH FAI will ultimately lead to reduced uncertainty this occurs after 2 elevated periods of higher uncertainty. Most strikingly from this oirf analysis is that POEs FAI leads to the greatest initial decline but this decline is not prolonged whereas the SOE FAI's impact is both impactful and sustained.

The model was tested with all orders with little variation of results however caution is still necessary when extrapolating too much from the results given the models: i) relative simplicity and ii) limited predictive power.

CHAPTER 5

Conclusion

5.1 Discussion

This thesis has sought to explore the positive impacts of SOE FAI as well as the rationality they may exhibit in their investment behaviour. Contrary to conventional wisdom that SOEs are inefficient zombies requiring reform, there does appear to be reasonable evidence in support of the contrarian view: that SOE zombie-like behaviour can – when viewed through a lens of *policy uncertainty* - be quite rational. Specifically, SOEs in their role as stability mechanisms appear to serve a purpose in reducing uncertainty. This is in line with the original reform agenda put forward by Jiang Ze Min and the current intentions of the CCP: to reduce the number of SOEs whilst not completely doing away with them.

Rather than characterising SOEs as zombies at the outset, I sought to establish the social stability mechanism they may play using a relatively recent metric of *policy uncertainty*. I identified from initial regression models, that there was indeed a significant difference in the impact of FAI on uncertainty dependent on the type of enterprise that was increasing their investment. Both regression models and adapted models identified that the posited relationships from my hypotheses were supported.

On implementation of VAR(4) models and subsequent tests on Granger causality, it was also identified that the predominant causal variable – that is SOE and SH FAI - did have significant relationships with policy uncertainty whereas the obverse was not true. This is perhaps the most important find of the thesis, as typically uncertainty is assumed to be the independent variable.

However, whereas the initial regressions identified relatively robust results when the model was time-adjusted (and which would have enabled me to reject the null hypotheses) for SOE FAI, the VAR(4) model subsequent oirf results suggests that this may lead to a Type 1 error for SH FAI: that is rejecting the null when it is true. As such it is prudent to conclude only on a precautionary basis that initial results *appear* promising and further research with more sophisticated methods can seek to refute my claims.

Interestingly, SH FAI was also found to Granger cause GDP whilst also causing declines in policy uncertainty in the initial regressions. This may suggest that SH FAI is the more efficient form of investment in the economy not POE FAI as has been documented in prior research (e.g., Lardy, 2014; Freund & Sidhu, 2017). It also tentatively suggests that POE FAI *relative* to SH FAI could be "inefficient" when framed in terms of uncertainty. However, prior to making this claim and to steelman the Lardy "Markets over Mao" argument: i) more sophisticated models ought to be run on the data; ii) some of the POEs may have political connections which lead to SOE-type profligacy undermining their true causal mechanisms and efficiency; iii) the sequencing of causation is not definitive from my results and iv) the subsequent oirf suggests a different relationship between POE and SH FAI with uncertainty (see below).

Further to the granger causality results, I ran oirf models to assess the relationship between FAI shocks on policy uncertainty over a short duration (here 24 months ex-post). These results also exhibited a negative relationship between SOE FAI and policy uncertainty over the near term, supportive of the initial hypothesis that SOE FAI would have a negative relationship with policy uncertainty. However, results for SH FAI were less consistent. POE FAI as discussed above also

appears to also have a *negative* impact on uncertainty over the near term when shocked on uncertainty.

Evidently, there may be reasons for why I did not identify more consistently robust results or for why I unearthed any significant findings at all. Ability notwithstanding it is also important that these measures be properly assessed in models that are more accurately defined and the ordering of the variables into an oirf be sequenced accurately. Further research is therefore necessary to either confirm or deny this paper's results and implication/s.

Nevertheless, if we are to make any policy recommendations based on the current thesis, my results are indicative of FAI-uncertainty relationships dependent on firm type. They lend credence to the continued use of SOEs within China's state capitalist model: private investment will tend to decline in uncertain times as individuals become more risk averse which further causes the economy to contract and potential political ramifications to manifest themselves. As discussed in the introduction, Summers (2014, 2016) secular stagnation hypothesis proposes a lack of investment demand for the absence of any real recovery in the US and EU post the GFC. Similarly, the IMF (2014) found that fiscal expansions through public investment in infrastructure at a current cost of 1% of GDP can lead to 6-7% reductions in debt burdens 4-5 years hence. Assuming a recession is an uncertain event, these results are fairly consistent with my finding that SOE FAI (i.e., public investment) reduces uncertainty. Summers states he finds it "hard to make a *rational* case against a substantial increase in public investments in Europe and the United States" (italics added; Summers, 2015: 64). Similarly, China's SOEs could also be considered "rational" and not

inefficient allocators of capital if used as tools to increase public investment so as to reduce uncertainty of recessionary events.

5.2 Policy recommendations

The results suggest that SOEs can act via investment to reduce policy uncertainty. If we assume that prior research on private investors' investment under uncertainty and more specifically high risk situations displays a negative relationship, this implies that as uncertainty reduces as a result of SOE and state intervention, private investors will begin to gradually increase their investment as risk subsides. As of the third plenum of the 18th party congress in 2013 and the third plenary of the 19th in 2018[13], the CCP stated that the Party will provide a leadership role and the market will be allowed to play a deciding role in capital allocation – the visible and invisible hands would work together.

From this cursory analysis the analogy of the visible hand of the state and the invisible hand of the market coordinating toward a positive outcome theoretically appears possible. However, the sequencing of FAI is only discretionary at the level of the state hence my defining them earlier as *discretionary* as opposed to automatic stabilisers. I am by no means arguing in favour of complete state control but to continue to reduce SOEs in number and in kind is from the macro analysis net negative. If China does experience a recession at some stage in the future these discretionary stability mechanisms will be of great value. Thus, even if many SOEs continue to be zombie-like in terms of efficiency, the state and party should continue to sustain them at least over the short term.

[13] http://www.xinhuanet.com/english/2017-10/24/c_136702726.htm [accessed on the 18/08/2018]

To extrapolate to other transitional economies without assessing institutional variance would likely lead to unintended consequences. However, the results do suggest that if this dynamic is replicated across other economies controlling for these institutional differences, then there may be a case for the model being applied – in an incremental and gradual way as Deng would advise – in these other developmental and transition economies. Schick's (1998) pragmatic warning over budgeting reform – to get the principles and basics in place *prior* to implementing any more significant reforms – is a useful heuristic in this context to rely.

The current policies that the Xi administration has taken with respect to SOEs and the continuation of a gradual approach to reform make intuitive sense: there does appear to be a need for flexibility in the system to reverse course should any unplanned events appear on the horizon. Indeed, over the short term escalations over unfair trade with the US means that the brakes may need to be pulled on rebalancing. And SOEs are one of the ways in which this can be done without having to rely on the "invisible hand" of the market. If we assume that inefficient investment over the long term will require adjustment then state-led investment may be causing increased fragility however, given the *uncertainty* that arises and the onus on the party to maintain stability from any form or cause of crisis, this increased fragility may be a necessary cost to bear. Over the short run until uncertainties over the US-China trade frictions can reach some form of equilibrium, the CCP and State council stalling their rebalancing agenda may be the correct course of action at least based on the investment-uncertainty relationship identified in the current study.

The state's role in providing investment where there is an absence of private sector risk-taking as a result of uncertainty, as well as this thesis' finding that SOE FAI Granger causes uncertainty to

decline, suggests that China's SOEs play an important and rational stabilising role. Again, given the thesis adopts a relatively simplistic model I suggest not to extrapolate too much from my results. However, the notion that China's SOEs are zombies that require complete substitution by the market would be ill-advised especially in the context of the current environment.

China's SOEs then are certainly more rational than the stereotypical zombie. They have a role to play as state discretionary stabilisation mechanisms. With a current rise in trade policy rhetoric and action on the part of the US administration, SOEs' stabilising role for the domestic economy and in turn CCP legitimacy is one that the Party can ill afford to dismiss. The state capitalist SOE model may not be completely efficient long term, however over the short and medium term as mechanisms to hedge risk and uncertainty they are tools that can be used to the the CCPs and State Council's political economic advantage. A rational zombie then – at least one with Chinese characteristics – does appear theoretically plausible.

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Appendix

Appendix A

As Baker et al (2014) point out, the difficulty with measuring any form of uncertainty is that by definition it is not observed. Unlike risk.

For the US metric Baker, Bloom and Davis take 10 major US newspapers, take monthly counts of articles with the following text:

E {economic or economy}

P {regulation or deficit or federal reserve or congress or legislation or white house}

U {uncertain or uncertainty}

Where any words within {} are included in the count aside from "or".

They then divide the sum of the count by the total sum of the count of all articles; normalise the numbers and sum the 10 papers to derived the index.

For China, the South China Morning Post (SCMP) of Hong Kong is used with the same algorithm but the additional term sets:

1) {China, Chinese}
2) They then identify the subset of the China EU articles that also discuss policy. This requires {policy or spending or budget or political or interest rates or reform} AND {government or Beijing or authorities}} or tax or regulation or regulatory or "central bank" or "People's Bank of China" or PBOC or deficit or WTO.
3) An automate search is then conducted using the above requirements in 2 over all articles since 1995. This generates the monthly frequency count of articles.

4) This is then divided by the total number of SCMP articles for the month
5) This is then normalized to a mean of 100 for January 1995 to December 2011.

Human audit verification was performed over 500 randomly selected articles on economic uncertainty from Jan 1995-Feb 2012. Human readings are considered correct. 492 of the 500 articles were assessed as pertaining to economic uncertainty in China (i.e., 8 were incorrectly flagged by the algorithm – 1.6%).

Additionally, the following results were found:

1) Policy-related economic uncertainty count produced by automated algorithm has an 0.82 correlation with human readings;
2) The net error rate from automated search is close to having a zero correlation (-0.15) with the true count over quarterly time series;
3) The overall false positive rate via algorithm was 0.11 and the false negative rate was 0.21.

Additionally, academics and financial institutions have corroborated the validity of the metric identifying high correlations with other measures of ex-ante and ex-post risk (see policyuncertainty.com; Bloom, 2015).

Appendix A.1 Data Appendix

Variable name	Variable name in data set	Description	Source
Main variables			
China Policy Uncertainty	*CPU_Baker*	Monthly index of policy uncertainty for China from SCMP	Baker et al (2013); policyuncertainty.com
lnChina Policy Uncertainty	*CPU_log*	Natural logarithm for Monthly index of policy uncertainty for China from SCMP	Baker et al (2013); policyuncertainty.com
POE FAI	*POE_real_log*	Private Owned Entity Fixed Asset Investment adjusted for CPI (all FAI are monthly)	CEIC database, NBS
SOE FAI	*SOE_FAI_log* *SOE_FAI_real_log*	State Owned Entity Fixed Asset Investment adjusted for SH, Joint Operating (JO) and LLC (State) variables and CPI	CEIC database, NBS
SH FAI	*SOH_real_log*	State Holding Entity Fixed Asset Investment adjusted for SOE, Joint Operating (JO) and LLC (State) variables and CPI	CEIC database. NBS
rGDP	*rGDP_log*	natural logarithm of monthly GDP adjusted for the GDP deflator	GDP from CEIC database adjusted for inflation from Higgens et al, 2016.
Control Variables			
CPI	*CPI_log*	natural logarithm of monthly Consumer Price Inflation	Chen et al, 2018; CEIC Datatbase
CSI300	*CSI300_log*	natural logarithm of the monthly CSI300 equity index	CEIC database
M2	*M2_log*	natural logarithm of the monthly M2 money supply	Chen et al, 2018; CEIC database, PBOC
Residual FAI	*Residual_FAI_real_log*	natural logarithm of Total FAI less SOE, SH, POE FAI	CEIC database, NBS
CSOE leverage	*CSOE_leverage*	natural logarithm of CSOE leverage calculated from Total Liabilities and Total Assets in CSOE independent variables (= Total liabilities/Total Assets).	CEIC database, NBS
LSOE leverage	*LSOE_leverage*	natural logarithm of LSOE leverage calculated from Total Liabilities and Total Assets in LSOE (= Total liabilities/Total Assets).	CEIC database, NBS

Appendix B Granger causality results

VAR Granger test for causality

```
. vargranger

  Granger causality Wald tests
```

Equation	Excluded	F	df	df_r	Prob > F
CPU_log	SOE_FAI_log	1.9986	4	127	0.0987
CPU_log	SOH_real_log	4.4712	4	127	0.0021
CPU_log	PO_real_log	5.0276	4	127	0.0009
CPU_log	M2_log	.61243	4	127	0.6544
CPU_log	rGDP_log	.39456	4	127	0.8122
CPU_log	CPI_log	1.0373	4	127	0.3907
CPU_log	CSOE_leverage	.36817	4	127	0.8309
CPU_log	LSOE_leverage	.4807	4	127	0.7499
CPU_log	ALL	1.7305	32	127	0.0174
SOE_FAI_log	CPU_log	.54961	4	127	0.6996
SOE_FAI_log	SOH_real_log	33.231	4	127	0.0000
SOE_FAI_log	PO_real_log	6.1398	4	127	0.0002
SOE_FAI_log	M2_log	.34847	4	127	0.8447
SOE_FAI_log	rGDP_log	.44147	4	127	0.7784
SOE_FAI_log	CPI_log	1.008	4	127	0.4060
SOE_FAI_log	CSOE_leverage	.72908	4	127	0.5737
SOE_FAI_log	LSOE_leverage	.38448	4	127	0.8194
SOE_FAI_log	ALL	4871.1	32	127	0.0000
SOH_real_log	CPU_log	.1832	4	127	0.9468
SOH_real_log	SOE_FAI_log	2.1408	4	127	0.0795
SOH_real_log	PO_real_log	1.3166	4	127	0.2674
SOH_real_log	M2_log	10.623	4	127	0.0000
SOH_real_log	rGDP_log	1.8331	4	127	0.1265
SOH_real_log	CPI_log	.63052	4	127	0.6416
SOH_real_log	CSOE_leverage	1.5945	4	127	0.1798
SOH_real_log	LSOE_leverage	1.1555	4	127	0.3337
SOH_real_log	ALL	3.2818	32	127	0.0000
PO_real_log	CPU_log	.2062	4	127	0.9346
PO_real_log	SOE_FAI_log	2.0388	4	127	0.0928
PO_real_log	SOH_real_log	.29013	4	127	0.8839
PO_real_log	M2_log	10.67	4	127	0.0000
PO_real_log	rGDP_log	2.0616	4	127	0.0897
PO_real_log	CPI_log	.71099	4	127	0.5859
PO_real_log	CSOE_leverage	1.6006	4	127	0.1782
PO_real_log	LSOE_leverage	1.1753	4	127	0.3249
PO_real_log	ALL	4.276	32	127	0.0000
M2_log	CPU_log	.63523	4	127	0.6383
M2_log	SOE_FAI_log	4.4206	4	127	0.0022
M2_log	SOH_real_log	.65278	4	127	0.6260
M2_log	PO_real_log	2.9742	4	127	0.0218
M2_log	rGDP_log	1.8592	4	127	0.1216
M2_log	CPI_log	.59638	4	127	0.6659
M2_log	CSOE_leverage	.18954	4	127	0.9435
M2_log	LSOE_leverage	.21615	4	127	0.9290
M2_log	ALL	2.3037	32	127	0.0006
rGDP_log	CPU_log	.62266	4	127	0.6472
rGDP_log	SOE_FAI_log	2.2682	4	127	0.0655
rGDP_log	SOH_real_log	5.9512	4	127	0.0002
rGDP_log	PO_real_log	5.6323	4	127	0.0003
rGDP_log	M2_log	1.8306	4	127	0.1269
rGDP_log	CPI_log	1.8579	4	127	0.1219
rGDP_log	CSOE_leverage	1.7838	4	127	0.1361
rGDP_log	LSOE_leverage	1.4963	4	127	0.2072
rGDP_log	ALL	2.1199	32	127	0.0017
CPI_log	CPU_log	.79264	4	127	0.5320
CPI_log	SOE_FAI_log	1.6838	4	127	0.1577
CPI_log	SOH_real_log	1.8129	4	127	0.1303
CPI_log	PO_real_log	.66108	4	127	0.6202
CPI_log	M2_log	.8346	4	127	0.5056
CPI_log	rGDP_log	.52344	4	127	0.7187
CPI_log	CSOE_leverage	1.2253	4	127	0.3034
CPI_log	LSOE_leverage	.37686	4	127	0.8248
CPI_log	ALL	1.1695	32	127	0.2670
CSOE_leverage	CPU_log	.79928	4	127	0.5278
CSOE_leverage	SOE_FAI_log	.14152	4	127	0.9664
CSOE_leverage	SOH_real_log	.40515	4	127	0.8047
CSOE_leverage	PO_real_log	.41596	4	127	0.7969
CSOE_leverage	M2_log	.77538	4	127	0.5432
CSOE_leverage	rGDP_log	.55715	4	127	0.6942
CSOE_leverage	CPI_log	.75109	4	127	0.5591
CSOE_leverage	LSOE_leverage	.5296	4	127	0.7142
CSOE_leverage	ALL	.72052	32	127	0.8584
LSOE_leverage	CPU_log	1.0597	4	127	0.3793
LSOE_leverage	SOE_FAI_log	.19815	4	127	0.9389
LSOE_leverage	SOH_real_log	.16363	4	127	0.9564
LSOE_leverage	PO_real_log	.34621	4	127	0.8463
LSOE_leverage	M2_log	1.0331	4	127	0.3929
LSOE_leverage	rGDP_log	.15483	4	127	0.9605
LSOE_leverage	CPI_log	1.4324	4	127	0.2270
LSOE_leverage	CSOE_leverage	.30015	4	127	0.8774
LSOE_leverage	ALL	.95796	32	127	0.5384

Appendix B.1 VAR pre-estimation checks

AIC and LR pre-estimation for lag order

```
. varsoc CPU_log rGDP_log CPI_log M2_log SOE_FAI_real_log SOH_real_log PO_real_log CSOE_leverage LSOE_leverage

   Selection-order criteria
   Sample:  5 - 168                          Number of obs      =       164
```

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	23.1137				6.8e-12	-.172118	-.103058	-.002003
1	1875.66	3705.1	81	0.000	2.8e-21	-21.7763	-21.0857*	-20.0751*
2	1981.95	212.59	81	0.000	2.1e-21	-22.0848	-20.7726	-18.8526
3	2087.36	210.81	81	0.000	1.6e-21*	-22.3824	-20.4487	-17.6192
4	2171.11	167.51*	81	0.000	1.6e-21	-22.416*	-19.8608	-16.1218

```
   Endogenous:  CPU_log rGDP_log CPI_log M2_log SOE_FAI_real_log SOH_real_log
                PO_real_log CSOE_leverage LSOE_leverage
    Exogenous:   cons
```

Stability test

```
. varstable

   Eigenvalue stability condition
```

Eigenvalue	Modulus
.9965401	.99654
.973414 + .03141979*i*	.973921
.973414 - .03141979*i*	.973921
.9383742 + .07581301*i*	.941432
.9383742 - .07581301*i*	.941432
.7575116 + .4796863*i*	.896617
.7575116 - .4796863*i*	.896617
-.4082668 + .754798*i*	.858139
-.4082668 - .754798*i*	.858139
.845349	.845349
.7973316 + .07871073*i*	.801207
.7973316 - .07871073*i*	.801207
-.4512075 + .5585529*i*	.718032
-.4512075 - .5585529*i*	.718032
.1181384 + .6974682*i*	.707403
.1181384 - .6974682*i*	.707403
-.1416659 + .6920468*i*	.706398
-.1416659 - .6920468*i*	.706398
-.6188966 + .2008926*i*	.650685
-.6188966 - .2008926*i*	.650685
.6215214 + .1583012*i*	.641364
.6215214 - .1583012*i*	.641364
-.4639409 + .3500274*i*	.581171
-.4639409 - .3500274*i*	.581171
-.5523386	.552339
.156712 + .5203104*i*	.543398
.156712 - .5203104*i*	.543398
-.1807058 + .4962389*i*	.528117
-.1807058 - .4962389*i*	.528117
.4932606 + .170028*i*	.521743
.4932606 - .170028*i*	.521743
.06232115 + .393561*i*	.398465
.06232115 - .393561*i*	.398465
.194933 + .3108308*i*	.366899
.194933 - .3108308*i*	.366899
-.1259383	.125938

```
   All the eigenvalues lie inside the unit circle.
   VAR satisfies stability condition.

.
```

Autocorrelation Lagrange Multiplier Test

```
. varlmar, mlag(4)

  Lagrange-multiplier test
```

lag	chi2	df	Prob > chi2
1	76.6562	49	0.00698
2	63.7568	49	0.07655
3	65.3684	49	0.05888
4	48.7602	49	0.48278

```
  H0: no autocorrelation at lag order
.
```