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Conference name: 54th Australian Agricultural and Resource Economics Society Conference

Year: 2010

Paper title: Climate change and Australia’s comparative advantage in wheat

Author(s): Todd Sanderson and Fredoun Z. Ahmadi-Esfahani

Climate change and Australia's comparative advantage in wheat*

Todd Sanderson and Fredoun Z. Ahmadi-Esfahani

The University of Sydney

Australia has long been a major exporter of wheat, a commodity well suited to the economic and climatic conditions of Australia. According to the conventional wisdom, Australia holds a comparative advantage in wheat. However, the future validity of this proposition is sensitive to the proposed impacts of climate change. This paper develops a framework with which to examine the future patterns of comparative advantage in wheat given the projections of several global climate models. We find support for the conventional wisdom, and identify the presence of substantial resilience in Australia's comparative advantage to adverse yield change.

1. Introduction

Australia has traditionally been a significant global agricultural exporter of wheat (3rd largest exporter) (FAOSTAT 2009). This is a consequence of the prevailing broadacre production conditions in Australia, in which land is employed intensively relative to both labour and capital, which has led to extremely low production costs, especially for grains (Mauldon 1991). Conventional wisdom has treated this observation as an indication of a comparative advantage in broadacre agriculture (Davidson 1981; Wonder and Fisher 1990). However, the land intensity of production makes broadacre agriculture vulnerable to impacts of climate change which may alter the global endowment patterns of arable land.

* Contributed paper presented at the 54th Annual Conference of the Australian Agricultural and Resource Economics Society, Adelaide, 10 – 12 February, 2010.

Projections of climate change in Australia suggest that crop and livestock industries are likely to be adversely impacted, diminishing the established position of Australia as an exporter of food, including wheat (Heyhoe *et al.* 2007; Garnaut 2008). This presents policy makers with a significant challenge – designing policies which facilitate economically resilient adaptations to climate changes. Recently, the Australian government outlined broadly-defined objectives for its climate change policy, highlighting the need to develop strategies to adapt to unavoidable climate change (Commonwealth Treasury 2008). However, adaptation strategy has a strong economic dimension (for example, Clarke 2008; Dobes 2008).

We seek to examine the implications of climate change for Australia's wheat trade in a Heckscher-Ohlin-Vanek (HOV) framework. Viewing climate change as an exogenous process of land endowment alteration, we simulate for future time periods the patterns of comparative advantage in wheat arising from several predictions of climate change. In section 2, we describe the state of the HOV literature and explore options for adjusting the basic model. Section 3 outlines the analytical framework, and section 4 reports the methods and procedures with which to approach the empirics. Section 5 describes the data used to estimate the model. Section 6 reports the simulation results, and section 7 concludes with a brief discussion of the policy implications.

2. Relevant literature

Treating climate change as a process of endowment alteration, we employ the Heckscher-Ohlin-Vanek (HOV) model, an n-factor, m-good, k-region framework, in which the patterns of factor endowments determine the patterns of comparative advantage. The intuition being, that a country abundant in a particular factor, say labour, will have a capital-labour ratio embodied in consumption that will exceed the capital-labour ratio embodied in production (Leamer 1980). The use of such a model is well established in the literature, and empirical tests have been performed. Leamer (1984), for example, presents an empirical analysis of the HOV framework for 10 trade aggregates (goods) and 11 factors in 58 countries. Although this amounts to a test of weak version of the HOV theorem, endowments are found to be significant in predicting trade patterns. Maskus (1985) uses data for the years 1958 and 1972 in testing the HOV theorem for the U.S., and concludes that the predictions of the HOV model are inconsistent with the data for factor endowments, factor intensities and trade. Similarly, Bowen *et al.* (1987) employing data for 12 factors and 27 countries in 1967 test the HOV model and conclude that the evidence does not support the strict definition of the HOV model. Weakening the HOV proposition to allow for differences in technology improves the performance of the model. More recently, employing the HOV model, Peterson and Valluru (2000) suggest that factor endowments at the national level describe well the variation in net trade patterns for cereal grains, oilseeds and cotton. The HOV model has been employed as a tool for simulation, such as Hayes *et al.* (1995), who project the evolution of the economies of former Soviet Union countries as they transition to market economies. Similarly, Fang and Beghin (2000) examine the potential implications of trade liberalisation on the patterns of Chinese agricultural production. In a similar manner, this paper will employ the HOV model as a tool with which to make some projection about the patterns of comparative advantage under climate change in the Australian wheat economy.

The use of the HOV allows us to also consider the so-called Rybczynski effects, according to which an increase in the endowment of a factor will expand output of one industry employing it intensively proportionately more than the increase in the endowment itself, and simultaneously decrease the output of another industry (Rybczynski 1955). The Rybczynski theorem implies that changes in endowments which are used intensively in a particular industry, such as arable land in agriculture, will cause more than a proportional change in the output of that industry, implying that climate change will affect trade patterns more dramatically than changes in the factor endowments. Ethier (1984) generalises this proposition, arguing that in the *n x n* case each good has a factor which constitutes a "friend" and another which represents an "enemy". In the non-even *n*-factor *m*-good case, this generalisation still holds when $m>n$ but significantly weakens in the case where $m<n$ (Ethier 1984).

In order to make the simulation more tractable, we relax the assumption of homogenous technology *A*, as in Trefler (1993) and Trefler (1995) in which technology differences serve to augment the endowment of the factors. Employing 1983 data for 33 countries, Trefler (1993) identifies a significant improvement in the explanatory power in terms of the factor content of trade and differences in international factor prices. More recently, Hakura (2001) relaxes the assumption of identical technology among countries to examine trade within the European Community. Employing a similar methodology and data for the period between 1960 and 1995 for 10 OECD countries, Davis and Weinstein (2001) present an improvement in the explanatory power of the HOV model when technical differences are incorporated. In addition to this, we allow for the possibility of sector specific-factors such as those in the Abbott and Thompson (1987) model of agricultural comparative advantage. Allowing for such a framework ensures the existence of weak Rybczynski effects for any specific-factors, although it also eliminates any Rybczynski effects for the mobile factors (Feenstra, 2004).

3. Conceptual framework

In the exposition of the HOV model, we follow the static model insights provided in the *m*-factor, *n*-good general equilibrium framework of Chang (1979) and the static empirical application of the HOV framework in Leamer (1984). The basic HOV model is based on several assumptions, that is, the homogeneity of technical knowledge and preferences among countries, constant returns to scale production, and perfect competition in factor and commodity markets which face the same set of prices. Denoting the outputs by Y_n and the inputs by X_m, and defining a_{mn} as the amount of the factor (resource) X_m needed to produce a unit of the good (output) Y_n, we can set factor supply equal to factor demand and obtain:

$$X_m = \sum_{n=1}^{N} a_{mn} Y_n \qquad \forall m = 1,...,M \text{ and } n = 1,...,N \tag{1}$$

This is a system of equations that can be solved for outputs as a function of the endowments. It is convenient to represent this system in matrix form:

$$AY = X \tag{2}$$

where A is a $n \times m$ 'technology' matrix of a_{mn} elements, X is a vector of m endowed factors and Y a vector of n outputs. We may invert A to obtain a set of solutions for each of the outputs:

$$Y = A^{-1} X \tag{3}$$

Because of the linearity of these equations (and the consequent unresponsiveness of total world outputs to factor migration), we can also write total world outputs Y^W as a function of total world endowments X^W:

$$Y^W = A^{-1} X^W \tag{4}$$

Since the relative prices of outputs are given in world markets and are the same for all countries, the assumption of identical consumer preferences implies that each country consumes a vector C of n outputs in the same proportions, that is:

$$C = sY^W \tag{5}$$

where s is some scalar corresponding to the relative size of the country in terms of share of world GNP. The trade balance requires that the value of production equal the value of consumption, that is:

$$p'Y = p'C = sp'Y^W \tag{6}$$

where p is a vector of prices corresponding to the vector of output Y. Then, if trade is balanced, the consumption share is the ratio of own GNP to world GNP:

$$s = \frac{p'Y}{p'Y^W} \tag{7}$$

The vector of net exports *T,* is the difference between production and consumption:

$$T = Y - C = A^{-1}\left(X - sX^W\right) \tag{8}$$

We can transform this into the *factors embodied in net exports*, vector AT:

$$AT = X - sX^W \tag{9}$$

This equation describes the relationship between the factor intensity of trade and excess factor endowment supplies, that the factors embodied in net exports equal the excess factor supplies. The vector AT is composed of positive and negative elements, reflecting the import – export flows. These are the HOV equations, according to which a country is said to be abundant in a factor *m* if its share of the world's supply of that factor exceeds its consumption share. Similarly, a country abundant in a factor *m* will return a positive net export value for goods in which that factor is employed intensively.

4. Methods and procedures

We estimate the HOV model with an explicitly-defined wheat producing sector. For simplicity, we assume there to be four factors of production, capital, skilled labour, unskilled labour and "wheat land" which is land defined as being suitable for growing wheat. These factors are employed in four possible productive sectors – wheat, light manufacturing, heavy manufacturing and food processing. Although wheat land is strictly employable in the wheat sector, capital and labour may move freely among all four sectors. The non-wheat sectors have been selected because they reflect differing labour and capital input requirements as revealed in the matrix of technical coefficients *A*. The *A* matrix is formed using data in the GTAP 7. We have aggregated data for the four sectors from which information on factor demand and output was gathered. Each of these was formed into a matrix, factor demand *U* and output *V* (ten Raa, 2005). There are as many factors as goods, with each sector using a vector of factor inputs to produce a single good. This means that V is a diagonal matrix, such that the matrix of technical coefficients A is given by:

$$A = UV^{-1} \tag{10}$$

Given the A matrix, the vector of trade values T was derived by application of Cramer's rule to equation (9), having pre-calculated the vector formed by $X - sX^W$.

A combination of 27 of the largest wheat producing and exporting nations according to (FAOSTAT 2009), for which other necessary data are available, will be used in this modelling exercise. These are: Argentina, Australia, Austria, Belgium, Canada, China, Czech Republic, Denmark, Egypt, France, Germany, Hungary, India, Iran, Italy, Kazakhstan, Mexico, Netherlands, Pakistan, Poland, Russian Federation, Spain, Turkey, UK, Ukraine and the United States. In addition to these, an aggregate of the rest of the world countries has been formed, as these are thought to be the bulk of net importers of wheat. Data collected on national endowments of wheat land, labour and capital will be used to estimate equation (9), which help to provide us with the patterns of factor endowments in excess of those which are consumed domestically. These patterns assist in exposing a preliminary view of the patterns of comparative advantage in Australian wheat.

5. Data

We require information on the country level endowments of capital, labour and wheat land, in addition to information about the relative size of each country's economy, given by gross national product. We derive an estimate of the capital endowment in 2006 by employing the method outlined in Leamer (1984) and Peterson and Valluru (2000). That is, assuming an asset life of 15 years, we sum data on gross capital formation available from the World Bank for the period 2006 – 1992, depreciated linearly at 6.67 percent per annum. Labour endowment and gross national product is extracted from the 2006 World Bank *World Tables*. Each of these are reported in Table 1.

Table 1 Capital and labour endowments, and gross national product, 2006

	Capital Endowment ($US Bil.)	Labour		Gross National Product (% of World total)
		Unskilled (.mil workers)	Skilled (.mil workers)	
Argentina	375.29	12.45	5.61	0.4377
Australia	851.25	6.28	4.49	1.4799
Austria	337.48	2.47	1.71	0.6610
Belgium	386.02	2.65	1.95	0.8115
Canada	1,200.30	11.20	6.80	2.6047
China	4,310.11	606.36	169.38	5.4300
Czech Republic	138.07	3.53	1.66	0.2907
Denmark	255.03	1.66	1.26	0.5639
Egypt	150.49	18.12	6.60	0.2196
France	2,064.91	15.78	12.05	4.6326
Germany	3,021.25	24.46	17.22	5.9519
Hungary	95.01	2.99	1.37	0.2309
India	1,080.70	334.43	105.09	1.8691
Iran	264.59	18.48	9.15	0.4553
Italy	1,797.57	14.32	10.41	3.7932
Kazakhstan	41.35	5.84	2.11	0.1655
Mexico	938.90	27.58	17.03	1.9385
Netherlands	630.54	4.79	3.65	1.3695
Pakistan	101.90	38.26	14.70	0.2601
Poland	288.58	11.44	5.92	0.6980
Rest of World	19,146.87	741.09	416.64	28.5565
Russian Federation	452.08	50.64	23.64	2.0237
Spain	1,279.48	13.12	8.58	2.5142
Turkey	460.02	17.71	7.33	1.0826
Ukraine	64.22	15.68	7.45	0.2201
United Kingdom	2,089.73	17.84	13.40	4.9086
United States	14,866.10	87.63	67.60	26.8304

Source: World Bank

Data on the endowment patterns of these wheat lands are available from the International Institute for Applied Systems Analysis (IIASA) in their publication *Global Agro-ecological Assessment for Agriculture in the 21st Century* (IIASA 2002). A simulation methodology known as agro-ecological zoning (AEZ) has been employed, which generates an inventory of land resources given area specific soil, terrain and climate characteristics and the biophysical requirements of crops. We identify for a given country the endowment of land suitable for producing a given agricultural commodity. For illustrative purposes, the calculated endowments of wheat suitable land for the modelled countries with associated average yield are presented in Table 2. We employ the factor augmenting productivity difference approach of Trefler (1995) to calculate the productivity (yield) augmented endowments of wheat suitable lands (Table2). This information constitutes the feedstock for the HOV model from which we examine the patterns of agricultural comparative advantage under climate change.

Table 2 Wheat land endowments

	Productivity Augmented Wheat land Endowment (mil. Ha)			
	Very Suitable	**Suitable**	**Moderately Suitable**	**Marginally Suitable**
Argentina	9.911	26.534	20.783	13.625
Australia	6.112	12.202	14.175	14.558
Austria	0.924	1.853	0.892	0.606
Belgium	0.927	0.908	0.364	0.594
Canada	1.798	10.108	24.231	33.301
China	1.167	19.478	33.853	52.923
Czech Republic	1.958	3.679	1.590	1.079
Denmark	1.580	1.302	0.608	1.008
Egypt	0.000	0.000	0.017	0.000
France	12.516	15.603	11.746	6.675
Germany	11.121	11.503	7.312	4.219
Hungary	1.229	5.184	3.263	0.764
India	0.001	1.182	4.562	3.643
Iran	0.000	0.137	0.615	4.550
Italy	3.594	4.557	4.556	4.176
Kazakhstan	0.001	0.140	1.868	6.460
Mexico	0.902	2.285	3.504	4.070
Netherlands	0.430	0.716	0.340	1.032
Pakistan	0.114	0.571	0.738	0.800
Poland	9.118	7.657	6.077	6.930
Rest of World	33.938	94.008	117.532	106.535
Russian Federation	15.834	91.636	90.933	99.763
Spain	0.308	1.608	4.709	9.128
Turkey	0.846	4.505	13.184	18.371
Ukraine	9.632	18.116	22.499	15.625
United Kingdom	1.995	6.500	4.983	4.981
United States	56.595	150.039	115.698	54.384

Source: IIASA (2002)

6. Results

Given equation (9), we calculate the status quo excess factor endowments of wheat land, labour and capital (Table3). The revealed patterns broadly correspond to our *a priori* suspicions that Australia is abundant in wheat land and scarce in labour, and China has the reverse pattern. As we have identified above, a country is said to be abundant in a factor if its share of the world's supply of that factor exceeds its consumption share, that is, if (*AT*) is positive. Further, a country which happens to be relatively abundant in a factor, say wheat land, is likely to return a positive net export value for goods in which that factor is employed intensively, that is wheat.

Table 3 Status quo excess factor supplies

	Capital ($US Bil.)	Unskilled (.mil workers)	Skilled (.mil workers)	Wheat Land (mil. Ha)
Argentina	127.17	3.23	1.48	63.61
Australia	12.35	-24.90	-9.46	22.56
Austria	-37.22	-11.45	-4.53	-6.66
Belgium	-74.00	-14.45	-5.70	-10.64
Canada	-276.26	-43.68	-17.76	26.33
China	1,231.94	491.95	118.19	17.55
Czech Republic	-26.75	-2.59	-1.08	3.49
Denmark	-64.64	-10.22	-4.06	-4.83
Egypt	26.01	13.50	4.53	-3.62
France	-561.20	-81.82	-31.63	-30.13
Germany	-352.74	-100.93	-38.90	-64.35
Hungary	-35.86	-1.87	-0.80	6.62
India	21.13	295.06	87.47	-21.55
Iran	6.47	8.89	4.85	-2.23
Italy	-352.74	-65.59	-25.35	-45.89
Kazakhstan	-52.46	2.35	0.55	5.73
Mexico	-160.01	-13.26	-1.24	-21.32
Netherlands	-145.80	-24.06	-9.26	-20.15
Pakistan	-45.56	32.78	12.25	-2.08
Poland	-107.12	-3.27	-0.66	18.23
Rest of World	2,958.81	139.45	147.41	-120.60
Russian Federation	-695.14	8.01	4.56	264.67
Spain	-145.77	-39.85	-15.12	-25.86
Turkey	-153.71	-5.10	-2.88	18.99
Ukraine	-60.57	11.04	5.38	62.23
United Kingdom	-692.84	-85.58	-32.88	-62.78
United States	-343.49	-477.64	-185.36	-67.33

However, this is subject to the country's specific patterns of abundance, and where there is a stronger abundance of some other factor, this may overwhelm exports in that good. Therefore, we need to disentangle the patterns of factor abundance from those of trade by employing the technology matrix to establish opportunity costs of factor employment. The status quo patterns of trade are presented in Table 4, where volume of wheat trade and an aggregate of manufactures trade are listed. Countries are ordered by the strength of their comparative advantage in wheat, with the Russian Federation being the first and the Rest of World aggregate last. This corresponds to the factor abundance patterns in Table 3, as these are the two extrema in terms of wheat land abundance.

To analyse the implications of climate change for comparative advantage in wheat, we employ two representative examples of simulation results for yield change arising from general circulation models (GCMs). These are the HADCM2 model of the Hadley Centre for Climate Prediction and Research, and the CGCM1 model of the Canadian Centre for Climate Modelling and Analysis. IIASA (2002) has used these GCM's to generate wheat yield estimates for future time periods 2020, 2050 and 2080. Simulation results of these future yield changes for our agricultural trading model are presented in Table 4 and Table 5, respectively. Simulation results employing yield predictions for other GCM's, namely those of Rosenzweig and Iglesias (2006) are presented in the Appendix A, these contain a similar pattern of results to those reported in this section. Given a predicted percentage change in wheat yield, the resulting adjustment in the traded volumes is reported for both wheat and an aggregate of the manufactured goods. For Australia, apparently moderate declines in predicted yield result in a proportionately greater reduction in exports of wheat – a consequence of substantial increases in wheat yields in the Russian Federation and Canada. Zero yield changes in Egypt, and consequent decreases in wheat trade, illustrate the case that these GCMs predict an overall increase in the availability of wheat suitable lands, and no country can expect to foster its comparative advantage in wheat without also experiencing

Table 4 Status quo trade and simulated wheat and aggregate manufactures changes under HADCM2

	Status Quo		HADCM2 2020			HADCM2 2050			HADCM2 2080		
	Wheat Trade	Aggregate Manufactures Trade	YieldΔ%	wheatTΔ%	manTΔ%	YieldΔ%	wheatTΔ%	manTΔ%	YieldΔ%	wheatTΔ%	manTΔ%
Russian Federation	1972.615	-3930.052	12.139	13.024	-3.910	24.411	26.461	-7.943	24.287	26.694	-8.013
Argentina	474.081	-293.992	2.549	2.254	-2.174	-2.081	-3.254	3.138	7.460	7.711	-7.436
Ukraine	463.788	-268.565	-1.781	-2.186	2.258	-2.924	-3.576	3.693	-5.580	-6.214	6.418
Canada	196.244	-954.746	7.620	11.683	-1.436	20.658	41.032	-5.044	22.444	50.573	-6.217
Australia	168.106	-435.124	-2.008	-9.768	2.257	-12.414	-34.812	8.043	-10.623	-27.872	6.440
Turkey	141.523	91.786	-1.373	-7.517	6.932	-0.248	-8.233	7.592	-7.228	-19.014	17.534
Poland	135.863	-41.901	-7.188	-15.000	29.087	-8.028	-18.321	35.528	-3.285	-8.702	16.875
China	130.834	659.773	14.865	64.658	-7.668	15.941	55.498	-6.582	16.533	74.227	-8.803
Hungary	49.332	4.863	1.236	-1.017	6.168	2.213	-1.251	7.591	4.571	4.171	-25.309
Kazakhstan	42.698	-257.246	18.954	25.558	-2.537	46.206	64.369	-6.390	33.269	46.659	-4.632
Czech Republic	26.044	21.065	0.838	-5.085	3.760	-0.171	-11.718	8.664	-2.311	-12.739	9.420
Pakistan	-15.519	115.271	-4.979	-15.939	1.283	-25.088	-43.763	3.524	-39.111	-52.631	4.238
Iran	-16.650	-1314.699	2.814	-10.657	0.081	-1.427	-31.095	0.236	2.722	-11.292	0.086
Egypt	-26.959	-154.974	0.000	-5.163	0.537	0.000	-8.252	0.859	0.000	-5.288	0.550
Denmark'	-36.027	-18.333	5.544	-4.762	5.597	4.953	-11.248	13.220	-5.002	-14.816	17.414
Austria	-49.667	168.322	3.927	-5.917	1.044	2.079	-12.150	2.144	-3.713	-11.021	1.945
Belgium	-79.278	154.317	-16.871	-10.919	3.355	-27.826	-17.678	5.432	-17.266	-11.179	3.435
Netherlands	-150.157	211.272	-19.988	-8.279	3.519	-18.612	-11.566	4.916	-30.247	-9.701	4.123
Mexico	-158.915	247.408	2.017	-6.714	2.579	7.557	-8.545	3.283	4.756	-5.519	2.120
India	-160.585	763.264	-6.897	-10.383	1.306	-17.470	-19.404	2.442	-20.610	-16.535	2.081
Spain	-192.714	659.586	-1.336	-9.084	1.587	-12.816	-21.026	3.674	-5.493	-11.816	2.065
France	-224.554	984.390	-15.518	-37.047	5.054	-24.963	-59.461	8.112	-4.824	-20.844	2.844
Italy	-342.052	936.219	10.000	-5.190	1.134	-2.039	-11.986	2.619	-0.400	-7.346	1.605
United Kingdom	-467.877	371.862	-10.953	-9.871	7.428	-32.015	-20.043	15.082	-37.832	-17.935	13.496
Germany	-479.590	1354.889	-0.461	-8.111	1.717	-0.975	-13.091	2.771	-5.328	-10.884	2.304
United States	-501.778	3874.589	7.418	7.613	-0.590	12.743	17.131	-1.327	-3.672	-55.259	4.280
Rest of World	-898.803	2949.243	2.990	-11.413	2.080	3.946	-20.673	3.768	4.222	-8.301	1.513

Table 5 Simulated wheat trade changes under CGCM1

	CGCM1 2020			CGCM1 2050			CGCM1 2080		
	YieldΔ%	wheatTΔ%	manTΔ%	YieldΔ%	wheatTΔ%	manTΔ%	YieldΔ%	wheatTΔ%	manTΔ%
Russian Federation	16.320	18.336	-5.504	21.712	24.458	-7.342	42.022	46.022	-13.815
Argentina	-9.290	-10.392	10.022	-5.979	-6.660	6.423	-3.141	-4.685	4.518
Ukraine	-7.582	-8.049	8.313	-1.924	-2.037	2.103	3.492	3.086	-3.188
Canada	6.251	15.848	-1.948	15.744	41.509	-5.103	35.443	76.420	-9.394
Australia	-4.895	-10.631	2.456	-7.551	-15.757	3.641	-5.195	-22.145	5.117
Turkey	-2.307	-4.850	4.473	-5.854	-11.383	10.497	-2.411	-14.513	13.383
Poland	-1.727	-3.068	5.949	-4.996	-8.166	15.836	-2.016	-9.893	19.184
China	7.101	41.463	-4.917	11.598	70.937	-8.413	2.423	-38.484	4.564
Hungary	0.319	0.279	-1.691	6.463	10.191	-61.831	0.971	-4.480	27.180
Kazakhstan	10.332	15.086	-1.498	2.897	4.278	-0.425	17.223	20.478	-2.033
Czech Republic	3.764	8.413	-6.221	-1.563	-3.723	2.753	-5.221	-26.750	19.779
Pakistan	-16.656	-18.582	1.496	-15.850	-16.932	1.363	-28.220	-51.655	4.159
Iran	9.101	20.288	-0.154	8.229	19.509	-0.148	17.378	6.111	-0.046
Egypt	0.000	-0.390	0.041	0.000	-0.006	0.001	0.000	-10.463	1.089
Denmark'	4.489	3.428	-4.029	-0.781	-0.739	0.868	-3.076	-22.969	26.996
Austria	1.285	0.187	-0.033	2.480	1.581	-0.279	8.449	-11.675	2.060
Belgium	-10.800	-3.327	1.022	-17.294	-4.550	1.398	-20.281	-18.475	5.676
Netherlands	-18.410	-2.738	1.164	-26.067	-3.265	1.388	-25.708	-14.928	6.345
Mexico	-0.782	-0.979	0.376	2.526	1.265	-0.486	2.263	-14.528	5.581
India	0.604	-0.294	0.037	-2.697	-1.184	0.149	-4.685	-16.993	2.138
Spain	-3.206	-2.578	0.450	-14.082	-8.590	1.501	-15.883	-26.435	4.619
France	-6.227	-10.607	1.447	-20.680	-31.960	4.360	-16.355	-51.764	7.062
Italy	1.586	0.052	-0.011	3.665	1.340	-0.293	13.928	-9.122	1.993
United Kingdom	-2.007	-1.093	0.822	-11.335	-3.341	2.514	-13.241	-17.370	13.071
Germany	0.358	-0.404	0.086	-2.507	-1.340	0.284	-4.923	-18.555	3.928
United States	-10.855	-63.303	4.903	-16.004	-89.592	6.939	11.864	-2.301	0.178
Rest of World	1.286	2.231	-0.407	-0.193	-0.589	0.107	-2.652	-48.554	8.850

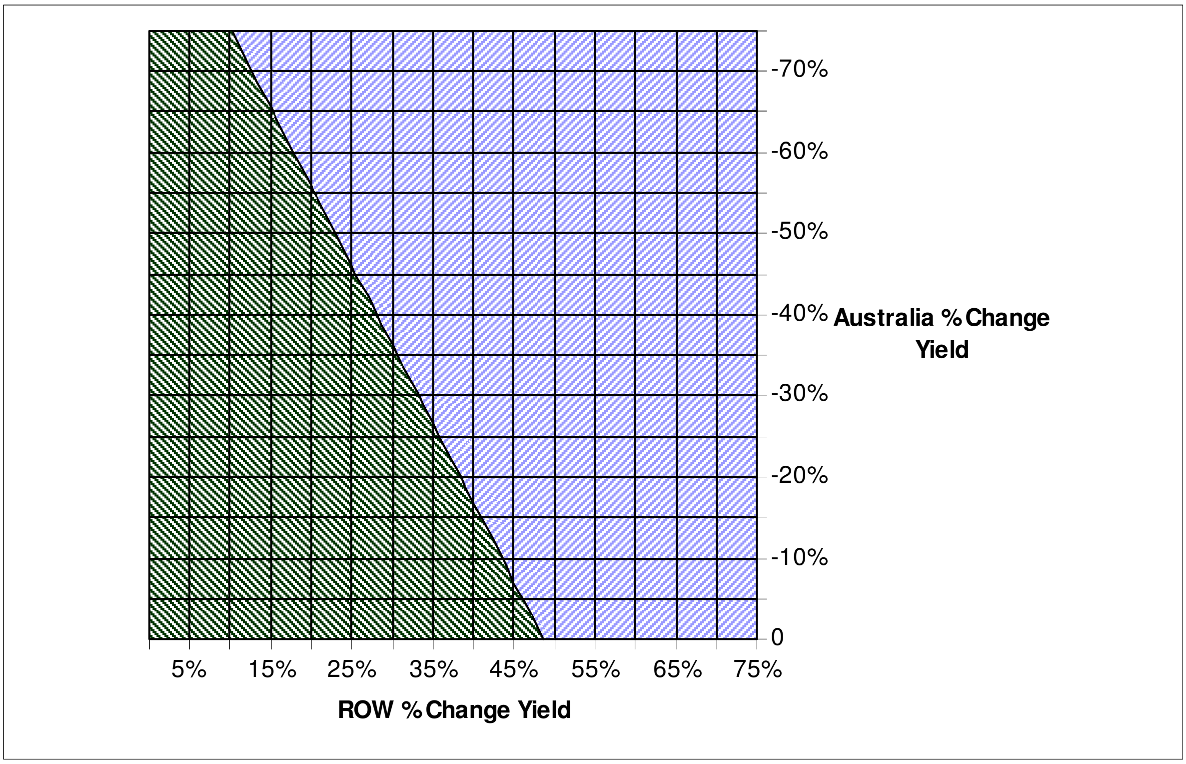
improving yields. Notwithstanding this, for the scenarios modelled, Australia appears to be able to maintain its comparative advantage, although it will experience a substantial weakening. In additional, effects consistent with the Rybczynski predictions are observed for Australia (and other countries), that is, a decrease in the wheat land endowment gives rise to a proportionately greater contraction in the wheat sector. Further, consistent with *a priori* expectation, change in activity level in the wheat sector appears to be negatively related to activity in the manufacturing aggregate, so that declining yield is associated with the growth of the manufacturing aggregate.

7. Policy implications and discussion

At a general level, we may propose that with a *ceteris paribus* decline in the improvement in comparative advantage enjoyed by a country, there will be a concomitant decline in the absolute advantage for that good. This implies that the returns to factors – land, labour and capital, employed in that sector will decline. It is possible to conceptualise the policy maker's problem as one in which the state of a country's comparative advantage in any good is characterised by a system of resilience. That is, when a country possesses a strong comparative advantage position, its distance to some "comparative advantage threshold" is greater than a country with a weaker position. The current analysis of Australia's comparative advantage in wheat against an aggregated rest-of-world (ROW) (all 26 other countries and the rest of world aggregate) reveals substantial resilience to adverse yield change. This threshold may be represented graphically (Figure 1), below which Australia maintains a comparative advantage, and above which it is lost. The distance from the threshold indicates the strength of the position, and hence the strength of returns – indicated by absolute advantage – to the factors used intensively in wheat production. This implies that as climate change induced yield change diminishes the distance to the threshold, the returns to activities in the wheat sector likewise diminish.

The apparent resilience of Australia's comparative advantage under climate change in wheat makes resolving the policy maker's problem identified earlier somewhat easier. Developing on the magnitude of Australian and ROW yield change, the policy maker may either choose to invest in adaptation activities, which will have, *ceteris paribus*, the effect of increasing resilience of the comparative advantage position. The need for, and choice of investment, must reflect expectations about the trajectory of change, and whether or not that change causes the threshold to be crossed, and by how much.

Figure 1 Comparative advantage threshold – Australia against rest of world (ROW)



This is particularly important, given the Rybczynski effects, by which moderate declines in yield may be sufficient to cause the system to cross the threshold. In light of Mullen (2007), who has identified that in Australia there exist strong returns to public investment in broadacre agricultural research and development activities. It is, therefore, possible to establish a *prima facia* case for investment in yield preserving adaptation activities.

The analysis presented above suggests that the United States and the majority of the European countries (Denmark, Austria, Belgium, the Netherlands, Spain, France, Italy, the United Kingdom and Germany) all continue to enjoy a comparative disadvantage in wheat. This may be thought of as operating to the left of the comparative advantage threshold, a state in which negative economic returns may arise, and may only be maintained beyond the short run by the application of government subsidies. A move towards liberalised trading markets would see the collapse of grains production in these countries. Under climate change, the simulation results imply that maintaining the systems of support for grains production in those countries will entail progressively higher costs, as these countries move further away from the threshold. This process is driven by declining domestic yields and improved yields in other competitor countries – particularly Russia, for which increases in yield translate into substantial expansion of the wheat sector.

Australia continues to possess a status quo comparative advantage in wheat help to establish that, in the absence of climate shocks, there is some scope to maintain that advantage in the presence of positive shocks to the cost of production. These shocks may take the form of government intervention through imposed environmental standards or the mandated inclusion of agriculture in an Australian emissions trading scheme (ETS). The apparent robustness of the advantage which Australia has in wheat production, including that under climate change, implies that the inclusion of agriculture (at least the wheat sector) in the proposed ETS is unlikely to substantially diminish that advantage. This is especially true when the value added per unit of emissions is considered in a broader agricultural context. In 2005, sheep and beef subsectors account for 31.7 percent of total value and 80.1 percent of total emissions in the agricultural sector, however, grains accounted for 17.2 percent of total value and only 2.5 percent of total emissions (ABS 2008; Garnaut 2008). The implication is that any positive price on carbon emissions will have a substantially lesser effect on grains than on sheep and beef, diminishing the strength of any argument against the exclusion of the grains sector from the ETS, as proposed by the draft legislation.

8. Concluding comments

In this simple representation of an agricultural trading world under climate change, we have demonstrated that Australia keeps in fact enjoying a comparative advantage in wheat. Further, in spite of a substantial decline in the resilience of that comparative advantage, for the two GCMs considered above, that proposition remains firm for the simulated years to 2080. Further empirical work, may help to shed light on the patterns of sectoral change within the agricultural sector itself. This may be achieved by incorporating other agricultural activities, for which data are pending.

References

Australian Bureau of Statistics (ABS) (2008), "Australian National Accounts: Input-Output Tables 2004-05" (Canberra: ABS), http://www.abs.gov.au/AUSSTATS/abs@.nsf/allprimarymainfeatures/2CAAA988DEF27248CA2576470014EBF9?opendocument

Bowen, H.P., Leamer, E.E. and Sveikauskas, L. (1987). Multicountry, mutlifactor tests of the factor abundance theory, *American Economic Review* 77 (5): 791-809.

Chang, W.W. (1979). Some theorems of trade and general equilibrium with many goods and factors, *Econometrica* 47: 709-726.

Davidson, B. (1981). *European farming in Australia: an economic history of Australian farming*. Elsevier, Amsterdam.

Davis, D.R. and Weinstein, D.E. (2001). An account of global factor trade, *American Economic Review* 91 (5): 1423-1453.

Ethier, W.J. (1984). Higher dimensional issues in trade theory. in Jones, R.W. and Kenen, P.B. (eds.), *Handbook of International Economics, vol. 1*. Elsevier.

Fang, C. and Beghin, J.C. (2000). Food Self-Sufficiency, Comparative Advantage, and Agricultural Trade: A Policy Analysis Matrix for Chinese Agriculture, *Working Paper 99-WP 223*.

Garnaut, R. (2008). *The Garnaut climate change review: final report*. Cambridge University Press.

Hakura, D.S. (2001). Why does HOV fail? The role of technological differences within the EC, *Journal of International Economics* 54: 361-382.

Hayes, D.J., Kumi, A. and Johnson, S.R. (1995). Trade impacts of Soviet reform: a Heckscher-Ohlin-Vanek approach, *Review of Agricultural Economics* 17: 131-145.

Heyhoe, E., Kim, Y., Kokic, p., Levantis, C., Ahammad, H., Schneider, K., Crimp, S., Nelson, R., Flood, N. and Carter, J. (2007). Adapting to climate change: issues and challenges in the agriculture sector, *Australian Commodities* 14(1): 167-178.

International Institute for Applied Systems Analysis (IIASA) (2002). Global agro-ecological assessment for agriculture in the 21st century: methodology and results. IIASA, Laxenburg, Austria.

Leamer, E.E. (1980). The Leonteif Paradox, reconsidered, *Journal of Political Economy* 88 (3): 495-503.

Leamer, E.E. (1984). *Source of international comparative advantage: theory and evidence*. MIT Press, Cambridge, Massachusetts.

Maskus, K.E. (1985). A test of the Heckscher-Ohlin-Vanek theorem: the Leontief commonplace, *Journal of International Economics* 19: 201-212.

Mauldon, R. (1991). Concluding comments. in Copeland, L. and Ahmadi, F. (eds.), *Grains Research Symposium: products, processing, marketing*, The University of Sydney.

Mullen, J. (2007). Productivity growth and the returns from public investment in R&D in Australian broadacre agriculture, *The Australian Journal of Agricultural and Resource Economics* 51: 359-384.

Peterson, E.W.F. and Valluru, S.R.K. (2000). Agricultural comparative advantage and government policy interventions, *Journal of Agricultural Economics* 51: 371-387.

Rosenzweig, C. and Iglesias, A. (2006). *Potential Impacts of Climate Change on World Food Supply: Data Sets from a Major Crop Modeling Study*. Goddard Institute for Space Studies, Columbia University, New York. Available at http://sedac.ciesin.columbia.edu (accessed October 29, 2009).

Rybczynski, T.M. (1955). Factor endowment and relative commodity prices, *Economica* 22: 336-341.

Raa, T. T. (2006). *The Economics of Input-Output Analysis*. Cambridge University Press.

Trefler, D. (1993). International factor price differences: Leontief was right!, *Journal of Political Economy* 101 (6): 961-987.

Trefler, D. (1995). The case of the missing trade and other mysteries, *American Economic Review* 85 (5): 1029-1046.

Wonder, B. and Fisher, B.S. (1990). Agriculture in the economy. in Williams, D.B. (ed.), *Agriculture in the Australian Economy*. Sydney University Press, pp 50-67.

Appendix A

Table 1A Simulated wheat trade changes under CM3-A scenario, both CO_2 and no CO_2 effects

	CM3-A, no CO_2 effect						CM3-A, CO_2 effect					
	2020		2050		2080		2020 (475 ppm)		2050 (574 ppm)		2080 (712 ppm)	
	YieldΔ%	TΔ%	YieldΔ%	TΔ%	YieldΔ%	TΔ%	YieldΔ%	TΔ%	YieldΔ%	TΔ%	YieldΔ%	TΔ%
Argentina	-2.00	-1.29	-7.00	-6.10	-10.00	-8.85	4.00	4.71	5.00	5.90	7.00	8.15
Australia	0.00	8.96	-10.00	-4.65	-26.00	-32.41	6.00	14.96	2.00	7.35	-9.00	-15.41
Austria	-1.00	-12.91	-3.00	-22.58	-8.00	-27.86	5.00	-6.91	9.00	-10.58	9.00	-10.86
Belgium	-1.00	-10.16	-3.00	-18.06	-8.00	-23.27	5.00	-4.16	9.00	-6.06	9.00	-6.27
Canada	-7.00	-4.95	-13.00	-9.84	-22.00	-25.11	-1.00	1.05	-1.00	2.16	-5.00	-8.11
China	0.00	42.25	-8.00	27.47	-13.00	23.34	6.00	48.25	4.00	39.47	4.00	40.34
Czech Republic	-1.00	8.99	-3.00	13.42	-8.00	8.66	5.00	14.99	9.00	25.42	9.00	25.66
Denmark	-1.00	-15.00	-3.00	-26.03	-8.00	-31.36	5.00	-9.00	9.00	-14.03	9.00	-14.36
Egypt	-5.00	-8.27	-13.00	-14.94	-28.00	-20.06	1.00	-2.27	-1.00	-2.94	-11.00	-3.06
France	-1.00	-19.46	-3.00	-33.35	-8.00	-38.78	5.00	-13.46	9.00	-21.35	9.00	-21.78
Germany	-1.00	-12.10	-3.00	-21.26	-8.00	-26.52	5.00	-6.10	9.00	-9.26	9.00	-9.52
Hungary	-1.00	3.19	-3.00	3.89	-8.00	-1.02	5.00	9.19	9.00	15.89	9.00	15.98
India	-12.00	-6.62	-18.00	-13.59	-28.00	-16.65	-6.00	-0.62	-6.00	-1.59	-11.00	0.35
Iran	-5.00	-15.97	-13.00	-19.50	-28.00	-1.34	1.00	-9.97	-1.00	-7.50	-11.00	15.66
Italy	-1.00	-10.92	-3.00	-19.32	-8.00	-24.55	5.00	-4.92	9.00	-7.32	9.00	-7.55
Kazakhstan	-18.00	-22.66	-27.00	-32.77	-31.00	-36.21	-12.00	-16.66	-15.00	-20.77	-14.00	-19.21
Mexico	-6.00	-9.39	-20.00	-12.37	-38.00	-11.06	0.00	-3.39	-8.00	-0.37	-21.00	5.94
Netherlands	-1.00	-9.16	-3.00	-16.42	-8.00	-21.61	5.00	-3.16	9.00	-4.42	9.00	-4.61
Pakistan	-13.00	-3.19	-22.00	-7.38	-33.00	-6.32	-7.00	2.81	-10.00	4.62	-16.00	10.68
Poland	-1.00	3.60	-3.00	4.56	-8.00	-0.33	5.00	9.60	9.00	16.56	9.00	16.67
Rest of World	-8.45	-7.68	-17.35	-7.86	-27.40	1.22	-2.45	-1.68	-5.35	4.14	-10.40	18.22
Russian Federation	-18.00	-19.23	-27.00	-28.53	-31.00	-32.38	-12.00	-13.23	-15.00	-16.53	-14.00	-15.38
Spain	-1.00	-12.67	-3.00	-22.19	-8.00	-27.47	5.00	-6.67	9.00	-10.19	9.00	-10.47
Turkey	-18.00	-27.20	-26.00	-36.45	-27.00	-33.51	-12.00	-21.20	-14.00	-24.45	-10.00	-16.51
Ukraine	-18.00	-18.57	-27.00	-27.71	-31.00	-31.64	-12.00	-12.57	-15.00	-15.71	-14.00	-14.64
United Kingdom	-1.00	-10.39	-3.00	-18.44	-8.00	-23.66	5.00	-4.39	9.00	-6.44	9.00	-6.66
United States	-6.00	-20.86	-10.00	-42.50	-10.00	-76.60	0.00	-14.86	2.00	-30.50	7.00	-59.60

Table 2A Simulated wheat trade changes under CM2-S550 scenario with no CO_2 effect

	CM2-S550, no CO_2 effect							
	2020		2050		2080		2110	
	YieldΔ%	TΔ%	YieldΔ%	TΔ%	YieldΔ%	TΔ%	YieldΔ%	TΔ%
Argentina	-2.00	-1.69	-2.00	-1.78	-3.00	-2.67	-3.00	-2.81
Australia	-5.00	-5.35	-5.00	-6.11	-6.00	-6.09	-8.00	-11.60
Austria	1.00	-8.33	0.00	-6.52	0.00	-9.71	-1.00	-7.05
Belgium	1.00	-6.17	0.00	-5.02	0.00	-7.47	-1.00	-5.65
Canada	-4.00	-2.89	-2.00	1.23	-4.00	-0.86	-3.00	-0.24
China	-3.00	5.61	-2.00	8.11	0.00	30.28	0.00	23.97
Czech Republic	1.00	8.82	0.00	5.47	0.00	8.15	-1.00	4.07
Denmark	1.00	-9.97	0.00	-7.67	0.00	-11.42	-1.00	-8.11
Egypt	-4.00	-4.68	-8.00	-3.96	-8.00	-5.91	-10.00	-4.66
France	1.00	-13.46	0.00	-10.11	0.00	-15.05	-1.00	-10.37
Germany	1.00	-7.70	0.00	-6.08	0.00	-9.06	-1.00	-6.64
Hungary	1.00	4.28	0.00	2.29	0.00	3.41	-1.00	1.13
India	-8.00	-3.23	-13.00	-0.04	-15.00	-1.96	-20.00	1.99
Iran	-4.00	-6.30	-8.00	5.58	-8.00	-0.97	-10.00	7.93
Italy	1.00	-6.77	0.00	-5.44	0.00	-8.09	-1.00	-6.04
Kazakhstan	-6.00	-6.63	-5.00	-5.49	-7.00	-7.52	-5.00	-5.15
Mexico	-11.00	-1.49	-12.00	0.08	-10.00	-3.85	-15.00	0.52
Netherlands	1.00	-5.39	0.00	-4.47	0.00	-6.65	-1.00	-5.14
Pakistan	-7.00	-2.21	-11.00	3.53	-14.00	2.71	-17.00	8.46
Poland	1.00	4.60	0.00	2.52	0.00	3.75	-1.00	1.33
Rest of World	-3.80	-7.25	-4.75	-1.71	-10.35	7.03	-7.75	4.27
Russian Federation	-6.00	-6.17	-5.00	-5.13	-7.00	-7.14	-5.00	-5.04
Spain	1.00	-8.14	0.00	-6.40	0.00	-9.52	-1.00	-6.93
Turkey	-4.00	-3.36	-3.00	-2.08	-5.00	-4.14	-6.00	-7.24
Ukraine	-6.00	-6.08	-5.00	-5.06	-7.00	-7.06	-5.00	-5.02
United Kingdom	1.00	-6.35	0.00	-5.14	0.00	-7.66	-1.00	-5.77
United States	-8.00	13.89	-5.00	1.76	-6.00	-5.44	-4.00	-8.51

Table 3A Simulated wheat trade changes under CM2-S550 scenario with CO_2 effect

	CM2-S550, CO_2 effect							
	2020 (410 ppm)		2050 (458 ppm)		2080 (498 ppm)		2110 (530 ppm)	
	YieldΔ%	TΔ%	YieldΔ%	TΔ%	YieldΔ%	TΔ%	YieldΔ%	TΔ%
Argentina	3.00	3.37	6.00	6.36	8.00	8.54	7.00	7.19
Australia	-1.00	-1.77	1.00	-1.02	2.00	0.59	2.00	-1.60
Austria	5.00	-3.68	6.00	0.84	8.00	0.28	9.00	2.95
Belgium	5.00	-1.68	6.00	2.03	8.00	2.06	9.00	4.35
Canada	0.00	0.47	4.00	5.87	4.00	5.15	7.00	9.76
China	1.00	7.59	4.00	9.86	8.00	32.07	10.00	33.97
Czech Republic	5.00	12.28	6.00	10.33	8.00	14.47	9.00	14.07
Denmark	5.00	-5.21	6.00	-0.07	8.00	-1.08	9.00	1.89
Egypt	0.00	-0.29	-2.00	2.88	0.00	3.31	0.00	5.34
France	5.00	-8.45	6.00	-2.00	8.00	-3.97	9.00	-0.37
Germany	5.00	-3.09	6.00	1.19	8.00	0.80	9.00	3.36
Hungary	5.00	8.05	6.00	7.81	8.00	10.71	9.00	11.13
India	-4.00	1.33	-7.00	7.15	-7.00	7.78	-10.00	11.99
Iran	0.00	-0.97	-2.00	14.38	0.00	11.13	0.00	17.93
Italy	5.00	-2.23	6.00	1.70	8.00	1.57	9.00	3.96
Kazakhstan	-2.00	-2.82	1.00	0.11	1.00	-0.10	5.00	4.85
Mexico	-6.00	2.60	-4.00	6.32	1.00	4.46	-5.00	10.52
Netherlands	5.00	-0.95	6.00	2.46	8.00	2.71	9.00	4.86
Pakistan	-3.00	2.61	-5.00	11.24	-6.00	13.22	-7.00	18.46
Poland	5.00	8.35	6.00	7.99	8.00	10.98	9.00	11.33
Rest of World	0.75	-3.31	2.55	3.75	-0.55	14.53	2.25	14.27
Russian Federation	-2.00	-2.22	1.00	0.77	1.00	0.71	5.00	4.96
Spain	5.00	-3.51	6.00	0.94	8.00	0.43	9.00	3.07
Turkey	0.00	0.27	3.00	3.14	3.00	2.72	4.00	2.76
Ukraine	-2.00	-2.10	1.00	0.89	1.00	0.87	5.00	4.98
United Kingdom	5.00	-1.84	6.00	1.93	8.00	1.92	9.00	4.23
United States	-3.00	14.89	3.00	2.05	5.00	-6.23	6.00	1.49

Table 4A Simulated wheat trade changes under CM2-S750 scenario with no CO_2 effect

	CM2-S750, no CO_2 effect							
	2020		2050		2080		2110	
	YieldΔ%	TΔ%	YieldΔ%	TΔ%	YieldΔ%	TΔ%	YieldΔ%	TΔ%
Argentina	-1.00	-0.55	-3.00	-2.57	-3.00	-2.33	-5.00	-4.10
Australia	-7.00	-9.25	-10.00	-13.48	-14.00	-19.52	-18.00	-23.51
Austria	0.00	-8.09	-1.00	-10.52	-4.00	-12.07	-11.00	-14.17
Belgium	0.00	-6.23	-1.00	-8.32	-4.00	-10.21	-11.00	-13.43
Canada	-3.00	0.16	-9.00	-12.60	-8.00	-6.50	-14.00	-15.75
China	2.00	37.48	-3.00	16.45	-1.00	39.53	-5.00	35.59
Czech Republic	0.00	6.79	-1.00	6.99	-4.00	2.77	-11.00	-8.34
Denmark	0.00	-9.52	-1.00	-12.20	-4.00	-13.49	-11.00	-14.72
Egypt	-5.00	-4.93	-8.00	-6.79	-13.00	-8.90	-16.00	-12.91
France	0.00	-12.55	-1.00	-15.76	-4.00	-16.51	-11.00	-15.91
Germany	0.00	-7.55	-1.00	-9.88	-4.00	-11.53	-11.00	-13.95
Hungary	0.00	2.85	-1.00	2.35	-4.00	-1.16	-11.00	-9.89
India	-9.00	-3.16	-15.00	-3.23	-20.00	-4.09	-23.00	-8.54
Iran	-5.00	-4.77	-8.00	-3.95	-13.00	0.78	-16.00	-5.64
Italy	0.00	-6.74	-1.00	-8.93	-4.00	-10.72	-11.00	-13.64
Kazakhstan	-7.00	-7.99	-10.00	-11.53	-12.00	-13.47	-14.00	-14.51
Mexico	-10.00	-2.37	-10.00	-5.18	-17.00	-4.84	-22.00	-8.35
Netherlands	0.00	-5.55	-1.00	-7.52	-4.00	-9.53	-11.00	-13.17
Pakistan	-7.00	-2.72	-14.00	0.89	-18.00	0.78	-23.00	-2.18
Poland	0.00	3.12	-1.00	2.68	-4.00	-0.88	-11.00	-9.78
Rest of World	-7.15	1.55	-6.20	-8.55	-9.75	-6.48	-13.00	-12.72
Russian Federation	-7.00	-7.26	-10.00	-10.41	-12.00	-12.39	-14.00	-14.14
Spain	0.00	-7.93	-1.00	-10.33	-4.00	-11.91	-11.00	-14.10
Turkey	-4.00	-3.12	-5.00	-3.30	-8.00	-7.14	-14.00	-15.01
Ukraine	-7.00	-7.12	-10.00	-10.19	-12.00	-12.18	-14.00	-14.06
United Kingdom	0.00	-6.38	-1.00	-8.50	-4.00	-10.36	-11.00	-13.50
United States	-6.00	1.05	-8.00	-0.08	-10.00	-2.85	-15.00	-1.34

Table 5A Simulated wheat trade changes under CM2-S750 scenario with CO_2 effect

	CM2-S750, CO_2 effect							
	2020 (424 ppm)		2050 (501 ppm)		2080 (577 ppm)		2110 (643 ppm)	
	YieldΔ%	TΔ%	YieldΔ%	TΔ%	YieldΔ%	TΔ%	YieldΔ%	TΔ%
Argentina	3.00	3.45	5.00	5.43	9.00	9.67	10.00	10.90
Australia	-3.00	-5.25	-2.00	-5.48	-2.00	-7.52	-3.00	-8.51
Austria	4.00	-4.09	7.00	-2.52	8.00	-0.07	4.00	0.83
Belgium	4.00	-2.23	7.00	-0.32	8.00	1.79	4.00	1.57
Canada	1.00	4.16	-1.00	-4.60	4.00	5.50	1.00	-0.75
China	6.00	41.48	5.00	24.45	11.00	51.53	10.00	50.59
Czech Republic	4.00	10.79	7.00	14.99	8.00	14.77	4.00	6.66
Denmark	4.00	-5.52	7.00	-4.20	8.00	-1.49	4.00	0.28
Egypt	-1.00	-0.93	0.00	1.21	-1.00	3.10	-1.00	2.09
France	4.00	-8.55	7.00	-7.76	8.00	-4.51	4.00	-0.91
Germany	4.00	-3.55	7.00	-1.88	8.00	0.47	4.00	1.05
Hungary	4.00	6.85	7.00	10.35	8.00	10.84	4.00	5.11
India	-5.00	0.84	-7.00	4.77	-8.00	7.91	-8.00	6.46
Iran	-1.00	-0.77	0.00	4.05	-1.00	12.78	-1.00	9.36
Italy	4.00	-2.74	7.00	-0.93	8.00	1.28	4.00	1.36
Kazakhstan	-3.00	-3.99	-2.00	-3.53	0.00	-1.47	1.00	0.49
Mexico	-6.00	1.63	-2.00	2.82	-5.00	7.16	-7.00	6.65
Netherlands	4.00	-1.55	7.00	0.48	8.00	2.47	4.00	1.83
Pakistan	-3.00	1.28	-6.00	8.89	-6.00	12.78	-8.00	12.82
Poland	4.00	7.12	7.00	10.68	8.00	11.12	4.00	5.22
Rest of World	-3.15	5.55	1.80	-0.55	2.25	5.52	2.00	2.28
Russian Federation	-3.00	-3.26	-2.00	-2.41	0.00	-0.39	1.00	0.86
Spain	4.00	-3.93	7.00	-2.33	8.00	0.09	4.00	0.90
Turkey	0.00	0.88	3.00	4.70	4.00	4.86	1.00	-0.01
Ukraine	-3.00	-3.12	-2.00	-2.19	0.00	-0.18	1.00	0.94
United Kingdom	4.00	-2.38	7.00	-0.50	8.00	1.64	4.00	1.50
United States	-2.00	5.05	0.00	7.92	2.00	9.15	0.00	13.66