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Urbanization forces driving rural urban income disparity: Evidence from metropolitan areas in China

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ABSTRACT

The rural urban income gap in China ranks as one of the largest in the world. This imbalanced rural urban relationship and the associated socioeconomic disparity have caused a weak and inefficient resource allocation, harmed the country's long-term economic development, and led to scores of socioeconomic problems. Concurrent with the widening rural urban income gap, China has been transformed by rapid urbanization. However, to date, there is limited understanding of the links between urbanization forces and this rural urban income disparity. This study uses the dynamic panel data model to investigate the influence of both economic and institutional urbanization forces and other socioeconomic factors on China's rural urban income disparity. Our results show that two economic urbanization factors—rural productivity and urban productivity—have contrasting effects on this income disparity. While rural productivity can significantly narrow the rural urban income disparity, urban productivity can positively contribute to widening the rural urban income disparity. We also find that the *hukou* openness policy negatively affects the rural urban income disparity with a one-year lag. Finally, consistent with the Kuznets theory, per capita GDP and urban population size both negatively correlate with the rural urban income disparity. Our findings provide insights into why rapid urbanization and the widening of the rural urban income gap coexist in China. Moreover, our results provide clear policy implications on how to mitigate the disparity. The most compelling suggestion is that sustainable agricultural productivity improvement is critical to achieving the goal of mitigating the income gap between rural and urban areas.

1. Introduction

China's rural urban income gap ranks as one of the largest over the globe (UN, 2012). The ratio of per capita disposable income of the country's urban residents versus rural residents increased by 42.3%—from 2.20 in 1990 to 3.13 in 2011 (NBSC, 1991–2019). This rural urban income disparity substantially affects the regional disparity in China (Kanbur and Zhang, 1999; Luo et al., 2018; Wan and Zhou, 2005) and is a major component of its overall income inequality (Sicular et al., 2007a,b; Wan, 2007). Further, the imbalanced rural urban relationship and the associated socioeconomic disparity have caused weak and inefficient resource allocation, harmed the country's long-term economic development, and led to scores of socioeconomic problems (De La Croix and Doepke, 2003; Xie and Zhou, 2014; Yuan et al., 2018; Wan et al., 2006). Therefore, a better understanding on the major factors that influence the income disparity is critical to formulate effective policies that can mitigate the rural urban income difference, and achieve coordinated rural and urban development.

Concurrent with the widening rural urban income difference, China has been transformed by rapid urbanization (Song et al., 2012; Xing and Zhang, 2017). The proportion of its urban population surged from 26.4% to 52.6% during 1990–2012 (NBSC, 1991–2013) (Fig. 1). Moreover, extrapolated from this trend, it is projected that a 213 million will be added to the country's urban population over the next two decades (UN, 2018). There has been some consensus in the literature that this urbanization process can be an important factor in narrowing the rural urban income difference (Lu and Chen, 2006; Wang et al., 2019; Li et al., 2014, 2019; Chen and Lin, 2014; Lin and Chen, 2011). In this vein, the Chinese government has promoted urbanization as a development strategy to reduce this gap. As a result, China's urbanization rate has increased consistently for more than three decades. However, contrary to expectations, the rural urban income gap has widened, with the ratio of per capita disposable income of urban relative to rural residents reaching a record high of more than 3.0 since 2002. During 1990–2012, it is also observed that urban productivity increased by six folds, much faster than the increase of rural productivity (Fig. 2).Why do rapid

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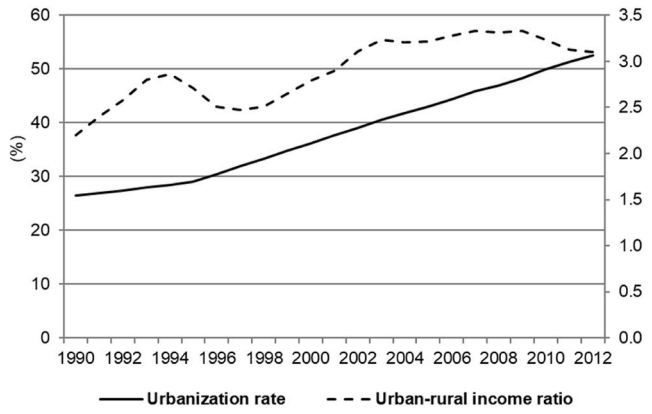

Fig. 1. The changes in the urbanization rate and urban-rural income ratio in China, 1990–2012.

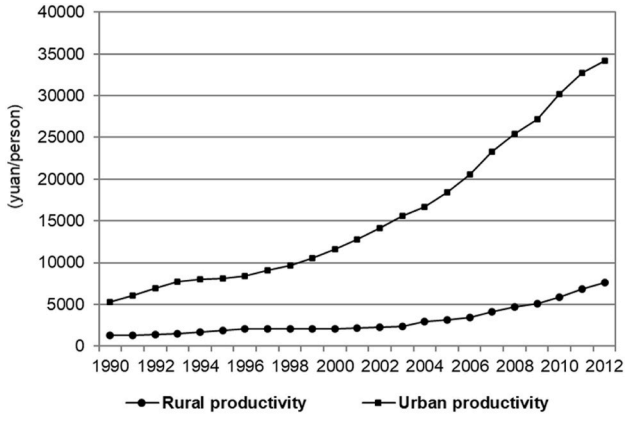

Fig. 2. The changes in rural productivity and urban productivity in China, 1990–2012.

urbanization and a widening rural urban income disparity coexist in China? Why are the policies propagated by the government ineffective in reducing the gap? Which can narrow the rural urban income gap, improvement in urban productivity or rural productivity? To answer these questions, we investigate the forces underlying the process of urbanization to gain a better understanding of the relationship between urbanization and the rural urban income disparity in this country.

There is limited understanding about the links between the urbanization forces and the rural urban income difference. Although there have been many studies about the relationship between urbanization and the rural urban income difference in China, the findings are mixed (Lu and Chen, 2006; Wang, 2011; Su et al., 2015; Wang et al., 2019; Li et al., 2014, 2019; Chen and Lin, 2014; Lin and Chen, 2011; Zhou et al., 2010). On one hand, a large number of studies argues that urbanization plays a significant role in reducing rural urban income inequality (Lu and Chen, 2006; Wang et al., 2019; Li et al., 2014, 2019; Chen and Lin, 2014; Lin and Chen, 2011). On the other hand, some scholars show different results. Wang (2011) finds that urbanization has expanded the income gap. Zhou et al. (2010) reveals a threshold effect associated with the impact of urbanization. Urbanization can effectively narrow the rural urban income gap, only if the level of urbanization overcomes some threshold value. Su et al. (2015) displays that the interaction between urbanization and rural urban income gap has regional variations. These mixed results indicate that more efforts should be paid on understanding the influences of the forces underlying the process of urbanization. Yet, to our knowledge, no study has systematically examined the impacts of urbanization forces on the rural urban income disparity from both economic and institutional perspectives. Moreover, previous empirical studies on urbanization and the rural urban income gap in China have either focused on the whole country (Wan, 2007) or analyzed the issue at the provincial level (Chen and Lin, 2014; Li et al., 2014, 2019; Wang et al., 2019; Su et al., 2015). These studies basically do not reveal the income gap between the origin and destination locales of migration during urbanization, and therefore cannot clearly explain the link between the rural urban income gap and the process of urbanization. Finally, researchers in urban economics have theoretically and empirically studied how various urbanization factors affect urbanization through rural–urban migration decisions (Davis and Henderson, 2003; Lucas, 2004; Gollin et al., 2002; da Mata et al., 2007). These factors include both urban pull factors which attract workers from the countryside and rural push factors which induce the release of rural labor for the urban sector. However, these studies generally focus on explanations of the urbanization process alone. Little attention has been paid on the relationship between the urbanization forces and income disparity.

The purpose of this study is to explore the influence of major urbanization forces and other socioeconomic factors on the rural urban income difference and provide policy suggestions on how to mitigate this disparity. Using econometric panel models, we investigate the following questions: (1) what economic and institutional urbanization factors drive the rural urban income gap, (2) what are the effects of these urbanization factors? and (3) what is the impact of the development stage on the rural urban income gap? To this end, we conduct a study at the national level by collecting and investigating data from 30 metropolitan areas for the period 2000–2011. The remainder of the paper is arranged as follows. In the next section, we briefly review the theories of the changes in rural urban income disparity. After that, we describe a national dataset for rural and urban areas in 30 metropolitan areas constructed for the study. We then present the empirical models and variables specified in the study, and interpret the empirical results associated with the effects of urbanization factors on rural urban income difference. This is followed by a discussion of the main results and policy implications on how to mitigate the income disparity. The last section concludes.

2. Literature review on theories of the changes in rural urban income disparity

The Kuznets theory of development stages (Kuznets, 1955) describes the evolution in income distribution in the process of urbanization. The Lewis dual economic structure model (Lewis, 1954) explains the mechanisms through which key economic urbanization factors affect the urban-rural income disparity. The urban-biased theory (Lipton, 1977; Bates, 1981) provides explanations about major institutional urbanization factors contributing to the urban-rural income disparity. Yet, no study to date has investigated the linkages between urbanization forces and the rural urban income gap from both economic and institutional perspectives. Our study fills the gaps by empirically examining the impact of these forces—both economic and institutional—on the rural urban income disparity.

The Kuznets (1955) theory of development stages describes the evolution of income distribution in the urbanization process of a country. The theory claims that the long-term interrelationship between economic development and income disparity conforms to an inverted U-curve pattern; the underlying assumption being that urban incomes are higher and less equally distributed than rural ones. The initial urban demographic shift increases income disparity in the early stage of economic development, as an increasing proportion of people seek and acquire urban employment with higher incomes. After a turning point, as the majority of people earn higher urban incomes, income disparity shrinks (Acemoglu and Robinson, 2002). Based on the Kuznets curve, the rural urban income gap first increases, reaches a peak, and then decreases in the urbanization and economic development process. However, as its focus is on the relationship between urbanization and income disparity, the Kuznets theory does not provide information on

the impact of socioeconomic factors driving the urbanization process. In addition, existing empirical studies on the connection between urbanization and the rural urban income difference in China present mixed results regarding the influence of urbanization (Lu and Chen, 2006; Wang et al., 2019; Wang, 2011; Su et al., 2015; Li et al., 2014, 2019; Chen and Lin, 2014; Lin and Chen, 2011; Wan, 2007). In China, where a labor shortage still exists in some rural areas and thus, the assumption of unlimited labor supply cannot be completely satisfied, the dynamics of urbanization and the mechanisms that affect the rural urban income gap may differ from those in developed countries. In fact, some Chinese studies do not conform to the Kuznets theory (Wang, 2011; Chen and Lin, 2014). This inconsistency between theory and reality implies that the Kuznets theory can explain the interrelationship between urbanization and the rural urban income difference only to some extent.

The Lewis dual economic structure model (Lewis, 1954), as the basis of regional economic theory, focuses on the key economic factors that determine rural urban income difference. It depicts the process of industrialization and urban growth as the shift of rural surplus labor from the agricultural sector, with relatively low labor productivity, to the urban industrial sector, with relatively high labor productivity. According to the model, rural and urban productivity are the major economic factors affecting the rural urban income gap. An increase in rural productivity is expected to have a dual effect on the rural urban income gap. The first is that the increase in rural productivity and agricultural output will raise income levels of rural residents. The second is that the increase in rural productivity will generate a rural labor surplus, prompting farmers to pursue off-farm employment opportunities in higher income urban areas (Wang et al., 2019). Both of these effects are expected to shorten the rural urban income difference. In contrast, an increase in urban productivity can result in two contrary effects. On the one hand, an increase in urban productivity can mean higher urban wages, which can widen the rural urban income difference. On the other hand, an urban productivity enhancement and the associated higher urban wages can attract surplus labor from rural areas, which will narrow the gap.

The urban bias theory (Lipton, 1977; Bates, 1981) provides explanations about major institutional urbanization factors contributing to the rural urban income disparity. The essence of the urban bias theory is that urban-biased institutions combined with government policies that induce a rural urban imbalance in the resource allocation of public expenditures, education, human capital, and social welfare, are a driving force in rural urban income disparity. Using this theory, some studies have highlighted the importance of institutional factors in the country's rural urban income disparity, including the government's prioritized development of heavy industries (Chen and Lin, 2014; Kanbur and Zhang, 2005), the *hukou* system of residency permits (Lu and Chen, 2006), financial reform (Wang and Fan, 2005), education expenditure and attainment (Sicular et al., 2007a,b; Choy and Li, 2017), and other separate public expenditures (Chen et al., 2010).

Given the limitations of the Kuznets theory, to understand the links between the process of urbanization and the rural urban income disparity, the impacts of major urbanization forces on this disparity need to be investigated. Moreover, to address the conflicting results in China, the nature of the relation between urbanization and the rural urban income disparity needs to be confirmed through an empirical investigation. Studies have shown that various urbanization forces, including both urban pull and rural push factors, jointly affect migration decisions and play important roles in accelerating urbanization (Lucas, 2004; Gollin et al., 2002). Further, with the guidance of the Lewis model and the urban bias theory, both economic and institutional factors affect the rural urban income disparity. Therefore, to examine the impacts of urbanization forces on the urban-rural income disparity, we consider urban pull and rural push factors from both economic and institutional perspectives.

3. Methodology: Constructing a national dataset for rural and urban areas in 30 metropolitan areas

Previous studies on urbanization and the rural urban income gap in China have focused either on the whole country or representative regions as the study area, investigating all rural and urban areas within the study area. In these studies, virtually all rural areas in a certain region are identified as the origin of migration, while all urban areas in the same region are identified as the destination of migration during urbanization. Based on the data and design used, these studies do not clearly reveal the income gap between the origin and destination locales, and therefore cannot explain the link between the income gap and the process of urbanization. Unlike previous studies, we investigate 30 individual metropolitan areas, each of which includes its own urban and rural areas. This allows us to identify the rural and urban areas within each metropolitan area as the origin of migration and the destination of migration, respectively, and link the income gap between the origin and destination locales with the process of urbanization.

There are additional reasons why data from rural and urban areas in individual metropolitan areas are more conducive for this study. First, in less developed countries nearby megacities attract migrants from rural areas significantly (Puga, 1996). China's urban migration is highly constrained within regions and provinces, and has relatively less inter-regional migration compared with other large countries (Su et al., 2018). Research has shown that as China's metropolitan areas generally comprise rural areas as well, half of the migration during the country's urbanization can be attributed to migration from rural to nearby urban areas within individual metropolitan areas (Davis and Henderson, 2003). Second, due to agglomeration effects and the government's urban-biased policy, large cities associated with the metropolitan areas have higher urban wages and more social benefits than small and medium cities. This has resulted in wider income gaps and greater rural–urban migration inflow in metropolitan areas (Guo et al., 2019). Therefore, studies on the rural urban income difference and interrelationships in metropolitan areas are more representative of this phenomenon compared to other areas in China.

We constructed a national dataset for rural and urban areas in 30 metropolitan areas in China for 2000–2011 (Table 1). In China, each metropolitan area corresponds to specific administrative district. Moreover, municipalities, provincial capital cities, and vice-provincial cities represent the major metropolitan areas at the provincial and vice-provincial levels. Originally, the data included 4 municipalities, 17 provincial capital cities, and 15 vice-provincial cities. However, because of data constraints, Lhasa, Lanzhou, Taiyuan, Huhhot, Xining, and Shenzhen were excluded from the list of metropolitan areas. As a vice-provincial city, Shenzhen does not have a rural area and thus lacks statistical data for rural areas. In addition, data for Lhasa, Lanzhou, Taiyuan, Huhhot, and Xining were either unavailable or incomplete. For instance, statistical data for Lhasa and Lanzhou, the capital cities of Tibet and Gansu, were unavailable. Additionally, 2011 data for Huhhot, the capital city of Inner Mongolia (2010), 2011 data for Xining, the capital city of Qinghai, and 2000 and 2004 data for Taiyuan, the capital city of Shanxi were also unavailable.

Our hypothesis is that the rural urban income gap is influenced by economic and institutional urbanization factors (urban productivity, rural productivity, *hukou* openness policy, and rural public expenditures) and other essential socioeconomic factors reported in the

Table 1
The Metropolitan areas Used in the Study.

Municipalities	Beijing, Shanghai, Tianjin, Chongqing
Provincial capital cities	Fuzhou, Hefei, Nanchang, Zhengzhou, Changsha, Kunming, Guiyang, Shijiazhuang, Haikou, Nanning, Yinchuan, Urumqi
Vice-provincial cities	Guangzhou, Shenyang, Dalian, Nanjing, Wuhan, Chengdu, Xi'an, Jinan, Qingdao, Hangzhou, Ningbo, Changchun, Harbin, Xiamen

literature (development stage). To build the variables, we use data on the per capita annual disposable income of the two types of residents, total and sector GDP, sector employment, total and rural public expenditures, total population, and permanent residents in urban areas for individual cities for the period 2000–2011. These data were obtained from the China City Statistical Yearbook (NBSC, 2001–2012). Additionally, we gathered data on the number of *hukou* openness policies from the documents ratified by the government of each metropolitan area.

4. Variable descriptions and empirical models

We follow the literature to construct the econometric data panel model on rural urban income gap across space and time. As the Lewis model suggests rural and urban productivity as important economic urbanization factors affecting the rural urban income difference and the urban bias theory highlights the institutional urbanization factors, such as the *hukou* related policies and rural public expenditures, we combine these two. Specifically, rural productivity represents the economic rural push factor while urban productivity represents the economic urban pull factor. The *hukou* related policies are the institutional urban pull factor and rural public expenditures are the institutional rural push factor. We also consider the influence of development stage, an important socioeconomic determinant of the rural urban income disparity both claimed by the Kuznets theory and reported in empirical studies for China (Chen and Lin, 2014).

We use the ratio of per capita annual disposable income of urban versus rural residents for each metropolitan area in a given year during 2000–2011 (*IncRatio*) as our dependent variable. The explanatory variables are urban productivity, rural productivity, *hukou* openness policy, rural public expenditures, and development stage. Urban productivity (*UrProd)* is specified by the ratio of the value of GDP over the employment in the second and tertiary sectors of a metropolitan area in a given year during 2000–2011. Rural productivity (*RuProd)* is measured by the ratio of the value of GDP over the employment in the primary sector of a metropolitan area in a given year during 2000–2011. Thus, *UrProd* and *RuProd*, representing the pull factor from the urban side and the push factor from the rural side, respectively, are the major economic urbanization factors expected to affect the rural urban income disparity. Rural productivity increase is correlated with rising agricultural output and surplus rural labor. According to the Lewis dual economic structure model, both of these effects are expected to reduce the rural urban income difference. Urban productivity increase is linked with rising urban wages and the accelerated absorption of surplus labor from rural areas. By contrast, both these effects result exert a contrary impact on the rural urban income gap. Therefore, the outcome of this relationship needs to be determined empirically.

Hukou openness policy (*HukOpen)* is measured by the number of favorable policies that the government of a metropolitan area provides for non-local urban *hukou* residents in a given year during 2000–2011. The *hukou* system is suspected of discouraging migration from rural to urban areas. Therefore, to overcome these obstacles, metropolitan authorities provide specific policies for non-local urban *hukou* residents, including medical insurance, endowment insurance, unemployment insurance, and schooling for children. The higher the value of *HukOpen*, the greater the openness associated with the *hukou* policy in a metropolitan area. Rural public expenditures *(RuExp)* are measured by the ratio of public expenditures on rural affairs over total public expenditures for a metropolitan area in a given year during 2000–2011. *HukOpen* and *RuExp*, representing the pull factor from the urban side and the push factor from the rural side, respectively, are the major institutional urbanization factors expected to affect rural urban income disparity. A more open *hukou* policy in a metropolitan area, offering rural migrants more opportunities to receive public services and social welfare, is likely to be a strong attraction for rural migrants. Public expenditures from the government of a metropolitan area allocated to rural affairs are aimed at promoting rural economic development and improving farmers' incomes.

Per capita GDP (*GDPpct)* for the whole population in a metropolitan area in a given year during 2000–2011 measures the level of economic development directly. Development stage, as a main factor discussed in the Kuznets theory, is incorporated in the econometric model to test whether the changes in China's rural urban income gap conform to the inverted U-curve. Urban population size (*UrPop)* is measured by the number of permanent residents in a metropolitan area, including local urban *hukou* residents and migrants from outside the urban area in a given year during 2000–2011. Urban population size, as a proxy of the scale of urban development, is used together with per capita GDP to test the Kuznets theoryu (Table 2).

4.1. Static panel data models

The static panel data model for the relation between the IncRatio and its socioeconomic explanatory variables can be constructed as

$$Log(IncRatio)_{it} = \beta_0 + \sum_{p=1}^{P} \alpha_p X_{pit} + \sum_{q=1}^{Q} \lambda_q Y_{qit} + \mu_i + \varepsilon_{it} \quad (1)$$

where $IncRatio_{it}$ is the urban-rural ratio of per capita annual income for metropolitan area i in year t. X_{pit} consists of p economic and institutional urbanization factors (*UrProd*, *RuProd*, *HukOpen*, and *RuExp*), and Y_{qit} contains q socioeconomic control variables (*GDPpct* and *UrPop*). β, α, and λ are the regression coefficients to be estimated. μ is the individual error term associated with particular metropolitan area and ε is the random error term. Whether fixed or random effects model is selected for model estimation relies on the properties of the individual error term. If μ is correlated with the regressors, the fixed effects model is preferred to derive consistent estimates. Otherwise, the random effects model is used. Here, we apply both models and compare their results using the Hausman test (Hausman, 1978).

4.2. Dynamic panel data model

It is likely that there are dynamics between certain urbanization forces and the rural urban income gap. Kuznets inverted U-curve pattern indicates that the rural urban income gap may affect urbanization and various urbanization factors. To more accurately identify the impacts of the selected urbanization factors on rural urban income gap, we employ the dynamic panel data (DPD) model. There are two potential issues when applying the DPD model, which can lead to bias in the estimation results: (1) the endogeneity of the explanatory variables and (2) the unobserved time and regional effects. Therefore, Arellano and Bond (1991) proposed using the generalized method of moments (GMM) estimator to minimize the potential for the two aforementioned issues. A main merit of the GMM estimator is that the effect of unobserved

Table 2
Description of variables.

Variable	Description
Dependent variable	
IncRatio	Ratio of per capita annual disposable income of urban relative to rural residents (ratio)
Independent variables	
UrProd	Ratio of the value of GDP over the number of employment in the second and tertiary sectors (yuan/person)
RuProd	Ratio of the value of GDP over the number of employment in the primary sector (yuan/person)
HukOpen	Number of *hukou* openness policies (number)
RuExp	Ratio of public expenditures into rural affairs over total public expenditures (ratio)
GDPpct	Per capita GDP for the whole population (yuan)
UrPop	Number of permanent residents in urban area (10,000 people)

*1 Chinese yuan ≈ 0.145 US dollars.

variables can be controlled by variable difference or instrument variables. Additionally, endogeneity is taken into account by employing the instrument variables in the form of the lagged terms of dependent and explanatory variables.

Including a one-year lagged dependent variable as an extra regressor, the model can be described as follows:

$$Log(IncRatio)_{it} = \beta_0 + \beta_1 Log(IncRatio)_{i,t-1} + \sum_{p=1}^{P} \alpha_p X_{pit} + \sum_{q=1}^{Q} \lambda_q Y_{qit} + \mu_i + \varepsilon_{it} \quad (2)$$

where $IncRatio_{i,t\text{-}1}$ is the urban-rural ratio of per capita annual income for metropolitan area *i* in year *t-1*.

Considering different lag intervals of the dependent variable, according to the criterion in Wintoki et al. (2012), a two-year lagged dependent variable can be added to Eq. (2). Additionally, due to the potential endogenous effects from the rural urban income disparity from *hukou* openness, a one-year lagged term of *HukOpen* can be added to Eq. (2). This model can be framed as:

$$Log(IncRatio)_{it} = \beta_0 + \beta_1 Log(IncRatio)_{i,t-1} + \beta_2 Log(IncRatio)_{i,t-2} + \beta_3 HukOpen_{i,t-1} + \sum_{p=1}^{P} \alpha_p X_{pit} + \sum_{q=1}^{Q} \lambda_q Y_{qit} + \mu_i + \varepsilon_{it} \quad (3)$$

where $IncRatio_{i,t\text{-}2}$ is the urban-rural ratio of per capita annual income for metropolitan area *i* in year *t-2*. $HukOpen_{i,t\text{-}1}$ is the number of *hukou* openness policies for metropolitan area *i* in year *t-1*.

We apply the GMM estimator to calculate the DPD model (Arellano and Bond, 1991). There are two major GMM models—the differential GMM and the system GMM. The former only estimates the difference equation, which results in a loss of some sample information. In contrast, the system GMM model is more effective as it estimates the horizontal equation and the difference equation simultaneously and includes more sample information. Further, unlike the one-step GMM, some claim that the two-step GMM is not easily affected by heteroscedasticity (Arellano and Bond, 1991). Therefore, we chose the two-step system GMM for this study.

There are two potential problems when applying the two-step system GMM. First, under the condition of limited samples, the standard error of the two-step GMM is likely to be downward biased. To address this, we adopt the criterion proposed by Bond and the colleagues (2001) to evaluate the bias of the results, comparing the coefficient estimate of the one-year lagged dependent variable derived from the GMM with the coefficients estimated by the ordinary least squares (OLS) and fixed effects model (Bond et al., 2001). Bond claims that the coefficient estimates from the OLS and the fixed effects model have upward and downward biases, respectively. Therefore, we expect that the coefficient estimate of the lagged dependent variable from the GMM will be greater than the fixed effects estimation and smaller than the OLS estimation. In addition, for the validity of the parameter estimation of the GMM, we need to check the validity of the newly added instrument variables. Therefore, we apply two types of statistical tests—the Hansen test and the second-order autocorrelation test for the residual error to confirm the validity of the model. For the Hansen test, acceptance of the null hypothesis indicates that the instrument variables are appropriately selected. The autocorrelation test examines whether there is a second-order autocorrelation in the differential residual error. When AR (1)<0.05 and AR (2)>0.1, we can accept the null hypothesis that the original residual error is not autocorrelated.

5. Results

We investigate the rural urban income disparity for 30 metropolitan areas across 12 years using both the static panel data model as specified in Eq. (1) and the DPD model as specified in Eq. (2) and Eq. (3). According to the Hausman test ($p < 0.00001$), we reject the null hypothesis that there are not significant variations between the fixed and random effects estimates. This reveals that the fixed effects specification is more proper for the static panel data model (Table 3). Table 4 displays the estimation results for the DPD model, with different groups of socioeconomic variables (Models 1-3). The results of the Bond criterion indicate that the coefficient estimates of the one-year lagged dependent variable from the GMM (Models 1–3) method fall between those estimated by the OLS and fixed effects model, indicating the validity of the results. The results of the Hansen test (Models 1–3) suggest that the null hypothesis of the validity of instrument variables is not rejected ($p > 0.1$). The results of the second-order autocorrelation test (Models 2 and 3) support the null hypothesis that the original residual error is not autocorrelated (AR (1)<0.05 and AR (2)>0.1). The results in Table 4 demonstrate that *UrProd*, *RuProd*, *GDPpct*, and *UrPop* correlate significantly with the income ratio. Moreover, the coefficient estimates of these socioeconomic factors of the rural urban income gap have consistent signs and small differences in magnitudes from Models 1 to 3, suggesting the robustness of these results. Therefore, we use the full model (Model 3), the most comprehensive DPD model, to interpret the effect of each socioeconomic factor.

Both the $Log(IncRatio)_{i,t-1}$, the one-year lagged dependent variable and $Log(IncRatio)_{i,t-2}$, the two-year lagged dependent variable, are significantly positively correlated with the income ratio. This indicates that there is a significant lag effect associated with rural urban income gap, and that income gap persists over time. This is consistent with the argument that macroeconomic factors, including income gap, are influenced easily by their lagged values (Beck et al., 2007).

Our results show that the two economic urbanization factors exhibit significant and contrasting effects on the rural urban income disparity. *Log(RuProd)*, our proxy of rural productivity, negatively affects the income ratio. This estimated effect conforms to our expectation that higher rural productivity can increase agricultural output and stimulate and enable the transfer of surplus rural labor, and thereby reduce the rural urban income disparity. By contrast, *Log(UrProd)*, our proxy of urban productivity, exhibits a positive impact on the income ratio. This suggests that rising urban wages, which expand the rural urban income difference, is the dominant outcome of an increase in urban productivity.

Although the two institutional urbanization factors reflect contrasting influences on the rural urban income gap, neither of them is significant. Specifically, *Log(RuExp),* the measure of rural expenditures, negatively correlates with the income ratio, while *HukOpen,* the measure of *hukou* openness, positively correlates with the income ratio. However, we find that $HukOpen_{i,t\text{-}1}$, the one-year lagged term of the *hukou* openness policy, demonstrates a significant negative correlation with the income ratio. This suggests that the increased openness associated with the *hukou* policy in a metropolitan area helps reduce the rural urban

Table 3
Random effects and fixed effects model results.

	Dependent variable: Log (IncRatio)	
	Random effects model	Fixed effects model
Intercept	0.720*** (3.82)	0.704*** (3.64)
Log (UrProd)	0.054** (2.31)	0.041* (1.74)
Log (RuProd)	−0.014** (−2.04)	−0.020*** (−2.87)
HukOpen	0.007 (1.60)	0.001 (0.12)
Log (RuExp)	0.004 (0.36)	0.035*** (2.64)
Log (GDPpct)	−0.031 (−1.33)	−0.006 (−0.23)
Log (UrPop)	0.009 (0.47)	0.030 (1.39)
Observations	360	360
R-squared	0.03	0.24

Notes.
(1) t statistics in parentheses.
(2) *p < 0.1; **p < 0.05; ***p < 0.01.

Table 4
Two-step system GMM results.

	Dependent variable: Log (IncRatio)		
	Model 1	Model 2	Model 3
OLS	0.932	0.937	0.934
FE	0.735	0.728	0.742
Intercept	0.241** (2.33)	0.331** (2.44)	0.371 (1.63)
$Log(IncRatio)_{i,t-1}$	0.906*** (30.08)	0.859*** (21.86)	0.837*** (24.26)
$Log(IncRatio)_{i,t-2}$		0.031 (0.90)	0.072* (1.76)
Log (UrProd)	0.059** (2.54)	0.063*** (2.84)	0.081*** (2.72)
Log (RuProd)	−0.015*** (−2.60)	−0.019** (−2.33)	−0.023** (−2.39)
HukOpen	0.001 (0.34)	0.001 (0.19)	0.007 (1.12)
$HukOpen_{i,t-1}$			−0.005*** (−2.68)
Log (RuExp)	−0.012 (−1.13)	−0.004 (−0.34)	−0.004 (−0.30)
Log (GDPpct)	−0.044** (−2.18)	−0.040** (−2.01)	−0.040** (−2.17)
Log (UrPop)	−0.044** (−2.13)	−0.058** (−2.35)	−0.130** (−2.57)
Hansen	0.342	0.385	0.323
AR (1)	0.001	0.001	0.002
AR (2)	0.027	0.191	0.302
Groups	30	30	30
Observations	330	330	330

Notes.
(1) z statistics in parentheses.
(2) *p < 0.1; **p < 0.05; ***p < 0.01.
(3) Hansen represents the p-values of the Hansen test.
(4) OLS and FE represent the coefficient estimates of $Log(IncRatio)_{i,t-1}$ from the OLS and fixed effects models.

income difference with a one-year lag. This is expected because the *hukou* openness policy is a strong impetus, attracting rural migrants to off-farm employment with higher incomes in urban areas, which, in turn, may narrow the rural urban income difference. In addition, the shift of rural surplus labor to urban areas increases average resource endowment and enhances agricultural productivity and farmers' income levels, which also leads to a reduction in the rural urban income disparity.

The two socioeconomic control variables have significant coefficients in all three models and the signs are stable. *Log (GDPpct)*, our measure of the level of economic development, and *Log (UrPop)*, the indicator of the level of urban development, both negatively correlate with the income ratio. These results suggest that the rural urban income difference becomes smaller with increased economic and urban development. This is reasonable because the 30 metropolitan areas in our study are municipalities, provincial capital cities, or vice-provincial cities, all with relatively high economic and urban development. Thus, it is highly likely that these cities have crossed the peak point in the Kuznets inverted U-curve and entered the stage of post-urbanization. Our results relying on the national level analysis of metropolitan areas in China conform to the Kuznets theory.

Our attempt to evaluate the influence of urbanization forces on rural urban income disparity has several limitations. First, ideally longer time series could facilitate the identification of trend. However, the reform of household registration system initiated by the central government after 2011 required that both agricultural and non-agricultural residents within the urban area of a district were registered as urban residents. In this context, there was large inconsistency in the population data for individual metropolitan areas before and after the reform. For example, Qingdao reports agricultural and non-agricultural population only by 2012, and has reported urban permanent population instead since 2013 (NBSC, 2001–2019). Given the data constraint, we are not able to expand the study period to longer time span. Second, the dynamic panel data model applied for this study presumes that the effects of explanatory variables are symmetric. Testing whether the urban-rural income ratio behaves asymmetrically towards certain determinants is an issue worth more exploration in future work. For example, does the rural urban income gap respond the same to an increase in rural productivity as it does to when rural productivity decreases by the same magnitude?

6. Discussion and policy implications

Our results generate key insights about why rapid urbanization and an expanding rural urban income disparity coexist in China. Both urban pull and rural push factors affect the migration decision and accelerate urbanization (Gollin et al., 2002; da Mata et al., 2007). Therefore, increases in urban productivity and rural productivity, representing the urban pull effect and the rural push effect, respectively, are expected to accelerate the process of urbanization. However, we identify a positive effect of urban productivity and a negative effect of rural productivity on the rural urban income gap. This means that urban productivity and rural productivity affect the income gap in different directions, and that the ultimate consequence for income disparity depends on the net effect of these two factors. When the impact of urban productivity exceeds that of rural productivity, the rural urban income disparity widens, which is consistent with the situation in this country. In the planned economy period, several institutional barriers and urban-biased policies, including the prioritized development of heavy industries and the *hukou* system, are implemented to support urban development. In addition to the lingering effect of the planned economy, economic reform has led to prioritized resource allocation of public expenditures and services, housing, education, information, and human capital, in urban areas relative to rural areas (Zhang et al., 2003). Planned economy institutions and policies and the inequality in resource allocation have resulted in rapid economic growth and a significant increase in wages in urban areas. However, rural income has increased at a slower pace since the economic reform. There are two likely causes which may explain the slow growth in rural income—insufficient increases in agricultural productivity and lower income levels in the informal sector in urban areas. Although the household responsibility system (HRS) reform improved agricultural productivity and output, the impact of the reform has declined and faded. Recent trends demonstrate that China has to confront yield stagnation in 56%, 52%, and 79% of the total wheat, maize, and rice areas, respectively (Ray et al., 2012). Extrapolating from this trend, it is likely that any contribution from technology improvements that can increase agricultural productivity will be limited. Additionally, research shows that generally rural migrants pursuing urban employment can only acquire the informal or temporary positions in urban areas, the salaries of which are lower than those of the formal and permanent positions (Yang, 2005).

Our research draws attention to the rural urban income disparity within a close spatial distance. Existing studies have examined the rural urban income disparity in China at different levels of aggregation (i.e. the national, regional, or provincial level), using the total or mean values of all rural and urban areas within the representative regions. The rural urban income disparity identified by this means virtually conceals the inter-urban and inter-rural heterogeneities in each sample region. Because the urban areas in those studies not only include the urban areas of megacities and large cities, but also those of small and medium-sized cities. The rural areas not only embrace the suburbs of large cities, but also the countryside in remote regions. It is expected that the rural urban income disparity within a close distance should be very different from that in a long or remote distance. Focusing on the rural and urban areas within individual metropolitan areas, this study clearly links the income gap between the origin and destination locales of migration with the process of urbanization. Further, the results derived from this study on the causes of rural urban income disparity in metropolitan areas can shed light on the bottom up strategies for achieving the goal of regional sustainable development.

The imbalance and inequality in urban and rural development is one of the fundamental issues in China which significantly affect regional sustainable development of the country. It is more meaningful to narrow

down the rural urban income disparity within a close spatial distance in order to reduce overall regional inequality and achieve regional coordinated development, as the rural and urban areas within this distance are with similar geographical settings. By contrast, geography is a dominant factor in determining income disparity in a long distance, for example, between provinces at the national scale (Wan and Zhou, 2005). On one hand, as China's urbanization has entered the stage of stable development, the focus of the problem of rural urban disparity has shifted to the precise control of the disparity. On the other hand, at present, China is taking the metropolitan area as the main carrier of promoting urbanization. Shortening the gap between urban and rural areas in metropolitan areas will become the critical breakthrough point for solving the urban and rural problems, and for boosting regional coordinated development. In these senses, our results based on the analysis of metropolitan areas have important practical significance on how to vitalize the countryside and reach regional sustainable development.

The results of this study provide clear policy implications on how to mitigate the rural urban income gap. The negative effect of rural productivity indicates that the rural urban income difference can be reduced by an increase in agricultural productivity. Therefore, to reach the goal of mitigating the income disparity between rural and urban areas, more emphasis should be placed on improving agricultural productivity. There are several possible options to achieve this.

The first promising option is expanding the service scale in agriculture. Other parts of the world have shown that there is an inverse correlation between farm scale and land productivity. Therefore, it is difficult to achieve further production efficiency and high economic returns in agriculture only through land consolidation. However, the expansion of service scale and the improvement in labor division through the entire agriculture supply chain have an enormous potential to raise agricultural productivity and economic returns. This is an important path for China to follow, where agricultural industrialization and modernization characterized by the restructuring of the agricultural sector can be realized. For example, Shandong Province, one of 13 main grain producing provinces in China, has restructured agricultural production using supply and marketing cooperative organizations, promoting the development of service scale through land trusteeship, and establishing individual agricultural service centers to provide centralized, standardized, and specialized services for agriculture within certain areas (Liu and Wang, 2019). This rapid development of service scale is accompanied by a substantial improvement in the level of agricultural mechanization. The total power of agricultural machinery in Shandong Province increased by 48.5% from 2000 to 2018. Consequently, the proportion of agricultural machinery workers employed in the province's primary sector is over one third in 2018, much greater than the national average (NBSC, 2001–2019).

The second promising option is investments in agricultural infrastructure. Previous research has shown that investments in agricultural infrastructure, including irrigation, electric systems, and transportation, not only directly promote agricultural economic growth but also have a significant spillover effect on the increase in agricultural productivity. The agricultural infrastructure in China has developed rapidly since the economic reform. The electricity consumed in the country's rural areas in 2018 reached 936 billion kWh, almost four times the amount in 2000. During the same period, effectively irrigated areas increased by 36% from 24,493 to 33,324 thousand ha (NBSC, 2001). However, the agricultural infrastructure is still relatively weak in less developed regions, particularly rural areas in western provinces. In 2018, the electricity consumed in the rural areas of 11 western provinces took up less than 10% of the electricity use in rural China (NBSC, 2018). In addition, to strengthen agricultural infrastructure construction and achieve sustainable agricultural economic development, more factors need to be considered and included when forming rural development policies. Both the strength of the agricultural investments and effective allocation and management of agricultural infrastructure are important for the success of such policies.

The third promising option is the development of agricultural insurance. The frequency of natural disasters in China has been constraining further agricultural industrialization and modernization in the country. The crop areas affected by natural disasters in China covered 20.8 million ha in 2018, of which the total crop failure area was 2.6 million ha (NBSC, 2001). As an effective measure of risk protection, agricultural insurance can disperse and transfer risks, thereby prompting rural households to resume agricultural production activities immediately after a disaster. It is of great importance in stabilizing farmers' incomes and boosting agricultural economic growth. As a critical financial instrument, agricultural insurance has contributed significantly to China's agricultural economic development since the economic reform. In 2018, the coverage of agricultural insurance for the three major staples—wheat, rice, and corn—in China was over 70%. The total agricultural insurance premium revenue has grown nearly tenfold over the past decade, reaching 57.3 billion yuan in 2018. In the same year, the agricultural insurance covered 39.4 billion yuan claims and payments for rural households in 2018, which effectively guaranteed the resumption of agricultural production and substantially reduced the poverty induced by disaster (NBSC, 2001).

7. Conclusions

In this study, we use the DPD model to investigate the influence of both economic and institutional urbanization forces and other socio-economic factors on rural urban income disparity. Our results show that the two economic factors have contrasting effects on the rural urban income gap. Moreover, rural productivity can significantly narrow the rural urban income gap, while urban productivity positively contributes to widening rural urban income disparity. We also find that *hukou* openness negatively affects the rural urban income disparity with a one-year lag. Finally, consistent with the Kuznets theory, per capita GDP and urban population size both negatively correlate with rural urban income disparity.

Our findings provide some insights into why rapid urbanization and the expansion of rural urban income difference coexist in China. Moreover, our results provide clear policy implications on how to mitigate the disparity. The most compelling implication is that to mitigate this disparity, sustainable agricultural productivity improvement is critical. The promising options we suggest include expanding the service scale in agriculture, investments in agricultural infrastructure, and the development of rural finance and agricultural insurance.

CRediT authorship contribution statement

Yongling Yao: Conceptualization, Methodology, Formal analysis, Writing – original draft. **Li Jiang:** Conceptualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

Acemoglu, D., Robinson, J.A., 2002. The political economy of the kuznets curve. Rev. Dev. Econ. 2, 183–203.

Arellano, M., Bond, S., 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. Rev. Econ. Stud. 58 (2), 277–297.

Bates, R.H., 1981. Markets and States in Tropical Africa. University of California Press.

Beck, T., Demirguc-Kunt, A., Levine, R., 2007. Finance, inequality and the poor. J. Econ. Growth 12 (1), 27–49.

Bond, S., Bowsher, C., Windmeijer, F., 2001. Criterion-based inference for GMM in autoregressive panel data models. Econ. Lett. 73 (3), 379–388.

Chen, B., Lin, J.Y., 2014. Development strategy, urbanization and the urban-rural income gap in China. Soc. Sci. China 35 (1), 5–20.

Chen, Y.P., Liu, M., Zhang, Q., 2010. Development of financial intermediation and the dynamics of urban-rural disparity in China, 1978-1998. Reg. Stud. 44 (9), 1171–1187.

Choy, L.H., Li, V.J., 2017. The role of higher education in China's inclusive urbanization. Cities 60, 504–510.

da Mata, D., Deichmann, U., Henderson, J.V., Lall, S.V., Wang, H., 2007. Determinants of city growth in Brazil. J. *Urban Econ.* 62 (2), 252–272.

Davis, J.C., Henderson, J.V., 2003. Evidence on the political economy of the urbanization process. J. Urban Econ. 53 (1), 98–125.

De La Croix, D., Doepke, M., 2003. Inequality and growth: why differential fertility matters. Am. Econ. Rev. 93 (4), 1091–1113.

Gollin, D., Parente, S.L., Rogerson, R., 2002. The role of agriculture in development. Am. *Econ. Rev.* 92 (2), 160–164.

Guo, X., Zhang, J., Wu, L., 2019. City size, productivity advantage, and resource allocation. Manag. World 35 (4), 77–89 (in Chinese).

Hausman, J.A., 1978. Specification tests in econometrics. Econometrica: J. Econom. Soc. 46 (6), 1251–1271.

Kanbur, R., Zhang, X., 1999. Which regional inequality? The evolution of rural-urban and inland-coastal inequality in China from 1983 to 1995. J. Comp. Econ. 27, 686–701.

Kanbur, R., Zhang, X., 2005. Fifty years of regional inequality in China: a journey through central planning, reform, and openness. Rev. Dev. Econ. 9 (1), 87–106.

Kuznets, S., 1955. Economic growth and income inequality. Am. Econ. Rev. 45, 1–28.

Lewis, W.A., 1954. Economic development with unlimited supplies of labour. Manch. Sch. 22 (2), 139–191.

Li, Y., Wang, X., Zhu, Q., Zhao, H., 2014. Assessing the spatial and temporal differences in the impacts of factor allocation and urbanization on urban-rural income disparity in China, 2004-2010. Habitat Int. 42, 76–82.

Li, J., Cheong, T.S., Shen, J., Fu, D., 2019. Urbanization and rural-urban consumption disparity: evidence from China. Singapore Econ. Rev. 64 (4), 983–996.

Lin, J.Y., Chen, B., 2011. Urbanization and urban-rural inequality in China: a new perspective from the government's development strategy. Front. Econ. China 6 (1), 1–21.

Lipton, M., 1977. *Why poor People Stay Poor: Urban bias in World Developmen*t. Harvard University Press.

Liu, S., Wang, R., 2019. Agricultural industrialization and scale economy of service: theory and experiences. Int. Econ. Rev. 6, 9–23 (in Chinese).

Lu, M., Chen, Z., 2006. Urbanization, urban-biased policies, and urban-rural inequality in China, 1987-2001. Chin. Econ. 39 (3), 42–63.

Lucas, R.E., 2004. Life earnings and rural–urban migration. J. Polit. *Econ* 112 (S1), S29–S59.

Luo, T., Xu, M., Huang, T., Ren, X., Bu, X., 2018. Rethinking the intensified disparity in urbanization trajectory of a Chinese coastal province and its implications. J. Clean. Prod. 195, 1523–1532.

NBSC, 1991-2019. China Statistical Yearbooks. China Statistics Press, Beijing, China.

NBSC, 2001-2012. China City Statistical Yearbooks. China Statistics Press, Beijing, China.

NBSC, 2001-2019. Shandong Statistical Yearbooks. China Statistics Press, Beijing, China.

Puga, D., 1996. Urbanization Patterns: European vs. Less Developed Countries. Discussion Paper, No. 305. Centre of Economic Performance. London School of Economics.

Ray, D.K., Ramankutty, N., Mueller, N.D., West, P.C., Foley, J.A., 2012. Recent patterns of crop yield growth and stagnation. Nat. Commun. 3 (1), 812–818.

Sicular, T., Yue, X., Gustafsson, B., Li, S., 2007a. The urban-rural income disparity and inequality in China. Rev. Income Wealth 53 (1), 93–126.

Sicular, T., Yue, X., Gustafsson, B., Li, S., 2007b. The urban-rural income gap and inequality in China. Rev. Income Wealth 53 (1), 93–126.

Song, H., Thisse, J.F., Zhu, X., 2012. Urbanization and/or rural industrialization in China. Reg. Sci. Urban Econ. 42, 126–134.

Su, C., Liu, T., Chang, H., Jiang, X., 2015. Is urbanization narrowing the urban-rural income gap? A cross-regional study of China. Habitat Int. 48, 79–86.

Su, Y., Tesfazion, P., Zhao, Z., 2018. Where are migrants from? inter- vs. intra-provincial rural-urban migration in china. China Econ. Rev. 47, 142–155.

UN, 2012. Human Development Report 2012. UN.

UN, 2018. The 2018 Revision of World Urbanization Prospects. UN.

Wan, G., 2007. Understanding regional poverty and inequality trends in China: methodological issues and empirical findings. Rev. Income Wealth 53 (1), 25–34.

Wan, G., Zhou, Z., 2005. Income inequality in rural China: regression-based decomposition using household data. Rev. Dev. Econ. 9 (1), 107–120.

Wan, G., Lu, M., Chen, Z., 2006. The inequality-growth nexus in the short and long run: empirical evidence from China. J. Comp. Econ. 34 (4), 654–667.

Wang, Z., 2011. A reexamination of urbanization and urban-rural income gap in China. Econ. Geogr. 8, 1289–1293 (in Chinese).

Wang, X., Fan, G., 2005. Income inequality in China and its influential factors. Econ. Res. J. 10, 24–36 (in Chinese).

Wang, X., Shao, S., Li, L., 2019. Agricultural inputs, urbanization, and urban-rural income disparity: evidence from China. China Econ. Rev. 55, 67–84.

Wintoki, M.B., Linck, J.S., Netter, J.M., 2012. Endogeneity and the dynamics of internal corporate governance. J. Financ. Econ. 105 (3), 581–606.

Xie, Y., Zhou, X., 2014. Income inequality in today's China. Proc. Natl. Acad. Sci. Unit. States Am. 111 (19), 6928–6933.

Xing, C., Zhang, J., 2017. The preference for larger cities in China: evidence from rural-urban migrants. China Econ. Rev. 43, 72–90.

Yang, T., 2005. China's urbanization and within-urban inequality: theory and its Test. Journal of Renmin Unviersity of China 4, 71–76 (in Chinese).

Yuan, Y., Xu, M., Cao, X., Liu, S., 2018. Exploring urban-rural disparity of the multiple deprivation index in Guangzhou City from 2000 to 2010. Cities 79, 1–11.

Zhang, L., Zhao, S., Tian, J., 2003. Self-help in housing and Chengzhongcun in China's urbanization. Int. J. Urban Reg. Res. 27 (4), 912–937.

Zhou, S.F., Qi, S.W., Lu, Z.B., 2010. Region difference, urbanization and urban rural income gap. China Population, Resources and Environment 8, 115–120.