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ABSTRACT

This paper carries out a pilot empirical study on how income inequality affects growth and the macro economy by means of incorporating panel data information into a macro-econometric model. China is used as the pilot field. Provincial urban and rural household data are used to construct inequality measures, which are then used to augment household consumption equations in the ADB China model. Model simulations are performed to study the effect of inequality on GDP growth and its sectoral components. Results show that inequality is a robust explanatory variable of consumption and that the way inequality develops over time carries certain negative consequences on GDP and sectoral growth.

Key words: Income inequality, Growth, Econometric model, China

JEL classification: R11, E21, D3, C5, C2

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1. Introduction

Since undertaking market reforms, the Chinese economy has achieved sustained high growth and rapid progress in poverty reduction. The World Bank estimates that in the more than two decades since reforms started, average income per capita in the country has quadrupled while more than 270 million people have been lifted out of poverty (Chen and Wang 2001). From 1978-2004, GDP growth in China averaged nearly 10 percent annually, the highest growth rate of any country in the world for the same period, and, at least in the near term, it has yet to show a sign of slowing down.

If there seems to be a dark lining to these extraordinary achievements, it is that inequality in the country – seen as a whole, within urban and rural areas, and across provinces – has also risen quite rapidly in the period (see, for example, World Bank 1997, Chen and Wang 2001, Kanbur and Zhang 2005). For any given level of natural or human capital, the greater the inequality the higher the poverty one could expect. Inequality is also seen to affect long-term economic growth, although there is no consensus on the direction of the effect.

If inequality affects growth positively, it is possible that the poverty-reducing impact of this growth offsets the direct adverse effect of inequality on welfare, and thus reason to tolerate relatively high inequality. On the other hand, if inequality affects growth negatively, then addressing it immediately should be an important concern.

This paper investigates empirically how much and in what ways income inequality affects China's economic growth by means of incorporating income disparity measures derived from provincial panel data of urban and rural household income into a macro-econometric model, and simulating the effects of changes in inequality on growth. The rest of the paper is structured as follows. Section 2 gives a summary of the inequality situation in China. Section 3 briefly surveys the literature on the transmission mechanism between inequality and economic growth, and then discusses the inequality measures available in general. Section 4 describes the estimation results of incorporating inequality into the macro-econometric model. Section 5 presents the results of model simulations showing the effects of changes in inequality on other economic variables. The last section concludes.

2. Background on Inequality in China

Inequality in the country has risen following the government's introduction of individual incentives (also known as the household responsibility system) and market forces in 1978 as these immediately began to increase returns to capital and land, diversify employment, and increase factor mobility (World Bank 1997). Inequality has risen significantly for the country as a whole, within urban and rural areas, between urban and rural areas, and across provinces. This is particularly interesting in view of the fact that inequality is found to remain fairly constant over time in many economies, e.g. see (Besley and Burgess 2003).

Krongkaew (2003) reports the per capita income Gini ratio in the whole of China to be at 0.29 in 1981, and to have risen progressively to 0.30 in 1984, 0.35 in 1989, 0.39 in 1995, and 0.46 in 2000. Li *et al* (2000) estimate that *within rural areas* the Gini ratio of household income rose from 0.21 to 0.34 from 1979 to 1995 and that *within urban areas* the Gini ratio went up from 0.16 to 0.28 in the same period. Li *et al* (2000) and Zhang (2003), meanwhile, report the inter-provincial per capita income Gini ratio to have been rising almost consistently from 0.32 in 1978, to 0.28 in 1983, 0.38 in 1988, 0.39 in 1995, 0.40 in 1999, and 0.42 in 2000.

The household responsibility system initially resulted in rural income growth surpassing urban income growth as farms achieved greater productivity, but this trend was soon reversed as agricultural productivity hit ceiling and rural income fell further behind urban income. In fact, one may divide the period 1981 up to the present for China into three different sub-periods differentiated by the growth-equity characteristic of the economy, as was done by the World Bank (1997). The period 1981-1984 could be classified as a period of *growth with equity* as real mean income increased by 12.6 percent a year during this period while the Gini ratio rose only marginally. The period 1984-1989 could be classified as a period of *inequality with little growth* as overall real mean income increased by less than one percent a year for this period, and this was very unevenly distributed as income of the richest decile increased while the income of the poorest decile fell (World Bank 1997).[1] Finally, the period 1990 up to the present is a period of *growth with inequality* as both overall real mean income and the Gini ratio grew rapidly.

Some researchers have claimed that China possibly has the largest income gap between the rural and urban sectors in the world, e.g. see (Lin 2003). Inequality decompositions done by the government show that the rural-urban income gap explained one-third of total inequality in 1995 and one-half the increase in inequality since 1985. Rural per capita income was 38.9 percent of urban per capita income in 1978, 53.8 percent in 1985, and was down to 35.9 percent in 2000 (Lin 2003). Li *et al* (2000) note the same diverging path of rural and urban incomes. This does not even take into account the set of publicly provided services – housing, pensions, health, education, and other entitlements – that augment urban incomes by an average of 80 percent. When these are considered, rural-urban disparities accounted for an

[1] However, this description may not be so accurate if we look at the official statistics on per capita GDP.

even greater share of total inequality (World Bank 1997). Figure 1 shows for the period 1992-2003 the widening gap between urban and rural per capita incomes.

Across provinces, the biggest source of increasing inequality appears to be between coastal and interior provinces. Coastal provinces benefited from their proximity to world markets, better infrastructure, and educated labor force as China opened to the outside world (World Bank 1997). Inter-provincial inequality accounted for a quarter of total inequality in 1995 and explained a third of the increase since 1985. In 1985 residents of interior China earned 75 percent as much as their coastal counterparts, by 1995 this had dropped to 50 percent (World Bank 1997).

3. Theories on inequality → growth nexus and measurement of inequality

One of the most famous postulates concerning inequality and growth was put forward by Kuznets (1955). In what has come to be known as Kuznet's hypothesis, it is postulated that in the course of the development of a country, inequality first rises before eventually declining – the inverted-U hypothesis. However, Kuznet's hypothesis implies a causal relationship of growth → inequality at a macro level, i.e. relating inequality to the stages of economic development.

Theories concerning how inequality affects economic growth are more micro oriented, i.e. relating heterogeneous consumers' behavior and investment indivisibility to aggregate demand, e.g. see (Bagliano and Bertola 2004). Specifically, the theories demonstrate that unequal income distribution among households – at a point in time but more especially as it changes over time[2] – affects aggregate consumption and demand structure through heterogeneous

[2] An early pioneer of this issue is H. Staehle (1937; 1938), who demonstrated how visible income distribution

propensities to consume and to save, and these effects are then transmitted to investment allocations, especially investment in human capital.[3] Consequent theories augment the transmission process by studying the effect of inequality on redistributive policies and the possible inefficiencies those may bring.[4] Broader sociological studies also pinpoint inequality as a possible cause for socio-political instability or violence,[5] and even for the differences in fertility rate.[6]

Many empirical studies have produced positive evidence about the link between growth and inequality, e.g. see (Aghion *et al* 1999). These studies can roughly be divided into two strands: cross-country analyses and micro-based (usually household survey based) studies. Cross-country analyses are frequently carried out by running regressions of growth rates on various proxies for inequality and redistribution effects together with relevant control variables. These are often criticized, however, for lack of structural models and thus methodological crudity, e.g. see (Figini 1999). Micro applied studies, on the other hand, while methodologically tighter, often lack a systematic and direct link to the macro economy.

One increasingly popular approach is to study the subject by means of computable general equilibrium (CGE) models. The CGE approach has the attraction of providing a logically consistent way of analyzing the link between aggregate economic growth and disaggregated

changed in Germany using quarterly data and how such changes affected aggregate market demand. In this context, he pointed out the weakness of Keynes' aggregate propensity to consume for overlooking the implication of income distribution and endorsed J. Robinson's (1933) proposal to bring income distribution between classes into discussions of aggregate output growth. Noticeably, Robinson's idea is precursory to the later development of growth models with two classes, e.g. see (Kaldor 1956; 1957), (Bourguignon 1981). An example of recent theories is (Zweimüller 2000), which shows how inequality can affect long-run growth negatively by depressing aggregate demand for innovative products.

[3] See for example (Benabou 1996), (Galor and Zeira 1993), (Galor and Tsiddon 1997).

[4] See, e.g. (Alesina and Rodrik 1994), (Perrson and Tabellini 1994), (Perotti 1996), (Deininger and Squire 1998) for evidence or lack of this.

[5] See for example (Knack and Keefer 2000).

[6] See for example (Perotti 1996).

income changes. A good example of this is the model developed recently by the Poverty and Social Impact Analysis Group at the World Bank (see Bourguignon *et al*, 2003). But the approach is not free of problems, an important one being that the structural equations of CGE models are heavily calibrated and thus beyond empirical tests. Other problems are that CGE models tend to lack realistic dynamic adjustment mechanisms and that they might not be able to account for the heterogeneous effects of a given policy within assumed homogenous agent groups, thus making them miss important sources of change in inequality.

In this paper, we attempt to augment a relatively robust macro-econometric model, later referred to as the ADB China model, so that it can include income distribution measures to enable us to study the impact of inequality on growth and the macro economy. These measures are derived from panel data and enter the macro model as exogenous variables. Hence, the growth→inequality nexus is beyond the scope of the present study.

The panel data consist of urban and rural household per capita incomes of 30 provinces and autonomous municipalities at annual frequency.[7] In the ADB China model, aggregate quarterly time series of average urban and rural household per capita incomes are used in the private consumption block, see (Qin *et al* 2005). Two types of inequality measures can be derived from the available data. One is inequality between urban and rural areas measured by the ratio of their mean per capita incomes using solely the aggregate time-series data, see Figure 1. The other is inequality within urban and within rural areas, obtained by exploiting provincial panel data on per capita incomes.

[7] Beijing, Tianjin and Shanghai are counted as independent entries, but Chongqing, a relatively new autonomous municipality, is still regarded as part of Sichuan in our sample.

As for the panel data based inequality, there are several possible measures according to the literature. Table 1 gives the formula for some of the more prevalently used ones, which are the Gini coefficient *(G)*, the variance (*V*), the coefficient of variation (*c*), the log of variance (*v1*), the variance of logarithms (*v2*), Atkinson's Index (*A*), Dalton's Index (*D*), Theil's Index (*T*), and Herfindahl's Index (*H*). In Figure 2, time-series graphs of each of these inequality measures are plotted using panel data set for the period 1992 – 2003.

Four basic properties are commonly used to evaluate the goodness of various inequality measures, e.g. see (Cowell 1995), (Deininger and Squire 1998), (Chakravarty 1999), and (Fields 2001). These properties are most widely known as 'anonymity', 'population homogeneity' or 'population independence', 'transfer principle' or 'the Pigou-Dalton condition', and 'income homogeneity' or 'scale independence' or 'normalization'. 'Anonymity' means that the names of the individuals are irrelevant to the question of inequality. 'Population homogeneity' means that when one income distribution is an *n*-fold replication of another, the two distributions would be regarded as equally unequal. 'Transfer principle' means that an income transfer from a rich person to a poor person that does not make the poor the richer of the two, reduces inequality. 'Income homogeneity' means that a relative inequality measure is scale invariant or homogeneous of degree zero in incomes.[8] Alternatively, these properties are referred to, respectively, as 'weak principle of transfers', 'principle of population', 'decomposability', and 'income scale independence'.[9]

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[8] Absolute inequality and relative inequality are not alternative measures of the same underlying concepts; they measure fundamentally differently concepts. Absolute inequality relies on dollar differences in real incomes. By contrast, relative inequality is measured in terms of income ratios.

[9] Cowell (1995) identifies an additional property – *strong principle of transfers*. An inequality measure satisfies this property if any transfer of income from a "rich" household to a "poor" one generates a reduction in inequality that increases as the distance between the two households' incomes increases.

Of the above inequality measures, the *weak principle of transfers* is satisfied by G, V, c, T, H, A, and D and failed by $v1$ and $v2$. The property of *income scale independence* is satisfied by all aforementioned inequality measures except V and D. All measures except D and H satisfy the *principle of population*. *Decomposability* is satisfied by all except $v1$, $v2$, and G. Therefore the measures that satisfy all four properties are c, T, and A, see the last column of Table 1. In the choice of which inequality measures to be finally included in the model, we consider only these last three measures.

4. Econometric model results

As mentioned above, separate consumption equations for urban and rural households are built in the ADB China model, following (He *et al* 2005). The model is a compact quarterly macro model built by Asian Development Bank jointly with the Institute of World Economics and Politics of the Chinese Academy of Social Sciences. The model currently contains 75 endogenous variables and 16 non-modeled variables, and is structured into six blocks: private income and consumption, investment, foreign trade, government, banking, and prices, see Figure 3 for a flow chart of the model. It is estimated based on a data sample starting from 1992Q1, see (Qin *et al* 2005) for more detailed description of the model and the modeling strategy.

The primary channel through which we believe inequality could enter the macro model is through the private consumption equations, similar to what Qin (2003) has done. The consumption equations are of the form:

$$(1) \qquad PCON_{it} = f(PCINC_{it}, IR\%_t, P\#C_t, \frac{PCINC_{ut}}{PCINC_{rt}}, INEQ_{rt}, INEQ_{ut}) \quad i = r, u$$

where *PCON* denotes per capita consumption, *PCINC* denotes per capita income, *P#C* denotes the consumer price index, *INEQ* denotes income inequality measures, *IR%* denotes the interest rate on demand deposits, the subscript i denotes subgroup of rural and urban households, and t denotes time. To get rid of the scale factors, we reformulate equation (1) in logarithms, i.e., we assume there are log-linear relationships between the variables, except for the interest rate and inequality variables.

The effect of inequality on consumption (and therefore savings) is of uncertain sign *a priori*, see e.g. (Ray 1998). If marginal savings increase with income, then an increase in inequality, insofar as it is equivalent to a transfer of income to the relatively rich, will mean an increase in aggregate savings *ceteris paribus*. On the other hand, if marginal savings decrease with income, an increase in inequality could lower savings.

In practice, regressions directly based on the log-linear form of (1) risks nonsense results due to the nonstationarity of most economic time series. Hence, we adopt the general → specific dynamic modeling approach, e.g. see (Hendry 1995). Specifically, we start with an autoregressive distributed-lag model based on (1), gradually reduce and re-parameterize it into a parsimonious, data-congruent and economically interpretable ECM. Statistical diagnostic tests, parameter constancy tests, and economic interpretability of individual coefficients are used extensively as the main criteria in the model reduction.[10] We pay particular attention to individual parameter constancy, as this is vital in ensuring relatively high confidence in model forecasts and simulations.

[10] The softwares PcGive 10.0 and PcGETS 1.0 are used in the model reduction and estimation (see Doornik and Hendry 2001).

As mentioned in Section 3, three types of inequality measures which satisfy all the four properties are chosen to be included in the China model, and these are the coefficient of variation, Theil's index, and Atkinson's index. Through modeling experiments, we find that the results are consistent for all three measures but that using Theil's index generally produces a more parsimonious model. For this reason, we decide to use Theil's index as the inequality measure in the model. The sample size is 1992Q1-2003Q4. A simple smoothing method is used to interpolate annual inequality measures into quarterly series.

Tables 2 and 3 present the final model reduction and estimation results of the two consumption equations based on (1) together with the original equations and the relevant diagnostic test statistics.[11] The original equations are simply formulated without the inequality measures, i.e.:

(2) $$PCON_{it} = f(PCINC_{it}, IR\%_t, P\#C_t) \quad i = r, u$$

A number of interesting observations are discernible from the tables. First, the encompassing test statistics show that the inclusion of inequality measures improves the equations significantly. Second, changes in Theil's inequality measures are found to exert only short-run impact. These two results corroborate the classical finding, e.g. (Staehle 1937; 1938) that income inequality cannot be ignored in determining aggregate consumption, especially when the inequality is changing over time. Noticeably, urban and rural households react to the changing gap between urban and rural inequality measures and, in addition, urban households also react to changes in urban inequality. The short-run, positive reaction of rural households towards consumption with respect to increasing inequality may be explained by the fact that

[11] The original equations are from the 2004 version of the China model, which is also used for the later simulations. The model presented in (Qin *et al* 2005) contains some modifications of that version.

the rural households became more dependent on cash consumption rather than self-sustained consumption during the sample period. Finally, an increase in average income level of the urban/rural households relative to the rural/urban households is found to exert significantly negative long-run impact on the urban/rural consumption. This suggests that urban/rural households exhibit a greater savings motive when they perceive their income growing steadily faster than their rural/urban counterparts. This result partly conforms to the theory that inequality affects aggregate demand negatively in the long run, e.g. see (Zweimüller 2000).

Of course, it is inconclusive to infer that inequality is definitely harmful for long-run aggregate demand by looking at the consumption effects alone. One also needs to take into account the effect of inequality – even indirect ones – on the other variables. For instance, suppressed consumption will raise savings and hence may encourage investment, and eventually enhance future consumption. To investigate the overall macro impact of inequality, we carry out a number of model simulations, which are presented in the next section.

5. Model simulations

In order to study how inequality affects growth and the macro economy, we substitute, in the ADB China model, the two consumption equations without inequality measures (Model 1 in Tables 2 and 3) by the two equations with the measures (Model 2 in Tables 2 and 3), and carry out two sets of model simulations.[12] The base run assumes that inequality is constant at the 2003Q4 level from the beginning of 2004 up to the end of the simulation period, which covers 2005Q1 – 2010Q4.[13]

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[12] The simulations are carried out using WinSolve, see (Pierse 2001) for a detailed description of the software.
[13] The simulations start from 2005Q1 to avoid the periods where there are already actual values for the variables of interest, even though the data series of the inequality measures end at 2003Q4.

The first set of simulations is the conventional impulse, step, and trend shocks on each of the urban and rural inequality measures. These shocks are defined below.

1. *Impulse shock* refers to an increase in inequality for one year (2005Q1 – 2005Q4) by 10% from its 2003Q4 level; then it returns to the 2003Q4 level at 2006Q1 and remains so to the end of the simulation period.
2. *Step shock* refers to an increase in inequality by 10% from its 2003Q4 level at 2005Q1, and remains so to the end of the simulation period.
3. *Trend shock* refers to a linear increase in inequality at 10% per annum starting from 2005Q1. The growth rate is chosen with reference to the increase in overall Theil index during recent years, e.g. 9% in 2002 and 13% in 2003 (see also the bottom left panel of Figure 2).

Notice that *INEQu* and *INEQr*, the inequality measures, are calculated from panel data whereas *PCINCu* and *PCINCr*, the household per capita income series, are taken from *China Monthly Economic Indicators*. Therefore, the shocks defined above implicitly assume that changes in *INEQu* and *INEQr* do not affect *PCINCu* and *PCINCr* directly. However, as the income variables are endogenous in the model, they will be affected indirectly by changes in the inequality measures. Hence, the only assumption we need to make is that the shocks do not affect the income levels at the initial point when they first occur. In Figures 4 and 5, the indirect effect of the shocks on *PCINCu* and *PCINCr* are plotted (top panels). It is interesting to see that increasing urban inequality would, to a large extent, stimulate the growth of both urban and rural average income level whereas both urban and rural average incomes would decline from increasing rural inequality. More interestingly, the rural household income growth would not be significantly affected downwards if the inequality situation keeps evolving at the present pace (the trend shock case), i.e. unless there is an abrupt deterioration in inequality (the impulse and step shock cases). Nevertheless, this result highlights the need, at the macro level, to address rural inequality, especially considering that much of the poverty is concentrated in the rural area in China.

Figures 4 and 5 also demonstrate, for the urban and rural sectors respectively, the effects of the inequality shocks on GDP, its supply-side components of the three sector output, and its demand-side components of private consumption and capital formation, all measured in constant price. In the urban scenario (Figure 4), rural inequality is assumed to remain at its 2003Q4 level throughout the simulation period. The same applies to the rural scenario (Figure 5). It can be seen that the overall effects of rising inequality on GDP growth are almost negligibly small. In the urban scenario, rising inequality appears to stimulate slightly the production of the industry and services sectors if viewed from the supply-side of GDP. Agriculture seems to be the only sector that would get virtually no long-run benefit. In comparison, agriculture is slightly worse off and the other two sectors are significantly worse off in the rural scenario.

From the demand-side of GDP, private consumption is the most responsive to inequality shocks in terms of both velocity and volatility, with the response rapidly tapering off to virtually zero. This is not surprising given the household consumption equations reported in Tables 2 and 3. The volatility in aggregate consumption undulates on to aggregate investment, whose responses oscillate more persistently and more strongly than those of the three sectors. In a recent study by Qin, Cagas, He and Quising (2005), impulse shocks in investment are found to affect the output growth in the industry and services sectors far more than that of the agricultural sector. This helps to explain why the output growth of the three sectors responds so differently to the inequality shocks. If judged by economic stability, the simulation results show that changing inequality adversely affects the stability by encouraging more volatility in the growth of aggregate consumption, investment, and GDP.

The second set of simulations tests the effects of inequality as measured by the urban and rural income gap, *PCINCu/PCINCr*. Default forecasting shows that this gap remains at about 2.5 (i.e. urban per capita income is two and half times of rural per capita income on average) for the foreseeable future. Here the interest is to see what happens to the economy when the current gap narrows versus the situation when it widens. The simulations are designed as follows: the *narrowing gap scenario* assumes that beginning 2005Q1, the government gives a lump-sum transfer to the rural households equivalent to 1% of the previous year's GDP; the *widening gap scenario*, on the other hand, assumes that the government taxes the rural household income an amount equivalent to 1% of the previous year's GDP.[14] The two scenarios amount to shifting the existing income gap by 0.15 roughly during the simulation period, as shown in Figure 6. It is clear from the figure that, for the most part, the two scenarios result in opposite effects. Narrowing the income gap has an immediate and sustained positive impact on GDP growth over the simulation period, whereas widening the gap has a negative immediate effect that eventually tapers off and becomes positive towards the end of the simulation period. On the whole, the narrowing-gap scenario results in weaker macroeconomic responses in terms of magnitude as rural households account for a smaller share of aggregate private consumption than urban households.

[14] The simulations implicitly assume that the taxes and transfers are proportional to household incomes so that within-urban and within-rural inequalities are unaffected.

In terms of dynamics, the step shocks of changing urban and rural income gaps affect private consumption almost immediately and very significantly, and in turn its responses are transmitted to investment, agricultural production, industrial production and services supply. The narrowing-gap scenario initially boosts aggregate private consumption by up to around 2.7% in the short run, whereas the widening-gap scenario depresses it, and both effects recede quickly to about 0.15~0.19% in absolute value in the long run. Consumption responses in turn are transmitted to demand for sectoral output, especially for agricultural produce and services, and these undulate on to investment demand as well. Notice that the responses of the secondary sector follow closely those of investment, only on a smaller scale, as this is the sector which is most dependent on investment. In comparison, the primary and tertiary sectors are more demand-driven. Hence their growths are buoyed by the increase in disposable income in the narrowing-gap scenario, and vice versa in the widening-gap scenario.

Compared to the results from the first set of simulations, the results of the second set show evidently that further widening of rural-urban income inequality would hinder economic growth, while narrowing the inequality would actually boost long-run growth. Overall, the simulations suggest that further disparate income distribution is unlikely to contribute favorably to sustaining steady economic growth in the long run, even though the likely adverse impact may not yet be very significant at the macro level.

6. Conclusion

A pilot empirical study is carried out here on how income inequality affects growth and the macro economy by means of incorporating panel data information into a macro-econometric model. China is used as the pilot field. A panel of provincial urban and rural household income data is used to construct inequality measures, which are used to augment the urban and rural consumption equations of the ADB China model. Simulations are then carried out on the modified model to show how future changes in income inequality would affect the macro economy.

Through model augmentation, the rapidly changing income inequality is found to exert significant impact on consumption of both urban and rural households. While rising urban inequality holds back urban consumption in the short run, increase in the relative income level between rural and urban areas is found to stimulate household savings in the long run.

Through model simulations, we observe several interesting results. We find that significant changes in inequality – whether within-urban, within-rural, or urban-rural – carry negative effects on macro-economic stability as they cause consumption and then investment to undulate. Comparing the effects of shocking each of the urban and rural inequality measures, we find that increases in urban inequality carry more favorable (or less negative) effects to the macro economy than increases in rural inequality. In simulating the impact of changing urban-rural average income disparity, we see that GDP growth is highest in the long run when urban-rural income gap is narrowed (i.e. rural-favorable growth), as compared with the scenario where it is widened, and that the urban-favorable growth scenario (i.e. widening urban-rural gap) would only benefit the industrial sector in the long run.

Several extensions of the present study are desirable. First, it is desirable to extend the consumption block to base it on panel data entirely so as to achieve data consistency between aggregate income levels and income inequality measures. Secondly, it is desirable to explore explicit links between income inequality and employment distribution among the three sectors of GDP. More data would be needed for this extension. Thirdly, it is desirable to extend the fiscal block of the model to establish explicit links between income inequality and income re-distribution policies. The last aspect is especially important since significant alleviation of income inequality entails powerful fiscal policy measures, see (Besley and Burgess 2003). Whichever direction of extension, a wider mix of time-series and panel data in macroeconometric modeling seems the desirable way forward.

Appendix: Main data sources and variable definition

National Bureau of Statistics: *Statistics Yearbook of China* (SYC), *China Monthly Economic Indicators* (CMEI), *Comprehensive Statistical Data and Materials on 50 years of New China* (1999, CSDM). Some of the historical data are from National Bureau of Statistics directly.

Variables	Definition	Source
GDPc	Gross Domestic Product, quarterly frequency (million yuan, in 1992Q1 price)	CMEI
INQu, INQr	Income Inequality measures, quarterly frequency interpolated from annual data (Theil's index is the final choice)	Own calculation
IR%	Interest rate on demand deposits, quarterly frequency	CMEI
P#C	Consumer Price Index, quarterly frequency 1992Q1=100	CMEI
$PCINCr_i$	Provincial Per Capita Net Income of Rural Households of China, annual frequency (*yuan*)	CSDM
PCINCr	Per Capita Net Income of Rural Households of China, quarterly frequency (*yuan*)	CMEI
$PCINCu_i$	Provincial Per Capita Disposable Income of Urban Households of China, annual frequency (*yuan*)	CSDM
PCINCu	Per Capita Disposable Income of Urban Households of China (*yuan*)	CMEI
PCONr	Per Capita Living Consumption of Rural Households of China, quarterly frequency (*yuan*)	CSDM & CMEI
PCONu	Per Capita Living Consumption of Urban Households of China, quarterly frequency (*yuan*)	CSDM & CMEI
POPr	Population of Rural China, annual frequency (1000 persons)	SYC
$POPr_i$	Provincial Population of Rural China, annual frequency (1000 persons)	CSDM
POPu	Population of Urban China, annual frequency (1000 persons)	SYC
$POPu_i$	Provincial Population of Urban China, annual frequency (1000 persons)	CSDM

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Table 1. Inequality Measures and their Properties

Measure	Formula	Properties: a. weak principle of transfers b. scale independence c.,principle of population d. decomposability
1. Gini coefficient	$G = \frac{2\,\mathrm{covar}(y, r_y)}{n\bar{y}}$	a,b,c
2. Variance	$V = \frac{1}{n}\sum_{i=1}^{n}[y_i - \bar{y}]^2$	a,c,d
3. Coefficient of variation	$c = \frac{\sqrt{V}}{\bar{y}}$	a,b,c,d
4. Log of variance	$v1 = \frac{1}{n}\sum_{i=1}^{n}\left[\log\left(\frac{y_i}{\bar{y}}\right)\right]^2$	c,d
5. Variance of logarithms	$v2 = \frac{1}{n}\sum_{i=1}^{n}\left[\log(y_i) - \frac{1}{n}\sum_{i=1}^{n}\log(y_i)\right]^2$	c,d
6. Atkinson's Index	$A = 1 - \frac{1}{\bar{y}}U^{-1}\left(\frac{1}{n}\sum_{i=1}^{n}U(y_i)\right)$	a,b,c,d
7. Dalton's Index	$D = 1 - \frac{\frac{1}{n}\sum_{i=1}^{n}U(y_i)}{U(\bar{y})}$	a,d
8. Theil's Index	$T = \frac{1}{n}\sum_{i=1}^{n}\frac{y_i}{\bar{y}}\log\left(\frac{y_i}{\bar{y}}\right)$	a,b,c,d
9. Herfindahl's Index	$H = \left(\frac{y_i}{n\bar{y}}\right)^2$	a,b,d

Notes: For all measures *y* denotes income. 1. r_y is the correlation coefficient between income and the ranks of all individuals according to their income from poorest to richest, *N* is the population size; 2. $\bar{y}$ is mean income; 6. *U(·)* denotes a social utility function which in this paper we assumed to take the form of a constant relative inequality aversion utility function

Table 2. Per capita consumption of urban household

Without inequality measure (Model 1)	$\Delta_2 \ln(PCONu)_t = -\underset{(0.0301)}{0.0644} - \underset{(0.0138)}{0.0419} *(SQ1+SQ2) - \underset{(0.1006)}{0.3761} *\Delta_2 \ln(PCONu)_{t-2} + \underset{(0.0733)}{0.4562} *\Delta_2 \ln(PCINCu)_t + \underset{(0.1032)}{0.2573} *\Delta_4 \ln(P\#C)_t - \underset{(0.1126)}{0.5172} *\left(\ln\frac{PCONu}{PCINCu}+0.005*\left(IR\%-100*\Delta_4 \ln(P\#C)\right)\right)_{t-2}$		
Residual Diagnostics	σ (standard error) No autocorrelation Normality Homoscedasticity RESET	0.0245413 F(3,32) = 1.5187 [0.2285] $\chi^2(2)$ = 3.2946 [0.1926] F(9,25) = 1.7550 [0.1285] F(1,34) = 1.5233 [0.2256]	
With inequality measure (Model 2)	$\Delta_2 \ln(PCONu)_t = -\underset{(0.0107)}{0.0305} - \underset{(0.0751)}{0.3854} *\Delta_2 \ln(PCONu)_{t-2} - \underset{(0.0139)}{0.0341} *SQ2 - \underset{(0.0185)}{0.0612} *SQ3 + \underset{(0.0523)}{0.3742} *\Delta_2 \ln(PCINCu)_t + \underset{(0.0608)}{0.2628} *\Delta_4 \ln(PCINCu)_{t-1} + \underset{(0.3490)}{0.5805} *\Delta_2\Delta_4 \ln(P\#C)_t + \underset{(6.306)}{18.5771} *\Delta\Delta(INEQu-INEQr)_{t-1} - \underset{(11.10)}{43.72} *\Delta\Delta INEQu_{t-1} - \underset{(0.0752)}{0.7333} * \left[\ln\frac{PCONu}{PCINCu}+0.005*\left(IR\%-100*\Delta 4\ln(P\#C)\right)_{-1}+0.13*\ln\left(\frac{PCINCu}{PCINCr}\right)_{-1}\right]_{t-2}$		
Residual Diagnostics	σ (standard error) No autocorrelation Normality Homoscedasticity RESET	0.01798 F(3,28) = 1.6566 [0.1989] $\chi^2(2)$ = 0.4401 [0.8025] F(16,14) = 1.3718 [0.2790] F(1,30) = 0.9166 [0.3460]	
Encompass-ing test	 Cox Ericsson IV Sargan Joint Model	Model 1 versus Model 2 N(0,1) = -8.620 [0.0000]** N(0,1) = 5.032 [0.0000]** χ^2 (7) = 18.859 [0.0086]** F(7,28) = 4.6736 [0.0014]**	Model 2 versus Model 1 N(0,1) = -0.4500 [0.6527] N(0,1) = 0.1229 [0.7023] χ^2 (3) = 0.92356 [0.8197] F(3,28) = 0.2866 [0.8347]

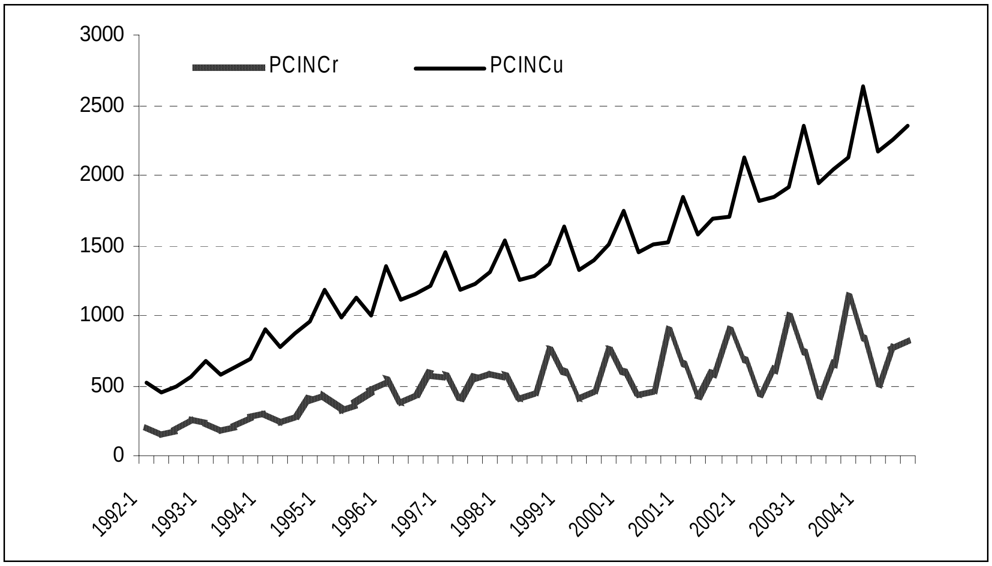
Note: The variable notations are given in the appendix. Δ_2 denotes second-order difference, i.e. x_t-x_{t-2}. *SQ* denotes quarterly seasonal dummy. The statistics in the brackets below coefficient estimates are standard errors. The statistics in the squared brackets following test statistics are the associated probabilities; the ** mark indicates that the probability is smaller than 1%, i.e. strongly rejecting the null hypothesis.

Table 3. Per capita consumption of rural household

Without inequality measure (Model 1)	$\Delta_3 \ln(PCONr)_t = -\underset{(0.0390)}{0.4190} + \underset{(0.0218)}{0.3226} * SQ1 - \underset{(0.002)}{0.0064} * \Delta_3 \left(IR\% - 100 * \Delta_4 \ln(P\#C)\right)_t + \underset{(0.0041)}{0.0113} * \Delta\left(IR\% - 100 * \Delta_4 \ln(P\#C)\right)_{t-3} + \underset{(0.0323)}{0.5159} * \Delta_3 \ln(PCINCr)_t + \underset{(0.0218)}{0.1367} * \Delta \ln(PCINCr)_{t-2} - \underset{(0.0605)}{0.5971} * \left(\ln \frac{PCONr}{PCINCr} + 0.007 * \left(IR\% - 100 * \Delta_4 \ln(P\#C)\right)\right)_{t-3}$		
Residual Diagnostics	σ (standard error) No autocorrelation Normality Homoscedasticity RESET	0.03896 F(3,30) = 1.7641 [0.1753] $\chi^2(2)$ = 0.2127 [0.8991] F(11,21)= 0.9133 [0.5451] F(1,32) = 0.1853 [0.6697]	
With inequality measure (Model 2)	$\Delta_3 \ln(PCONr)_t = -\underset{(0.0629)}{1.0056} + \underset{(0.0329)}{0.2338} * SQ1 - \underset{(0.0017)}{0.0095} * \Delta_3 \left(IR\% - 100 * \Delta_4 \ln(P\# C)\right)_t + \underset{(0.0016)}{0.0058} * \Delta_3 \left(IR\% - 100 * \Delta_4 \ln(P\# C)\right)_{t-3} + \underset{(0.0257)}{0.3755} * \Delta\Delta_3 \ln(PCINCr)_t + \underset{(0.0592)}{0.3537} * \Delta_3 \left(\ln \frac{PCINCr}{PCINCu}\right)_{t-1} + \underset{(0.0258)}{0.1525} * \Delta \left(\ln \frac{PCINCr}{PCINCu}\right)_{t-2} + \underset{(6.059)}{16.939} * \Delta\left(INEQr - INEQu\right)_t - \underset{(0.0615)}{0.9921} * \left(\ln \frac{PCONr}{PCINCr} + 0.008 * \left(IR\% - 100 * \Delta_4 \ln(P\# C)\right) + 0.4 * \left(\ln \frac{PCINCr}{PCINCu}\right)\right)_{t-3}$		
Residual Diagnostics	σ (standard error) No autocorrelation Normality Homoscedasticity RESET	0.03023 F(3,26) = 0.8101 [0.4998] $\chi^2(2)$ = 1.3326 [0.5136] F(15,13) = 0.6528 [0.7869] F(1,28) = 0.2033 [0.6556]	
Encompass -ing test		Model 1 versus Model 2	Model 2 versus Model 1
	Cox	N(0,1) = -6.590 [0.0000]**	N(0,1) = -0.5074 [0.6119]
	Ericsson IV	N(0,1) = 3.871 [0.0001]**	N(0,1) = 0.4279 [0.6687]
	Sargan	χ^2 (6) = 15.470 [0.0169]*	χ^2 (4) = 2.5040 [0.6439]
	Joint Model	F(6,25) = 4.1504 [0.0050]**	F(4,25) = 0.5907 [0.6725]

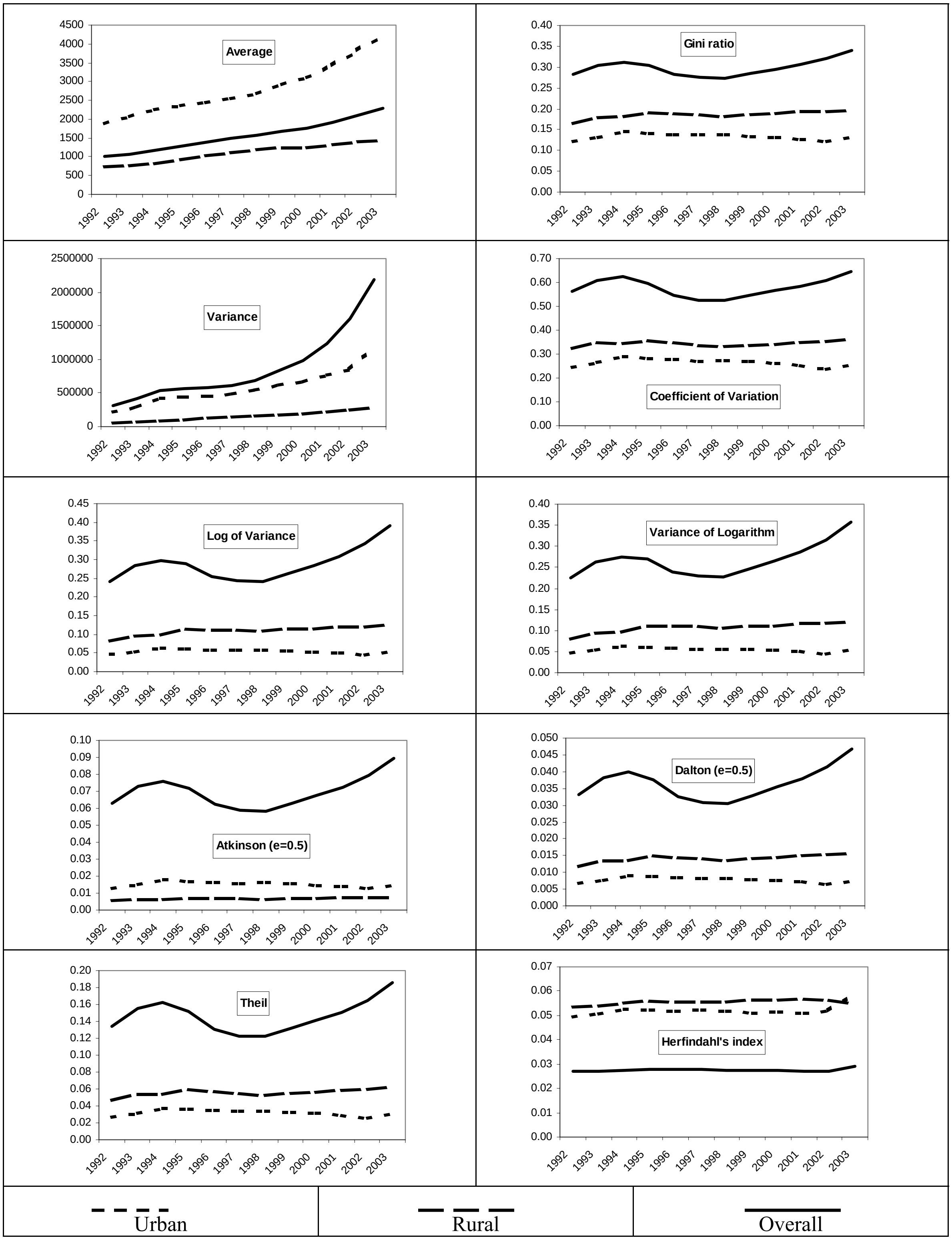
Note: See the note in Table 2.

Figure 1. Per capita household income (*RMB* per quarter)



Note: Figures are in nominal terms. See the appendix for the data source.

Figure 2. Urban, Rural and Overall Inter-provincial Per capita Income Inequality



*Source: Authors' computations. Gini ratios were computed using the Distribution Analysis Software (DAD).

Figure 3. A flow chart of the ADB China model

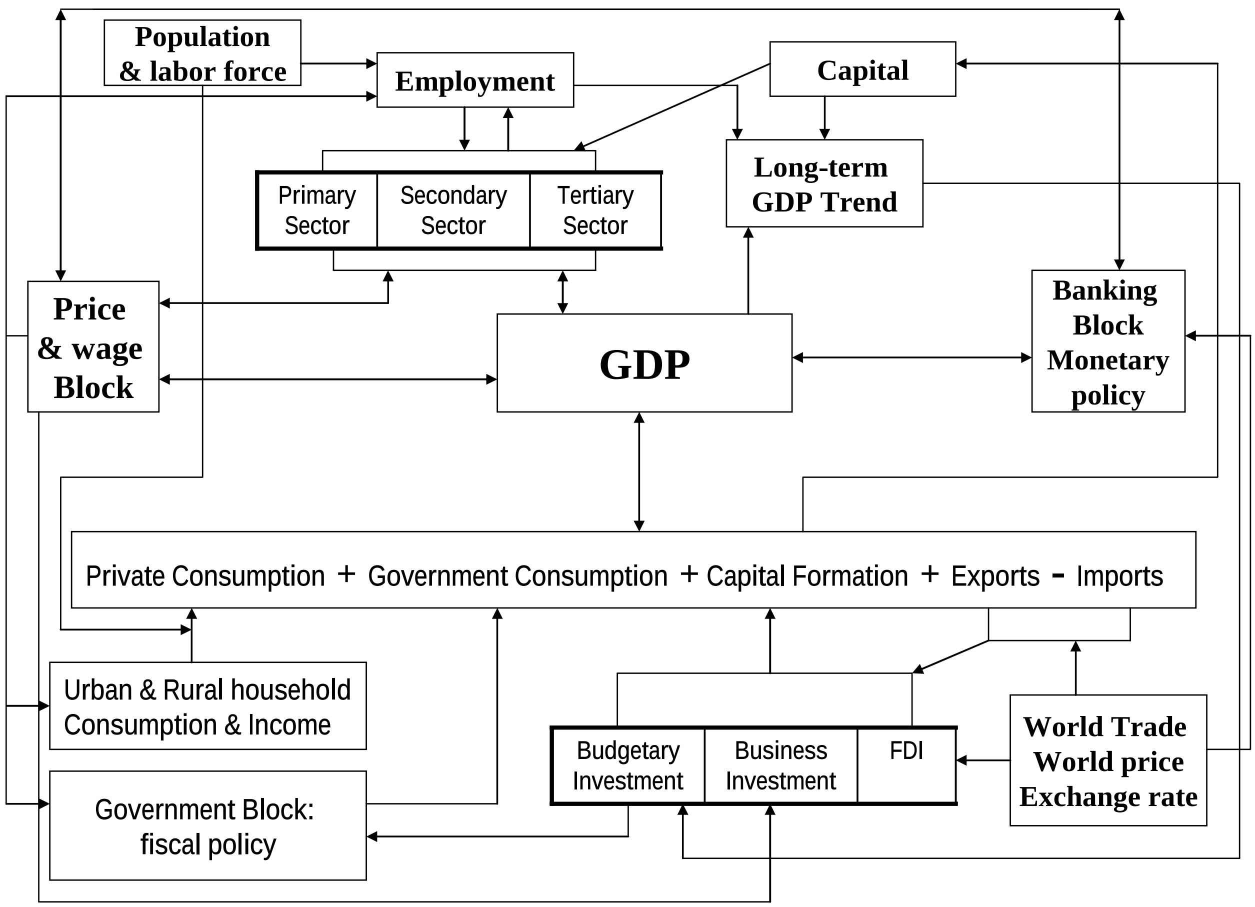
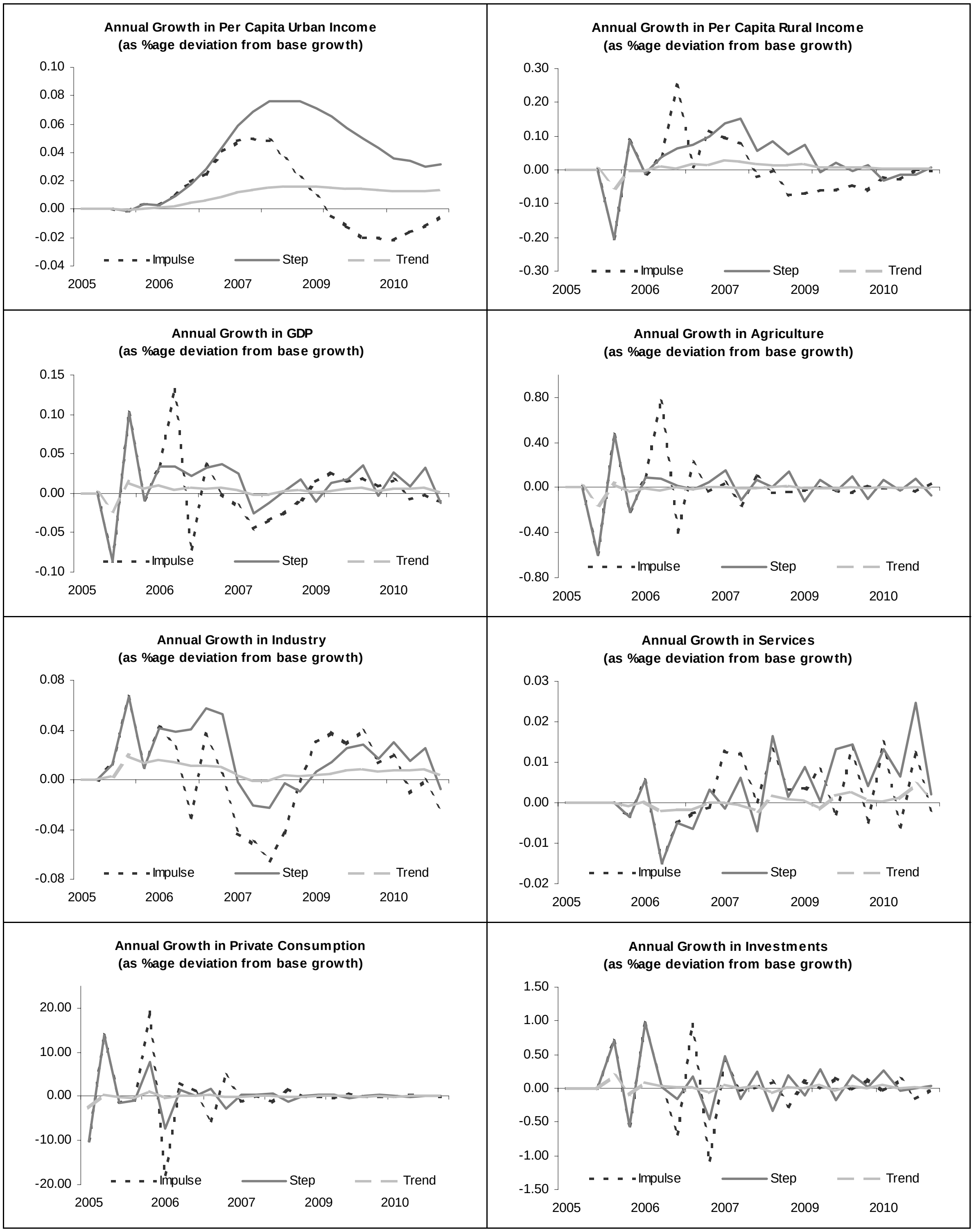


Figure 4. Urban Inequality Shocks



Note: the scale of each vertical axis is quite different from each other.

Figure 5. Rural Inequality Shocks

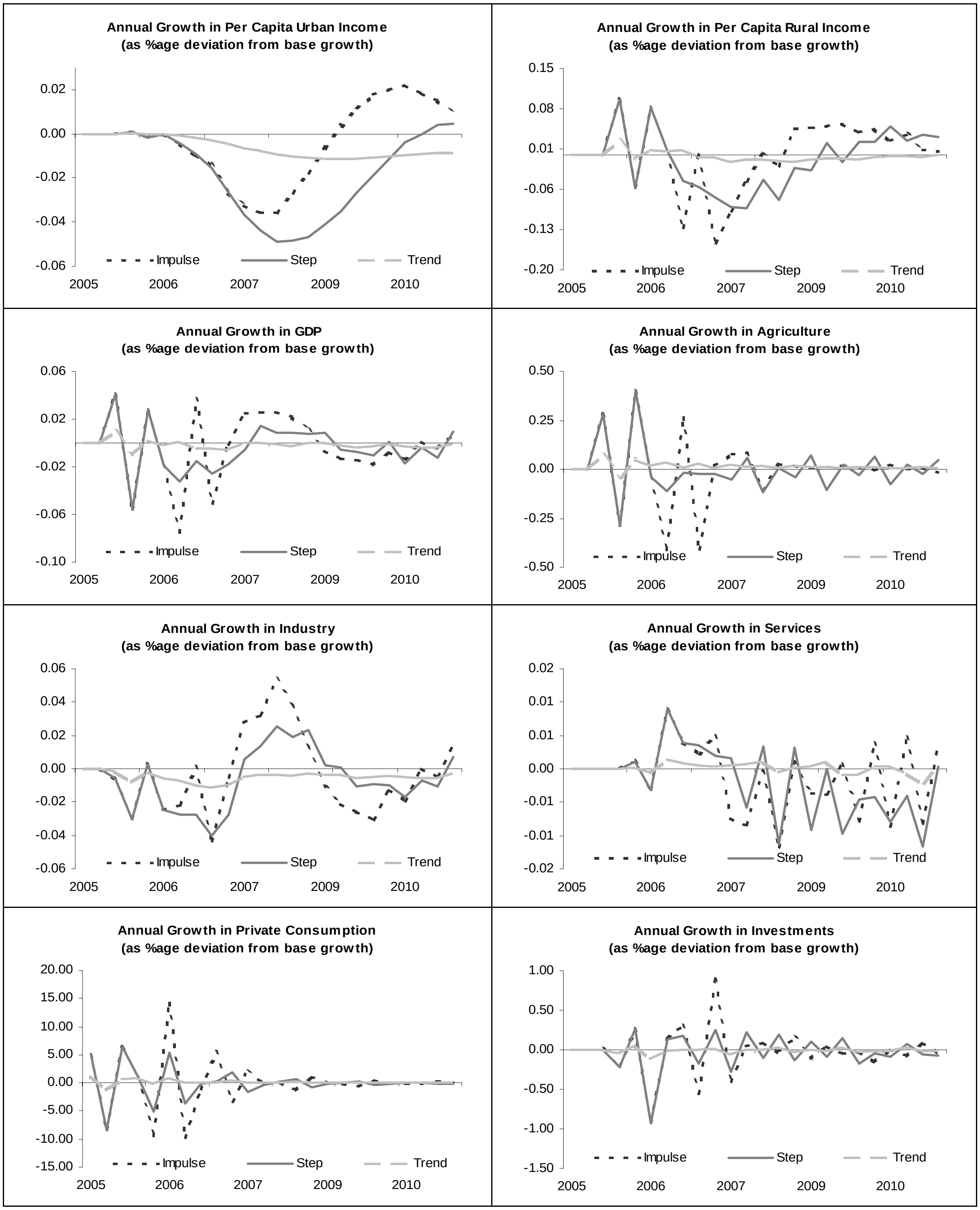
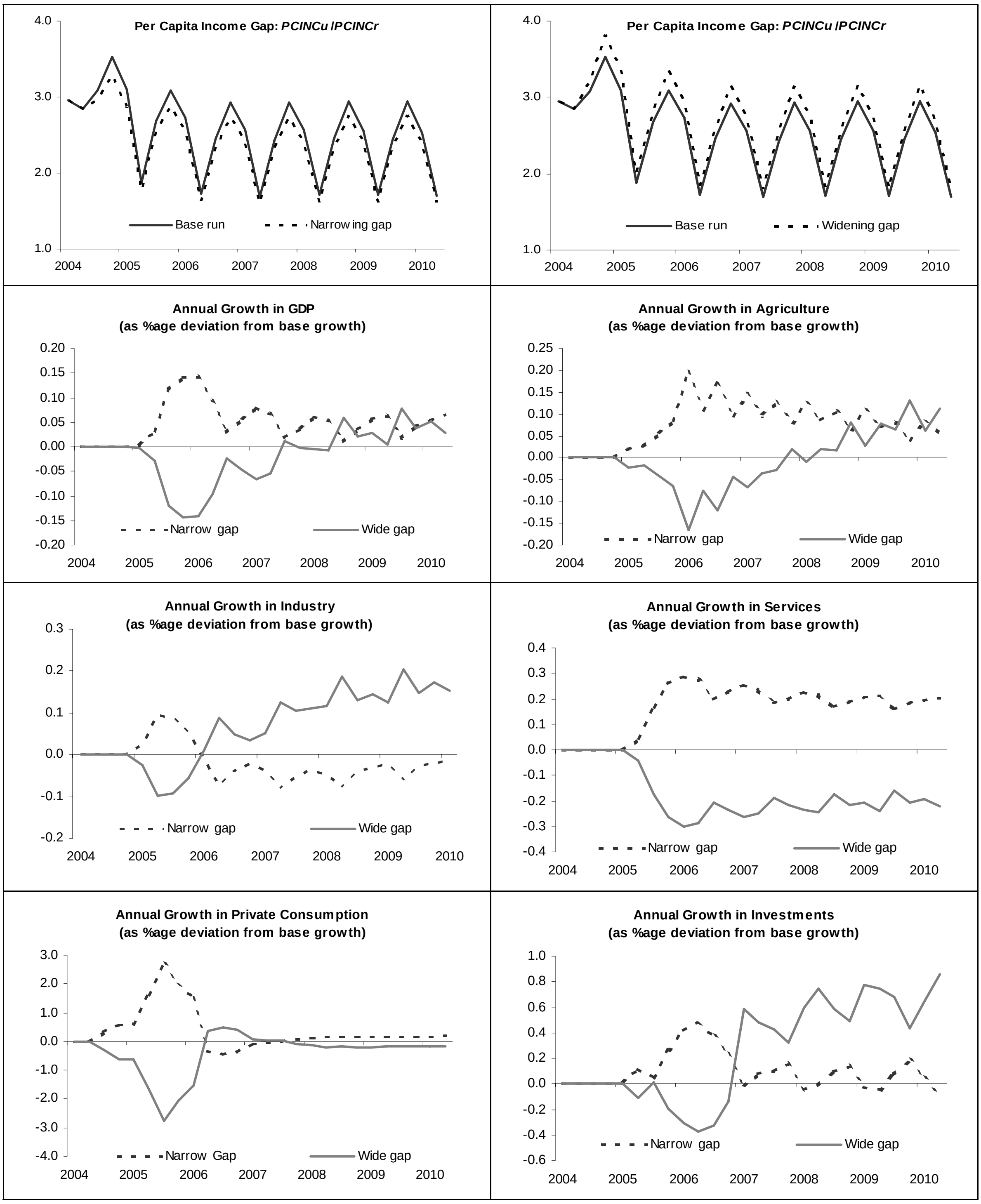


Figure 6. Rural-Urban Income Gap Shocks



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