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China's GDP Per Capita from the Han Dynasty to Communist Times

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Abstract

Our article is a critical survey of the concepts and data utilized by economists and economic historians that purport to measure relative levels and long term trends in GDP per capita from the Han Dynasty to Communist times. We favour attempts to extend macro-economic analysis and its associated quantification to China's long imperial history, but have concluded that estimates calibrated in international dollars for 1900, or 2005 or 2011 are not fit for that purpose. Furthermore, and after surveying recent endeavours to reconstruct the published secondary and official statistical sources available for the measurement of primary production for Ming and Qing China (1368-1911), we reluctantly suggest that Kuznetian paradigms for empirical economics are probably not viable, either for the measurement of the empire's growth over time or for reciprocal comparisons with European economies. This is because on both conceptual and statistical grounds the concept and associated metric for GDP per capita does not travel easily and securely between the fiscal systems of China and the West (Yun-Casallila and O'Brien 2012).

Keywords: GDP accounting, Kuznetsian paradigm, Great Divergence

JEL Codes: N00, N55, O40, O53

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1. Introduction and Preliminary Tabulations

In a sequence of widely cited articles and two editions of a book (the leading proponent of the Kuznetsian paradigm for empirical economics) has laudably endeavoured to relocate the history of economic growth for the Chinese Empire from year one of the Common Era to our times upon a statistical basis. For that purpose Maddison utilized: (a) a contested series of revised official estimates for gross domestic products for 1956, 1960 and 1990 and one unofficial estimate for 1933 as a basis for backward and forward projections covering the years 1870-1990; and (b) several assumptions that has allowed him and his followers to extrapolate insecure estimates of per capita income (conceptualized and calibrated for contemporary purposes of international comparisons) from the Han dynasty to modern times (Maddison 2007 a). As "facts" for analysis we find the results unconvincing. As numbers they are instructive to confront because they reveal the limitations of research based upon the programme for a quantified analysis of "modern" economic growth inaugurated by Simon Kuznets (Kuznets 1966; Fogel 2013). That programme extended latterly to include China, India and other Asian economies as an outcome of the Divergence Debate, enjoys success for industrial, agricultural, regional and country studies of long term growth where and when statistical information for factors of production (land, labour, technologies, capital) inputs and outputs (for national, agricultural, industrial and service production) are available at macro levels. The data should (as the pioneers of historical national accounts recognized) be reliable within the margins of error tested and recognized as adequate for economic analyses of long run economic change (Clark 1940; Zimmerman 1965; Bairoch 1981 and 1997; Kuznets 1971).

We will argue that on both factual and conceptual grounds these preconditions do not apply arguably even for the twentieth century and certainly not to any long run economic history for China (Deng 1999). The Maddison agenda to construct a statistical framework for a macro-economic analysis of the economic development of that huge empire and republic is (as a previous generation of Sinologists anticipated) doomed to frustration (Eckstein 1968; Feuerwerker 1992). This has led to the "manufacture" of proxies for data that is simply not there and which represents nothing other than abstract and subjective impressions derived from the imposition of numbers on histories (written on a basis of traditional evidence for which Jacques Derrida's famous quote (*"il n'y a plus hors du texte"*) seems apposite, Putnam 1988).

Our view is that Maddison's widely cited estimates or revision to them purporting to cover nearly two millennia of history have and cannot provide conceptually sound or statistically secure figures to facilitate either the measurement or the comprehension of long term trends for rates of growth or statistically based representations of comparative levels of incomes per capita afforded to their citizens by the Chinese and other Eurasian economies, as they evolved between the Han dynasty and the end of China's imperial regime in 1911. In simplified form the basic Maddison data are tabulated below:

Table 1: Measured Maddison's Estimates for Long Run Trends and Relative Levels of GDP per capita for the Chinese Empire for Bench Mark Years from Year 1 to 1990, Measured in International Dollars and Recalibrated into Kilocalories of Nutrients per Capita

A	B	C	D	E	F	G
Bench Mark Year circa	GDP per capita in 1990 International Dollars	Index for GDP per capita in 1990 International Dollars	GDP per capita estimates transformed into Kilo-calories of Edible Rice at Constant 1990 prices	Per Capita Consumption of Edible Rice (Year = 2100 Kilocalories per day)	Index measuring changes above Food Security Levels (4 /5)	Variance between Maddison's preferred Estimate for population and the highest and lowest of international Estimates in Print, in 10 million persons, Maddison's figures in []
1	450	100	3374	2100	160	5 and 7 [5.9]
1000	466	104	3495	2175	166	6.6 and 10 [5.9]
1300	600	133	4492	2800	214	6 and 8.6 [10]
1500	600	133	4492	2800	214	5.1 and 11 [10.3]
1600	600	133	4492	2800	214	5.6 and 16 [16]
1700	600	133	4492	2800	214	5.6 and 16 [13.8]
1820	600	133	4492	2800	214	36.1 and 38.3 [38.1]
1850	600	133	4492	2800	214	43.5 and 45 [41.2]
1860	530	118	3444	2473	163	? [37.7]
1890	540	120	3506	2520	167	37.8 and 37.8

						[38]
1900	545	121	3537	2543	168	36.8 and 47.5 [40]
1913	552	123	3587	2576	171	[43.7]
1933	579	129	4338	2715	206	[50]
1956	616	137	4617	2888	220	[54.7]
1960	662	170	4961	3577	236	[66.7]
1990	1871	415	14022	8738	667	[113.5]

Notes to the Table

Column A displays a series of benchmark years selected by Maddison.

Column B is a run of estimates for GDP per capita copied from Maddison 2007, pp. 24, 31, 37, 151 and 157. Maddison's exposition of how he derived an estimate of China's GDP for 1990 and a coefficient to convert that estimate into international dollars for 1990 is elaborated in Maddison (1995) appendix, pp. 162-76 and Maddison (2007) pp. 24 and 154. Maddison relied upon the work of Ren (1997) pp 38-40 and Ren and Chen (1995) p. 14. His conversion coefficient is 1 international dollar equals 1.1538 yuan at 1990 prices and weights.

Column C is an index based on conversions of estimates in 1990 yuan into international dollars but is recalibrated to represent trends from year 1 to 1990.

Column D is Column B divided by the official price per kilogramme of edible rice for 1990 (0.0648 yuan per kilogram) and converted into kilocalories using methods and coefficients prescribed by FAO (2002) as elaborated in NIIR Project Consultancy Services, 2012.

Column E selects the modern FAO level for "food security" (2100 kilocalories per day) as an alternative conjecture for average levels of nutritional-based welfare afflicting the population of China under the Han Dynasty for Year 1 and extrapolates that level forward to 1990 utilizing rates of growth as postulated by Maddison in Column C.

Column F quantifies changes in levels above food security enjoyed by the Chinese population implied by Maddison's estimates for trends in per capita incomes in 1990 international dollars.

Column G displays the variance found in a range of published estimates for the population of China (Durand 1960; Perkins 1969; McEvedy and Jones 1978; Liang 1980; Chao 1986; Jiang 1998; Maddison 1998; Ge 2000-1; Deng 2004; Zhao and Chen 2006).

2. Conceptual and Empirical Incongruities

Column G of the Table includes our calculations of the variance between a range of alternative revisions to official estimates for total population by Maddison and historical demographers of China currently in print. That table also displays a sequence of benchmark estimates based upon rates of growth that Maddison postulated for forward extrapolations from a baseline figure for Year 1 (Column B). For the years from 1870 to 1990 he based his estimates on backward extrapolations from estimates for GDP in 1990 and 1933.

All sixteen benchmarked estimates are from year 1 to 1990 and are expressed in a common numeraire of 1990 international dollars. Prima facie that numeraire conveys an undiscussed impression that the cited levels for GDP per capita have been derived from a sequence of benchmarked estimates expressed in current prices and currencies for sixteen pre-selected years that have been converted to international dollars at a constant rate of exchange designed and calibrated to represent the purchasing power parity of the Chinese yuan against a large sample of other national currencies for the year 1990.

Thus our initial and primary objection to these and other sequences of numbers is that even if more or less plausible estimates for GDP per capita in current prices ever become available for the 16 years benchmarked in the table the meaning and sense of converting them into international dollars at a constant purchasing power parity rate of exchange designed and calibrated to estimate a transitive and transnational value for the yuan in 1990 dollars is conceptually misplaced.

In order to expose the ambiguities embodied in that rate of exchange and its enticing numeraire we have recalibrated Maddison's estimates into their grain and kilocalorie equivalents, utilizing an equally implausible numeraire, based upon the average prices of two staple nutrients : rice and wheat for the year 1990. Our calibrations utilize Maddison's trends, but they support very different impressions for a possible chronology for the Great Divergence between China and the West. Maddison's interpretation of that historical conjuncture is based on comparisons of his estimates for GDP per capita between China and Europe. He maintains that data suggests average standards of living between China and the West diverged around 1600 and the gap widened continuously down to very recent decades when the Chinese economy began to deliver increasing standards of living for its population at levels that continue to converge rapidly towards those afforded by western economies. But recalibrated into kilocalorie equivalents at constant 1990 prices for Chinese rice and European wheat the series generates alternative runs of estimates for China's economic performance over the long run. Columns D, E and F of the table support an entirely different and optimistic interpretation of the Great Divergence. Although that on average Chinese standards of living could be represented as static after 1300, they also remained discernibly above European standards for some six to seven centuries down to the mid-19th century.

This more favourable interpretation of Chinese economic history based upon an alternative numeraire (namely rice at constant 1990 prices) is not only at odds with inferences of long term retardation drawn by Maddison (and others) but could paradoxically be read as an inflated version of the historical revisionism published recently by all members of the California school and the late Gunder Frank. Our crude test simply reveals that the concepts and statistics utilized by Maddison and others who continue to construct estimates of China's GDP per capita expressed in a common and modern numeraire conveys to facilitate the construction of both trends over time and comparisons with Europe need to be critically evaluated

That examination will start with the figures in Columns B and C which were constructed by way of a backward extrapolation for 1990-1870 and forward extrapolation for the period from Years 1 to 1870. Prima facie the two series have been linked together by an ostensibly comparable numeraire derived from rates of exchange designed and calibrated to represent the international purchasing power parity of the yuan for the year 1990 (Maddison 1995a, pp 162-78 and 2007b, p. 154).

For the first period 1990-1870 Maddison applied a single conversion purchasing power parity rate of exchange for 1990 to official and revised estimates in yuan at current prices for China's GDP for the years 1990, 1960 and 1956 and to an estimate for 1933 , again expressed in yuan at current prices, published by two Chinese economists Liu and Yeh in 1965 (Liu and Yeh 1965). With estimates for 1990 and 1933 in international dollars in place, Maddison then deployed a series of sectoral growth rates in constant prices published by three economists with expertise on China (Perkins, Rawski and Wang) to produce an annual average rate of growth for GDP per capita from 1913-33 (Maddison 1995, pp. 145 and 195). He then asserted that this rate could be applied to the "years of recovery" from internal disorder and warfare 1870-1912 (Maddison and Wu 2008).

Furthermore, and because estimates originally compiled in yuan at current prices had been converted into dollars at international prices for 1990, Maddison claimed that these numbers could also be compared with all other economies whose currencies could, theoretically, be converted directly or indirectly into the same numeraire (Fukao et al. 2007). As historians endeavouring to locate a chronology for economic divergence between China and Europe, the period 1870 to 1990 is not our primary concern. We simply note that the benchmark figures cited for more than a century of time are the product of contestable backward extrapolations, depend upon revisions to official estimates for GDP for 1990, 1960, 1956; rely on an estimate constructed as best they could by two economists for 1933 and assume that the averaged annual growth rate for 42 years before 1912 was the same as the rate constructed by three economists for 1913-33 (Maddison 2007b, pp. 156, 157; Maddison 1995, pp. 194, 195; Maddison and Wu 2009, pp. 13-44).

Although Maddison was undoubtedly aware that when numbers representing base or end years are compounded, they cumulate (over long periods of time) into large magnitudes, he rarely included sensitivity tests. He anticipated that the publication of “negotiable numbers” would stimulate other academics to revise them into plausible explicanda for econometric testing, historical analyses and statistical mapping for the history of China and other parts of the world economy. His work continues to be recognized as a stimulus for programmes of research designed to construct national accounts for historical periods when states did not fund institutions to measure gross national products (Henderson 2010; Bolt and Van Zanden 2013).

Maddison was also aware of the properties of index numbers and how sensitive calibrations of purchasing power parity rates of exchange are to the range and quality of the data required to convert Chinese yuan and other national currencies into a common numeraire for purposes of conducting comparisons across countries and over strictly delimited spans of years for recent times (Prados 2000).

Unfortunately he is no longer with us to respond to a recently published bibliography of literature from economists debating, criticizing and revising the methods, statistics and inferences that have been drawn from successive rounds of data collection and calibration conducted by international organizations in order to construct purchasing power parity rates of exchange for an increasingly large sample of national currencies that refer to data for 2005 and 2011 (Deaton and Heston 2010).

Publications by the World Bank have recently exposed high degrees of variations in estimates for gross domestic products, denominated in international dollars and based upon national prices and quantities for 2005 and 2011 compared to similar exercises designed to construct purchasing power parity rates of exchange for earlier years calibrated to include 1990 (Heston 2010; Feenstra 2013). The differences are far too large to be accepted as the outcome of China's economic growth and structural change (World Bank 2008 and 2013).

For economic history prolonged and unresolved debates among economists concerned with the compatibility of published estimates for China's GDP per capita denominated in international dollars for the years 1990, 2005 and 2011 raises questions that could, by extension, be levelled at any sequence of numbers purporting to refer to estimates for GDP per capita denominated in international dollars for any one of these years and for the short period 1990-2013. Clearly the extension of an international data base to include the prices and quantities for far larger and more carefully specified samples of the commodities and services produced by national economies has improved the accuracy of the statistics and helped to refine the calibrations required to construct purchasing power parity rates of exchange for an extended and diverse range of national economies (Deaton and Heston 2010). That alone has rendered the selection of 1990 international dollars redundant as the numeraire for transnational comparisons of China's and other accounts of GDP per capita over centuries of time (Bolt and Van Zanden 2013).

Furthermore "the degree" to which the revised methodology applied to the extended and improved data base of prices and volumes of "matched" commodities and services produced by most of the world's national economies for 2005 and 2011 has generated more accurate and realistic purchasing power parity rates of exchange for the yuan and other currencies is neither transparent nor settled (De Jong and Van Ark 2013; Feenstra 2013). Above all, the meaning and provenance of any historical sequence of estimates for GDP per capita denominated in international dollars that refer to recent years has been dismissed as conceptually misplaced (Johnson et al. 2013).

Although purchasing power parities are not difficult to comprehend because they embody the potentially quantifiable notion of precisely what a particular amount of goods and services valued in one national currency would cost to purchase in the currency of another country (Sarno and Taylor 2002; World Bank 2008). Clearly an accurate answer depends upon the specification and exact measurement of the quantities of goods and services under consideration and their averaged prices at particular places and times. For example, if a typical family resident in Shanghai spent 50,000 yuan on goods and services in 2005 and an identical basket of goods and services would have cost them US$5000 in New York, the command over goods and services exercised by a modal Shanghai family for, say 2005, can be expressed as a purchasing power parity equivalent to ten yuan equals one US$. Binary parities are calculable for micro units (families) living, working and consuming in geographically confined spaces and comparable cultures such as Shanghai and New York. When it comes to the calculation of parities that aim to refer to the entire range of goods and services produced by the economies and consumed by modal families resident in China and the United States, the volume and complexity of the calibrations required to construct purchasing power parity rates of exchange for macro-economic comparisons of private consumption, investment, governmental services and other additive components of GDP multiples exponentially (Rogoff 1996; Deaton and Heston 2010; World Bank 2013).

By 1970 the construction of parities had moved on from binary comparisons of purchasing power parities to embrace the more abstract concept of an international (Geary-Khamis) dollar designed and redesigned to construct a transitive conversion coefficient to transform any one national currency into all other national currencies (Asian Development Bank 2007). Simply put for purposes of cross country comparisons, that parity would ideally embody a nationally weighted set of prices expressed in a transnational numeraire (conventionally the US dollar) that refers to a particular benchmark year and would somehow cover a representative sample of the range of diverse goods and services produced and/or consumed by each and every economy that had opted to participate in these periodic exercises designed to measure the global value of a national currency expressed in international dollars. Conceptually this implies that an average world price in international dollars for any specified commodity or service (or aggregations of commodities and services produced by the Chinese, German or any other national economy operating within a modern "composite" world economy) would be the sum of the calculated weighted average national prices expressed in American dollars for a large and ostensibly representative sample of commodities and services produced by that particular economy divided by the number of countries included in samples that have increased over the years to become almost universal in their reach and scope (Rao 2013; Deaton and Heston 2010).

Demands upon the statistical services of governments and international organizations calibrating national data into purchasing power parities to collect, match-up and deliver proxies for missing and low quality official statistics are enormous. China did not participate in any of these exercises before 1993. Meanwhile the extraordinary variance in prices across the Peoples Republic and between its cities and rural areas has persisted (Ward

2004). Thus the data available for average prices of commodities and services produced within modern China as well as the contested estimates for that huge and complex economy's national accounts support a stance of scepticism towards all statistics that depend on estimates and rates of exchange constructed by international organizations and utilized to convert revised official estimates, surveys of household expenditures and averaged "nationwide" prices into international dollars for years before, during and even after 1990 (De Jong and Van Ark 2012, pp. 1-20; Rao 2013).

Estimates expressed in 1990 international dollars have now, moreover, been confronted with the reformed methods and a larger (146 countries for 2005 and 199 for 2011) and a more reliable data base for the construction of purchasing power parities for cross country comparisons of GDP per capita in international dollars (World Bank 2013; De Jong and Van Ark 2012). Along with economists, historians will note that the magnitudes of the revisions contemplated for major economies are highly significant. For examples for China and India the estimates for both absolute and relative levels of their gross domestic products per capita expressed in international dollars declined abruptly by more than 40% when converted on the revised parities published for 2005 and they "bounced" back up again when converted to 2011 international dollars (Feenstra et al. 2013).

The statistical reasons behind major revisions over such a short span of time (1990-2011) are well understood. The quality of Chinese, Indian and other national statistics has improved. Not only has the urban and dollar denominated bias in averaged prices been recognized but prices have been more carefully aligned with the qualities of the goods, but especially with services produced and purchased in China, India and other developing economies (Heston 2010; World Bank 2013). Conversely, for several developed economies, especially Germany and the United States, growth measured in both domestic and international prices seems to have been understated (Brümmerhoff and Grömling 2012).

Historians fastidious about facts who have grappled with discussions among economists and statisticians remain concerned about the complexities of measuring levels and rates of growth in international dollars, particularly for China. The recent exposure of high degrees of variance connected to the methods, data and samples utilized to convert Chinese and other estimates for GDP into international dollars will leave them with a suspicion that figures for a plausible year of reference have yet to be constructed.

Meanwhile, and more seriously, they will recall two theoretically valid conditions that are necessary to transform any historical series of estimates for GDP measured in yuan at current prices into international dollars or some alternative and acceptable numeraire. First, a database containing a sufficient range and quality of the statistical evidence required to calibrate purchasing power parity rates of exchange for China, along with a representative sample of other national currencies calibrated into a numeraire that refers to a selected year for historical reference (Deaton and Heston 2010; Rao 2013).

Over the past and future time the transnational purchasing power of the yuan would rise, fall and fluctuate with changes in the volumes, composition and prices of the commodities and services produced by the Chinese and all other national economies. For China, the observed movements in the transnational value of the yuan could, in theory, be converted into an index and used to deflate any available or constructible estimates for GDP for years in the past selected for purposes of simultaneously comparing changes over time and with levels for other countries.

Apart from the entirely familiar problems involved in designing index numbers to capture changes in volumes, qualities and prices of goods and services produced and/or consumed by modal Chinese families over long spans of time, the tasks of assembling statistical evidence and constructing an acceptable database for the construction of purchasing power parity and rates of exchange for anything but a tiny number of national economics for the years preceding 1900 remain extremely problematical for historians in touch with the sources to contemplate (Prados 1990).

Indeed, estimates for Chinese GDP and purchasing power parity rates of exchange for the yuan cannot (for reasons elaborated below) be constructed from the extremely meagre range of reliable historical statistics available either for Imperial China or probably from the more extensive data available for twentieth-century China.

To circumvent the almost insuperable difficulties involved in the construction of a series of benchmark estimates for the GDP of imperial China converted in to numeraire that could theoretically allow for an estimation of trends in the empire's rate of growth and comparisons with other economies. Maddison (and those who continue to revise and follow his procedures), have however resorted to methods for the calibration of the extremely poor and virtually unusable official data available for Imperial China and the improved, but imperfect and contested statistics for Republican China, in order to generate a sequence of estimates for GDP per capita in 1990 international dollars.

Prima facie these numbers lack any semblance of the credence required to serve either for cross country comparisons or as indices to measure rates of growth over such long spans of historical time.

No acceptable estimates for Chinese GDP exist or could conceivably be constructed from imperial data for production, incomes and expenditure for years before 1911. Even if such estimates could be constructed (within levels of sensitivity normally associated with "plausible conjectures") their conversion into a universally valid numeraire reflecting the transnational purchasing power parity of the yuan for a long sequence of years in the past would ideally require exercises for the collection and calibration of data comparable in scale and scope to those conducted by lavishly funded international organizations for modern times. Furthermore, three most recent programmes rigorously designed and carefully conducted to produce comparable and reliable estimates for GDP per capita in international dollars for 1985, 2005 and 2011 have generated results that are explicable but have not been accepted by economists either as valid representations of relative levels of modal standards of living across national economies or as a metric that measures their rates of growth for a span of time covering just twenty-one years (Feenstra et al. 2013; Johnson et al. 2012).

Two economists (Angus Deaton and Alan Heston) who have been closely engaged with the design of a conceptual framework for the collection and calibration of statistics required to construct purchasing power parity rates of exchange for these exercises remain agnostic about the inferences that have and continue to be drawn from utilizing even the most recent and revised rates for conversions into international dollars. They have concluded that "one general rule is that comparisons become less reliable the further apart one of the structures of GDP (or its components) or the countries being compared". They have also recognized that "this is essentially the same as the unreliability of long run historical comparisons, the further back we go". And they observed that "many of these numbers have substantial uncertainty and that extrapolations over long periods can easily lead to results that make no sense" (Deaton and Heston 2010, pp. 41-34; Heston 2010).

For economic historians it continues to be the case that the meaning and provenance of chronological and comparative tabulations for GDP per capita published as explicanda for a statistically based economic history of China have not been clarified.

Maddison's methods are commendably transparent, but our perceptions are that they could indeed lead to results that make no sense, even if they are revised to update and refine the process and procedures utilized to convert estimates of improved reliability for Chinese GDP per capital into international dollars. For example, what meaning could be inferred from Maddison's estimate for Chinese GDP per capita of 552 1990 international dollars which was derived from the backward extrapolation 1990 to 1913 using estimated rates of growth based presumably on Paasche or Laspeyres' index numbers designed to measure annual percentage changes in levels of Chinese prices.

The procedure conflates and confuses two methods of deflation: one calibrates growth over time using a weighted average movement in the level of Chinese prices, and the other assumes that the transnational purchasing power parity of the yuan expressed in international dollars remains constant between 1990 and 1913 and by extension all the way back to year 1 of the common era (Johnson et al. 2013, pp. 255-74).

For the analysis of long run growth we concluded that a numeraire for Chinese GDP per capita based upon modern conversion coefficients expressed in international dollars, has the same implausibility as a numeraire expressed in kilocalories of husked rice at a constant and averaged price for rice sold in China over the year 1990.

3. Poverty Lines, Base Years and Extrapolators for the Measurement of China's Economic Growth from the Western Han to the Qing Dynasties

Equally problematical for the measurement of very long run growth and the location of a chronology for the Great Divergence is the reference year estimate that Maddison selected to represent the per capita income for an average Chinese living under the Western Han Dynasty around Year 1. Maddison postulated that this typical individual disposed of an annual amount of purchasing power that was equivalent to that commanded by her/his modern day counterpart, living on an income definable as poverty – namely 450 international dollars in 1990 prices. This guess was derived from ongoing attempts by economists employed by the World Bank to construct a metric for a notional and universal poverty line or subsistence level for samples of third world populations (Ravallion et al. 1998, 2004 and 2008; Jerven 2012). Famously the Bank's figure for 1985 was set at US$1 per day and revised upwards to US$1.25 a day or US$456 for 1990. That concept and its conjoined metric have come under sustained and convincing theoretical and empirical attacks (Ravallion 2009; Deaton 2010; Stiglitz 2010; Allen 2013).

Maddison did not clarify or justify his selection of 450 international dollars for base year 1. Yet the figure does not convert to anything comparable to the annual amounts in yuan designated by the modern Chinese state to represent poverty lines for its rural or urban poor (Ravallion 2009 and 2010; Allen 2013). Furthermore, as the calibrations in Columns D, E and F in our table suggest a per capita income of US$450 international dollars converted to kilocalories at the averaged price for Chinese rice for 1990 would have allowed the typical Han Chinese families to have allocated an improbable 62% of their income to nutrients necessary for food security. Prima facie that ratio looks implausibly low (Deaton 2010; Stiglitz 2010).

Sustained controversy has and continues to attend programmes designed to formulate a universal standard for the measurement of global poverty and/or subsistence for our own times (Alam 2006 and 2013). Maddison did not confront the conceptual and statistical complexities involved in constructing and pricing a basket of goods consumed by the very poor across the world in 1990 international dollars for our own times. He simply assumed that the populations of the Chinese empire, before the era of the Song Dynasty, lived at a standard of living that could be proxied by a highly controversial modern metric of 450 international dollars (Stiglitz 2010; Allen 2013).

With a base line estimate conveniently denominated in 1990 dollars in place, variations and cycles in the growth of population and output are ignored by Maddison's data for GDP per capita which suggests (vide table 1) that almost no change occurred for over a millennium before the advent of the Sung Dynasty. According to some contested statistics for population totals, the production of iron, urbanization rates as well as the consensual views of historians of medieval China under that Dynasty, the imperial economy experienced an "efflorescence" that carried per capita incomes up to a significantly higher level (Deng 2013 and 2015). Maddison's figures suggest that this uplift amounted to an order of magnitude of approximately 33% over some three centuries of time. So much for an eminent Sinologist's considered view that "One of the most dramatic cycles of economic development and decline in all Asian history occurred in North China between the eighth and thirteenth centuries" (Skinner 1985, p. 166). Thereafter, Maddison posited that the Chinese economy "suffered setbacks under the Yuan" (Mongol Dynasty) from which (so his numbers suggest) it recovered and thereafter experienced some 350 years of stasis followed by a century of fluctuations in incomes per capita around a level that remained discernibly below a static level sustained from circa 1300 to circa 1850. In his view that level diverged sharply from levels attained by the economies of Western Europe, North America and

Australasia (vide Maddison 2007b, p. 43; 1998 and 2001, p. 264 for comparisons with Europe).

These speculations for rates of growth are drawn from a restricted range of reading from secondary sources in Chinese history published in English and transposed into numerical abstractions deserve to be quoted in his own words: "I assume growth per capita income under the Song was substantial ([i.e.] "it grew by about a third") but [was] "slower in pace than Europe achieved in the proto-capitalist period 1400-1820". I assume that per capita income peaked in the Song … [when] "there is good reason to believe Europe had fallen substantially below Chinese levels! [A] "temporary setback" [occurred] under the Yuan but over the long run in the Ming-Ch'ing dynasties per capita performance was roughly stable". This bold summary, covering centuries of Chinese economic history, could hardly become consensual among experts for a field that is distinguished by the most impressive historiographical tradition for research and debate for any Asian country.

On the contrary, a bibliography of monographs in Chinese history is easily marshalled to suggest the Ming-Qing period witnessed a steady performance in agricultural and industrial growth despite the onset of a 'Little Ice Age' (Zhang 1996; Man 2009). Supplies of arable land remained elastic until the late Qing (Deng 2011, pp. 19-20; Deng 2016, p. 18). Double-cropping of rice was introduced to the south of the Yangzi River on a noticeable scale for the first time in China's history (Chao 1986, p. 199; Cheng 1992, pp. 98-101; Liang 2006, p. 117). A real push for the new cropping practices came directly from the Kangxi Emperor in the form of a well-publicised five-year experiment (1715-20) conducted on a model rice farm of 100 mu in south Jiangsu. The experiment achieved an average increase of 47% in output per unit of land cropped (Zhang 1996, p. 412). This became the yield plateau that prevailed for the rest of the Qing period (Shi 2012, p. 56). According to Liu, yield levels in the Lower Yangzi Region increased by a factor of 2-2.5 by 1850 from their Song levels. In some places, they had risen by a factor of 5 (Liu 2013, pp. 104, 106). Farming tools had also improved (Yin and Hui 2012). Chinese economic historians agree that commercialized domestic cotton textile production took off during the Ming Period (Xu 1989; Fan 2008; Wu 2009).

Maddison recognized that complementary historical statistics could also serve to represent the economic performance of the Chinese Empire under the Ming and Qing dynasties (1368-1911) were needed to carry conviction. He found support for his speculations in the quantified conclusions based upon the historical research and analysis conducted by two distinguished American sinologists and social scientists: Dwight Perkins of Harvard and Gilbert Rozman of Princeton. Rozman concluded that there had been little change in the proportion of the population living in towns from the Tang to Qing dynasties (Maddison 1995 and his 2007b, pp. 10, 24, 31, 37, 151; Rozman 1973). Perkins had written a classic book exposing trends in long term per capita grain production (Perkins 1969). We deemed it necessary to review the nature and quality of the data that American scholars had produced, used by Maddison to underpin his tabulations for GDP per capita which correctly serve to provide a factual foundation for more recent and on-going attempts to construct estimates for Chinese GDP ab initio from primary sources.

Perkins' endeavours to produce economic indices to represent trends in per capita production of grain output for the Chinese Empire in "Ming-Qing" times are scholarly, widely cited and commendable. Since the state made no attempt to collect imperial statistics either for agricultural production, for the cultivated area or for yields per mu for land cropped, Perkins constructed estimates based upon: (a) official records including: censuses of taxed population, cultivated areas subjected to taxation, scattered references to grain yields per mu cultivated for particular localities, and (b) ad hoc data culled from revisions and reconstructions by Chinese scholars of agrarian history including backward extrapolations from Buck's surveys of villages for the 1920s and 1930s, official statistics for 1957 and for years thereafter. His book contains a range of estimates that offered admirably qualified conjectures for the absence of valid official statistics for the agrarian sector of the economy – statistics that Alex Eckstein (another distinguished economist and sinologist) did not consider it possible to construct (Eckstein 1968, pp. 34-5).

Perkins' primary contested series of estimates consisted of population totals culled from several secondary sources to which he attached possible margins of error. Problems with imperial China's demographic data are familiar and for present purposes the figures used can be commended for attaching potential degrees of variation to estimates that he utilized.

We suggest there is no need to review or revise the diverse range of figures currently in print for China's population because they are (as we will show) the only acceptable series of statistics Perkins had access to in order to measure historical trends in grain output and by inference food consumption per capita for the Chinese empire.

With imperfect but discussable estimates for population in place, Perkins' second task was to establish a sequence of multipliers in order to calculate estimates for volumes of grain output per capita. Grains included rice, wheat, millet and potatoes that he measured in catties of unhusked rice equivalents converted to a metric standard at a rate of 2 catties equals 1 kilogramme (Perkins 1969, p. 309). Perkins then settled not for a sequence of multipliers but for a constant 527 catties per capita by positing that:

(a) Per capita grain output fluctuated if at all only within narrow limits – an assertion that was not checked against records for changes in grain prices
(b) Variations were bounded by a subsistence level of 400 catties and an upper limit of 700 catties per capita (Perkins 1969, pp. 14-15 and 297)
(c) In Ming-Qing times (1368-1911) "less than 500 seems more likely than 600"
(d) The "130 villages or so surveyed by John Lossing Buck in the late 1930s the estimates for fewer than 10 villages fall below 400 carries" (Perkins, pp. 15-16).

In his Chart F1 Perkins also cited five historical sources from Sung times to 1844 to claim "it does seem clear that 3 shi (600 catties) of husked rice represented typical annual grain consumption." 600 catties is equivalent to 300 kilograms for edible rice but on p. 301 he confusingly states "both the Buck and provincial data indicate that per capita grain availability seldom fell below 180-240 kilograms (unhusked) during the twentieth century" (Perkins 1969, Appendix F).

Agrarian history for China is frustratingly resistant to quantification, not least because the figures recorded for rice production and consumption are expressed in volumes (shi) and weights catties). They are often not distinguished between husked and unhusked rice. One shi of husked rice weighs 200 catties. In unhusked, inedible and coarse form a shi weighs 130 catties (Li 1998, p. xvii). Perkins' consistently used a fixed multiplier of 572 catties (286 kilograms) of unhusked rice which he reduces by 50% to 286 catties (143 kilograms) of husked rice (Perkins 1969, p. 309). Modern food science utilized by the FAO and United States Department of Agriculture obtain their coefficients for the conversion of unhusked to husked and edible rice by positing a lower wastage rate (32% instead of 50%) and transform a kilogramme of husked rice into nutrients with an energy value of 3,660 kilocalories a day (F.A.O. 2002; U.S.D.A. 2010).

If Perkins is to be corrected by modern science his 572 catties of unhusked rice translates into

$$\underline{0.68\ (286\ \text{kg})\ (3{,}660\ \text{kilocalories})}$$

which transforms into 1,950 kilocalories per capita per day, which comes close to Buck's estimate of 1,823 kilocalories for the 1930's (Buck 1937).

The multiplier selected by Perkins for purposes of providing an index of historical trends in grain output per capita is above the level of 200 kilograms of unhusked rice that Perkins (and Buck) defined for "subsistence" but is clearly below the level of 2,100 kilocalories a day prescribed today by the FAO as necessary for "food security" (F.A.O. 2002).

Interpreted in terms of standards recommended by modern nutritional science Perkins' estimates for per capita grain consumption imply that a majority (and possibly a substantial majority) of the population of the Chinese Empire lived in conditions at the edge of "food security" for more than half a millennium after 1400. For masses of Chinese, standards of living could only have fallen below that precarious level in times of disorder and crisis (the years of takeover by Manchu armies and the Taiping rebellion). If Perkins' speculations are plausible they also subsisted at that level for most years during Ming-Qing times. Thus, Maddison's numerical depiction and interpretation of long run stasis is supported by Perkins.

But the big question remains: how acceptable is the cited data from Perkins by Maddison and those who repeat and reuse his rates of growth in per capita income in 1990 dollars. They are derived from contested statistics for population growth and a selected non-validated constant of 572 catties of unhusked rice. Could Perkins' estimates represent trends that correlate with trends in GDP per capita? Perkins thought they could. He attempted to corroborate his conjectures with reference to evidence derived from an official survey of agricultural output for 1957 and more historically with statistics derived from an elaborate alternative calculation based upon reconstructed estimates for the area of arable land cultivated with grains multiplied by another "guess" for weighted average yields (again measured in catties of unhusked rice equivalents per mu). We suggest that for reasons that he almost recognizes, these alternative and potentially corroborative estimates are equally unconvincing (Perkins 1969, p. 298).

Two runs of statistics are required for such an exercise. First, estimates for the area of arable land available for cultivation with one or more crops of grain for a series of "representative/modal" years. Secondly, (and accepting Perkins' "assumption" that 80% of the cultivated arable land of the Chinese Empire produced grain year after year) viable estimates for average annual yields per mu cropped once, twice or even three times with rice and other grains (Perkins 1969, p. 17).

Despite their importance for government finance, cadastral surveys for Imperial china were rarely undertaken and subject to wide margins of error. The first attempt to carry out an empire-wide cadastral survey was made under the Northern Song dynasty when private land ownership became the dominant form of landholding. In 1072 AD, Emperor Shenzong (r. 1068-85) issued a decree to survey all farmland in Song territory utilizing the fangbu as the standard survey unit for cultivated land (Zhang 1986, vol. 10, p. 7981; Wu 1985, pp. 17-18). Each fangbu consisted of 6 paces^2. 5 chi was counted as 1 pace; hence 1 fangbu was 30 chi^2. Only five provinces were properly surveyed under this scheme (Tuotuo 1986, vol. 7, p. 5716). A second systematic survey began in 1387. Six years later a total of 850,762,300 mu (1 mu = 240 x 6 paces^2 and often translated into 0.38 hectares) had been officially registered (Zhang 1986, vol. 10, p. 7981; Liang 2004). In 1578 the Ming government carried out another limited cadastral survey. Cadastral Registration was resumed under the Qing Dynasty in 1654 and that cadastral record was used as the basis for taxation until 1690 (Zhao 1986, vol. 11, p. 9260). Ad hoc amendments occurred but after 1690 no empire-wide cadastral surveys were ever carried out (Zhao and Chen 2006, ch. 2). According to official regulations for 1765, "villagers measure their own lands, officials conduct random checks" (Zhao 1927, 'Shihou 2', in *Twenty-Five Official Histories* 1986 vol. 11, p. 9259). Zhao estimated under-reporting in cadastral surveys amounted to 20-30 per cent (Zhao 2007).

Furthermore and as a unit of cultivated land the mu was never standardized across imperial china. Its area and fecundity varied significantly from province to province, locality to locality and from time to time. In general the average output from one mu (i.e. 240 x 6 paces^2) of medium fertility in a region became fixed as a fiscal benchmark. That benchmark was then used as the common denominator to convert outputs ("bags" of grain) from plots of different areas and fertilities to a number of taxable units in order to simplify assessments for taxation. This deliberate and persistent government procedure for "mu conversion" was known as zhemu. For example, in 1109 Emperor Shenzong decreed that 1 mu of the highest quality was equal to 10 mu of the lowest quality (Xu 1976, vol. 7, p. 6416). A government registered mu became nothing more than a virtual unit for fiscal purposes century after century and continued as such during the Ming and Qing dynasties (Liang 1980, p. 528) and Zhao 2007). In 2012 Shi Zhihong observed "Gross mu (damu) were larger than the official size of 240 x 6 paces^2. Across China the mu varied from 260 x 6 paces^2, 430 x 6 paces^2, 480 x 6 paces^2, 540 x 6 paces^2, 600 x 6 paces^2, 720 x 6 paces^2, 960 x 6 paces^2, to 1200 x 6 paces^2 . Thus, figures for mu recorded in official historical records cannot be converted into a standard/imperial mu unless we can clarify the type of 'mu' referred to by a particular record." (Shi 2012, p. 55)

Surveys conducted under Ming and Qing governments do not provide historians with records of the empire's area of cultivated land expressed in a standardized unit for area. Official statistics for cultivable land are distorted by textual errors, the inclusion of untaxed land and significant degrees of variance in the area denominated in mu. Above all they are distorted by grading land for fiscal purposes to reflect differences in the underlying fertility of the soil. To convert Ming surveys of fiscal mu to estimates that approximate to the area cultivated with grains requires arduous and complex manipulations of data that ceased to be collected after 1690. Perkins (with help from a prior exercise published by Fujita) produced a series of "most likely" estimates of 370 million mu plus or minus 70 million shimu ("modern mu" for circa 1400 and 500 million shimu plus or minus 100 million mu for circa 1600 and 666 million (presumably plus or minus 20%) for 1661 and 950 shimu for the 1770s (Perkins 1969, Appendix B, pp. 221-35).

Perkins also made the not implausible assumption that the cultivated area (shimu) grew between 1685 and 1700, 1725, 1766, 1777, 1812 and 1851 in line with the area measured as non-standardized fiscal mu for these surveyed years (Perkins 1969, pp. 231-4). For 1873 and years thereafter he utilized estimates of the area cultivated and compiled by the Department of Agricultural Economics of Nanjing University and the officially measured area for 1957 (Perkins 1969, pp. 232-6).

With very rough estimates for areas of cultivated and not cropped land expressed in a reconstructed and partially standardized mu in place, Perkins then considered a database of 900 observations he collected for yields "per mu" for disparate years and for scattered locations across the empire. For circa 1500 to circa 1800 he noted their high degree of variance and observed the lack of uniformity in Chinese weights and measures and the resort to figures for rents (normally levied as a share of the first rice crop) as a substitute for crop yields (Perkins 1969, Appendix 1; Li 1998; Huang 1988).

For reasons that are not elaborated, his book tabulates a drastically reduced sample of estimates for unhusked rice yields (catties per shimu) for just four locations that he referred to centuries of time: 1500-99, 1600-99 and 1700-99. Even for that reduced sample the variations for just twelve observations ranged from 250 to 520 catties per annum (Perkins 1969, p. 315, Table G.2). He almost admits that this data could not be used for purposes of constructing an alternative conjecture for total grain output in unhusked rice that might otherwise support his basic estimates. Nevertheless, on close examination that conjecture turns out to be based upon contested statistics for the empire's population, multiplied by a discussed but hardly verifiable constant for purposes of estimating production per capita (Deng 2004; Lavely and Wong 1998).

To sum up, Perkins' serious attempts to come to grips with inadequate and unreliable data for grain production/consumption has been translated into upper and lower bound estimates that remain wide apart. They have been used to support his and Maddison's perceptions of stasis over the Ming-Qing era. Perkins preferred estimates are based on nothing more than population totals and a conjectured constant of 286 kilograms of unhusked rice per capita which transforms into a contestable level of 1,995 kilocalories per person per day (vide table 1). His altogether more tentative manipulations of insecure data for cultivated land and its gross average yields per semi-standardized mu expressed in catties of unhusked rice generate numbers that translate into lower and upper bound numbers of 2,635 and 5,124 kilocalories a day. They do not corroborate his estimates for kilocalories based upon the size of the empire's population multiplied by a constant (Perkins 1969, Appendix G).

Perhaps the most balances judgment to make about an exercise conducted by a distinguished economist to relocate the agrarian history of Imperial China on a statistical basis for purposes of measuring rates and levels of agricultural growth is that it remains as a heuristic example of an endeavour to produce data for the Kuznetian paradigm for the "empirical tradition economics" (Fogel 2013). Sadly it does not supply economic historians with the macro-economic data required to forge a statistical explicandum for a modern economic history of the Ming-Qing Empire. Perkins' data (referred to as "mostly likely conjectures") are, we have concluded, based upon official sources that are simply not fit for that purpose (vide Perkins 1969, pp. 8-17).

Maddison depended on Perkins to select the otherwise unverifiable rates of growth he utilized to extrapolate his own numerical constructions for China's GDP in international dollars backwards and forwards through centuries of Chinese imperial history. He also cited Rozman's 1973 figures for the empire's urbanization ratio (Rozman 1973). Some archaeologists cling resolutely to that ratio as the only statistical evidence available to them for meta-narratives of economic development for prehistoric and classical centuries (Morris 2010 and

2013). Nevertheless, correlations between that index and changes in real levels of GDP per capita are not uncritically recognized by economic historians of Europe or China as transparent enough to be transposed into cycles or even medium term trends for the development of pre-modern economies. They remain aware of cycles in the location of proto industry (Braudel 1988). The data gathered by Chandler and Fox 1987 and Bairoch 1988 is not, moreover, canonical (vide Bloom and Khanna 2007; Pascarti and Dunn 2002; Taylor 2013).

Agreed, the economic mechanisms through which the agglomeration of populations within the boundaries of geographical units (designated as "urban" by states for administrative purposes, and by historians in terms of population and households that vary in scale from 1,000 to 50,000 people) could, theoretically, operate to promote nationwide economic growth are well understood (Fujita et al. 2000; Krugman and Venables 1995; Ge 2000-1). Relevant correlations have, moreover, been tested for recent times (Fujita et al. 2000; Taylor 2013; Polere 2009; De Long and Shleifer 1993).

Nevertheless, it has not been established precisely how other features and factors such as differentials between rural and urban wages or variations in the administrative boundaries established by political authorities for purposes of governance, taxation and defence) operated across space and time. Meanwhile Rozman's set of urbanization ratios for the Chinese empire continue to retain their status as an insecure indicator for the measurement of trends or levels of economic development (Ge 2000-1; Duan 1999). Imperial China's relatively low and stable ratios may simply reflect a greater degree of dispersal of more productive activities associated with manufacturing and professional services across a vast empire. They have also been plausibly related to: the overall area of an expanding polity, internal peace and security, the size of the empire's population and to the densities of its transportation of communications networks (Cao 2001; McKeown 2011, pp. 309-19; Rosenthal and Wong 2011).

4. Conclusions on Prospects for the Construction and Reconstruction of Estimates for Imperial China's Gross Domestic Products

Our ostensibly negative conclusions will be formulated in the wake of the Divergence Debate to recall that the Kuznetian paradigm for modern economic history depends upon access to data that is statistically and conceptually secure enough to provide quantified explicanda as a basis for competing analytical narratives addressing the course, patterns and causes of long term trends in GDP per capita.

Our sense is that no secure basis exists for backward extrapolation based upon modern concept and contemporary statistics. For post-Imperial China official estimates for gross domestic product and its sectoral components are few in number confined to very recent years and remain contestable (Feenstra et at. 2013). Furthermore, the variance in prices for comparable commodities and services produced within China's vast and geographically heterogeneous territory continues to frustrate the efforts of the Chinese state to provide international organizations with averaged prices for specified samples of goods and services required to convert domestic outputs denominated in yuan into international dollars even for very recent years (Heston 2010; World Bank 2013). Furthermore, if and when more acceptable estimates in international dollars for a contemporary base year becomes available their extrapolation over decades and centuries of time at constant transitive and transnational rates of exchanges is a flawed procedure because it will lead (as recent exercises for a 23 year period have revealed) to implausible variations over an entirely short span of years (Feenstra et al. 2013; World Bank 2013; Deaton and Heston 2010).

Prospects for the construction of any long run historical chronology within which narratives of the Great Divergence might be located and analysed are, we contend, entirely remote. No such sources for Imperial China have emerged or have been embodied in modern secondary literature that might conceivably allow historians to construct reliable estimates or even plausible conjectures for historical trends or levels of the empire's primary production. Our close examination of a pioneering and classical attempt by Perkins has exposed the transparent but unveritable assumptions that a distinguished Harvard economist made in order to publish estimates for the long term growth in the output of food grains alone.

To proceed towards the construction of a feasible run of statistics for grain output per capita, Perkins plumped for estimates with variances of 20% each way for the total population. He derived that denominator from a range of secondary sources based on the numbers of male taxpayers registered by the state and a competing range of multipliers for average family sizes. He assumed that 80% of the cultivated area was cropped with food grains (rice, wheat, barley, millet, maize and potatoes) and calibrated a ratio between the area of arable land recorded more or less accurately as land subjected to tax by the state and the wider area of land recorded for just three years and a lot less comprehensively or accurately depicted as cultivated land in cadastral surveys conducted by the Ming state in 1578 and by the Qing state in 1654 and 1690.

Somehow Perkins also transformed a regionally restricted and locally diverse range of "fiscal land" cropped with grains denominated in a non-comparable unit for measurement of cultivated areas into a standardized and modern shimu. Historically the mu had varied by a factor of 4.62 across China, which probably accounts for large variations in the range of estimates for the cultivated area, published in modern secondary literature. With very rough estimates for the empire's population and with guesses for an arable area cultivated with grains in place, Perkins then constructed two multipliers to guestimate trends in the total value of grain produced over time. For grain output per head of population he selected a constant of 286 kilograms of unhusked rice equivalents. For grain output per modern shimu cultivated Perkins also considered a database of 900 observations for yields which he reduced to just twelve (presumably modal) quotations ranging from 250 to 520 catties of unhusked rice per shimu referred to three demarcated centuries of time from 1500 to 1800. These estimates did not, however, corroborate conjectures for outputs of grains per capita.

It is not difficult to expose deficiencies in the guestimates for total grain output made by Perkins. Nevertheless, his selection of a constant for grain output per capita has in effect predetermined a conception of early modern Chinese economic history as one of stasis. Needless to say that interpretation has been disputed, not only by the California School but by an extensive bibliography of scholarship from Chinese historians – whose expertise resides in their knowledge of the diverse and particular ecological conditions, cropping patterns and institutions of China's geographically heterogeneous sector for primary production (Li 1998).

Primary production is, moreover, the dominant component of all pre-modern gross domestic products. The virtual absence of official statistics covering the empire for the production and prices of: grains, other food, crops, outputs from livestock, and fish, organic raw materials (including timber, cotton fibres, ramie, silk, opium, vegetable oils, etc) seems to be nothing less than an insuperable obstacle for the construction of comprehensive national accounts for pre-modern China.

Two reasons are behind this unwelcomed conclusion. First, since the Han Dynasty (206 BCE-220AD) a practice has prevailed of writing up official histories of a succession of Chinese dynasties by state appointed scholars. After the completion of that task the dynasty's archives were destroyed. The Qing (1644-1911) is an exception because there is no official history for the last imperial dynasty. Nevertheless, surviving archives and records for the Qing are sparse and defective.

No empire-wide economic surveys or investigations were ever conducted by specialized state institutions mandated to gather statistics. Information despatched to Beijing on agriculture and food prices depended upon casual and often outsourced observations from local officials and was rarely checked.

Generations of historians of China would agree with “Skinner’s suspicion” that data for the Qing and all other dynasties are anecdotal, compromised by urban bias and are not independently verifiable (Skinner 1987). Among historians and social scientists confronting this restricted volume narrow range and poor quality statistical evidence for the economic history of the empire, the response has been to “manufacture” guestimates for macro-economic magnitudes that purport to refer to China as a whole.

Furthermore, and once these guestimates are in print and cited, they become canonical and acquire the status of primary sources. As numbers they tend to be recycled and fine-tuned. Their origins and accuracy are too rarely investigated or questioned. Almost all currently published data for China’s GDP can be traced back to a handful of secondary sources including: Wu Hui’s books that includes guestimates (1) for farm output and grain yields (Wu 1985; Wu 2009), (2) for industrial and service outputs for the 18th and 20th centuries (Xu and Wu 1985), and (3) for services of the Chinese gentry at the end of the 19th century (Chang 1955). For the Republican era, two studies for national income have also matured into canonical sources for purposes of the backward extrapolation of growth to include the late Qing economy (Ou 1947; Liu and Yen 1965), and many have followed the suit (e.g. Xu and Wu 1985).

More recently a trio of European economic historians with help from Chinese collaborators have attempted to apply the Kuznetian paradigm as exemplified by Maddison’s attempts to manufacture a series of estimates for GDP per capita to the economic history of the Chinese empire. They continue to fine-tune, revise and refine the same body of primary statistical sources manipulated by Perkins and subsequent generations of Chinese economic historians.

They anticipate that their heroic endeavours might allow economists and historians to refer to an imperial economy as it developed over the Ming-Qing along with other eras of China’s very long run history of economic development and to settle debate on the Great Divergence (Liu 2012; Broadberry 2013; Broadberry et al. 2014, 2015).

It is our contention that they have unfortunately, but predictably, run into the buffers of access to a body of imperial statistics that are extensive in coverage and secure enough for the estimation of levels and for trends in primary production. Given that an overwhelming share of imperial output remained primary and land based, for present purposes we propose to bypass all other estimates now in print for industry and services.

Meanwhile (and as we read them) surveys in English of recently published books and articles in Chinese designed to construct viable historical estimates for Imperial China's GDP per capita and its sectoral components have neither recovered new and more reliable official sources for primary production nor revised, refined and supplemented the limited and unreliable statistical evidence available to Perkins nearly fifty years ago (Broadberry et al. 2014 and 2015; Shi et al. 2014; Ma and de Jong 2014).

To forensically examine the array of estimates even for primary production culled from secondary sources published in Chinese in order to provide the statistics required for viable exercises in national accounting would make for a lengthy and tedious elaboration of a basic point long familiar to generations of historians who have conducted research into statistical records of the Ming-Qing state that are written in classical Chinese.

Instead we invite colleagues who have assiduously scoured the secondary literature in search of "numerical evidence" to respond to their depressing judgments that have been made over the years to the ad hoc "numbers" that they are prepared to manipulate and calibrate into plausible estimates in order to construct national accounts for China going back to the Northern Song dynasty (Broadberry et al. 2014; Ma and de Jong 2014). We urge them to empirically examine the insurmountable deficiencies in the restricted range of official statistical evidence available for the Chinese empire.

For example, the Ming-Qing regimes (1368-1911) never conducted a population census, but simply aggregated "figures" submitted by provincial officials on the numbers of male taxpayers. The range of estimates for total population currently in print are derived from multipliers for family size that display rather high and unsettled degrees of variation from author to author (see Table 1). Most scholars of China's historical demography remain cautious and unwilling to commit to any sequence of estimates for the empire's total population (Pomeranz 2000; Lee and Wang 1999).

Between 1368-1911 the Ming-Qing states conducted just three geographically confined and inefficiently executed cadastral surveys of their empires cultivated area. For that variable (crucial for quantification) the archival evidence consists basically of arable land subjected to taxes assessed and collected by local officials on behalf of the state. Fiscal and agrarian historians of China have, however, published an impressive range of local evidence to suggest that the figures recorded as taxed arable land often fell way short of the land actually allocated to the production of food crops (including tea, sugar and fruit) to organic raw materials or to mulberry trees and timber, as well as land used as pasture for rearing varieties of farm animals.

Perkins utilized a ratio derived from figures for the share of taxed to cultivated land as recorded in so-called cadastral surveys conducted by Ming and Qing officials. There is, however, no evidential basis for assuming that even his or other "constructed" ratios had, or could conceivably have remained constant over centuries of time while the empire's territory was expanded. The route for calibration from taxed to cultivated arable land has been over simplified by methods that resort to constant but unverified ratios between two seriously imperfect sets of statistics. Furthermore, the "failure" of the dynastic state to prescribe and enforce a standardized unit for the measurement of the area of land under cultivation or taxed has left historians with the well-nigh impossible task of interpreting meanings attachable to records that refer to areas of land cultivated, cropped or liable for taxation, expressed in mu.

Areas denominated in mu varied significantly across the provinces and prefectures of China, from place to place and time to time. Moreover and for fiscal purposes the state denominated "arable" potentially liable for taxation in relation to its underlying fecundity. Perkins and other scholars in grappling with the problem of converting a heterogeneous range of official and other numbers recognized these difficulties, but "ploughed on" with the well-nigh impossible task of converting mu as recorded in the Ming-Qing documents into a modern standardized shimu.

Their frustrations with the extant imperial records available for the estimation of arable, pastoral and forest land allocated to primary production continue, moreover, to be compounded by the almost total absence of statistics exposing plausible conjectures for the shares of cultivated mu allocated to a variety of food crops (including tea and sugar) to organic raw materials, to trees and to pasture for animal products.

An array of ad hoc references to yields per mu have been collated into imperial databases, but the observed variance across space and through time has left agrarian historians of China and all but a minority of resolute economists with the sense that a series of weighted imperial average yields for the food crops and raw materials produced by the farmers operating during Ming-Qing times has not and probably cannot be constructed (Shi 2012). Furthermore, it is imperative to recognize that many if not most of the references to yields per mu cited by Bozhong Li and other agrarian historians have been extracted from manuals and agrarian treatises, published by literati and designed to instruct peasant farmers on best practice techniques for the cultivation of crops .It is not fortuitous that the surveys and estimates conducted by John Buck in the 1920s and 1930s of farms and farming at village levels continue to command respect as the canonical point of reference and comparison for hard evidence about all aspects of Chinese agriculture (Buck 1964). Buck recorded actual yields for the 1920s that are considerably lower than those anticipated as possible or ideal in manuals published in Qing-Ming and earlier times (Deng 1993).

Finally, and what has not invariably been taken into account for the estimation of the net value added for this dominant component of China's GDP is multiple cropping. The same area of cultivated mu (if and where that unit could be properly measured) often yielded two or more crops per annum. Yet references to yields often refer to the cultivated and not to the cropped area. Furthermore, and as the extent of multiple cropping increased over time, demands for unpaid labour to maintain the infrastructural capital of canals, dykes and ditches required to carry water on to and off arable land along with expenditures upon purchased inputs such as organic fertilizers, seeds, tools and animal power increased in order to maintain and raise yields. Differentials between gross and net farm outputs surely widened. That gap varied by place, crop and over time and to degrees that cannot feasibly be encapsulated by another resort to simple or constant averages between supposedly known and unknown outputs and to any constant relationship over centuries of time between inputs and outputs.

It is appropriate to draw this old fashioned exercise in data validation to a conclusion by reaffirming our support for the Kuznetian paradigm for empirical economics including the deployment of macro-economic theory allied to the construction of social accounts. We ardently advocate quantifying the quantifiable in order to provide explicanda for the analysis of long term, economic growth. We have no wish to fuel the now currently fashionable rejection of GDP per capita as a misleading macro-economic indicator and starting point for the construction of analytical narratives for (a) the long run growth of national economies, (b) for reciprocal comparisons designed to provide quantified impressions of how effectively polities and economies sustained the welfare of their populations, and (c) above all to establish a chronology for current debates on the Great Divergence (Mishan 1977; Jerven 2012; Philipsen 2015). Nevertheless, we are as sceptical as Simon Kuznets might well have been of heroic attempts to extend his paradigm for modern economic history to include China, India and other Asian empires.

The geopolitical history and political economy of the Mughal, Ottoman and above all the Ming-Qing regimes reveals that they lacked the political and administrative capacities required for sustained centralized and direct rule over vast territories and heterogeneous populations. Prudentially their rulers settled for strictly limited degrees of fiscal penetration and lacked the power and administrative capacities to obtain the flows of information required to create and sustain fiscal states. Basically this is why the primary sources available for the macro-economic reconstruction of estimates of GDP per capita is far more limited for the Orient than for the Occident.

The unavoidable resort to distant secondary sources and to the manipulation of ad hoc and ambiguous figures for key statistics for population, for cultivated and cropped areas, for the composition coverage and prices for agricultural outputs; for yields of land based farm outputs has not generated acceptable estimates for either primary and, we suspect, most other forms of production. Although attempts to construct such estimates contain scholarly and heuristic contributions to the economic history of China, they are not fit for the purpose of serving as an explicadum for trends and cycles in the empire's long term developments. Concepts such as GDP per capita do not travel either through time or across the polities and economies of Eurasia (Howlett and Morgan 2010).

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