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Income inequality in China 1952–2017: persistence and main determinants

JEL Classification: *C1; D31; E24; N15*

Keywords: *China; income inequality; fractional integration; persistence; economic growth*

Abstract

Research background: China's economic growth, however remarkable, is due to the Harrod-Domar nature of economic growth and, therefore, limited. The main limitation lies in the extension of the neoclassical growth model and the government need to decrease regional disparities using new migration, urbanization and social policy.

Purpose of the article: It is the rising regional disparity in the total factor productivity to cause the income inequality increase (measured by GINI index) in China from 1952–2017. Our paper brings new insight into the main inequality determinants and causes in China, using a fractional integration modeling framework.
Methods: Using fractional integration, we find total factor productivity (TFP), real gross domestic product per capita and growth and expenditures for the social safety net and employment effort to have a statistically significant impact on GINI. Income inequality in China is of a persistent nature with the effects of the shocks affecting the GINI index enduring over time.
Findings & value added: The results of this study highlight the importance for model/policy changes by the policy makers and practitioners in China to deal with the inequality issue. This involves improving the growth model through innovation and technological advancement, relaxing TFP dependence on the physical inputs (labor and capital) to reduce income inequality.

Introduction

China experienced an exponential rise in pre-tax national income of the top 1% of income earners, as well as in associated net personal wealth. From 1978 to 2015, the average pre-tax national income (World inequality database definition and data) of the top 1% was rising by 8.57% annually (annual growth rate). For the bottom 20%, annual growth rate of the pre-tax national income was 3.38%. The difference in the income growth of the top 1% to the bottom 20% was 5.20% annually. Direct evidence can be observed on the path of income inequality during the observed period (income of the richest growing significantly faster in relation to the income of the poorest). Consequently, a significant increase in the output per person measured by real gross domestic product per capita in China (RGDPC) contributes to rising income inequality.

In fact, annual average GDP per capita growth rate in China 1952–2017 was 6.92% with the GINI index rising during these years by 1.05% annually. During the same period, the average annual growth rate of total factor productivity (TFP) was 0.46%. Growth in TFP has a negative impact on income inequality. Important determinants of income inequality in China are the official migration policy pattern in China (Hukou — intervention government policy in regulation migration from rural to urban areas) and the social safety net. The rapid economic development in China in the last decades has fostered a rapid growth in income inequality, which in turn could slow down future economic growth or cause a recession in China (McCombie & Spreafico, 2017).

The growth of social safety expenditure was (3.36%) and the growth of income inequality (1.05%) annually. Therefore, the volume of the social safety expenditure transferred was not sufficient to limit the growth of inequality. Human capital, referred to in the body of literature as being an important inequality determinant, was growing by 1.30% annually. This

coincided with the growth registered in the tertiary industry (share of the GDP) with an annual average growth rate of 1.02%. Labor productivity was rising as a consequence of organizational and structural changes under modest technological improvement (TFP annual growth 0.46%). Labor productivity was growing 4.45% annually with a slow rising wage share of the GDP of 0.42%. The great decoupling between labor productivity and wages is sizable in China, having a significant negative impact on income inequality. The neoclassical marginal revenue productivity theory of wages does not hold in China, implying future inequality. This is confirmed by the negative average annual consumption growth rate of -1.26%, with household consumption falling steadily.

The significant impact on income inequality came from the changing labour market in China (Luo & Zhu, 2008). Contractual employment, as China moved towards a 'GIG' economy, began to dominate over traditional long-term employment. Short-term employment (contractual employees as a % of total employment) from 1952–2017 increased significantly at a pace of 9.36% annually. That is a direct consequence of slower technological innovation and capital driven TFP growth. Under such conditions, rural employment slowed down, increasing by 1.11% annually, while urban employment was growing. Because of the 'GIG' effect, the urban/rural income ratio was not increasing as expected, but steadily dropping by 0.39% annually. The economic growth model of China is boosting future income inequality, and inequality is steadily approaching the threshold when it will slow down and eventually trigger a recession in China. A change in the economic growth model is needed if China wants to efficiently fight the problem of income inequality.

This paper aims to provide new insight into the main determinants and causes of inequality in China. We want to analyze whether this increase in income inequality is highly persistent or not, and isolate the main determinants behind it. For this purpose, it applies fractional integration and distinguish several variables that have a significant impact on income inequality. Finally, based on our results, we offer practical guidance to policymakers on how to address the problem of inequality in China.

Nest section offers a detailed view on important studies on the inequality issue in China, while in Section third data sources and stylized fact on income inequality in China is introduced. Section fourth presents the empirical results of the fractional integration study, which are discussed in Section five. Concluding remarks present significant findings for the policy makers, practitioners and researchers focusing on the issue of income inequality in China today and in the future.

Literature review

There has been a great deal of confusion in the literature regarding the variables that influence income inequality and how it changes trends in inequality. A considerable body of the literature points out that policy and institutions are the main determinants of income inequality in China (Wang *et al.*, 2015; Han *et al*., 2016; Kanbur *et al*., 2017). The other channels through which inequality affects the long-run process of development are globalization and openness (Zanden *et al*., 2014; Fujiwara *et al*., 2008), industrial agglomeration (Chen & Lu, 2009; Kanbur & Zhang, 2005), urbanization (Chen *et al*., 2016) and skill premium (Zhuang & Shi, 2016).

Moreover, an as yet unresolved question is the impact of policy changes and trends in inequality. Wang *et al.* (2015) found that sizable income inequality existed, largely attributable to urban-rural gaps and disparities within the rural sector. Intra-rural and intra-urban inequalities have been increasing until recently. However, overall inequality declined in the first few years of the reforms due to the narrowing of the urban-rural gap. From the mid-1980s until the early 2000 inequalities in all dimensions in the PRC exhibited increasing trends. The results by Kanbur *et al.* (2017) indicate that after a quarter century of rapid sustained increase, Chinese inequality is plateauing and even diminishing. Chinese inequality indicates a turnaround towards the latter part of the 2000s, although, the level is still high compared with other countries.

Kanbur and Zhang (2005) pointed out that there have been three peaks in inequality: first, the Great Famine of the late 1950s; second, the Cultural Revolution of the late 1960s and 1970s, and finally the period of openness and global integration in the late 1990s. Bringing the inequality path to the center of development integrates the major emphases in development thinking on taxes, poverty, economic convergence and labor.

Lin (2009) discussed tax reforms as being an important part of economic reforms in China. He raises the question about the reasons behind the decline in government revenues in the 1980s and early 1990s, and the reasons for the increase in government revenues since the late 1990s and in recent years. He stated that further tax reforms should aim at reducing taxes on enterprises, raising more tax revenues from personal income and establishing new taxes, such as personal property, inheritance and gift taxes.

A summary of the studies which should give us the latest information about the main determinants and the impacts of policy changes on China inequality are presented in Table 1.

Maddison (1998) made an effort to explain why China's role in the world economy has changed so dramatically. Growth analysis has concen-

trated on the past two centuries of capitalist development in which rapid technical change, structural transformation and rising per capita income were the norm. A long-term view helps to understand China's contemporary policies and institutions.

In a more recent work, Majid (2015) found that China has improved her employment situation in the last 25 years, but the great challenge for China's policy makers is to continue to increase the overall share of regular employment in total employment and the process of labour transfer out of agriculture to non-agriculture. Whether China will take advantage of accelerated growth depends on inequality challenging. The analysis of Chinese inequality persistence, which is the goal in this paper, can provide new perspectives on the nature and causes of economic growth.

After a quarter century of rapid, sustained rise, China's inequality is plateauing and decreasing. Urbanization has an immediate impact on income inequality. Huge inequality in China does not fit into a socialist country's profile. Rapid economic growth in China is based on a model that pays high returns on various types of capital. We include these determinants in our model to explore the main sources of inequality in China using fractional integration modeling.

Dealing with the issue of inequality in time series nonstationary unit root tests along with VAR approaches have been widely used. In this paper, we take methodologically one step ahead by using fractional integration that allows the number of differences to be any real value and thus potentially fractional.

Research methodology

Data

To study the inequality issue in China we use annual data from 1952 to 2017 with 2640 observations across forty variables in total over 66 years. We start our analysis with forty variables in total to narrow it down to the most important (after causality test) to the seven variables we use in our empirical study. Prior to analysis, the data have been preprocessed using singular spectrum method (Ghil *et al*., 2002).

Since 1952, China has experienced rapid economic growth with an average annual rate of real GDP growth of 7.11%. Rapid economic expansion was followed by a large and significant increase in income inequality. This leads us to the question: can economic growth be achieved without a simultaneous severe increase in income inequality? Data for China show that, at

least for the period under examination, the answer would appear to be negative. Nevertheless, to rigorously study income inequality dynamics, we need to identify the main determinants behind the change in inequality using the following set of variables:

- *GINI index* – as defined in Kanbur and Zhang (2005) with a inequality index calculated as generalized entropy index for China for 1952–2000, Solt (2016) with data from the standardized world income inequality database (disposable income distribution) from 1979–2018 and Milanović (2019) data from the All the Ginis dataset from 1950 to 2007.
- *TFP* – Total Factor Productivity at Constant National Prices for China, Index 2011=1, Annual, Not Seasonally Adjusted, FRED Database, University of Groningen and University of California, Davis, accessed October 2019.
- *HCAPITAL* – index of Human Capital per Person — This provides an index of human capital per person, which is related to the average years of schooling and with the return to education, Penn World Table 9, (Feenstra *et al*., 2015).
- SOCIAL – expenditure for social safety net and employment effort as a % of GDP, National Bureau of Statistics of China database, Ministry of Finance China, http://data.stats.gov.cn/english/index.htm, accessed June 2018, Ministry of Finance, http://www.mof.gov.cn/index.htm, accessed June 2018.
- HUKOU – dummy variable for the intervention government policy in regulation migration from rural to urban, equal to 1 from the start of the Hukou implementation in 1953 until 1978 when a more flexible policy of migration was reinstated.
- URBAN – urban population share in total population, National Bureau of Statistics of China database, http://data.stats.gov.cn/english/index.htm, accessed June 2018.
- RGDPc – GDP per capita in 2018 US$, The Conference Board Total Economy Database™ (Original version), https://www.conference-board.org/data/economydatabase/index.cfm?id=27762 April 2019, accessed June 2019.

Figure 1 (A to F) shows a set of variables that might have a significant impact on income inequality. Income inequality is falling when agricultural production measured by its share in the GDP is increasing (Figure 1A). Today's agricultural sector share in the GDP is 8.9% (2016) in contrast to a 50.5% share in 1952. The widening gap between rural and urban income is not caused by significantly stronger wage growth in industry and the service sector in relation to the agricultural sector but to starting wages in 1952 in agriculture, industry and services. Wages in agriculture did not fall

significantly in relation to other sectors, during 1952–1990 and later from 2009–2016, except in the following years: 1956 (-4.91%), 1977 (-9.1%), 1985 (-15.3%), 1992 (-9.6%) and 2001 (-7.67%).

A strong positive linear relationship between income inequality and contractual employment exists in China (Figure 1B). Income inequality is rising as the share of contractual employment is increasing. Wages and compensations on contractual employment (temporary employment) are lower compared to the regular one. Contractual employees, as a percentage of total employment in China, have averaged about 50% in the last 20 years. Just how dramatic the change is on the labor market can be seen when we compare the 52.2% of contractual employees with the 0.6% in 1983. Contractual employment in China is not adequately regulated and firms take advantage of the employees, offering them lower wages under longer working hours. Outsourcing and production migration to China from large transnational corporations resulted in a significant increase in contractual employment from 1983 to 2016.

Transnational corporations took advantage of the high purchasing power standard in China and modest per person income to offer them employment standards below average in their respective countries (Figure 1C). Consequently, wages for contractual employees working in transnational corporation production based in China are lower in relation to employees in other Chinese states and private firms. An increasing number of contractual employees with lower wages widens the gap between non-contractual and contractual employees increasing nationwide inequality. China is an economic world superpower with fast and strong economic growth but with poor regional development policy and numerous asymmetries.

Notable asymmetries in economic development between Chinese provinces are present. Three provinces are well beyond the average national GDP per capita (Beijing 216%, Shanghai 209%, Tianjin, 200%), eight provinces are above, ranging from 104%–80% of average national GDP per capital. More provinces (20) are below the average national GDP per capita ranging from Shaanxi with 96% to Gansu with 49%. Under such conditions of uneven regional development, decentralization increases income inequality.

From Figure 1C, we can see a strong positive linear relationship between decentralization (Decen) and GINI.

Income inequality in China is strongly affected by national fiscal policy. Data show that most developed provinces such as Beijing, Jiangsu, Shandong, Guangdong, producing the highest regional product, also retain the largest share of the total local government general budgetary revenues. The most developed provinces benefit from the largest share of the local gov-

ernments' budgetary revenues. In 2016, Beijing produced 25.569 (100 million yuan) of regional product representing 3.28% of the gross regional product. At the same time, in 2016 Beijing's share in the local government budgetary revenues was 5.69%. The same holds for the most advanced province of Guangdong with a 10.3% share of the gross regional product and having 11.6% of the local government budgetary revenues.

This is certainly good for national growth, but at the regional level it is causing unequal regional development. As a result, large regional income disparities cause sizeable increases in the national income inequality index (GINI) (Figure 1F).

Method

The methodology is based on the concept of fractional integration. We will start the empirical section by focusing on the orders of integration of the series, investigating its stationary-nonstationary properties from a fractional viewpoint. Thus, for each series, our model of interest is the following one,

$$y_t = \alpha + \beta t + x_t, (1 - B)^d x_t = u_t, t = 1,2, \ldots \quad (1)$$

where y_t is the observed time series; α and β are unknown coefficients referring respectively to the intercept and a linear time trend; B is the backshift operator; the residuals in this regression (first equation in (1)), x_t, are integrated of order d, i.e., I(d) and u_t is an error term in the d-differences, that we supposed to be first uncorrelated (i.e., white noise) and then weakly autocorrelated, in the latter case, using a non-parametric method proposed in Bloomfield (1973).

In the multivariate case, we consider a similar model, but we replace the first equation in (1) by a multiple regression setting such that

$$y_t = \beta^T z_t + x_t, \quad (1 - B)^d x_t = u_t, \qquad t = 1, 2, \ldots, \quad (2)$$

where z_t is a (kx1) vector of exogenous regressors that might help to explain the behavior of yt (GINI).

Fractional integration modeling

Fractional integration is a time series technique that is characterized because the number of differences required in the data to get a stationary I(0)

process is a real value and thus potentially fractional. Thus, if the differencing parameter, d is positive, we are in the context of long memory processes, because of the high degree of dependence between the observations, being higher as higher is the value of d. The I(d) specification has the advantage of being more general than the classical methods and that are based exclusively on integer degrees of differentiation, i.e, d = 0 for stationary series and d = 1 for nonstationary one. Moreover, it allows us to consider a variety of models, including short memory (d = 0); stationary long memory (0 < d < 0.5); nonstationary mean reverting processes (0.5 ≤ d < 1); unit roots (d = 1) or even explosive process (d > 1). These processes, originally proposed by Granger (1980, 1981), Hosking (1981) and Granger and Joyuex (1980) has been widely used in the analysis of economic data during the last twenty years (see e.g., Gil-Alana & Robinson, 1997; Teyssiere & Kirman, 2007; Abbritti *et al.,* 2016; etc.)

Results

We start this section by examining the statistical properties of our series of interest. In particular, we look at the model given in equation (1), presenting the results in terms of the estimated values of d for the three cases of no deterministic terms, i.e., with α = β = 0 in (1), with a constant (β = 0) and with a linear time trend (both α and β unknown) (see Table 1), marking in bold in the table the selected specification in relation with these deterministic components.

The upper panel of Table 2 refers to the case of uncorrelated errors, while the lower panel focuses on the autocorrelated case. In both cases, we observe the same pattern with respect to the deterministic components and the time trend is required in all the series except RGDPC and SOCIAL. Interestingly, the time trend appears statistically significant in the former series if the logged form is used (LRGDPC). If now we focus on the orders of integration, starting first with the white noise case, we observe that the I(1) hypothesis cannot be rejected for GINI, but this hypothesis is rejected in all the remaining cases in favor of various alternatives. Thus, mean reversion (i.e., d < 1) is found in the case of TFP; I(d, 1 < d < 2) is obtained in the case of LRGDPC (d = 1.23), SOCIAL (1.25) and HCAPITAL (1.47); while the I(2) hypothesis cannot be rejected for URBAN (logged and unlogged data) and RGDPC.

Allowing for autocorrelated disturbances, we observe some differences and the estimated values of d are generally smaller. Mean reversion takes place once more for TFP but the I(0) hypothesis of short memory behavior

(d = 0) cannot be rejected in this case. Mean reversion also takes place now in the GINI with an estimated value of d equal to 0.45. The I(1) hypothesis is supported by LRGDPC and SOCIAL, while in the rest of the cases the estimated value of d is substantially above 1. As a conclusion, mean reversion is only supported in the case of TFP and partially for GINI if autocorrelated errors are allowed.

Due, in part, to this heterogeneity in the orders of integration of the series, in the following part of the manuscript, we consider the regression model:

$$\begin{gathered} GINI_t = \beta_0 + \beta_1 TFP_t + \beta_2 URBAN_t + \beta_3 LRGDPC_t + \\ +\beta_4 SOCLAL_1 + \beta_5 HUCOYU_t + \beta_6 HCAPITAL_t + \\ +x_t, (1-L)^d x_t = u_t \end{gathered} \tag{3}$$

where all regressors are supposed to be weakly exogenous in relation with the dependent variable GINI. However, instead of imposing d = 0 in the above equation, as is the case in standard linear regression models, we also estimate this parameter along with the coefficients of the model. In doing so, we can test the significance of the estimated coefficients to find which are the main determinants of GINI. Nevertheless, as a preliminary step, we impose d = 0, and the results in terms of the estimated coefficients along with their corresponding t-values are reported in Table 3.

We observe that only significant values are obtained in the cases of URBAN (-0.268), HUKOU (2.524), and to a lesser extent for the log of the GDP per capita, LGDPC (6.683). Table 3b reports the results including only those significant coefficients. We observe that three of them (URBAN, LRGDPC and HUKOYU) are positive. However, the assumption that x_t is I(0) in Tables 3a and 3b may be too restrictive and even invalid, especially noting that the order of integration for GINI was found to be significantly positive in the results reported in Table 2 for the two cases of uncorrelated and autocorrelated errors. In Table 4a we report the estimated coefficients with d jointly estimated along with the other parameters of the model. Panel i) refers to the case of uncorrelated errors while Panel ii) reports the results for the case of autocorrelated (Bloomfield) disturbances. Starting with the results based on white noise errors, we observe that d is found to be around one (1.021), which is consistent with the result in Table 1, and the significant coefficients are now TFP (-5.605), LGDPC (2.799) and SOCIAL (2.188). Allowing for Bloomfield-type (autocorrelated) disturbances (in panel ii), the significant coefficients refer to the same variables, TFP (-3.686) LGDPC (3.833) and SOCIAL (0.916) along with the dummy variable HUKOU (2.180). Table 4b reports the estimated coeffi-

cients using only those significant variables: TFP (-5.744), LRGDPC (4.572) and SOCIAL (1.910).

Discussion

Using fractional integration modeling, we isolate the main determinants of income inequality in China during the period 1952–2017. The results are in harmony with the theory and they confirm that the Chinese economic growth model is behind the growing income inequality issue.

This is in line with the findings by Wang *et al.* (2017), as the share of gross national labor income decreases with an increasing Gini coefficient. Empirical results of urbanization impact on inequality from Chen *et al.* (2016) corroborate our results on urbanization, driving inequality down. Kanbur and Zhang (2005) presents similar results supporting our own finding that inequality has peaked three times in the last fifty years, coinciding with the Great Famine of the late 1950s, the Cultural Revolution of the late 1960s and 1970s, and the period of openness and global integration of the late 1990s.

It can be seen from the results in Table 4 that the total factor productivity growth (TFP), real GDP per capita growth in logarithm terms (LRGDPC) and social expenditure for social the safety net and employment effort as a % of GDP (SOCIAL) have statistically significant impacts on income inequality in China. We also observe that income inequality measured by the GINI index does not show mean reversion. Income inequality in China is of a persistent nature with the effects of the shocks affecting the GINI index persisting over time. The impact of total factor productivity growth on income inequality in China is statistically significant. A rise in the total factor productivity has a negative impact (-5.605 under white noise errors and-3.686 under autocorrelation) on the GINI index. It is also important to notice that TFP shows mean reversion properties. In the case of China, this is because actual growth in TFP is caused by the increase in the capital stock through gross fixed capital investments and not by true innovation and technological progress. Whenever growth in fixed capital investments loses steam, TFP decreases, as well converges to the mean. China would need a substantial increase in the total factor productivity in order to significantly decrease inequality in income distribution since the average growth in TFP 1952–2017 was just 0.46%. Such a scenario would be possible if TFP in China starts to be driven by innovation and technological advancements.

Our findings are supported by the results from Wei and Hao (2011), Kang and Peng (2018) and Luckstead *et al.* (2014), showing that an increased enrolment at all levels of education contributes greatly to productivity growth. When the quality of education is considered, productivity growth is still attributed to the three levels of school enrolment, but is greatly influenced by advances in basic education in developing countries (Joshua, 2015).

Otherwise, the rise in income inequality in the future will act as a severe economic growth constraint in case of a tightening monetary policy or a new global financial crisis.

While the importance of state-owned enterprises to China's economy is diminishing, a growth in TFP is realized through changes in the firms' organizational structure and human capital management. Capital and input changes (structure and management) have a positive impact on TFP just in the short or medium term. Long-term beneficial effects to TFP growth can only be achieved by R&D, innovation and technological progress. Only then will TFP growth in China force income inequality to fall significantly assuring robust future economic growth. Otherwise, a future recession is likely to occur as income inequality rise (Quadrini *et al*., 2015).

The results of TFP are validated by the empirical results obtained for LRGDPC. Real GDP per capita growth has a positive and statistically significant impact on the GINI index in China. A 1% increase in LRGDPC is followed by an increase in the GINI index by 2.977 points under the white noise specification and by 3.883 with the model of Bloomfield (1973). LRGDPC is a highly persistent series, meaning a shock in output has long lasting effects on the economy and thus income inequality. Unexpectedly the TFP impact on GINI, LRGDPC is large and significant as China's economy has grown by 6.92% annually in the last 65 years. Considering this empirical result, we can see how large the impact of economic growth is. This is clear from the fact that in the period 1952–2017 the urban/rural income ratio declined by 0.39% annually. Technological advancement shifts the demand for labor from traditional to modern sectors driving the general wage level up. Thus, prospective employees seek University degrees to get the qualifications required in the more advanced technological sectors. Following the neoclassical marginal revenue productivity theory of wages, under which increased productivity is followed by wage increase, the urban/rural income gap is expected to expand. In China, as we can see, the urban/rural income gap contracted, proving that increased productivity in the modern industrial sector was not followed by an expected increase in the general wage level in the sectors. At the same time, the tertiary industry share in the GDP was rising by 1.02% annually. Employment in the tertiary

industry rose from 9.1% in 1952 to 44.9% in 2017 with high average annual growth rate of 4.48%.

Gil-Alana *et al.* (2020) provide evidence of the decoupling in China between 1952 and 2018. Driven by innovation-based shifts, globalization, a shift to knowledge growth management, 'supercycles and boom-bust,' 'superstars,' declining labor share and increasing wage inequality. The results show a divergent trend between labor productivity and labor compensation supporting our findings. Robust estimation results (Zhang *et al*., 2017) show that China's mostly capital-driven technical changes are negatively associated with the share of labor corroborating the results of our study.

Consequently, a sharp wage increase is registered in the banking and insurance sector and scientific research (skill-intensive sectors) rising above the general wage level in other sectors. Skill premiums in the banking and insurance industry were much higher in relation to other industries driving the inequality gap. Depending on the provincial/regional industry dominance, income inequality at the provincial/regional level subsequently increased. Provinces/regions with traditionally rural employment experienced a much lower increase in the general wage level in relation to urban/modern employment provinces/regions. Since the majority of the investments in gross fixed capital formation were generated through the private banking sector, skill premiums in this sector were higher, resulting in a national GINI rise.

Expenditure for the social safety net and employment effort as a % of GDP (SOCIAL) was not sufficiently large to constrain the income inequality generating mechanism of China's economic growth model. As a consequence, income inequality increased during the 1952–2017 period, despite a strong increase in the social safety net and employment effort expenditure, which reflected an average annual growth of 3.36%. In fact, according to our empirical results, a percentage point increase in SOCIAL caused an increase in GINI by 2.188 points under the white noise specification and by 0.916 under the exponential spectral model of Bloomfield (1973).

Conclusions

Since the reform of 1979, a dramatic increase has accompanied the miracle of economic development in income inequalities. Our work shows that this growth in income inequality is persistent, and we identify the main reasons. We separate many variables that have a major impact on income inequali-

ties using a fractional integration model and give policymakers and practitioners practical advice on how to address the inequality problem in China.

China's economic growth, while spectacular, is constrained by the Harrod-Domar model (the average annual growth rate of 8.52 percent and savings 1.13 percent). The primary conclusion is that the neoclassical growth model and the neoclassical marginal tax theory of wages cannot be extended in China's future development model. The combination of both economic models / policies is the main reason for the increase in income inequality in China (as assessed by the GINI) from 1952 to 2017. When these two economic models / policies are coupled, they exacerbate income inequalities, causing business cycles and future recessions.

Our study is limited by the data availability and policy indicators (dummy variables to account for several structural breaks and change in economic policy due to state reforms). Nevertheless, our results stand as robust to different model specifications. Moreover, future studies on income inequality in China can use our results and identified inequality determinants in their model formulation. Future research should also account for policy and regime changes extending our model and results presented in this article.

If China wants to avoid a recession in the future caused by rising income inequality, we believe there are three possible solutions. The first solution might be to gradually change the model of economic growth. In the first phase, this would mean a transition from Harrod-Domar's to a neoclassical model of growth based on technological progress. The second phase would be marked by the abandonment of the neoclassical growth model with a transition to the endogenous human capital-based growth model. Another solution might be to have the government investing more in human capital. The third solution is the complete redesign of the social policy and social networks to improve overall efficiency in fighting inequality.

The results of this study highlight the importance for model/policy changes by policy makers and practitioners in China to deal with the inequality issue. This involves improving the growth model through innovation and technological advancement, relaxing TFP dependence on the physical inputs (labor and capital). The current research was limited by data availability and particularly the lack of data availability at provincial and regional level. Future work should examine other potential determinants of income inequality such as skill premiums, financial cycles, the great decoupling and public services. From a methodological viewpoint, the possibility of structural breaks or non-linear structures can be taken into account still in the context of fractional integration. In fact, this is an interesting

issue, since several authors have suggested that long-term memory can be directly caused by the presence of breaks and other nonlinearities that have not been taken into account (Diebold & Inoue, 2001; Granger & Hyung, 2004; etc.). Moreover, fractional cointegration, panel fractional cointegration and other econometric frameworks can also be employed for the same purposes as in this paper. We hope to encourage researchers to study in depth the relation between economic growth and inequality in China for possible inequality- recession causality.

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Annex

Table 1. Literature review summary

Author and year	Period	Variables that influence income inequality	Results
Wang *et al.* (2017)	1996– 2010	Labor income	The share of gross national labor income decreases with an increasing Gini coeff.
Kanbur *et al.* (2017)	1995–2014	Policy changes and the nature of structural transformation. (They also summarized the most significant studies concentrating on the inequality trends)	After a quarter century of rapid sustained increase, Chinese inequality plateauing and diminishing. Chinese inequality indicates a turnaround towards the latter part of the 2000s. Although, the level is still high if we compare with other countries
Stratford and Cowling (2016)	1983–2013	*Hukou* system, social security and pension reforms	Although household income is likely to continue to grow over the long run, there could be volatility along the way as the economy rebalances
Chen *et al.* (2016)	1978–2014	Urbanization	Urbanisation has an immediate alleviating effect on income inequality
Han *et al.* (2016)	2004–2013	Policy and Institution	Huge inequality in China does not fit into the profile of socialist country and its socialist influence is far less than the Europeans even inferior to typical capitalist countries. The Gini coefficient began to decline in 2010 but it is still very high
Zhou and Song (2016)	1981–2013	Functional distribution of income, political and economic institutions, pattern of structural changes	The rapid economic growth in China has been relying on a model that pays high returns to various kinds of capital including financial capital and real estate, while the ownership of capital is very unequal
Ziesemer (2016)	1950–2010	Tertiary education	Tertiary education is shown to reduce education inequality
Wroblowsky and Yin (2016)	2000–2014	Policy; the regional aspect of income inequality is very strong but not dominant as is usually considered	Income inequality remains stable in recent years and its relationship with economic growth is very ambiguous
Zhuang and Shi (2016)	1978–2015	Skill premium; shares of labor and capital incomes; spatial inequality; wealth distribution	In recent years, the skill premium has declined, the share of labor income has been on the rise and capital income on the decline, regional inequality has fallen. These may have

Table 1. Continued

Author and year	Period	Variables that influence income inequality	Results
			been underlying factors contributing to the decline in PRC's overall income inequality as measured by the Gini coeff. since 2008.
Wang *et al*. (2015)	mid-1980s–early 2000s	Institutional Factor: The *Hukou* system; policy issues: Regional development policies and the opening up, preferential investment, taxation, banking policies, industrial agglomeration. Location or geographic factors; external factor; Trade and FDI. Other factors: Education and skills (human capital-related factors)	Overall inequality declined in the first few years of reform due to the narrowing of the urban-rural gap. From the mid-1980s until the early 2000 inequalities in all dimensions in the PRC exhibited increasing trends.
Cheremukhin *et al.* (2015)	1953–2012	Changes in the intersectoral labor wedges play an important role in structural transformation	They show that reforms yielded a significant growth and structural transformation differential. GDP growth is 4.2 percentage points higher and the share of the labor force in agriculture is 23.9 percentage points lower compared with the continuation of the pre-1978 policies.
Zanden *et al.* (2014)	1820–2000	Globalisation and deglobalisation	Between 1820 and 1950 increasing per capita income is combined with increasing global inequality. After 1950 global inequality remains more or less constant
Yang *et al.* (2012)	1952–2009	Regional speciality and non mobility	The inequality between the northern and the southern China has been decreasing from 1952 to 2009 and it was reversed in 1994 and 1995
UNCTAD (2012)	1978–2000	Agricultural growth, urbanisation, rapid changes in employment and real wages	1978–1984 decreasing trend 1985–.. increasing trend 2000s – increasing trend
Chen and Lu (2009)	1987–2005	Industrial agglomeration	Industrial agglomeration has boosted economic growth but also exacerbated interregional and urban-rural income disparities

Table 1. Continued

Author and year	Period	Variables that influence income inequality	Results
Fujiwara, Otsu and Saito (2008)	1950–2004	China 's reform and opening up policy	Opening-up per se is welfare improving for China but has had little impact on the issue given a balanced trade constraint
Kanbur and Zhang (2005)	1950–2000	Heavy industry played a key role in forming the enormous rural-urban gap while decentralisation and openness contributed to the rapid increase in inland-coastal disparity in the reform period of 1980s and 90s. Convergence and divergence of a nation's economy is dependent not only on its domestic policies but also on its openness.	There have been three peaks in inequality in the last fifty years; coinciding with the Great Famine of the late 1950s, the Cultural Revolution of the late 1960s and 1970s and the period of openness and global integration in the late 1990s.
Jianlin (2004)	1978–2002	The effects of resource endowments, the historical heritage, economic structure, government policy, marketisation, ownership, the institutional system, the legislative system, individual differences, wealth accumulation, economic development etc.	Increasing trend
Wenxiu (2004)	1978–2001	Imbalance in economic development; differences in natural conditions, historical endowments, human resource, disparities, ideological changes, ...	Increasing trends
Zhang *et al.* (2001)	1952–1997	The economic reforms, cultural revolution	Their results suggest that China's regions especially the eastern and the western regions, have converged to their own specific steady states over the past 40 years
Zhao *et al.* (2019)	1995–2013	Gender differentials	Reform of income distribution policies lead to more equal society
Liu and He (2019)	2004–2015	Public services	Basic public services narrow the urban-rural income gap
Hong *et al*. (2019)	1997–2011	Regional integration	Regional integration strengthens economic growth and reduce inequality
Chen (2019)	2001–2015	Misallocation of human capital	Better allocation of human capital lowers income inequality

Table 2. Estimated values of d for each series

i) No autocorrelation			
Series	**No terms**	**With intercept**	**With time trend**
GINI	0.97 (0.78, 1.24)	0.99 (0.80, 1.32)	**0.99 (0.78, 1.32)**
TFP	0.95 (0.80, 1.17)	0.41 (0.23, 0.83)	**0.47 (0.20, 0.85)**
URBAN	1.10 (1.00, 1.26)	2.06 (1.88, 2.34)	**2.06 (1.90, 2.31)**
URBAN	0.95 (0.80, 1.17)	2.08 (1.87, 2.37)	**2.04 (1.87, 2.29)**
RGDPC	1.88 (1.78, 2.03)	**1.93 (1.83, 2.11)**	1.93 (1.83, 2.11)
RGDPC	0.95 (0.78, 1.17)	1.16 (1.01, 1.65)	**1.23 (1.02, 1.68)**
SOCIAL	1.18 (1.05, 1.36)	**1.25 (1.11, 1.46)**	1.26 (1.12, 1.47)
HCAPITAL	0.94 (0.77, 1.16)	1.51 (1.32, 1.70)	**1.47 (1.32, 1.65)**
ii) With autocorrelation			
Series	No terms	With intercept	With time trend
GINI	0.59 (0.30, 1.04)	0.70 (0.58, 0.92)	**0.45 (0.58, 0.88)**
TFP	0.83 (0.53, 1.20)	0.03 (-0.21, 0.31)	**-0.16(-0.43, 0.33)**
URBAN	1.14 (0.96, 1.41)	1.73 (1.50, 2.13)	**1.85 (1.65, 2.18)**
URBAN	0.86 (0.55, 1.25)	1.60 (1.27, 2.11)	**1.74 (1.40, 2.16)**
RGDPC	1.82 (1.66, 2.01)	**1.84 (1.68, 2.04)**	1.84 (1.68, 2.04)
RGDPC	0.82 (0.51, 1.23)	0.92 (0.83, 1.03)	**0.81 (0.66, 1.04)**
SOCIAL	1.17 (0.92, 1.57)	**1.11 (0.88, 1.45)**	1.12 (0.88, 1.47)
HCAPITAL	0.82 (0.47, 1.25)	1.92 (0.94, 2.37)	**1.78 (1.06, 2.42)**

Note: In bold the selected models according to the deterministic terms. In parenthesis, the 95% confidence intervals for d.

Table 3a. Estimated coefficients with d = 0

Regressors	**Estimated value (t-value)**
Constant	-14.217 (-1.402)
TFP	-1.129 (-0.235)
URBAN	**-0.268 (-1.993)***
LGDPC	**6.683 (2.816)***
SOCIAL	1.134 (1.469)
HUKOU	**2.524 (3.688)***
HCAPITAL	2.683 (0.612)

Note: In bold, significance at the 5% level.

Table 3b. Estimated coefficients with d = 0

Regressors	**Estimated value (t-value)**
URBAN	**0.0979 (2.82)**
LGDPC	**4.0525 (2.63)**
HUKOU	**1.5162 (2.54)**

Note: In bold, significance at the 5% level.

Table 4a. Estimated coefficients with d = 0

	No autocorrelation	**Autocorrelation**
D	1.021 (0.725, 1.272)	0.467 (-0.191, 1.201)
Regressors	Estimated value (t-value)	Estimated value (t-value)
Constant	11.313 (0.921)	-1.909 (-0.230)
TFP	**-5.605 (-1.914)***	**-3.686 (-1.986)***
URBAN	0.028 (0.091)	-0.158 (-0.966)
LGDPC	**2.977 (1.885)***	**3.883 (1.994)***
SOCIAL	**2.188 (1.936)***	**0.916 (1.739)***
HUKOU	0.604 (0.706)	**2.180 (2.848)***
HCAPITAL	-2.718 (-0.250)	6.985 (1.367)

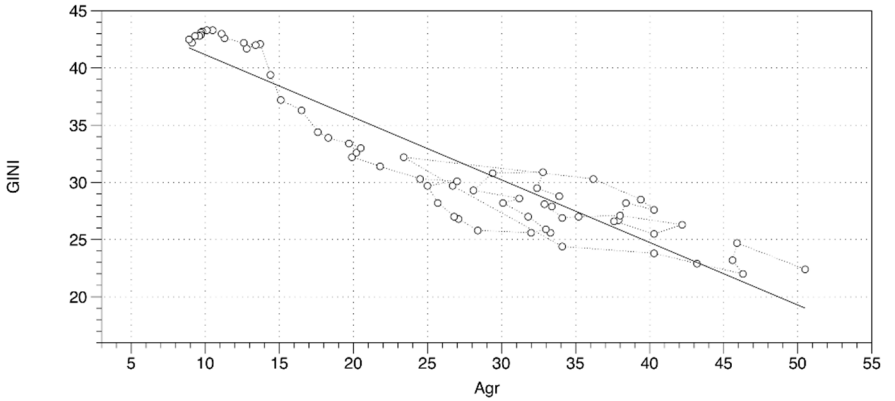
Note: In bold, significance at the 5% level.

Table 4b. Estimated coefficients with d = 0

	No autocorrelation	**Autocorrelation**
d	1.066 (0.831, 1.367)	0.454 (-0.277, 1.147)
Regressors	Estimated value (t-value)	Estimated value (t-value)
TFP	**-5.7442 (-2.02)**	**-3.2461 (-1.92)**
LGDPC	**4.5720 (9.08)**	**4.7873 (10.27)**
SOCIAL	**1.9102 (1.75)**	**0.1366 (2.19)**

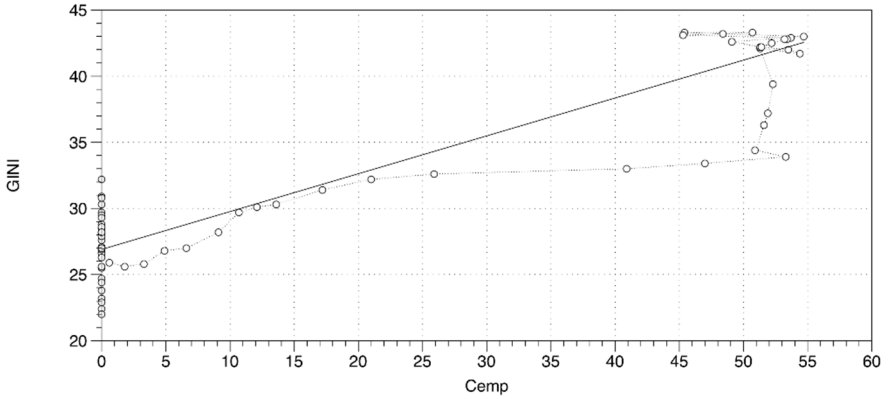
Note: In bold, significance at the 5% level.

Figure 1. Income inequality main determinants in China 1952–2017

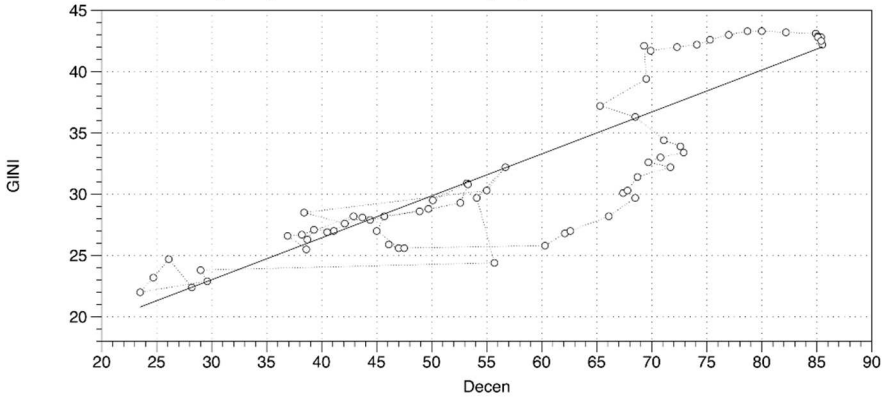


A. Income inequality and agriculture

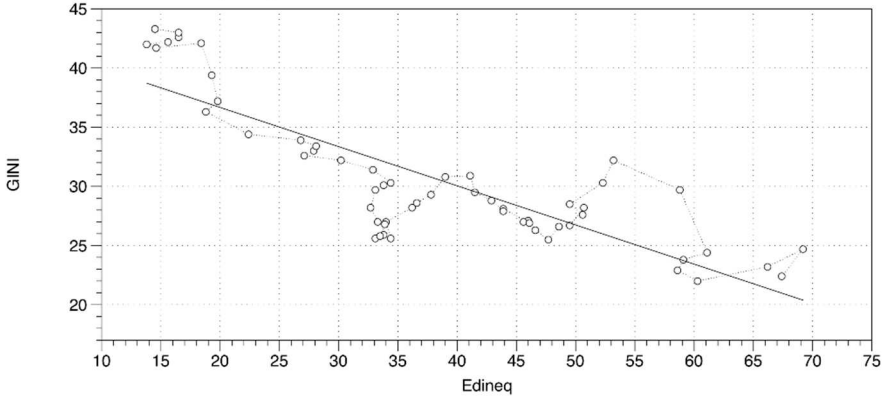
Figure 1. Continued



B. Income inequality and contractual employment

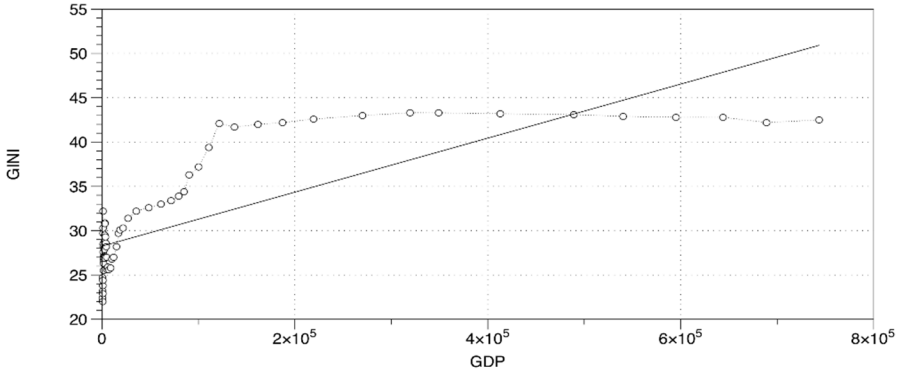


C. Income inequality and decentralization

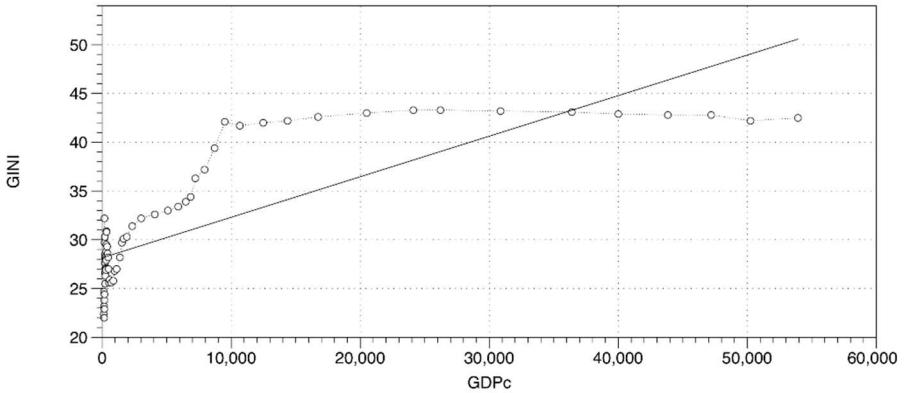


D. Income inequality and educational inequality

Figure 1. Continued



E. Income inequality and GDP



F. Income inequality and GDP per capita