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# The Reliability of Chinese Economic Statistics

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# THE RELIABILITY OF CHINESE ECONOMIC STATISTICS

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## ABSTRACT

China's rapid economic growth over the past three decades has drawn attention from all over the world. The sources and reliability of the official statistics behind the tremendous growth have been the subject of heated debate among economists. This paper contributes to this data reliability debate by analyzing on the GDP statistics of China and seeks to establish whether or not the official data are valid.

This study begins with a review of the prominent research on the topic. The majority of these studies, reviewed in chapter two, point to a series of inherent contradictions in the official figures, which casts doubt upon the reliability of the data. This chapter also presents a discussion of the methodologies other researchers have used, and identifies the ones appropriate for this particular paper. Chapter Three, reuses the approaches identified in the previous chapter but employs new data and finds that some approaches verify the official statics, while other approaches refute the official statistics. The paper then extends one of the identified methodologies, conducting an empirical analysis on the cointegration relationship between GDP and TEC (total energy consumption) by using the Engle-Granger Augmented Dicky-Fuller Test (EG-ADF test). Based on this, the final chapter concludes with the observation that even though a certain level of fabrication exists, the quality of the official data has been significantly improved.

At last, the paper also addresses a few possible reasons for the obtained results, and suggests implications of improving the data reliability.

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# CHAPTER ONE: INTRODUCTION

Accurate economic statistics about China are critical for a variety of reasons, but ultimately to promote future economic growth. Since the Chinese government implemented the "Reform and Opening-up"[1] policies in 1978, the economy of China has grown at an average rate of approximately 9% per year, an unprecedented achievement for any economy in history (Todaro and Smith, 2008). In light of the rapid growth of the emerging Chinese economy, China is receiving more attention from the rest of the world, including foreign prospective investors, policy-makers, institutions, and etc. As a result, an increasing number of scholars and economic consultants conduct research on the Chinese economy concerning (mostly) investment opportunities and potential for trade agreements, in order to establish and evolve the economic relations between China and potential economic partners. Since this research is based on official Chinese statistics, a pressure for more accurate statistics on economic figures has evolved to help external entities making optimal decisions. At the same time, as the Chinese economy is developing on a fast pace, it is rather necessary for statistics to reflect actually economic

[1] In 1979, China decided to open up to the outside world. Since then, a few important steps have been taken in this effort: (1) the government has decentralized decision making regarding exports and imports to local governments or regional foreign trade corporations. (2) A series of special economic zones and coastal open cities have been designated for the purpose of stimulating exports and attracting foreign investment. (3) Administrative restrictions on exports and imports have been replaces by tariffs, quotas, and licensing. (4) Controls on foreign exchange have been loosened over the years, particularly for foreign-invested/managed firms.—Shangjin Wei, The open door policy and China's rapid growth: Evidence from city-level data, 1995.

performance. This aids Chinese policy-makers in making optimal decisions in a rapidly changing environment. In light of this, whether or not the official statistics is reliable has become a heated debate.

While the reliability of different types of Chinese economic data are questioned including data on unemployment, income distribution, capital flows, etc., this paper focuses on the reliability of data on national output (GDP). Starting in 1998, China has continuously had two-digit GDP growth rates, which suggest the economy has performed very well even during the most recent economic recession where most other countries struggled. Hence many suspect that, regardless of the statistics mistakes the defective statistical system may bring about, intentional falsification of economic performance may exist and can lead to enormous bias concerning the real development status. A tremendous amount of implausible statistics has been revealed over time, and many economists call it a "wind of falsification and embellishment" suggesting a definite trend. This may result in inaccuracy of economic predictions and analyses that is based on the biased data, and may mislead investment decisions and further financial losses. Therefore, it is important to estimate and improve the reliability of the Chinese official statistics, in order to create a clearer academic atmosphere, a better investment climate, and more importantly, to be able to keep the economic development rate at a relevantly high level.

This paper will test the reliability of Chinese GDP growth statistics between 1978 and 2012. This study begins with a review of the prominent research on the topic, which will point to a series of inherent contradictions in the official figures, and cast doubt upon

the reliability of the data. This paper will also present a review of the methodologies other researchers have used, and identify the ones appropriate for this particular paper. Thereafter, this study takes advantage of these identified approaches and employs new data, finding out that some approaches verify the official statics, while other approaches refute the official statistics. The paper then extends one of the identified methodologies, conducting an empirical analysis on the cointegration relationship between GDP and TEC (total energy consumption) by using the Engle-Granger Augmented Dicky-Fuller Test (EG-ADF test). Based on this, the paper finally concludes with the observation that even though a certain level of fabrication exists, the quality of the official data has been significantly improved. At last, the paper also addresses a few possible reasons for the obtained results, and suggests implications of improving the data reliability.

## CHAPTER TWO: LITERATURE REVIEW

During the past decades, a growing trend in the literature has expressed skepticism over the reliability of the China's official economics statistics. Much of the skepticism dates back to 1998, the year where high-level Chinese government officials "guaranteed" the country would achieve an eight-percent growth rate despite the economic downturn of the Asian Financial crisis (Hsu and Gale, 2001) and coinciding numerous natural disasters that weakened the economy. Observers have different views on the degree of overestimation of growth, but most agree that the official statistics are indeed overstated and not reliable for statistical inference.

Almost all current research relies on a combination of theoretical and simple statistical analysis, while few studies employ more advanced econometric modelling. This literature review first inspects research on "stand-out" contradictions in the official data, which seems to undermine the validity of the statistics. What then follows is an examination of research based on simple statistical analyses where the literature reaches no consensus on the resulting validity of official statistics. Another strand of literature is considered thereafter, where more advanced econometric methods are used. Finally, work on the suggested causes of data falsification is scrutinized.

## Stand-out Contradictions

Countless economic reports have indicated that governmental statistics are "cooked" and misrepresentative. In the national inspection of statistics in 1997, over 60,000 cases of illegal practices were detected, 56.7% of which were due to falsification of statistics, 18.4% were due to delays or refusals of submitting relevant statistics, and the remaining 24.9% were due to other reasons (Wang, 1998), etc. A similar observation was apparent at the regional level. During an official inspection of the relevant statistics pertaining to the Liaoning province, gross falsification of industry output was identified: 5.4 billion Yuan in 1993, 4.8 billion in 1994, and 5.0 billion in 1995(Economics Daily, 1996). This attests to the internal contradictions in the data.

Another contradiction was found in the data where an extraordinary raise in industrial output was not matched by increases in other critical indicators, including that of energy and raw materials consumption. According to the public data of 1992, gross industrial and agricultural output in the county of Taicang of the Jiangsu province was 16.9 billion Yuan, among which industrial output counted for 16.1 billion Yuan, representing an increase of 153.1% compared to the year before. In contrast to the enormous rise in industrial output, the industrial electricity consumption increased by only 13.28%, and industrial goods and raw material consumption increased by less than 10%. This is clearly pointing to a discrepancy between production of output and consumptions of energy/raw material, which typically change proportionally in their positive relationship. Another implausibility was apparent in the same county, during the

same year, where it claimed its gross industrial output to be 0.138 billion Yuan by November, and surprisingly adjusted this to 0.28 billion Yuan by late December, which implied that this county's entire industrial output approximately doubled in just a month (Cui, 1995).This seemed odd suggesting some level of data falsification.

It is shown that deviations exist between the aggregate weighed regional GDP growth rate and the official national GDP growth rate in almost all years. Starting from 1998, when the "wind of falsification and embellishment" took off and became a trend, the NBS tried to build its own network that bypassed local and provincial governments by rejecting and adjusting provincial data on economic growth according to its own calculation of national GDP. Therefore, there is always a discrepancy between the adjusted official national figures and the original aggregated regional data. According to Meng and Wang's study (2000), the difference can be as big as 3.3%, especially in the years after 1992. In a sense, this discrepancy intuitively shows how much the official growth rate is off compared to the regional data. The official data reveals the central government's incentive to adjust the growth rate in a higher or lower direction since the government attempts to compensate for the data reported from the local governments, such that the end results reflects reality as closely as possible. This discrepancy discloses the degree of inefficiency of the Chinese statistics system in the sense that, the NBS fails to present consistent data. Hence, the difference between aggregate weighted regional growth rate and the officially published national growth rate is worth studying, especially by using more recent data.

China has conducted two nationwide economic censuses (in 2004 and 2009), based on which, the NBS conducted data revisions especially of national output. These revisions revealed contradiction besides plausible adjustments. As was mentioned above, to obtain national GDP, the NBS did not calculate aggregate regional GDP using data collected directly from regional provinces. Instead, it conducted adjustments of regional data based on its own estimations of real regional data. That said, the discrepancy between official GDP and the aggregate regional GDP indicates the perception the NBS had of actual regional economic performance. After the national economic census, the NBS conducted additional revisions of the national output data according to the census results. Undeniably, the national economic censuses contributed to the integrity of the national statistics and were instrumental for statistical work to reach a more reliable level. But the fact that the NBS did revise its own data inevitably challenged the validity of the official statistics, and questioned the ability of the NBS to adjust regional data to reflect the overall economy.

For example, before the first economic census, the aggregate regional GDP was 18.9% higher than the national GDP, which reflected the downward adjustment the NBS conducted of aggregate regional GDP, resulting in a measure of national GDP. However, after the census, the NBS increased the national GDP by 16.8% according to the results, which made the new national GDP only 2.1% lower than the aggregate regional GDP (Holz, 2006). Hence, the contradiction is apparent since the NBS underestimated national GDP at first only to readjust it in an upward direction later. This somewhat odd situation is not unique for the first period of data revisions, since later revisions produced similar

outcomes. This suggested that the adjustment the NBS conducted of regional data was redundant or rather erroneous.

The statistical revision has brought tremendous change to the country's official figures, which means the updated GDP statistics will be different from the data people used in previous studies before the censuses were conducted. Therefore the empirical analysis presented in Chapter Three will provide revealing insight to the quality of the statistical work the NBS has conducted overtime, and inspire the estimation of the reliability of the official statistics.

Another outstanding contradiction shown from the post-economic census-revision was that the NBS left the real GDP growth figure for 1998 unchanged (Xu, 2009). This was highly implausible because 1998 was the year when the Asian Financial Crisis swept across the entire of Asia, along with the mentioned natural disasters. This contradictory observation has cast doubts upon the NBS's ability to conduct high-quality statistical work.

Besides identifying the inconsistencies intuitively seen in the data, many studies have revealed various implausible observations from statistical perspectives. The following section of this literature review will discuss this from the following aspects: mathematical approaches using domestic and foreign data resources.

## Mathematical Approaches

The mathematical approaches previous studies have used on this debate can be categorized as follows: statistical approaches using domestic data, and statistical approaches using non-domestic data.

The most commonly used approach is the former, where scholars study the relationship between national output figures and the various domestic economic indicators, such as price level, energy consumption, freight traffic volume, industrial electricity consumption, etc., and others study the data in a more rigorous way by applying econometric methods. This part of the literature review is devoted to introducing a few of the most commonly used representative economic indicators in the studies on this topic, and afterwards uses and discusses Meng and Wang's econometric model as an example of rigorous analyses. Many of the methods discussed in this section will also serve as guide lines to the method we will use in Chapter Three.

The latter approach studies the accuracy of the Chinese official data by comparing it with reliable data resources from foreign prominent institutions including the IMF. This will discuss the study on international trading statistics conducted by John, Isreal and Mark (2013).

Among the various articles, which argue that China's official statistics are likely seriously falsified, two of the earliest stood out and had significant influence on the work that followed. Meng and Wang (2000) argued that the GDP growth rate was inflated by 0.5 percent during 1978 and 1991, and 2.2 percent between 1992 and 1997. Rawski

(2001) claims that the official statistics "contain major exaggerations of real output growth beginning in 1998", and that the real GDP level can be no more than a third of the officially claimed number. Also, because these two articles are arguably the most influential and commonly quoted originators in the area, this paper will refer back to their methods and arguments throughout this literature review, and eventually test their validity against new data in Chapter Three of this paper.

*Domestic resources: Economic Indicators*

Several important price indices – Retail Price Index, Producer Price Index for Industrial Products, Purchasing Price Index for Agricultural products, and Price Index for Investment in Fixed Assets – are experiencing contradictory growth patterns relative to the official GDP index. Meng and Wang (2000) believed that falling price indices or a lower growth rate of price indices is often associated with a slow-down in economic development or due to insufficiency of demand. Therefore, the fact that the official GDP index (of growth rates) between 1996 and 1997 is at a very high level while the other related indices (such as that of price) during the same period were experiencing downturns, indicates that the official data during this period of time is likely falsified. However, the assumption of the positive correlation between price indices and economic growth is questionable, vague, and lacks rigor. This paper will as well examine this relationship in Chapter Three, using the most current available data. It is valuable to study this relationship because it allows one to question the reliability of the official GDP statistics, especially that after the national economic census and statistics revisions.

The departmental figures of national output are also quite dubious. Some studies have observed implausible relationships between other indicators, such as freight traffic volume, industrial electricity consumption, and industrial production growth rate. In general, the freight traffic volume and industrial electricity consumption should both have a clear positive correlation with industrial production growth. However, according to the comparison of freight traffic volume and the value-added of industry, it is revealed that starting from 1991, the growth rate of value-added of industry was far bigger than that of freight traffic, which did not deviate from normal growth rates. Based on Meng and Wang's calculation (2000), the industrial growth rate during 1991 and 1997 was falsified by 4.57%, in comparison to the freight traffic volume and the industrial electricity consumption. What is more, Rawski (2001) has also observed questionable figures in consumption, which is believed to be the driving force in the rapid development of the economy. He pointed out that the national figures for retail sales increases a lot more rapidly than per capita expenditure of households. Furthermore, studies during the same time found out that the average propensity to consume among households was decreasing (Tao, 2000; Zhang, 2000). These facts contradict each other and cast doubt on the reliability of the official retail sales figure. Hence, data fabrication is very likely to exist in different categories of national output figures as well.

Returning to the national output figures, there are also contradictions between the outstanding high GDP growth rate and many other indicators, such as the stagnant industrial production, minimal employment growth, widespread excess supply, downward price pressure, inventory build-up, and large-scale accumulation of idle bank

deposits, etc. (Iacob N. Koch-Weser, 2013). Therefore, many economists argue that the real growth is well below the 9% average level that has been published, and most have reached to the conclusion that Chinese official statistics are most likely to be falsified.

*Foreign Resources: International Trade*

While it is rather complex to study the reliability of Chinese official data with statistical analysis, not to mention the questionable domestic data, there is an alternative data resource that is more trustworthy: international data resources. Currently, it is impossible for international statistical institutions to obtain economic data for all industries in China, but the data collected about China by foreign trade partners is highly accessible and reliable. The reliability of the Chinese official international trade data should serve as a good estimator for the quality of the national statistics.

This part of the literature review will discuss a study conducted by John, Israel and Mark in 2013. In their study, two sources of data were used: data based on the trade with the "trio" (US, EU, and Japan) and overall international trade data provided by the IMF. They compared the relationship between relevant data from these two sources and the official GDP, and found that the Chinese official GDP is significantly and positively correlated with the data from trading partners. They also compared the forecasted GDP statistics based on the actual GDP, with the predicted GDP statistics based on exports from overall world exports to China, and found the two figures being roughly consistent. This study reached the conclusion that the reported Chinese output data were systematically related with the trade volume, externally reported by reliable international

institutions. This result suggested that Chinese official data had been consistent with real economic behavior.

*Econometric Analysis*

Besides various empirical observations that have been addressed concerning data reliability, only very few authors approached the topic by using advanced econometric methods. This section will focus on Meng and Wang's econometric model (2000).

As is mentioned earlier, Meng and Wang compared the growth patterns of various economic indicators, including freight traffic volume, industrial electricity consumption, and industrial production. They found out that the industrial growth rate had deviated, starting in 1990, from all other indicators. In order to study whether higher productivity - due to improved technology, high value-added products, or industrial development - or statistical falsification led to the deviation of the high industrial growth rate starting from 1978 to 1997, they used the Cochrane-Orcutt regression model. This resulted in the following series of regression equations capturing the relationship between output, and capital and labor:

Industrial production function (constant returns to scale):

$$\ln Y_2 = a + \alpha ln K_2 + (1-\alpha) ln L_2 + \sum g_i T_i$$

And with some simplification the GDP production function is derived:

$$\ln\left(\frac{Y}{L}\right) = a + \alpha \ln\left(\frac{K}{L}\right) + \sum g_i T_i$$

Where Y denotes the value-added of a certain industrial department or overall GDP, K denotes capital, L denotes the amount of workers employed in a certain department or simply labor, T denotes the variable of time trend, a is a constant, α and 1-α respectively denotes the elasticity of capital and labor, g donates the growth rate of total factor productivity.

The associated regression results show that, unlike the data from 1953-1977 and data from 1978-1991, the data from 1992-1997 led to a sudden rise in total factor productivity. In order to capture the positive influence from foreign direct investment, Meng and Wang performed another regression by adding $f_k$ (the proportion of foreign direct investment in total industrial capital) to the regression function above, and it turned out that the coefficient of $f_k$ was negative and not significant. This result means this sudden rise in productivity was not caused by a sudden rise in foreign investment. At the same time, there was no sudden improvement in technology, so the authors came to the conclusion that the data between 1992 and 1997 was very likely to be falsified.

This conclusion is vague and not convincing in the sense that it assumes there are constant returns to scale (CRS[2]). Chinese economists and scholars have always based

[2] If, when we multiply the amount of every input by the number α, the resulting output is multiplied by α, then the production function has constant returns to scale (CRS). More precisely, a production function F has constant returns to scale if, for any $\alpha > 1$,
$F(\alpha z1, \alpha z2) = \alpha F(z1, z2)$ for all (z1, z2).
If, when we multiply the amount of every input by the number α , the factor by which output increases is less than α, then the production function has decreasing returns to scale (DRS). More precisely, a production function F has decreasing returns to scale if, for any $\alpha > 1$,
$F(\alpha z1, \alpha z2) < F(z1, z2)$ for all (z1, z2).
If, when we multiply the amount of every input by the number α, the factor by which output increases is more than α, then the production function has increasing returns to scale (IRS). More precisely, a production function F has increasing returns to scale if, for any $\alpha > 1$,
$F(\alpha z1, \alpha z2) > F(z1, z2)$ for all (z1, z2).

their research on the assumption of CRS, because during a long time, the economic growth has been mostly generated by increase in input. However, Yan and Wang (2004) studied the Malmquist Production Index and its composition of data from 30 provinces in China from 1978-2001, and reached the conclusion that most provinces are experiencing DRS. But more recent studies have shown that the economic growing scheme is shifting from CRS to IRS (Xu and Yang, 2007). Wang (2008) conducted empirical research on the data from 5 OECD countries, and concluded that CRS is not a proper assumption in studies on the development of modern economies, and instead IRS widely exists. The CRS assumption is important because it directly influences whether Meng and Wang's study can be valid or not. The Chinese economy has experienced tremendous change within the past three decades; hence it is implausible to conduct a precise empirical study based on a dubious prior assumption.

## Theoretical Approaches: Causes

Regardless of the various mathematical approaches to study the reliability of official GDP statistics, there are general theoretical explanations among scholars for the causes of data falsification: Internal Causes, which come from the incapacity of the NBS to conduct up-to-standard statistical work, and External Causes, which refer to the interference from the central government upon statistics.

*Internal Causes: technological incapacity*

Many believe that the unreliability of China's official statistics is due to reasons of poor technology that prevents the NBS from conducting statistical work that is up to international standard. The U.S.-China Economic and Security Review Commission conducted an in-depth study in 2013 on the quality of the statistical work the NBS completed over the past decades. It pointed out that even though the NBS had made successful reforms and improvements concerning statistical work (Table 2, Appendix 1) over the course of the past three decades, it is still below international standards.

Various mistakes were commonly observed throughout the statistical process from data collection, data measurement, to data reporting and presentation. In general, China's statistics work is very much decentralized and the statistical methods used by different regions or different levels within regions vary and lack uniformity. Particularly during data collection, one of the most common mistakes was partial geographical survey coverage where certain sectors of the economy, such as the small-scale businesses, and

“grey” incomes (non-wage incomes) were not captured. Another important problem that occurred during data collection was associated with the direct reporting approach, where companies reaching a certain threshold would report their revenues directly to the NBS. But due to the growing Chinese economy the number of direct reporting companies exploded, which pressured the NBS beyond its means. This induced the NBS to increase the threshold forcing lower-revenue companies to resort to less reliable ways of reporting.

Problems also arose from the censuses, where inefficient and unsystematic enumeration methods were employed causing many self-employed persons and labor migrants to be overlooked in the collection of data.

During the measurement and presentation of data, the statistical work was also deficient in many different aspects. One of the most important problems was associated with the transparency of the measurements and calculations the NBS conducted, especially for the measurement of some significant economic indicators, such as inflation. The NBS refused to release details on how much weight it gave different product categories when calculating inflation, and therefore the big gap between China’s food inflation and general inflation made this figure less trustworthy. Since inflation is a vital indicator of real GDP statistics, its reliability is critical to the reliability of the real national output data. Problems also occurred in the calculation of inflation related indicators, such as price indices. The NBS created the Consumer Price Index (CPI) based upon prices of incomprehensive product compositions, leaving many important factors excluded. This left the CPI dubious and not well correlated with the implicit GDP

deflator (based on the producer price index). For example, the GDP deflator was twice as high as the CPI in 2010 but became identical with CPI in the first half of 2012 (Iacob, 2013).

Many of these mistakes take place because China is lacking a mature statistics regime and local reporting institutions are important sources of unsophisticated statistical work. Fragments of local governments have untrained personnel in conducting statistical work, and the associated statistics positions are often only part-time. Moreover, fear of exposing commercial information and even the incentive to evade taxes are also reasons for local companies and institutions to fabricate their data. Therefore, all these facts make the quality of the statistics collected highly questionable.

In 2004, Deshui Li (2004), the then NBS commissioner, presented a list of reasons and corrections of exaggerated data as explanation of the discrepancies discovered in official statistics. He pointed out that provinces double-counted cross-provincial economic activities; provinces take advantage of the opportunity of the incomplete measurement of tertiary sector activities to fabricate data to reach a desired aggregate output value; they used old base year prices when calculating real growth while the NBS used the price index base year of 2001. Causes like these are technical, and have been or will be solved through technique improvements and system reforms. The subsequent session will discuss the external causes of data falsification.

*External Causes: Political interference*

Besides various internal problems, Deshui Li also pointed to a different type of problems, such as provinces having incentives to exaggerate output to compete with one another or to reach yearly targets. Issues like such are considered as external causes that are out of control of the NBS. External causes require more efforts and deeper political reforms rather than mere statistics system perfection. External causes play a critical role story of data falsification.

Political interference is believed to be one of the most influential external causes of the quality issue of China's official statistics. The political interference from the central government pressures officials, not the NBS, and generates great desires for institutions to falsify their data. This pressure can be in the form of new policies, new national goals, new orders, etc. In China, people generally believe that "data leads to promotions and promotions lead to data", which means that yearly reports submitted to the central government by regional governments, will determine where one will stand in the rewards system. This explains why the behavior of manipulating statistical data can be widely observed. Falsification exists in Chinese official statistics out of a combination of incentives designating it so.

The special Chinese political scenario plays an important role in the inaccuracy of the official data. After two decades of reforms, the Chinese statistical system experienced significant improvements, yet still did not live up to the international standard. Improving statistical techniques takes time, and so does reducing political interference. All central

governments have power over local governments, and China is no exception. With the special one-party "monopoly", this power becomes drastically stronger and more dominant. Lower level governments almost unconditionally take orders and submit to pressures from the upper level government.

Statistics play an essential role in the planning process and the rewards system. Rigid development goals were made for reaching a higher level of national economic growth, and targets and quotas were distributed down from the central government in Beijing to each lower tier of regional governments. By the end of the economic year, data collected from all fields - industrial output, labor input, investment, etc. - will be reported upward through the same tiers to the central government, and becomes the national statistics, as well as the yearly performance of a specific region.

> Beijing issued orders to every province and city. Shanghai, for example, was to ensure economic growth of 12 per cent. To this end, the Shanghai government also issued quotas to each level . . . plans that cannot ensure 12 per cent growth must all be returned for amendment. Eight percent growth became a great political responsibility. Subordinates, fearing that failure to deliver 8 percent might endanger their careers, forced statisticians into upward revisions or simply fabricated figures to document the required growth. (Rawski, 2001)

Therefore, even though falsification from different levels of government becomes less common with time, the fear of the upper level of the governmental edifice makes it impossible to vanish completely in the economy, especially when manipulation occurs most frequently at the lower level of the government (or local government). One example of such scenario is that accumulated regional output figures often surpass the national. For example, the sum of regional GDP of 2011 exceeded the national total GDP by 11%. Right before the agricultural census was introduced by NBS in 1997, the estimate of

cultivated land area was 95 million hectares, however after the census being conducted, the figure jumped to 130 million hectares. Apparently a much lower figure was initially provided in order to boost reported yields (Fred Gale. 2001). It is commonly acknowledged that this happened partially due to technical reasons but, more likely, due to data falsification by local governments.

## Summary

This literature review has shown that most previous studies have taken the position that the Chinese official statistics are falsified, and there is an active debate taking place and perspectives arguing the opposite. Firstly, that various stand-out contradictions clearly indicate that the reliability of official data is highly questionable. Secondly, most statistical studies based on the domestic resources support the idea that the official data is inaccurate in part due to poor quality statistical work and in part due to explicit falsification, while those based on foreign resources have the opposite opinion. At the same time, the NBS has conducted reforms of the statistical regime and undertaken revisions of long-run regional GDP data in light of the national economic censuses. Most studies agreed that these actions had improved the statistical system, and improve the accuracy of official statistics over time. At last, from a theoretical point of view, most studies discussed possible causes for falsification, if any, and concluded that both internal and external causes can be significant sources for official data falsification.

## Exigent Improvements on Statistical System

The Chinese statistical system has experienced significant changes during the past thirty years. The NBS has made many statistical reforms, and many of which have had profound and positive influence on the quality of the statistics. Also, China's accession of WTO reduced the control of agricultural procurement and marketing from the government, and created a much more transparent information system (Fred Gale. 2001). In recent years, international organizations and foreign governments have provided considerable technical assistance to help the NBS modernize and improve its data collection and reporting capabilities in agricultural and other statistics. However, it is not hard to imagine how difficult it is to essentially improve the authenticity of the official data as long as the government plays a motivating role in the system, regarding how lower-level officials are affected by higher-levels officials.

Therefore, a series of measures must be taken to inform economists, officials, and institutions on the risks they might face by using the official data. Firstly and most importantly, the NBS should increase the transparency of its statistical work. The NBS has been trying to avoid using data directly collected from regional governments, and has adjusted data according to some methods never revealed to the public. It uses a combination of deflators to calculate inflation, but it does not publish how it arrives at the deflator each year (Iacob N. Koch-Weser, 2013). While many other countries are very transparent about how they compile their data, these dubious behaviors of NBS make the authenticity of the official Chinese statistics questionable. Clearly, it is exigent and

important for the NBS to improve its transparency in its work in order to improve its authority, and to provide quality statistics for the public.

All in all, more statistical reforms must take place. In the short-run, alternative data sources, such as independent data gathered by foreign and private entities, would be helpful to reduce the leeway for manipulation and improve data reliability. In the long-run, the NBS should keep on reforming and transitioning to a system that is up to international standard.

## CHAPTER THREE: METHODOLOGY

The literature review revealed some questionable factors that are worth studying, including the discrepancy between official GDP growth rate and aggregate weighted regional GDP growth rate (AW GDP GR), the inconsistency between the GDP index and various price indices, the conflict between GDP growth rate (GDP GR) and total energy consumption growth rate (TEC GR), and the contradictory relationship between official GDP and total energy consumption (TEC). The debate about the reliability of the Chinese statistics was highly contested particularly at the end of last century, but has cooled down ever since. All of the mentioned implausible relationships were discussed at first before the year of 2000, and has not been systematically tested since, which makes an updated study necessary.

This chapter will firstly introduce the "falsification map" that compares various degrees of suspicious data falsification among different regions. Thereafter, it will conduct updates of previous studies and entertain questions mentioned above using the most current data. At last, this paper will study the cointegration relationship between GDP and TEC using the EG-ADF model. This econometric study will also test the cointegration relationship between AW GDP and TEC, inspired by the test of GDP vs.

AW GDP, and finally compares the integrating degree between TEC and the two GDP statistics.

## Description of Data

All the Chinese official output data examined in this paper are time series data reported by the NBS, attained from "China Statistical Yearbook" (CSY) database (http://www.stats.gov.cn/english/Statisticaldata/AnnualData/).

This chapter will examine the data from 1978 to 2013. At the Third Plenary Session of the 11th Central Committee in 1978, the political attention was for the first time transferred from class struggle as the overarching concern to economic development, and a series of economic reforms started to take place. Ever since, the Chinese economy has experienced significant changes and taken a historical leap to a new era of fast development of all industries and aspects of the society. The year 1978 became the benchmark for the foundation of the Chinese modern economic system, so this paper will only consider data after 1978.

In the empirical analysis, $Y_t$ (total amount of output) is measured by gross domestic product (GDP) in constant Yuan (the Chinese currency) in a year; this data series is available from 1978 to 2013 and is directly collected from CSY. $X_t$ (TEC, total energy consumption) is in 10,000 tons of SCE, collected from CSY (8-2 Total consumption of energy and its composition) and China Compendium of Statistics (CCS). Data for TEC is available from CSY only in years after 1990, and the rest of the data between 1978 and 1989 is obtained from CCS. The CCS is conducted by the department of integrated statistics of national economy of NBS, and the data from CCS in years after

1990 are identical with the data from CSY, so this paper will consider CCS as authentic official statistic resource, and use it in place of the missing NBS data. Therefore, the econometric analysis will be conducted on GDP and TEC statistics between 1978 and 2013.

## "Falsification Map"

There is an inverse relationship between the wealth of provinces and their reported growth rates of output. This suggests a very particular pattern of data falsification, which is referred to as a falsification map. Poorer provinces (or municipalities) are more likely to have higher growth rates than richer provinces. Poorer provinces also display growth rates that are much higher than the national level, while richer provinces typically have lower growth rates than the national level. This situation leads to the fact that the weighted average of the regional growths rate exceeds the national growth rate, because most provinces reported growth rates that were higher than the national level. Having observed this, it is suggested that poorer regions have greater incentive to falsify their data, while richer regions do not. This forms an interesting "falsification map" (shown in Table 3) that lists the GDP growth rates of different provinces in descending order by their GDP GR, which indeed shows that the poorer the province the higher the growth rate. In order to examine this phenomenon in greater detail, one needs to analyze the regional data.

As is shown in Table 3 bellow, all 31 provinces are highlighted by five different colors according to their regional GDP percentage (RGP), the percentage regional GDP takes in national GDP, which is marked as 'p' in the table. Provinces highlighted with pink have the highest growth rates, yet the lowest RGP ranging from 0 to 2; provinces highlighted with blue have RGP ranging from 2 to 6 and intermediate level of growth rates; provinces highlighted with purple are those with the highest RGP and located at the

very bottom of the table, which is associated with very low growth rates. The four entries highlighted with dark blue are the four municipalities in China. These are among the most developed cities in the country, and seemingly they all locate at the bottom of the table with relatively lower growth rates. For example, Beijing and Shanghai, as two of the most developed cities in China, have close to the lowest GDP growth rates during the first 3 quarters of 2013. On the contrary, the GDP growth rates of Xinjiang Uygur Autonomous Region and Ningxia Hui Autonomous Region - the two least developed provinces - rank highest in the country. This pattern, shown in Table 3, presents circumstantial evidence that falsification may be occurring in poorer /less developed regions.

The falsification map appears mostly due to government interference. More developed places are more closely monitored and receive extensive supervision by/from the central government and statistics institutions. For example, municipalities receive direction directly from the central government, and have very close relations with it. Cities like Beijing and Shanghai are indeed defined as municipalities (or direct-controlled municipalities in Chinese): urban administrative divisions/cities with the highest level of classification and the same status with provinces/states, they often has the power of self-governance and jurisdiction, which implies the mentioned monitoring. It is therefore difficult for such places to manipulate data under the direct supervision of the central government.

The “falsification map” reveals the relationship between regional wealth and the incentive for provinces to fabricate their data, and it ought to give the NBS useful

guidance on how to adjust regional data to better reflect the real economy. The fact that there exist an inverse correlation between government supervision of regions and the level of data falsification attests that the government and statistics institutions perhaps would be well off implementing more supervision in order to conquer the apparent data falsification problem.

**Table 3** GDP statistics of the first 3 seasons of 2013 for 31 Provinces

| Province/municipolity | GDP: 1st Season | GDP: 2nd Season | GDP: 3rd Season | Sum of GDP | Growth Rate | Regional GDP Percentage (%) | |
|---|---|---|---|---|---|---|---|
| Xinjiang Uygur Autonomous Region | 1157.15 | 1613.91 | 2680.29 | 5451.35 | 0.53 | 1.41 | 0<p<2 |
| Ningxia Hui Autonomous Region | 415.69 | 592.47 | 749.6 | 1757.76 | 0.35 | 0.45 | |
| Gansu | 1065.38 | 1284.19 | 1809.98 | 4159.55 | 0.31 | 1.08 | |
| Guizhou | 1231.86 | 2017.99 | 1860.81 | 5110.66 | 0.28 | 1.32 | |
| Tibet Autonomous Region | 152.87 | 176.72 | 246.14 | 575.73 | 0.27 | 0.15 | |
| Qinghai | 356.81 | 531.8 | 543.85 | 1432.46 | 0.26 | 0.37 | |
| Hebei | 5312.15 | 7842.43 | 7792.74 | 20947.32 | 0.23 | 5.42 | 2=<p<6 |
| Jilin | 2166.02 | 2641.99 | 3206.6 | 8014.61 | 0.22 | 2.07 | |
| Inner Mongolia Autonomous Region | 2943.92 | 4143.63 | 4250.45 | 11338 | 0.22 | 2.93 | |
| Jiangxi | 2712.28 | 3189.35 | 3972.65 | 9874.28 | 0.21 | 2.55 | |
| Anhui | 3652.36 | 4938.92 | 5022.58 | 13613.86 | 0.18 | 3.52 | |
| Fujian | 3713.44 | 5141.82 | 5032.37 | 13887.63 | 0.18 | 3.59 | |
| Sichuan | 5436.95 | 6218.1 | 7483.89 | 19138.94 | 0.17 | 4.95 | |
| Hubei | 4699.47 | 6249.83 | 6150.34 | 17099.64 | 0.16 | 4.42 | |
| Liaoning | 5296.16 | 7038.57 | 6929.2 | 19263.93 | 0.16 | 4.98 | |
| Hunan | 4658.82 | 6262.99 | 5991.77 | 16913.58 | 0.15 | 4.37 | |
| Zhejiang | 7261.54 | 9692.38 | 9241.11 | 26195.03 | 0.14 | 6.77 | 6=<p<12, except for Yunnan and Tianjin |
| Yunnan | 2260.42 | 2380.17 | 2905.15 | 7545.74 | 0.14 | 1.95 | |
| Guangdong | 12612.88 | 15853.04 | 16005.61 | 44471.53 | 0.13 | 11.50 | |
| Henan | 6993.68 | 7562.95 | 8959.39 | 23516.02 | 0.13 | 6.08 | |
| Shandong | 11076.48 | 14881.67 | 13643.53 | 39601.68 | 0.13 | 10.24 | |
| Tianjin (municipolity) | 2915.85 | 3663.16 | 3644.03 | 10223.04 | 0.13 | 2.64 | |
| Jiangsu | 11881.25 | 15722.73 | 14330.32 | 41934.3 | 0.12 | 10.84 | |
| Shanxi | 3069.41 | 3708.32 | 3801.7 | 10579.43 | 0.12 | 2.74 | |
| Heilongjiang | 2608.67 | 2936.43 | 3203.71 | 8748.81 | 0.11 | 2.26 | |
| Shanxi | 2610.08 | 3406.5 | 3012.41 | 9028.99 | 0.09 | 2.33 | |
| Beijing (municipolity) | 4101.23 | 5011.56 | 4653.39 | 13766.18 | 0.08 | 3.56 | |
| Guangxi Zhuang Autonomous Region | 2779.39 | 3030.79 | 3197.04 | 9007.22 | 0.07 | 2.33 | |
| Shanghai (municipolity) | 4937.5 | 5231.02 | 5305.61 | 15474.13 | 0.04 | 4.00 | |
| Chongqing (municipolity) | 2725.9 | 3114.61 | 2796.59 | 8637.1 | 0.02 | 2.23 | |
| Hainan | 734.62 | 782.07 | 707.88 | 2224.57 | -0.02 | 0.58 | |

## Quantitative Consistency Test

Rigorous quantitative analysis is illuminating and necessary for drawing any convincing conclusion on this topic. In order to study the reliability of official output data, this paper will conduct various consistency tests between the official GDP statistics and several economic indicators that are supposed to be highly correlated to GDP according to economic theories. Many literatures study this relationship using indicators, such as retail sales, tertiary industry output and etc., which may themselves be distorted, making it difficult or impossible to accurately assess where the falsification lies. For example, the secondary industry output data should be highly correlated with GDP statistics in a developing country like China, but the secondary industry output won't be a good indicator for revealing the falsification of national output data because it can be similarly fabricated, or even worse, the fabrication of secondary industry output data could be one of the main composition of the falsification of national output statistics.

The indicators selected for this study are different from the ones above because the associated data is available over a long time span, is less susceptible to manipulation, and better reflects the real economic performance. As mentioned earlier, this study will investigate the discrepancy between official GDP GR and AW GDP GR, the inconsistency between the GDP index and various price indices, and the conflict between GDP GR and TEC GR all using data from 1987 to 2013 (when available). This study not only further examines the results derived in previous works, but more importantly, it

inspects the quality of official statistics of the current decade and provides an in-debt analysis based on data after the statistics revisions.

1. GDP GR vs. AW GDP GR

Unlike what Meng and Wang's study showed, the update of their study showed that the range of discrepancy between GDP GR and AW GDP GR increased with time (Table 4.2). Based on the regional GDP statistics from the China Statistical Yearbook, the aggregate weighted national growth rate for years from 1999 to 2012 is calculated, shown in Table 4.1. According to Table 4.1, the official growth rate was lower than the aggregate weighted growth rate in all years but in 1999. In the year of 2004, 2008 and 2011, this difference even exceeded 10%, while the highest discrepancy Meng and Wang found in their study was only 3.3%. However, in many other years the discrepancy remained well below 3%. This greater range of discrepancy suggests that data falsification or the mismatch between regional and national data consistently exists in the Chinese statistical system. While it appears that the gap has been increasing, this cannot be established statistically. By running both a basic and a heteroskedasticity-adjusted regression of the discrepancies over the time span (commands and results shown in Table 4.3 in the appendix), the regression result shows that there is no significant correlation between the discrepancies and the time term, however the coefficient of the discrepancies is negative. This indicates that the difference between GDP GR and AW GDP GR decreases over time, which suggests that the national statistics is becoming more reliable.

**Table 4.1, 4.2 GDP GR vs. AW GDP GR**

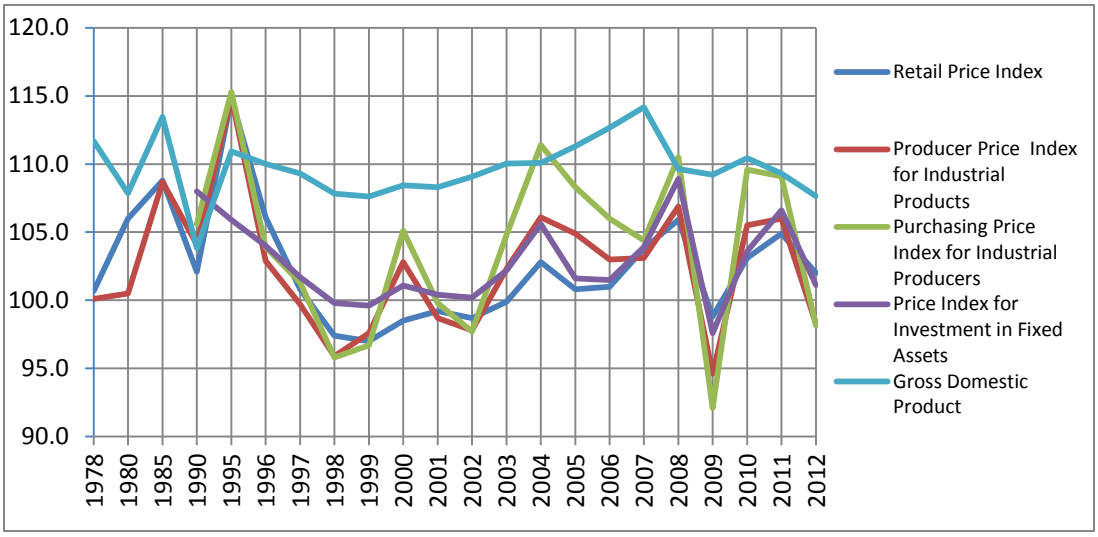
| Year | Aggregate Weighted GDP GR | Official GDP GR | Difference |
|---|---|---|---|
| 4.1 The Comparison of official GDP GR and AW GDP GR (%) | | | |
| 1999 | 6.3 | 7.6 | -1.3 |
| 2000 | 11.0 | 8.4 | 2.5 |
| 2001 | 9.9 | 8.3 | 1.6 |
| 2002 | 10.1 | 9.1 | 1.1 |
| 2003 | 15.4 | 10.0 | 5.4 |
| 2004 | 24.7 | 10.1 | 14.6 |
| 2005 | 18.1 | 11.3 | 6.8 |
| 2006 | 16.6 | 12.7 | 3.9 |
| 2007 | 19.6 | 14.2 | 5.5 |
| 2008 | 21.2 | 9.6 | 11.6 |
| 2009 | 9.7 | 9.2 | 0.5 |
| 2010 | 19.7 | 10.4 | 9.3 |
| 2011 | 19.4 | 9.3 | 10.1 |
| 2012 | 10.6 | 7.7 | 3.0 |
| Source: China Statistical Yearbook 2013 | | | |
| 4.2 the Comparison of official GDP GR and AW GDP GR (%), Meng and Wang (2000) | | | |
| 1988 | 11.8 | 11.3 | 0.5 |
| 1989 | 4.1 | 4.1 | 0 |
| 1990 | 5.4 | 3.8 | 1.6 |
| 1991 | 9.7 | 9.2 | 0.5 |
| 1992 | 15.8 | 14.2 | 1.6 |
| 1993 | 16.8 | 13.5 | 3.3 |
| 1994 | 14.90 | 12.60 | 2.30 |
| 1995 | 13.1 | 10.5 | 2.6 |
| 1996 | 11.9 | 9.6 | 2.3 |
| 1997 | 11.1 | 8.8 | 2.3 |
| 1998 | 9.7 | 7.8 | 1.9 |
| Source: The Estimation of the Chinese Economic Growth Statistics, Meng and Wang, 2000 | | | |

2. GDP Index vs. Other Price Indices (Retail Price Index, Producer Price Index, Purchasing Price Index, Price Index for Investment in Fixed Assets)

Figure 1 compares the growth pattern of GDP Index and four other price indices, including Retail Price Index, Producer Price Index, Purchasing Price Index, and Price Index for Investment in Fixed Assets. This is an update and a reflection of the methodology Meng and Wang's study used and this section seeks to update that study using new data. Chapter Two of this paper questioned the assumption that there is a strict positive relationship between GDP Index and other price indices. So far, most economists agree on the idea that there is a certain level of positive correlation between GDP and various price indices, but there is no such a theory which regulates this relationship being strictly positive. At best, this assumption will provide insight to data falsification. At worst, this will not be insightful although, and this would not challenge the conclusions of the paper because this is a peripheral discussion.

Comparing the newest data (Table 5.1) and the data used by Meng and Wang (Table 5.2), the figures of various indices, as well as the GDP index has not changed much for years before 1998. Based on the data from Table 5.2, Meng and Wang concluded that GDP index was greatly falsified in 1996 and 1997, because GDP index displays contrary trend in these years, compared to the four price indices.

Figure 1 Comparison of GDP Index and four Price Indices




Source: China Statistical Yearbook 2013, preceding year=100. Respectively, Table 5.1 and 5.2 contain revised data from 2013 and unrevised data Meng and Wang used from 2000.

Figure 1 shows the growth rates of all five indices in the past three decades (same data from Table 5.1), which revealed subsequent facts:

a. All four price indices are sharing similar growth patterns, and the GDP index grows roughly along this pattern with a much smoothed pattern.

b. There is controversial growth pattern shown in certain period of time between the GDP index and four other price indices. For example, the most problematic pattern appeared between 2004 and 2008, when GDP index grew to totally the opposite direction than all four other price indices did. Also, while four price indices went through a sharp downturn and upturn from 2008 to 2010, the GDP index stayed relatively unchanged.

c. When the price indices reached their periodical trough in 2007, the GDP index reached its historical new high record.

d. The GDP index and the price indices showed comparable growth pattern before 2004 and after 2010.

If the assumption holds, these observations from this figure indicate that the GDP statistics are questionable during 2004 and 2010, but has a roughly positive correlation with the four price indices over the course of last three decades.

3. GDP Growth Rate (GDP GR) vs. Total Energy Consumption Growth Rate (TEC GR)

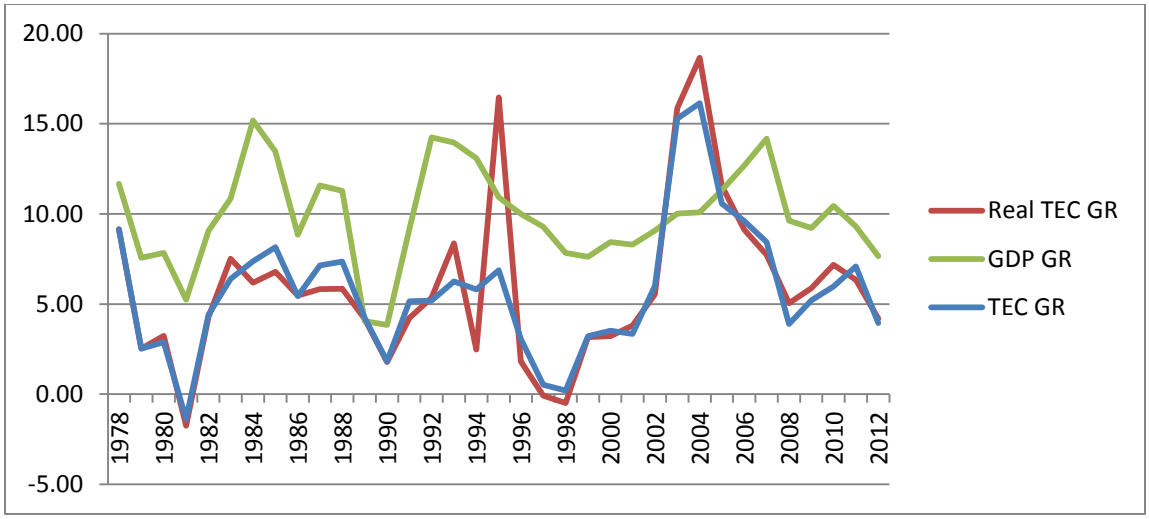
An increase in output should be associated with an increase in energy consumption if there is no significant technology breakthrough or tremendous foreign capital inflow, which considerably improves (increases) the output-energy ratio. It is hard to directly capture the influence technology breakthrough has on GDP and TEC statistics, but it is possible to estimate whether it is significant enough to increase the output-energy ratio. Assuming there is significant technology breakthrough during the past three decades, the output-energy ratio should be increased and there should be a greater divergence between GDP GR and TEC GR. However, according to Figure 2 which displays data of GDP GR and TEC GR from 1978 to 2012, the GDP GR and TEC GR moved well in parallel during the first two decades and merged to each other between 2001 and 2005. This situation suggested that the technology breakthrough was not significant enough to change the overall relationship between output and energy consumption. According to the China Statistic Yearbook 2013, the efficiency of energy

conversion increased from roughly 66.5% in 1990 to roughly 72.5% in 2011. In order to more accurately study the relationship between GDP and energy consumption, this section will take the energy conversion efficiency into consideration, and apply the efficiency rates to the TEC statistics, obtaining the yearly real TEC data.

This section will not consider foreign capital inflow as a factor that will influence the relationship between GDP and TEC. Foreign capital inflow will stimulate domestic demand, which will lead to more production. More production will lead to more energy consumption, with the same output-energy ratio. Therefore, foreign capital will work fundamentally similarly with any other capital inflow, considering how energy consumption is involved. Foreign direct capital inflow will not change the output-energy ratio.

Figure 2 below shows the growth patterns of GDP GR, Real TEC GR, and TEC GR. It implies that real TEC GR and TEC GR are coincident to each other, which implies that technology improvement for energy conversion efficiency did not have much influence. Moreover, all three figures have been consistently positive in almost all years, and they exhibit roughly similar patterns. However some other implausible observations are also revealed.

**Figure 2** GDP GR vs. TEC GR (%)




Source: China Statistic Yearbook (CSY) and China Compendium of Statistics (CCS).

During 2004-2008, the most questionable patterns appear where the respective rates move in opposite directions, displaying inverse relationships. Starting from 2004, the real TEC GR pattern experienced a significant downturn, while the GDP GR was still growing. Moreover, the real TEC GR showed abrupt and extreme downturn and upswing in 1994 and 1995 respectively. To the contrary, the TEC GR grows more coherently with the GDP GR. Furthermore, Figure 2 does show a parallel relationship between GDP statistics and TEC statistics, but with a few years of lags. TEC GR peaks or hits a low point years before GDP GR peaks or hits a low point, especially during years after 1998.

A valid cointegration between the GDP statistics and the real TEC data will have a strong indication for the reliability of the official statistics. In order to conduct a more rigorous

study on the correlation between TEC and GDP and the "lagged relationship" observed, this chapter will test the co-integration between these two rates through econometric approach.

## Econometric Approach: GDP vs. TEC

Based on the analysis above, it is expected that GDP and real TEC are cointergrated over the long run. Because GDP and TEC are both nonstationary time series data, this session will take advantage of EG-ADF model and test the cointegration between GDP and real TEC statistics. If there is no obvious data falsification, the result of this test should show a good cointegration relation between GDP and real TEC statistics. To the contrary, if there is obvious data falsification, the test result should not indicate a significant cointegration relation between the two time series.

To formalize this economic intuition, let Yt, Xt be the official GDP and real TEC, respectively, in period t. Then Yt and Xt should have the following cointergrating relationship:

$$Y_t = \alpha + \theta X_t + \varepsilon_t \tag{3.1}$$

where θ is the cointergration coefficient, which is chosen to eliminate the common trend of Yt and Xt; α denotes the drift of the random walk, and $\varepsilon_t$ is an error term. Since both GDP and real TEC are considered approximately exponential, this paper will skip the processes of Unit Root test for both GDP and real TEC, and pursue the cointegration relationship analysis based on the assumption that both Yt and Xt are nonstationary.

Noting that both GDP and real TEC exhibit growth that is approximately exponential, the logarithm of the series grows approximately linearly. By taking the logarithm on variables of both sides of the equation, the relationship between the variables remains, yet the coefficient represents the elasticity between two variables. Here we will take the logarithm of the series for simplicity:

$$\ln Y_t = \alpha + \theta ln X_t + \varepsilon_t \tag{3.2}$$

where $\alpha$ still represents the drift, but now related to the transformed variables. The same situation applies to $\varepsilon_t$. Here, the notation is kept for simplicity.

This paper will use the Engle-Granger Augmented Dicky-Fuller Test (EG-ADF) to test for cointergration between GDP and real TEC. Engle and Granger (1987) suggest a two-step cointegration test, which consists of estimating the cointegration regression by OLS, obtaining the residual $\widehat{\varepsilon_t}$, and applying unit root test for $\widehat{\varepsilon_t}$.

Step 1, the test will estimate the cointegrating coefficient θ using OLS estimation of the regression in Equation (3.2):

$$\underset{\substack{(1.5)\\ }}{\widehat{ln Y_t} = -15.2} + \underset{(0.12)}{2.2 ln X_t}, \ \bar{R}^2 = 0.938, n = 23 \tag{3.3}$$

according to the regression result, the t value (17.75) for $\theta$ = 2.2 is significantly below a 5% confidence level, therefore $\theta$ = 2.2 is a valid cointegrating coefficient of $\ln Y_t$ and $ln X_t$.

Step 2, use a Dickey-Fuller t-test (with an intercept but no time trend) to test for a unit root in the residual $\widehat{\varepsilon_t}$ from the regression Equation (3.3). To begin with, it must be specified how many lags to include. According to the result shown in Table 7, three lags

are used for this bivariate model, because the Hannan–Quinn information criterion (HQIC) method, Schwarz Bayesian information criterion (SBIC) method, and sequential likelihood-ratio (LR) test all suggest to use three lags, as indicated by the "*" in the output shown in Table 7(Appendix 2 ).

Apply three lags while identifying the number of cointegrating relationships. As is indicated from the estimating result shown in Table 7 (Appendix 2), the test statistics are based on a model with three lags as designated and a constant trend by default. In the output shown in Table 7 (Appendix 2), the trace statistic is significantly larger than the

5% significance value for zero cointegration relationship and is smaller for one cointegration relationship (a max rank of 1), so we strongly reject the null hypothesis of no cointegration and fail to reject the alternative hypothesis of at most one cointegrating equation. Thus we accept the null hypothesis that there is one cointegrating equation in the bivariate model. Based on this result, we cannot conclude that the official output data is falsified because of the contradictory growth track during certain years, because after rigorous test, official GDP and real TEC are cointegrated in a long run.

This paper compared the difference between official GDP GR and aggregate weighted GDP GR earlier, and the result designates a big discrepancy between them, which further indicates that the adjusted official GDP might not reflect the real GDP level. This paper will run the same EG-ADF Test on real TEC and AW regional GDP, so as to see whether the regional data better co-integrates with the TEC figures.

The result of the EG-ADF Test (shown in Table 7) indicates that real TEC and AW regional GDP are also cointegrated. However, it's worth to mention that the AW regional GDP shows a higher level of cointegration with a near perfect adjusted $R^2$ value and a much more significant F-test value (44291.68 for AW regional GDP vs. 315.22 for GDP) This result, to some extent, works in concert with the conclusion drawn from the study of the data revision: the regional data better reflects the real economic performance, in absolute value and in trend, and the data adjustment before the economic census by NBS has been biased and lack of reliability. Nevertheless, the revised data has a good cointegration relationship with real TEC, which indicates a more plausible growth pattern against TEC than its pre-revision version (tested by former economists).

This econometric study has some limitations. Firstly, this study did not exchange the order of GDP and real TEC statistics as dependent and independent variables, because this econometric analysis was not designed to identify the causal relationship between GDP and real TEC, instead it was designed to simply study the cointegration relationship between the two time series data. Secondly, since this study did not try to forecast these variables, it did not use error correction model (ECM) in the econometric analysis. With a certain level of limitation of this econometric analysis, this study concludes that the post-revision official data is plausible in value and in trend, and TEC will not be considered as an inconsistency or unreliability indicator of the official statistics.

## CHAPTER FOUR: CONCLUSION

This paper has shown that the data falsification is very likely to remain in the current Chinese economic statistics system, but the quality of the official data has been significantly improved.

The majority of the literature, reviewed in chapter two, pointed to a series of inherent contradictions in the official figures, which casted doubt upon the reliability of the data. Various stand-out contradictions clearly indicated that the reliability of official data is highly questionable, and domestic resources showed that the official data was inaccurate in part due to poor quality statistical work and in part due to explicit falsification. However, statistical studies based on the foreign resources provided supporting proves for the reliability of the Chinese official data. Moreover, the NBS has conducted reforms of the statistical regime and undertaken revisions of long-run regional GDP data in light of the national economic censuses, which is believed, by most scholars, to be helpful for the improvement of the quality of official statistics.

Chapter Three, on one hand, reused the approaches identified in the previous chapter and updated them by employing new data; on the other hand, it introduced some new method that could have been used in the study, and showed that the quality of the official data had been improved. Some updates of the previous methods verified the

official statistics, while others refuted the official data. The comparison of GDP growth rates vs. Aggregated Weighted growth rates indicated that data manipulation widely existed in the national system. The “falsification map" presented circumstantial evidence that data falsification may more likely to occur in poorer or less developed regions. The comparison between the GDP index and the four price indices revealed supporting evidence for opposite sides on this debate. The comparison of GDP growth rates vs. Total Energy Consumption growth rates demonstrated that some of the former arguments used to suggest unreliability of the Chinese official statistics no longer held, and that the official data in fact was reliable or at least more reliable than ever. The paper then extended one of the identified methodologies, and conducted an empirical analysis on the cointegration relationship between GDP and TEC (total energy consumption) by using the Engle-Granger Augmented Dicky-Fuller Test (EG-ADF test). The test result showed that the GDP and TEC statistics were very well cointegrated, suggesting no significant data falsification in the national output data.

Based on all the combined results from Chapter Two and Chapter Three, this paper reaches to the conclusion that even though a certain level of data falsification still exists in the current official economic statistics, the quality of the data has been significantly improved.

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## APPENDIX 1

**Table 1** Definition and Sources of Data Series

| **Term Name** | **GDP (constant LCU), 1960-2013** |
|---|---|
| **Definition:** GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant local currency. | |
| **Source** | China Statistical Yearbook. 2013. Chinese National Bureau of Statistics. |

| **Term Name** | Cointergration |
|---|---|
| **Definition:** Suppose Yt and Xt are integrated of order one. If, for some coefficient θ, Yt - θXt is integrated of order zero, then Xt and Yt are said to be cointegrated. The coefficient is called the cointegrating coefficient. If Xt and Yt are cointegrated, then they have the same, or common, stochastic trend. Computing the difference Yt -θXt eliminates this common stochastic trend. | |
| **Source** | Clive Granger, 1983. |

| **Term Name** | EG-ADF test |
|---|---|
| **Definition:** Engle-Granger Augmented Dickey-Fuller test for cointegration (Engle and Granger, 1987). …in the first step the cointegrating coefficient is estimated by OLS estimation of the regression. In the second step, a Dickey-Fuller t-test (with an intercept but not time trend) is used to test for a unit root in the residual from this regression. This two-step procedure is called the EG-ADF test. | |
| **Source** | Stock and Watson. 2007. |

**Table 2** Timeline of Statistical Reform in China

| Year | Event |
|---|---|
| 1983 | National Statistics Law introduced to reduce manipulation of statistics |
| 1984 | Consumer price offices introduced at provincial and municipal level to sample data for price indexes |
| 1985 | National Bureau of Statistics begins to compile tertiary sector and aggregate production GDP stats |
| 1990 | First volume published with national and provincial GDP going back to 1978 |
| 1991 | First tertiary sector census (lasts from 1991 to 1995) |
| 1993 | Official switch to UN System of National Accounts |
| 1995 | First secondary (industrial) sector census reveals problems of rural industrial data for first time. Results in a downward revision of up to 25 percent for the gross output value of collective-owned and private enterprises in 1991-1994, and as well as major revisions in production accounts |
| | Begins reporting according to the UN System of National Accounts (SNA) and discontinues the Soviet Net Material Product (NMP) system |
| 1996 | 1st Revision of 1983 National Statistics Law drastically reduces the role of the traditional industrial enterprise reporting system in favor of censuses and sample surveys |
| 1997 | NBS publishes national accounts for every province for the time period 1952-1995, with expenditure accounts in nominal and real growth terms |
| | Local government data manipulation comes to a head: (1) February 1998: State Council threatens disciplinary measures if local officials falsify statistics; (2) March 1998: NBS dispatches investigative teams to provinces |
| | Two laws are issued to codify the calculation of annual and seasonal GDP |
| 1998 | Reform of ownership classification results in a new category for state-owned enterprises (SOEs), which provides a very broad definition for the state-owned sector |
| | Direct reporting system reformed for first time in order to include only larger industrial enterprises |
| 1999 | NBS increases monitoring of provincial-level statistical work, especially in order to monitor major |
| 2004 | First national economic census - GDP revised by 16 percent |
| 2007 | Direct reporting system again adjusted to include less firms |
| 2009 | Second national economic census - GDP revised by 4 percent |
| | 2nd Revision of National Statistics Law increases punishments for manipulation of statistics |
| 2011 | Seasonally adjusted quarter-by-quarter growth metric introduced for the first time (as of 1Q11) |
| | Direct reporting system adjusted again to include less firms |

**Table 4.3**

Basic regression of the difference term and the time term

| | Coefficient | p-value |
|---|---|---|
| Difference | -0.1328741 | 0.57 |
| Constant | 2003.841 | 0 |

Heteroskedasticity-corrected regression of the difference term and the time term

| | Coefficient | p-value |
|---|---|---|
| Difference | -0.1459649 | 0.57 |
| Constant | 298.6941 | 0.561 |

**Table 4.1, 4.2** GDP GR vs. AW GDP GR (In text)

**Table 5.1** GDP index and 4 other price indices

表 2.2 全国各种物价指数与国内生产总值指数 （上年=100）

| 年份/项目 | 各种价格指数 | | | | 国内生产总值指数 |
|---|---|---|---|---|---|
| | 商品零售价格指数 | 农产品收购价格指数 | 全部工业品出厂价格指数 | 固定资产投资价格指数 | |
| 1979 年 | 102.0 | 122.1 | 101.5 | 102.2 | 107.6 |
| 1980 年 | 106.0 | 107.1 | 100.5 | 103.1 | 107.8 |
| 1981 年 | 102.4 | 105.9 | 100.2 | 103.2 | 105.2 |
| 1982 年 | 101.9 | 102.2 | 99.8 | 102.3 | 109.1 |
| 1983 年 | 101.5 | 104.4 | 99.9 | 102.5 | 110.9 |
| 1984 年 | 102.8 | 104.0 | 101.4 | 104.0 | 115.2 |
| 1985 年 | 108.8 | 108.6 | 108.7 | 107.2 | 113.5 |
| 1986 年 | 106.0 | 106.4 | 103.8 | 106.4 | 108.8 |
| 1987 年 | 107.3 | 112.0 | 107.9 | 105.3 | 111.6 |
| 1988 年 | 118.5 | 123.0 | 115.0 | 113.5 | 111.3 |
| 1989 年 | 117.8 | 115.0 | 118.6 | 108.5 | 104.1 |
| 1990 年 | 102.1 | 97.4 | 104.1 | 105.5 | 103.8 |
| 1991 年 | 102.9 | 98.0 | 106.2 | 109.5 | 109.2 |
| 1992 年 | 105.4 | 103.4 | 106.8 | 115.3 | 114.2 |
| 1993 年 | 113.2 | 113.4 | 124.0 | 126.6 | 113.5 |
| 1994 年 | 121.7 | 139.9 | 119.5 | 110.4 | 112.6 |
| 1995 年 | 114.8 | 119.9 | 114.9 | 105.9 | 110.5 |
| 1996 年 | 106.1 | 104.2 | 102.9 | 104.0 | 109.6 |
| 1997 年 | 100.8 | 95.5 | 99.7 | 101.7 | 108.8 |
| 1998 年 | 97.4 | 92.0 | 95.9 | 99.8 | 107.8 |

注：据《中国统计年鉴》和有关部门提供数据。

Source: Meng and Wang, 2000. The columns are Year/Item, Retail Price Index, Agriculture Purchasing Price Index, Industrial Price Index, Fixed Asset Investment Price Index, and GDP respectively.

**Table 5.2** GDP index and 4 other price indices

(preceding year=100)

| Year | Price Indices | | | | Gross Domestic Product |
|---|---|---|---|---|---|
| | Retail Price Index | Producer Price Index for Industrial Products | Purchasing Price Index for Industrial Producers | Price Index for Investment in Fixed Assets | |
| 1978 | 100.7 | 100.1 | | | 111.7 |
| 1980 | 106.0 | 100.5 | | | 107.8 |
| 1985 | 108.8 | 108.7 | | | 113.5 |
| 1990 | 102.1 | 104.1 | 105.6 | 108.0 | 103.8 |
| 1995 | 114.8 | 114.9 | 115.3 | 105.9 | 110.9 |
| 1996 | 106.1 | 102.9 | 103.9 | 104.0 | 110.0 |
| 1997 | 100.8 | 99.7 | 101.3 | 101.7 | 109.3 |
| 1998 | 97.4 | 95.9 | 95.8 | 99.8 | 107.8 |
| 1999 | 97.0 | 97.6 | 96.7 | 99.6 | 107.6 |
| 2000 | 98.5 | 102.8 | 105.1 | 101.1 | 108.4 |
| 2001 | 99.2 | 98.7 | 99.8 | 100.4 | 108.3 |
| 2002 | 98.7 | 97.8 | 97.7 | 100.2 | 109.1 |
| 2003 | 99.9 | 102.3 | 104.8 | 102.2 | 110.0 |
| 2004 | 102.8 | 106.1 | 111.4 | 105.6 | 110.1 |
| 2005 | 100.8 | 104.9 | 108.3 | 101.6 | 111.3 |
| 2006 | 101.0 | 103.0 | 106.0 | 101.5 | 112.7 |
| 2007 | 103.8 | 103.1 | 104.4 | 103.9 | 114.2 |
| 2008 | 105.9 | 106.9 | 110.5 | 108.9 | 109.6 |
| 2009 | 98.8 | 94.6 | 92.1 | 97.6 | 109.2 |
| 2010 | 103.1 | 105.5 | 109.6 | 103.6 | 110.4 |
| 2011 | 104.9 | 106.0 | 109.1 | 106.6 | 109.3 |
| 2012 | 102.0 | 98.3 | 98.2 | 101.1 | 107.7 |

Source: China Statistical Yearbook 2013 9-1 Price Indices

## APPENDIX 2: STATA COMMANDS AND OUTPUT

**Table 7 STATA output**

| GDP vs. TEC | | | | AW GDP vs. TEC | | | |
|---|---|---|---|---|---|---|---|
| **Identify the number of lags** | | | | | | | |
| lag | LR | HQIC | SBIC | lag | LR | HQIC | SBIC |
| 0 | | -0.2902 | -0.2076 | 0 | | -0.9840 | -0.8886 |
| 1 | 147.25 | -7.5856 | -7.3379 | 1 | 104.91 | -7.4468 | -7.1606 |
| 2 | 17.488 | -8.0514 | -7.6384 | 2 | 22.286 | -8.4012 | -7.9242 |
| 3 | 16.947* | -8.4886 | -7.9105 | 3 | 11.496 | -8.6363 | -7.9684 |
| 4 | 4.185 | -8.2542 | -7.5109 | 4 | 11.413* | -8.8659 | -8.0072 |
| **Identify the number of cointegrating relationships** | | | | | | | |
| rank | trace statistic | | 5% critical value | rank | trace statistic | | 5% critical value |
| 0 | 24.9445 | | 15.41 | 0 | 26.3662 | | 15.41 |
| 1 | 0.222* | | 3.76 | 1 | 1.4652 | | 3.76 |
| 2 | | | | 2 | | | |

**Table 8** Do-file for Empirical Study using STATA

```
use "TEC and GDP.dta", clear
tsset Year
generate lgdp = log(GDP)
generate ltec = log(TEC)
generate laggdp = log(AgGDP)
*testing the integration relationship between GDP and TEC
reg lgdp ltec
predict res, r
varsoc lgdp ltec
vecrank lgdp ltec, lag(3)
vec lgdp ltec
*testing the integration relationship between aggregate GDP and TEC
reg laggdp ltec
predict resag, r
varsoc laggdp ltec
vecrank lgdp ltec, lag(4)
```