THE EFFECT OF URBANIZATION ON CHINA'S FERTILITY*

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ABSTRACT

The relationship between urbanization and fertility decline is known to be inverse in developed countries. However, the nature of this relationship in developing countries that already have relatively low fertilities is not well-understood. This study aims to illustrate how much urbanization contributed to China's fertility decline between 1982-2008 and forecasts how much it can contribute to future reductions in fertility. The study examines changes in the total fertility rate (TFR) at both the national and provincial levels, given regional differences in the urbanization rate. The results show that changes in rural fertility behavior accounted for most of the decline in the national TFR between 1982 and 2008. This finding suggests that official birth control policies were instrumental in curbing China's population growth. However, urbanization was responsible for about 22 percent of the decrease in TFR during this period, and its effect was especially important during the latter years (2001-2008). In most provinces, urbanization associated with a decline in provincial-level fertility. The forecasts indicate that urbanization will become the primary factor behind future declines in national fertility. Given the negative effect of urbanization on the TFR, it is possible to relax the one-child policy without having adverse implications for population growth.

Key words: Urbanization, fertility, China

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Introduction

China's total fertility rate (TFR) declined from 2.78 in 1978 to 1.47 in 2008 (National Bureau of Statistics of China 2008). The TFR decreased to sub-replacement levels sometime during the early 1990s (Feeney and Yuan 1994). The pace of this decline is remarkable considering that the TFR was over 5.0 until the 1970s (Gu 2007). This change has been attributed primarily to the Chinese government's efforts to curb population growth, such as the one-child policy (Feeney and Wang 1993). These birth control interventions certainly set China's demographic transition apart from other transitions to low-fertility. However, whether birth planning policies are the primary reason for China's low fertility is not uncontested (Cai 2010). At least, it appears that, similar to the demographic transitions in Western countries, socioeconomic forces have also contributed substantially to China's transition (Poston and Gu 1987).

In most countries, there is an inverse relationship between TFR and socioeconomic development, with fertility declining as development progresses (Bongaarts and Watkins 1996; Bryant 2007). This is demonstrated in the long-established TFR differential between urban and rural areas (Jaffe 1942). Given that urbanites tend to have/prefer fewer children than rural residents, the process of urbanization propels a reduction of national TFR. Over two decades ago, Zeng and Vaupel (1989) observed that this process would likely decrease future birth rates in China. At that time, the urban-rural fertility differential remained quite large. In 1986, the urban TFR was 1.96 compared to the rural TFR of 2.72. Since China was predominantly a rural, agricultural society in the mid-1980s, Zeng and Vaupel anticipated that the national TFR had much room to decline

through rural-to-urban migration and the re-classification of rural areas into urban areas. This would occur as former rural residents voluntarily adopted the preference for fewer children that is prevalent among urbanites or were compelled to have fewer children because of the stricter enforcement of the one-child policy in urban areas.

At the time Zeng and Vaupel made this observation, China's TFR was above the replacement level and almost two-thirds of the population lived in rural areas. At present, China's TFR is 1.47 (see Figure 1) and over 46 percent of the population resides in urban areas (United Nations 2010). The proportional size of China's urban population is below the global average (50 percent) and far below the average (75 percent) for developed countries. Hence, the potential for urban growth is large and it is expected that 73 percent of the Chinese population will live in urban areas in 2050. What is uncertain is how much urbanization can contribute to future reductions in China's TFR. In general, our knowledge is limited about the determinants of fertility behavior in countries that are undergoing the process of development but have low fertility (Bongaarts 2002). This leaves questions about the relationship between TFR and urbanization in China, which cannot be considered a developed country, but has achieved sub-replacement fertility.

Figure 1 About Here

In China, the fertility differential between rural and urban areas has narrowed since 1978, but it is still large (see Figure 2). In 2008, the TFR was 1.73 in rural areas and 1.22 in urban areas. The rural-urban TFR differential has, moreover, remained fairly stable since the early 1990s. If urban fertility behavior remains consistent, this implies that urban expansion will propel further reductions in China's fertility. According to Bongaarts (2002), at high levels of development the relationship between TFR and

socioeconomic indicators is likely to be nonlinear, because it is unreasonable to expect an indefinite decline in TFR as socioeconomic development progresses. That is, although socioeconomic development corresponds to a reduction in fertility, it cannot totally extinguish the desire for children. For China, this relationship could become nonlinear at a comparatively lower stage of development as China's TFR is already among the lowest in the world. The continuing urbanization of China appears to be inevitable, but it is likely that at some point this process will no longer lead to further reductions in TFR.

Figure 2 About Here

The issue here is whether the relationship between TFR and urbanization is weakening in the Chinese context. The demographic trends suggest this is the case. Figure 1 illustrates that urbanization corresponded with a large decline in TFR from 1978 and sometime in the mid-1990s. However, the TFR plateaued thereafter, even though the urbanization rate kept increasing. This raises the question of how much fertility changes (or can change) in response to urbanization in low-fertility regimes. To address this question, this study uses decomposition models to assess the contribution of urbanization to the decline in China's TFR since 1978. The study examines both the national and provincial levels because there are regional differences in socioeconomic development and the enforcement of national birth planning policies. In addition, the study simulates how much more urbanization can be expected contribute to fertility decline, under several alternative scenarios of urban expansion and birth planning reforms, forecasting TFR until 2030.

Background

A key debate in the literature regards the primary source of China's fertility decline. The debate is about how much socioeconomic factors have contributed to this decline, given the Chinese government's tight regulation of fertility behavior. The predominant notion is that birth planning policies are the fundamental reason for China's demographic transition (Poston and Gu 1987). These interventions – which reportedly have prevented over 300 million births since 1978 (Peng 2004) – have led to doubts about whether the socioeconomic indicators that were instrumental to fertility decline in Western countries are also good explanations for China's demographic transition. In China, the congruence of the timing of fertility change with the implementation of birth control policies is clear evidence for the importance of government intervention (Feeney and Wang 1993). For this reason, the Chinese transition is considered to be a unique experience among the countries that have reached sub-replacement levels of fertility (Cai 2010).

Though best known is the controversial one-child policy, China's efforts to control population growth began well before this. The earliest interventions came as a response to the Great Famine of 1959-61. After this natural disaster, the government began to set official targets for population growth and provide better access to contraception and birth planning information (Wu, Schimmele, and Li 2009). However, birth control did not become a core aspect of economic planning until the 1970s (Sharping 2003). This started with the *Wan-Xi-Shao* (later-longer-fewer) campaign, which promoted later marriage and childbirth, longer birth intervals, and fewer births (Liang and Lee 2006). Coinciding with the economic reforms, the Deng administration implemented the one-child policy in 1978 to improve China's prospects for

modernization and industrialization and to address concerns about foodgrain shortages (Wu at el. 2009). The one-child per couple rule applies to around two-thirds of Chinese couples, with most concessions to this rule applying to couples residing in rural areas (Cai 2010).

Feeney and Wang (1993) suggest that over one-half of China's fertility decline is attributable to state intervention. There is no doubt that government policies hastened the "diffusion" of low fertility through China. In 1975, the TFR was lower than what could be expected from the level of development at that time, and reflected the success of the *Wan-Xi-Shao* campaign (Cai 2010). But state intervention, and the one-child policy in particular, is not the sole reason for the decline in fertility. The persistence of sub-regional variation in fertility after the intensification of state interventions appears to parallel sub-regional differences in socioeconomic development (Tien 1984). Cai (2010) observes that China's fertility in 2005 fell within a range that could be expected from its level of development. In addition, the TFR remained above replacement levels during the 1980s, when the one-child policy was enforced with fewer exceptions than later. Cai concludes that socioeconomic development, in conjunction with state intervention, generated an ideational shift toward a preference for smaller families. For the one-child policy to be the sole or decisive factor, the fertility behavior of Chinese couples would need to have been radically different from the fertility behavior of couples in other countries.

To some extent, China's path to low fertility supports the assumptions of Demographic Transition Theory (DTT). A central theme of DTT is that the shift from rural (agricultural) to urban (industrial) life initiates a change in the economics of

childbearing (Kirk 1996). According to Notestein's (1953) classic argument, fertility is high in agrarian societies as insurance against high mortality and because children were an important source of agricultural labor. Modernization first leads to a reduction in mortality, which decreases the need for high fertility to insure population survival (Bongaarts and Watkins 1996). The transition to industrial economies (and urban environments) also decreases the economic contributions of children, whereas the costs of their upbringing and education increase. Though no two transitions are alike, it remains plausible that modernization is responsible for decreasing the need and incentives for large families in numerous societies (Kirk 1996).

This theory of fertility change has been criticized for over-emphasizing the role of economic motivation (Hirschman 1994). To be sure, the precise reasons for the relationship between TFR and socioeconomic development are difficult to ascertain, and are surely irreducible to economic factors. Even though DTT offers an incomplete explanation of fertility change, this does not undermine the empirical relationship between TFR and levels of socioeconomic development (Bryant 2007; Cai 2010). The main criticism of DTT is not the relationship between modernization and fertility per se, but the mechanisms that constitute this relationship (Bongaarts and Watkins 1996). The criticism of DTT also focuses largely on the role of socioeconomic indicators in the onset and early phase of the transition to low fertility. However, Bongaarts (2002) observes that fertility behavior is more consistent with DTT at later stages of the transition, which is our concern.

Of course, the relationship between fertility and socioeconomic development cannot be reduced to rational decisions about the costs/benefits of children (Hirschman

1994). However, DTT does not preclude other causal variables and indeed acknowledges the importance of ideational factors. Notestein (1953) observed that it is “impossible to be precise” about the mechanisms that drive fertility change in modern societies, and he indicated that economic factors cannot provide a sufficient explanation. He remarked that the anonymity of urban life weakened social control over fertility behavior and modernization created more opportunities for women outside the domestic sphere. Urbanization is a proxy for changes in social norms and gender roles, which, together with economic forces, generate a preference for smaller families.

The economics of children and ideational preferences for smaller families are important components of the relationship between fertility decline and socioeconomic development in China (Cai 2010). However, rural-urban differences in the enforcement of the one-child policy suggest that an increasing proportion of urban residents will lead to an inevitable decline in national fertility, unless China reforms the policy. The one-child rule is strictly enforced in all urban areas in China and throughout 6 provinces (Gu et al. 2007). There are some exceptions for couples that have agricultural household registration status. In 19 provinces rural couples are allowed a second child if their first child is a girl and in another 5 provinces all rural couples are permitted two children. The urban population remained stable until 1978, but the relaxation of official restrictions on rural-to-urban migration and the reclassification of rural areas into urban areas have fueled the proliferation of the urban population (Zeng and Vaupel 1989). This process is exposing a growing number of Chinese to urban values and subjecting them to the one-child rule.

Methods

The data for the country-level TFR and the proportion of urban females of reproductive age come from the 1982 Census, the 1990 Census, and the 2001 and 2008 1 per thousand population surveys conducted by the National Bureau of Statistics of China (NBS, 2009). The estimates for provincial-level fertility are drawn from an NBS and East-West Center (2007) report. A decomposition approach is used to model the effects of urbanization on fertility change. Following Das Gupta (1991), the analysis decomposes TFR_{asfr} into three components to estimate the separate effects of changes in urban fertility, rural fertility, and urbanization on TFR. For the reader's convenience, the mathematical expression is recapitulated as below.

Total fertility rate can be formulated as $TFR_{asfr} = 5\sum_x F_x$, where F_x is the age-specific birth rate for the 5-year age group starting at age x. F_x can be expressed as a weighted sum of urban-age-specific birth rate ($F_{x,u}$) and rural-age-specific birth rate ($F_{x,r}$), where the weights $k_{x,r}$ and $k_{x,u}$ are the proportion of women in age group x to x+5 residing in rural and urban areas, respectively (here we have $k_{x,r} + k_{x,u} = 1$, $\Delta k_{x,u} = -\Delta k_{x,r}$). This leads to the reformulation of $TFR_{asfr,}$

$$TFR_{asfr} = 5\sum_x F_x = 5\sum_x (F_{x,r}k_{x,r} + F_{x,u}k_{x,u}) \quad (1)$$

It follows that the change in the TFR_{asfr} is,

$$\Delta TFR_{asfr} = 5\sum_x (\overline{F_{x,u}} - \overline{F_{x,r}})\Delta k_{x,u} + 5\sum_x \overline{k_{x,r}}\Delta F_{x,r} + 5\sum_x \overline{k_{x,u}}\Delta F_{x,u} \quad (2)$$

where the symbol Δ denotes change, and $\overline{F_{x,r}}$, $\overline{F_{x,u}}$, $\overline{k_{x,r}}$ and $\overline{k_{x,u}}$ are average values over the period. The first of the three principal terms on the right hand side of Equation (2) denotes the contribution to change in TFR from changes of the age-specific proportion of urban females within the total female population at reproductive age. The second term

denotes the contribution from changes in age-specific rural fertility. The third term denotes the contribution from changes in age-specific of urban fertility.

To demonstrate the results of this decomposition exercise, we begin with the scenario where (i) the rural fertility is always higher than urban fertility in any age-group ($F_{x,r} > F_{x,u}$), (ii) all components have no changes during the period ($\Delta k_{x,u} = \Delta F_{x,r} = \Delta F_{x,u} = 0$). This situation is illustrated in Figure 3a, in which all TFRs are constant during the period.

Suppose now that, under the same assumptions (i and ii), we now allow the proportion of urban females to increase at each reproductive age ($\Delta k_{x,u} > 0$). Equation (2) is simplified: $\Delta TFR_{asfr} = 5\sum_x(\overline{F_{x,u}} - \overline{F_{x,r}})\Delta k_{x,u}$ where $\overline{F_{x,u}} - \overline{F_{x,r}} < 0$ according to assumption (i) and $\Delta TFR_{asfr} < 0$. As shown Figure 3b, this change drives down the national fertility despite the urban and rural fertility remains unchanged. Furthermore, if there is a positive change in both urban and rural age-specific birth rate ($\Delta F_{x,u} > 0$ and $\Delta F_{x,r} > 0$) and in the proportion of urban females ($\Delta k_{x,u} > 0$), the first term of Equation (2) becomes negative but the second and third terms turn positive, such that the change of national TFR, as the sum of the three terms, can be unchanged ($\Delta TFR_{asfr} = 0$). This scenario is demonstrated in Figure 3c. In short, this illustration demonstrates that the trends of national fertility, urban fertility and rural fertility may not be in the same direction when we take into account the role of urbanization.

Figure 3 About Here

National TFR, 1982 – 2008

Table 1 presents the change in age-specific national TFR, which is decomposed into three components. The first component represents changes in rural fertility, the second component represents changes in urban fertility, and the third component represents the influence of urbanization, i.e., changes in the proportion of urban females aged 15-49 years. The results show a 1.15 decrease in China's TFR between 1982 and 2008. The change in rural fertility behavior contributed to 0.83 of this decrease and the change in urban fertility behavior contributed to 0.07 of this decrease. The change of urbanization resulted in a 0.25 decrease in the national TFR, which represents about 22 percent of the total reduction in TFR from 1982 to 2008. The change in rural fertility behavior accounted for the largest amount (72 percent) of the decline in TFR during this period.

Table 1 About Here

From 1982-1990, both the changes in rural fertility behavior and urbanization led to a reduction in national TFR. During this period, there was an increase in urban births, and thus urban fertility behavior had a positive impact on national TFR. The reduction of national TFR through rural fertility behavior and urbanization likely reflect the impact of the one-child policy. The results suggest a tightening up of the one-child policy in rural areas, such as preventing 3rd and higher order births. The effect of urbanization is presumably a result of a greater number of people becoming adherents to the strict one-child rule through permanent migration or the reclassification of rural areas into urban areas. The impact of urban fertility behavior is not that surprising. Urban fertility has been considerably lower than rural fertility since the 1960s and it reached the sub-replacement level in the early 1970s (Zeng and Vaupel 1989). Given that the urban TFR

was 1.4 in 1981 (see Figure 2), it is unreasonable to anticipate that it could decline much more.

Changes in rural fertility behavior, urban fertility behavior, and levels of urbanization all contributed to the reduction in national TFR from 2.30 in 1990 to 1.39 in 2001. The change in rural fertility behavior had the greatest effect, accounting for 69 percent of the decline in national TFR. The effect of urban fertility behavior accounted for 20 percent of the decline in TFR and urbanization accounted for the remaining 11 percent. From 2001 to 2008, the national TFR increased from 1.39 to 1.47. This was a result of growth in both rural and urban fertilities. However, the effect of urbanization on national TFR growth was negative. The rebound of national TFR demonstrates the challenge of reducing TFR in low-fertility regimes. But these results also show that urbanization remains a source of declines in TFR in developing countries with low fertility.

Table 1 demonstrates that urbanization was primary reason for the decline in China's TFR between 2001 and 2008. To illustrate the independent effect of urbanization on fertility change, we compared the national TFR with and without the effect of urbanization. In Figure 4, the dotted line represents what the national TFR would be without urbanization (counter-factual test). This figure confirms the importance of urbanization to the decline in China's fertility. Without urbanization, China's TFR would be higher than it actually is.

Figure 4 About Here

Province-Level TFR in 2000 and 2005

In this section, we present the decomposition of changes in TFR for 30 of 31 provinces and municipalities in mainland China. The region of Tibet is excluded because the sample size of birth numbers is too small to permit an accurate analysis. In China, socioeconomic development has been uneven and there are disparities between the provinces (Peng 2011). The national results presented above could, therefore, provide an incomplete picture of the relationship between TFR and urbanization. China's provinces and municipalities fall under four levels of urbanization (see Fu, Wei, and Jin 2009). The first level includes municipalities such as Shanghai, Beijing, and Tianjin, which are China's economic powerhouses and have the highest national levels of urbanization. The second are provinces at a medium level of urbanization, including Heilongjiang, Jilin, and Liaoning. The third level consists of nine provinces with low levels of urbanization: Guangdong, Jiangsu, Shandong, Hubei, Shanxi, Qinghai, Xinjiang, Hainan, and Ningxia. The remaining provinces have very low levels of urbanization.

Figure 5 plots the province-level TFRs according to degree of urbanization. This figure indicates that there is, in general, an inverse relationship between TFR and urbanization. In accordance, the most urbanized provinces also had the lowest TFRs in 2000 and 2005. However, there are incidences where low levels of urbanization are associated with high levels of fertility. Table 2 provides additional evidence for this relationship. Between 2000 and 2005, both changes in urban fertility behaviors and levels of urbanization contributed to a decrease in the national TFR, but these effects were somewhat offset because of an increase in the rural TFR across China. During this time, the TFR declined in 23 provinces/municipalities. The greatest decreases occurred in the four large metropolitan municipalities, Beijing, Tianjin, Shanghai, and Chongqing. The

majority of reduction in these provincial TFRs is attributable to changes in urban fertility behavior and the expansion of the urban population. Other provinces also experienced large reductions in their TFRs. These include three coastal provinces, Liaoning in the north and Guangdong and Hainan in the south, and three inland provinces, Shanxi, Henan, and Jiangxi.

Figure 5 and Table 2 About Here

However, the relationship between TFR and socioeconomic development is not entirely consistent across China. Several lesser developed provinces (Guizhou, Yunnan, Qinghai, and Xinjiang) also experienced large declines in their TFRs. The declines in these provinces were largely a result of changes in fertility behavior in rural areas. In six inland provinces (Guangxi, Sichuan, Hubei, Jiangsu, Hebei, and Anhui) the TFR increased. In some of these provinces, the relationship between TFR and urbanization does not appear to be as robust as it is elsewhere, but this is generally because high fertility in rural areas offset the effect of urbanization. Shandong is the only coastal province that experienced a large increase in its TFR. That said, Figure 6 illustrates that, between 2000 and 2005, increases in levels of urbanization associated with a decline in the TFRs in all provinces except for Jilin, Shanghai, and Xinjiang.

Figure 6 About Here

The decompositions presented in Table 2 suggest that changes in urban fertility behavior in the most urbanized provinces accounted for most of reduction in TFR observed among them. These provinces (and municipalities) are Beijing, Tianjin, Shanghai, Liaoning, Jilin, Heilongjiang, Zhejiang, and Guangdong. In these provinces, an average of 65 percent of women aged 15-49 reside in urban areas, compared to the

national average of 41 percent. The declines in the number of urban births in these provinces represented an important source of the decrease in the national TFR. While changes in rural fertility behavior contributed much to decline in the national TFR from 1982-1990 and also from 1990-2001 (see Table 1), this effect seems to have ebbed in recent years. Between 2000 and 2005, rural fertility had a positive effect on the national TFR, even though this effect was offset because of decreases related to urban fertility behavior and urbanization.

In 12 provinces, change in rural fertility behavior was instrumental in propelling either the growth or the reduction of provincial-level fertility between 2000 and 2005. These 12 provinces can be classified has having comparatively small urban populations. In seven of these provinces (Hebei, Jiangsu, Anhui, Shandong, Hubei, Guangxi, and Sichuan) the provincial-level TFR increased because of increases of fertility in rural areas. In several of these provinces the TFR increased despite a decrease in urban fertility and a negative effect of urbanization. Moreover, urbanization had a negative effect on the TFR in each of these provinces, and fertility in urban areas increased in only in Anhui and Guangxi. In some provinces, such as Henan, Guizhou, and Yunnan, the reduction in their TFRs was mainly a result of declines of fertility in rural areas.

Future Effects of Urbanization

The evidence presented above suggests that urbanization is an important factor in the reduction of China's TFR. The question that remains is whether urbanization will have a negative effect on China's fertility in the future. To address this question, we forecasted China's fertility from 2010 to 2030, using six scenarios based on three

assumptions about urban growth and two assumptions about differences in rural and urban fertilities. Under our low-growth assumption, 62 percent of the population will be urban in 2030. In the medium-growth assumption, the proportion of the urban population will be 67 percent in 2030. In the high-growth assumption, the urban population will account for 84 percent of the general population in 2030. The figures for the medium-growth scenario best accord with official estimates of future urbanization (Pan and Wei, 2010). Because predicted data are not age-specific based, a simplified version of the decomposition equation is introduced and presented in Appendix A.

We considered these three assumptions about urban growth under two different assumptions about future differences in rural and urban fertilities. First, we used a time series model to project the stochastic pattern of rural and urban fertilities. Details about the stochastic model are presented in Appendix B. In this model, rural TFR is stable at 1.6 and urban TFR is stable at around 1.1, for a fairly persistent difference of 0.5 between them. Second, we used a model of the rural-urban TFR differential that assumes that the birth planning policy has been relaxed to a two-child rule for all couples. Under this assumption, the rural TFR would be 1.88 and the urban TFR 1.5 in and after 2010 (see Zheng 2004). While the second assumption suggests a narrowing gap of rural and urban TFRs (0.38), it is unreasonable to expect rural and urban fertility behaviors will converge in the next twenty years, even if the one-child policy is relaxed in urban areas.

Table 3 presents the estimated TFRs under these six scenarios of urbanization and differences in rural and urban fertility. In all six scenarios, urbanization is projected to be the primary factor behind fertility change from 2010-2030, and the national TFR will remain at sub-replacement levels. The stochastic projections result in little variation in

rural and urban fertilities during this time. Changes in rural and urban fertility behaviors are projected to have small negative effects on China's TFR under the present birth planning policy. Under the "relaxed policy" assumption, rural and urban fertility do not affect the national TFR. This implies that the projected decline in TFR will occur entirely through urbanization. Under medium-growth (the expected level of urbanization), the national TFR will decrease from 1.44 in 2010 to 1.25 in 2030 under the stochastic assumption and from 1.7 to 1.6 under the "relaxed policy" assumption.

Table 3 About Here

Conclusions

China has experienced rapid urbanization since 1978 and the urban population is projected to continue growing for several more decades. As noted above, there is an inverse relationship between TFR and urbanization. This study examined the effects of urbanization on fertility change in China between 1978 and 2008, and projected how much more urbanization can be expected to contribute to fertility change between 2010 and 2030. This study decomposed China's present and future TFR into three components to estimate the separate effects of changes: the effect of change in rural fertility behavior, the effect of change in urban fertility behavior, and the effect of urbanization. The study assumed that regional differences in levels of urbanization could influence the relationship between national TFR and urbanization. Hence, the analysis includes findings for the decomposed effects on the national and provincial-level TFRs for 2000-2005.

The study offers three major conclusions about past and future fertility trends. First, the change in rural fertility behavior accounted for most of the decline in the national TFR from 1982-2008. The national TFR declined from 2.62 to 1.47 during this period. The reduction in rural fertility was responsible for 72 percent of this decline. This finding suggests that the one-child policy was the primary instrument of China's achievement of sub-replacement fertility. Between 2000 and 2005, several less developed provinces (e.g., Guizhou, Yunnan, Xinjiang) experienced large declines in their TFRs largely because of reductions in number of rural births. It is possible that some of these declines in rural fertility is related to other aspects of socioeconomic development, such as improvements in the educational attainment of rural residents or decreases in need for agricultural labor, but the one-child policy is likely the main factor for this change. In seven provinces, however, an increase of fertility in rural areas was the driving factor for increases in province-level TFR, which could reflect local variation in the enforcement of the one-child policy. As the majority of Chinese (54 percent) still live in rural areas, it is unsurprising that this population remains the vanguard of China's fertility transition.

Second, the contribution of urbanization to the decline of China's TFR between 1982 and 2008 was modest in comparison to the large effect that decreases in rural fertility had. However, urbanization was indeed an important factor and it had a negative effect on the national TFR in each of the periods observed (1982-1990, 1990-2001, 2001-2008, and 1982-2008). About 22 percent of the reduction in the national TFR between 1982 and 2008 is related to the process of urbanization. Moreover, the findings suggest that urbanization has recently become the principal source for curbing population growth. From 2001-2008, urbanization had a negative effect on the national TFR, but increases in

rural and urban births offset this effect. In all but three provinces, urbanization was associated with a decline in province-level TFRs between 2000 and 2005. The three exceptions (Jilin, Shanghai, and Xinjiang) had relatively low rates of urbanization during this period, thus the impact of urbanization on TFR in these areas was also minimal. Low rates of urbanization and possible measurement errors in TFRs may explain the unexpected relationship between TFR and urbanization among them. In contrast, in provinces with high rates of urbanization and large rural-urban fertility differentials, the effect of urbanization on province-level TFR is quite pronounced.

Given the short period of observation for changes in province-level TFRs (five years), it is possible that the findings presented here do not reflect the full effect of urbanization. The intent here is to disentangle the effect of urbanization from the effect of urban fertility behavior. To some extent, the change in urban fertility behavior is likely a "lagged" effect of urbanization. That is, the effects of rural-to-urban migration and the reclassification of rural areas into urban areas on urban fertility are not immediate. Rather, these new urbanities gradually adopt urban fertility behaviors and are exempt from the strict one-child rule in the short-term. This effect is difficult to decompose because of data limitations, but it suggests that a portion of the decreases in the national and province-level TFRs related to changes in urban fertility behavior represent an unobserved effect of urbanization.

Finally, the findings suggest that urbanization will take over as the main engine of fertility decline from 2010-2030. This is evident from recent trends. While the national TFR increased from 1.39 to 1.47 from 2001 to 2008, this change would have been larger without the negative effect of urbanization. After several decades of birth planning, it

appears that the one-child policy is reaching the limits of what it can accomplish. Our projections indicate that changes in rural and urban fertility behaviors have small effects on the TFR under the current policy. In general, it is becoming increasingly difficult to decrease the TFR, given that it is already very low. However, given the levels of urbanization that can be realistically expected in 2030 and beyond, relaxing the one-child policy to a two-child policy would not have a major effect on China's population growth. Under this scenario, we project the TFR to be 1.6 in 2030. This supports studies that call for alternative policies to the one-child rule (e.g., Greenhalgh and Bongaarts 1987; Wang 2005; Zeng 2007).

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Appendix A: A Simplified Version of the Decomposition Equation

To derive a simplified version of decomposition equation, Equation (1) requires three additional assumptions: a) $F_x$is constant for all x, i.e., age specific fertility rates are constant in all ages; b) $k_x$is constant for all x, meaning that the proportion of urban females at aged x in the total female population is constant; and c) the sex composition of urbanites remains constant while urbanization rate (C_u) increases such that $C_u = k_u$. Under these assumptions, Equation (1) can be re-written as

$$TFR_{asfr} = F_r C_r + F_u C_u \qquad \text{(A1)}$$

and decomposing (A1),

$$\Delta TFR = (\overline{F_u} - \overline{F_r})\Delta C_u + \overline{C_r}\Delta F_r + \overline{C_u}\Delta F_u \qquad \text{(A2)}$$

where F_r and F_u denote rural TFR and urban TFR, respectively; C_r and C_u denote the proportion of rural and urban population; and again we have $C_r + C_u = 1$. Appendix A1 shows that the difference in TFR between using Equation (1) and Equation (A1) is minimal (see the last column of Appendix A1), suggesting that it is not unreasonable to decompose TFR, rather than TFR_{asfr}, in the decomposition exercise and the forecasts of TFRs (see Appendix B).

Appendix B: Forecast of TFRs in Urban and Rural Areas

To forecast future national fertility, we estimated a conventional time series model for the log-transformed rural and urban TFRs (F_r and F_u), conditional upon that the TFRs are greater than 0 (e.g., Box, Jenkins & Reinsel, 2008). We used data from 1950-2008. The fitted models for F_u and F_r are given below (standard errors in parentheses):

$$\ln F_{u,t} = 0.992(0.0096) \times \ln F_{u,t-1},\ R^2 = 0.904$$

$$\ln F_{r,t} = 0.995(0.0065) \times \ln F_{r,t-1},\ R^2 = 0.903$$

Using these equations, it is straightforward to forecast TFRs in urban and rural area for the next twenty years (see Appendix B1). Appendix B1 shows that rural TFRs in next 20 years are fairly stable at approximately 1.6, while urban TFRs are around 1.1.

Table 1 Decomposition of the Changes in TFR in China: 1982-2008

	TFR (per 1,000)			Absolute change (per 1,000)		
Period	Start	End	Change	Rural	Urban	Urbanization
1982-1990	2620	2300	-320	-310	60	-70
1990-2001	2300	1390	-910	-630	-180	-100
2001-2008	1390	1470	80	110	50	-80
1982-2008	2620	1470	-1150	-830	-70	-250

Table 2 Decomposition of the Changes in TFR: Chinese Provinces, 2000-2005

	Absolute change in TFR (per 1,000)				Relative change in TFR (percent)		
	Total	Rural	Urban	Urbanization	Rural	Urban	Urbanization
China	-74	23	-51	-45	1.6	-3.7	-3.2
Beijing	-202	2	-189	-16	0.2	-21.7	-1.8
Tianjin	-177	-3	-146	-27	-0.3	-14.8	-2.7
Hebei	101	142	-6	-36	9.7	-0.4	-2.4
Shanxi	-173	-85	-72	-15	-5.2	-4.4	-0.9
Neimenggu	-27	-4	3	-26	-0.3	0.3	-2.2
Liaoning	-104	21	-98	-28	1.9	-9	-2.5
Jilin	-13	54	-69	2	5.4	-7	0.2
Heilongjiang	-12	52	-63	-1	5.2	-6.2	-0.1
Shanghai	-389	-20	-371	2	-1.9	-34.8	0.2
Jiangsu	52	152	-49	-52	13.6	-4.4	-4.6
Zhejiang	-69	37	-79	-27	2.8	-6	-2.1
Anhui	301	323	61	-83	21.8	4.1	-5.6
Fujian	-29	104	-80	-53	8.5	-6.5	-4.4
Jiangxi	-120	-70	18	-68	-3.9	1	-3.8
Shandong	253	204	84	-35	16.1	6.6	-2.7
Henan	-301	-221	-44	-36	-13.9	-2.8	-2.2
Hubei	119	104	41	-25	8.3	3.3	-2
Hunan	-16	13	11	-40	0.9	0.7	-2.7
Guangdong	-421	-78	-313	-30	-5.4	-22	-2.1
Guangxi	43	88	2	-47	5	0.1	-2.7
Hainan	-226	-56	-102	-68	-3.1	-5.5	-3.7
Chongqin	-239	-36	-92	-112	-2.5	-6.4	-7.8
Sichuan	36	92	-30	-27	6.3	-2	-1.8
Guizhou	-450	-367	-50	-32	-15.4	-2.1	-1.3
Yunnan	-307	-240	-19	-49	-11.8	-0.9	-2.4
Shaanxi	-85	-11	-51	-23	-0.9	-4	-1.8
Gansu	-29	-7	-13	-10	-0.5	-0.9	-0.6
Qinghai	-435	-275	-138	-22	-15.1	-7.5	-1.2
Ningxia	-19	30	-4	-45	1.7	-0.2	-2.6
Xinjiang	-156	-109	-61	14	-6.3	-3.5	0.8

Sources: Fertility Estimates for Provinces of China (National Bureau of Statistics of China & East-West Center, 2007) and The Report of China's 2005 National 1 Percent Sample Survey. Beijing: National Bureau of Statistics of China, 2006.

Table 3 Decomposition of the Predicted TFRs: 2010-2030

Urbanization development	Fertility assumption	TFR (per 1,000)			Absolute change (per 1,000)		
		Start	End	Change	Rural	Urban	Urbanization
High growth	"Stochastic"	1440	1200	-240	-20	-30	-190
	"Relaxed"	1700	1560	-140	0	0	-140
Medium growth	"Stochastic"	1440	1250	-190	-20	-30	-140
	"Relaxed"	1700	1600	-100	0	0	-100
Low growth	"Stochastic"	1440	1310	-130	-10	-40	-80
	"Relaxed"	1700	1640	-60	0	0	-60

Appendix A1: A Simplified Decomposition of TFRs

Year	TFR(rural)	TFR(urban)	Urbanization rate	TFR(1)	TFR(A1)	Difference
1982	3.02	1.40	21.13%	2.62	2.68	0.06
1990	2.58	1.59	26.41%	2.30	2.32	0.02
2001	1.60	1.08	37.66%	1.39	1.40	0.01
2008	1.73	1.22	45.68%	1.47	1.50	0.03

Sources: The 1982 Census, the 1990 Census; the 2001 and 2008 0.1 Percent Population Surveys.

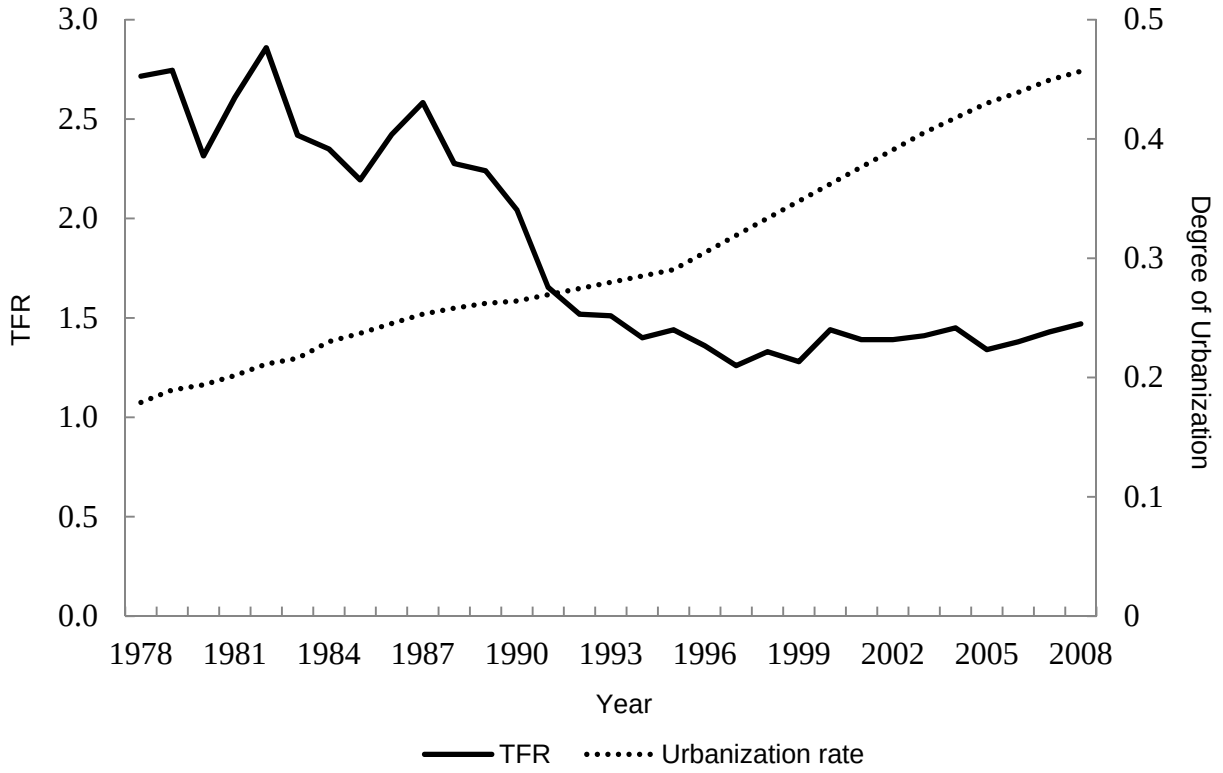


Figure 1 Trends of TFRs and Urbanization Rates, 1978–2008, China

Sources: National Bureau of Statistics of China, 2009.

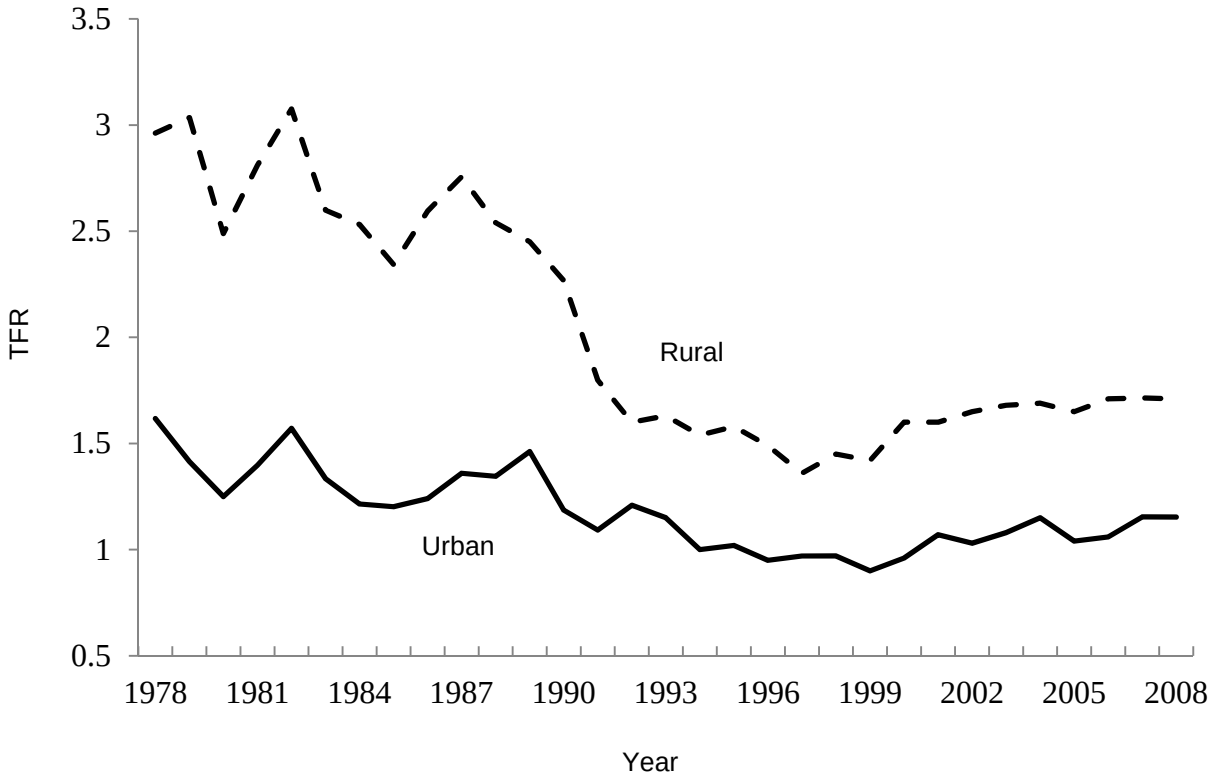


Figure 2 Trends of TFRs in Urban and Rural Areas in 1978 - 2008

Sources: The 1978-1987 data came from the 2/1000 Fertility and Contraceptive Use Survey conducted in 1988; the 1988-1992 data came from the National Fertility Survey conducted in 1992; the 1993-2000 data came from the 2001 National Fertility and Reproductive Health Survey; and the 2001-2008 data came from the Annual Population Monitoring Surveys.

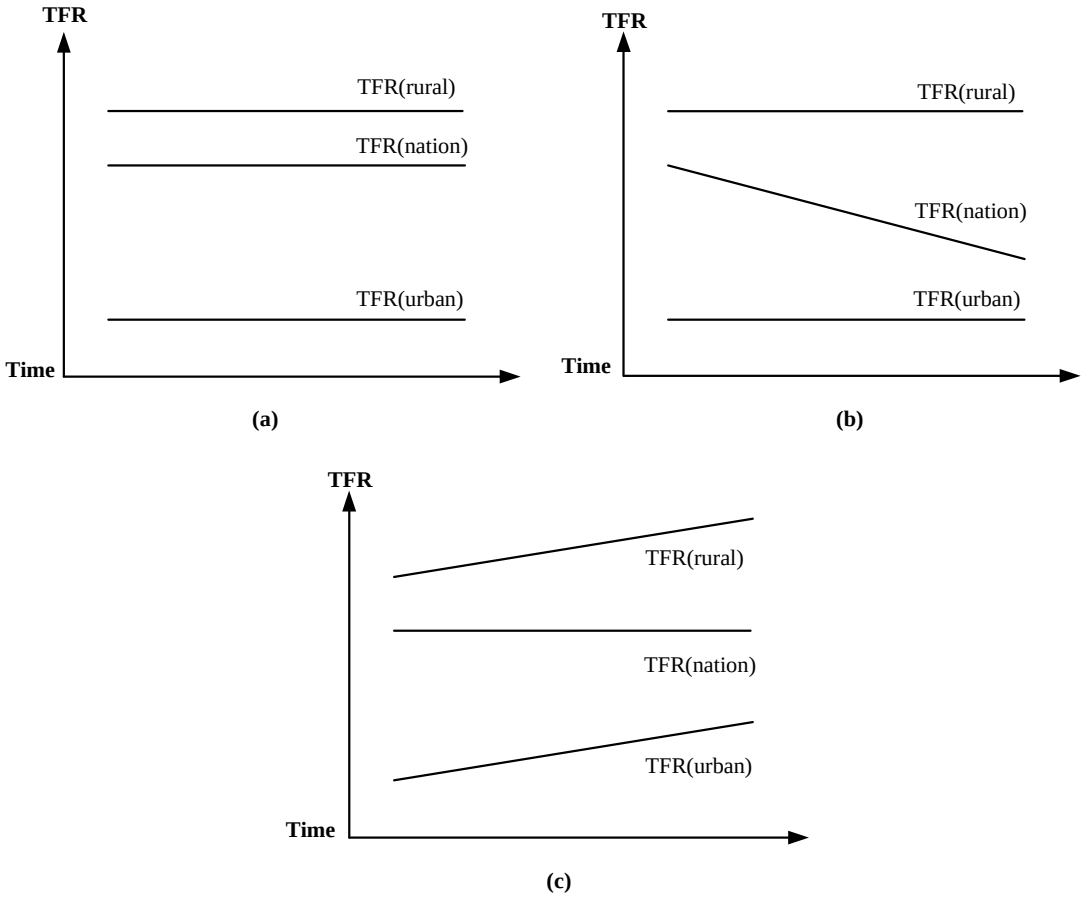


Figure 3 Illustrations of Urbanization Effect on Fertility

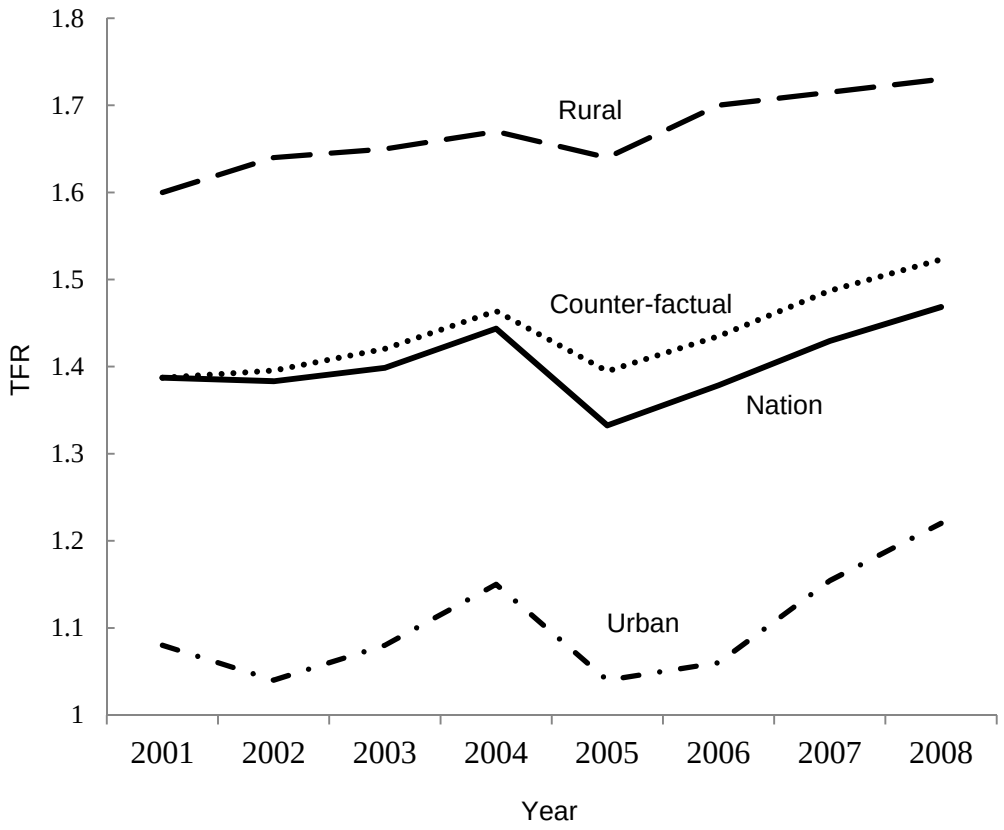


Figure 4 Counter-Factual Test on TFRs from 2001 to 2008

Source: National Bureau of Statistics of China, 2009.

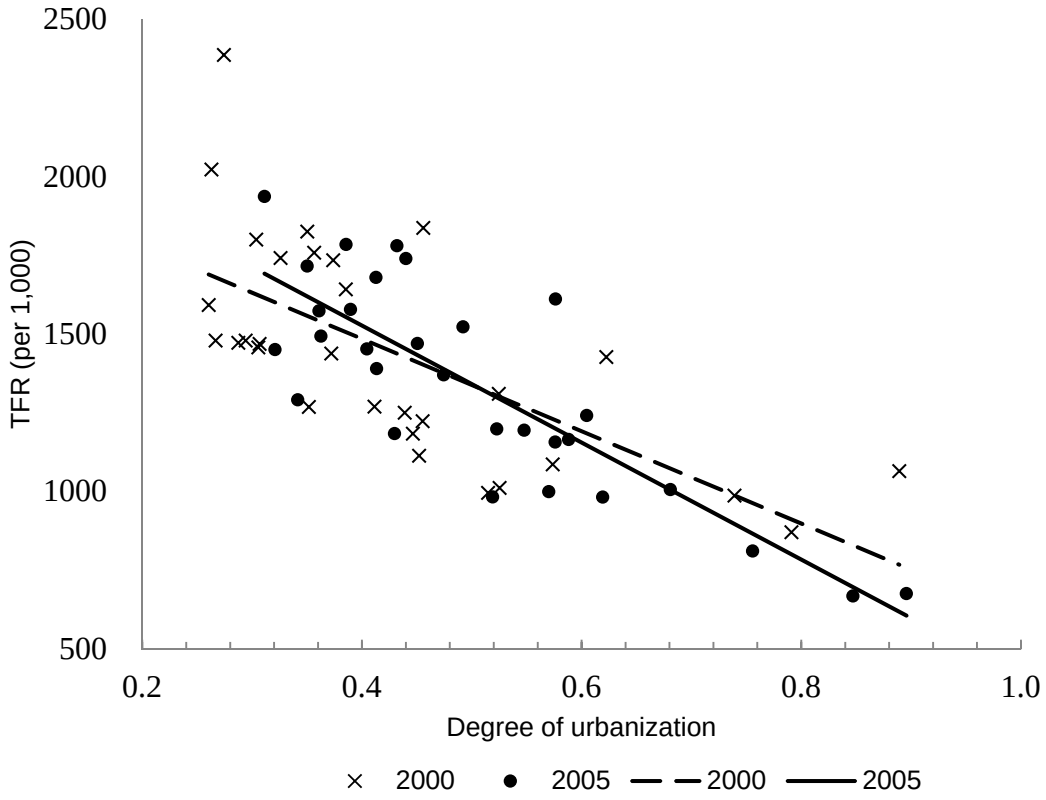
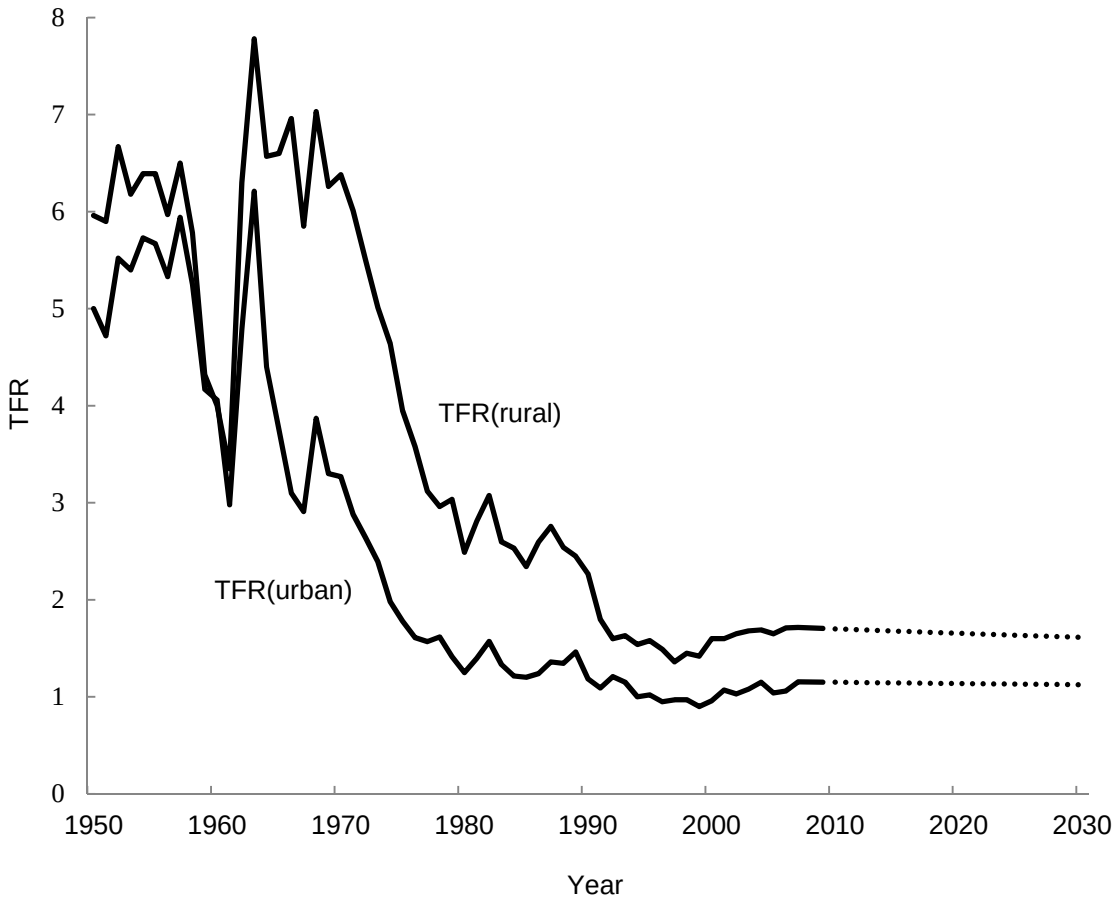


Figure 5 Trends of urbanization rates and TFRs in 2000 and 2005

Sources: “Fertility estimates for provinces of China” (National Bureau of Statistics of China & East-West Center, 2007) and The Report of China’s 2005 National 1 percent Population Survey. Beijing: National Bureau of Statistics of China, 2006.

Figure 6 Effect of Change in the Urbanization Rate on TFR in 2000-2005, Chinese Provinces



Appendix B1: Forecast of TFRs in Urban and Rural areas

Sources: The 1950-1977 data came from 1/1000 Fertility Survey conducted in 1982; the 1978-1987 data were from the 1988 2/1000 Fertility and Contraceptive Use Survey; the 1988-1992 data came from the 1992 National Fertility Survey; the 1993-2000 data were obtained from the 2001 National Fertility and Reproductive Health Survey; and finally the 2001-2008 data came from the Annual Population Monitoring Surveys.