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"So far the decisive data on prices, wages, etc., are absent [In China]"

Max Weber, *The Religion of China* (1920-1), translated by Hans Gerth (New York 1964, p. 80)

Abstract

Our article is a critical survey of the concepts, methods and date constructed and utilized by scholars (particularly the late Angus Maddison) in order to provide estimates for the measurement of relative levels and long term trends in the GDP per capita for China from the Han Dynasty to modern times. We applaud the endeavour but have reluctantly concluded that, even as conjectures, they are not fit for purpose. Furthermore, our article suggests that the Kuznetsian paradigm in empirical economics may not turn out to be viable for qualitative analysis of the long term development of imperial economies of pre-modern East and South Asia.

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Abstract

Our article is a critical survey of the concepts, methods and date constructed and utilized by scholars (particularly the late Angus Maddison) in order to provide estimates for the measurement of relative levels and long term trends in the GDP per capita for China from the Han Dynasty to modern times. We applaud the endeavour but have reluctantly concluded that, even as conjectures, they are not fit for purpose. Furthermore, our article suggests that the Kuznetsian paradigm in empirical economics may not turn out to be viable for qualitative analysis of the long term development of imperial economies of pre-modern East and South Asia.

1. Theoretical Ambiguities and Empirical Incongruities

In a sequence of widely cited books and articles the late Angus Maddison 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 he utilized: (a) a contested series of official and revised estimates for the empire's population; (b) an unofficial estimate for gross domestic product in 1933 as a basis for backward and forward projections across the century 1890-1990; and (c) several assumptions that has allowed him and his uncritical followers to extrapolate insecure estimates of per capita income conceptualized and calibrated for contemporary purposes and times all the way back to the Han dynasty (Maddison 2007 a). For historians dealing in "facts" the results are unconvincing. Nevertheless, these numbers are instructive to confront particularly for economists and economic historians whose agendas for research continue to be based upon the programme for a quantified analysis of "modern" economic growth inaugurated by Simon Kuznets (Kuznets 1966 and Fogel 2013). That programme, extended geographically to include Asian economies by Colin Clark, Paul Bairoch, Leonard Zimmerman and others, enjoys success for industrial, agricultural, regional and country studies of long term growth where and when statistical information for both inputs (land, labour, technologies, capital) and outputs (for national, agricultural, industrial and service production) are available at a macro level and are reliable within the margins of error tested and recognized as adequate for economic analyses of long run economic change (Clark 1940; Bairoch 1981 and 1997; Zimmerman 1965). As Kuznets anticipated these preconditions apply to just a small sample of countries that

collected statistics for the compilation of national accounts and/or compiled data that could serve as proxies for such accounts for limited spans of time (Kuznets 1971).

In this paper we intend to argue that on both factual and conceptual grounds these preconditions do not apply arguably for even modern times and certainly not any to long run economic history for China (Deng 1999). Maddison's attempts to construct a statistical framework for a macro-economic analysis of the economic development of that huge empire which was, and remains, a large component of the modern and pre-modern global economy 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 might well represent nothing other than abstract and personal numerical derivations from professional histories written on a basis (of traditional evidence) and for which Jacques Derrida's famous quote ("*il n'y a plus hors du texte*") seems apposite (Putnam 1988).

The Kuznets programme for careful quantification was designed to replace historical narratives, dense description, unreliable and untypical numbers with national accounts and not to transform the explicandum for an economic history of imperial China into abstractions purporting to measure per capita income under the Han and other dynasties in International Dollars of 1990 (Fogel 2013). Thus our view elaborated below is that Maddison's widely cited data purporting to cover nearly two millennia of history, are not fit for the purpose of providing conceptually sound or statistically secure estimates to facilitate first the measurement and then the comprehension of long term trends for rates of growth let alone for a statistically based representation of comparative levels of incomes per capita afforded to its citizens by the Chinese economy as it and other economies evolved between the Han dynasty and the end of China's imperial regime in 1911. We open the argument with Table 1, which problematizes his data (Columns 2 and 3) by converting it into kilocalories and grams of fine silver (Columns 4-7).

Table 1. Maddison's Estimates for Long Run Trends and Relative Levels for 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 and Grams of Silver per Capita

Bench-mark year circa	GDP per capita in the 1990 International Dollars	Index for GDP per capita in the 1990 International Dollars	GDP per capita estimates transformed into kilocalories of edible rice	Per capita consumption of edible rice per day (Year 1 = 2100 kilocalories per day)	Index measuring changes above food security levels (4 ÷ 5)	GDP per capita in the 1990 Silver oz
1	2	3	4	5	6	7
1	450	100	3374	2100	160	93.2
1000	466	104	3495	2175	166	96.5
1300	600	133	4492	2800	214	124.2
1500	600	133	4492	2800	214	124.2
1600	600	133	4492	2800	214	124.2
1700	600	133	4492	2800	214	124.2
1820	600	133	4492	2800	214	124.2
1850	600	133	4492	2800	214	124.2
1870	530	118	3444	2473	163	109.7
1890	540	120	3506	2520	167	111.8
1900	545	121	3537	2543	168	112.8
1913	552	123	3587	2576	171	114.3
1933	579	129	4338	2715	206	119.9
1956	616	137	4617	2888	220	127.5
1960	662	170	4961	3577	236	137.1
1990	1871	415	14022	8738	667	387.4

Notes: Column 1 displays a series of benchmark years selected by Maddison.

Column 2 is his 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 3 is an index based on conversions of estimates in 1990 *yuan* into International Dollars but is recalibrated to refer to year 1 = 100.

Column 4 is Columns 2 divided by the official price per kilogramme of edible rice for 1990 (0.0648 *yuan* per kilo) and converted into kilocalories using methods and coefficients prescribed by FAO (2002) as elaborated in NIIR Project Consultancy Services, 2012.
Column 5 selects the modern FAO level for "food security" (2100 kilocalories per day) as conjecture for the average level enjoyed by the population of China under the Han Dynasty in year 1 and extrapolates that level forward to 1990 utilizing the rates of growth postulated by Maddison in Column 3.
Column 6 quantifies changes in the levels above food security as implied by Maddison's estimates for per capita incomes in 1990 International Dollars.
Column 7 is ounces of silver at 1990 prices in *yuan*. [Silver implied for the value of Chinese GDP per capita in Column 2].

In Table 1, Maddison's estimates expressed in International Dollars for the base year of 1990 have been converted into their implied equivalents in kilocalories and grams of fine silver in order to expose how problematic they might be. For example, Column 4 converts Chinese per capita income as measured in *yuan* for 1990 into kilograms of edible rice at its official current price of 0.648 *yuan* per kilogram and transforms that number into kilocalories per capita per day using FAO conversion coefficients (FAO 2002; NIIR Project Consultancy Services 2012). The conversion for 1990, namely 14022 kilocalories per capita per day, has been extrapolated backwards at rates of growth constructed by Maddison for his series expressed in International Dollars for 1990 to represent changes in per capita income over nearly 2 millennia of Chinese history (Column 2). Our calibration (vide Column 4) which displays the same trend (Column 3) through time could be plausibly interpreted to show possible variations in levels of kilocalories available to the Chinese population through better (1300-1850) and worse (1850-1963) times for the welfare of the Chinese population. Furthermore, our estimates denominated in kilocalories can be used to support an impression (Columns 4, 5 and 6) that for nearly two millennia of imperial history the economy possessed the capacity to sustain the expanding population of the Chinese empire at levels of nutrition discernibly higher than standards of 2100 kilocalories a day (Column 5) proscribed by modern physiological sciences and the FAO as necessary (compare with Column 4) for food security. Furthermore, these levels in kilocalories derived from Maddison's figures suggest that for centuries before 1850 the population of imperial China enjoyed standards of nutrition that were clearly and discernibly superior to anything afforded by most national economies of Europe for its populations living below the upper percentiles of income distributions (Column 6, as compared with data for England in Deng and O'Brien forthcoming 2015; Muldrew 2011; Meredith and Oxley 2013).

Another sensitivity test that we applied to Maddison's numbers that displays trends in Chinese per capita incomes transforms his numeraire (1990 International Dollars) into ounces of fine silver at a conversion rate of $4.83 per ounce (conversion rates for silver into US dollars and RMB *yuan* are recorded in DUHP: www.silver.institute.org/site/silver-visa.com/news/usa/332/). This number was then extrapolated backwards (deploying the index in Column 3) through the years benchmarked in Column 1 to produce the series reported in Column 7. The possible meaning and plausibility for this series of numbers expressed in grams of fine silver converted into *yuan* at the 1990 exchange rate could be exposed in several ways. One, in kilogrammes of edible rice at 1990 prices produces absurd results. Another, which converts grams of silver into silver taels – China's official currency under the Qing dynasty and compares the results with nominal daily wage rates for which independent historical evidence for the years 1728-92 has been recently published in a special issue of the Economic History Review (Broadberry and Hindle 2011). According to this widely cited paper by Allen et al, nominal daily wage rates for unskilled labour employed in the cities of Beijing, Suzhou and Canton over the period 1728-92 amounted to an average of 0.01 silver taels per capita per day for a labourer supporting a wife and three children (Allen et al 2011). For that period Maddison's implied estimate of 124.4 ounces of silver per capita per annum (Column 7, Table 1) converts into a far higher average per capita value of 1.26 taels per capita per day. Either the figure published by Allen et al for wage dependant workers is far too low or Maddison's estimates, when translated into silver taels, seem far too high. Of course, the purchasing power of fine silver changed over two centuries of time and Maddison's estimates for 1728-92 refer to its value in 1990 prices. Furthermore, there is no reason to suppose that the income from wages available to an unskilled labourer and his family for 1728-92 would be highly correlated with per capita incomes for that same period. Nevertheless, these estimates seem prima to be too far apart to be reconciled with each other or with other published figures for real GDP per capita in taels per head (Liu 2009, p. 155).

Thus in different ways and for varying degrees crude sensitivity tests expressed in kilocalories and silver reveal the potential ambiguities and inconsistencies embodied in Maddison's laudable endeavours to construct a series of estimates for GDP per capita for the Chinese empire covering two millennia of time expressed in a numeraire (International Dollars at 1990 prices and weights). Yet Maddison's data is both transparent and enticing. It promises nothing less than the statistics required to

both quantify trends and relative levels of well-being provided by the imperial economy for the population of China. Unfortunately the numbers, for reasons we will now proceed to elaborate, are insecure and will be represented as a thought provoking but unconvincing exercise in quantification.

2. Bench Mark Estimates and Indices in 1990 International Dollars

Economic historians are certainly interested in measuring in the long run economic growth achieved by the Chinese Empire between the times of the Western Han Dynasty (206 BCE – 25 CE) to the end of dynastic rule under the Qing (1644-1911). Currently they are particularly concerned to locate a chronology for divergence when the empires rates and levels of economic development fell behind those of Western Europe (Pomeranz 2000).

Maddison's series of numbers for China's GDP per capita have been constructed by way of a backward extrapolation for 1990-1870 and a forward extrapolation for the years 1-1870. The two series are linked together by conversion into a common and ostensibly comparable numeraire namely, International Dollars that have been 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 series Maddison apparently applied a single conversion coefficient to official and revised estimates for China's GDP for the years 1990, 1960 and 1956 and to an estimate for 1933 expressed in prices and *yuan* for that year published by two Chinese economists Liu and Yeh in 1965 (Liu and Yeh 1965). He did not use the estimate published in 2007 for 1934-36 based upon a recalibrated purchasing power parity exchange rate for the mid 1930s which raised his estimate for China compared to the United States by 10% (Fukao et al 2007). With his estimate in 1990 International Dollars for 1933 in place Maddison then deployed a series of sectoral growth rates computed and published by three economists (Perkins, Rawski and Wang) to produce an overall rate of growth for GDP per capita from 1913-33 (Maddison 1995, pp. 145 and 195). He then asserted that this estimated growth rate could be applied to the "years of recovery" from internal disorder and international warfare 1870-1912 (Maddison and Wu 2008).

Maddison claimed that the procedures he deployed to manipulate this limited range of imperfect data could generate acceptable proxies for trends in the rates of change

in GDP per capita at constant (1990) prices between 1870 and 1990. Furthermore, and because estimates originally compiled in *yuan* at current prices had been converted into dollars at international prices for 1990 these numbers could also in Maddison's view be compared with all other economies whose currencies could 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 that century or so in Table 1 are the product of backward extrapolations, depend upon revisions to official estimates for GDP for 1990, 1960, 1956; on an estimate constructed as best they could by two economists for 1933 and rely upon an averaged annual growth rate for 1870-1912 that is assumed to be the same as the constructed rate for 1913-33 (Maddison 2007b, pp. 156, 157; Maddison 1995, pp. 194, 195; and Maddison and Wu 2008, 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, when presenting data for China that departed from established standards for statistical veracity he rarely included sensitivity tests. He anticipated that the publication of negotiable numbers would stimulate other academics to revise and correct them. He cannot be faulted for an outcome that has now become a sustained and uncritical use of data that he made accessible as evidence for econometric tests, historical analyses, statistical mapping of the history of the world economy and academic controversy? His work will, and should, continue to be recognized as a pioneering stimulus for programmes of research designed to construct national accounts for historical periods when states did not support institutions to measure national incomes (Henderson 2010).

Nevertheless, Maddison was certainly very well informed and had been cogently reminded by Leandro Prados De La Escosura about the properties of index numbers and how sensitive all calibrations of purchasing power parities are to a specific period of time. We add they are also sensitive to the range and quality of the data required to convert Chinese *yuan* and other national currencies into some kind of universal numeraire for purposes of conducting comparisons across countries and over spans of years (Prados De La Escosura 2000). Recently, critics of the methods, statistics and inferences derived from several rounds of data collection designed, managed and funded by the world bank and other international organisations to provide purchasing power parities for the worlds currencies have exposed both their heuristic

and tightly contextualized validity as well as the fragility of the extant range of published purchasing power parity rates of exchange currently available for the conversion of currencies (particularly the *yuan*) into either American or International Dollars (World Bank 2008).

That literature has certainly exposed basic and unavoidable critiques of the inferences and conclusions that continue to be drawn from Maddison's data. Criticism falls into two categories: (a) those that pertain to the meaning specification and measurement of Gross Domestic Products (GDP); and (b) standard index number problems embodied in projections from singular and more or less accurate estimates for GDP expressed in this case in 1990 International Dollars that purport to refer by way of backward and forward extrapolation to more than a century before 1990 and audaciously (as we will argue in section 3) to nearly two millennia of Chinese economic history moving forward from Han times.

There will be no need to survey widely accepted critiques even to standardized and carefully measured accounts of GDP as the internationally accepted indicator for any national economy's potential for the production of commodities and services and often extended to its relative success in providing security, social welfare and desirable levels of private consumption for its citizens (Abramovitz 1959; Prados 2013; Korzeniewicz et al 2004). That has been very well done by a recent article in the *Journal of Global History* (Jerven 2012). If, when and wherever it can be measured GDP retains its place as the basis and starting point for macro-economic analysis of long run economic growth. Nevertheless, we should add a familiar point, namely, that the accounts and data published by the Peoples' Republic of China for GDP for, household expenditures and average nationwide quotations for the domestic prices of goods and services is of low quality, the subject of persistent controversy and revisions that are frequently updated and presumably improved (Holz 2006; Feenstra 2009)? For example Maddison and his co-author Wu have claimed that China's rate of growth for 1978-2003 should be revised downwards from 9.3% accepted by the World Bank to 7.9% (Maddison and Wu 2008, pp. 13-44). While Ren's reconstituted estimates for 1986, utilized by Maddison to reformulate his GDP estimate for 1990, have been described as "badly out of date" (Dekhanov and Swansen 2010, p. 200). Latterly the Chinese state is, however, engaged in improving and standardizing the low quality of current official statistics which signals the need to revise previous estimates utilized for historical analysis (Heston 2010, pp. 3-31).

What has recently been clarified as a deeply flawed procedure is Maddison's own methodology utilized for the statistical mapping of long term trends and which has generated estimates for China's GDP and GDP per capita by way of two extrapolations that are both consistently and ambiguously denominated in International Dollars connected to purchasing parities that serve to align a series of numbers to constant relative prices for 1990 and to Year 1 as a reference year for the representation of trends over two millennia of time.

Conceptually, purchasing power parities are not difficult to comprehend because they embody the potentially quantifiable notion of precisely what a given amount of goods and services valued in one national currency could cost to purchase in the currency of another country (Sarno and Taylor 2002; World Bank 2008). Clearly, the 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 in the countries or cities being compared as well as a range of other factors explored in depth and theoretical sophistication by economists interested in explaining their connexions to trading rates of exchange (Rogoff 1996, pp. 647-68; Prados de la Escosura 2000, pp. 1-41). For example, if a typical family resident in Shanghai spent 50,000 *yuan* on goods and services in 1990 and an identical basket of goods and services would have cost them US$5000 in New York, the command over goods and services exercised by a modal Shanghai family in 1990 can be expressed as a purchasing power parity equivalent to ten *yuan* equals one US$. Binary parities are easy enough to calculate for micro units (families) living, working and consuming in geographically confined spaces and comparable cultures such as Shanghai and New York who purchase a similar range of goods and services over a given year. 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 the citizens of China and the United States the volume and complexity of the calibrations required to construct purchasing power parities for macro economic comparisons of private consumption, investment, governmental services and other additive components of GDP multiplies exponentially (Deaton and Heston 2010; and World Bank 2013).

Nevertheless, several exercises have been conducted under the auspices of international organizations to cover an increasing number of national economies at levels of conceptual sophistication and statistical accuracy that have improved

significantly since their emergence in the 1950s (World Bank 2008). By 1970 the construction of parities had moved on from binary comparisons of purchasing power to embrace the more abstract concept of an international (Geary-Khamis) dollar designed and redesigned to construct a conversion coefficient to transform any one national currency into all other national currencies (Asian Development Bank 2007). Simply put and for purposes of cross country comparisons, that parity would ideally embody a nationally weighted set of prices expressed in a transnational numeraire (dollars) that refers to a particular benchmark year and would somehow cover the largest possible range of diverse goods and services produced and/or consumed by each and every economy in the world – or more realistically for the sample of countries who opted to participate in these international statistical exercises, which are designed to measure the global value of all national currencies. Thus a world average price in dollars for any specified commodity or service (or aggregations of commodities and services produced and consumed in this "composite" or "proto-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 particular national economies divided by the number of countries included in samples that have increased to over the years to become almost global in their reach and scope (Deaton and Heston 2010).

Clearly demands upon the statistical offices of governments and on international organisations calibrating national data into purchasing power parities to collect, match-up and find 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 persisted (Ward 2004). These factors remain along with the contested estimates for that huge and complex economy's national accounts lend strong support to the stance of scepticism towards Maddison's and similar estimates that depend on purchasing power parities constructed before 2005 which have been used to convert revised official estimates, surveys of household expenditures, and averaged "nationwide" prices into International Dollars for 1990 (de Jong and van Ark 2012, pp. 1-20). Those and older estimates expressed in that same numeraire are now being confronted with the reformed methods and an altogether larger and more reliable data base (for 146 countries) utilized to construct the purchasing power parities for cross country comparisons in International Dollars for years after and by implication before the construction of parities for 2005 (World Bank 2013; de Jong

and van Ark 2012). The magnitudes of the revisions contemplated and discussed for the currencies for several economies are really significant. This became obvious for India and China because 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% on the revised parities published for 2005.

In general the statistical reasons behind these recent and by implication historical revisions in levels of GDP denominated in International Dollars are well understood. The quality of Chinese and Indian statistics has improved. Not only has the urban bias in averaged prices been recognized but prices have been more carefully aligned with the qualities of the goods and especially the services produced and purchased in China, India and other developing countries (Heston 2010; World Bank 2013). Finally, it is of paramount importance to observe that augmenting the number, range and structures of economies included in a matrix and process for calibration designed to generate weighted average prices for a greater diversity of commodities and services produced across an enlarged sample will effect parities not only for referenced years but fluctuations in relative prices will alter parities for years between benchmarked years (World Bank 2013). For example, China's GDP "bounced back" when it was converted into International Dollars on the latest PPP for 199 countries in 2011 (vide *Economist*, 03 May 2013). These changes in the parity of the *yuan* will depend not only upon variations in production, prices and wages within China but variations in all countries included in the sample (Ravallion 2010). More generally the major and known point exposed by the 2005 exercise is an acceptance of a bias embodied in the process of constructing otherwise heuristic and transitive purchasing power parity rates of exchange (Diewert 2010, pp. 11-13). Those involved with these exercises for the construction of "international" prices for commodities and especially for services recognise that their procedures maximize the weights accorded for both the prices and volumes of commodities and services consumed by the populations of larger and richer countries. They warn of a systematic tendency to inflate the significance of non- traded commodities, particularly local services produced and consumed by the world's poorest nations. Thus the dramatic downward revisions in per capita incomes expressed in International Dollars for China, India and other developing countries can be plausibly represented as: a "big" step in a more realistic direction for estimates that purport to measure both relative levels and rates of growth for Asian and African economies over restricted time spans for the twentieth century (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 have grappled with discussions among economists and statisticians concerned with the complexities of measuring levels and rates of growth in International Dollars over the last four decades, particularly for China and other developing economies. They could only conclude that a secure base or reference year for purposes of backward extrapolation extended through time has yet to be constructed. One may emerge from the data sets collected and recalibrated on a new basis for 2005 and 2011 (Deaton and Heston 2010; Diewert 2010). Meanwhile only limited confidence could be reposed in historical estimates for China in 1990 International Dollars and (as we will argue) even less credence could be placed in the sequence of numbers purporting to represent both levels and rates economic growth of China for centuries before that year (Crowshore 2011). Our scepticism must, moreover, be reinforced by the following quotation from two economists Angus Deaton and Alan Heston who have been closely engaged with the design of a conceptual framework and the manipulations of data required to construct purchasing power parities for our times. "One general rule is that comparisons become less reliable the further apart are the structures of GDP (or its components) of the countries being compared." And they add, "this is essentially the same as the increasing unreliability of long run historical comparisons, the further back we go." (Deaton and Heston 2010, p. 4). Our sensitivity tests in Table 1, together with critiques of the methods and sources used by Maddison to produce a statistical map for the economic history of China, supports their perception "that many of these numbers" (which continue to find their way into global economic history) "have substantial uncertainty and that extrapolations over long periods can easily lead to results that make no sense" (Deaton and Heston 2010, p. 33).

Uncertainty already surrounds Maddison's figures for 1913, 1900, 1890 and 1870 as tabulated in Table 1. This is so because the price indices used for the measurement of growth rates in constant prices are domestic prices embodied in a GDP deflator, cost of living index or consumer price index (CPI). Deflation has not been conducted with an index based upon international prices. Since International Dollars were designed to allow for cross sectional comparisons at different points in time consistency would seem to require that changes in China's GDP from 1810 or 1890 to 1990 could only be constructed in prices that move in tandem with annual fluctuations and trends in the international purchasing power parity of the *yuan*. For

the years 1870 to 1990 Maddison's estimates for levels of GDP are derived from growth rates. Those rates embody questionable estimates for GDP deflated by imperfect indices for changes to the levels of Chinese prices. They do not reflect changes in the parity of the *yuan*. They can be read as an undefined and ambiguous hybrid of changing domestic and constant set of 1990 international prices (Johnson et al 2009, pp. 3 and 20; Crowshore 2011).

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 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 at 1990 prices. This basic number has been derived from controversial and ongoing attempts by economists employed by the World Bank to construct a metric for a notional and universal poverty line or subsistence income for samples of third world societies (Ravallion et al 1998, 2004 and 2008). 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 2005. That concept and its conjoined metric have come under sustained and convincing theoretical and empirical attacks (Ravallion 2009; Stiglitz 2010; and Allen 2013).

Maddison has not, it appears, clarified or justified his selection of 450 International Dollars for Year 1 as a plausible representation of a poverty line or subsistence income measured in International Dollars for 1990 (Federicko 2002, p. 6). Furthermore, the figure selected by Maddison as a proxy for per capita income in Han times will not convert or extrapolate into anything comparable to the annual amounts in *yuan* designated by the modern Chinese state to represent poverty lines or subsistence incomes for its rural or urban poor (Ravallion et al 2001; Allen, 2013). Prima facie a level of 60% above the level postulated as sufficient for food security looks implausibly high (vide Table 1). It is, moreover, unlikely to be rendered more plausible by unquantifiable surpluses appropriated from GDP by high, unrealistic and historically implausible impressions of income inequality under the Han dynasty (Wang 2007, pp. 162-74, 278-99).

In short, serious doubts surround attempts to transform and transpose a metric designed for the measurement of global poverty and / or subsistence in our own times into proxies for GDP per capita in the very remote past (Alam 2006; Allen 2013). Maddison did not confront the complexities involved in constructing and pricing a basket of goods consumed by the poor across the world for modern times (Deaton 2010). Instead he assumed that the populations of the Chinese empire, before the era of the Sung (or Song) Dynasty, lived at a standard of living that could be captured and proxied by a highly controversial modern metric of 450 International Dollars (Stiglitz 2010; Allen 2013).

Apart from serious theoretical rejections to a numeraire based on 1990 International Dollars and the whole notion of international poverty, long cycles in the growth of population and output are ignored by Maddison's data for GDP which suggests (vide Table 1) that almost no change occurred for over a millennium before the advent of the Sung. According to some contested statistics for population totals, the production of iron and urbanization ratios as well as the consensual views of historians of medieval China under the Sung dynasty, the imperial economy experienced an "efflorescence" that carried per capita incomes up to a significantly higher level (Deng 2013). Maddison asserted that this uplift amounted to an order of magnitude of approximately 33% over more than 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). 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 the static level sustained from circa 1300 to circa 1850. 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).

Maddison's inferences 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 considerable number of Chinese historians have suggested that the Ming-Qing Period was one of steady performance in economic 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). During this period, the 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 47% increase in output per unit of land (Zhang 1996, p. 412). This led to the yield plateau that prevailed for the rest of the Qing period (Shi 2012, p. 56). Even so, according to Liu, yield levels in the Lower Yangzi Region had 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 improved (Yin and Hui 2012). These yields were simply unobtainable before 1700 and the traditional view that double-cropping of rice began with Champa Rice introduced in the early Song is no longer tenable (Deng 2013; Liu 2013, p. 104). Finally, Chinese economic historians agree that commercialized household cotton textile production took off during the Ming Period (Xu 1989; Fan 2008; Wu 2009).

Maddison recognised that complementary historical statistics to bolster his numbers for GPD that could also serve to represent the economic performance of the Chinese Empire under the Ming and Qing dynasties (1368-1911) would as one of stasis might carry conviction. He found support for his perceptions 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 2007b, pp. 10, 24, 31, 37, 151; Rozman 1973). Perkins wrote 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 this scholarship used by Maddison to underpin his tabulations for GDP. We begin with the figures that Perkins published for the period before 1870.

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 yields per unit of land cropped, Perkins attempts to construct conjectures were based upon: (a) official records including: censuses of population, cultivated areas subjected to taxation, scattered references to grain yields per mu cultivated for particular localities for odd years 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 1930s, official statistics for 1957 and for years thereafter. His book contains a range of numbers that offered more or less plausible conjectures for the absence of properly validated official statistics for the agrarian sector of the Chinese economy – numbers that Alex Eckstein (another distinguished economist and sinologist) did not consider it possible to construct (Eckstein 1968, pp. 34-5).

His primary, acceptable but debatable series of estimates were culled from population totals for bench mark years from 742 to 1953 and to which he attaches possible margins of error. China's demographic data are familiar and for present purposes estimates cited by Perkins and Maddison can simply be placed alongside other recently published series.

Table 2. Published Population Figures of the Chinese Empire (in Millions)

Year	Chao 1986	Deng 2004	Durand 1960	Ge 2001	Jiang 1998	Liang 1980	Maddison 1998	McEvedy-Jones 1978	Perkins 1969	Zhao-Chen 2006
1					60			50		
2	59	59.6	59	60		59.6	59.6	53		59.6
25				35	30					
50							40			
57		21				21				31
75		34.1								
88		43.4								
105	53	53.3	53.2			53.3				53.2
125		48.7								
140				60						

144		47.6								
146	47					47.6				
156			56.4							
157		56.5				56.5				
180					60					
220				23	20					
259								63		
280		18.5	16.2		30	18.5				16.2
320					20					
520		28.9			50					
560					40					
606			46					50		46
609		46		60	60	46				
620					25					
705		37.1	37.1			37.1				37.1
755		52.9	52.9	70	80	52.9		50		52.9
760					50					
859					60			50		
960	32				30		55			32
980				35.4						
1000							59	66		
1006		42.8				16.3				
1009										121
1053		62.3				22.3				
1078				90.9						
1083		99.3								
1109	121							105		
1110		120.5		140	100	46.7				
1130				90						
1140					70					
1187		110.6				69				
1195		112.7				76.3		115		
1210				145						
1220					100					
1270					60					
1280							100			
1291		59.8		75		59.8				59.8
1300							100	86		
1330		77.3		85						
1350					85					
1370					60					
1380							68			
1381		60	59.8			59.8				59.8
1390							69			
1391	60	56.8	60.5	71.6		56.8				60.5
1400							72	81		
1403		66.6				66.6				
1410							71			
1420							73			
1423		52.8				52.8				
1440							82			
1445		53.8				53.8				

1450						53.8	88			
1460							93			
1464		60.5				60.5				
1470							104			
1474		61.8				61.9				
1480							116			
1484		62.9				62.9				
1490		50.3				50.3	98			
1500							103	110		
1502		50.9				50.9				
1510		59.5				59.5	117			
1519		60.6				60.6				
1520							133			
1530							139			
1532		61.7				61.7				
1540							144			
1542		63.4				63.4				
1550							146			
1552		63.3				63.3				
1560							151			
1562		63.7				63.7				
1570							155			
1571		62.5				62.5				
1580							162			
1590							162			
1592	200									200
1600							160	160		
1602		56.3				56.3				
1610						51.7	153			
1620		51.7			160		145			
1630				192.5			138			
1640							130			
1644				152.5						
1650					80		123	140		
1655		38.6				14				
1657	72		70.2							
1660							135			
1661		52.6				19.1				83
1670							148			
1673		53.3				19.4				
1680		47		160		17.1	126			
1690							144	150		
1700							138	160		
1701		56.1				20.4				
1710							156.6			
1711		67.7				24.6				
1720							177.8			
1721		70.4				25.6				
1730							201.8			
1734		75.2				27.4				
1740							229			
1750							260	225	270	

1753		102.8				102.8				
1760							274.6			
1766		208.1				208.1				
1770							290			
1776	268		268.2	311.5						268.2
1780							306.3			
1790							323.5			
1800	295		295.2				341.6	330		295.2
1810							360.8			
1812		361.7				361.7				
1820				383.1			381			
1830							409			
1833		398.9				398.9				
1840							412			
1848	426		426.7							426.7
1850				436.1	450		412	435		
1860							377			
1870					350		358			
1880				364.5			368			
1887		377.6				377.6				
1890							380			
1900							400	475		
1911		368.1		346	460	368.1				

Source: (1) Official censuses based on Liang 1980, pp. 4–11. Adjusted official population data, Deng 2004, Appendix 2. (2) Estimates: Perkins 1969, Appendix A; McEvedy and Jones 1978, pp. 166–74; Chao 1986, p. 41; Maddison 1998, p. 267; Jiang 1998, p. 84, Ge 2001, pp. 831–2; Zhao and Chen 2006, p. 110.

There will to be no need to review or revise the diverse range of figures currently in print for China's population if only because they are (as we will show) the only acceptable series Perkins had access to in order to measure historical trends in grain output and by inference food consumption per capita for the Chinese empire. Furthermore, he quoted his preferred totals as a wide range of possible numbers.

With imperfect but discussable figures 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 measured in catties of unhusked rice equivalents and converted to a metric standard at a rate of 2 catties equals 1 kilogramme (Perkins 1969, p. 309). Perkins *settled* not for a sequence but for a *constant* 527 catties per capita by positing that:

a) Per capita grain output fluctuated if at all only within narrow limits:- fluctuations in grain prices, an assertion that was not checked against price data
b) Those limits 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 catties” (Perkins, pp. 15-16).

In Chart F1, Perkins also cited 5 historical sources from Sung times to 1844 to claim “it does seem clear that 3 *shi* (piculs, 600 catties) of husked rice represented typical annual grain consumption”. 600 catties is equivalent to 300 kilogrammes of 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 kilogrammes (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 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 kilogrammes) of unhusked rice which he reduces by 50% to 286 catties (143 kilogrammes) 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 than Perkins (32% instead of 50%) and transform a kilogramme of husked rice into nutrients with an energy value of 3660 kilocalories a day (F.A.O. 2002; and U.S.D.A. 2010).

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

$$\frac{0.68\ (286\ \text{kg})\ (3660\ \text{kilocalories})}{365}$$

which transforms into 1950 kilocalories per capita per day, which comes close to Buck’s estimate of 1823 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 kilogrammes of unhusked rice that Perkins (and Buck) defined for "subsistence" but is clearly below the level of 2100 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. By implication for masses of Chinese, standards of living not only fell below that precarious level in times of disorder and crisis (the years of takeover by Manchu armies and the Taiping rebellion) but if Perkins' speculations are plausible they subsisted at that level for most years during Ming-Qing times.

Maddison's numerical representation and interpretation of stasis is certainly supported by Perkins but, as Table 1 exposes, his estimates for GDP per capita founded upon a base-line figure of 450 International Dollars and extrapolated forward from 1300 to 1870 using average annual rates of growth derived from Perkins' estimates for grain production per capita are not consistent with our calculations that generate far higher **levels** of kilocalories per day provided by estimates of around US$600 1990 International Dollars for these years benchmarked in Column 4 of Table 1 for the period 1300 to 1870.

But the question remains: could data from Perkins (accepted by Maddison and those who cite his rates of growth in per capita income in 1990 dollars) which are derived from statistics for population growth and a conjectured constant of 572 catties of unhusked rice, be used as trends that correlate with trends in GDP per capita? Perkins suggested they could and attempted to corroborate his conjectures with reference to evidence derived from an official survey of agricultural output for 1957 and more seriously with statistics derived from an elaborate alternative calculation based upon reconstructed estimates for the area of arable land cultivated with grains multiplied by a guess for weighted average yields (again measured in catties of husked rice equivalents per *mu*). We suggest that for reasons that he almost recognizes these estimates are unconvincing if not unacceptable (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 vital importance for government finance, cadastral surveys in Imperial China were sporadic and subject to wide margins of error. The first attempt to carry out an empire-wide cadastral survey was made in late Northern Song 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, and Wu 1985, pp. 17–18). Each *fangbu* was made 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 attempt was made in 1387. By1393, a total of 850,762,300 *mu*, officially, 1 *mu* = 240 x 6 paces^2 (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 cadastral survey. Cadastral Registration was resumed under the Qing Dynasty in 1654. 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 the 1765 regulations, 'villagers measure their own lands, officials check at random' (Zhao 1927, 'Shihou 2', in *Twenty-Five Official Histories*, 1986, vol. 11, p. 9259). And Zhao has estimated under-reporting in cadastral surveys of 20-30 per cent (Zhao 2007).

In reality, the *mu* as a unit of cultivated land was never fixed. Its area and fecundity varied significantly from province to province, locality to locality and from time to time. Usually, 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 fertilities to a number of taxable units in order to simplify assessment for taxation. This was a deliberate and persistent government procedure, known as "*mu* conversion" (*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 century after century. The practice continued during the Qing (Liang 1980, p. 528, and Zhao 2007). According to Shi Zhihong, "Gross *mu* (*damu*) were larger than the official size of 240 x 6 paces^2. Mu varied from 260 x 6 paces^2, 360 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. Even if we know such variations, we cannot convert *mu* recorded in historical materials into the official standard *mu* unless we can clarify the type of '*mu*' referred to in a particular record." (Shi 2012, p. 55)

In short, the surveys conducted under Ming and Qing governments do not provide historians with records of the empires area of cultivated land expressed in standardized units. Official statistics for cultivable land are distorted by textual errors, the inclusion of untaxed land and significant degrees of variance in the area called a mu. Above all, they are inflated by grading land for fiscal reasons to reflect differences in the underlying fertility of the soil. To reduce Ming surveys of fiscal mu to estimates that approximate to the area cultivated with grains required arduous and complex manipulations of data that ceased to be collected after 1690. Perkins (with help from a prior exercise published by Fujii) 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 1770's (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 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 land expressed in his reconstructed and standardized mu in place, Perkins then confronted his database of 900 observations 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 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 he tabulated a drastically reduced sample of estimates for unhusked rice yields (catties per *shimu*) for just 4 locations that he referred to centuries of time: 1500-99, 1600-99 and 1700-99. Even for that reduced sample the variations for just 12 observations ranged from 250 catties per annum to 520 (Perkins 1969, Table G.2, p. 315). 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 conjecture and which is in fact based solely on contested statistics for the empire's population (Lavely and Wang 1998; Deng 2004).

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 but are deployed to refer to his (and to 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 kilogrammes of unhusked rice per capita which transforms into a contestable level of 195-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 unstandardized mu expressed in catties of unhusked rice (which are quoted by Maddison) generate numbers that translate into lower and upper bound numbers of 2635 and 5124 kilocalories a day. They do not corroborate estimates for kilocalories per day based upon the size of the empire's population multiplied by a constant (Perkins 1969, Appendix G).

Perhaps the most balanced judgement to make about a scholarly 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 Kuznetsian paradigm for the "empirical tradition economics" (Fogel 2013). Sadly, he

has not supplied historians or Maddison with the macro-economic data required to forge a statistical explicandum for a modern economic history of the Ming-Qing empire. These data (referred to by Perkins as "most likely conjectures") are, we regret to say, simply not fit for that purpose (vide Perkins 1969, pp. 8-17).

Maddison certainly depended on Perkins for the rates of change he utilized to extrapolate his own numerical constructions for China's GDP in International Dollars backwards and forwards through some 1900 years of history. He also, moreover, cited Rozman's 1973 figures for the empire's urbanization ratio (Rozman 1973). Except for some archaeologists who cling resolutely to that ratio as the only statistical evidence available to them for metanarratives of economic development for prehistoric, and classical centuries, the correlations between that particular numerical index and changes in levels of GDP per capita are recognised as conceptually ambiguous and depend upon an uncritical view of statistical evidence that is conceptually dubious, namely, multipliers that convert areas of settlement into populations of towns (Bloom 2007; Pascarti and Dunn 2002).

Agreed, the economic mechanisms through which the concentration or 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 from 1000 to 50,000 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 been tested for recent times (Polere 2009; De Long and Shleifer 1993; Taylor 2013). Nevertheless, unless and until it has been established precisely how other features and factors (particularly variations in the administrative boundaries established by political authorities for purposes of governance, taxation and defence) behind the correlation also operated across space and time, the set of disparate urbanization ratios for China will continue to retain their status as an ambiguous indicator for the measurement of trends or levels of economic development (Ge 2000-1; and Duan 1999). China's relatively low and stable urbanization ratios may simply reflect a greater degree of dispersal of more productive activities associated with manufacturing and professional services across space? They can be plausibly related to: the overall area of an enormous and expanding polity, internal peace and security, the size of the empire's population and the densities of its transportation of communication networks (Cao 2001; McKeown 2011, pp. 309-19; Rosenthal and Wong 2011).

While Kuznets established clear connexions between macro-economic growth and the shares of workforces engaged in agriculture, neither he, Rozman, nor most historical geographers are prepared to posit any close and invariant correlation between urbanization ratios, the sectoral allocation of the workforce and levels of per capita income (Taylor 2013). Even for Europe that ratio fluctuated across space and over time in line with changes in the comparative advantages of villages and towns (Crouzet 2001). There seems to be no evidence covering the share of the workforce (or ideally the share of its labour time) allocated to non-agricultural pursuits in China. Before the late eighteenth century the absolute numbers of Chinese workers employed in "urban" locations variously defined, probably exceeded the total for Western Europe. The most recent data for 1776 offers urbanization ratios of 7.4% for China, 10% for Europe, 16% for Britain. The ratio for Jiangnan, the most commercialized pocket of Qing China is cited as 14% (Li and van Zanden 2012). But the problem is that the term 'Jiangnan' refers only to 27% of all prefectures (8 out of a total of 29) across Jiangsu and Zhejiang provinces (Tan 1991, pp. 51–2, 59–66; Feng 2002, pp. 22, 24–7; Guo 2007, p. 152), or 4% of all prefectures (190) across the empire (Cao 2001, pp. 828-9; Ge 2000-1, vol. 4, pp. 282, and vol. 5 pp. 808, 811). In short, correlations between underspecified and unmeasured ratios for urbanization and GDP per capita vary across space and time.

4. Conclusions: Can the Kuznetsian Paradigm Be Extended to Include the Long Run Development of the Chinese and Other Oriental Empires?

Our view of prospects for the construction of macro-economic history of the Chinese Empire from the Western Han or even from Ming-Qing dynasties is one of pessimistic regret. We have reached this unwelcome conclusion by way of a critique of the innovatory endeavours of the late Angus Maddison to discover and calibrate data that might serve as plausible conjectures for trends in China's GDP per capita from Han to modern times. Aware that his indices continue to be widely cited by economists and that other economic historians are engaged in revising comparable categories and ranges of Chinese data this essay has been written to remind them that the Kuznetsian paradigm for economic history depends upon access to statistical evidence that is secure enough to provide an explicandum for competing analytical narratives (Bairoch 1981; Liu 2010; Bolt and van Zanden 2013; Broadberry et al 2013).

For reasons that we will now summarize the work of the most committed and prolific Kuznetsian scholar of his generation shows this is patently not the case for Chinese economic history. First, the foundations upon which Maddison projected intervals of growth from (*circa* Year 1) to the end of the Sung Dynasty (*circa* Year 1300) are based on no statistical evidence other than the disputable figures he cited for total population (see Table 2). This also applies for the interlude of decline and recovery from circa 1850 to circa 1890 associated with the highly destructive Taipei rebellion and two foreign invasions. While the presentation of index numbers that suggest six centuries of stasis in per capita production and consumption from Sung to late Qing times are based almost entirely upon an enlightening but ultimately unsuccessful attempt by Perkins to measure trends in the volume of grain output supported by Rozman's conceptually ambiguous and statistically insecure ratios for urbanization. Despite the understandable urge of our colleagues in archaeology and classical history to quantify their evidence, most historians do not read data for changes over long spans of time in the shares of an economy's population resident on sites designated as "towns" (let alone a numerator that purports to measure the size of its largest city) as an adequate proxy for rates of growth in GDP per capita (Morris 2010 and 2013; Taylor 2013).

For the period after 1890 Maddison's numbers that appear in several publications rely on official and revised estimates from the Communist state, and outdated revision of these estimates by Ren Ruoen for 1986; an unofficial construction of one national account for 1933 by an academic economist, Ou Pao-san (1947), and then by Liu and Yeh (1965), for 1933 and some more or less plausible conjectures for average annual rates of growth for the years 1914/18-33 published by Perkins, Rawski and Chang, which Maddison asserted could be applied to the periods from 1890-1913 and 1870-90.

Economic historians might be persuaded that inadequate but perhaps acceptable statistical evidence might emerge to construct an imperfect but potentially useable series for GDP and GDP per capita in *current and constant prices* for bench mark years after 1890? Nevertheless, and in the light of recent and ongoing discussions among economists in the wake of 2005 statistical exercise conducted under the auspices of the World Bank designed to convert estimates for the gross domestic products of 146 countries for purposes of international comparisons they will become more aware and sceptical about the provenance, confined context and meaning of

numbers expressed in International Dollars and projected backwards or forwards in time for purposes of historical analysis (World Bank 2006, 2008 and 2013).

For example, they will note that Maddison's own forward projections of growth from Western Han to Sung times also rests upon a base line guess for per capita consumption which he defined as equivalent to a modern universal poverty line of 450 International Dollars which is convertible into the same amount of American dollars and 518 Chinese *yuan* for 1990 (Table 1). Apart from the difficulty of imagining survival in contemporary America on an income of US$1.25 dollars a day that particular poverty line figure was constructed by the Bank's economists in order to provide a headlined numerical impression for conditions afflicting the lives of the very poor in the poorest countries of the modern third world. It is neither transparent conceptually nor uncontroversial. The acceptable general question for historians is could this or even some revised figure for a global poverty line be transposed to serve as a plausible proxy for the standard of living for a modal Chinese family unfortunate enough to have lived under the Han dynasty? Some classical historians may embrace that number as a possibility for quantification but serious theoretical and empirical objections surround the conflation of a metric designed to facilitate comparisons of average standards of living across populations in ancient times with any contemporary and supposedly global metric for a poverty line (Morris 2013, and Pritchett 1997). That line will fluctuate with the purchasing power parity exchange rates for currencies in ways, directions and degrees that are not related to either the range of prices or quantities of commodities actually consumed by the poor purchasing and/or producing enough for subsistence (Reddy and Pogge 2010). World Bank figures have, moreover, been exposed as out of line with standards and measurements for poverty established by national governments expressed in local prices and incomes. For China, recent official estimates distinguish rural from urban poverty and suggest levels in *yuan* that are not even close to the reference year figure of 450 International Dollars for year 1 selected by Maddison as a basis for forward extrapolation from Han times (World Bank 2006).

Furthermore, our tests for sensitivity and consistency (vide Table 1) based upon alternative data for normal daily wages in grams of fine silver and a metric established by the Food and Agricultural Organization of the United Nations of 2100 kilocalories per capita a day as the nutrients required for "food security" suggest that for almost two millennia Chinese families enjoyed levels of nutrition that were paradoxically far more optimistic than anything suggested by participants in the

Divergence Debate, either for the Chinese Empire or the labouring poor of Western Europe (Vries 2013). Taken at face value Maddison's reference figure for year 1 (i.e. 450 International Dollars) converts into *yuan* and then into edible rice equivalents (at the official average price of 0.648 *yuan* per kilogramme for 1990). The implausible numbers that are generated by this calculation suggest that under the Han dynasty an average Chinese family allocated only 30% of a subsistence-cum-modern poverty income to the purchase of food (Piazza et al 2001; Ravallion and Chen 2004).

Sensitivity tests reveal that there is something amiss not simply with the evidence and conjectures for the rates of growth utilized for forward projections from the Han era to 1850 but more seriously with the conceptual foundations of any index expressed in constant 1990 International Dollars utilized as a base line level for the projection of long term trends in GDP per capita. There is no statistically based evidence for accepting inferences that could prima facie be drawn from Maddison's estimates in International Dollars. They suggest that after an "efflorescence" (revealed as a mere "blip"?) experienced under the Sung dynasty the macro economy of the empire stagnated and China's population experienced no improvement in their standard of living before 1960. Maddison's innovatory and persistent attempts to manufacture statistics in order to work within the paradigm established by Simon Kuznets for empirical economics has led to nothing better than abstract numerical impressions which are no more nor less secure than historical narratives that they seek to replace. Historians of art work with abstract and realistic paintings. Both are interesting but for very different reasons. Economic historians remain committed to facts embedded in theory from which they derive consistency (Clark 2008).

For example, Maddison's imaginative guess expressed in numerical form that GDP per capita income at the time of the Han Dynasty might plausibly or arguable have been equivalent to a World Bank estimate of third world poverty. For our own times of 450 dollars in 1990 prices does not match with his text when transposed into kilocalories – *vide* Column 6 of the table. Nevertheless, that number might, *prima facie*, be rescued by the argument that while a majority of the population subsisted on 2100 kilocalories per day a minority owning land, capital or enforcing rights to appropriate taxes or to expropriate tribute taxes, extracted a surplus of somewhere close to 60% of the Han empire's GDP. In short the distribution of income in Han China might have been close to an "inequality possibility frontier" (Milanovic et al

2007). That possibility cannot be ruled out *ab mitio.* Nevertheless, the political and logistical conditions required for surplus extraction on the scale and regularity required to support Maddison's bold guess for GDP per capita under the Han were not present in ancient empires (Bernholz and Vaubel 2004; Yun-Casalilla and O'Brien 2012). Furthermore, almost no support can be found in historical literature to suggest that Han China was a society characterized by high degrees of inequality (Wang 2007, pp. 162-74, 278-99). Maddison's imaginative numerical speculation for the empire's base line level of per capita income is not consistent with the analytical narrative based upon numbers that he constructed to analyse more than two million years of Chinese history (Maddison 2007).

Perhaps our overtly sceptical stance towards an index designed to expose trends in levels and rates of growth in China's GDP per capita which are ostensibly measured and expressed in 1990 International Dollars for such a long span of time might be further clarified with reference to the figures reported in Table 1 for 1990 and 1490. For this "thought experiment" let us set aside as potentially reparable the real problems Maddison encountered in converting imperfect quasi-official estimates for GDP available for 1990 and the biases and ambiguities now clearly exposed by the 2005 and 2011 exercises for the construction of a viable exchange rate to measure the purchasing power parity of the *yuan* (and multiple other currencies) in International Dollars for those same years (World Bank 2008). Even with more acceptable purchasing power parities major ontological questions will remain. For example, what exactly could a number of around 600 International Dollars or thereabouts for modern times reveal about the global status of the imperial economy and the standard of living it afforded for its population back in 1490? Have our own contemporaries – i.e. families residing in modern day China - enjoyed standards of living that could be represented by a multiplier that *prima facie* suggests that their current standards of living amount to little more than three times the average level of material welfare afflicting their ancestors ruled by the Ming Dynasty?
Did the "Confusions of Pleasure" experienced by wealthy urban Chinese in late Ming times rest on levels of agrarian productivity that provided surpluses way above the levels prescribed for food security for that empire's population? (Brook 1998) Did those levels exceed the levels of production and consumption provided by other Eurasian economies when Columbus set off on his voyage of discovery? According to Maddison's metric and calculations the gap in per capita income at that conjuncture in Eurasian history was around 170 International Dollars (Maddison

2001). To measure divergence at that momentous point in history he had manufactured an estimate for Europe of 771 dollars and another for Ming China of 600 dollars utilizing 1990 purchasing power parities between the *yuan* and a weighted average of European currencies. But his estimates lack not only statistical reliability but conceptual meaning because the relative standing of the Chinese economy and the material welfare of its population measured and ranked according to the international power parity of the *yuan* for 1990 might bear little or no resemblance to its position in the world 500 years earlier. That position could only be established by an exercise designed to convert the currencies of the world by rates of exchange based upon the relative prices and volumes of output for goods and services generated by the technological and production possibilities and preferences that pertained in Ming times (Prados De La Escosura 2000).

Furthermore, libraries of theoretical and empirical literature on the properties of index numbers agree that highly significant variations can and indeed have occurred in the measurement of GDP and GDP per capita between calculations that endeavour to quantify and compare either standards of living (or values of national outputs) in the prices and volumes for periods separated by anything longer than rather short spans of time (World Bank 2013). As Simon Kuznets and Moses Abramovitz told us years ago these conceptual problems are evaded, not solved, by arithmetical or geometric averaging of deflators based on different sets of prices (Abramovitz 1959; Kuznets 1981; and Usher 1968). Of course, their modern economy provides much more by way of goods and services for Chinese citizens in 1990 than in 1490. Just how much more depends not only upon how appropriately and accurately GDP is defined and measured in current prices for both years but also upon changes to the structures of production and the composition of consumption over such a long span of time and statistically on the capacities of price deflators to capture profound discontinuities in technologies for production and the emergence of both new and superior goods and services.

Even if familiar conceptual and statistical problems involved in the definition and measurement of GDP could be taken as unavoidable the meaning and heuristic purpose of a number representing per capita GDP for 1490 denominated in International Dollars – based upon the international purchasing power parity of the *yuan* for 1990 remains difficult to comprehend. Has Maddison's appealing run of ostensibly comparable index numbers circumvented familiar problems of deflating estimates for GDP in current prices into constant prices for the measurement of

growth, stasis or regression in national production or welfare (Abramovitz 1959)? Or, is not the case that Maddison's procedures for the deflation of China's GDP have generated conceptually ambiguous numbers (Usher 1968)? By 1990 Chinese families were purchasing a volume, range and quality of commodities and services that could be represented as either uniquely modern or obtainable at prices that placed them, or conceivable substitutes for them, way beyond the reach of their ancestors alive in 1490.

This point embodies nothing more than a thought experiment that refers to the familiar Geschenkron effect of measuring changes in the volume of goods and services that over time have improved significantly in quality and performance while declining in price (Gerschenkron 1966). That effect has been explored by classic articles on the long run costs of health, travel and artificial light music and other hedonistic attributes of goods and services purchased by modern populations. The problem has been a constant preoccupation for statisticians engaged with the construction of deflators to measure changes in the costs of living and rates of growth for GDP. Recent discussions among economists show these problems are compounded and not solved by the deployment of numbers expressed in International Dollars for modern times to measure anything other than depressingly short term changes in average levels of welfare and volumes of production (World Bank 2013). Ontologically it remains difficult for philosophers and historians to conceive of models or fictions whereby a modern Chinese might be persuaded to take a time train back to the era of the Ming for an annual income that was anywhere near as low as her annual income of 1871 International Dollars for 1990 (vide Table 1).

Valid statistics collected and calibrated with improved precision into International Dollars do help a Chinese, Indian or American to formulate a reasonably clear and accurate perception of where their economy and income stands in relation to other economies and populations elsewhere in the world at the present time. Extrapolated backwards to include pre-modern classical centuries (let alone pre-historic eras) such numbers or indices expressed in modern International Dollars provide them with virtually no conceptions of the relative scale and efficiency of China's imperial economy in times long past or with any convincing way of informing a modern Chinese just how much better off in material terms she could be compared to her ancestors. Mutatis mutandis these widely cited macro economic indicators have not and cannot provide economists or economic historians with access to the body of

statistical date that they so ardently desire in order to publish in ways and journals that cling to Kuznetsian and derivative paradigms for the study of long run economic growth. For pre-modern statistical "dark ages" that paradigm may be degenerate and should be reformulated in ways and along lines that could include more illuminating, transparent and available economic facts such as kilocalories or measures of the exceptional standards of living enjoyed by tiny populations residing in favourably endowed micro-spaces such as the Huating-Lou area of the Yangzi Delta. Such facts might travel to link the past with the present in impressionistic and confined but more realistic ways (Li 1998; Li and van Zanden 2012). Maddison's endeavours are heroic but heuristic failures that leave us with the question of how far the paradigm for research he recommended can be realistically pursued? Meanwhile there is no warrant for facts to travel in the direction of convenient, consoling and publishable abstractions. And it might well be regarded as "Eurocentred" to ignore debates among Chinese economic historians about the evidence available for an empirical tradition in economics.

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