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The Kuznetsian Paradigm for the Study of Modern Economic History and the Great Divergence with Appendices of Literature Review and Statistical Data

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1. Historiographical Context

After twenty-odd years of lively discourse the Great Divergence Debate should be credited with establishing a view among economic historians that the organic economy of Imperial China may be represented as being more economically and technologically advanced in pre-industrial times, than the cluster of national economies located within the frontiers of modern Western Europe. Only late in the day did that interconnected group of countries evolve to become scientifically, technically, economically and geopolitically the most developed and powerful in the world.[1]

Thus, the recent debate has been concentrated on the meta question of when, how and why the Western economies led by Britain, became clearly more efficient than the economy of Imperial China.[2] Since these two regions of Eurasia had remained virtually disconnected for centuries preceding this discontinuity**,** narratives in modern global history could include a short chapter on their limited inter-connexions and remain concentrated on two contrasting trajectories for long-run economic growth.[3]

The core question to debate is why one historical trajectory led to the observed and more rapid development of western economies, while for the past three or four centuries the other has exhibited pronounced retardation and relative decline. Either way, and within a world economy of increasingly extensive and intensive geopolitical and economic connexions (including commerce and competition between Europe and Asia) the relative position of China deteriorated. That economy's retardation continues to be explained with reference to the maintenance of a traditional political system for the governance of a vast territorial empire, archaic institutions, conservative

[1] Pomeranz, 'Without Coal'.
[2] Daly, *Historians Debate.*
[3] Vries, *State.*

beliefs and backward technology, which for centuries placed China's organic economy upon a trajectory leading to avoidable stasis and a prolonged widening of divergence with the West.[4]

The core of the modern revisionist rejection of this view (which provoked a vigorous counter attack) can be read in the writings of the California School of Historical Sociology. The School has formulated, fortified and defended a now famous thesis that for several centuries before the French and Industrial Revolutions, the economies of Western Europe and China operated in ways that look similar. Supporters of 'surprising resemblances' maintain that the supposedly superior and more efficient political systems, cultural beliefs, economic institutions and technologies of Western European nations had not generated anything approximating to clear differentials in the productivities of labour and standards of living for their populations that are the hallmarks of more advanced and progressive economic systems.[5]

The unsettled dispute over a chronology for contrasts in per capita levels of welfare provided by the Chinese economy for its population compared to European standards forms an essential preface to any serious discourse about divergence that aspires to the recognized as persuasive.[6] If acceptable statistical evidence could be assembled, dated and compared the respective historical trajectories for the national economies of Western Europe and China could be located and compared across space and through time. Macro-economic indices could be deployed to 'test' the plausibility of the basic revisionist arguments deployed by the California School to undermine Eurocentred/Weberian views that divergence had occurred because the framework of cultural beliefs and institutions surrounding production in Imperial China had evolved historically to support a trajectory for long-run economic progress that could be represented as negative for the structural changes and innovations leading to modern industrial market economies.[7]

Western economists and economic historians have not been slow to respond to the challenge to provide both theoretically plausible reasons as well as statistical evidence to undermine the critique that their perceptions of late Imperial China are superficial and Eurocentric. Predictably they have subjected core theses of the California School to the heavy artillery of standard tests deployed by economists and economic historians to quantify rates of growth and relative levels of welfare provided by national economies for their citizens.[8]

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[4] O'Brien, *Economies*.
[5] Parthasarathi and Pomeranz, 'Debate'.
[6] Roy and Riello, *Global Economic History*.
[7] Vries, *State Economy*.
[8] Van Zanden and Ma, 'Maddison'.

This programme of historical research continues to uncover statistical evidence that has been heuristic to contemplate, compare and elaborate upon for economic historians of Imperial China and Western Europe. It has matured into a major example of the paradigm established decades ago for the study of national economic histories, empirical economics and the application of comparative methods for global histories of long-term economic growth by a Nobel Prize winner in Economics, Simon Kuznets.[9]

The Kuznets' paradigm for the study of national and comparative trends in the long run economic growth of nations explicitly recommends a conceptual framework (national accounts) and a methodology for quantification which has involved generations of economists and economic historians in the collection and calibration of data that could be validated as sufficiently reliable for the construction of a series of estimates for GDP's of Western economies. These disciplined endeavours have involved:

1. The measurement of the net annual values of outputs emanating from the primary, secondary and tertiary sectors of national economies.
2. The aggregation of these outputs into a series of annual estimates of gross domestic products available to be divided by accessible and more or less secure statistics for national/imperial populations in order to measure trends and cycles in GDP per capita.
3. The construction of price indices and purchasing power parity rates of exchange in order to convert estimates for GDP from current into constant prices and an appropriate numeraire to facilitate:

(a) The measurement of trends, and (if possible) cycles in growth over time;

(b) Cross-country comparisons that quantify the relative capacities of national/imperial economies to supply commodities and services for their populations and revenues for their states over selected periods in history.[10]

The plausibility of the results flowing from this productive paradigm for historical research depends upon: the availability, accessibility, volume and quality of statistical evidence as well as the methods and concepts adopted by scholars who have been engaged with the construction of indices designed to measure and compare China with Western Europe. For example, relative levels of GDP per capita, real wage rates and the family incomes for Chinese peasants and landless

[9] Kuznets, *Growth Rate*; Fogel, *Political Arithmetic*; and Floud, *Britain and Europe*.
[10] Kuznets, *Growth Rate*; and his *Growth of Nations*.

workers compared with incomes derivable from wages payable to unskilled labour employed in the construction industries of European towns.[11] At present it looks as if this hard won and transparent body of statistical evidence has undermined the thesis of the California School that contrasts in productivity and welfare between the economies of late Imperial China and Western Europe had not occurred before the late 18th century, and divergence cannot be explained with reference to any longer term contrasts with institutions for the management of Imperial China's organic economy.[12]

Chronology remains central to the revisionist argument that Europeans and Chinese lived and worked in a world of surprising resemblances until late in the eighteenth century because if it could be supported by statistical evidence, then the defects (posited by 'Weberians') in the culture, institutions and above all, in the constitution of the state established and maintained over many centuries for the management of a very large imperial economy are no longer tenable.[13] Furthermore, this Sinocentred chronology supporting an analysis that Europe's convergence towards an ultimate divergence from China also becomes more logical to represent as the outcome flowing from a range of contingent factors. They included: natural endowments of a new and eventually highly significant source of energy, namely coal; the discovery and gradual exploitation of a massive bounty of natural resources in the Americas; and the unintended consequences of interstate rivalry, mercantilist competition and protracted interludes of warfare that emanated from Europe's failure to construct and sustain an hegemonic state to rule and regulate the fragmented economy of that sub-continent.[14]

A brigade of distinguished scholars with credentials in European economic history aided and abetted by a platoon of economists educated at western universities have continued to maintain that their representations and calibrations of data sets for Imperial China demonstrate that divergence occurred much earlier than the eighteenth century.[15] We find, however, that the statistics utilized by *both* sides in this debate will not wash.[16] As most historians in touch with the primary sources utilized for macro-economic measurement have recognized (even for European economies with archives of official data available for their construction) indices that are reliable enough to support plausible conjectures for rates and relative levels of economic development

[11] Deng and O'Brien, 'Debate'.
[12] Berg, *Writing the History*.
[13] Goldstone, *Why Europe*; van Zanden and Ma, 'Maddison'.
[14] Rosenthal and Wong, *Before and Beyond Divergence*; and van Halte, 'Escaping the Great Divergence'.
[15] Van Zanden and Ma, 'Maddison'.
[16] Deng and O'Brien, 'Debate'; 'Statistical Foundations'; and 'GDP per Capita'.

have been difficult to construct. On close examination they have often turned out to be less than durable.[17] For Imperial China, even the most basic evidence required for the construction of plausible conjectures for a total population, areas of land cultivated and cropped, nominal daily wage rates, outputs of major crops and industrial commodities, the volumes of exports, imports and internal trade expressed in standardized or standardisable moneys of account are simply not available.[18]

Our investigations into the data utilized by both sides in the Divergence Debate has reluctantly concluded that the application of the Kuznetsian paradigm for historical research designed to locate the conjuncture in premodern history when divergence between Imperial China and Western Europe emerged, persisted and widened is not viable. As Karl Popper might say for this particular debate, the paradigm is degenerate. Its status approximates to conceptual art in the history of art and as such is convincing only to those who claim the impressions conveyed by their constructed numbers are historical 'facts' that approximate to the explicanda required for analytical narratives of long-run growth.[19]

2. Primary and Secondary Sources for Kuznetsian Economic Histories of Imperial China

Undaunted by the paucity and quality of primary sources as well as the complexities involved in the construction of purchasing power parity rates of exchange for historical comparisons across continents, our colleague Stephen Broadberry with two Chinese co-authors (Hanhui GUAN and David Daokui LI) have ventured to publish a series of estimates for the GDP per capita for Imperial China from the Song to the Qing Dynasties – 980 to 1850. For purposes of comparison with western economies they have converted the series into 1990 international dollars.[20]

We applaud their ambition and welcome the opportunity to engage in a discussion with them on the evidential basis for an extension of the Kuznetsian paradigm for historical national accounting, to include Asian economies in general and to provide statistics for a chronology and explicanda that could reconfigure the unsettled debate on the Great Divergence between Imperial China and Europe in particular.[21]

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[17] Speich, 'Global Abstraction'; Jerven, 'Unlevel Playing Field'; Boldizzioni and Hudson, *Handbook*.
[18] Deng and O'Brien, 'Maddison Was Wrong'; Hatcher and Stephenson, *Unreal Wages*.
[19] Vries, *State Economy*.
[20] Broadberry, et al., 'Divergence'.
[21] Goldstone, 'Data and Dating'.

Now that the results of a Kuznetsian endeavour by Broadberry, Guan and Li (hereafter BGL) have been published and prefaced by an understatement that the data available for the vast and complex economy of Imperial China is 'not as abundant as British data' we decided to elaborate and update the view we had formed, circulated in working papers and published as articles in three journals.[22] Briefly it stated our view was written to defend a traditional historiography which maintained that the primary statistical sources available for the construction of estimates of GDP per capita for Imperial China (even for so-called 'normal' years of Ming and Qing rule) are not sufficient in quantity, scope or quality to support claims for a macro-economic framework for the analysis of the empire's long-run development from 1400-1840.[23]

Our response to BGL's laudable endeavour would probably not, moreover, surprise political historians who are familiar with the complexities of governing empires of the size and geographical diversity of Ming and even more of Qing China.[24] Historians of pre-modern China recognize Chinese dynasties reigned rather than ruled over their empires. They lacked the fiscal resources, administrative capacities and access to technologies to govern such extensive and diverse areas of territory and the ethnically heterogeneous populations living within the vulnerable frontiers of their empires.[25] The statistical information that the State managed to collect could only have covered confined regions and localities of the polity. Data were only acquired sporadically. Statistical information available to China's imperial regimes must have been subject to more significant margins of error than the data acquired by the altogether smaller and more governable polities of western Europe.[26]

Nevertheless, BGL consulted an impressive bibliography of modern secondary literature on the economic history of Imperial China (including printed and edited collections of primary sources) published in Chinese and English over the last 60 years. The authors have somehow managed to recover and calibrate a sufficient volume of statistical data to publish estimates that *prima facie* appear to satisfy the core prescription of the Kuznetsian paradigm for writing economic histories based upon national accounts: to 'quantify the quantifiable.'[27]

[22] Deng and O'Brien, 'Debate'; Statistical Foundations'; 'GDP per Capita'; and 'Maddison Was Wrong'.
[23] Eckstein, *Economic Trends*; Feuerwerker, 'Presidential Address'.
[24] Emigh, et al., *Antecedents*.
[25] Deng, *Premodern Chinese Economy*; Jones, *Growth Recurring*; Elvin, *Pattern*; Fairbank and Liu, *Cambridge History*.
[26] Emigh, et al., *Antecedents*; Yun-Casallila and O'Brien, *Fiscal States*; von Glahn, *Economic History*.
[27] Kuznets, *Growth of Nations*, p. 16.

Explicitly and implicitly BGL have also endeavoured to reassure fastidious historians that Asia like early modern Europe was 'more literate and numerate than is often thought and left behind a wealth of data in documents.'[28] Unfortunately relative levels of literacy and numeracy for Ming and Qing China compared to Western Europe have not and probably cannot be measured.[29] While the 'wealth of data' included in the authors list of 'European documents' and compared to a list of 'Chinese' data sources do not equate to a procedure for the validation of the type and quality of statistical evidence that they used for the construction of a historical sequences of macro-economic estimates for domestic production.[30] We retain our view that the primary sources available for Ming and Qing China do not allow for the construction of estimates that could refer to or represent either rates or relative levels of growth for the Imperial economy as a whole.[31]

We recognize that BGL made a real effort to consult the current bibliography of published secondary and printed primary literature that might contain statistical evidence for the compilation of historical accounts for Imperial China. We will, however, suggest that their validation of that evidence does not (as we read their paper) seem to have been sufficiently critical. For example, merely listing sources that contain statistics is not a procedure for verification. Historians of Imperial China long been aware that most documents collected for the governance of the empire were systematically destroyed with each and every change of dynastic regime after its official history had been written by 'historians' employed in the service of a successor regime seeking legitimacy for a mandate to rule China. Thus, however efficiently or inefficiently official statistical information may have been gathered in order to administer policies for the empire the records for dynasties**,** apart from records for the Qing regime were to repeat destroyed.[32]

Furthermore, records that fortunately survived are unlikely to be either imperial in scope or to include statistics that might serve as proxies for the 'plausible conjectures' that historians could recognize as viable enough for the calibration of evidence required to compile imperial accounts for annual outputs emanating from primary, secondary and tertiary forms of domestic production in current and constant prices that could be converted into conceptually valid values denominated

[28] Broadberry, et al., 'Divergence', p. 957.
[29] Deng and O'Brien, 'Standards of Living'.
[30] Broadberry, et al., 'Divergence', pp 959-62.
[31] Deng and O'Brien, 'Debate'; 'Statistical Foundations'; 'GDP per Capita'; and 'Maddison Was Wrong'.
[32] Zan and Deng, 'Micro Foundations'.

in some globally accepted currency or commodity that represents their purchasing power parity values on markets for national currencies in pre-modern times.[33]

Several features of the imperial state and the economy help to explain the paucity of historical statistics that are available for Imperial China.[34] Sooner or later dynastic regimes confronted the omnipresent political and technological constraints of ruling over and taxing an extensive territorial and ecologically varied empire with long and vulnerable frontiers containing populations that were ethnically and culturally diverse. Contexts of time, place and political prudence confined their role in the management of a polity of interrelated but less than integrated local economies dominated by household units for the organization of production, to relatively low rates of fiscal extraction and expenditure.[35] Taxation accompanied by bouts of predation were normally sufficient to maintain regime stability, internal order, external security and social relief from disasters**.** While demands on the state for higher and more active levels of involvement in the economic affairs of the empire remained at tolerable levels of political pressure from a population growing slowly. Incentives and pressures on the imperial state to acquire statistical information about China's economy and society were altogether weaker than those operating among the mercantilist and warring states of Western Europe.[36]

Various historians of Imperial China do not regard the volume, range and quality of statistical records to be remotely comparable to those available to their colleagues who specialize on the polities of medieval and early modern Europe.[37] Furthermore, a survey of the bibliography of books and articles published in recent decades on the economic history of the Chinese empire will, we also suggest, expose the understandable frustrations of their colleagues with ambitions to write modern Kuznetsian-style economic histories of the empire.[38] After all they are now writing at a time of accelerated globalization when China (and India) are regaining their historical status as advanced economies. BGL's ambition has, moreover, almost certainly been fuelled by an expectation that as a 'way of knowing' Kuznetsian analysis is superior to more traditional methods on display in the Cambridge and other histories of China (and India).[39]

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[33] Vide our debate with van Zanden and Ma, 'Maddison' versus Deng and O'Brien, 'Statistical Foundations', and 'GDP per Capita'.
[34] Wong, *China Transformed*; Li, 'Economic History'.
[35] Yun-Casallila and O'Brien, *Fiscal State*; Liu, 'Vision'.
[36] Deng, *Political Economy*, Pt 1; Brook, *Chinese State*; Dincecco and Onorato, *From Warfare to Wealth.*
[37] Ge, et al., 'Farmland Resources', Zhong, 'Quantitative Estimates'; Peng, 'Long-term Changes'; Peng, 'Prices'; Yang, 'Tang Records'; Shi and Ma, 'Yield per Mu'; Wang, 'Summary'; Liu, 'Maddison'; Liu, *Total GDP*; Wei, 'Reality and Fairy Tale'; Ni, 'China's Total GDP'.
[38] Ibid.
[39] Fairbank and Liu, *Cambridge History*; Raychauduri, et al., *Cambridge History.*

BGL were certainly aware of the scale, scope and quality of the data at their disposal and they have dealt with the problem in three distinct ways. First, they have attempted to reassure their readers about a 'wealth of data' available in primary sources.[40] Secondly, they adopted the margins of error technique deployed by the distinguished Harvard economist and sinologist Dwight Perkins who attempted to produce an acceptable series of statistics for the empire's population and agricultural output fifty years ago.[41] Thirdly, in emulating the Perkins' example three scholars (with recognized distinctions in disciplines other than Chinese history) have awarded their own 'reliability grades' to statistics that they represent as quantified estimates for domestic, primary, secondary and tertiary production for benchmarked but 'normal' years of Chinese imperial history under the Northern Song, Ming and Qing dynasties. Their numbers are expressed in current and constant prices as well as 1990 international dollars, decade by decade, from 980-1850. The grades they awarded themselves range from A ('firm figures') to D ('conjectures') are derived from: 'error margins' (*pace* Perkins) and 'comparisons with alternative series by other authors and by taking account of fluctuations in the underlying data.'[42] This procedure of 'subjective' data validation has not, however, been based on close engagement with an entirely limited range of official primary sources that refer to the empire as a whole.

In general, the foundational evidence for their estimates has been derived in large part from a historiography of secondary literature (books and articles) published by professional economic historians of Imperial China. In search for statistics that referred to the empire, Chinese historians too have also grappled as best they could with a restricted volume of unreliable official data for macro-economic measurement.[43] Much of this secondary literature (referred to by BGL as 'credible' and which contains statistical evidence) is based upon a body of unofficial publications (gazettes and private histories) that tend to be unambiguously provincial, prefectural, county and even more local and spatial in their focus. It is rarely the product of properly designed and executed local surveys. According to Zhai's unpublished research the statistics in these sources often consist of numbers copied repeatedly from reports written from time to time by Mandarins to inform the central government that economic conditions in more or less remote parts of a rapidly expanding territorial Qing empire are satisfactory.[44]

[40] Broadberry, et al., 'Divergence', p. 957.
[41] Perkins, *Agricultural Development*; Broadberry, et al., 'Divergence', pp. 957, 979-81.
[42] Broadberry, et al., 'Divergence', pp. 979-8 and appendices published online, pp. 50-62
[43] The first published attempt was made by Chung-li Chang, an American trained economist, in his study of China's gentry class; see Chang, *Chinese Gentry*. His bold, but primitive, methods have inspired many works including those by Perkins, *Agricultural Development* and Zhao, et al., *Grain Yield*.
[44] Zhai, 'Economic Performance'.

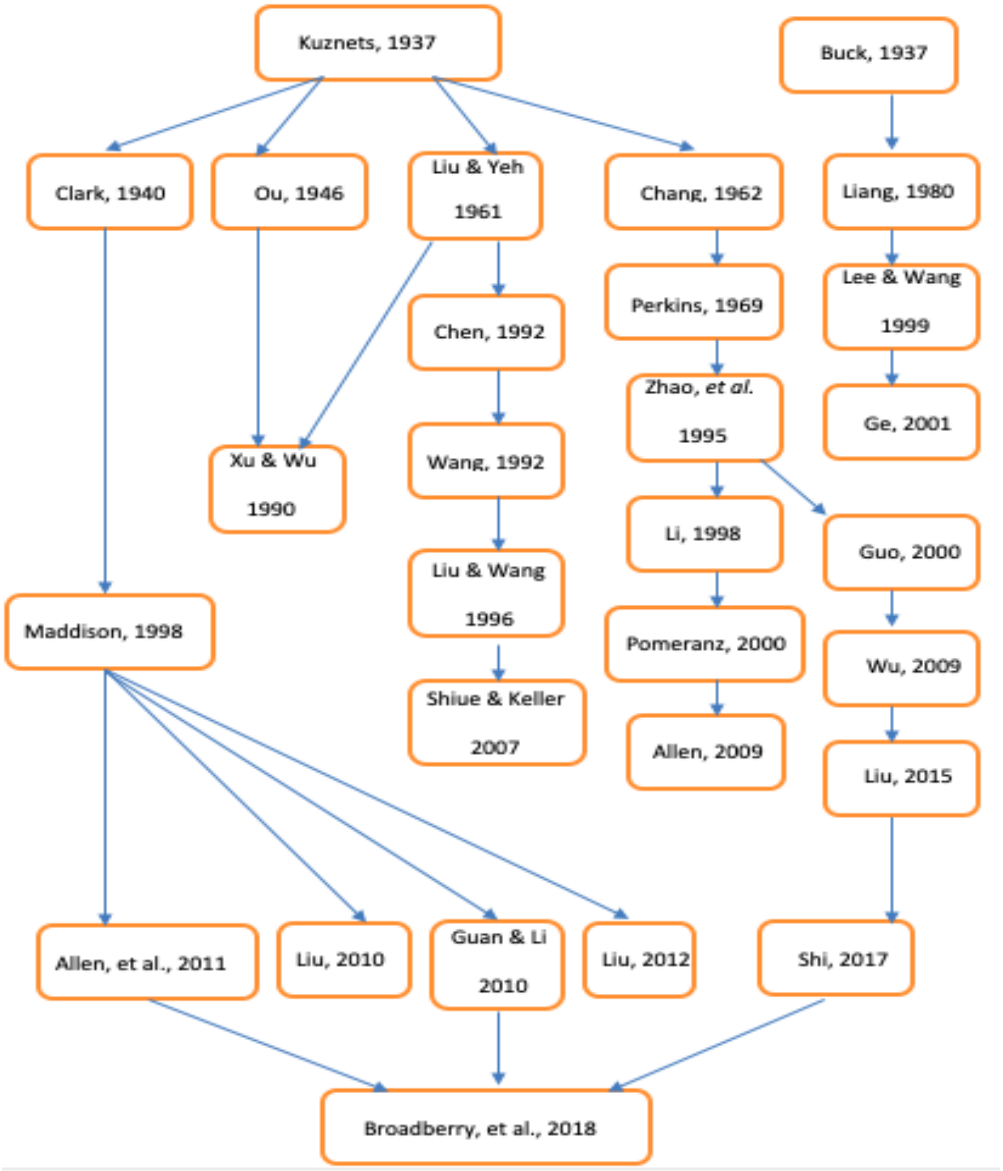
To sum up: It is our perception that in an endeavour to find quantitative evidence that might conceivably refer to Imperial China as a single macro-economic unit BGL confronted insoluble problems of validating the nature and quality of data that they utilized. They have also found it necessary to make claims for statistics that are geographically confined in reference but have been aggregated and refined into macro-economic statistical evidence that purports to refer to the vast complex and diverse economy of Imperial China.

In order to gain acceptance for their calibrations of this evidence they have conceded that 'some data from official historical literature suffers from inaccuracies and biases'.[45] The ways and degrees that is the case is not, however, analysed. Instead they add a confident assertion that 'Chinese economic historians have drawn upon other (again unspecified) sources to publish adjusted data.' We do appreciate that a major feature of Kuznetsian economic histories consists of statistical evidence derived from refinements to imperfect primary sources until a consensus emerges around a range of 'plausible conjectures.' Nevertheless, along with most other students of Imperial China, we are not convinced that the state and status of the secondary literature published over the past sixty years includes anything like the range of canonical publications required for the construction of a plausible set of benchmarked estimates aggregated to represent acceptable conjectures for trends and levels in the empire's GDP from 980-1850. In his historiographical survey of the field Li Bozhong states that 'We don't really know what the economy looks like as a whole.'[46] Li resists the temptation to generate imperial national accounting for China.

As we read it the secondary literature that BGL rely upon for statistical evidence for their estimates will not stand up to examination for reasons we elaborate upon in detail in sections 3 to 5 above. Meanwhile we conclude this section with an illustrative genealogy of Chinese and Western scholars who have also published macro-economic statistics (both with and without qualification) that purport to refer to an Imperial Economy (Figure 1).

[45] Broadberry, et al., 'Divergence', p. 961.
[46] Li, 'Economic History in China', p. 304. Also, see Ge, et al., 'Farmland Resources', Zhong, 'Quantitative Estimates'; Peng, 'Long-term Changes'; Peng, 'Prices'; Yang, 'Tang Records'; Shi and Ma, 'Yield per Mu'; Wang, 'Summary'; Liu, 'Maddison'; Liu, *Total GDP*; Wei, 'Reality and Fairy Tale'.

Figure 1. Two Genealogies of Quantitative Approaches to the Economic History of China



Sources (by date of publication): Kuznets, *National Income*; Buck, *Land Utilization*; Clark, *Economic Progress*; Ou,[47] 'New Estimate'; Ou, *National Income*; Wu, *China's National Income*; Liu, *China's National Income*; Liu, 'Structural Changes'; Liu and Yeh, 'Preliminary Estimate'; Chang,[48] *Chinese Gentry*; Perkins, *Agricultural Development*; Liang, *Dynastic Data*; Xu and Wu, *Capitalist Development*; Chen, *Market Mechanisms*; Wang, 'Rice Prices'; Zhao, et al., *Grain Yield*; Liu and Wang *Market Development*; Li, *Agricultural Development*; Maddison, *Chinese Economic Performance*; Lee and Wang, 'Malthusian Models'; Guo, 'Food Production'; Pomeranz, *Great Divergence*; Ge, *Demographic History*; Shiue and Keller, 'Markets in China'; Allen, 'Agricultural productivity'; Wu, *Quantitative Issues*; Liu, *Chinese Market Economy*; Allen, et al., 'Wages'; Liu, *China's Total GDP*; Guan and Li, 'China's GDP'; Liu, *GDP and Economic Growth*; Shi, *Development and Underdevelopment*; Shi, *Agricultural Development*; Broadberry, et al., 'Divergence'.

[47] Pao-San Ou is also known as 'Wu Baosan' in Mandarin.
[48] Chung-li Chang is also known as 'Zhang Zhongli' in Mandarin.

Prima facie, there are two genealogies that exemplify quantitative approaches to the economic history of Imperial China. The first can be ascribed to the enduring influence of Simon Kuznets' who invented historical national accounting in the 1940's. The second originated with John Buck, the American agro-economist who in the 1920's carried out the first scientific survey of China's farming sector and produced hard data. Unfortunately, the methods pioneered by Buck have been less influential than the approach favoured by 'Kuznetsians'. Kuznets himself never studied China. His followers – namely Colin Clark, Pao-san Ou (or Wu Baosan), Ta-chung Liu, Kung-chia Yen, Angus Maddison and BGL - have not shared his respect for the need to comprehend and validate data from reliable primary and secondary sources for the measurement of GDP. Instead, they have circumvented an insurmountable problem by reconstructing and refining each other's educated guesses and subjective impressions into ambiguous and misleading proxies for the statistics required for the measurement (and analysis) of China's production, incomes and consumption.

Three examples of this influential but egregious tendency found in publications by Chung-li Chang (or 'Zhang Zhongli', according to the Mandarin spelling) are summarised in this paper and elaboration in detail in appendices to this paper. Chang manufactured a database of macro-economic statistics that purports to refer to the Empire as a whole from a scattered chronology of numbers and anecdotal evidence that he found in eighty-three local gazettes. He refers to just 4% of the ecologically diverse and almost certainly unrepresentative counties included in the Qing empire. Needless to say Chang's 'numbers' are open to criticism. Another more example is Guo Songyi who cited six sporadic observations of farm outputs for benchmark years for the Ming Period (1368-1644). Guo's data refer to the Lake Tai Region which included 8 prefectures governing 51 counties.[49] He went on to create another set of benchmarks that were also based on six sporadic observations, for the Hu-Guang region that included 16 prefectures.[50] Guo's calibrations include figures for double cropping and New World crops (maize and sweet potatoes) as well as figures based on the assumption that rent amounted to 50% of gross output. He asserts that average China-wide yield levels per *mu* rose from 240 catties to 256 catties, and to 319 catties for the early Ming, late Ming and late Qing, respectively. His assumption about rents is incorrect. In the Ming-Qing period, a fixed rent based on the first crop (main crop) was widespread. Furthermore, Guo's benchmark years make no allowance for crop failures that probably occurred

[49] Guo, 'Food Production'; Deng and O'Brien, 'Nutritional Standards', p. 241.
[50] Guo, 'Food Production'.

every third year.[51] Our third example is the book published in both English and Chinese by Shi Zhihong in 2017 which we examine in detail in our working paper Section 4.

3. Areas of Cultivated Land Allocated to the Production of Grains in Ming-Qing China

Section 3 is devoted to an altogether more detailed critique of the methods, sources and assumptions adopted by BGL for the estimation of trends in the nominal values, volumes and relative levels of grain output produced by the agricultural sector of the Imperial economy 1400-1840. We have set aside the period 980-1400 and concentrated on their estimates for grains. Rice, wheat, barley, millet, corn, potatoes and sorghum constitute roughly half of their estimate for net value added in current prices of Imperial China's gross domestic production for 1840. Furthermore, we also observe that the range of ostensibly hard statistics cited by BGL as 'firm' or 'good' figures for net values added for cash crops and other primary products are derived as mark-ups at a constant ratio of 20% on their ostensibly measured output for grains. A similar resort to mark-ups on figures designated as derivable from grain output also generated estimates for components of BGL's estimates for net values added of the industrial and service sectors for 1840.

BGL recognized that the 'groundwork for this mode of estimation was laid by Perkins who drew upon the work of Chinese and Japanese scholars to derive 'adjustment coefficients' applied to official but highly imperfect primary sources for Ming and Qing China.'[52] They did not mention that Perkins published two sets of estimates calibrated with different data to measure trends and levels of grain output for Imperial China. One was based his selection of estimates for the size of the empire's population to which Perkins attached 'subjective margins of error' which he multiplied by a constant of 527 catties of (unhusked) rice per capita. He offered both numbers as a transparent and plausible way to construct a long run series of estimates that might conceivably represent trends in the volume of grains produced by the empire's agricultural sector. Perkins obtained his 'impressions of grain output *per capita*' from data published by Buck and several other historians. He noted their estimates seldom fell below 360-480 catties or rose above 700 catties.'[53] Alex Eckstein, another economist with credentials as a sinologist, considered the construction of such estimates to be impossible.[54] Perkins conveyed commendable hesitations about the whole exercise of multiplying contested data for China's total population by a constant volume of rice

[51] For the frequency, scale and scope of natural disasters, see Fairbank and Liu, *China*, vol. 11, pt. 2, p. 7; Perkins, *Agricultural Development*, p. 172; also Buck, *Atlas*, pp. 30–1.
[52] Broadberry, et al., 'Divergence', pp. 965-69.
[53] Perkins, *Agricultural Development*, pp. 308-10.
[54] Eckstein, *Economic Trends*.

equivalents representing educated but subjective and configured impressions of a modal but unchanging level of *per capita* consumption production of grains for 1368-1850. Transparency does little, however, to alleviate scepticism towards this way measuring trends in the production of food grains. It simply begs the question?

For their purposes BGL sensibly decided to concentrate on an alternative and complementary sequence of exercises (also initiated by Perkins) to construct estimates of the area of Imperial China's land cultivated with food grains multiplied by estimates of averaged annual yields for food grains converted to rice equivalents.[55] Unfortunately, neither the Ming nor the Qing state conducted comprehensive systematic cadastral surveys required to measure the empire's cultivated area of farmed land – 80% of which, according to Perkins, was sown with food grains – principally under rice and/or wheat. The only potentially relevant data available to estimate the area of Imperial China's land cultivated with grains are for farmland liable to taxation. Although land-owners had a legal incentive to register their property rights, fiscal and agrarian historians have recognized that a significant but virtually unmeasurable share of the empire's cultivated area legally and illegally avoided and/or evaded taxation. Furthermore, and apart from the aforementioned absence of empire-wide cadastral surveys, in 1712 by decree, the Qing emperor capped the total amount of the land tax to be collected at a permanently fixed sum of 30 million taels per annum.[56] This decree effectively diminished any need for the state to systematically and regularly measure the area of cultivated land liable for taxation at a time when the Empire's population and extensive margin of cultivated land potentially available for taxation was increasing rapidly.[57]

In line with Perkins and other scholars BGL proceeded to 'adjust' records for 'taxed units' of land in order to estimate the area of taxed land sown with grains.[58] In doing so they recognized another and altogether 'a more serious worry' – namely, the lack of a consistent standard for the measurement of areas of land. The Chinese *mu* which varied (and historians suggest varied significantly) 'between regions and over time'.[59] Their ad hoc solution to this familiar and significant problem for Chinese agrarian history is to assure readers that 'much effort has been devoted to documenting this variation' and to work in terms of Perkins' solution published (with

[55] Perkins, *Agricultural Development*.
[56] Zhao, *History of the Qing Dynasty*, vol. 11, p. 8853.
[57] Ibid., vol. 11, p. 8883.
[58] Broadberry, et al., 'Divergence', pp. 964-67.
[59] Ibid., pp. 966-67; Perkins, pp. 218-21; also Zhang, 'Ming Dynasty', p. 7981; Liang, 'Survey'; Shi, 'Yields per *Mu*', p. 55; Zhao, 'Technical Errors'. Note: 15 *mu* = 1 acre.

hesitation) some 50 years ago which was to define 'a standard *mu* as equal to a tiny plot of land of 1/15th or 1/16th of a hectare.'[60]

We intend to scrutinize the plausibility of the Perkins' solution when we discuss the multiplier selected by BGL to represent modal yields of arable land allocated to the production of food grains. Meanwhile we observe that agrarian historians of Imperial China continue to grapple with official statistics for taxed land which are distorted by textual errors, the inclusion of untaxed land, corruption and, above all, by the state's endeavours to tax progressively by grading and recording the empire's cultivated area in a unit for measurement that officially allowed for variations in the quality of the soil. To convert millions of *mu* recorded in that way for fiscal purposes requires local archives and complex manipulations of data that ceased to be collected after 1644 when the Qing regime decided to adopt its Ming predecessor's 'Fish-scale Land Tax Registration' (*yulin ce*) despite the fact that Ming regulations covered less than half of the territory of a vastly expanded Qing empire.[61] The Ming system was established in 1393 when that regime's Treasury recorded a total of 850.7 million '*mu*' of farmland as liable for taxation, compared to 387.5 million *mu* actually taxed in 1391. By 1426 the total area recorded as taxed was 412.5 million *mu*. Clearly imperial fiscal records display significant degrees of mismatch between taxable, taxed and cultivated land.[62]

Perkins, with help from a prior exercise published by Fujita, manufactured another run of 'most likely estimates' of 370 million *mu* plus or minus 70 million standardized/*shimu* for circa 1400; 500 million plus or minus 100 million *shimu* for circa 1600 and applied his *subjective* correction factor of 20% to arrive at figures of 666 million *shimu* for 1661 and 950 million *shimu* for the 1770s. He also worked with an improbable assumption that between 1685 and 1851 the area of cultivated land measured in standardized *shimu* grew in line with the fiscal *mu* of taxed land.[63] Apparently his primary sources do not refer to anything approximating to regular and systematic cadastral surveys, but seem to be based on nothing more accurate than often-unchecked statements made by local government representatives, with vested interests of their own.[64]

Our reading of Perkins in conjunction with other agrarian histories of China leads us to conclude that no simple or secure method has been devised that might allow historians to measure the total

[60] Broadberry, et al., 'Divergence', p. 966.
[61] Rice paddies look like fish scales in a bird-eye map, hence the name; see Zhang, *Ming Dynasty*, ch. 'Shihuo Zhi'.
[62] Liang, *Dynastic Data*, p. 8; Liang, 'Survey'; Shi, 'Yields per *Mu*', p. 55; Zhao, 'Technical Errors'.
[63] Perkins, *Agricultural Development*, pp. 127, 298.
[64] Sobel, 'Principle-Agent Problem'.

area of the empire's land *cultivated* with food grains between 1400 and 1840.[65] Furthermore, this is also the case for the empire's *cropped* area. Predictably and where ecological conditions were favourable as and when Chinese farmers confronted population pressures, they compensated for a 'Malthusian' decline in land labour ratios by producing more crops per year. According to Bozhong Li by the early 19th century farms in the Yangtze Delta had increased the ratio of cropped to cultivated area to an equivalent of 1.7 crops of rice per annum.[66] That ratio varied across the empire to a degree that makes it virtually impossible to construct acceptable estimates for either the areas or the yields per *mu* of imperial farmland sown with food grains.[67] There seems, moreover, to be no secure basis for 'contention from Guo or BGL that' doubling rent paid for access to arable land 'provides a good measure of crop yields'.[68] Needless to say historical evidence for farm rents is neither abundant nor anything but complex to interpret. Agrarian historians seem to agree that rents were in general levied on the first crop which implies that for most years of the Ming and early Qing rule, Chinese farmers operated under Malthusian pressures and incentives to maximize output from their diminishing access to arable land of high fecundity.[69]

Finally, there are serious issues concerning the data on market prices for food upon which several estimates as well as the purchasing power parity rate of exchange for 1840 depend.[70] For example, the heavily utilized monthly reports for grain prices only appeared as late as 1738. Their coverage was uneven across the empire and many never arrived in Beijing.[71]

As historians who support the Kuznetsian injunction to quantify the quantifiable, we have read no publications that convince us that this injunction has been acceptably followed by a sequence of calibrations that have produced estimates for either the cultivated or cropped areas of arable land sown with food grains between 1400 and 1840.[72] We also remain sceptical towards any estimates that 'reflect subjective judgment rather than formal statistical criteria;' particularly if they are published with an unsupported 'error range' which, for unspecified reasons, apparently progressed from 'plus or minus 20% in 1400 to 5% by the late nineteenth century.'[73]

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[65] Perkins, *Agricultural Development*, Appendix 13, pp. 226-36.
[66] Li, *Agricultural Development.*
[67] Deng and O'Brien, 'Debate'.
[68] Broadberry, et al., 'Divergence', p. 967.
[69] Deng, *Development versus Stagnation*, chs 4-6; Elvin, *Pattern*; Chao, *Man and Land*; Li, *Agricultural Development*.
[70] E.g. Chan and Kraus, *Mid-Qing*; Li, 'Integration'; Wang 'Secular Trends'; Cheung, *Price of Rice.*
[71] Lu and Peng, 'Grain Prices'; Yu, 'Data Quality'.
[72] Perkins, *Agricultural Development*; Chao, *Man and Land***;** Wang, 'Secular Trends'; Guo, 'Food Production'; Shi, 'Yields per *Mu*', and *Agricultural Development*; Broadberry, et al., 'Divergence'.
[73] Broadberry, et al., 'Divergence', p. 967.

4. Average Grain Yields per Standardized *Mu* of Farmed Land in Imperial China, 1400-1850

Our scepticism has been compounded by examining the basic data published by Perkins, Guo and Shi – data that BGL depended upon for the construction of estimates for weighted average yields of grains per standardized *mu* of farmland for Ming and Qing times.[74] BGL refer to a database of 900 recorded yields collected by Perkins.[75] Perkins clearly had grave doubts about this particular sample because (with characteristic caution) he selected only 12 figures for yields to represent a range of ecological locations and three centuries of Ming and Qing agrarian history 1500-1800. They range from 250-520 catties of unhusked rice per standardized *shimu*.[76] At his surmised wastage rate of 50% and with outlays on fertilizers asserted to be 15% of gross output, Perkins' data can be recalibrated into a net surplus and transformed into kilocalories produced and consumed by a peasant household farming 10 *shimu* of land. Our calibrations suggest that the kilocalories of food grains available for consumption would have fallen below the subsistence needs of a typical peasant family for food security.[77]

For the Ming period BGL also utilized data published by Guo who expressed dissatisfaction with Perkins' figures and somehow resolved the problem of standardizing the fiscal *mu* for the empire from local records.[78] For that purpose, Guo used a 'sample' of 37 rice areas in South China and eight localities in the North. He asserts that the fecundities of the areas of farmland covered by these sources and designated in fiscal units could be converted to a standardized *mu* by calibrations that are based upon his unverifiable *suggestions* that 10% of the farmed land covered by his sources consisted of land of low fecundity, 30% were of middling fecundity, 40% were of high fecundity and 20% were of the highest fecundity. Where Guo's rates for the standardization of *mu* came from is neither transparently explained nor justified? Nevertheless, they allow Guo to claim between 1400 and 1620 modal imperial yields increased by 17% to reach 148 kilogrammes per *mu*.[79]

Our examination of Guo's data is included as an appendix attached to an online working paper for this article.[80] We have noted above that Guo's statistical evidence consists of a disparate scatter

[74] Perkins, *Agricultural Development*; Guo, 'Food Production'; Shi, 'Yields per *Mu*', and *Agricultural Development*.
[75] Perkins, *Agricultural Development*, Appendix 1.
[76] Ibid., p. 315, Table G.2.
[77] Deng and O'Brien, 'Debate'; and Deng and O'Brien, 'Kuznetsian Paradigm'.
[78] Guo, 'Food Production'.
[79] Ibid.
[80] Deng and O'Brien, 'Kuznetsian Paradigm'.

of years in the 16th and 17th centuries and it refers to a tiny and potentially unrepresentative fraction of the empire's area cultivated with food grains. We now add that calibrations base on Guo's data reveal that the surplus outputs/incomes available to typical peasant families farming 10 *mu* of land in the Ming Period, could not have produced the volume of kilocalories of food grains that they required for food security.[81]

For the Qing period 1690-1850 BGL report that Shi's calculations for averaged imperial yields made allowance for multiple cropping and (presumably?) for variations in the fecundity of the *mu* in order to construct a database for yields derived 'from local sources for six bench-marked years, 1661, 1685, 1724, 1766, 1812 and 1850'. Shi's sources cover every province of the empire and ecological zones from north and south China as well as dry and paddy farming. His statistics suggest that imperial yields for grains continued to increase slightly from 154 kilogrammes per '*mu*' for 1685 to a level of 178 kilogrammes per *mu* for 1812. Shi's database of yields of grains per standardized *mu* of land is derived from local documents that record grain yields achieved on some 3,000 farms located in a dozen or so provinces of the Qing empire. The ratios cited in his book refer to: farms of disparate sizes; to a range of scattered years surrounding six benchmarked years covering two centuries of time and to years that include seasons marked by potentially significant fluctuations attributable to variations in harvests. While Shi's research represents a contribution to the agrarian history of the Qing empire, we are not convinced that the statistical evidence he collected and published could be utilized to estimate annual average imperial yields of the credibility required by BGL for the construction of benchmarked conjectures for imperial grain production.

Furthermore, and as they appear in print, the methods used by Shi to construct a run of yield ratios could not be recognized as an acceptable way to proceed. Shi seems: (a) to have grouped aggregated and averaged records for yields recorded for farms by province in order to calculate 16 mean (arithmetical averages) of provincial yields; and (b) to have calibrated figures purporting to represent trends and fluctuations in averaged grain yields for the whole empire as the mean of those sixteen provincial means for 6 benchmarked years across the 189 years cited above. The arithmetical calculations deployed by Shi are unlikely to generate acceptable conjectures for levels, trends and fluctuations in China-wide grain yields required to calculate grain production for 1661-1850. Table 1 quantifies potential margins of error in Shi's estimates for the size of farms and grain yields.

[81] Deng and O'Brien, 'Debate', and 'Kuznetsian Paradigm'.

Table 1. Margins of Error in Shi's Estimates[82]

	Landholding gap	Yield gap	Type I†	Type II§
Ratio*	205.7:1	8.6:1	839.2:1	586.3:1

***Notes**:* Landholding in *mu*; grain yield in *shi* per *mu*. * Ratios between the highest and the lowest values used by Shi for China's national averages. † Margin of errors in term of 'weightable gap' = the largest landholding • the highest yield level – the smallest landholding • the lowest yield level. § Margin of errors in term of 'weightable mean' = the largest landholding • the highest yield level + the smallest handhold • the lowest yield level • 1/2. Detail is provided in Appendix B of this working paper.
***Source**:* Shi, *Development and Underdevelopment*, pp. 179-318.

Furthermore, in line with estimates published by Perkins and Guo, Shi's numbers imply that the quantity of staple foodstuffs available to a typical peasant family cultivating, say, 10 *mu* of land could not (after payments for rent and fertilizers) have been sufficient to provide Chinese families, growing in size, with food security. In short, the micro-economic data in print for population growth as well as often statistical evidence about the standards of living of the peasantry in early Qing times are *prima facie* not consistent with Shi's (or Guo's) evidence for average yields.[83]

We do not, moreover, find the solutions to the problems of multiple cropping and standardizing the *mu* adopted by Perkins, Guo or Shi to be either transparent or conclusive. Apparently, Perkins' considered a *mu* of cultivable land to be equal to one fifteenth of a hectare, or one-sixth of an acre. This implies a majority of farms in the Qing empire could well have been too small to have provided food security for a majority of peasant families. Guo's sample is also too small to be accepted as representative. His solution to the problem of converting fiscal *mu* into a standardized area of cultivated land could well be mere guesswork?

While Shi is not transparent on how he constructed estimates for the empire's area of cultivated land. We show in our working paper, that the ratios he published to represent average grain yields which purport to refer to the whole of the Qing empire are numbers that are all too likely to obscure extraordinary degrees of variance/deviation from year to year and location to location. On examination they can be represented as a 'reduction' of some 3,000 figures recorded for a disparate range of annual harvests, farm sizes and ecologically distinct locations into simple arithmetical means of the data he discovered for grain yields for farms located in sixteen provinces of the Qing Empire.[84]

[82] For detail, see Appendix B of this working paper.
[83] Chao, *Man and Land*; Li, *Agricultural Development*; Huang, *Peasant Family*.
[84] Shi, *Development and Underdevelopment*.

Finally, agrarian historians recognize that household incomes and consumption were supplemented by net returns from the production of textiles. According to Pomeranz, the domestic production of textiles boosted the consumption of peasant families in the Yangtze region to a level that was discernibly above the level of kilogrammes designated by the F.A.O. as necessary for food security. Bozhong Li's data for the Jiangnan Delta support that position but Huang's Malthusian interpretation appeals to BGL.[85] Their interpretation rests, however, on a foundation of statistical evidence derived from data published by Perkins, Guo and Shi that purports to refer to averaged yields of food grains per standardized *mu* of land cultivated by the peasantries of Ming and Qing China. We do not accept the claim that these three scholars have or could produce plausible conjectures, let alone historical evidence that is firm enough to be a secure basis for the estimates (graphically displayed in Fig. 2 A, B and C of BGL's article).[86] The Qing empire's area of cultivated land denominated in a standardized *mu*, multiplied by Shi's estimates for yields of food grains for 6 benchmarked years from 1661 to 1850 cannot be accepted as 'firm' or even 'good' numbers.

BGL's estimates are 'foundational' for a Kuznetsian study in Historical National Accounting because several of the components or sub-sectors for primary, secondary and tertiary production are derived by way of more or less plausible but 'subjective' ratios, shares or coefficients, designed in their initial form by Perkins, to quantify trends in the levels of food grain production for the Ming and early Qing years of Chinese agrarian history. [87]

For example, 'BGL assume that net value added from food processing' grew in line with agricultural output and that textiles plus cloth consumption per capita can be linked (as Perkins suggested) to the production of food grains. *Prima facie* the ratios of the net outputs of both these sub-sectors to net output for primary production revealed by the estimates for 1840 in Table 3, could be understated. Agrarian historians suggest that by 1840 Chinese peasant households were allocating a substantial share of the labour time at their disposal to both these activities.[88] We remain to be persuaded that their combined net value added augmented the incomes of the workforce engaged in farming and other forms of household production amounted to a mere 6%

[85] Li, *Agricultural Development*; Huang, *Peasant Family*; Pomeranz, *Great Divergence*; and Zhai, 'Rural Economic Performance'.
[86] Broadberry, et al., 'Divergence', pp. 964-69.
[87] In his forthcoming paper in the *Journal of Economic History*, Peter Solar observes 'that the estimates for Chinese GDP over the long term depend for over 92% on grain output and population'.
[88] E.g. Xu, *Traditional Cotton Textiles*; Wang, 'Commercial Investment'; Li, 'Husband and Wife'; Pomeranz, *Great Divergence*.

of the net value added derived from primary production as a whole.[89] Or (to take another puzzling estimate) that as late as 1840 commerce (transport, trade and finance) added so little value to the diversified range of organic and manufactured commodities produced by a huge empire that had for centuries been seriously engaged in intra-regional trade.

5. The Construction of Trends and the Comparison of Levels for GDP per Capita in a Single and Singular Numeraire.

Our final critique of this ambitious and heuristic endeavour to provide 'firm' statistical evidence for a reinterpretation of Chinese economic history based on national accounts is concerned with the quantified results of exercises designed and conducted by BGL to compare 'Chinese Economic Performance' with Britain and other Western European economies in terms of 1990 International Dollars and/or in Sterling for 1840. The data methods and results of these exercises are displayed with clarity in Tables 4-8 and Figures 8 and 9 of their article.

Table 4 provides a summary of the ratios utilized for the construction of a purchasing power parity rate of exchange between Chinese and British currencies for 1840. That particular rate has been selected because it converts the multiplicity of commodities and services produced and valued at domestic Chinese prices into an 'equivalent' range and quality of commodities and services produced and valued in British prices for that same year. In brief, the rate has been designed to answer a key question: what might China's GDP for 1840 have been worth at British prices?

The complexities and problems of constructing anything clear and close to the complete range of 'comparable' goods and services produced and priced by modern organic and industrial economies has been intensively discussed among economists and statisticians funded by international organizations. They work collaboratively in teams in order to produce large and representative samples to cover the diverse range of outputs valued in two or more currencies for contemporary economies.[90] Their recent round of discussions has revealed just how sensitive the results can be to the number, range, quality and prices for 'equivalent' commodities and services included in 'representative' samples for particular years.[91] The empirical difficulties (and costs) of conducting these exercises in order to compare levels and changes in the volumes of gross domestic products across two or more national economies are formidable. Furthermore, experts who have engaged

[89] Broadberry, et al., 'Divergence', p. 973.
[90] Bolt and van Zanden, 'Maddison Project'.
[91] Deaton and Heston, 'Understanding PPPs'.

with these programmes in the empirical economics and statistics of national accounts have demonstrated not only how sensitive purchasing power parities can be to biased sampling, but also how vulnerable these exchange rates are to changes over short spans of time in the composition and productivity of primary, secondary and tertiary forms of production.[92]

Assumptions of the kind made by the late Angus Maddison that a purchasing power parity rate of exchange calibrated for China (under the auspices of the World Bank in international dollars for 1990) could serve as a numeraire for cross-country comparisons over eighteen centuries of imperial rule are, we have suggested conceptually and statistically flawed.[93] Maddison's assertion that income *per capita* for the base year 1 CE of the Han Dynasty could be defined as equal to the highly contentious figure published by economists at the World Bank to represent a universally valid poverty line denominated as 450 dollars of personal consumption of food, commodities and services purchasable at domestic prices that prevailed in the United States for 1990 is to say the least contestable and has been contested.[94] With that ambiguous number in place, in two editions of a book in 1998 and 2008, Maddison published seven estimates for Imperial China's GDP per capita for benchmarked years 1 CE, 1000, 1500, 1600, 1700, 1820 and 1850 based upon nothing other than extrapolated rates of growth that he somehow 'intuited' and interpolated from his reading of secondary literature on the economic history of the empire published in English.[95]

All Maddison's estimates are denominated in 1990 US dollars. They display no growth in GDP per capita for Ming or early Qing China between 1300 and 1850. Their denomination in international dollars ostensibly allows for immediate comparisons with other estimates for GDP per capita denominated in the same numeraire Their meaning as historical evidence is, however, hard to grasp?[96] None of the numbers are based on anything approximating to the construction of estimates for the production, incomes or consumption derived from more or less reliable statistical sources that refer to these particular benchmarked years. The inferences that historians could conceivably draw from them (either as an explicanda representing long term trends in economic growth of Imperial China or as a measure of changes in the capacity of the Chinese economy to supply goods and services for the empires' population over 1850 years of history from the Han to

[92] Feenstra, et al., 'Production and Expenditures'; and Feenstra, et al., 'Who Shrunk China?'
[93] Feenstra, et al., 'Who Shrunk China?'; Johnson, 'Is Never Better'; Deng and O'Brien, 'Maddison Was Wrong'.
[94] Stiglitz, *Global Poverty*.
[95] Maddison, *Chinese Performance*, *2nd Ed.*; also see Ma and de Jong, 'Unfolding the Turbulent Century'; Ma, et al., 'Living standards'; van Zanden and Ma, 'Maddison'.
[96] Deng and O'Brien, 'Maddison Was Wrong'.

the Qing dynasties) is not clear.[97] Nor, *prima facie*, could these numbers provide quantified impressions of the capacities and productivity of the Chinese economy compared to other empires and polities operating during such a very long span of world history.

Maddison's book is, nevertheless, important to consider because it reveals there is no shortcut way of simultaneously measuring either the economic growth of China over eras of history, or the relative capacities of that economy to provide commodities and services for the population that are not predicated on the construction of reliable runs of national accounts for GDP expressed in current and constant prices, convertible at regular and relatively short intervals into 'numeraires' that are analogous to a modern international dollar.[98] In other words, historians who wish to engage in cross-country comparisons of GDPs for pre-modern times will *ipso facto* need to construct purchasing power parity rates of exchange that are applicable and expressed in a relevant numeraire for a specified period of history. These prerequisites for comparative economic history have been difficult to comply with for modern times when states can rely on more or less efficient statistical services to provide the data they need for fiscal extraction and economic governance.[99] National accounts are particularly hard to construct for early modern imperial polities with large populations and extensive territories. Furthermore, a currency analogous to the modern dollar could be difficult to discern for the centuries from 1400-1800?[100]

BGL are to be commended for their endeavours to construct a purchasing power parity rate of exchange between sterling and Qing China's official currency (the silver *tael*) to facilitate an exercise in bilateral comparisons between their estimates for the British and Chinese GDPs per capita that could refer to levels of productivity and welfare provided by two very different economies for their respectively small and huge populations for years surrounding 1840.[101]

On subjecting their rate of exchange to scrutiny we find, however, that there are grounds for suggesting that the Chinese data they utilized for its construction may also be inadequate for the purpose that it was designed to facilitate? For example, the basket of goods selected and weighted to reflect the range of commodities and services produced (not consumed) in China and Britain includes only seven commodities and no services and does not begin to mirror the standards

[97] De Jong and van Ark, *GDP Levels*; Bolt and van Zanden, 'Maddison Project'.
[98] Maddison, *Economic Performance, 2nd Ed.*; and Ma, et al., 'Living standards'.
[99] Feenstra, et al., 'Production and Expenditures'.
[100] Jerven and Duncan, 'Revising GDP'.
[101] During the Ming-Qing Period, the term '*tael*' for silver was never a uniform quantity in terms weight and purity which varied from time to time and from region to region; see Deng, 'Foreign Silver'.

prescribed for modern exercises. Five of the commodities are foodstuffs and three (rice, sugar and tea) were not produced in Britain. The notes below table 4 in the article do not explain how averaged prices for seven supposedly comparable commodities have been calculated. For China's extensive territory and less integrated markets, variance around the prices of almost any commodity was likely to have been greater than it was for the United Kingdom. Furthermore, the use of British weights to represent the relative significance of six of the seven commodities included in an exercise designed to represent the composition of the empire's gross domestic 'product' is to conflate coefficients required for conversions to a numeraire relevant for comparisons of production with an exchange rate required to measure relative levels of income and consumption.[102]

Furthermore, the issue of the currency which has perplexed and frustrated generations of economic historians of pre-modern China, has not been addressed by BGL.[103] Yet most monetized transactions within the Ming and Qing empires were conducted in copper *wen* – a metallic coin produced by no less than 40 mints that was neither standardized as copper of a certain weight and finesse, nor convertible across the empire at a single stable rate of exchange into silver *taels*.[104] Silver utilized by and for transactions with the state and for long distance wholesale trade served basically as the empire's official unit of account. Its purchasing power depended not only on inflows of silver earned from net commodity exports, but also the form in which it was utilized for the purchase of goods, services and the settlement of debts. In their most acceptable and reliable form, namely, as Mexican dollars, grams of silver commanded a premium of up to 25% over bars, ingots and fragments.[105] Leading experts on the currency of Imperial China have concurred with King's classical and quotable assessment that 'in China every monetary transaction was to an extent an exchange transaction.'[106] These complexities can neither be dismissed as insignificant for the interpretation of modal prices for commodities produced in China, nor can they be ignored for the calibration of the purchasing power parity of the *tael*'s exchange rate with sterling in circa 1840. Above all, they reveal historical and institutional contexts that may well make it impossible to discover and calibrate the statistics required to uncover a representative set of prices and weights necessary to construct the sequence of bilateral purchasing power parity rates

[102] Usher, *Price Mechanism*; Taylor and Tailor, 'Purchasing Power'.
[103] Horesh, *Chinese Money*; Deng, 'Foreign Silver'; Peng, 'Prices'; Lu and Peng, 'Grain Prices'; Yu, 'Data Quality'; Kuroda, 'Anonymous Currencies'; *cf.* Kishimoto, *Prices and Economic Changes*.
[104] Deng, 'Foreign Silver'.
[105] Kuroda, 'Anonymous Currencies'; Kuroda, *Money*.
[106] King, *Money*, p. 7.

of exchange required to compare the domestic product of Imperial China with any of the leading economies of Western Europe for pre-modern times.[107]

This is unfortunate because theoretically plausible conjectures for gross domestic products per capita converted to a common numeraire for 1840 could conceivably serve to effectively undermined theses associated with the California School and the polemical writings of Gunder Frank that the economies of Imperial China and Western Europe had been on cultural, institutional, technological and economic trajectories with similar potential for the achievement of higher standards of living for their populations until late in the 18th century. We can all agree that rejections of Weberian and other Eurocentred interpretations of China's economic history have been stimulating to discuss, but after two decades of debate, are considered to be both unquantifiable and improbable.[108]

Unfortunately, the volume, range and quality of statistical evidence for Ming and Qing China for the period from 1400 to 1840 will not, in our view, turn out to be sufficient or accurate enough for the construction of plausible runs of estimates either for the empires' GDP or for an historical sequence of reliable purchasing power parity exchange rates for the complex array of currencies utilized across the empire for centuries before and after the 1840s.[109]

The estimates constructed by Stephen Broadberry and his Chinese co-authors are not, moreover, congruent with historiographical surveys of economic conditions recorded by European travellers to Ming and early Qing China.[110] Nevertheless, prestige is attached to numbers and the clarity imparted by the graphical representation of unexamined statistics is often impressionable. They may persuade those who are not *au fait* with the complexities involved in constructing national accounts, index numbers and purchasing power parity rates of exchange to treat ostensibly quantified interpretations of Chinese history as acceptable history.[111]

But could, for example, the differentials in average standards of living between the populations of early Qing China and Victorian Britain for the 1840s be realistically represented by the figures calibrated by BGL for Table 5? That table summarizes and conveys statistical evidence that suggests by 1840 a majority of the population of Qing China were subsisting in an economy that

[107] Deng and O'Brien, 'Standards of Living'.
[108] Roy and Riello, *Global Economic History*, O'Brien, *Economies*; Frank, *ReOrient*.
[109] Deng and O'Brien, 'Maddison Was Wrong'.
[110] Jones, *Image of China.*
[111] Phillipsen, *Little Big Numbers.*

provided them with levels of income and consumption that could be represented as equivalent to roughly a quarter (23.76%) of contemporaneous British levels. How plausible are numerical impressions that lays claim to a differential of 4 to 1 in labour productivity that had emerged between these two economies as early as 1840? If they are correct or even conceivable, they certainly support traditional views that smaller scale national economies like Britain (with a GDP that amounted to a mere 20% and a population that was only 5% of the totals recorded for Qing China) were likely to have been on far more sustainable trajectories for earlier transitions to modern economic growth. But is the estimated per capita income for early Qing China anything more than another set of manufactured numbers that could not for reasons elaborated here, undermine the more cautious claims of the California School? In essence, the School's revisionism can continue to be read as a reasonable rejection of Eurocentred views that the long-run economic development of Imperial China could be written as a history of long-term retardation compared with the West?

BGL's exercise in Historical National Accounting is the most recent and sophisticated attempt to mobilize what they claim as 'firm' statistical evidence that restores interpretations that have stimulated two decades of heuristic debates on the Great Divergence. Our thesis (to repeat) is that the primary sources available for the Ming and early Qing China are not good enough to support Kuznetsian forms of economic history for early modern Asian empires. Furthermore, we wish to observe that BGL's estimates for Chinese GDP per capita in 1840 not only could not (but even as they stand, do not) undermine positions taken in the California School in the divergence debate.

For example, their estimate of 13.5 silver *taels* as a 'median' figure for GDP per capita for Qing China for the decade around 1840 can be transformed (using their published average price for a kilogramme of 'edible rice') into a number expressed in modern kilocalories that 'suggests' that the early Qing economy while (undergoing accelerated rates of demographic growth) retained the capacity to provide nutrition for the majority of the Chinese population at a level of consumption (measured kilocalories *per capita* per day) that was discernibly above the levels prescribed in our own times for 'food security'.[112] Furthermore, if our calibrations for the nutritional standards of living provided by the wages of labourers employed in agriculture and urban construction in England between 1800-49 are more or less correct, they seem according to statistical evidence

[112] As far as one can tell, prior to the 1890s there were as many as 56 regional silver weight standards and 2 national silver weight standards for a *tael*; see Deng, 'Foreign Silver'. Thus, any *tael* figure arouses legitimate scepticism.

published by BGL to be on a par with those afflicting most Chinese peasant families around that time.[113]

There are, moreover, significant definitional and conceptual problems surrounding the conversion of 13.05 silver *taels* into ratios that they formulated to bring not only British but also global perspectives to bear on this new estimate for GDP per capita for circa 1840. This bilateral comparison transforms 13.05 silver *taels* with a contestable purchasing power parity ratio for exchange of £6.43 into an equivalent per capita sum in sterling that was certainly way below the income required to buy food security in Victorian Britain. And unless China's domestic consumption included a high proportion of British commodities and services it is difficult to conceive of the sense in which these estimates in sterling are a revealing way of comparing the welfare of the population of early Qing China with the population of Victorian Britons. The latter may or may not have been reassured to learn that the kingdom's economy was providing them with modal real incomes that could be represented as superior to Chinese 'real' incomes by a factor of around four.

BGL seem to be as keen as the late Angus Maddison to locate the economy of Imperial China in league tables of medieval and pre-industrial national economies. To do that they have, however, implicitly adopted his conceptually flawed methodology by expressing Chinese GDP per capita for circa 1840 in single and singular numeraire (namely international dollars for 1990. Furthermore (and by way of backward projection in rates of growth that are neither transparent, explained nor validated) they extended the number for 1840 all the way back to 980. As we elaborated above, a numeraire denominated in international dollars for years around 1990 was designed to render domestic national products of the world's economies published for that year and surrounding years in current domestic prices and currencies comparable across space and for circumscribed spans of history.

The meaning and limitations of BGL's numeraire as an index for the measurement of temporal as well as cross-country variations in levels of GDP and GDP per capita have been rigorously analysed in recent debates among economists, responding to pronounced discontinuities in the size and rankings of major national economies that appeared in mercantilist league tables, published by international organizations.[114] The discontinuities are now attributed to

[113] Deng and O'Brien, 'Debate'.
[114] Feenstra, et al., 'Production and Expenditures'; Feenstra, et al., 'Who Shrunk China?'

improvements to collaborative international endeavours to measure the purchasing power parities of national currencies for decades after 1990. In the light of this discussion we concluded Maddison's estimates for the per capita GDP of China denominated in 1990 international dollars which claim to refer to trends covering nearly two thousand years of imperial history might now be regarded as a provocative but conceptually ambiguous index, either for the simultaneous measurement for the empires' long-run rate of economic growth or for reliable statistically based impressions of its relative levels of economic development compared either to western European polities or other Asian empires.[115]

Another way of expressing this point is to consider the methods that BGL derived from Maddison to facilitate the conversion of their estimates for the nominal values of GDP per capita for Britain (£27.07) and China (13.05 *taels*) for circa 1840 into a numeraire that would allow for multilateral comparisons. Unfortunately the potential range of multilateral comparisons for that period in global history is restricted to a tiny range of national economies for which more or less reliable estimates for nominal GDP per capita happened to be available; along with the price and quantifiable data required to convert representative samples of domestically produced commodities and services, denominated in domestic prices and currencies into a currency that was universally used for that period for international transactions. For years circa 1840 that currency was more likely to be grams of silver or sterling than American dollars. Bilaterally the silver rate of exchange cited by BGL leads, however, to a hypothesis that British GDP per capita circa 1840 was already nearly seven times higher than the level prevailing in Qing China? Purchasing power parity rates of exchange for circa 1840 are most unlikely to be comparable to the rates calibrated in dollars to refer to a much larger sample of national economies for modern years circa 1990 or even for years after that period.[116]

Backward extrapolations over centuries of time from 1990 to year 1 CE (*pace* Maddison) or from 1840 to 1400 or to 980 (pace BGL) are heuristic numerical abstractions for economic historians to consider and debate. Nevertheless, in our view they seem to have raised rather than settled problems for a branch of the subject that laudably aspires to be transnational, reciprocally comparative and Kuznetsian in style.

[115] Asian Development Bank, *Purchasing Power Parity*; Rao, *Comparisons*.
[116] Taylor and Taylor, 'Purchasing Power'; Deaton and Heston, 'Understanding PPPs'; Johnson, 'Is Never Better?'

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Appendix A: Review of the Legacy Left by Chung-li Chang (or Zhang Zhongli)

Chang (or Zhang) has indeed left a legacy with which historical estimation has flourished. The problem however is that estimators cannot settle their differences. As a result, re-estimation is common in a completely open-ended fashion.

In addition, Chang's methodology nurtures ignorance, rather than enlightenment, of a range of defects and problems with quantitative information extracted from China's historical records.[117] We single out twelve areas as examples in Table A.

Table A. Summary of Defects in Information Available in China's Historical Records

Category	Defect/problem
(1) Agricultural yield	Four: (1) Land outputs were highly local and seasonal. The differences across villages in the same region were as great as those between mag-regions. In addition, yields were determined by labour skills/inputs as well as at the mercy of the mother nature. So, margins of error for calculating an average yield level are often intolerable. (2) The Chinese tradition paid most attention to good and, especially, exceptional yields as an omen of a good fortune. Thus, high yields appear disproportionately in Chinese written records. This bias was exposed when land surveys in the 1920s and 30s came along. (3) Moreover, estimates have so far been based on a 50-50 share-cropping split between the landlord and tenant, overlooking the entire output from the second crop (called the winter crop) which was completely rent free. In addition, it is questionable whether the 50-50 split was universal. (4) Finally, all estimates have been made on a disaster-free assumption. No study has so far factored in natural disasters which affected a third of the empire *per annum*.
(2) Archives	One: Since the Western Han Period (206 BC – 24 AD), it was a common practice for the descendant dynasty to compile the official history of its predecessor. To avoid future controversy, the descendant dynasty was obliged to destroy its predecessor's official archives after the official history was completed, the Qing Period (1644-1911) being the exception due to the fact that no official history has been compiled.
(3) Currencies	Four: (1) Scale and scope of the adoption and use of imported heterogeneous silver coins and the loose notion of the 'Chinese silver *tael*'. (2) Copper (actually bronze) currencies were the legal tender but not unified. No single benchmark for the whole empire was available at any given time. Regional differences were very common in sizes and shapes as well as alloys. (3) Debasement took place often. (4) Counterfeits, up to 40 percent of the money in circulation, were widespread and perpetual.

[117] Our observation resonates the breathtaking critique made by Professor Richard von Glahn of UCLA in 24 April 2019 at Peking University. He was quoted to state that 'In recent years much research into and analysis of quantitative history has often been based on fragmented historical data collected from Chinese literature. One big problem though is that European scholars lack both the basic knowledge of and a rational structure for China's economic history, and therefore are unable to evaluate the quality of the quantitative materials that they use.' (近年来的许多量化历史研究往往基于中国文献中支离破碎的历史数据进行比较分析，其中一个很大的问题是欧洲学者对中国经济史缺乏基本常识和理念框架，因而也无法评估所用量化资料的质量.)*Vide* *http://www.ihss.pku.edu.cn/templates/learning/index.aspx?nodeid=125&page=ContentPage&contentid=1164*, available on 1st November, 2020.

(4) Farmland	Three: (1) On the macro-level, cadastral surveys were always regional. True empire-wide cadastral surveys were non-existent. (2) On the micro-level, the land measurement unit *mu* varied from time to time and from place to place. (3) There was a common use of the 'fiscal *mu*' for collecting taxes. Although on government accounting records, the fiscal *mu* did not reflect the real farmland under real crops.
(5) Food prices	Three: (1) Officially reported foods prices were overwhelmingly urban. But the urban population was insignificant. So, such prices only affected a tiny market. (2) The urban food market was interfered by the state food procurement and discharge policies *via* a granary network at all levels: counties, prefectures and provinces. Thus, there was no real 'market prices' for staple food. (3) There was false sense of food price integration across the empire largely due to the same government interference.
(6) GDP	Three: (1) There was no reliable way to convert value or volume. (2) There was no single regional or national survey for the weight of each sector in the economy in terms of inputs, outputs, imports and exports. (3) Written records on industrial and service activities were anecdotal, sporadic and patchy.
(7) Living standards	Two: (1) There was no survey of living standards before the 1920s. (2) All estimates have so far been made according to 'Malthusian subsistence' which conceptually permits no population growth which contradicts pre-modern China's demography.
(8) Population	Two: (1) No regular population censuses were conducted. (2) No head-count of all residents. Instead, population numbers were exclusively for male tax-payers (*ding*) aged 16 to 60.
(9) Silver	Five: (1) Silver was in wide circulation since *circa* 1565 AD but not recognised as legal tender until the 1890s. (2) Silver was overwhelmingly imported by the private sector without records. (3) Silver weight *tael* varied from place to place. Also, *tael* did not specify the silver content which varied from 50 to 70 percent among imported species. (4) The 'copper-silver exchange rates' were highly local and customary. (5) *Tael* was also a 'phantom unit' with which actual transactions were often conducted without silver at all.
(10) Taxes	Two: (1) With the 1712 Decree to freeze the Qing land-poll tax revenue, the Qing tax was dis-connected from the size of China's population and farming acreage. (2) Until 1850, all rural exchanges, the backbone of China's market, were tax-free.
(11) Time series	One: There was no coherent and consistent set of spatial and temporal data whereby a time series can be constructed.
(12) Wages	Two: (1) The number of full-time wage-dependant workers in China's traditional economy was trivial (no more than one percent of China's total workforce). (2) Wages were always paid in a combination of cash and goods (food, shelter and clothing). The latter type was often hidden.

Sources: (1) Agricultural yields - Kent Deng and Patrick O'Brien, 'Nutritional Standards of Living in England and the Yangtze Delta (Jiangnan), c.1644 – c.1840', *The Journal of World History*, 26/2 (2015), pp. 233-67; Kent Deng and Patrick O'Brien, 'China's GDP per Capita from the Han Dynasty to Communist Times', *World Economics Journal*, 17/2 (2016), pp. 79-123. (2) Archives - Luca Zan and Kent Deng, 'Micro Foundations in the Great Divergence Debate: Opening up the Perspective', *Accounting History*, 22/4 (2017), pp. 530-53. (3) Currencies - Kent Deng, 'Miracle or Mirage? Foreign Silver, China's Economy and Globalisation of the Sixteenth to Nineteenth Centuries', *Pacific Economic Review*, 13/3 (2008), pp. 320-57. (4) Farmland - Kent Deng and Patrick O'Brien, 'China's GDP per Capita from the Han Dynasty to Communist Times', *World Economics Journal*, 17/2 (2016), pp. 79-123. (5) Food prices - Kent Deng and Shengmin Sun, 'China's Extraordinary Population Expansion and Its Determinants during the Qing Period, 1644-

1911', *Population Review*, 58/1 (2019), pp. 20-78. (6) GDP - Kent Deng and Patrick O'Brien, 'China's GDP per Capita from the Han Dynasty to Communist Times', *World Economics Journal*, 17/2 (2016), pp. 79-123. (7) Living standards - Kent Deng and Patrick O'Brien, 'Nutritional Standards of Living in England and the Yangtze Delta (Jiangnan), c.1644 – c.1840', *The Journal of World History*, 26/2 (2015), pp. 233-67. (8) Population - Kent Deng, 'Unveiling China's True Population Statistics for the Pre-Modern Era with Official Census Data', *Population Review*, 43/2 (2004), pp. 1-38. (9) Silver currency - Kent Deng, 'Miracle or Mirage? Foreign Silver, China's Economy and Globalisation of the Sixteenth to Nineteenth Centuries', *Pacific Economic Review*, 13/3 (2008), pp. 320-57. (10) Taxes - Kent Deng, *China's Political Economy in Modern Times: Changes and Economic Consequences, 1800–2000* (London, 2011), pp. 16-18, 34, 59. (11) Time series - Kent Deng and Patrick O'Brien, 'Establishing Statistical Foundations of a Chronology for the Great Divergence', *Economic History Review*, 69/4 (2016), pp. 1057-82. (12) Wages - Kent Deng and Patrick O'Brien, 'Establishing Statistical Foundations of a Chronology for the Great Divergence', *Economic History Review*, 69/4 (2016), pp. 1057-82.

Appendix B: Detailed Margins of Error in Shi's Estimates

Table B demonstrate problems with Shi's simple arithmetic averages. Firstly, the landholding ratios between the large and small farms on are huge (on average 205.7 to 1); and so are land yield ratios between the higher and lower ends (on average 8.6 to 1). If so, it is inappropriate to take simple arithmetic averages from such yield figures. Rather, it is sensible to factor in the size of farms. Secondly, arithmetic averages create huge margins of error measured by either the gap between the weighted highest and lowest farming acreages (839.2 to 1) or the mean value between the weighted highest and lowest farming acreages (586.3 to 1). These numbers look ridiculous. Given that Shi's entire matrix of GDP estimates is based on his estimates for the farming, the same margins of error are inevitably passed on to his estimates for the Qing GDP.

Table B. Shi's Data for Landholding Sizes (*Mu*) and Grain Yield Levels (*Shi* per *Mu*)

Region	Landholding ratio*	Yield ratio*	Maximal interval†	Gap‡	Mean§
Zhili	50.0	12.1	91; 1.5	89.5	46.3
	8.2	8.8	7.2; 0.8	6.4	4.0
	8.3	10.0	8.3; 0.8	7.5	4.6
	229.5	10.0	229.5; 23.0	206.5	126.3
Shandong	2.2	9.5	6.6; 0.9	5.7	3.9
	46.6	10.8	151.5; 14.0	137.5	82.8
	1.1	10.0	1.0; 0.1	0.9	0.6
	73.4	30.0	220.2; 7.3	212.9	113.8
Henan	8.0	5.8	7.0; 1.2	5.8	4.1
	27.2	5.5	32.6; 6.0	26.6	19.3
	361.0	15.0	1083.0; 72.2	1010.8	577.6
	273.0	21.9	835.4; 38.2	797.2	436.8
Shanxi	1041.8	13.3	1385.6; 104.2	1281.4	744.9
	19.5	53.5	20.9; 0.4	20.5	10.7
	38.3	12.5	38.3; 3.1	35.2	20.7
Shaanxi	86.3	40.0	138.1; 3.5	134.6	70.8
	535.7	13.3	2142.8; 160.7	1982.1	1151.8
	141.0	15.5	479.4; 31.0	448.4	255.2
	103.0	10.0	124.6; 12.4	112.2	68.5
	226.7	6.8	557.7; 81.6	476.1	319.7
	20.5	30.0	30.8; 1.0	29.8	15.9
Gansu	6.8	3.9	1.8; 0.5	1.3	1.1
	94.0	15.7	162.6; 10.3	152.3	86.5
	254.6	13.6	277.5; 20.4	257.1	149.0
	462.2	34.1	1261.8; 37.0	1224.8	649.4
	2.1	7.5	3.6; 0.5	3.1	2.1
Manchuria	1.5	4.1	2.5; 0.6	1.9	1.6
	2541.3	7.1	2338.0; 330.4	2007.6	1334.2
Jiangsu	1.7	4.9	32.0; 3.0	29.0	17.5
	50.0	8.6	275.0; 32.0	243.0	153.5
	6.7	6.7	44.8; 6.7	38.1	25.8
	3.0	8.2	21.0; 2.6	18.4	11.8
	256.0	3.9	1843.2; 471.0	1372.2	1157.1
	222.5	4.5	667.5; 149.1	518.4	408.3
	84.7	4.6	338.8; 73.7	265.1	206.3

	280.0	5.5	1960.0; 358.4	1601.6	1159.2
	626.7	5.3	4455.8; 839.8	3616.0	2647.8
	76.8	4.0	345.6; 86.8	258.8	216.2
	49.5	6.0	239.1; 39.6	199.5	139.4
Zhejiang	38.3	6.0	229.8; 38.8	191.0	134.3
	630.0	2.2	4202.1; 1953.0	2249.1	3077.6
	112.0	6.5	1456.0; 224.0	1232.0	840.0
	22.2	12.6	444.0; 35.3	408.7	239.7
	92.0	4.5	693.7; 153.6	540.1	423.7
	683.8	3.6	3897.7; 1094.1	2803.6	3350.7
Fujian	1.9	2.7	12.7; 4.6	8.1	8.7
	14.3	3.1	79.1; 25.7	53.4	52.4
	68.5	2.2	342.5; 154.1	188.4	265.4
	182.9	7.0	2397.8; 340.2	2057.6	1369.0
	10.0	3.8	63.4; 16.7	46.7	40.1
	35.8	5.2	307.9; 59.4	248.5	183.7
	93.8	2.8	405.2; 144.5	260.7	274.9
	150.0	8.0	1204.5; 150.0	1054.5	677.3
Jiangxi	146.3	3.0	823.7; 270.7	553.0	547.2
	228.2	5.1	912.8; 180.3	732.5	546.6
	51.8	4.7	212.4; 45.6	166.8	129.0
	149.3	2.6	718.1; 273.2	444.9	495.7
	49.2	2.7	283.4; 103.3	180.1	193.4
	376.7	3.0	2154.7; 719.5	1435.2	1437.1
	45.5	2.5	225.7; 91.0	134.7	158.4
	72.0	2.4	344.9; 144.0	200.9	244.5
	140.8	5.2	995.5; 190.1	805.4	592.8
	20.0	2.6	100.0; 38.0	62.0	69.0
Guangdong	62.5	3.7	531.3; 144.4	386.9	337.9
	51.5	4.8	386.3; 80.3	306.0	233.3
	146.0	3.7	1068.7; 289.1	779.6	678.9
	300.0	7.8	2433.0; 312.0	2121	1372.5
	122.0	7.2	1342.0; 185.4	1156.6	763.7
	117.8	5.1	1178.0; 229.7	948.3	703.9
	23.9	9.4	173.0; 18.4	154.6	95.7
	84.7	4.1	425.2; 104.2	321.0	264.7
	54.0	3.6	374.8; 103.7	271.1	239.3
	83.4	13.5	744.8; 55.0	689.8	399.9
	290.0	5.2	1824.1; 353.8	1470.3	1089.0
	143.7	5.8	469.9; 80.5	389.4	275.2
	217.1	7.8	1302.6; 167.2	1135.4	734.9
	121.0	6.5	588.1; 90.8	497.3	339.5
	20.4	9.8	130.6; 13.3	117.3	72.0
	83.1	17.6	554.3; 31.6	522.7	293.0
	23.9	8.9	99.4; 11.2	88.2	55.3
	3.2	3.1	12.3; 4.0	8.3	8.2
Hubei	9.8	3.0	23.3; 7.8	15.5	15.6
	14.1	4.9	69.5; 14.1	55.4	41.8
	5.8	5.8	23.2; 4.0	19.2	13.6
	2.0	2.2	4.7; 2.1	2.6	3.4
	3.2	6.5	196.8; 3.0	193.8	99.9

	7.0	4.7	28.0; 6.0	22.0	17.0
	47.1	4.4	165.8; 37.7	128.1	101.8
	23.5	5.5	129.3; 23.5	105.8	76.4
	6.2	6.7	24.5; 3.7	20.8	14.1
	33.8	5.2	202.8; 38.9	163.9	120.9
	197.0	7.3	1438.1; 197.0	1241.1	817.6
	99.2	2.0	398.8; 198.4	200.4	298.6
	238.8	2.1	1511.6; 709.2	802.4	1104.9
	26.5	3.2	159.0; 50.1	108.9	104.6
	131.0	7.4	969.4; 131.0	838.4	550.2
	357.8	3.2	1789.0; 558.2	1230.8	1173.6
	115.4	3.0	480.1; 158.1	322.0	319.1
	75.0	4.2	514.5; 123.0	391.5	318.8
	133.3	2.9	799.8; 274.6	525.2	537.2
	133.3	4.9	751.8; 153.3	598.5	452.6
Sichuan	41.0	1.8	221.4; 123.0	98.4	172.2
	69.9	3.1	529.1; 168.5	360.6	348.8
	20.0	8.0	128.0; 16.0	112.0	72.0
	1046.3	8.5	10034.0; 1182.3	8851.7	5608.1
	12.7	4.4	68.8; 15.6	53.2	42.2
	12.2	4.6	55.8; 12.1	43.7	34.0
	162.9	8.6	2225.2; 257.4	1967.8	1241.3
	113.0	6.8	339.0; 49.7	289.3	194.3
	210.0	3.2	1068.9; 329.7	739.2	699.3
	131.5	7.0	854.8; 122.3	732.5	488.6
	301.8	7.0	2109.6; 301.8	1807.8	1205.7
Yunnan	84.8	6.8	550.4; 80.6	469.8	315.5
	68.0	16.8	1224.0; 72.8	1151.2	648.4
	95.0	12.1	598.5; 49.4	549.1	324.0
	144.8	4.2	580.6; 137.6	443.0	359.1
	180.5	21.0	1397.1; 66.8	1330.3	732.0
	152.8	23.7	941.2; 39.7	901.5	490.4
	6660.0	12.1	26640.0; 2197.8	24442.2	14418.9
	600.0	14.6	4200.0; 288.0	3912.0	2244.0
	46.4	17.8	329.4; 18.6	310.8	174.0
	202.5	29.0	1233.2; 42.5	1190.7	637.9
Guizhou	128.0	6.6	960.0; 146.0	814.0	553.0
	77.3	9.8	470.0; 47.9	422.1	259.0
	189.0	30.4	2296.4; 75.6	2220.8	1186.0
	26.7	8.3	133.5; 16.0	117.5	74.7
Total	*26121.8*	*1089.4*	-	*106575*	*74458.3*
Overall average	*205.7*	*8.6*	-	*839.2*	*586.3*

***Notes**:* The grouping of the 127 sets of numbers comes from Shi's own method. * Ratios between the highest and the lowest values extracted by Shi from historical writings on different locations and times during the Qing rule (1644-1911). † Maximal interval = between the largest landholding • the highest yield level versus the smallest handhold • the lowest yield level. ‡ Gap = the largest landholding • the highest yield level – the smallest handhold • the lowest yield level. § Mean value = the largest landholding • the highest yield level + the smallest handhold • the lowest yield level • 1/2.

***Source**:* Shi, *Development and Underdevelopment*, pp. 179-318.