GDP Manipulation, Cost of Equity, and Firm Performance

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Abstract

We use satellite night lights data to estimate the extent of gross domestic product (GDP) manipulation in China and investigate how such manipulation costs local firms. Firms located in provinces that manipulate GDP more have higher cost of equity, lower investment efficiency, and poorer profits growth. In a difference-in-difference test, we show that cost of equity decreases and firm performance improves after unexpected top government official turnover which significantly lowers GDP manipulation. Our findings are consistent with the notion that local firms may collude with local government officials by engaging in costly data manipulation; we also show that firms located in provinces with greater GDP manipulation receive more subsidies and have lower managerial pay-performance sensitivity. Our results are more pronounced for state-owned enterprises.

Keywords: GDP manipulation; economic growth; cost of equity; China

JEL Classification: G12; G38; O11; R11

1. Introduction

Gross domestic product (GDP), an important macroeconomic indicator, can substantially influence decisions about investment and capital raising (Erel et al., 2011; Jeon and Nishihara, 2014). However, government officials and policymakers around the world have been known to manipulate GDP figures for various reasons (Magee and Doces, 2015; Zhou and Zeng, 2018; Chan et al., 2019; Martinez, 2019), particularly in China where the economy-first policy historically created strong incentives for manipulation (Lyu et al., 2018; Li and Zhou, 2005; Zhou and Zeng, 2018). Since 2017, two provinces (Inner Mongolia and Liaoning) and one municipality (Tianjin) have officially admitted to manipulating GDP figures. In February 2019, the state-run television broadcaster CCTV disclosed details of GDP manipulation in the wake of calls to curb GDP manipulation. While the rampant GDP manipulation by local government officials has been well documented, it remains unclear whether and how such manipulation costs local firms. We aim to address this question by investigating how GDP manipulation affects local firms' cost of equity and metrics of firm performance.

We argue that firms play an important part in GDP manipulation (Chen et al., 2020) as they report accounting data directly to China's National Bureau of Statistics. Given that China's GDP growth is largely driven by sizable industrial firms, it is very difficult for local governments to manipulate economic data in a large scale without colluding with local firms. A 2018 report by Securities Times, an influential state-run newspaper in China, suggested that local firms can "help" local governments achieve GDP manipulation goals by artificially inflating investment levels or falsifying key accounting items such as revenue and profit.[1] Such collusion activities can impose substantial costs to firms. First, data falsification is a serious breach of financial reporting guidelines and can substantially increase the perceived investment risk. Risk-averse investors, wary of the potential firm-government collusion, may assign greater risk to firms located in provinces that manipulate GDP figures and demand higher risk premium (Francis et al., 2004). Second, inflated investment and profit figures can herald poorer future firm performance, such as investment efficiency and profit growth (Hao and Lu, 2018). On the other hand, firms that collude with local governments in GDP manipulation may receive benefits in return, such as government subsidies or cheaper loans (Lyu et al., 2018; Chen et al., 2020; Cai et al., 2022). How such costs and benefits influence firms is an empirical question.

We analyze a sample of publicly-listed firms in China and examine how GDP manipulation affects their cost of equity and firm performance. To measure GDP manipulation, we estimate the gap between the economic growth implied by satellite night lights data and the official GDP figures for each province of China, following Henderson et al. (2012) and the previous literature (Chan et al., 2019; Martinez, 2019; Trinh, 2019; Chen and Zhang, 2020; Li et al., 2020). We show that firms located in provinces that

[1] For example, 28 firms in Yunnan Province were found in 2013 to have inflated their revenue by 125%. In 2018, the National Bureau of Statistics penalized 97 firms for severe data falsification.

manipulate GDP figures more are associated with higher cost of equity, lower investment efficiency, and lower profit growth.

To account for possible endogeneity arising from regional effects such as industrial structure or economic development, we use a quasi-natural experiment of unexpected top government official turnover to help with identification. Top government officials can be replaced unexpectedly if they are involved in corruption scandals, and the central government often sends a team to investigate all illegal activities in the province which effectively deters subsequent GDP manipulation activities. We find that firms located in provinces with unexpected top government official turnover due to corruption have significantly lower post-turnover cost of equity (by approximately 6% after accounting for other determinants of cost of equity), higher investment efficiency, and higher profit growth compared to firms in other provinces.

A natural question, as in all studies on collusion, is why firms are willing to collude with local government officials at the cost of firm value and financial performance. The literature suggests that firms may make politically-influenced decisions (such as overinvestment or over-hiring) in exchange for political benefits (Chen et al., 2013; Chen et al., 2017; Hao and Lu, 2018; Deng et al., 2020; Cai et al., 2022). Consistent with the notion, we show that firms located in provinces with greater GDP manipulation receive greater government subsidies; in addition, although we cannot observe managerial personal benefits, we show that managers of colluding firms may not care much about the worsening firm performance because they have lower managerial pay-performance sensitivity.

Our findings are robust to various measures of GDP manipulation, cost of equity, and firm performance. Specifically, our results hold when we (a) measure GDP manipulation using the paper management forecast error proposed by Lyu et al. (2018), (b) measure cost of equity using the GLS model (Gebhardt et al., 2001) and the CT model (Claus and Thomas, 2001), and (c) measure firm performance with EPS over the next three and five years. Finally, we show that our results are more pronounced for state-owned firms which are more closely tied to local government officials, as compared to firms that are not state-owned. This finding suggests that our results are unlikely driven by omitted regional characteristics or uncertainty aversion (Bernstein and Arnott, 2003; Cornell, 2010; Leuz and Verrecchia, 2005; Pástor and Veronesi, 2013; Savor and Wilson, 2013), as these factors will affect state-owned and non-state-owned firms alike.

Our paper contributes to the literature by providing comprehensive evidence on the cost of GDP manipulation in forms of higher cost of equity and poorer firm performance. This fills a gap in the strand of literature related to GDP manipulation, which largely focuses on the causes (e.g., Ma et al., 2014; Wallace, 2015; Lyu et al., 2018; Xiong, 2018; Chen et al., 2019) or the means of manipulation (Chen et al., 2020; Cai et al., 2022), but not so much on the consequences. Many of these studies (e.g. Lyu et al., 2018; Chen et al., 2020; Cai et al., 2022) suggest that firms may benefit from GDP manipulation by gaining access to cheaper loans or government subsidies; as such, findings in our study on costs associated with GDP manipulation are timely and critical to help assess the overall effect of GDP manipulation on firms.

Further, because the government-firm collusion in data manipulation can be considered a manifestation of government connection, our paper also contributes to the literature on how government connection affects firm performance, decisions, and value (Boardman and Vining, 1989; Boubakri and Cosset, 1998; Ramanna and Roychowdhury, 2010; Ben-Nasr et al., 2012; Li and Yamada, 2015; Bertrand et al., 2018; Preuss and Konigsgruber, 2021). Most of the studies view government connection as a given firm characteristic or even a resource, by focusing on factors such as government ownership and managerial political background. By contrast, we analyze how firms respond to a very specific opportunistic *action* by local governments – GDP manipulation, and suggest that the government-firm connection (in our case, collusion) can be quite complex and dynamic.

Finally, our study suggests that government subsidies can be an important motivation for firms to collude with local governments in data manipulation. This adds to a strand of literature documenting both the government's grabbing hand and the helping hand in China (Cheung et al., 2010; Chen et al., 2017). In addition, we show that weak pay-performance sensitivity helps explain why firm managers are willing to engage in costly manipulation. Most of the costs are born by investors rather than managers, who have compensation that is less tied to firm performance.

The remainder of this paper is organized as follows. Section 2 introduces the background of our study and develops hypotheses. Section 3 reports our data and empirical designs. Section 4 presents and discusses our empirical results. Section 5 concludes.

2. Research Background and Hypothesis Development

In this section, we introduce the background of GDP manipulation in China and its impact, and develop testable hypotheses based on the discussion.

2.1. Research Background

China has achieved impressive economic growth since the 1980s. However, many have expressed concern over the accuracy of its economic figures. A number of studies, such as those by Holz (2014) and Owyang and Shell (2017), suggest that China's GDP figures have been manipulated, especially at the provincial level. One example is the sum of provincial GDPs being substantially higher than the GDP reported by the National Bureau of Statistics of China (NBS). Consequently, the NBS has had to make downward adjustments averaging 5% of the GDP since the mid-2000s (Chen et al., 2019). Using a discontinuity approach, Lyu et al. (2018) argue that the provincial-level GDP figures are managed by local government officials, as the frequency of just meeting or beating GDP growth targets is approximately four times that of just missing the targets at the provincial level.

The extent of GDP manipulation peaked after the 2008 financial crisis, a period of decelerated economic growth. In 2017, the government of Liaoning Province admitted that economic data had been faked from 2011 to 2014 and that revenues had been inflated by approximately 20%.[2] By early 2018, two other provinces or direct-administered

[2] Source: The Economist, January 26, 2017. https://www.economist.com/finance-and-economics/2017/01/26/a-big-chinese-province-admits-faking-its-economic-data.

municipalities (Tianjin and Inner Mongolia) had admitted to falsifying economic data, including fiscal revenue and GDP.[3] Tianjin alone had manipulated its GDP by up to 335 billion yuan, or 30% of GDP. Jizhe Ning, former Director of the NBS, wrote in a column for China's state-run newspaper *People's Daily* that "currently, some local statistics are falsified, and fraud and deception happen from time to time, in violation of statistics laws and regulations."[4]

What causes the rampant data manipulation? Researchers argue that the promotion tournament system may be the culprit. Since the 1980s, GDP growth has been an important determinant of the promotion of local government officials (e.g., Chen et al., 2005; Li and Zhou, 2005). Although this provides great incentive for local officials to develop the local economy (Maskin, 2000; Blanchard and Shleifer, 2001; Li and Zhou, 2005), the tournament system also incentivizes local officials to manipulate GDP numbers to stand out in the promotion tournament. Shleifer and Vishny (1994) suggest that politicians may use their political power to achieve personal goals, which is usually done by exerting pressure on firms they can control. Piotroski and Zhang (2014) show that politicians influence IPO activities to improve economic achievements and obtain promotions.

2.2. Costs of GDP Manipulation

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[3] Source: Reuters, January 17, 2018. https://www.reuters.com/article/us-china-economy-data/another-chinese-city-admits-fake-economic-data-idUSKBN1F60I1.
[4]Source: Financial Times, December 8, 2016. https://www.ft.com/content/0361c1a4-bcfe-11e6-8b45-b8b81dd5d080.

China's GDP is largely driven by industrial activities by sizable firms, and that such firms typically report financial data directly to the NBS. Hence, large-scale GDP manipulation could proxy for the extent of firm-level data manipulation for firms operating in the environments. Indeed, in scandals related to GDP manipulation, local firms (especially those connected to the governments) have been found to play an important part, either by artificially inflating investment levels or by falsifying key accounting items such as revenue and profit.[5] These correspond to the two ways government officials use to manipulate GDP figures: boosting investment and data falsification (Lyu et al., 2018; Chen et al., 2020). Empirically, Chen et al. (2020) report that firms have reported falsified accounting data to meet the goals explicitly set by their local governments. Cai et al. (2022) suggest that local SOEs may cooperate with local government to manipulate GDP figures by managing earnings.

When firms collude with local governments in data manipulation, the opportunistic decisions can have adverse consequences for firms and investors, such as greater cost of equity, as firms deviate from optimal business decisions and lower financial reporting quality (Chen et al., 2008; Ramanna and Roychowdhury, 2010; Preuss and Konigsgruber, 2021). For example, Bertrand et al. (2018) find that politically connected firms bring cost not offset by other benefits as these firms help politicians by creating more jobs and building more plants. Li and Yamada (2015) argue that governments have incentives to

[5] For example, in 2020 and 2021 the National Bureau of Statistics found seriously inaccurate data in investment levels, sales, and industrial output in several provinces. Source: Reuters, May 27, 2022. https://www.reuters.com/world/china/china-punishes-local-officials-falsifying-economic-data-2022-05-27/

control firms to pursue costly political objectives (such as hiring more workers). Ben-Nasr et al. (2012) use a global sample of newly privatized firms and show that cost of equity is increasing in government connection. Boubakri et al. (2018) find that government ownership increases cost of equity especially for cross-border deals. The greater cost of equity may also stem from the risk of lower future earnings and less efficient investments (Chen et al., 2017; Deng et al., 2020). An opposing view argues that firms colluding with local government officials may receive beneficial treatment, such as access to financial resources (Claessens et al., 2008; Infante and Piazza, 2014; Lyu et al., 2018), government contracts (Cohen et al., 2011), subsidies or other forms of government protection (Chen et al., 2011; Chen et al., 2020; Cai et al., 2022). The overall cost of GDP manipulation to local firms is hence an empirical test of the following hypothesis:

Hypothesis 1: Firms located in provinces with more GDP manipulation have greater cost of equity, ceteris paribus.

A more explicit cost to investors and analysts is the risk of poorer financial performance. For example, a colluding firm artificially inflating its investment (by double counting or over-stating investment, or by reporting investment that does not occur) will see lower investment efficiency, and a firm reporting falsified and unsustainably high profit figures will likely see poorer profit growth. A rich literature suggests that sub-optimal decisions caused by firm-government collusion can lead to poorer financial performance. For example, Ling et al. (2016) and Deng et al. (2020) show that politically connected firms tend to report greater investment figures, which lead to investment inefficiencies and lower future profitability. The effect is clearly observed in state-owned enterprises (Chen et al., 2013), as well as non-state-owned enterprises (Liu et al., 2016). Again, the overall effect could be uncertain if benefits such as government subsidies and cheap loans are considered. We hence test the following hypothesis concerning firm financial performance:

Hypothesis 2: Firms located in provinces with more GDP manipulation have greater investment inefficiency and lower profit growth, ceteris paribus.

2.3. Firms' Incentives to Collude

How GDP manipulation benefits local government officials is relatively straightforward to understand. Economic growth figures can substantially benefit government officials in their promotion, and the costs are largely born by local firms and successors (Lyu et al., 2018; Chen et al., 2020; Pan et al., 2022). On the firm side, it is less clear how such collusion benefit firms given the large costs associated with data falsification. We discuss possible reasons suggested by prior studies.

The most widely discussed benefit is government subsidy, which includes the form of tax reduction (Chen et al., 2008). Though designed to help promising firms to further boost productivity, government subsidies in China often go to firms with political connections with little innovation (Cheng et al., 2019), especially when corruption levels are high (Fang et al., 2023). Lim et al. (2018) and Branstetter et al. (2023) report that subsidies tend to go to less productive firms and do little to improve productivity, and Tao et al. (2017) show that financially distressed firms with political connections are more likely to receive subsidies. Government subsidies alleviate under-investment problems but make firms more likely to over-invest (Hu et al., 2019) and hire more employees (Branstetter et al., 2023), both of which consistent with local government officials' goals of GDP manipulation. If firms operating in environments of GDP manipulation indeed collude with local government officials, we should expect greater subsidy levels for these firms, other things equal.

Hypothesis 3: Firms located in provinces with more GDP manipulation have greater government subsidy levels.

Finally, we consider GDP manipulation and managerial incentives. Managers may not have incentives to go against local government officials, especially when they have compensation or promotion that is tied to non-financial goals. Given that collusion could impose adverse impacts on firm performance, it is plausible to assume that firms with higher pay-performance sensitivity are less likely to collude with local governments. Political forces may impose constraints that weaken pay-performance sensitivity and alter managerial incentives (Jensen and Murphy, 1990), and specifically, firms that prioritize non-financial goals may favor weaker performance-based managerial incentives (Zhang et al., 2014; Wang and Xiao, 2011). We anticipate the same effect for firms located in provinces that manipulate GDP more, as those firms are more likely to have colluded with local governments.

Hypothesis 4: Firms located in provinces with more GDP manipulation have weaker pay-performance sensitivity.

3. Empirical Design

3.1. Sample and Data

Our initial sample includes all publicly listed firms covered by the China Stock Market and Accounting Research Database (CSMAR) from 2003 to 2014[6]. To construct our sample, we first exclude B and H shares which are denominated in foreign currencies and focus on the A-share stock market (Shanghai and Shenzhen Stock Exchanges). Next, we drop financial firms and financially distressed firms that are tagged "special treatment" (ST) or "particular transfer" (PT). Finally, we drop firms with missing financial data. Our final sample contains 10,817 firm-year observations. We report our sample selection criteria in Table 1.

[Insert Table 1 here]

We obtain our satellite night lights data from the National Geophysical Data Center (NGDC) of the National Oceanic and Atmospheric Administration (NOAA) for the period of 1992 to 2013.[7] Our data on each province's marketization index come from the National Economic Research Institute Index of Marketization of China's Province 2016 Report (Fan et al., 2016) and cover the period of 1997 to 2014. The provincial fiscal data are extracted from the China Statistical Yearbook. We obtain financial information and other firm-level

[6] 2003 is the first year we can identify firm ultimate controlling shareholder, and the DMSP/OLS satellite night light data ends in 2013. We lag our independent variable *GDPMAN* by one year, which was constructed by using the satellite night light data.

[7] Similarly, Clark et al. (2017) use the night light data up to 2013.

variables from the China Stock Market and Accounting Research Database. Data on local officials are hand-collected.

3.2. Cost of Equity and Firm Performance

We follow Barth et al. (2013) and implement a four-factor model with time-varying factors, risk-free rates, and risk premiums (Carhart, 1997) to estimate an ex-post cost of equity measure. For each firm, we estimate the betas of each factor from the following monthly time-series regression model:

$$RET_{i,m} - R_{f,m} = \alpha_i + \beta_{RMRF,i}(R_{M,m} - R_{f,m}) + \beta_{SMB,i}SMB_m + \beta_{HML,i}HML_m + \beta_{MOM,i}MOM_m + \varepsilon_{i,m} \quad (1),$$

where $RET_{i,m}$ is the monthly stock return of each firm, $R_{f,m}$ is the risk-free rate, and $R_{M,m}$ is the monthly return of the market portfolio. SMB_m and HML_m are the monthly returns on the size and value factor-mimicking portfolios described in Fama and French (1993). MOM_m is the monthly return on the momentum factor-mimicking portfolios mentioned in Carhart (1997). Using the most recent 36-month returns before the beginning of each firm's fiscal year to estimate equation (1), we obtain estimates of $\hat{\beta}_{RMRF,i,t}$, $\hat{\beta}_{SMB,i,t}$, $\hat{\beta}_{HML,i,t}$, and $\hat{\beta}_{MOM,i,t}$ for each firm and year.[8] We then calculate each firm's *EQUITY COST* for year *t+1* as of year *t* as follows:

$$EQUITY\ COST_{i,t} = \bar{R}_{f,t} + \hat{\beta}_{RMRF,i,t} \times \left(\overline{R_m - R_f}\right)_t + \hat{\beta}_{SMB,i,t} \times \overline{SMB}_t + \hat{\beta}_{HML,i,t} \times \overline{HML}_t + \hat{\beta}_{MOM,i,t} \times \overline{MOM}_t \quad (2),$$

[8] To account for the effect of IPOs, we exclude 6 months of returns after IPOs.

where $\hat{\beta}_{RMRF,i,t}$, $\hat{\beta}_{SMB,i,t}$, $\hat{\beta}_{HML,i,t}$, and $\hat{\beta}_{MOM,i,t}$ are the coefficient estimates from equation (1) and $\left(\overline{R_m - R_f}\right)_t$, $\overline{SMB}_t$, $\overline{HML}_t$, and $\overline{MOM}_t$ are the expected annual factor returns for year $t+1$. To estimate these expected annual factor returns, we first calculate the average values of all factors' monthly returns over the 36-month period before month *m* and then compound them over the 12 months before the beginning of each firm's fiscal year. To mitigate the impact imposed by outliers, we replace cost of equity values that are greater than 50% with 50%, and values that are negative with 0%. To account for possible industry differences across regions, we also use an industry-adjusted cost of equity measure which measures a firm's cost of equity in excess of its industry mean value of cost of equity. Note that the regression approach generates larger estimates for cost of equity than implied cost of equity measures such as the GLS measure developed by Gebhardt et al. (2001); in the robustness section, we use ex-ante measures implied in earnings forecasts such as the GLS and CT (Claus and Thomas, 2001) measures. Our sample size is approximately the same for the GLS measure but reduced by approximately 30% when the CT measure is used for analysis.

We measure investment (in)efficiency with the accounting-based framework proposed by Richardson (2006). Specifically, we define the absolute value of residual investment that cannot be explained by growth opportunities, financial constraints, and so on as investment inefficiency (*INV INEFF*). A greater value of *INV INEFF* suggests worse performance of firm investment, possibly due to inflated investment figures which correlate with GDP manipulation.

Another measure for firm performance is the growth in net profit. We consider two specific measures: *NET PROFIT GROWTH* is the annual growth rate in net profit, and *NET PROFIT MARGIN GROWTH* is the annual growth rate in net profit margin. We remove negative net profit values to avoid using negative denominators in growth calculation. In robustness tests, we also consider mean future EPS over the next three or five years as additional measures of firm performance.

3.3. Measuring Local GDP Manipulation

We employ a measure of GDP manipulation using the gap between official GDP growth figures and "true" GDP growth estimated using night lights data. Henderson et al. (2012) show that GDP can be accurately measured using the intensity of night lights, based on the observation by multiple US Air Force weather satellites, because night lights reflect the consumption of nearly all goods in the evening but are much less subject to measurement errors. Following Henderson et al. (2012), we estimate true GDP growth using the following regression equation:

$$LnGDP_{j,t} = \alpha_0 + \alpha_1 Lnlight_{j,t} + \delta_j + \eta_t + \varepsilon_{j,t} \qquad (3),$$

where j indexes provinces and t indexes years; $LnGDP_{j,t}$ is the natural logarithm of the officially reported GDP figures, deflated by the price index. $Lnlight_{j,t}$ is the natural logarithm light intensity measure at the provincial level (DN/Area). δ_j and η_t are the province-level and year-level fixed effects, respectively. $\varepsilon_{j,t}$ denotes the error term.

Following Chen and Nordhaus (2011) and Henderson et al. (2012), we use the predicted values of GDP growth estimated with equation (3) to construct a composite estimate of "true" GDP growth:

$$\textit{True GDP growth}_{j,t} = \lambda \textit{Official GDP growth}_{j,t} + (1-\lambda)\textit{Light estimated GDP growth}_{j,t} \quad (4),$$

where *Light estimated GDP growth*$_{j,t}$ is the predicted GDP growth from equation (3), estimated using the night lights data. *Official GDP growth*$_{j,t}$ is the officially reported GDP growth deflated by the price index. λ is a parameter determined by minimization of variance in equation (4) to alleviate measurement error – using the same methodology as Henderson et al. (2012), our calculation indicates an optimal λ value of 0.202. The independent variable *GDPMAN* is the measure of local GDP manipulation and is defined as the gap between *Official GDP growth*$_{j,t}$ and the composite estimate of true GDP growth from equation (4).

To examine the validity of the measure, we perform several preliminary tests. First, we examine the three provinces/municipalities that have officially admitted to GDP data manipulation – Inner Mongolia, Liaoning, and Tianjin. For all of them, the official GDP growth figures exceed the "true" GDP growth estimated using night lights data by at least 1% in our sample period, more than twice as much of the sample median of 0.5%. Second, we follow Lyu et al. (2018) and identify provinces that just meet or beat growth targets. We then show that our measure of GDP manipulation for these provinces is 1.4% higher than that of the provinces that just miss their growth targets. Third, our measure of GDP manipulation for Chongqing is significantly higher during the tenure of Bo Xilai, a member of the Politburo and Communist Party Secretary of Chongqing who reportedly falsified GDP data to win political support and was later convicted of corruption in 2012 (Liu et al., 2017). All these preliminary tests suggest that the gap between official GDP growth figures and the "true" growth estimated using the night lights data serves as a valid measure of GDP manipulation.

3.4. Other Variables and the Model

For hypotheses 1 & 2, we run regressions with cost of equity, investment inefficiency, and net profit growth as the dependent variables. For Hypothesis 3, the dependent variable is government subsidy measured in two ways: the total amount of government subsidy received by the firm divided by total assets (*SUBSIDY/ASSET*), and the total amount of government subsidy received by the firm divided by sales (*SUBSIDY/SALE*). For Hypothesis 4, the dependent variable is the annual change in managerial compensation of the top three managers (Δ*LNCOMPENSATION*), which is regressed on GDP manipulation (*GDPMAN*), change in ROA (Δ*ROA*), and the interaction between them (*GDPMAN**Δ*ROA*), following Ke et al. (1999). The managerial pay-performance sensitivity is hence measured by the coefficient of *GDPMAN**Δ*ROA*.

Our baseline regression model is as follows:

$$EQUITY\ COST_{i,j,t} \text{ or } FIRM\ PERFORMANCE_{i,j,t} = \alpha_0 + \alpha_1\ GDPMAN_{j,t-1} + \beta_1 Controls_{i,j,t-1} + \mu_{i,j,t} \quad (5),$$

where i indexes firms, j indexes provinces, and t indexes years. The dependent variable $EQUITY\ COST_{i,j,t}$ is firms' cost of equity, and $FIRM\ PERFORMANCE_{i,j,t}$ is either the firm's investment inefficiency or profit growth. The independent variable $GDPMAN_{j,t-1}$ is our measure of local GDP manipulation measured in year t-1. We also include the following control variables measured in year t-1: *SIZE* is the natural logarithm of total book assets of the firm. *LEV* is the firm's financial leverage which is total liabilities divided by total book assets. *ROA* is the return on assets defined as net profit divided by total book assets. *BETA* is the market beta coefficient, estimated using the capital asset pricing model (CAPM). *BM* is the book-to-market ratio of equity. *VOL* is the standard deviation of net profit in the past three years divided by the mean of net profit in the past three years. *TURNOVER* is the mean value of the turnover rate in one year. *SALEGROWTH* is the growth in sales. *TOP1* is the percentage of shares held by the largest shareholder. *AGE* is the natural logarithm of the number of years since the firm was founded. *HMARKET* is a dummy variable which equals one if the marketization index (Fan et al., 2016) is higher than the sample median and zero otherwise. *SURPLUS* is the government's fiscal surplus as a percentage of fiscal income. *POL TENURE* is the number of years the incumbent provincial party secretary has been in position. *POL AGE* is the age of the incumbent provincial party secretary. We also include region, year and industry fixed effects in our model, and winsorize all continuous variables at the 1% and 99% levels. We provide detailed variable definitions in Appendix 1 and report the descriptive statistics of the key variables in Table 2.

[Insert Table 2 here]

In our sample, the mean of the cost of equity (*EQUITY COST*) is 0.232 and the median is 0.201. The standard deviation is 0.205. Compared to the statistics reported by Barth et al. (2013), these numbers are slightly higher, which is not surprising given the higher interest rate environment in a developing country like China. The mean (median) value of local GDP manipulation (*GDPMAN*) is 0.5% (0.5%), suggesting that GDP manipulation is moderate on average. However, we note substantial variation in GDP manipulation across provinces, as *GDPMAN* has a large standard deviation of 2.4%. The 75th percentile of *GDPMAN* is 2.2% with the maximum value of 7.3%.

We report the Pearson correlation matrix of the main variables in Table 3. Most importantly, *EQUITY COST* is positively correlated with *GDPMAN* at the 1% significance level, while investment inefficiency and net profit growth are both significantly correlated with GDP manipulation.

[Insert Table 3 here]

4. Empirical Results

In this section, we present and discuss our empirical results. First, we report our baseline results on GDP manipulation, cost of equity, and firm performance. Second, we discuss potential endogeneity issues and related tests. Third, we investigate the association between GDP manipulation, government subsidy, and firm managerial pay-performance sensitivity, and discuss why firms may willingly collude with local governments. Fourth, we discuss the robustness of our findings. Finally, we present further analysis on state ownership and earnings opacity, and discuss the limitations of the study.

4.1. Baseline findings

In Table 4, we report regression results of cost of equity on GDP manipulation, along with the control variable discussed in the previous section.

The dependent variables are the unadjusted (*EQUITY COST*) and the industry-adjusted (*EQUITY COST ADJ*) cost of equity measures. The key independent variable, GDP manipulation (*GDPMAN*), is statistically significant across columns. In column 3 when all control variables are included, *GDPMAN* has a coefficient of 0.302 and is statistically significant at the 1% level. For column 6 in which the cost of equity is defined in excess of industry mean, the coefficient of *EQUITY COST ADJ* is 2.225 and significant at the 1% level. Results in Table 4 support Hypothesis 1 that GDP manipulation affects firms' cost of equity. In terms of economic significance, a one-standard-deviation increase in *GDP* manipulation is associated with a 0.72% increase in local firms' cost of equity, or approximately 3.12% of the mean cost of equity estimate.

[Insert Table 4 here]

We test Hypothesis 2 by regressing measures of firm performance on GDP manipulation, and report the results in Table 5. In columns 1-3 of Table 5, the dependent variables are investment inefficiency (*INV INEFF*), *NET PROFIT GROWTH*, and *NET PROFIT MARGIN GROWTH*. *GDPMAN* has coefficient estimates that are statistically significant at the 5% level or higher. In column 1, *GDPMAN* has a positive coefficient, while in columns 2 & 3 the coefficient estimates are negative. Consistent with Hypothesis 2, these results suggest that greater GDP manipulation in a province is associated with less efficient investment and lower profit growth for firms operating in the province, after accounting for other determinants of firm performance.

[Insert Table 5 here]

4.2. Endogeneity and Identification

In this subsection, we discuss some important sources of endogeneity and present tests which help with identification. The most important issue is that our variable of interest, *GDPMAN*, is defined at the provincial level and can be endogenous. Specifically, whether and how local governments manipulate GDP figures can be determined by a long list of factors including economic development, institutions, or culture. Some of these regional differences can be partially addressed by the methodology we use – for example, including regional fixed effects can deal with relatively time-invariant regional differences such as culture and institutions. However, it is difficult to rule out all sources of endogeneity.

To further mitigate the endogeneity concern, we utilize a quasi-natural experiment and perform a difference-in-difference test around unexpected top government official turnover. Specifically, we hand-collect all provincial-level top government official turnover events related to corruption investigations and convictions. We define provincial-level top government officials as provincial Communist Party secretaries, provincial governors, or vice governors in charge of economic development. These government officials are powerful political figures and also those who would benefit the most from GDP manipulation; as such, firms that collude with local government officials are more likely to be affiliated with these top government officials. In addition, immediately following the turnover events, the Chinese central government often send task forces to investigate these top government officials' criminal behavior and collect evidence that may go against them, including economic data manipulation. Consequently, we would see a substantial and unexpected decrease in GDP manipulation for provinces that experience top government official turnover, as compared to provinces that are not affected. If GDP manipulation indeed is what drives cost of equity higher, we should expect firms' cost of equity to decrease, and firm performance to improve, for firms located in affected provinces.

Our search resulted in 12 unexpected top government official turnover events in 10 provinces. The most notable event is the downfall of Bo Xilai, a powerful Chinese politician and a former member of the Chinese Communist Party's Politburo who has reportedly manipulated economic data to tout his economic achievements. Bo was stripped of all his positions in 2012 when he served as the Communist Party secretary of Chongqing because of corruption and murder, and the turnover had substantial impact on firms that are politically connected to him (Liu et al., 2017). In this particular case, our GDP manipulation measure for Chongqing decreased from 5% in 2011 to 0.46% in 2013. Since such decrease in GDP manipulation is less endogenous, a difference-in-difference test in cost of equity and firm performance would help mitigate endogeneity concerns.

We match all firms in the treatment group (i.e., firms located in provinces with unexpected top government official turnover due to corruption convictions) with similar-sized firms from the control group (i.e., firms located in provinces without unexpected top government official turnover due to corruption convictions). We then investigate firms' cost of equity and firm performance in a three-year period before unexpected top government official turnover (*POST* = 0) and in a three-year period after (*POST* = 1), for both the treatment group (*CORRUPTION* = 1) and the control group (*CORRUPTION* = 0). The results are reported in Table 6.

[Insert Table 6 here]

As reported in Panel A of Table 6, in provinces that experienced unexpected top government official turnover due to corruption convictions, firms' cost of equity decreases substantially after the unexpected turnover compared to similar firms in the control group. The economic magnitude of the difference-in-difference is approximately 1.3% for unadjusted cost of equity and 1.6% for cost of equity adjusted for industry mean. In Panel B of Table 6, we find significant improvement in firm performance following the government official turnover. Investment inefficiency decreases by 0.011, which is approximately one third of our sample mean, and the difference is statistically significant at the 1% level. For net profit growth and net profit margin growth, the differences are 0.3 and 0.4, respectively.

In untabulated results, we use another policy shock of a reform on local officials' performance evaluation. In 2013, the central government of China announced significant changes to the way local government officials are evaluated and promoted; economic growth was no longer the only important factor, and other indicators on environmental protection and quality of economic growth were included in evaluating local government officials. The reform significantly reduced the importance of local GDP growth figures in local government officials' promotion tournament. We find that firm cost of equity reduced significantly after the implementation of the reform, and the decrease is substantially greater for firms located in regions with heavy GDP manipulation prior to 2013.

4.3. Government Subsidies and Pay-Performance Sensitivity

In this subsection, we discuss why firms may willingly collude with local government officials in data manipulation. First, we test Hypothesis 3 by regressing the level of government subsidies on GDP manipulation: If firms that collude with local government officials get compensated through various government subsidies, the association between government subsidies and GDP manipulation should be positive and significant.

We report our findings in Table 7. In columns 1 & 2, the amount of total government subsidy is scaled by firm assets and firm sales, respectively. We find that the coefficient of *GDPMAN* is positive and statistically significant at the 5% level in both columns 1 & 2, consistent with Hypothesis 3.

[Insert Table 7 here]

A related issue is managerial compensation. So far, our findings indicate substantial costs of GDP manipulation to firms. Based on the fact that many top executives and managers own substantial stake in firms and have compensation tied to firm performance, one may argue that the firm managers will have to get very large financial or political gains to make up for the losses tied to poorer firm performance, should they choose to collude with local government officials. To address that issue, we test Hypothesis 4 and study if firms that are more likely to collude with local government officials also design top manager compensation plans that are less tied to firm performance.

We report our findings in Table 8. The dependent variable is the difference in the log of the total compensation for top three managers (Δ*LNCOMPENSATION*). To measure pay-performance sensitivity, we include both the increase in ROA (Δ*ROA*), GDP manipulation (*GDPMAN*), and their interaction term (*GDPMAN**Δ*ROA*), following Ke et al. (1999). We show that the coefficient of the interaction term is negative and statistically significant at the 5% level, consistent with Hypothesis 4. In other words, firms located in provinces with greater GDP manipulation appear to have substantially lower pay-performance sensitivity for top managers; although GDP manipulation cost firms, top managers may be able to limit their losses due to compensation plans that are less tied to firm performance.

[Insert Table 8 here]

Overall, our findings suggest that firms may have incentives to collude with local government officials in GDP manipulation, as they get compensated by increased government subsidies. In addition, such firms tend to have lower managerial pay-performance sensitivity, and their managers can indeed participate in the collusion if they get compensated in financial or political ways as they are less affected by poorer firm performance.

4.4. Robustness

We consider several different ways to measure our key dependent and independent variables to ensure robustness. First, we follow Lyu et al. (2018) and estimate the paper management forecast error (*PMFE*) using the following equation:

$$Agrowth_{j,t} = \beta_0 + \beta_1 \Delta Electricity_{j,t} + \beta_2 \Delta Freight_{j,t} + \beta_3 \Delta BankLoan_{j,t} + \varepsilon_{j,t} \qquad (6),$$

where $Agrowth_{j,t}$ is the change in inflation-adjusted GDP, $\Delta Electricity_{j,t}$ is the change in local consumption of electricity, $\Delta Freight_{j,t}$ is the change in rail freight volume, and $\Delta BankLoan_{j,t}$ is the change in median-long term bank loan balance adjusted for inflation. We scale these variables by inflation-adjusted GDP in year *t-1*. *PMFE* is the residual of equation (6) – intuitively, it is the part of GDP growth that cannot be explained by three important economic indicators which are difficult to manipulate (components of an important Chinese economic indicator known as the "Keqiang Index") [9] and hence serves as a proxy for the discretionary portion of GDP growth which may be manipulated. A positive *PMFE* therefore suggest possible overstatement of local GDP figures, and vice versa. We then we use *PMFE* (rather than *GDPMAN*) in our regression and report the results in Table 9.

[Insert Table 9 here]

In Panel A of Table 9, we show that the paper-based GDP manipulation measure yields very similar results as in Table 4. The coefficient estimates of *PMFE* are positive and statistically significant in all specifications, suggesting that GDP manipulation costs

[9] China's Premier Li Keqiang started using the three components of the index in 2007 when he was the province party secretary of Liaoning Province, arguing that they reflect economic growth better than officially reported GDP figures. In 2010, *The Economist* constructed the Keqiang Index using the three abovementioned components.

investors by increasing cost of equity. In Panel B of Table 9, we find that the paper-based GDP manipulation measure is positively associated with investment inefficiency and negatively associated with net income growth. In columns 2 & 3, the coefficient estimates of *PMFE* are significant at the 1% and the 5% level, respectively, although not significant in column 1.

We next consider the robustness of the cost of equity measure. Instead of the ex-post measure, we use ex-ante cost of equity measures based on the GLS and the CT models (Gebhardt et al., 2001; Claus and Thomas, 2001). We report our findings using these alternative cost of equity measures in Table 10. *GDPMAN* has positive and statistically significant coefficient estimates in both columns, for cost of equity measures using the GLS and CT models.

[Insert Table 10 here]

In Table 11, we investigate future EPS as an alternative measure of firm performance. In columns 1 & 2, we use future EPS over the next three and five years, respectively, as the dependent variables. Again, the coefficient estimates of *GDPMAN* are negative and significant. In untabulated results, we consider excluding regions that may have noisy nightlight satellite data due to their unique industrial structures. For example, we remove regions with intense natural resources industry presence to avoid possible influence from oil drilling activities which may bias the GDP manipulation estimate, and our findings hold.[10] Overall, we conclude that our baseline findings are quite robust to measures of both

[10] The provinces excluded include Heilongjiang, Jilin, Liaoning, Shandong, Qinghai, and Xinjiang.

the dependent variables (cost of equity and firm performance) and the independent variable (GDP manipulation).

[Insert Table 11 here]

4.5. Further Discussion

In this subsection, we discuss factors that may exacerbate the costs of GDP manipulation, and the limitations of our study. In our paper, GDP manipulation is a specific opportunistic government action measured at the provincial level; while our findings so far suggest it costs firms located in the province, surely the extent of impact can vary. For example, investors may believe that firms with political connections are more likely to collude with local government officials. One common way to measure such political connection is state ownership. Huyghebaert and Wang (2012) find that government expropriation of minority investors increases in state ownership, and Ben-Nasr et al. (2012) find that the adverse impact of political connections increases in state ownership. In Table 12, we divide our sample into state-owned enterprises (SOE) and non-state-owned enterprises (NSOE), and test the difference.

[Insert Table 12 here]

In Panel A of Table 12, the dependent variable is the cost of equity. We document positive coefficient estimates of *GDPMAN* for both the state-owned and the non-state-owned subsamples; however, the results are more pronounced for state-owned firms, and the coefficient difference is significant at the 10% level. In Panel B of Table 12, we also find that the effects of *GDPMAN* on firm performance mainly reside in SOE firms. These findings are consistent with the notion that SOE firms are more likely to collude with local government officials and hence more likely to bear the costs of GDP manipulation.

We next consider earnings opacity, which could interact with GDP manipulation and mainly affects firm cost of equity. The ease of data falsification largely depends on a firm's earnings opacity; specifically, a firm that wishes to collude with local government officials in data manipulation may find it easier to do so when its earnings are opaque. Bushman et al. (2004) argue that politically connected firms may benefit from more opaque earnings which allow them to hide opportunistic practices and avoid scrutiny from regulators. Ben-Nasr et al. (2015) suggest that value-destroying activities are easier to hide and thus more likely to occur in firms with low earnings qualities. Crutchley et al. (2007) find that firms with more opaque earnings are more likely to commit accounting fraud. Consequently, in the presence of GDP manipulation, investors will be more concerned about the possibility of fraud and data manipulation for firms with greater earnings opacity. Similar to Hutton et al. (2009), we define earnings opacity as the moving average of the absolute value of discretionary working capital accruals over the previous three years; we then analyze subsamples of firms based on whether their earnings opacity is higher than the sample median and report our findings in Table 13.

[Insert Table 13 here]

In Table 13, we report our findings for firms with high earnings opacity in columns 1 & 3, and for firms with low earnings opacity in columns 2 & 4. Our results are more pronounced for firms with above-median earnings opacity, and the differences in *GDPMAN* coefficients are statistically significant.

Finally, we discuss limitations in our study. First, our GDP manipulation measure is based on night lights data and an assumption that night lights data is strongly correlated with the "true" GDP figures in a province. This may be questionable given the imbalance of regional development in China (Xu et al. 2021), as the association between "true" GDP and night lights data can vary across regions. This limitation stems from the data and methodology, and hence is endemic to all studies using the night lights data and the methodology to estimate GDP. Second, although we have attempted to mitigate endogeneity, these attempts are far from perfect. For example, the difference-in-difference test is based on unexpected top government official turnover events, which are less endogenous but may still be correlated with regional economic development or other factors. Third, due to data limitation we cannot dig further into what firms are more severely affected by GDP manipulation, other than suggesting greater costs for SOE firms and firms with opaque earnings. Furthermore, we can only identify firms headquartered in a given province, but we do not know how much of the firms' operations and political connections are in the province. A firm headquartered in Beijing can have operations and political connections mainly in a nearby province, and can collude with local government officials of the nearby province. We leave these questions to future studies.

5. Concluding Remarks

GDP manipulation has been an important topic in economics and finance research. Using satellite night lights data, a growing strand of literature documents whether countries or regions manipulate their GDP figures, but few studies consider how such manipulation of GDP figures costs firms. We provide evidence showing that GDP manipulation may impose substantial economic costs, in terms of greater cost of equity, less efficient investment, and lower profit growth. We perform several tests to address the endogeneity in our GDP manipulation measure; most notably, we use unexpected top government official turnover events after which GDP manipulation is greatly reduced, and show that cost of equity reduces and firm performance improves afterwards compared to control firms. We also offer results on why firms may willingly collude with local government officials, by showing higher levels of government subsidies and lower managerial pay-performance sensitivity for firms in provinces with more GDP manipulation.

Several implications can be drawn from our results. First, our findings help us assess the full consequences of GDP manipulation. This complements the normative studies which often claim that GDP manipulation by local governments is "wrong" by providing evidence on how costly such manipulation can be. Second, our findings suggest the inefficiency of government subsidies which appear to be a reward or compensation for colluding firms in the context of GDP manipulation. Third, our findings help identify firms that are more vulnerable to the adverse impact of GDP manipulation. We find that SOE firms and firms with less transparent earnings are more likely to collude with governments in data manipulation and bear the costs. Finally, managers of colluding firms may be able to limit their losses as they tend to have lower pay-performance sensitivity; managerial compensation can play a key role in the collusion of firms and local governments.

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