Urbanization, Food Production and Food Security in China

Jikun Huang, Jun Yang, Xiangzheng Deng, Jinxia Wang

Center for Chinese Agricultural Policy of Chinese Academy of Sciences, Institute of Geographic Sciences and Natural Resources Research

Scott Rozelle

Freeman Spogli Institute for International Studies, Stanford University and LICOS, Katholic University, Leuven (KUL), Belgium (adjunct professor)

Acknowledgments: The authors acknowledge the financial support of the National Natural Sciences Foundation of China (71333013), the World Bank and the EU FP7 (290693). The research support by Zhurong Huang and Huaiju Liu and suggestions on earlier versions of this paper from Junfei Bai, Jun Han, Sanlin Jin, Will Martin, Huanguang Qiu, Ulrich Schmitt, Xiaobing Wang are appreciated.

Urbanization, Food Production and Food Security in China

I. Introduction

Tremendous achievements have been made in China's agriculture in past three decades since the economic reforms were launched in the late 1970s (NBSC, 2012). With the rise of output exceeding the rise of population, China has become increasingly food secure over the first three decades of reform (Huang et al., 2007; Yang et al., 2011). In recent years, however, the situation has begun to shift. Since 2004, China food, feed and fiber imports have exceeded exports (NBSC, 2004-2013). Between 2001 and 2012 the share of China's grain consumption that has come from domestic production fell from 97% to 87.5%. The main source of rising imports has been from increases in the import of soybean (which in China is considered a type of grain) and maize. The import of sugar, milk products and meat (including pork, beef and mutton) also has risen faster than production.

The emergence of pressures on China's food system to be able to maintain national food security has raised even more concerns inside and outside of China because of the timing. The rise of imports is occurring precisely as the nation is trying to accelerate the pace of urbanization (Chen, 2013). The concern about food security and urbanization is simple. Along with urbanization, incomes will rise, consumption patterns will change, land and water and labor—the key inputs into farming—will be diverted into the construction of China's cities (Jia et al., 1997; Zhong and Li, 2009; Li and Li, 2012).

Despite the intense interest in this topic, there is a little rigorous research that examines this question empirically. In the work that has been done, the findings are mixed. Some scholars predict that urbanization will have negative impacts on agricultural production, stimulate food consumption and, consequently, threaten

China's food security (Zhang et al., 2009; Yang and Zhang, 2010). There are others that believe China has a lot of growth potential in the production of agricultural commodities (Huang et al., 2010; Xu, 2001).

The overall goal of this study is to fill the gap in this important literature and evaluate the impact of China's urbanization on its agricultural production and national food security. To meet this goal, we have two specific objectives. First, we will assess the supply-side factors associated with urbanization that will affect China's future production. This part of the analysis will be looking at the direct supply effects of urbanization. Second, we will examine—using a partial equilibrium modeling approach—to examine the overall supply impacts, taking into account both the direct and indirect effects of urbanization on supply.

To accomplish the two objectives, the rest of this paper is organized as follows. The next part discusses the pressures associated with urbanization that will affect the ability of China's agricultural producers to supply the nation's food, feed and fiber needs. The third part presents the results on the impact of urbanization on China's agricultural production (and the effect of changes in domestic supply on trade) in 2020. The main conclusions and policy recommendation are proposed and discussed in the final part.

One of the limitations of this work is that it only examines the supply side. In fact, space limitations keep us from examining demand-side factors. In a working paper (Huang et al., 2014), because of sharply falling demand for grains as staples (for migrants compared to rural residents), despite of rising feed grain as meat consumption increases with urbanization, demand for total grain (one of China's main food security objectives) is actually shown to fall. On demand side, urbanization's effects are mainly on the food consumption structure, the overall impact is moderate (Huang et al., 2014).

II. Immediate (Direct) Pressures on Supply from Urbanization

In our study—and in China more generally, food security at the national level is defined as the share of food demand that is produced by domestic producers. In this way, food security can be affected by changes in the supply for food and feed. In examining the supply factors, there are two main types of effects—direct effects and indirect effects. Direct effects are the proximate factors influenced by urbanization that affect the supply of agricultural production. These direct factors include the immediate changes in water, cultivated land and labor that are needed to support the drive for urbanization in China. These direct effects are the ones discussed in this section. In the following section we examine the full effects of urbanization on supply, including the direct effect of urbanization on water, cultivated land and labor (the immediate supply effects), as well as the indirect effects that includes the responses of producers and consumers operating in the urbanizing economy after the prices of agricultural commodities rise in response to the falling supply of domestic production during the process of urbanization. These full (direct and indirect) effects are examined in the following section.

In total, in our modeling framework, there are three direct channels that we consider when we are looking at the proximate effects of urbanization on agricultural supply (and the trade/national food security impacts). In briefest terms, urbanization affects agricultural production directly through three different mechanisms: water, cultivated land and labor. Space restrictions necessarily mean that the explanations of our methods must be brief. For the interested reader, we cite the papers that have full explanations of the approaches. We then present our estimates of the direct effects of each of these factors. These estimates form the basis for our scenario analysis in the next section.

Water

The approach to examine the impact of urbanization on water available for agriculture consists of three steps. More detailed discussion of this issue can be found in Wang et al. (2013a).

First, we examine the changing trends of water use in agriculture, industry and domestic. The data series include observations from 1993 to 2011. The data series are available by crop and by province. On average, water use in agriculture has fallen monotonically; water used for industry and domestic uses has risen. These data are presented in Wang et al. (2013a).

Second, using a multivariate regression model, we empirically estimate the relationship between water use and urbanization, $W_t = F(U_t)$, where the dependent variable (W_t) represents the use of water in agriculture. In our analysis, W_t is measured by the ratio of water used for agriculture over total water use. The independent variable (U_t) represents urbanization. It is measured by the ratio of the urban population over the total population. Using the variation of agricultural water use over time and across space, we estimate a parameter that estimates how much water would be lost to agriculture for each percentage point rise in urbanization.

Finally, using the China Water Simulation Model (CWSM—Wang et al., 2013b), we estimate the changes in crop area and output per unit (or yield) that results from falling agricultural water availability. The CWSM divides whole China into ten large river basins and each basin consists of two key modules. One of them produces a water balance (“water in” must equal “water out”). The other module is a water allocation module that maximizes total profit by allocating water among crops. These two components are used to simulate water balance and predict the way that water is allocated across crops by river basin. Ultimately after solving the model we are able to calculate the impact of urbanization on agricultural production through changes in irrigated and rainfed area and the yield of each crop.

After using the three-step method, and aggregating all basin level impacts to the national level, we can see in Table 1, columns 1 and 2, the impact of urbanization on sown area and yield due to changes in water availability. According to the analysis, urbanization negatively affects the area and yield of all crops except wheat area, soybean area and yields, and the yield of edible oils (e.g., rapeseed). The largest decline in area from a one percentage point increase in urbanization is found in rice (-0.66) and edible oil (-0.58). The largest fall in yield is found in the case of wheat (-0.58). Water that is diverted to cities for industry and domestic water use does negatively affect the production of many crops—especially those that are large water users (e.g., rice). Some crops enjoy higher sown area and yields (e.g., soybean areas rises +1.81), mainly because these crops, which are not irrigated (and are less water-using), move onto higher quality land which were once irrigated and which now are not.

Cultivated Land

The research on the impact of urbanization on cultivated land to be used for agriculture also includes three steps. More detailed discussion of this issue (and details on the exact approach) can be found in Deng et al. (2013).

In the first step we create the baseline dataset using a GIS approach. To do this, we focus the analysis on China's eastern coastal region where urbanization has risen the fastest during the time for which we have data. We develop a 1 km x 1 km mapping of all of eastern coastal region for 4 years (1988; 1995; 2000 and 2008). In each pixel in each year we are able to identify the intensity of land utilization for 24 different types of land use. Of particular interest in our analysis is the basic trends of land use for built up area (BUA) and types of this land. In the final part of the first step of the analysis, we aggregate the pixel-level data to the county (or urban districts) in order to carry out the econometric analysis.

In the second step we use the county-level land use data from the first step to estimate the impact of urbanization on the area being used for crop farming. To do this, we divide all of the pixels that include BUA activity into three categories: BUA in villages, BUA in small cities, and BUA in large cities. The changes in the latter two types of BUAs are due to urban expansion. We compare the changes in these two types of BUAs to change in BUAs in the village group. For example, if there was no urbanization, how much BUA would emerge in rural villages. This is the counterfactual in our analysis. To show this, we run a regression explaining cultivated land as a function of the above three types of BUA pixels. We also hold constant a set of socioeconomic and geophysical factors.

After we run the regression, we examine the different nature of the impacts on the three types of BUA expansions on cultivated land. This part of the analysis allows us to produce a net impact of urban BUA expansion on cultivated land. Once this part of the analysis is completed, we can assess, given the change in urban population and urban BUA expansion over time, what is the change in BUA being associated with a one percentage change in urban population. This, of course, will allow us to estimate the impact of urban BUA expansion on cultivated land for a one (or ten) percentage point increase in the urban population.

In the third step we analyze the impact of the transformation from cultivated land into BUA due to urbanization on land productivity (or yield). Specifically, we use a tool called an agricultural ecological zoning (AEZ) model. This model uses information on the characteristics of each pixel to derive an AEZ score or primary productivity measure for each pixel. The assumption is that the higher the AEZ land primary productivity, the higher the crop yield. Using the AEZ model, we are able to estimate the fall in yield due to the urbanization-induced change in land use.

After using the three-step method, and aggregating to the national level, we can see from Table 1, columns 3 and 4, the impact of urbanization on cultivated land area and yield due to changes in cultivated area. According to the analysis, a one percentage point increase in urbanization negatively affects China's cultivated land area by 0.065% and land productivity (or crop yield) by 0.067%. Because we are not able to exactly identify the change in cultivated area on a crop by crop basis, we assume the estimated impacts (which are measured in percentage terms) are the same for all crops. The fall in yield is mainly due to the fact that urbanization is using up the best land and, hence, the average yields of the rest of China fall.

Labor and Wages

Urbanization also affects the amount of labor used in faming through a number of mechanisms. Urbanization—through the demand for construction and services as well as through the overall impact of increased efficiency of labor use on overall growth—requires more labor. In this way, then, the cost of labor should be expected to rise since rapid urbanization will raise the demand for rural labor in cities. In addition, if China's policymakers further loosen migration policies and increase services in the city, more labor might leave the rural economy and enter into the urban economy. The effect of these events on local farming communities would be to make it most costly (at least in terms of opportunity cost) to farm.

In our ultimate modeling framework, the impacts of rising labor costs due to urbanization on agricultural products are reflected by the responses of individual crop cultivated area and yield. Due to a lack of precise data on the relationship between urbanization and the wage rate, our work in this area is dealt with mainly by assumption. That is, a one percentage point increase in urbanization raises wage rate by one percent.

III. Projection of China's Food Supply toward 2020: a Partial Equilibrium Analysis

The analysis to this point in the paper is looking at differences in supply side in more or less isolation from all of the other factors and forces that are occurring in the economy. However, as urbanization takes place over the next decade, agricultural producers will not be making decisions in a vacuum. If producers end up reducing production due to urbanization pressures (from falling amounts of water, land and labor), the price of agricultural products might rise and this could moderate the effects. There would also be more of an impetus to import commodities, which would lead to lower domestic prices.

To study the full effects of urbanization through its direct effects on agricultural production, this study uses the China Agricultural Policy Simulation Model (CAPSiM) developed by the Center for Chinese Agricultural Policy (CCAP) of the Chinese Academy of Sciences. We use CAPSiM to analyze the effect of urbanization through its direct production effects due to changes in water, land and labor by 2020. CAPSiM is an agricultural sector-wide partial equilibrium model. The framework of CAPSiM and its application are discussed elsewhere (Huang and Li, 2003; Huang et al., 2007).

CAPSiM covers a large share of (and all of) the major China's agricultural commodities. There are 22 agricultural commodities covered in CAPSiM model. They are rice, wheat, maize, sweet potato, potato, other coarse grains, soybean, cotton, oil crops, sugar crops, vegetable and fruit. In addition, CAPSiM includes nine categories of livestock products and fishery products, namely pork, beef, mutton, poultry, egg, milk, fish, shrimp and other fishery products.

Scenarios design

In order to analyze the full (direct plus indirect) impact of urbanization through its effects on agricultural production due to changes in water, land and the wage rate on China's national food security, we need to set up a baseline for comparison. The baseline will examine the food supply (and other factors, such as land use, water use, labor use, demand, etc.) in a world without changes in water, land or wages due to urbanization from 2012-2020.

Once the baseline is established, we can then examine how urbanization will affect the supply of (and demand for) food by considering the changes in water, land or wage due to urbanization by 2020. The effects of urbanization on supply will be tracked through several scenarios that isolate the impact of urbanization on agricultural water use, farm land and employment (or the wage rate). The direct shocks to the model were discussed above (the direct effects). When accounting for the full effects, we need to also account for the responses farmers (and consumers) and track the changes in the overall economy that are triggered by the direct urbanization shocks. The responses include responses to price rises and falls, additional trade flows, etc. The full effects are derived through simulations, comparing the final levels of supply and demand (and prices and trade) in 2020 from the results of the model that is shocked with the results of the baseline model. Comparing the share of domestic production in total consumption between the scenario analyses and the baseline allows us to produce a measure of the effect of urbanization on national food security. The period of prediction and simulation analysis is from 2012 to 2020.

Baseline

For the purpose of analyzing the supply effects related to urbanization of different kinds on agricultural production during 2012-2020, we made a series of assumptions concerning economic growth, urbanization rate, wage growth rate, rural/urban income/price elasticities and technology advancement. The baseline model contains the following six sets of assumptions:

- The growth rate of GDP: We assume that China's economy growth will slow down in the future years (although in comparative perspective, the nation will maintain a relative fast rate of growth). China’s annual growth rate is assumed to be 7.5% from 2012 to 2015; and 7% from 2016 to 2020.
- The rural/urban income gap will gradually narrow. In recent years, there are indications that rural incomes are growing faster than urban ones. For example, in 2010-2012, rural income grew by 11% annually; during the same period, urban income grew by 8.6% (NBSC, 2013). Therefore, we assume for the 2013-2020 period that rural income will have an average annual growth of 8.33%; urban income will grow slower, an average annual rate of 6.83%.
- The population growth rate of China has fallen for the past several decades (NBSC, 2013). We expect this trend to continue. Accordingly, in our model the

annual average growth rates will be 0.61% from 2012 to 2015; and 0.44% from 2016 to 2020.

- The urbanization rate in China will continue to expand at a rate similar to the past (WDI, 2014). In the baseline, we assume that the urbanization rate will rise from 52% in 2012 to 56% in 2015 and to 60% in 2020.
- We also make assumptions on the changes of the rural wage and the cultivated land rental rate. The average annual growth of the actual wage for a rural laborer from 2012 to 2020 is assumed to be 6.0% annually; the growth rate of the land rental rate will be 2.5%.
- Agricultural technology will not be stagnant during this time period. We assume that the government will continue to invest heavily in the development of agricultural science and technology. However, because China's level of agricultural technology is already high, China is assumed to face rising marginal costs for technologies that will be successful in increasing the yields in agriculture. As a consequence, we believe in the coming years, science and technology will contribute to technological change at a slight lower rate than in the past.

Scenarios: The Effect of Urbanization on Agricultural Production

As mentioned above, the impacts of urbanization on agricultural production is complex. In the above section, we analyzed three sets of factors associated with urbanization that affect the supply of agricultural commodities: water, cultivated land and labor (or the wage rate). Also as discussed above, the shocks to the economy from a rise of each percentage point of urbanization between 2012 and 2020 for water, cultivated land and labor are given in Table 1.

Results

In this section we report the results of simulating the full (direct and indirect) impact of urbanization on China's agricultural supply and food security. To do so, we first present two tables showing the results of the baseline simulation in 2012 (base year) and 2020 (based on the run of our model under the baseline scenario). The following two tables then report on the impact of the rise of urbanization by one additional percentage point over the baseline on food security in 2020.

Baseline

In the base year (2012), China's agricultural economy produced a large share of its grain for total national consumption (Table 2, columns 1 to 5, rows 1, 2 and 14). Producers in China planted more than 111 million hectares of grain (including rice, wheat, maize and soybeans); they produced more than 589 million tons of grain. Rice, wheat and maize accounted for nearly 80 percent of China's grain sown area and output. Soybean farmers, however, only accounted for 7 percent of sown area and 2 percent of total production. Clearly, the only reason that the grain self-sufficient rate was low (87.5 percent) was due to the fact that China's soybean producers only produced 16.8 percent of the nation's soybean demand (the rest were imported). The high shares of total domestic demand produced by China's farmers in the case of rice (98.6 percent), wheat (97.0 percent) and maize (97.7 percent) mean that China was nearly nationally food secure in cereals in 2012.

With the exception of cotton, China also produced high shares of other crops beyond grain in 2012 (Table 2, columns 6 to 10, rows 1, 2 and 14). Domestic supplies accounted for all fruits (99.6) and vegetables (101.8). In fact, China was still a net exporter of vegetables in 2012. The domestic producers of vegetable oil (86.4 percent) and sugar (85.8 percent) supplied most of domestic demand also. Only in the case of cotton (57.2 percent) did imports make up nearly half of demand.

Self-sufficiency levels are also high for livestock commodities (Table 3, rows 1 to 8). In 2012, domestic production of meat (for pork, beef, mutton and poultry) accounted for between 96.6 percent (mutton) and 100.8 percent (poultry) of domestic demand. Self-sufficient levels of eggs (100.3 percent) and fisheries (103.3 percent) also were high. Only in the case of dairy products (86.4 percent) was any sizeable share of demand met by imports (13.6 percentage points = 100-86.4).

Under the baseline scenario, grain security will be still high in 2020 (Table 2, columns 1 to 5, rows 15 to 27). While the grain self-sufficiency will fall between 2012 and 2020, the reduction is modest—only three percentage points (to 84.3 percent). According to our analysis of the baseline scenario, the reason for the fall is the rising import of feed grains, especially maize. The self-sufficiency rates of maize are predicted to fall from 97.7 percent in 2012 to 91.9 percent in 2020. Soybean self-sufficiency will fall one additional percentage point (from an already low level) to 15.9 percent. According to our projections, in a baseline scenario future, China can produce nearly all of its total demand for rice (99.4 percent) and wheat (97.7 percent). The results suggest that—at least under the baseline scenario—China will not have serious overall national food grain (rice and wheat) security concerns in 2020.

Our projection results also demonstrate that China's national food security for other non-grain crops and livestock commodities will not change dramatically by 2020 under the baseline scenario (Table 2, columns 6 to 10, rows 15 to 27 and Table 3, rows 9 to 16). While the share of cotton demand supplied by domestic production will rise somewhat (from 57.2 to 62.8 percent), that of vegetable oil will fall a bit (from 86.4 to 83.5 percent). The shares of domestic demand produced by domestic livestock producers (meats, eggs, dairy products and fishery products) change little. Over all commodities, the average reduction in national self-sufficiency rates is predicted to be around (a bit less than) 2 percentage points. Poultry and egg producers and China's fisheries continue to be net exporters under the baseline scenario.

Urbanization scenario

In Tables 4 and 5, we present the results of the impact on each commodity of an increase in urbanization of one percentage point above the baseline. The results are presented so we can track the results of the effect of using more water for urbanization and reducing water allocated to agriculture (Table 4, column 2); the effect of using more and better quality cultivated land for BUA and less for agricultural production (column 3); and the effect of the rising wage (column 4). The total impact (column 1) is the horizontal sum of columns 2 to 4.

According to our analysis, an increase in urbanization by one percentage point above the baseline will result in a modest fall in national food security in 2020 (Table 4, rows 1 to 5). Grain production, in general, will fall by 0.18 percent. The impact is evenly divided among urbanization's effect on water (-0.06), cultivated land (-0.06) and labor (-0.07). In terms of a broader perspective, our results suggest that if the current plan to increase the pace of urbanization was able to boost the rate of movement to the city by an extra 10 percentage points, the supply side impact on national grain security (ceteris paribus) would be a fall in the share of total domestic demand supplied by domestic producers of 1.8 percent.

While the mechanism behind the falls differ among crops, our results show that the reduction in grain output due to urbanization comes from both food grains, rice (-0.34) and wheat (-0.17) and feed grains or maize (-0.18—Table 4, rows 1 to 4). The driving forces of fall in production differ among cereals. For example, rice production falls mainly due to reductions in available water (-0.25). Maize falls largely due to the rising wage and reductions in cultivated land.

Interestingly, the overall fall in grain production would have been higher had there not been an increase in the supply of soybean (+1.31—Table 4, row 5). This rise is fully due to the fact that soybean, a rainfed crop, expands sown area in response to falling water availability (+1.64). The water effect of urbanization on soybeans is actually large enough to fully offset negative cultivated land (-0.20) and labor (-0.13) effects.

The only other crops that are subject to relatively high impacts of urbanization are vegetable oils and sugar (Table 4, rows 6 and 7). A one percentage point rise in urbanization reduces the production of vegetable oils by 0.36 percent and sugar by 0.30 percent. The effects in both cases are affected mostly by water (nearly half of the effect in both cases: -0.19 for soybeans and -0.13 for sugar). Urbanization's effect on cultivated land and labor also reduce the production of vegetable oils and sugar.

The effects of urbanization on the rest of the commodities (vegetables and fruit—rows 8 and 9; and livestock commodities—rows 10 to 16) are more modest. The range of the overall effect is only between -0.10 and -0.14 for a one percentage point increase in urbanization. Cultivated land effects are the largest for vegetables and fruit; labor effects are largest for all of the livestock commodities (which is to be expected given the relatively small need for water and land for livestock).

When converting these production impacts from urbanization into trade impacts, the ultimate concern for policy makers interested in national food security, we find that imports rise somewhat by 2020, but, mostly in fairly modest ways (Table 5). Overall net imports (column 5) rise for all crops except soybeans (which fall by 96 thousand tons). Overall grain imports, according to our results, will rise by 275 thousand tons, with most of the increase coming from maize (+234 thousand tons). In total, a one percentage point rise in urbanization decreases overall self sufficiency rate of grain by 0.04 percent.

Our results also show net imports rising slightly for all other non-grain commodities and livestock products (Table 5, rows 6 to 16). The rises in net imports, however, have fairly modest effects on self-sufficiency rates. At most with a one percentage point rise in urbanization, the greatest decline in the self-sufficiency rate of any non-grain commodity is only 0.16 percent (sugar).

V. Supply vs. Demand: Does Urbanization Threaten China's Food Security?

The final accounting of the effect of urbanization on food security reveals that there is a negative effect (or self-sufficiency reducing) on food security. However, the effect is modest. For a ten percentage point increase in urbanization in the next ten years, the relatively small supply side effects (-2 percentage points) on grain production are partially offset by demand side effects (although not shown here, it is about -1 percentage point) (Huang et al., 2014). In the most gross terms, the change of domestic grain production and consumption balance (production-consumption) due to urbanization in the next ten years is only 1 percent. However, the fall in supply will result in the rise in price and corresponding fall in consumption. The final effect on grain self-sufficiency is project to be only 0.4 percent for a ten percentage point increase in urbanization (0.04 x 10, the last column, Table 5).

Beyond grain, our results show that self-sufficiency of non-grain commodities also falls modestly (the last column, Table 5). The productions of no-grain commodities will fall between one and four percentage points for a ten percentage point increase in urbanization (column 1, Table 4), their self-sufficiencies are projected to decrease by less than 0.2 percent for horticulture to 1.6 percent for sugar (the last column, Table 5).

In short, urbanization does affect food security. The impact of urbanization on food security is negative. The effect, however, is small.

VI. Conclusions

Internationally, urbanization is necessary and often accelerating for an economy in rapid transition and moving from middle income to high income. Recently, China's leaders have made urbanization a key part of the nation's development strategy. Despite the potential contribution of urbanization to the modernization of the economy, there is also rising concern that as more and more of the rural population shifts to the city, China's national food security may suffer. There is also fear that urbanization may seriously threaten the ability of China to produce (most of) its own grain.

Using several sets of data and a number of different analyses, our study shows that urbanization will lead to higher levels of imports of maize, edible oil, sugar, and milk. The supply of grain and other commodities generally do fall. Urbanization requires resources and agricultural supply is affected by the reductions of available land, water and labor. In our other results (in Huang et al., 2014), we show that there are actually positive effects on the demand for high value commodities. These reductions in supply and rises in demand do lead to a situation in which China's domestic production of commodities accounts for a small level of total demand—which by definition means there is a fall in national food security.

Despite the direction of the findings, our paper, however, concludes that the concern of a serious threat of urbanization to food security—especially grain security—is unfounded. The supply effects themselves are not large—the fall in total grain production due to urbanization will be only about 2 percent in next ten years. In addition, urbanization actually is shown to lead to lower demand for total grain demand by 1 percent (the fall in rice and wheat demand will exceed the rise in feed demand). If further considering food demand responses to the increase in food price resulted from the fall in production, the overall impact on grain security (or self-sufficiency) for a 10 percentage point rise in urbanization will be less than 1 percentage point.

Since food security in China is an important national security issue, leaders may even be concerned with a fall in grain self-sufficiency of one percentage point and a fall in non-grain food self sufficiency of two percentage points. In response, China appears to have a number of options if they would like to minimize the food security effects. In the past, leaders have kept agricultural productivity high by investing more into irrigation. Policies that facilitate agricultural mechanization may also help if they lead to higher output or a lower rate of output decline. While not shown in this paper, investment in agricultural technology has been and is going to continue to be one of the major engines of China's agricultural growth. Ensuring high productivity in the agricultural sector is probably the best way to ensure national food security.

Policies aimed at new investments into agricultural supply to offset the effects of urbanization should be feasible. If urbanization leads to faster growth, such growth will lead to rising wealth and generate higher fiscal revenues. If part of these new revenues can be invested into agriculture, they should be able to make the resources that remain in the sector more productive.

Table 1: The direct impacts on crop area and yield and farming wage from a one percentage point increase in urbanization in China.

	Impact through changes in water usage		Impact through changes in cultivated land		Impact on labor wage
	Area	Yield	Area	Yield	
Rice	-0.66	-0.001	-0.065	-0.0666	1
Wheat	0.21	-0.575	-0.065	-0.0666	1
Maize	-0.01	-0.001	-0.065	-0.0666	1
Soybean	1.81	0.009	-0.065	-0.0666	1
Sugar	-0.15	-0.029	-0.065	-0.0666	1
Vegetable oils	-0.58	0.317	-0.065	-0.0666	1
Cotton	-0.001	0.000	-0.065	-0.0666	1
Vegetables	-0.01	-0.001	-0.065	-0.0666	1
Other crops	-0.005	-0.003	-0.065	-0.0666	1

Table 2：China's supply and demand of agricultural commodities in 2012 and 2020 (all in 1,000 tons except those with specific unit))

	Grain [a]	Major grains				Cotton	Vegetable oils	Sugar	Vegetables	Fruits
		Rice	Wheat	Maize	Soybean [b]					
2012										
Sown area (1000 ha)	111267	30244	24421	33842	7407	4700	13980	2030	20044	20278
Production	589570	142965	120580	208190	13600	6840	8690	16435	307733	161669
Inventory change	72152	27683	11595	14863	7027	3850	-370	3104	0	0
Import	86890	2369	3701	5208	67530	5137	1400	2800	632	4014
Export	2830	279	0	257	385	18	33	70	6109	3422
Net import	84060	2090	3701	4951	67145	5119	1367	2730	-5477	592
Total demand	601477	117372	112686	198278	73718	8109	10427	16062	302256	162261
Food demand	316804	95727	72648	15791	71560	0	9801	8618	236138	104324
Per capita food demand (kg/person)	445.3	70.9	53.8	11.7	53.0	0.0	7.3	6.4	174.8	77.2
Fodder grain demand	158048	6283	18398	119986	656	0	0	0	0	0
Seed demand	12517	2219	5757	1640	688	0	144	0	0	0
Industrial demand	90202	7055	11318	53000	719	8041	236	6457	0	26640
Waste	23907	6088	4564	7861	94	68	247	986	66119	31297
Self-sufficiency rate (%)	87.5	98.6	97.0	97.7	16.8	57.2	86.4	85.8	101.8	99.6
2020										
Sown area	101968	24953	21536	33561	7424	4173	14527	1977	19985	20067
Production	568122	120449	110339	224070	14966	6537	10199	17269	348885	193316

Import	108918	1244	2628	19794	79536	3890	2036	2935	657	4270
Export	3086	531	0	140	327	23	23	67	6486	3548
Net import	105832	712	2628	19654	79209	3867	2013	2868	-5830	722
Total demand	673954	121161	112967	243724	94175	10404	12212	20138	343057	194038
Food demand	337018	99656	71090	10857	91800	0	11568	11991	276938	126984
Per capita food demand (kg/person)	479.3	70.9	50.6	7.7	65.3	0.0	8.2	8.5	197.0	90.3
Fodder grain demand	191754	5525	18503	155896	738	0	0	0	0	0
Seed demand	12324	2184	5666	1627	677	0	141	0	0	0
Industrial demand	109875	7947	13323	67791	868	10335	265	7160	0	36987
Waste	22983	5849	4385	7552	92	68	237	986	66119	15034
Self-sufficiency rate (%)	84.3	99.4	97.7	91.9	15.9	62.8	83.5	85.8	101.7	99.6

：CAPSiM simulation results

Note:

[a] To be consistent with the National Bureau of Statistics, data on rice used here reports data on un-husked rice.

[b] Soybean imports include imports of soybean oil. Soybean oil is converted into soybean at the rate of 1 ton of soybean oil = 5 tons of soybeans.

Table 3: China's supply and demand of livestock products in 2012 and 2020 (1,000 tons)

	Pork	Beef	Mutton	Poultry	Egg	Dairy products	Fishery products
				2012			
Production	46159	5296	3409	17319	19998	38680	33178
Import	522	49	119	49	0	6181	2208
Export	66	12	0	181	61	105	3253
Net import	456	37	119	-131	-61	6076	-1045
Total consumption	46615	5333	3528	17187	19937	44756	32132
Food consumption	44046	4919	3295	16294	19136	44008	29761
Per capita food consumption (kg/person)	32.6	3.6	2.4	12.1	14.2	32.6	22.0
Self-sufficiency rate (%)	99.0	99.3	96.6	100.8	100.3	86.4	103.3
				2020			
Production	56194	7272	4384	22379	23462	56906	43808
Import	728	165	328	67	0	11725	2975
Export	65	4	0	180	47	51	3298
Net import	664	161	328	-113	-47	11674	-323
Total consumption	56858	7433	4711	22266	23416	68580	43485
Food consumption	54289	7019	4479	21373	22615	67832	41113
Per capita food consumption (kg/person)	38.6	5.0	3.2	15.2	16.1	48.2	29.2
Self-sufficiency rate (%)	98.8	97.8	93.1	100.5	100.2	83.0	100.7

Source: CAPSiM simulation results

Table 4: Impacts on agricultural production from a one percentage point increase in urbanization in China in 2020 (%).

	Total impacts	Decomposition of impacts of urbanization		
		Agricultural water usage	Cultivated land	Labor wage
Grains	-0.18	-0.06	-0.06	-0.07
Rice	-0.34	-0.25	-0.04	-0.05
Wheat	-0.17	-0.09	-0.04	-0.04
Maize	-0.18	-0.02	-0.07	-0.09
Soybean	1.31	1.64	-0.20	-0.13
Vegetable oils	-0.36	-0.19	-0.10	-0.07
Sugar	-0.30	-0.13	-0.09	-0.08
Vegetables	-0.13	-0.03	-0.06	-0.05
Fruits	-0.10	0.00	-0.06	-0.04
Pork	-0.11	-0.01	-0.02	-0.09
Beef	-0.11	0.00	-0.01	-0.09
Mutton	-0.10	0.00	-0.01	-0.09
Poultry	-0.12	-0.01	-0.03	-0.09
Egg	-0.10	0.00	-0.02	-0.08
Dairy products	-0.14	-0.01	-0.02	-0.12
Fishery products	-0.11	0.00	-0.01	-0.10

Source: CAPSiM simulation results

Table 5：Impacts on agricultural trade and self-sufficiency from a one percentage point increase in urbanization in China in 2020.

	Export		Import		Net import (1000 tons)	Self-sufficient ratio (%)
	%	1000 tons	%	1000 tons		
Grains	-0.93	-26.7	0.23	248.6	275.3	-0.04
Rice	-2.83	-14.6	2.75	35.2	49.8	-0.03
Wheat	-1.94	0.0	1.89	50.9	50.9	-0.07
Maize	-0.57	-0.8	1.18	233.5	234.3	-0.05
Soybean	0.12	0.4	-0.11	-95.8	-96.2	0.01
Vegetable oils	-0.87	-0.2	0.88	17.8	18.0	-0.11
Sugar	-0.90	-0.6	0.87	26.3	26.9	-0.16
Vegetables	-0.69	-44.5	0.70	4.5	49.1	-0.02
Fruits	-0.58	-21.2	0.60	25.3	46.5	-0.01
Pork	-0.46	-0.3	0.46	3.4	3.7	-0.01
Beef	-1.00	0.0	0.95	1.6	1.6	-0.02
Mutton	-0.80	0.0	0.81	2.7	2.7	-0.05
Poultry	-0.48	-0.9	0.50	0.3	1.2	-0.01
Egg	-0.45	-0.2	0.46	0.0	0.2	0.00
Dairy products	-0.23	-0.1	0.20	23.6	23.7	-0.03
Fishery products	-0.30	-9.2	0.27	8.1	17.3	-0.04

Source: CAPSiM simulation results

References

Chen, X. 2013. The grain demand during the urbanization, China’s Construction of Old Revolutionary Basic Area. 6, 16-17.

Deng, X., J. Huang, S. Rozelle. 2013. Impact of Urbanization on Land Productivity and Cultivated Land Area in China. A project report submitted to World Bank and Development Research Center of the State Council. Working paper of Center for Chinese Agricultural Policy, CAS, Beijing.

Huang, J., and N. Li. 2003. China's agricultural policy analysis and simulation model — CAPSiM. Journal of Nanjing Agricultural University, 3(2), 30-41.

Huang, J., J. Yang, Z. Huang, H. Liu, and J. Bai. 2014. Urbanization and food consumption in China. A project report submitted to World Bank and Development Research Center of the State Council. Working paper of Center for Chinese Agricultural Policy, CAS, Beijing.

Huang, J., J. Yang, Z. Xu, S. Rozelle, and N. Li. 2007. Agricultural Trade Liberalization and Poverty in China, China Economic Review, 18 (2007): 244-265.

Huang, J., J. Yang, and S. Rozelle. 2010. China’s Agriculture: Drivers of Change and Implications for China and the Rest of World, Agricultural Economics. 41(11), 47-55.

Jia, S., H. Zhang, X. Meng.1997. Forecast and countermeasures of the change of the cultivated area of china. Progress in Geography. 16(1). 24-30.

Li, L., M. Li. 2012. The analysis on the influencing factors of grain production in the light of the current situation of china. China Business and Market. 2012.4. 109-115.

NBSC (National Bureau of Statistics of China). China Statistical Yearbook various version from 2010-2013. China Statistics Press. Beijing.

Wang, J., J. Huang, and S. Rozelle. 2013a. Urbanization, agricultural water use and crop production in China. A project report submitted to World Bank and Development Research Center of the State Council. Working paper of Center for Chinese Agricultural Policy, CAS, Beijing.

Wang, J., J. Huang, T. Yan. 2013b. Impacts of climate change on water and agricultural production in ten large river basins in China. Journal of Integrative Agriculture. 12(7), 1267-1278.

WDI (World Development Indicators). Available at http://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS

Xu, F. 2001. Scientific and technological innovation and grain development strategy in 21st century in China, Journal of hit (Social Sciences Edition). 3(1), 27-34.

Yang, X., S. Zhang. 2010. China’s current food security situation and the countermeasures. Economic Review. 6, 46-49.

Yang, J., J. Huang, and N. Li. 2011. The impact of the Doha trade proposals on farmers’ incomes in China. Journal of Policy Modeling. 33 (3), 439-452.

Zhang, Y.， Q. Chu, H. Wang. 2009. Trends and strategies of food security during process of urbanization in China. Research of Agricultural Modernization. 30(3), 270-274.

Zhong, S., K. Li. 2009. Countermeasure for Farm land Protection Based on Food Security. China Soft Sciences. 9, 1-8.