Lin, Tun; Liu, Xiaoyun; Wan, Guanghua; Xin, Xian; Zhang, Yongsheng

Working Paper

Climate Change and Agricultural Interregional Trade Flows in the People's Republic of China

ADB Economics Working Paper Series, No. 244

Provided in Cooperation with:
Asian Development Bank (ADB), Manila

ADB

ADB Economics
Working Paper Series

Climate Change and Agricultural Interregional Trade Flows in the People's Republic of China

Tun Lin, Xiaoyun Liu, Guanghua Wan,
Xian Xin, and Yongsheng Zhang

No. 244 | January 2011

Asian Development Bank

ADB

ADB Economics Working Paper Series No. 244

Climate Change and Agricultural Interregional Trade Flows in the People's Republic of China

Tun Lin, Xiaoyun Liu, Guanghua Wan, Xian Xin, and Yongsheng Zhang

January 2011

Tun Lin is Natural Resources Economist, East Asia Department, Asian Development Bank. Xiaoyun Liu is Professor at the China Agricultural University. Guanghua Wan is Principal Economist in the Economics and Research Department, Asian Development Bank (ADB). Xian Xin is Professor at the China Agricultural University. Yongsheng Zhang is Professor at the Development Research Center, People's Republic of China. Helpful comments from participants in various group discussions organized by ADB are also fully appreciated. This paper is part of the research work funded by ADB (Project Number: 43068). The authors accept responsibility for any errors in the paper.

Asian Development Bank

Asian Development Bank
6 ADB Avenue, Mandaluyong City
1550 Metro Manila, Philippines
www.adb.org/economics

January 2011
ISSN 1655-5252
Publication Stock No. WPS113173

The ADB Economics Working Paper Series is a forum for stimulating discussion and eliciting feedback on ongoing and recently completed research and policy studies undertaken by the Asian Development Bank (ADB) staff, consultants, or resource persons. The series deals with key economic and development problems, particularly those facing the Asia and Pacific region; as well as conceptual, analytical, or methodological issues relating to project/program economic analysis, and statistical data and measurement. The series aims to enhance the knowledge on Asia's development and policy challenges; strengthen analytical rigor and quality of ADB's country partnership strategies, and its subregional and country operations; and improve the quality and availability of statistical data and development indicators for monitoring development effectiveness.

The ADB Economics Working Paper Series is a quick-disseminating, informal publication whose titles could subsequently be revised for publication as articles in professional journals or chapters in books. The series is maintained by the Economics and Research Department.

Contents

Abstract

The impacts of climate change on agricultural production in the People's Republic of China (PRC) are significant, and differ across regions and crops. The substantial regional differences will induce changes in the agricultural interregional trade pattern. In this paper, we investigate the climate change impacts on this trade pattern, using a computable general equilibrium model of multiple regions and multiple sectors. The results indicate that Northwest, South, Central, and Northeast PRC will see increases in the outflows of agricultural products in 2030 and 2050. Conversely, outflows from East, North, and Southwest PRC will decrease. Grain handling and transportation facilities need to be repositioned to address the changes in agricultural trade flows.

I. Introduction

The People's Republic of China (PRC) is one of the countries that are most vulnerable to climate change (Germanwatch 2010). Studies indicate that global temperature will increase by 1.5ºC–5.0ºC within the 21st century (Darwin et al. 1995). The China National Climate Center projects that the PRC's temperature will rise by less than 2.5ºC by the end of the 21st century (CNCC 2009). Climate change will have significant impacts on the PRC's grain outputs, which will differ across regions and grain crops (Lin et al. 2010). Studies also indicate that the impacts of climate change on the PRC's livestock and vegetable sectors differ across regions (Liu and Xin 2010). These substantial regional differences will induce changes in agricultural interregional trade patterns, both in terms of volumes and directions of change. This, in turn, will generate demand for changes in grain handling and transportation arrangements. If transportation facilities could not be adjusted to meet these changes, agricultural prices may rise sharply in those regions with significant decline in agricultural output, and fall steeply in those regions with significant increases in agricultural output. These will have negative impacts on poverty and other aspects of social welfare, and may very likely affect millions of farmers and consumers' livelihoods. Moreover, even if the PRC's agricultural products can be self-sufficient at the national level, regional food security cannot be achieved without an efficient internal trade system. Nonagricultural sectors will also be adversely afftected since the linkages between agricultural and nonagricultural sectors are becoming much closer.

Studies on the impacts of climate change on the PRC's agriculture have been increasing. The current literature certainly helps us understand the impacts, which generally are estimated to be negative (Wang et al. 2009, Harasawa et al. 2003, Tsigas et al. 1997, Zhai et al. 2009, Kane et al. 1992). To the best of our knowledge, however, no previous studies have assessed the impacts of climate change on the PRC's agricultural interregional trade flows. The scarcity of such studies can be attributed to absence of data on the PRC's interregional trade flows until very recently. These data are now available for 2 years: 1987 and 2000. The 2000 data was published in Ichimura and Wang (2007). In passing, it is noted that earlier attempts to explore the PRC's interregional trade issues use spatial equilibrium model (SEM). For example, Hearn et al. (1990) use a hybrid SEM to evaluate the impact of transportation improvements on the spatial distribution of the PRC's corn production and consumption. Xin et al. (2005) use SEM to analyze feedgrain trade flows across regions in response to the PRC's WTO accession and technological changes. Xin et al. (2004) set up a SEM to examine the PRC's livestock interregional trade flows. The SEM, however, is intrinsically a kind of partial equilibrium model and could not capture all the interactions among different economic sectors.

This paper aims to fill this gap in the literature. We will investigate the climate change impacts on the PRC's agricultural interregional trade flows using a computable general equilibrium (CGE) model of multiple regions and multiple sectors. The simulation results indicate that climate change will result in significant changes in the PRC's agricultural interregional trade patterns. Northwest, South, Central, and Northeast PRC will see increases in agricultural interregional trade outflows in 2030 and 2050, whereas outflows from East, North, and Southwest PRC will decrease.

The rest of the paper is organized as follows. Section II describes the methodologies and data. In Section III, we present the simulation results. Section IV provides conclusions and policy implications.

II. Methodology

We use the CGE model developed by Liu et al. (2010) to assess the impacts of climate change on the PRC's agricultural interregional trade flows. In doing so, we take advantage of the existing literature to obtain the impacts of climate change on the PRC's regional agricultural output changes, which will be fed into the CGE model to gauge changes in agricultural interregional trade flows by simulation.

The CGE model consists of seven regions of the PRC and the rest of the world (ROW), and six commodities. The seven regions are Northeast PRC (including Heilonjiang, Jilin, and Liaoning); North PRC (including Beijing, Tianjin, Hebei, Shandong, Inner Mongolia); East PRC (including Jiangsu, Shanghai, and Zhejiang); South PRC (including Fujian, Guangdong, and Hainan); Central PRC (including Shanxi, Henan, Anhui, Hubei, Hunan, and Jiangxi); Northwest PRC (including Shannxi, Ningxia, Gansu, Qinghai, and Xinjiang); and Southwest PRC (including Sichuan, Chongqing, Guangxi, Yunnan, Guizhou, and Tibet). The six commodities are agriculture, mining, light industry, heavy industry, construction, and services.

The CGE model consists of production, demand, and market equilibirum equations. Prices are endogenously determined by clear market conditions. For simplicity, the ROW outputs of the six commodities are assumed to be exogenously given.[1] The production

1 To construct an input-output table for the ROW of the six commdodities is too complicated and involves voluminous work. Since we are focusing on examination of climate changes on the PRC's internal region trade flows, this assumption hopefully will not affect our main findlings. Were the input-output tables for the ROW available, our findings will be more convincing.

functions of the seven regions and the utility functions for the eight regions are assumed to be of the form known as nested constant elasticity of substitution (CES).[2]

On the production side, a three-stage nested CES production structure is used to describe the production of commodities. At the top level, firms are assumed to maximize profits using two aggregate inputs: value added (an aggregate of labor and capital), and aggregate intermediate inputs (an aggregate of the six commodities). At the second level, value added is also assumed to be a CES function of labor and capital, while aggregate intermediate input is a CES function of the six commodities. The bottom level function is assumed to be a CES function of commodities from different regions.

On the demand side, a two-stage nested CES utility structure is used to derive the final demand for commodities. At the top level, demands are generated by maximizing utility, choosing a bundle of agriculture, mining, light industry, heavy industry, construction, and service goods, each aggregated over the corresponding regional products in the various regions. Following the same nesting procedure as with intermediate inputs in the preference structure yields the PRC's final demand, and the ROW's total demand.

Equilibrium in the model is driven by goods and factor prices such that market-clearing conditions hold for all goods and factors by region.[3]

III. Simulation Results

We will conduct simulations under A2, B1, and A1B emission scenarios to explore the impacts of climate change on the PRC's agricultural interregional trade flows in 2030 and 2050.[4] Lin et al. (2010) and Liu and Xin (2010) have estimated the climate change impacts on the PRC's regional grain, livestock, and vegetables output changes in 2030 and 2050 under A2, B1, and A1B emission scenarios. These three sectors account for around 70% of the PRC's agricultural output value (National Bureau of Statistics of China 2009). Moreover, the seven regions of the PRC are exactly the same as those in the CGE model used in this paper. The impacts of climate change on the PRC's regional

---

2 The CES function form has advantages over the Cobb-Douglas function form (Arrow et al. 1961).

3 For details about the CGE model and parameters calibration, see Liu et al. (2010).

4 The Intergovernmental Panel on Climate Change developed four different narrative storylines to cover a wide range of the main demographic, economic, and technological driving forces of future greenhouse gas and sulphur emissions. The A2 storyline and scenario family describes a very heterogeneous world while the B1 storyline and scenario family describes a convergent world. The A1 storyline and scenario family describes a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and rapid introduction of new and more efficient technologies. The three A1 groups are distinguished by their technological emphasis: fossil-intensive (A1FI), nonfossil energy sources (A1T), or a balance across all sources (A1B) (where balanced is defined as not relying too heavily on one particular energy source, on the assumption that similar improvement rates apply to all energy supply and end-use technologies). See IPCC (2010) for details.

agricultural output changes are thus obtained by using the weighted sum of climate change impacts on grain, vegetables, and livestock sectors (see Table 1).

Table 1: Scenarios of Climate Change on the PRC's Agriculture

Region \ Scenarios	2030			2050		
	A2	B1	A1B	A2	B1	A1B
Northeast PRC	–2.40	–1.40	–2.40	–4.60	–1.90	–4.70
North PRC	–7.50	–4.20	–7.50	–10.50	–6.80	–11.00
East PRC	–16.40	–8.30	–13.70	–30.80	–14.40	–29.00
South PRC	0.10	0.10	–1.20	0.50	0.01	–0.80
Central PRC	0.60	1.70	1.30	1.60	2.80	2.70
Northwest PRC	10.10	7.20	10.10	16.40	13.10	16.80
Southwest PRC	–9.00	–7.40	–13.60	–18.80	–13.30	–22.00

PRC = People's Republic of China.
Note: The impacts of climate changes on the PRC's regional agricultural output changes are obtained by using the weighted sum of climate change impacts on grain, vegetables, and livestock sectors.
Sources: Authors' calculation using Lin et al. (2010) and Liu and Xin (2010).

Using the CGE model, the impacts of climate change on the PRC's agricultural interregional trade flows can be evaluated. We do this by introducing climate change into the the top level production function and then conducting experiments. The difference between the observed agricultural interregional trade flows and the simulation result is the contribution of climate change. The simulation results under the different scenarios are reported in Table 2. The results indicate that climate change will result in significant changes in the PRC's agricultural interregional trade patterns. Northwest, South, Central, and Norheast PRC will see increases in agricultural interregional trade outflows in 2030 and 2050; while outflows from the other three regions (East, North, and Southwest PRC) will decrease. Agricultural interregional trade inflows will decrease in those regions that will see increases in outflows, and vice versa. Tables 3a and 3b present more detailed simulation results by region.

Table 2: Impacts of Climate Change on the PRC's Agricultural Interregional Trade Flows (percent)

Region \ Scenarios	Agricultural Interregional Trade Outflows						Agricultural Interregional Trade Inflows					
	2030			2050			2030			2050		
	A2	B1	A1B	A2	B1	A1B	A2	B1	A1B	A2	B1	A1B
Northeast PRC	0.72	1.50	3.98	7.65	4.25	7.11	–6.10	–2.23	–5.24	–5.34	–3.11	–4.83
North PRC	–14.66	–8.19	–13.29	–12.29	–12.34	–14.19	3.44	6.50	9.22	13.10	11.69	15.12
East PRC	–40.65	–21.24	–32.20	–64.59	–34.98	–61.35	21.84	11.40	17.47	60.06	22.42	54.35
South PRC	11.08	7.22	9.72	33.47	12.82	27.64	–9.75	–4.63	–7.74	–14.71	–6.81	–12.44
Central PRC	8.68	9.99	14.49	26.44	17.82	30.86	–14.13	–8.63	–13.71	–18.81	–12.93	–20.45
Northwest PRC	37.86	29.90	48.49	89.83	58.85	93.43	–18.05	–11.96	–18.99	–27.34	–19.50	– 27.26
Southwest PRC	–7.66	–18.69	–31.59	–39.69	–31.99	–46.77	5.39	13.35	22.63	36.65	27.11	44.66
PRC	–1.76	0.78	0.77	6.29	2.96	6.99	–1.76	0.78	0.77	6.29	2.96	6.99

PRC = People's Republic of China.
Note: Comparisons with base scenario in 2005.
Source: Authors' simulation.

A. 2030

Climate change impacts on the PRC's interregional trade flows are significant and differ among regions, whereas the overall impacts on the PRC's total trade flows are small in 2030. Total agricultural interregional trade flows (outflows and inflows) will decrease by 3.52% under A2 emission scenario, but will increase by 1.56% and 1.54% under B1 and A1B emission scenarios, respectively.

However, substantial differences exist among regions in trade flows. Outflows from Northwest PRC will increase by 29.90%–48.49% in 2030 under different emission scenarios. Increases in outflows from Central PRC range from 8.68% up to 14.49%, and from South PRC by 7.22% to 11.08% in 2030. Outflows from Northeast PRC will also increase by 0.72% to 3.98%.

Inflows to East PRC will increase by 11.40% to 21.48%, Southwest PRC 5.39%–22.63%, and North PRC 3.44%–9.22%. Inflows to Northwest PRC will fall by 11.96% to 18.99%, Central PRC 8.63%–14.13%, South PRC 4.63%–9.75%, and Northeast PRC 2.23%–6.10%.

B. 2050

The climate change impacts on the PRC's overall interregional trade flows are relatively larger in 2050 than those in 2030. Total agricultural interregional trade flows (outflows and inflows) will increase by 5.92% to 13.98% in 2050.

Outflows from Northwest PRC will see a very significant increase in 2050, ranging from 58.85% to 93.43% under different emission scenarios. Outflows from Central PRC will increase 17.82%–30.86%, South PRC 12.82%–33.47%, and Northeast PRC 4.25%–7.65%.

Agricultural interregional trade inflows to East PRC will increase 22.42%–60.06%, Southwest PRC 27.11%–44.66%, and North PRC 11.69%–15.12%. Inflows to Northwest PRC will fall 19.50%–27.34%, Central PRC 12.93%–20.45%, South PRC 6.81%–14.71%, and Northeast PRC 3.11%–5.34%.

The impacts on interregional trade patterns, including directions and volumes, are reported in Table 3. The results suggest that outflows from a certain region to some regions may increase, while falling in other regions. For example, outflows from South PRC to Northeast, North, East, and Southwest PRC will increase in 2030. In contrast, outflows to Central and Northwest PRC will decrease. The percentage changes of outflows from a region also differ significantly, depending on the destinations.

In short, these results indicate that climate change will substantially affect the PRC's agricultural interregional trade patterns. Grain handling and transportation facilities need to be repositioned to address the changes in agricultural trade flows.

Table 3a: Impacts of Climate Change on the PRC's Agricultural Interregional Trade Flows by Region, 2030 (percent)

To / From	Northeast PRC	North PRC	East PRC	South PRC	Central PRC	Northwest PRC	Southwest PRC	Outflows
					Scenario A2			
Northeast PRC		–0.02	19.41	–5.98	–7.23	–15.75	–2.13	**0.72**
North PRC	–16.77		2.13	–19.58	–20.66	–27.94	–16.31	**–14.66**
East PRC	–39.28	–38.07		–41.33	–42.12	–47.41	–38.95	**–40.65**
South PRC	4.78	6.91	28.56		–0.11	–9.28	5.36	**11.08**
Central PRC	6.55	8.89	30.73	2.95		–7.75	7.13	**8.68**
Northwest PRC	35.56	40.40	66.32	30.97	29.21		36.29	**37.86**
Southwest PRC	–7.32	–5.17	13.70	–10.46	–11.66	–19.76		**–7.66**
Inflows	**–6.10**	**3.44**	**21.84**	**–9.75**	**–14.13**	**–18.05**	**5.39**	**–1.76**
					Scenario B1			
Northeast PRC		2.34	9.08	–3.11	–4.02	–10.99	5.59	**1.50**
North PRC	–9.44		0.31	–10.89	–11.74	–18.14	–2.91	**–8.19**
East PRC	–21.02	–17.92		–22.29	–23.03	–28.61	–15.33	**–21.24**
South PRC	2.86	6.89	13.92		0.24	–7.02	10.26	**7.22**
Central PRC	7.80	12.03	19.40	6.07		–2.55	15.57	**9.99**
Northwest PRC	26.54	31.50	40.16	24.51	23.32		35.66	**29.90**
Southwest PRC	–18.58	–15.39	–9.82	–19.89	–20.66	–26.39		**–18.69**
Inflows	**–2.23**	**6.50**	**11.40**	**–4.63**	**–8.63**	**–11.96**	**13.35**	**0.78**
					Scenario A1B			
Northeast PRC		4.71	16.63	–3.14	–4.78	–15.40	12.27	**3.98**
North PRC	-16.23		-0.25	–17.16	–18.56	–27.63	–3.98	**–13.29**
East PRC	-32.71	–28.05		–33.46	–34.59	–41.86	–22.88	**–32.20**
South PRC	1.36	8.36	20.69		–1.47	–12.44	16.17	**9.72**
Central PRC	9.35	16.91	30.21	8.13		–5.54	25.34	**14.49**
Northwest PRC	40.59	50.27	67.42	39.03	36.67		61.14	**48.49**
Southwest PRC	-32.34	–27.66	–19.43	–33.09	–34.23	–41.55		**–31.59**
Inflows	**-5.24**	**9.22**	**17.47**	**–7.74**	**–13.71**	**–18.99**	**22.63**	**0.77**

PRC = People's Republic of China.
Note: Comparisons with base scenario in 2005.
Source: Authors' simulation.

Table 3b: Impacts of Climate Change on the PRC's Agricultural Interregional Trade Flows by Region, 2050 (percent)

From \ To	Northeast PRC	North PRC	East PRC	South PRC	Central PRC	Northwest PRC	Southwest PRC	Outflows
					Scenario A2			
Northeast PRC		3.68	49.63	–9.03	–8.96	–24.77	14.37	**7.65**
North PRC	–20.51		24.29	–24.43	–24.38	–37.49	–5.01	**–12.29**
East PRC	–64.24	–61.25		–66.00	–65.98	–71.88	–57.27	**-64.59**
South PRC	11.21	20.51	73.88		5.80	–12.55	32.89	**33.47**
Central PRC	15.35	24.99	80.36	9.66		–9.29	37.85	**26.44**
Northwest PRC	73.76	88.19	171.69	65.18	65.30		107.65	**89.83**
Southwest PRC	–41.43	–36.54	–8.43	–44.33	–44.29	–53.95		**–39.69**
Inflows	**–5.34**	**13.10**	**60.06**	**–14.71**	**–18.81**	**–27.34**	**36.65**	**6.29**
					Scenario B1			
Northeast PRC		4.70	19.03	–3.57	–5.12	–17.11	12.94	**4.25**
North PRC	–15.34		2.54	–16.94	–18.27	–28.59	–2.71	**–12.34**
East PRC	–35.09	–30.85		–36.32	–37.35	–45.25	–25.42	**–34.98**
South PRC	3.85	10.64	25.77		0.25	–12.40	19.33	**12.82**
Central PRC	12.68	20.04	36.46	10.54		–4.96	29.48	**17.82**
Northwest PRC	50.54	60.33	82.31	47.68	45.32		72.98	**58.85**
Southwest PRC	–32.45	–28.04	–18.19	–33.73	–34.80	–43.03		**–31.99**
Inflows	**–3.11**	**11.69**	**22.42**	**–6.81**	**–12.93**	**–19.50**	**27.11**	**2.96**
					Scenario A1B			
Northeast PRC		3.93	44.17	–8.16	–9.88	–25.23	19.47	**7.11**
North PRC	–21.56		18.19	–24.71	–26.12	–38.70	–2.08	**–14.19**
East PRC	–61.18	–57.83		–62.74	–63.44	–69.67	–51.54	**–61.35**
South PRC	7.37	16.63	61.76		1.11	–16.09	34.02	**27.64**
Central PRC	19.35	29.65	79.81	14.55		–6.73	48.99	**30.86**
Northwest PRC	76.08	91.17	165.29	69.01	65.83		119.81	**93.43**
Southwest PRC	–48.09	–43.62	–21.80	–50.18	–51.12	–59.44		**–46.77**
Inflows	**–4.83**	**15.12**	**54.35**	**–12.44**	**–20.45**	**–27.26**	**44.66**	**6.99**

PRC = People's Republic of China.
Note: Comparisons with base scenario in 2005.
Source: Authors' simulation.

V. Concluding Remarks

This paper represents a first attempt to analyze climate change impacts on the PRC's agricultural interregional trade flows using a computable general equilibrium model of multiple regions and multiple sectors. A series of simulations were conducted under A2, B1, and A1B emission scenarios to explore these impacts for the years 2030 and 2050.

The results indicate that climate change will result in significant changes in the PRC's agricultural interregional trade patterns. Northwest, South, Central, and Norheast PRC will see increases in agricultural trade outflows in 2030 and 2050. Conversely, outflows from East, North, and Southwest PRC will decrease. Agricultural interregional trade inflows will decrease in those regions that will see increases in outflows, and vice versa.

Our results imply that grain handling and transportation facilities need to be repositioned to address the changes in agricultural trade flows. A well-functioning agricultural marketing system has to be established to ensure smooth and timely shipments of grains across regions. Without such a system, even if the PRC's agricultural products can be self-sufficient at the national level, regional food security cannot be achieved. Our model results are based on the seven broad regions. If the seven broad regions are disaggregated into smaller regions, changes in internal trade flows triggered by impacts of climate changes will be more significant. More studies are thus called for on this topic.

References

Arrow, K., H. Chenery, B. Minhas, and R. Solow. 1961. "Capital-Labor Substitution and Economic Efficiency." *Review of Economics and Statistics* 43(3):225–50.

CNCC. 2009. *China's Regional Climate Changes Simulation Model and Its Applications in Evaluation of Climate Changes Impacts.* China National Climate Center, Beijing.

Darwin, R., M. Tsigas, J. Lewabdrowski, and A. Raneses. 1995. World Agriculture and Climate Change. Agricultural Economic Report No. 703, US Department of Agriculture, Economic Research Service, Washington, DC.

Harasawa, H., et al., 2003. "Potential Impacts of Global Climate Change." In M. Kainuma, Y. Matsuoka, and T. Morita, eds., *Climate Policy Assessment: Asia-Pacific Integrated Modeling.* Tokyo: Springer.

Hearn, D., C. Halbrendt, C. M. Gempesaw II, and S-E Wbb. 1990. "An Analysis of Transport Improvements in China's Corn Sector: A Hybrid Spatial Equilibrium Approach." *Journal of Transportation Research Forum* 31(1):126–38.

Ichimura, S.,and H. J. Wang, eds. 2007. *Interregional Input-Output Analysis of the Chinese Economy.* Beijing: Chemical Industry Press.

IPCC. 2010. *The Projections of the Earth's Future Climate*. Available: ipcc.ch/ipccreports/tar/wg1/029.htm.

Kane, S., J. M. Reilly, and J. Tobey. 1992. "An Empirical Study of the Economic Effects of Climate Change on World Agriculture." *Climatic Change* 21:17–35.

Lin, T., X. Y. Liu, G. H. Wan, X. Xin, and Y. S. Zhang. 2010. The Impacts of Climate Change on the People's Republic of China's Grain Output--Regional and Crop Perspective. ADB Economics Working Paper Series No. 243, Economics and Research Department, Asian Development bank, Manila. Forthcoming.

Liu, X. Y., and X. Xin. 2010. The Impacts of Climate Changes on China's Regional Livestock and Vegetable Production. Center for Rural Development Policy Working Papers, China Agricultural University, Beijing.

Liu, X. Y., X. Q. Wang, J. Whalley, and X. Xin. 2010. "Technological Change and China's Regional Disparities—A Calibrated Equilibrium Analysis." *Economic Modeling.* Forthcoming.

National Bureau of Statistics of China. 2009. *China Statistical Year Book.* Beijing: China Statistical Press.

Tsigas, M.E., G. B. Frisvold, and B. Kuhn. 1997. "Global Climate Change in Agriculture." In T. W. Hertel, ed., *Global Trade Analysis: Modeling and Applications*. Cambridge: Cambridge University Press.

Wang, J. X., R. Mendelsohn, A. Dinar, J. K. Huang, S. Rozelle, and L. J. Zhang. 2009. "The Impact of Climate Change on China's Agriculture." *Agricultural Economics* 40(3):323–37.

Xin, X., X. Y. Liu, and G. H. Wan. 2005. "Regional Feedgrain Demand, Supply and Trade Flows after the WTO Accession." In *Grains in China: Foodgrain, Feedgrain and World Trade*. Hampshire: Ashgate Publishing Limited.

Xin, X., J. Yin, and N. H. Jiang. 2004. *China's Livestock Market: Regional Supply, Demand and Trade Flow.* Beijing: China Agricultural Press.

Zhai, F., T. Lin, and E. Byambadorj. 2009. "A General Equilibrium Analysis of the Impact of Climate Change on Agriculture in the People's Republic of China." *Asian Development Review* 26(1): 206–55.

About the Paper

Substantial regional differences in the People's Republic of China (PRC) will induce changes in its agricultural interregional trade pattern. Tun Lin, Xiaoyun Liu, Guanghua Wan, Xian Xin, and Yongsheng Zhang investigate climate change impacts on the PRC agricultural interregional trade pattern using a computable general equilibrium model of multiple regions and multiple sectors. The results indicate that Northwest, South, Central, and Northeast PRC will see increases in the outflows of agricultural products in 2030 and 2050. Conversely, outflows from East, North, and Southwest PRC will decrease. Grain handling and transportation facilities need to be repositioned to address the changes in agricultural trade flows.

About the Asian Development Bank

ADB's vision is an Asia and Pacific region free of poverty. Its mission is to help its developing member countries substantially reduce poverty and improve the quality of life of their people. Despite the region's many successes, it remains home to two-thirds of the world's poor: 1.8 billion people who live on less than $2 a day, with 903 million struggling on less than $1.25 a day. ADB is committed to reducing poverty through inclusive economic growth, environmentally sustainable growth, and regional integration.

Based in Manila, ADB is owned by 67 members, including 48 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.

Asian Development Bank
6 ADB Avenue, Mandaluyong City
1550 Metro Manila, Philippines
www.adb.org/economics
ISSN: 1655-5252
Publication Stock No. WPS113173

<0113 1734>

Printed in the Philippines