Effects of Trends in Chinese Production, Consumption, and Price Support Policies on World Grain Price Volatility and Food Security (Incomplete Working Draft)

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1 Objective

In this paper, we develop a structural dynamic stochastic simulation model of the world market for a generic storable food commodity and use it to explore how global commodity price volatility and general food security will be affected by recent and anticipated future changes in Chinese commodity trade and price support policies and trends in Chinese agricultural production and consumption. Our analysis will focus on two major commodities, wheat and corn.

2 Introduction

With the world population surpassing seven billion in 2012, food security is once again emerging as a major issue in development economics. Producing adequate supplies of food at a reasonable price is an important issue to everyone, especially those in poverty. The world's poor spend as much as 40 percent of their income on staple foods and large food price increases, such as those experienced during the recent World Food Price Crisis, have been a severe blow to their purchasing power (FAO, 2011). The World Food Price Crisis also has also created difficulties for many governments, leading to financial crisis and social unrest (Lagi et al, 2011).

The World Food Price Crisis in 2007-8 caught most countries unprepared. As shown in Figure 1, the price of wheat started to rise rapidly since May 2007 from near $200/ton and reached a peak of $440/ton in March 2008. The price of corn reach $287/ton in June 2008, nearly double its price the preceding year. The sudden price increases particularly hurt the poor in developing countries. The Food and Agriculture Organization of the United Nations (FAO) estimates that, as a result of high food prices, the number of chronically hungry people in the world rose by 75 million in 2007 to reach 923 million (FAO, 2008).

Governments responded to the food crisis through a number of measures. As of January 2008, 25 countries around the world, including some of major grain exporters such as India, Vietnam and Pakistan, restricted or banned grain exports. These restrictions stimulated panic buying by some large importers. Forty-three countries, including Indonesia, Nigeria

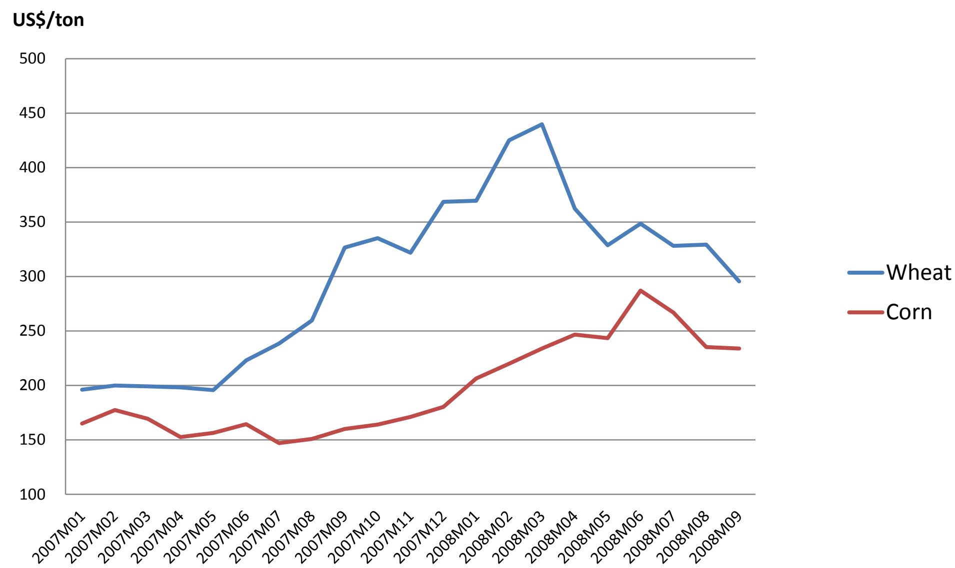

Figure 1: World Corn and Wheat Prices, 2007-2008

and Iran, reduced or eliminated tariffs or custom fees to encourage grain imports. Thirty-five countries released stocks from government stockpiles to moderate domestic grain prices. Twenty-three countries suspended or reduced taxes on grain production to encourage domestic grain supply. Twenty-one countries implemented administrative grain price control or restricted private grain trade to stabilize grain prices (FAO, 2009).

China, however, was not heavily affected by the 2007-8 world food price spikes. When the benchmark international price for rice tripled between May 2007 and May 2008, the nominal domestic price of rice in China rose by only 9% for japonica and 12% for indica rice. China also escaped serious wheat and maize price increases. Between 2006 and 2008, the domestic wheat and maize prices in China rose by 17% and 23%, respectively, as compared to 73% and and 34% increases internationally (Fang, 2010).

Chinese historical policies of grain self-sufficiency, maintenance of large buffer stocks, and insulation from world markets all have contributed to stable domestic food price in China during the 2007-8 World Food Price Crisis. China has consistently kept grain stocks proportionately much larger than the rest of the world in order to insure against domestic shortages. Most wheat and corn consumed in China has historically been supplied by domestic production, with quantities traded on the world market accounting for only a small proportion of Chinas production and consumption, insulating the domestic corn and wheat markets from the volatile global market (Lilliston, 2012). For most years before 2009, the amount of wheat and corn imported by China was less than 1% of its annual domestic production. Though China is growing into a larger importer of wheat and corn after 2009, the amount is still less than 5% of its annual production. China exported some corn and wheat in the early 2000s, but the amounts in recent five years have been negligible.

However, Chinese agricultural production and consumption have been experiencing major changes in recent years. Rising living standards and increased urbanization rate has led to increasing per capita meat consumption, particularly for pork and poultry, which has led, in turn, increased demand for grains and oilseeds as Chinas livestock farms continue their transition to more concentrated mode of operations that use commercial feeds more intensively (Hansen and Gale 2014, see Figures 2 and 3). USDA projects that China may accounts for as much as 40 percent of the rise in global corn trade over the next decade and the leading importer by 2022/23 (USDA 2014).

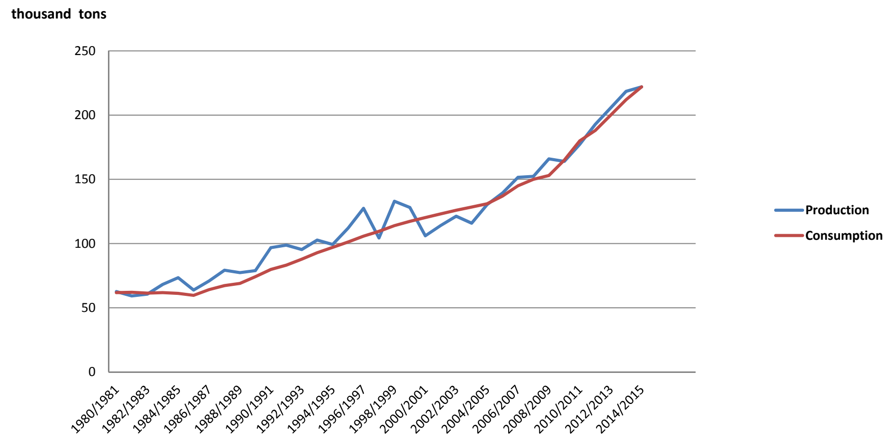

Figure 2: China Corn Production and Consumption

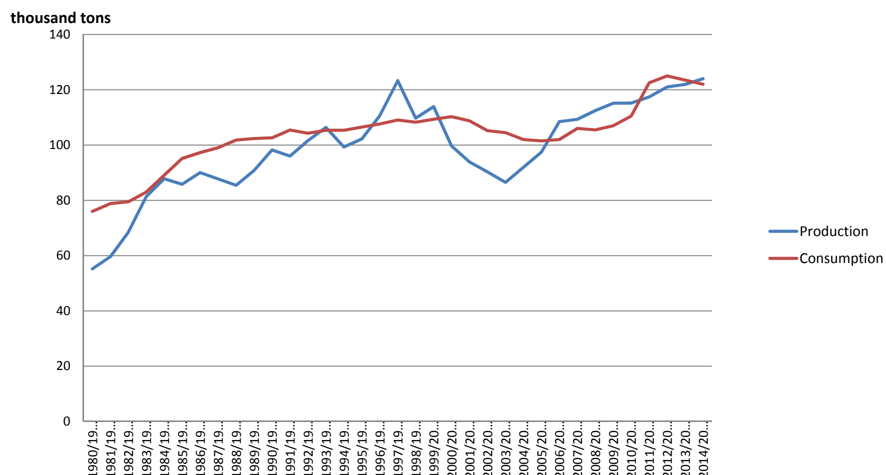

Figure 3: China Wheat Production and Consumption

Chinese agricultural support policies have also undergone major changes in recent years. Starting in 2004, after decades of taxing agricultural production, China began to subsidize agriculture production in order to address rural poverty, concerns about food security, and increasing demand by a growing and more affluent urban population. Agricultural subsidies reached a total of \$73 billion in 2012, accounting for 9% of the value of agricultural output, and are expected to continue to rise. Price floors for wheat and rice were introduced in 2004 and maintained by the buying and selling of government reserves. Failure to keep pace with rising production costs (largely due to rising off-farm wages) has placed increasing pressure on government officials to raise price supports even further. Between 2008 and 2013, government price supports rose between 60-70% for corn and wheat, and more so for different types of rice (See Figures 4 and 5). The Chinese government's 5-year plan for 2011-15 and central authorities 2013 Number 1 Document, called for steady increases in agricultural price supports. Support levels are now approaching those of developed countries, prompting calls for increased scrutiny of Chinese agricultural policies among China's World Trade Organization trading partners (Gale 2013). Increases in support prices have caused market prices for major farm commodities in China to rise above world levels, attracting a surge in imports. The U.S. has been one of the major beneficiaries, seeing the value of its exports to China triple between 2007-12, reaching nearly $16 billion in 2012 (See Figures 6 and 7).

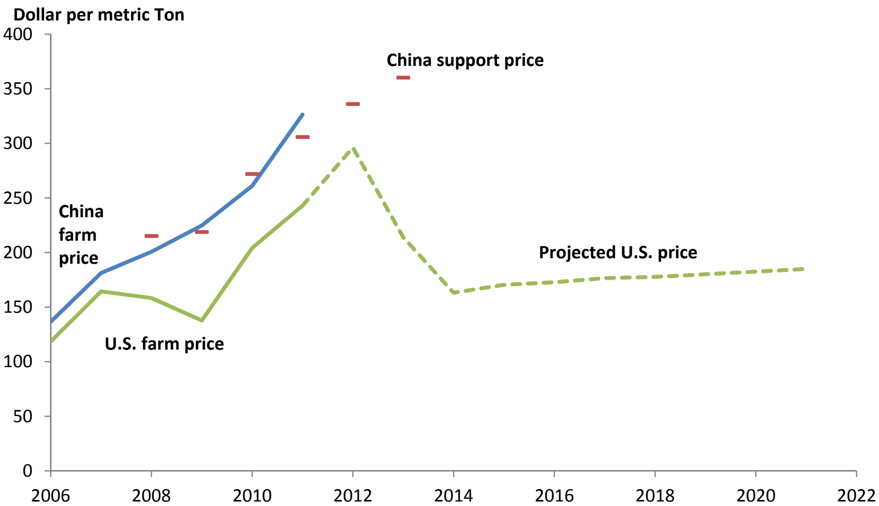

Figure 4: China Corn Prices and Price Supports

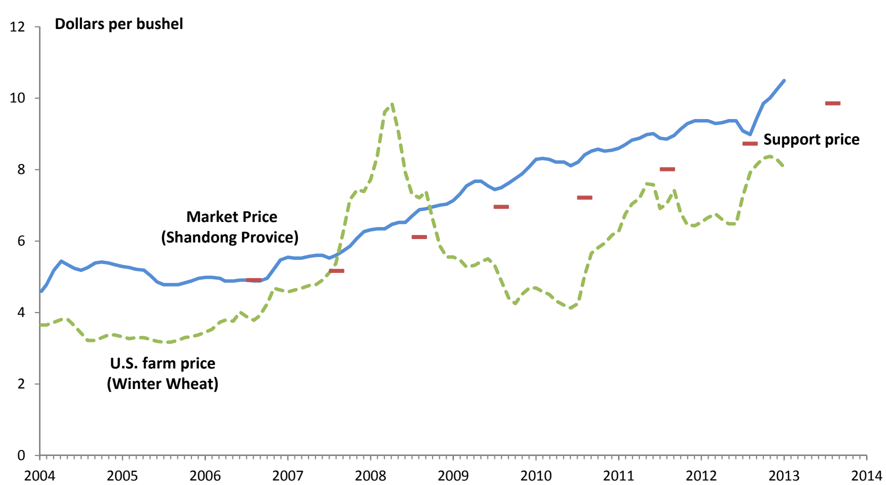

Figure 5: China Wheat Prices and Price Supports

It is natural to ask how trends in Chinese production and consumption of basic food commodities, recent changes in Chinese agricultural price support and buffer stock policy, and China's increasing integration with global food commodity markets through expanded trade, will affect international commodity flows and global food price levels and price stability over the coming decades. Chinas integration into the world grain market might increase world price volatility because of the significant increase in demand, aggressive government price support policies, and increased reliance in imports; alternatively, China could become as a stabilizing force by maintaining large buffer stocks that could meet unanticipated surges in

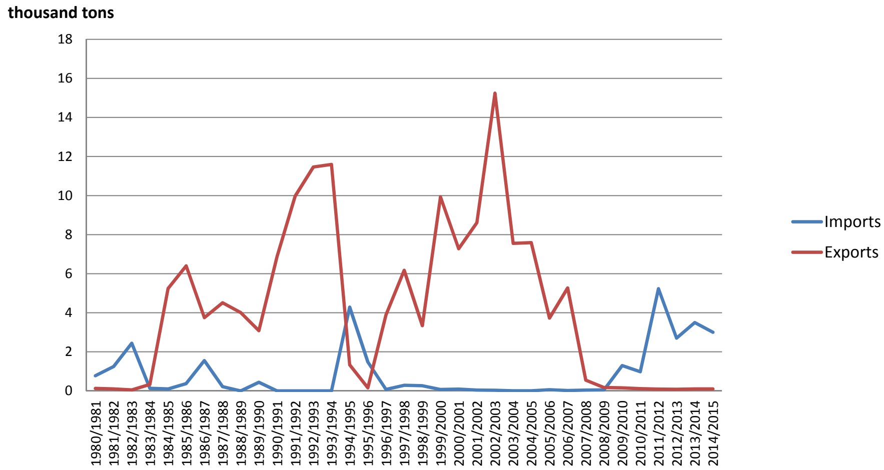

Figure 6: China Corn Trade

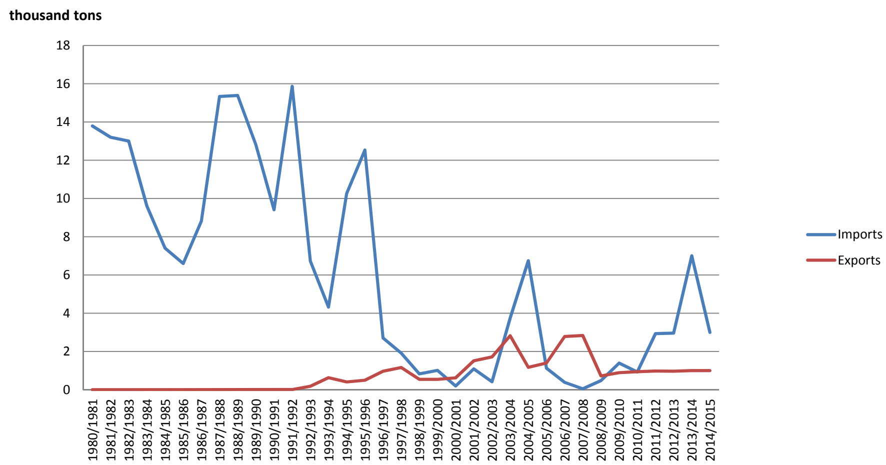

Figure 7: China Wheat Trade

world prices. The purpose of this paper is to examine the various possibilities for China's impact on global commodity markets. To this end, we develop a structural dynamic stochastic simulation model of the world market for a generic storable food commodity, with China as the centerpiece, and use it to explore how global commodity price volatility and general food security will be affected by changes in Chinese commodity trade and price support policies and trends in Chinese agricultural production and consumption. Our analysis will focus on two major commodities, wheat and corn .

3 Global Commodity Market Model

Consider a generic storable food commodity that is produced and consumed in two distinct markets: China (c) and the Rest of the World or simply World (w). Absent restrictive trade policies, the commodity may flow from one market to the other in response to price differentials that exceed transportation costs. Storage in the World market is undertaken by expected-profit-maximizing private storers who store whenever the expected interseasonal spread in the world price is sufficient to cover carrying charges. Storage in China is undertaken exclusively by a government stockpiling authority that buys and sells at a prescribed support price.

Each period begins with a predetermined amount S_i of the commodity available in each

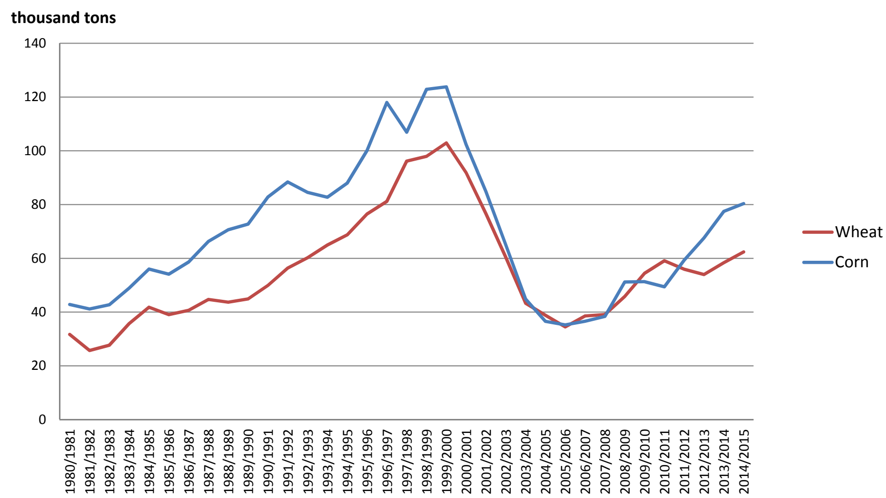

Figure 8: China Estimated Corn and Wheat Ending Stocks

market $i \in \{\text{c,w}\}$. Availability in each market may be supplemented by imports or depleted by exports, but, net of imports and exports, must either be consumed or stored. Material balance in the both markets thus requires that

$$S_c + X_w = C_c + Z_c + X_c \tag{1}$$
$$S_w + X_c = C_w + Z_w + X_w. \tag{2}$$

Here, C_i and Z_i, respectively, denote consumption and ending stocks in market i, and X_i denote exports from market i to the other market.

The amount C_i consumed in market i is a strictly decreasing constant-elasticity function of the price P_i in market i:

$$C_c = \alpha_c P_c^{-\beta_c} \tag{3}$$
$$C_w = \alpha_w P_w^{-\beta_w} \tag{4}$$

Here, the β_i are the price elasticities of demand and the α_i are scale factors.

Trade is driven by inter-market arbitrage profit opportunities, leading to the enforcement of the following spatial equilibrium complementarity conditions:

$$0 \leq X_c \leq \bar{X}_c \perp P_w - P_c - \tau_c \tag{5}$$
$$0 \leq X_w \leq \bar{X}_w \perp P_c - P_w - \tau_w. \tag{6}$$

Here, $\bar{X}_i$ denotes maximum export capacity in market i and τ_i denotes the constant unit cost of exporting from market i to the other market[1]

Storage in China is undertaken by a government stockpiling authority that is prepared to buy and sell at a prescribed support price, subject to storage capacity constraints. This leads to the enforcement of the following equilibrium complementarity conditions:

$$0 \leq Z_c \leq \bar{Z}_c \perp \bar{P}_c - P_c. \tag{7}$$

[1] The notation $a \leq x \leq b \perp f(x)$ indicates a complementarity condition whose solution x must simultaneously satisfy $a \leq x \leq b$, $f(x) < 0 \implies x = a$, and $f(x) > 0 \implies x = b$. In economic applications, $f(x)$ typically indicates the marginal profit from an activity x. In equilibrium the marginal profit may be negative only if x is constrained at its lower bound and may be positive only if x is constrained at its upper bound.

Here, $\bar{Z}_c$ denotes storage capacity in China and $\bar{P}_c$ denotes the price at which the Chinese stockpiling authority in China is willing to buy and sell the commodity.

Storage in the Rest of the World is undertaken by expected-profit-maximizing storers, leading to the following intertemporal equilibrium complementarity condition:

$$0 \leq Z_w \leq \bar{Z}_w \perp \delta E P'_w - P_w - K. \tag{8}$$

Here, $\bar{Z}_w$ denotes the rest of the World's maximum storage capacity, δ is the per-period discount factor, EP'_w is the world price expected the following period, and K denotes the unit cost of storage, which is assumed constant.

Farmers decide how much acreage A_i to cultivate based on the output price expected next period:

$$A_c = \theta_c \left[EP'_c\right]^{\phi_c} \tag{9}$$

$$A_w = \theta_w \left[EP'_w\right]^{\phi_w}. \tag{10}$$

Here, the ϕ_i are the expected price elasticities of acreage and the θ_i are scale factors.

The amount S'_i of the commodity that will be available in market i at the beginning of the following period is the sum of ending stocks this period Z_i plus new production, which is the product of acreage A_i and a random per acre yield $\tilde{Y}_i$ whose precise value is unknown at planting:

$$S'_c = Z_c + A_c \tilde{Y}_c \tag{11}$$

$$S'_w = Z_w + A_w \tilde{Y}_w. \tag{12}$$

We assume that yields are lognormally distributed, time-stationary, and independent across markets and time. For each market i, we denote expected yield by $\bar{Y}_i$ and the yield volatility (i.e., coefficient of variation) by σ_i.

Under the aforementioned assumptions, equilibrium in any period is characterized by two prices, two consumption levels, two storage levels, two export flows, and two acreage levels. Given the predetermined availabilities S_i, the ten variables are determined by the ten mixed-complementarity conditions (1)-(10). It follows that the market equilibrium prices are functions of the predetermined availabilities

$$P_i = f_i(S_c, S_w). \tag{13}$$

The price functions f are known to exist and to be unique because it must satisfy a strong contraction in the complete metric space of bounded continuous functions (Miranda and Fackler). Unfortunately, the unique equilibrium price functions are not known a priori and cannot derived analytically. They can, however, be computed numerically to any desired degree of accuracy using numerical methods.

To understand how the rational equilibrium price functions f may be derived, consider the following. Begin with guesses $f_i^{(0)}$ as to what the equilibrium price functions might be. Given these provisional guesses for the equilibrium price functions, it is possible in principle to solve equilibrium conditions (1)-(10) to compute the equilibrium prices for any set of availabilities S_i, allowing us to derive updates $f_i^{(1)}$ for the equilibrium functions. It is then possible to repeat the process to obtain updated guesses $f_i^{(2)}$ for the equilibrium price functions. The process may be repeated indefinitely until the sequence of iterates converge to the true equilibrium price functions f_i. Convergence is guaranteed by the same Contraction Mapping Theorem that is used to establish the existence and uniqueness of f_i. Although the equilibrium price functions f_i do not possess a known closed-form expressions, they may be computed to any desired degree of accuracy using standard projection methods. In particular, we construct finite-dimensional approximations

$$f_i(A_c, A_w) \approx \sum_{j=1,2,\dots,n} c_{ij}\phi_j(Z_c, Z_w)$$

where c_{ij} are a set of coefficients to be determined and ϕ_j are basis functions selected by the analyst. For our purposes here, we use a tensor product Chebyshev basis, 21 per dimension, for a total of 441 basis-polynomials (Miranda and Fackler).

4 Model Simulations

Our base-case parametric assumptions are given in Tables 2 and **??**. Price and quantities are normalized so that the certainty-equivalent price and expected annual global production both equal 1. The consumption scale parameters α_i and planned production scale parameters ϕ_i are normalized so that aggregate consumption and planned production are 1. China supply and demand elasticities drawn from Zhuang and Abbott (2007). Storage capacity in each region is assumed to be 1.5 times the maximum historical storage (based on data from USDA since 1960). We assume that exports are constraint only by production. We assume a per-period discount factor δ of 0.95.

Table 1: Wheat Base-Case Parameter Values

Symbol	Description	China	ROW
ϕ	Acreage Supply Elasticity	0.32	0.10
β	Consumption Demand Elasticity	0.24	0.20
α	Proportion of World Consumption	0.17	0.83
θ	Proportion of World Production	0.17	0.83
$\bar{Z}$	Storage Capacity	0.22	0.32
σ	Production Volatility	0.18	0.08
τ	Export Unit Cost	0.23	0.23
K	Storage Unit Cost	N.A.	0.03
$\bar{P}$	Support Price	1.06	N.A.

Table 2: Corn Base-Case Parameter Values

Symbol	Description	China	ROW
ϕ	Acreage Supply Elasticity	0.28	0.10
β	Consumption Demand Elasticity	0.32	0.20
α	Proportion of World Consumption	0.23	0.77
θ	Proportion of World Production	0.225	0.775
$\bar{Z}$	Storage Capacity	0.19	0.23
σ	Production Volatility	0.28	0.24
τ	Export Unit Cost	0.30	0.30
K	Storage Unit Cost	N.A.	0.04
$\bar{P}$	Support Price	1.06	N.A.

To understand the effects of Chinese agricultural policy and trends in consumption demand, we solve the model under ten different scenarios (for each corn and wheat), resulting from two different assumptions about consumption demand and five storage policy rules. In the High demand scenarios, we assume that consumption demand in China grows by 20% relative to the baseline values in Tables 2 and **??**, which we refer to as Low Demand. The five policy rules are defined in terms of the support price and the storage capacity. In scenarios of Low Support, the government sets the support price at 1.06, as opposed to 1.20 in High Support cases.

On the other hand, with limited accumulation, the government can stored up to the storage limits specified in Tables 2 and **??**, and it is willing to sell grain at the specified support price. Otherwise, with unlimited accumulation, the government buys grain at the support price but does not release it at any price, effectively hoarding the grain. The baseline case assumes no storage from the government. For each of these scenarios, we ran two alternative Monte Carlo simulations to approximate the short-term and long-term mean and standard deviation of consumption, net exports, prices, production, and storage levels in World and in China.

In the first case, the model is simulated once for an horizon of 10^5 periods, starting from an arbitrary state. We use this simulation to approximate the long term ergodic distribution of the process. The results are summarized in Tables 3 and 4 (5 and 6) for corn (wheat). In each case, the table compares the means and volatilities of the variables of interest under the five different storage rules; the first (second) table for each grain presents Low demand (High demand) scenarios. Notice that in scenarios with Unlimited accumulation, China's simulated storage *level* is not stationary: for these scenarios, the reported statistics for China refer to the one-period *accumulation* of stocks.

Furthermore, Figures 19 (corn) and 30 (wheat) show the relationship between the price of grain World and China. In these figure, each point represents one realization of the Monte Carlo simulation, and darker regions indicate higher frequency of the realized prices.

To gain insight on the short term implications of changes in China's grain market, in the second set of simulations we consider conditional forecasts of the model. In this exercise, we set the level of availability at time $t = 0$ at its *baseline* ergodic mean, that is, to the mean availability of the No support, no storage, low demand scenario. We further assume that at time $t = 0$ a permanent and unexpected change of scenario occurs. We then simulate the model for the next $t = 10$ years; this is repeated for 10^5 independent replications. For each time t from 0 to 10, the mean and standard deviation is computed. The results are shown in Figures 9 to 18 for corn and 20 to 29 for wheat.

4.1 Summary of Corn Model Simulations

sec:corn

Relative to the baseline, in the long-run,

- Volatility in World price increases due to higher consumption demand in China, but it's actually reduced by storage policy in China.
- Despite reducing the World price volatility, a high-support unlimited storage rule would result in a 16% increase in mean World Price: World would export 5% of its production to China (compared to negligible trade in baseline), while its private stock levels (relative to production) would fall from 29% to 20%. The higher long-term price induces a 2% increase in World production (compared to 6% increase in China's production).
- a 20% increase in China's demand for corn would cause a 10% increase in the World long-run price.
- The increase would be 20% if on top of the demand increase, the Chinese government sets a high support price with unlimited accumulation. But since supply elasticity are small, the increase in global (world + china) production would be only 3.8%.

Relative to the baseline, in the short-run,

- With unlimited accumulation, stock level in China would reach nearly 60% of Global production in just six years! (fig 17)

Variable	Mean		Standard deviation	
	R. World	China	R. World	China
No support price, no accumulation				
Consumption	0.778	0.231	0.061	0.032
Net Exports	-0.001	0.001	0.050	0.050
Price	1.060	1.114	0.596	0.555
Production	0.777	0.231	0.190	0.067
Storage	0.226	0.000	0.169	0.000
Low support price, unlimited accumulation				
Consumption	0.761	0.218	0.047	0.016
Net Exports	0.022	-0.022	0.070	0.070
Price	1.145	1.231	0.568	0.485
Production	0.784	0.238	0.191	0.068
Storage	0.203	0.042	0.146	0.078
Low support price, limited accumulation				
Consumption	0.777	0.230	0.055	0.027
Net Exports	-0.001	0.001	0.058	0.058
Price	1.048	1.095	0.557	0.481
Production	0.777	0.230	0.190	0.067
Storage	0.149	0.113	0.148	0.070
High support price, unlimited accumulation				
Consumption	0.749	0.211	0.042	0.014
Net Exports	0.040	-0.040	0.097	0.097
Price	1.226	1.346	0.564	0.472
Production	0.789	0.244	0.192	0.070
Storage	0.160	0.073	0.104	0.106
High support price, limited accumulation				
Consumption	0.779	0.228	0.054	0.029
Net Exports	-0.003	0.003	0.062	0.062
Price	1.030	1.118	0.529	0.461
Production	0.776	0.231	0.190	0.067
Storage	0.141	0.135	0.154	0.064

Note: In scenarios with Unlimited accumulation, China's simulated storage *level* is not stationary: China's statistics refer to one-period *accumulation* of stocks in these scenarios.

Table 3: Corn simulations: Low consumption demand in China

Variable	Mean		Standard deviation	
	R. World	China	R. World	China
		No support price, no accumulation		
Consumption	0.763	0.261	0.058	0.035
Net Exports	0.021	-0.021	0.054	0.054
Price	1.165	1.320	0.656	0.633
Production	0.784	0.241	0.191	0.069
Storage	0.228	0.000	0.167	0.000
		Low support price, unlimited accumulation		
Consumption	0.755	0.251	0.048	0.020
Net Exports	0.032	-0.032	0.061	0.061
Price	1.205	1.405	0.636	0.560
Production	0.786	0.245	0.192	0.070
Storage	0.226	0.025	0.164	0.057
		Low support price, limited accumulation		
Consumption	0.763	0.260	0.054	0.026
Net Exports	0.021	-0.021	0.056	0.056
Price	1.158	1.299	0.644	0.583
Production	0.783	0.239	0.191	0.069
Storage	0.200	0.056	0.150	0.070
		High support price, unlimited accumulation		
Consumption	0.745	0.247	0.044	0.017
Net Exports	0.046	-0.046	0.087	0.087
Price	1.269	1.468	0.631	0.551
Production	0.791	0.247	0.193	0.071
Storage	0.192	0.047	0.124	0.088
		High support price, limited accumulation		
Consumption	0.761	0.261	0.053	0.028
Net Exports	0.023	-0.023	0.066	0.066
Price	1.164	1.287	0.632	0.571
Production	0.784	0.238	0.191	0.069
Storage	0.167	0.097	0.139	0.077

Note: In scenarios with Unlimited accumulation, China's simulated storage *level* is not stationary: China's statistics refer to one-period *accumulation* of stocks in these scenarios.

Table 4: Corn simulations: High consumption demand in China

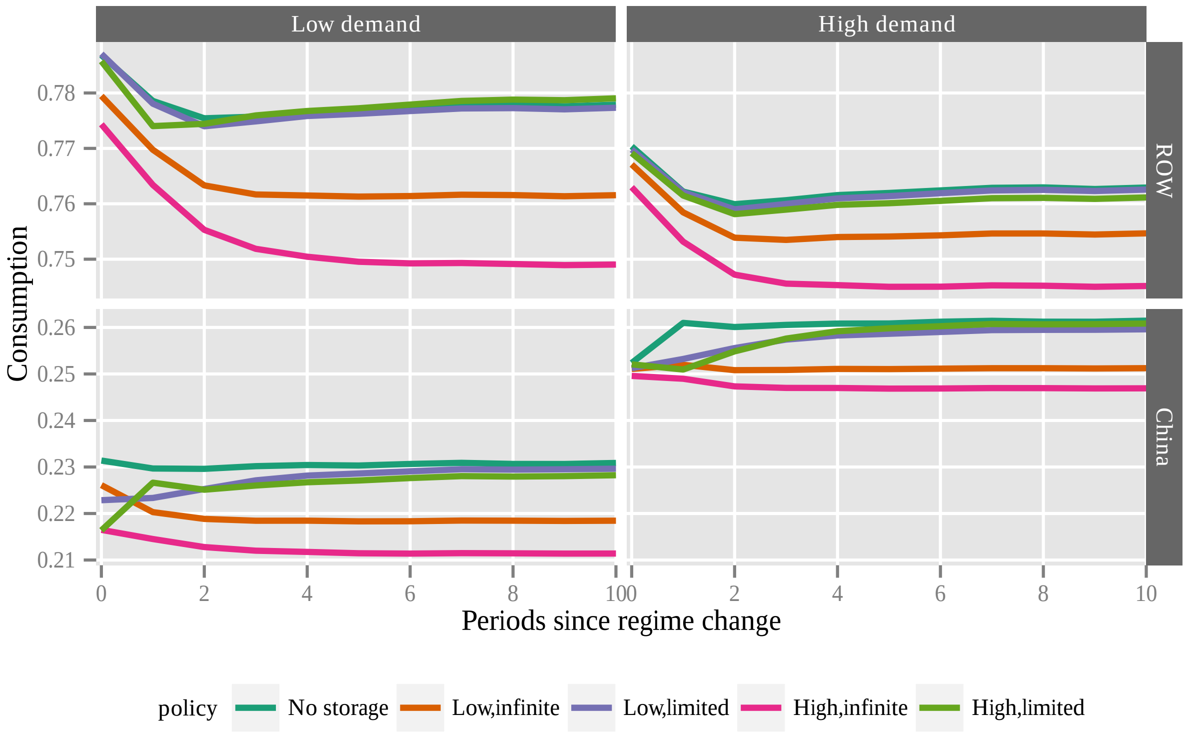

Figure 9: Corn consumption forecast: Mean

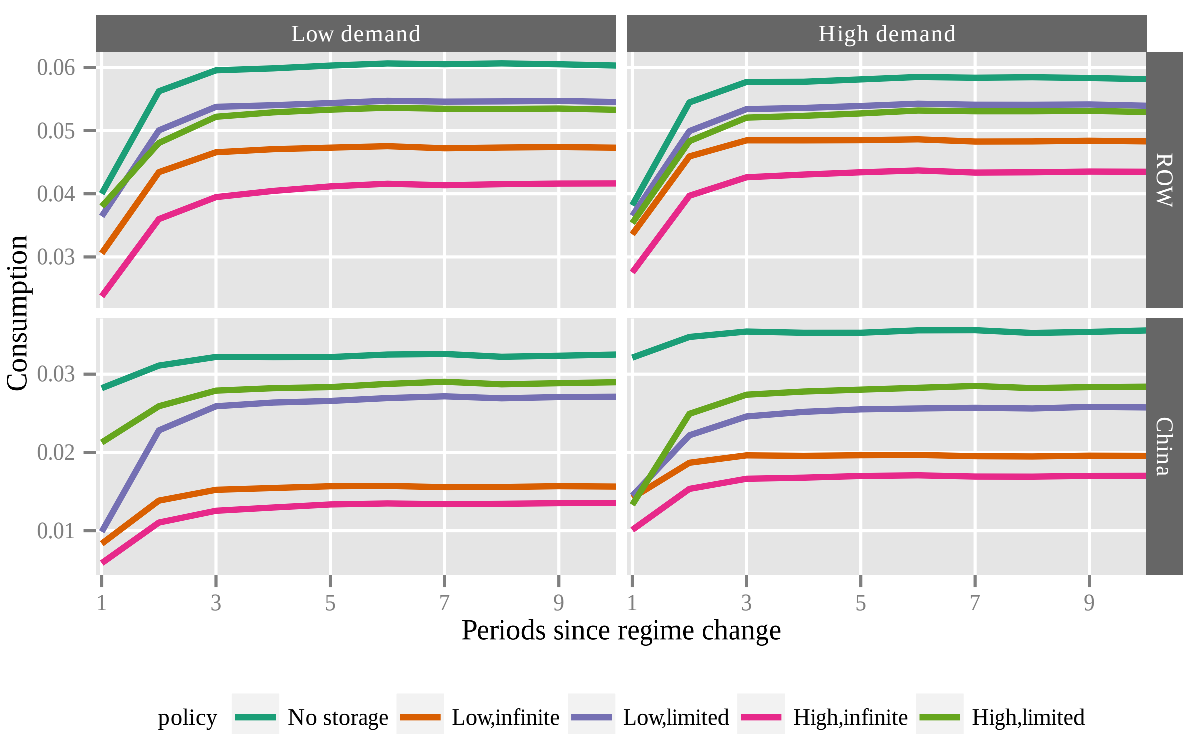

Figure 10: Corn consumption forecast: Standard deviation

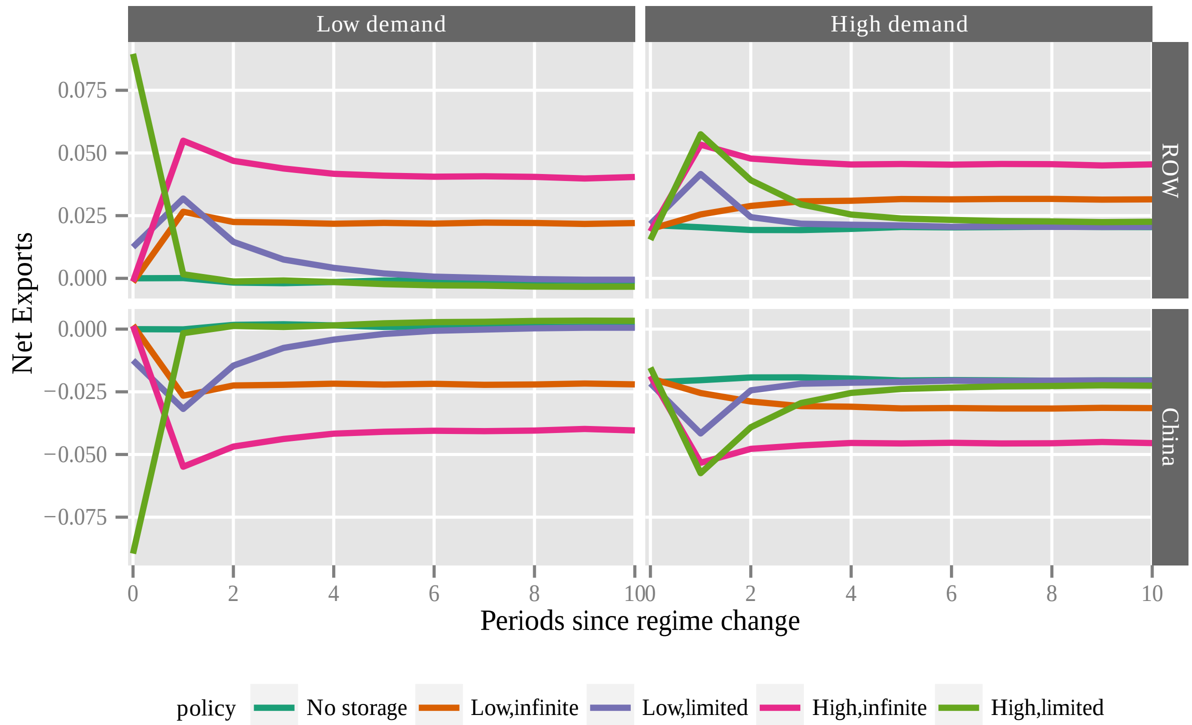

Figure 11: Corn net exports forecast: Mean

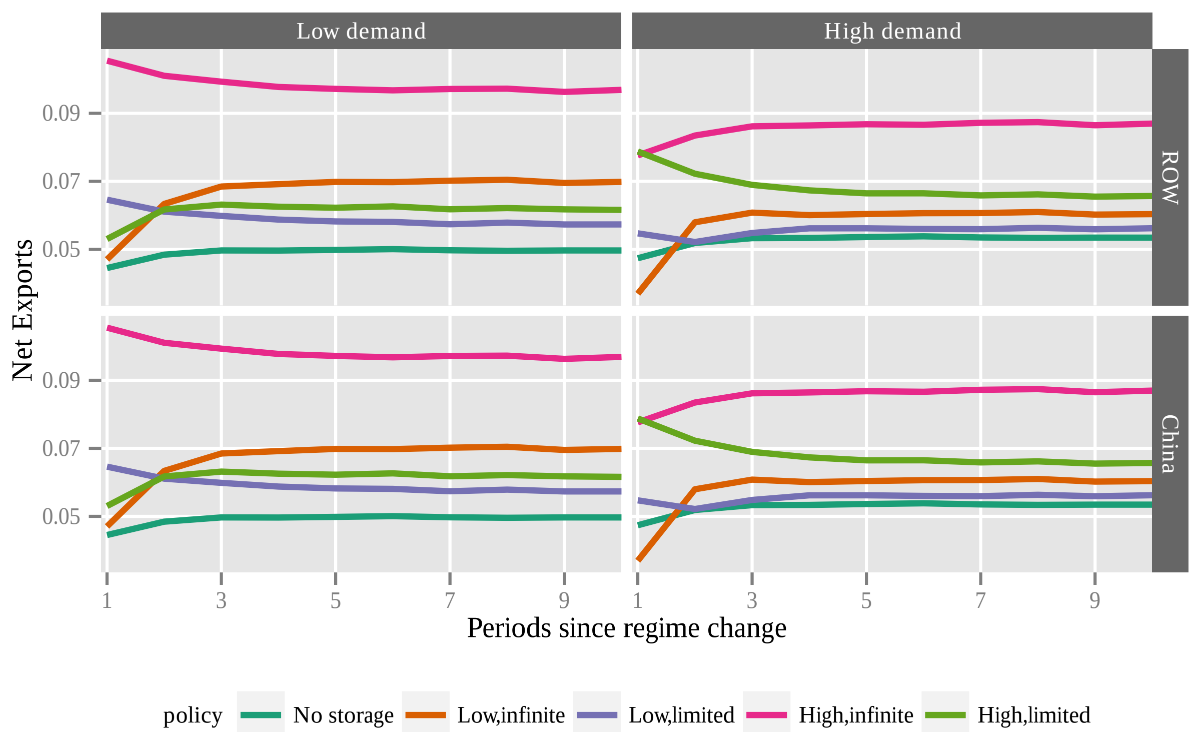

Figure 12: Corn net exports forecast: Standard deviation

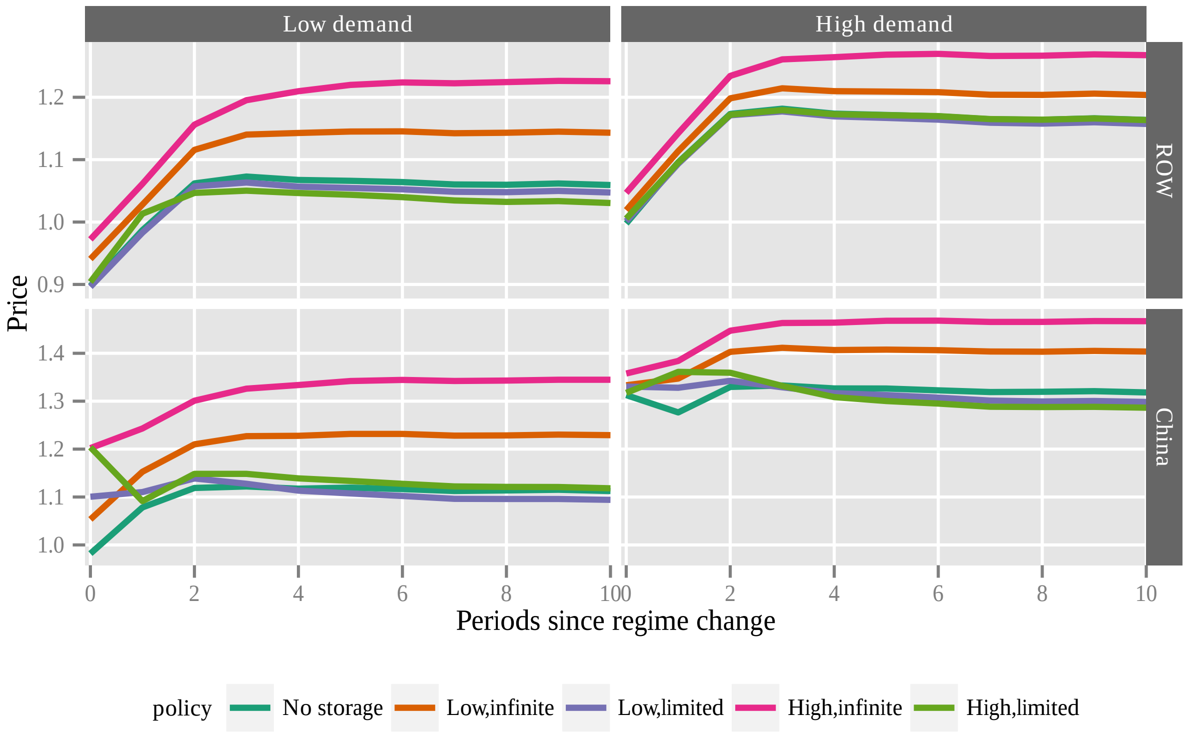

Figure 13: Corn price forecast: Mean

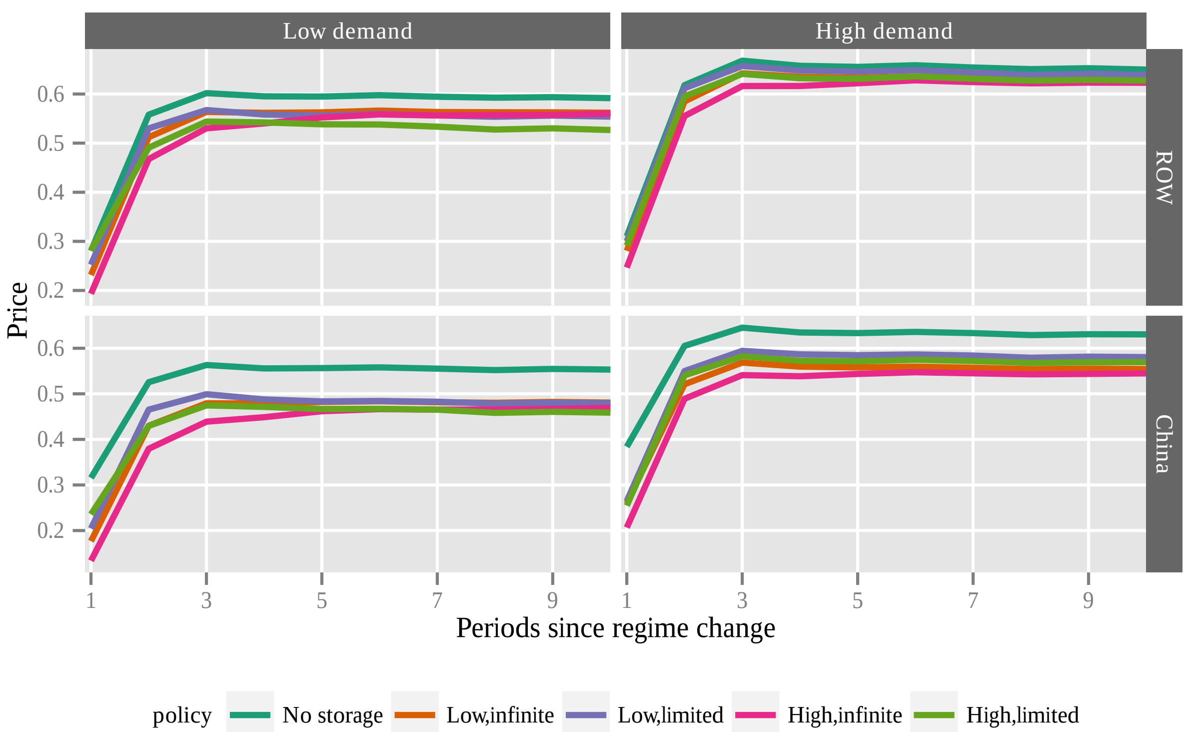

Figure 14: Corn price forecast: Standard deviation

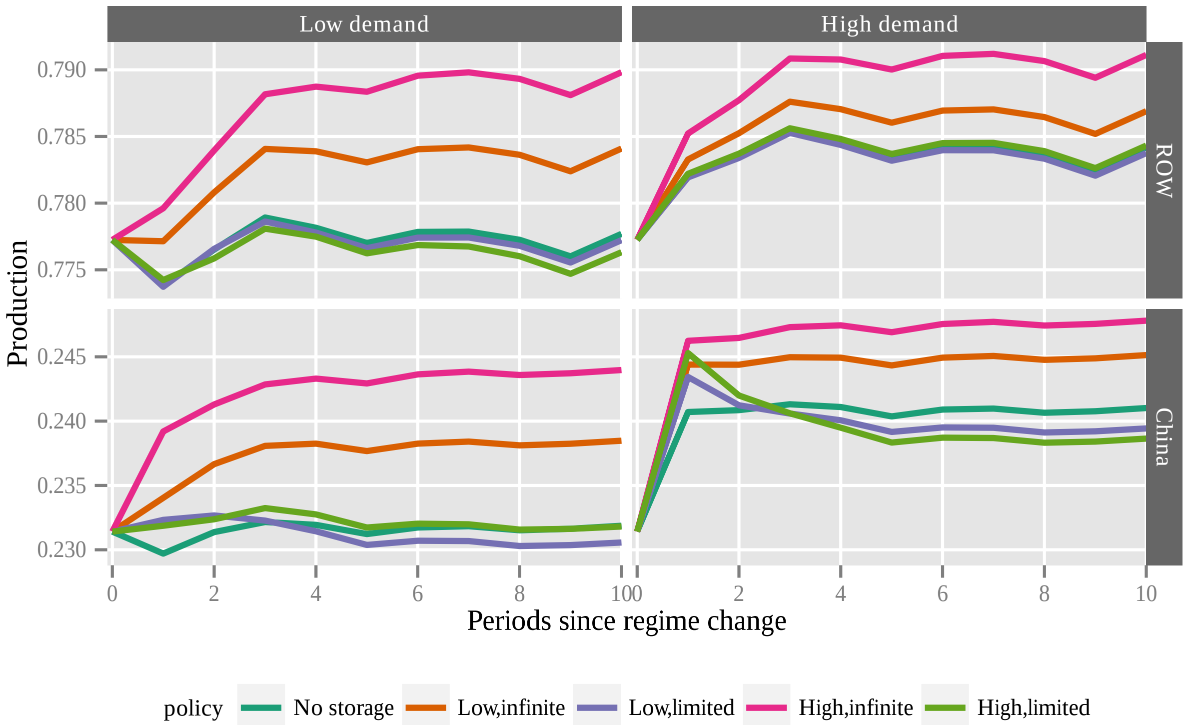

Figure 15: Corn production forecast: Mean

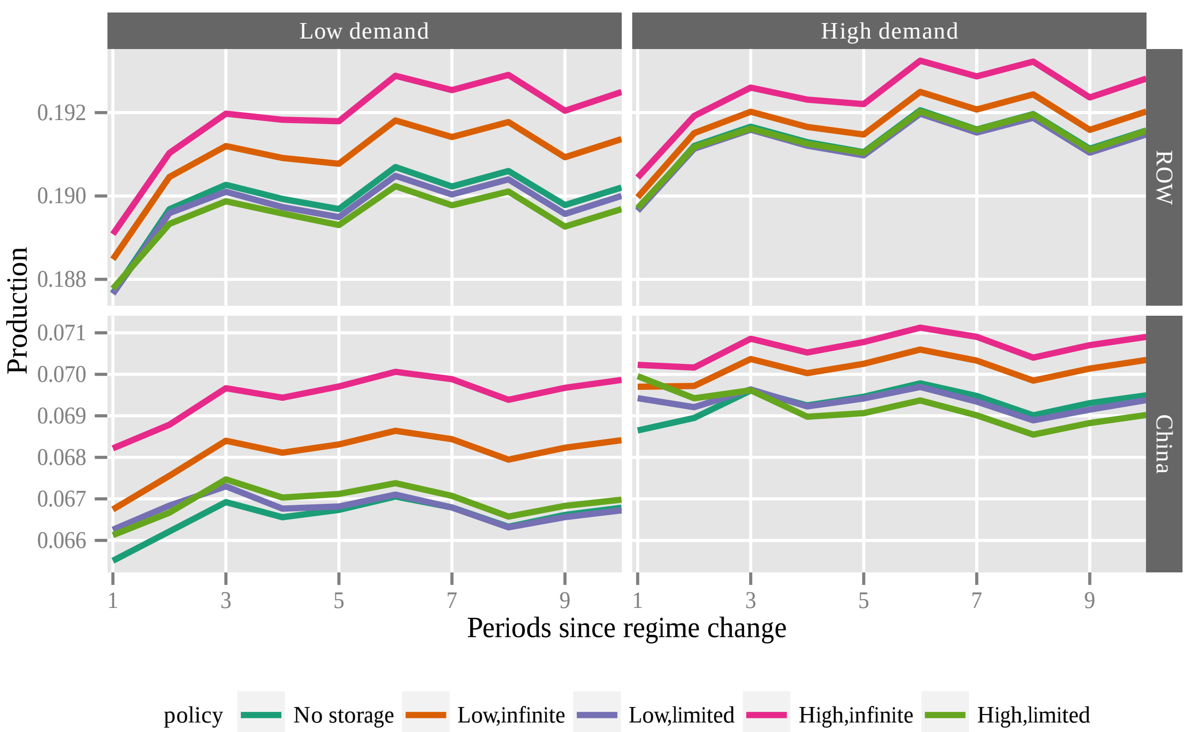

Figure 16: Corn production forecast: Standard deviation

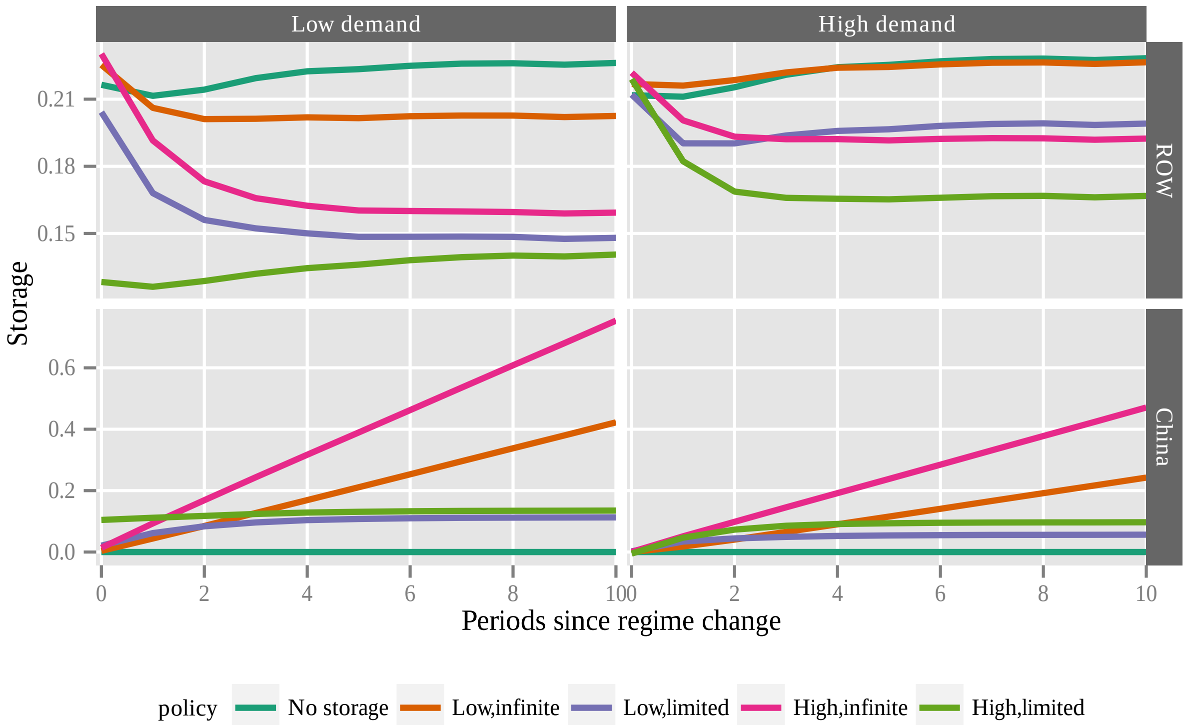

Figure 17: Corn storage forecast: Mean

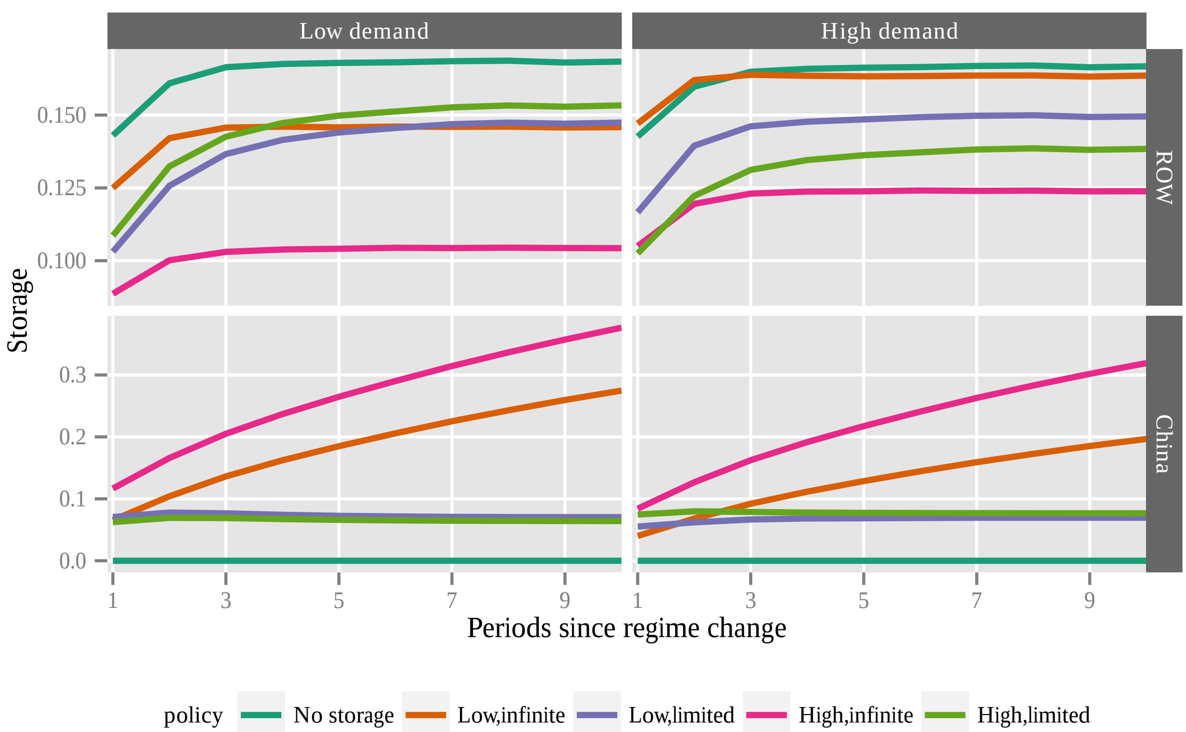

Figure 18: Corn storage forecast: Standard deviation

4.2 Summary of Wheat Model Simulations

sec:wheat

Variable	Mean		Standard deviation	
	R. World	China	R. World	China
No support price, no accumulation				
Consumption	0.833	0.170	0.034	0.011
Net Exports	-0.002	0.002	0.024	0.024
Price	1.010	1.046	0.258	0.274
Production	0.831	0.172	0.067	0.031
Storage	0.043	0.000	0.049	0.000
Low support price, unlimited accumulation				
Consumption	0.828	0.165	0.031	0.005
Net Exports	0.006	-0.006	0.021	0.021
Price	1.040	1.140	0.243	0.199
Production	0.833	0.177	0.067	0.032
Storage	0.033	0.018	0.040	0.027
Low support price, limited accumulation				
Consumption	0.834	0.169	0.027	0.007
Net Exports	-0.004	0.004	0.024	0.024
Price	0.996	1.049	0.191	0.159
Production	0.830	0.173	0.067	0.032
Storage	0.027	0.074	0.038	0.049
High support price, unlimited accumulation				
Consumption	0.821	0.161	0.028	0.003
Net Exports	0.017	-0.017	0.040	0.040
Price	1.080	1.245	0.227	0.145
Production	0.837	0.182	0.067	0.033
Storage	0.021	0.038	0.015	0.046
High support price, limited accumulation				
Consumption	0.833	0.169	0.027	0.009
Net Exports	-0.004	0.004	0.028	0.028
Price	0.997	1.050	0.184	0.181
Production	0.830	0.173	0.067	0.032
Storage	0.028	0.115	0.042	0.035

Note: In scenarios with Unlimited accumulation, China's simulated storage *level* is not stationary: China's statistics refer to one-period *accumulation* of stocks in these scenarios.

Table 5: Wheat simulations: Low consumption demand in China

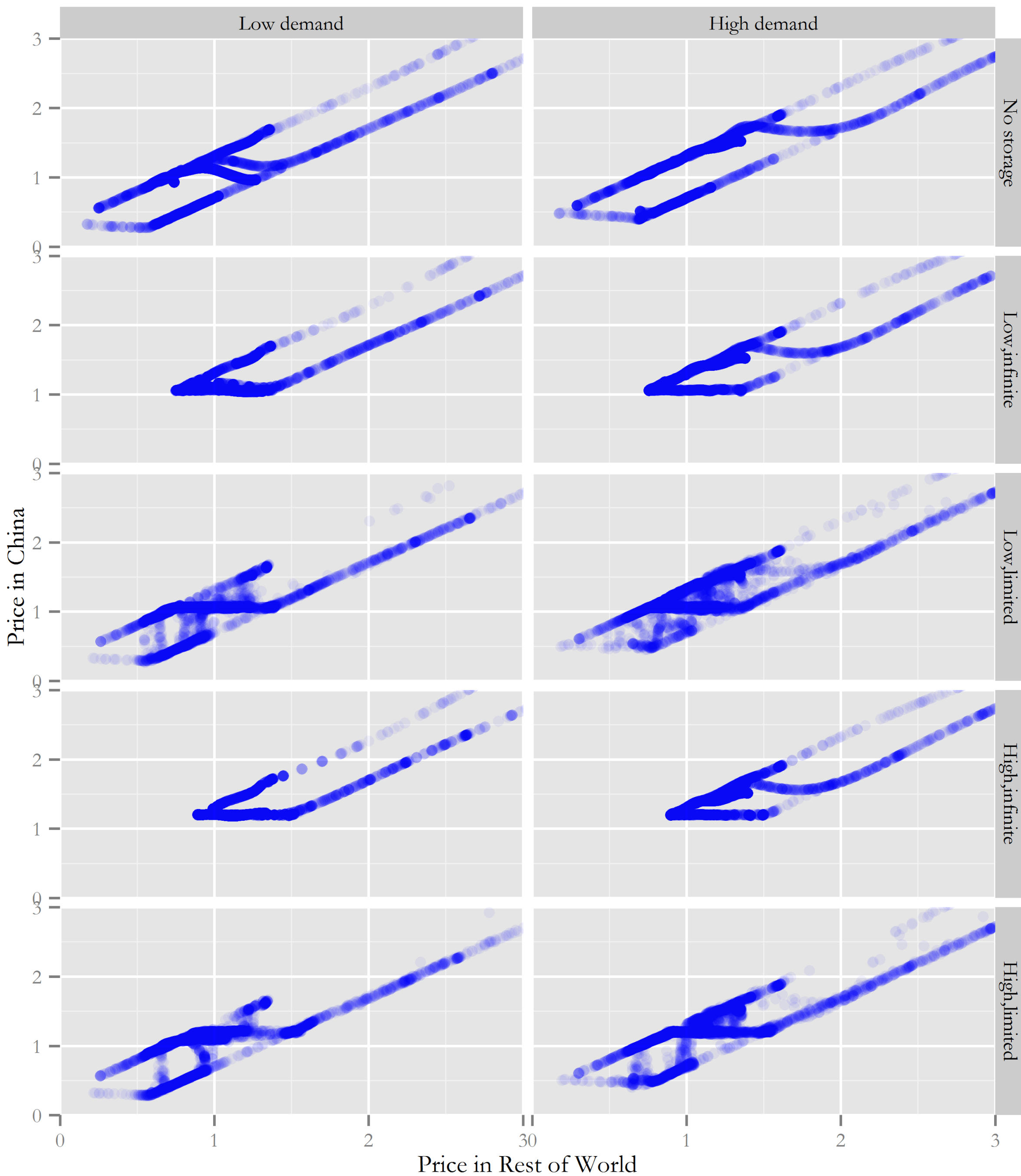

Figure 19: Corn prices long-term simulation

Variable	Mean		Standard deviation	
	R. World	China	R. World	China
No support price, no accumulation				
Consumption	0.821	0.197	0.033	0.013
Net Exports	0.016	-0.016	0.025	0.025
Price	1.086	1.213	0.273	0.304
Production	0.837	0.181	0.067	0.033
Storage	0.043	0.000	0.047	0.000
Low support price, unlimited accumulation				
Consumption	0.820	0.193	0.033	0.007
Net Exports	0.017	-0.017	0.022	0.022
Price	1.091	1.265	0.271	0.229
Production	0.837	0.183	0.067	0.033
Storage	0.041	0.008	0.045	0.017
Low support price, limited accumulation				
Consumption	0.822	0.195	0.033	0.007
Net Exports	0.014	-0.014	0.024	0.024
Price	1.077	1.224	0.269	0.229
Production	0.836	0.181	0.067	0.033
Storage	0.037	0.015	0.041	0.031
High support price, unlimited accumulation				
Consumption	0.815	0.191	0.029	0.006
Net Exports	0.026	-0.026	0.035	0.035
Price	1.123	1.312	0.248	0.195
Production	0.840	0.185	0.067	0.034
Storage	0.032	0.021	0.025	0.036
High support price, limited accumulation				
Consumption	0.821	0.196	0.029	0.008
Net Exports	0.015	-0.015	0.041	0.041
Price	1.078	1.208	0.236	0.196
Production	0.836	0.180	0.067	0.033
Storage	0.014	0.068	0.027	0.056

Note: In scenarios with Unlimited accumulation, China's simulated storage *level* is not stationary: China's statistics refer to one-period *accumulation* of stocks in these scenarios.

Table 6: Wheat simulations: High consumption demand in China

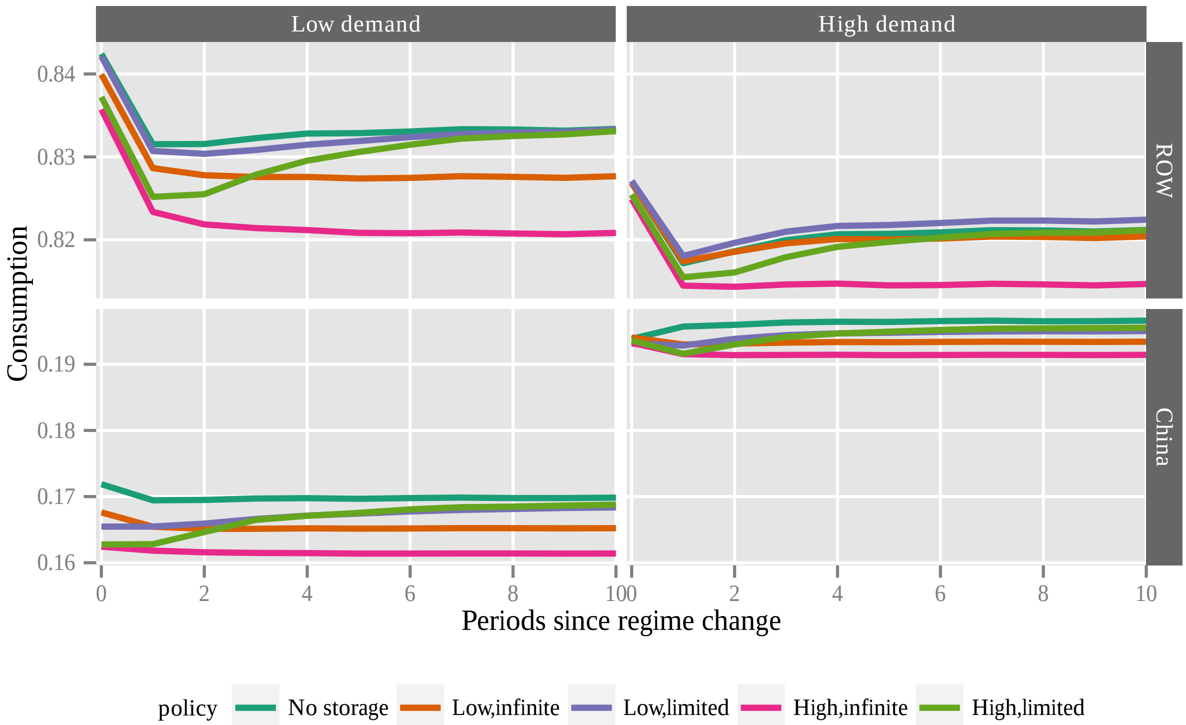

Figure 20: Wheat consumption forecast: Mean

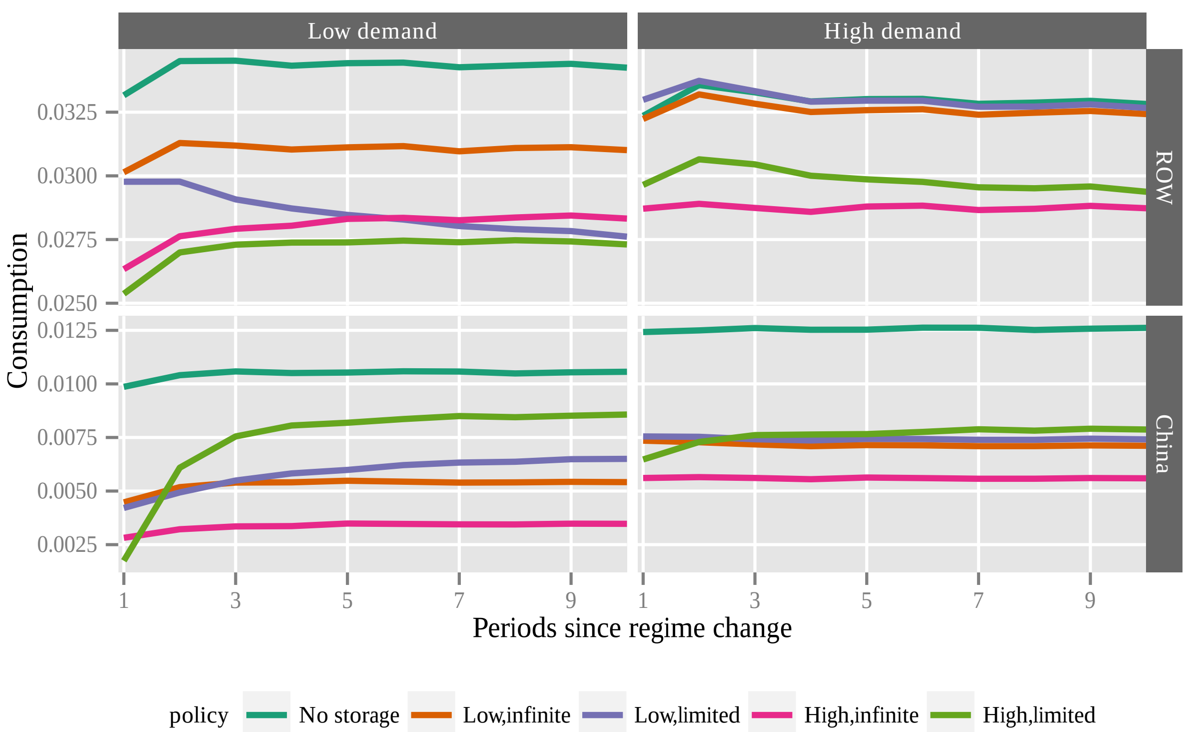

Figure 21: Wheat consumption forecast: Standard deviation

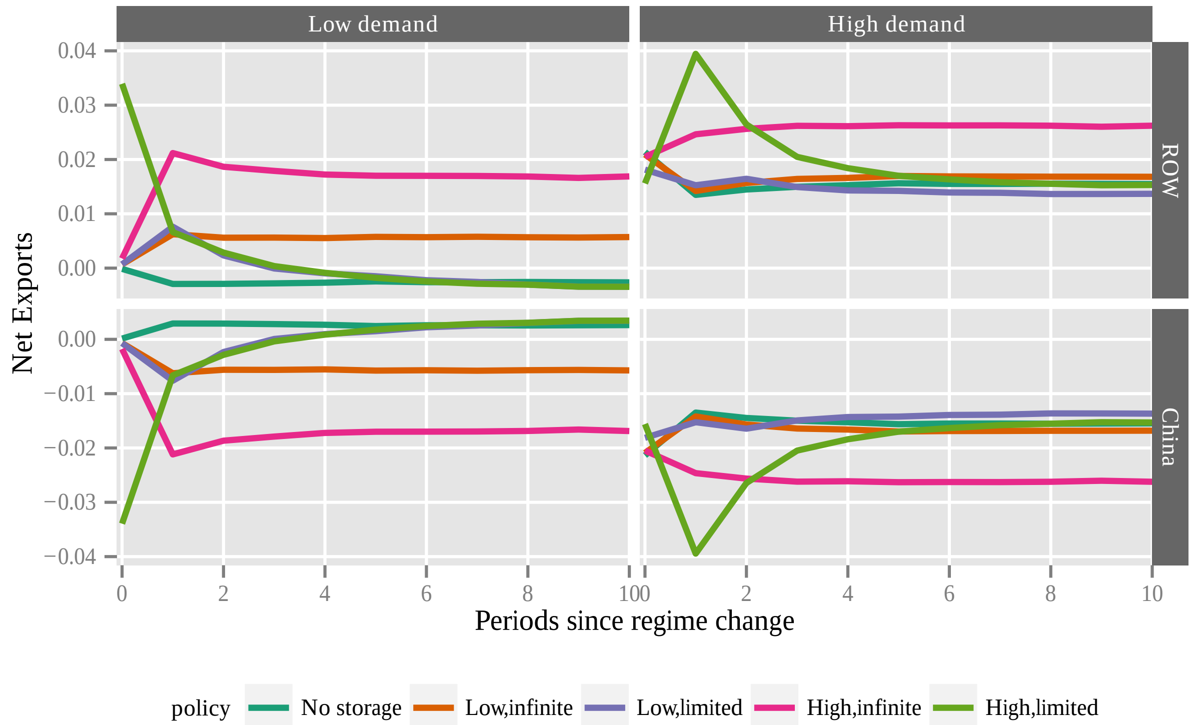

Figure 22: Wheat net exports forecast: Mean

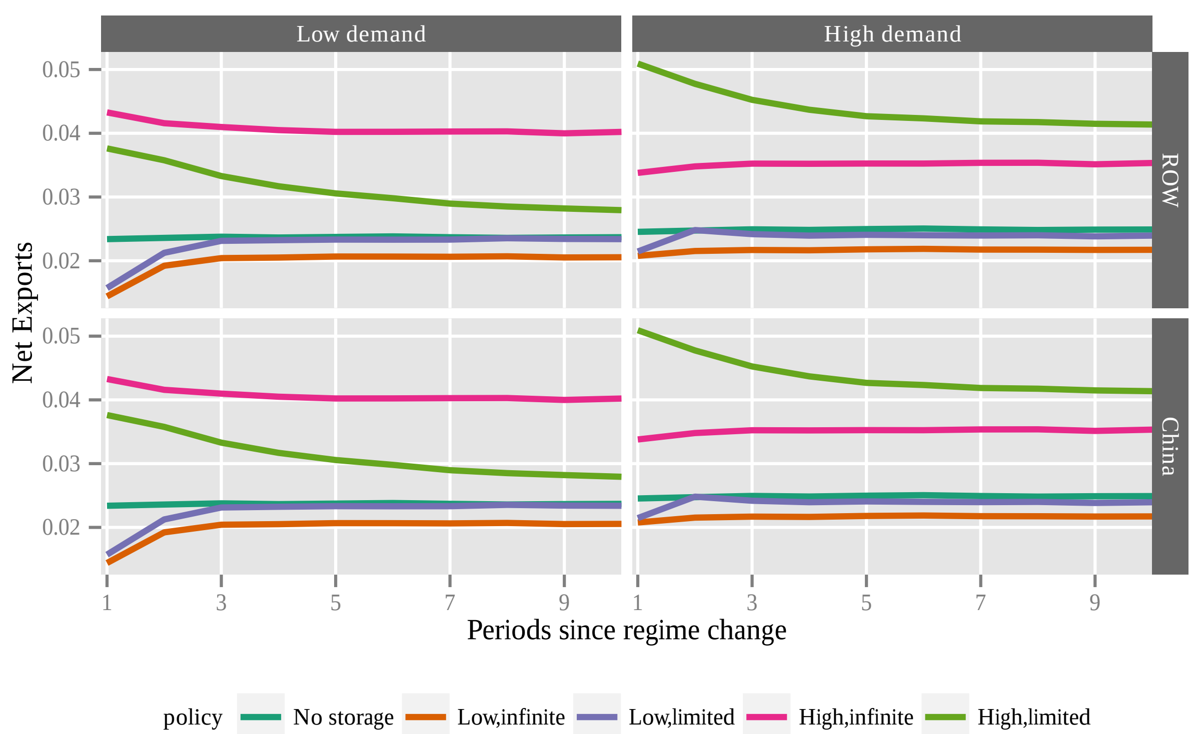

Figure 23: Wheat net exports forecast: Standard deviation

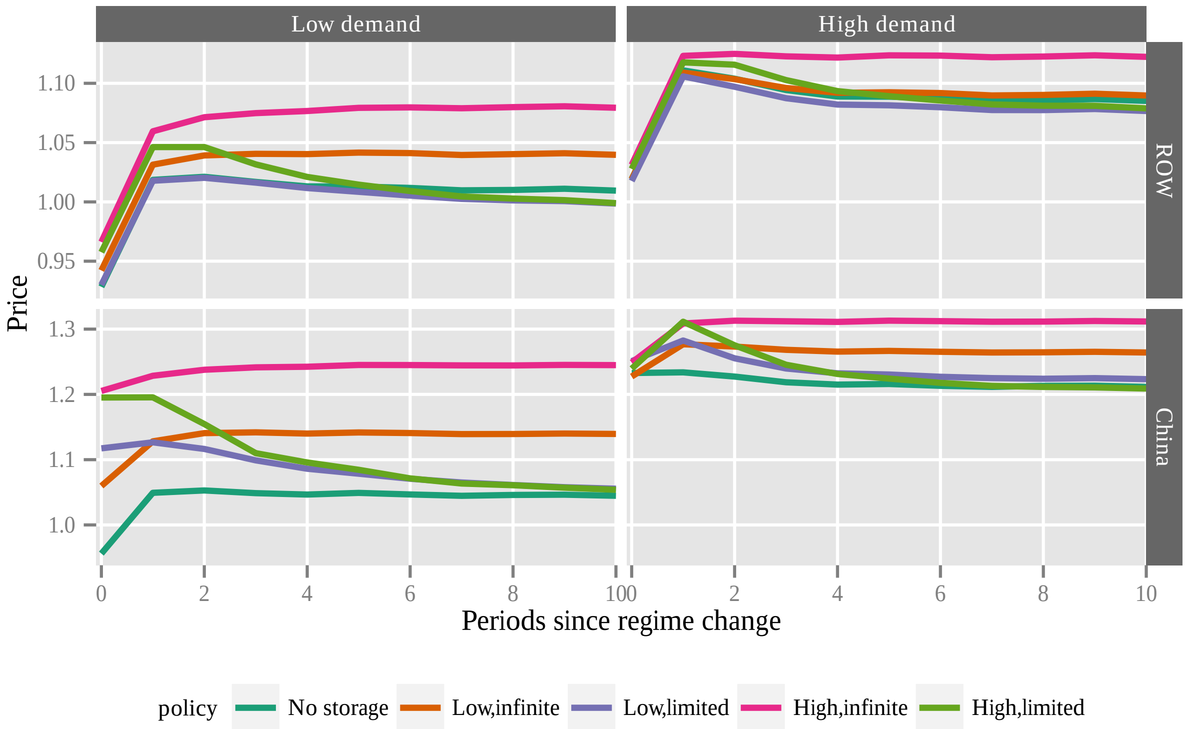

Figure 24: Wheat price forecast: Mean

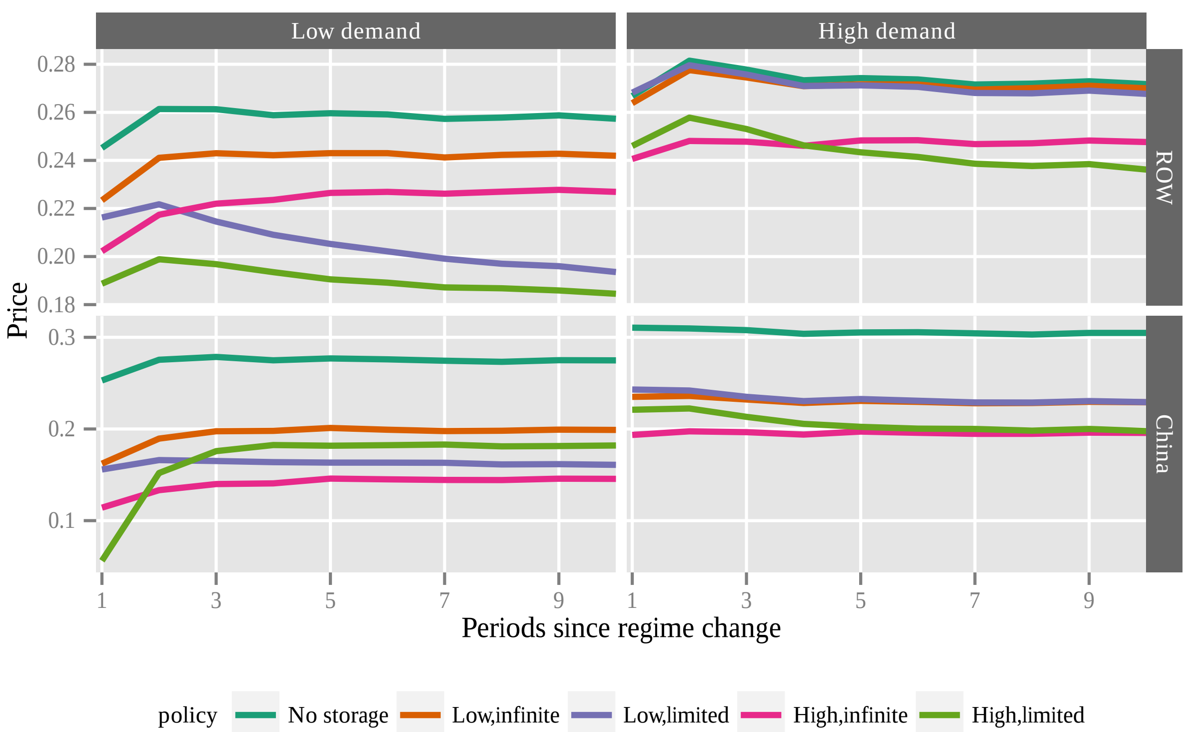

Figure 25: Wheat price forecast: Standard deviation

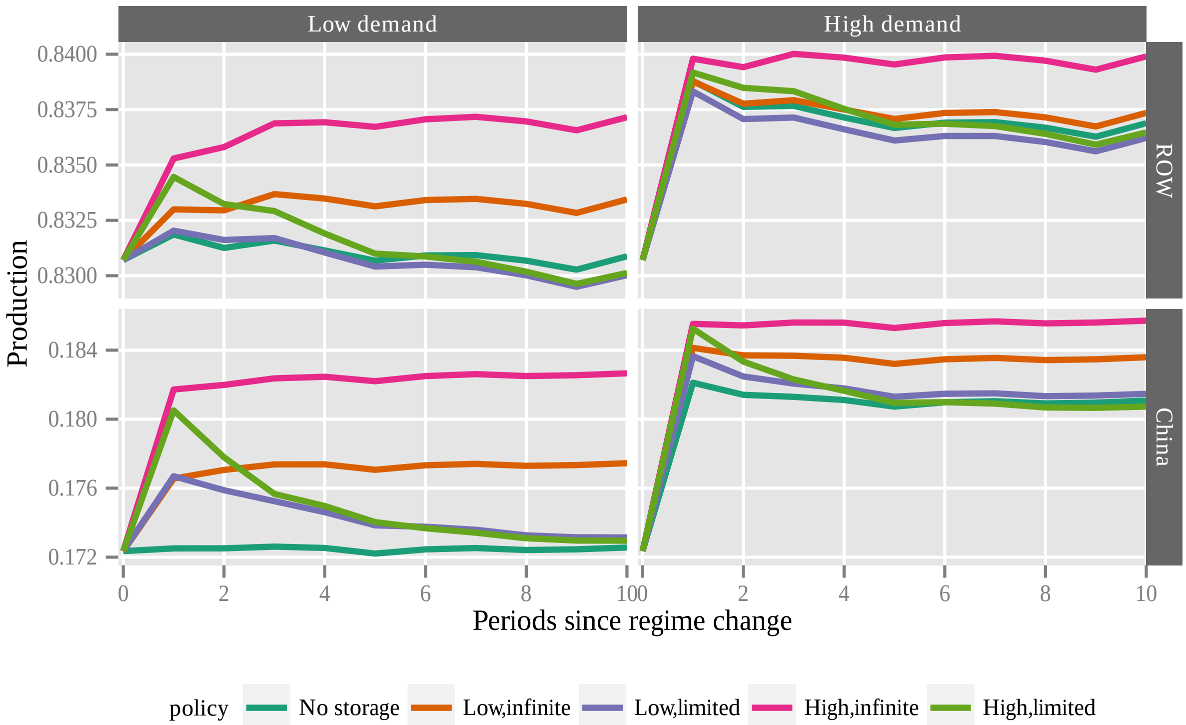

Figure 26: Wheat production forecast: Mean

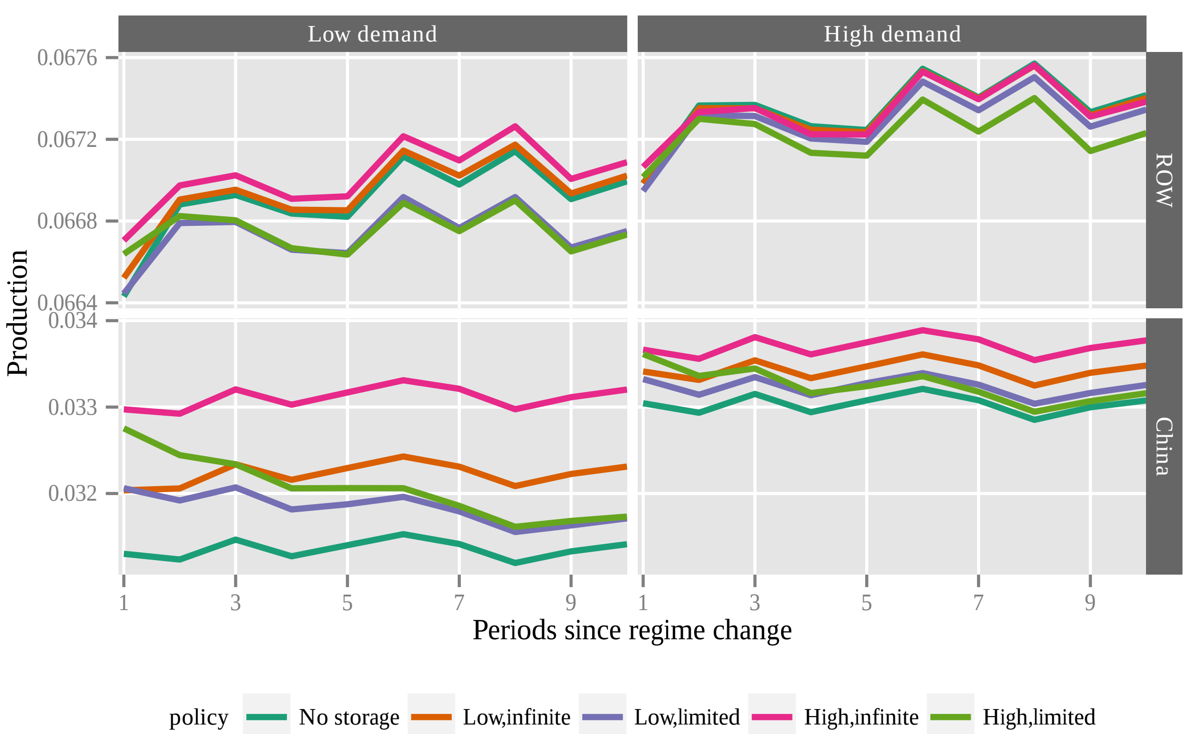

Figure 27: Wheat production forecast: Standard deviation

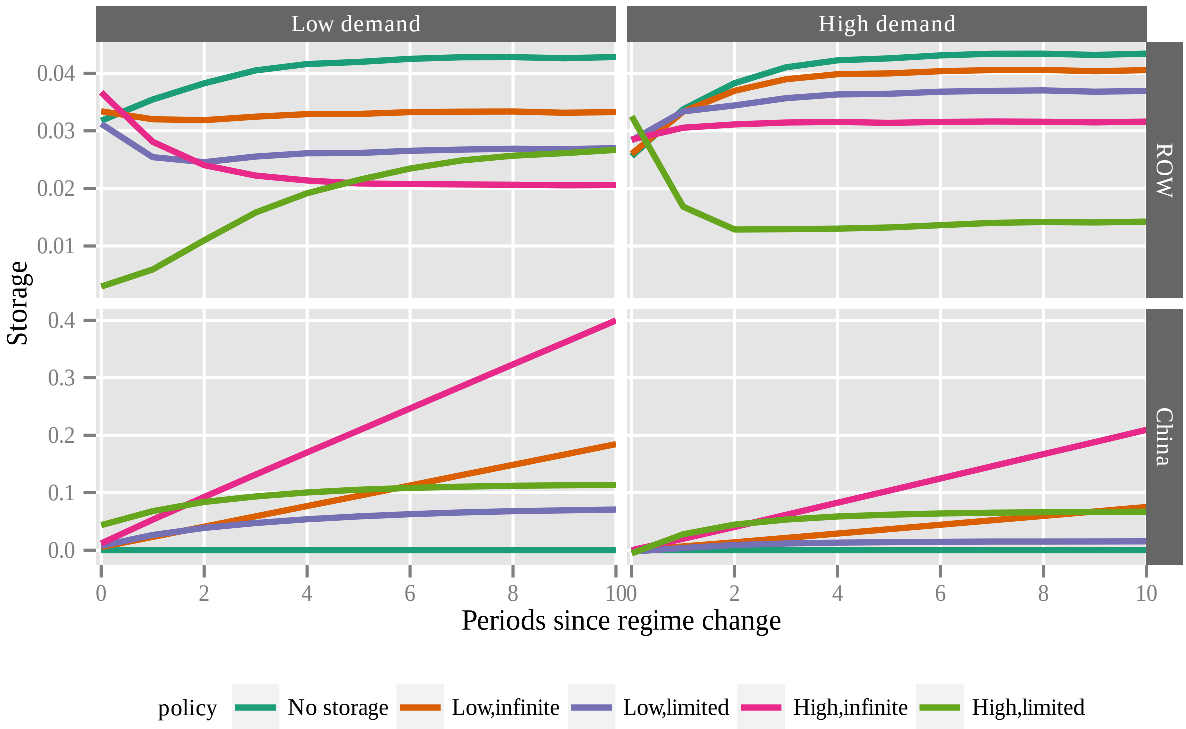

Figure 28: Wheat storage forecast: Mean

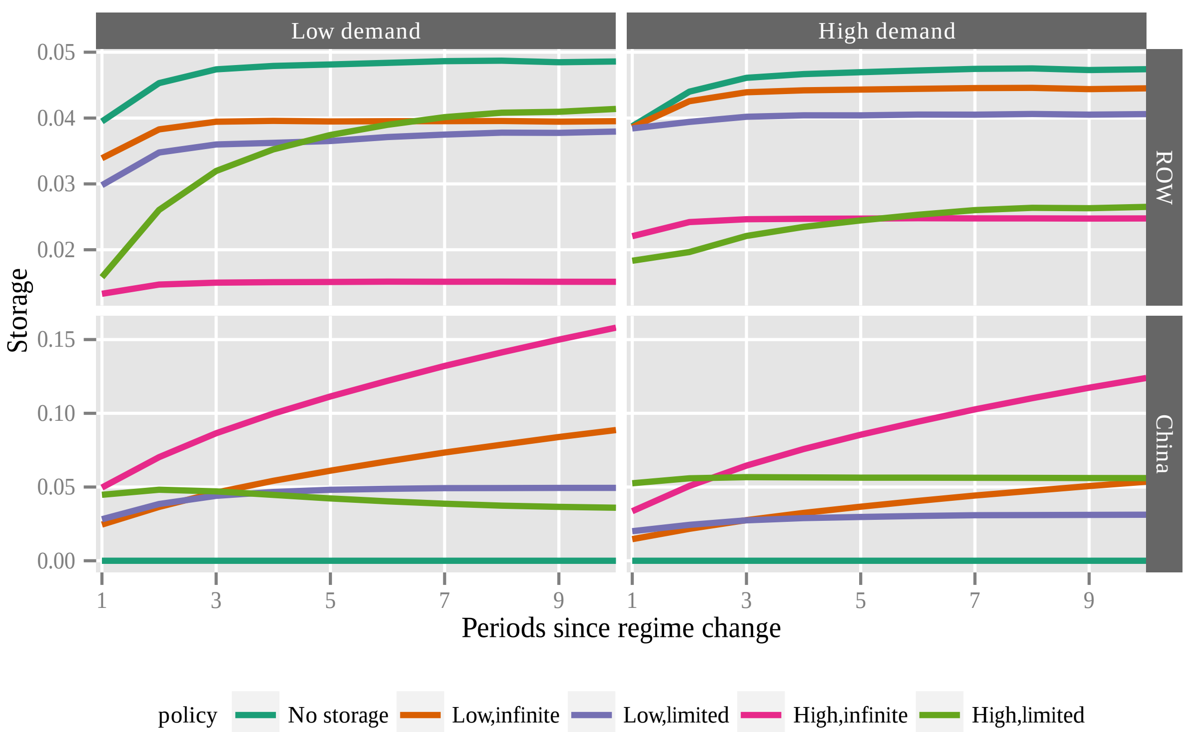

Figure 29: Wheat storage forecast: Standard deviation

5 Anticipated Extensions

- Explicitly model USA in addition to China and ROW.
- Or explicitly model “exporters” and “importers” in addition to China and ROW.
- Add acreage supply that responds to expected revenue, not expected price.
- Add distinct release price.

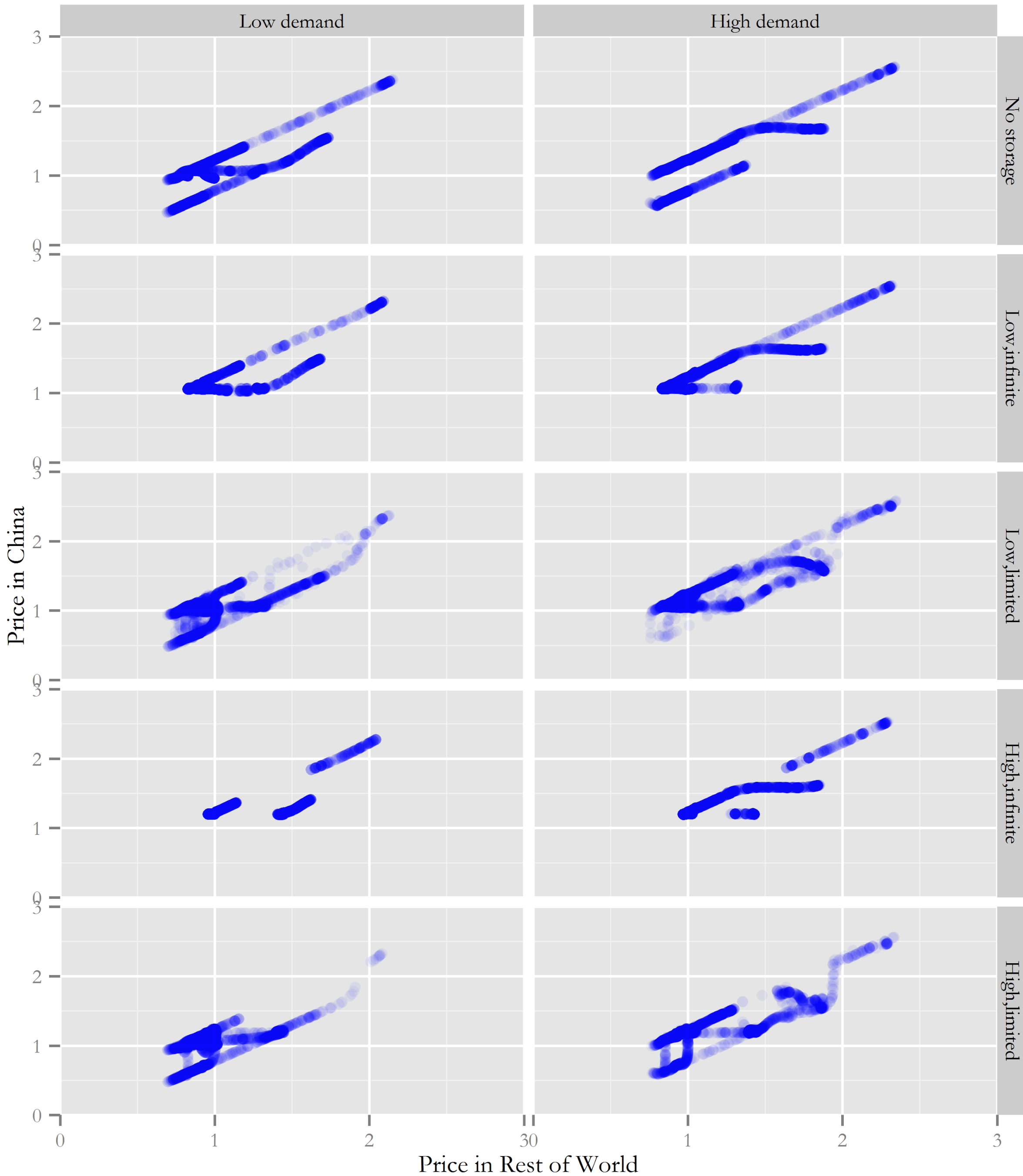

Figure 30: Long-term Simulation: Wheat Prices