Australian Government
Department of Agriculture, Water and the Environment
ABARES

Simulating effects of agricultural support policies under price volatility

A China case study

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Research by the Australian Bureau of Agricultural and Resource Economics and Sciences

Conference Paper 20.2
April 2020

Cataloguing data

This publication (and any material sourced from it) should be attributed as: Cao, L, Thorpe, S & Fell, J 2020, *Simulating effects of agricultural support policies under price volatility – a China case study*, ABARES Conference Paper 20.2, for the Global Trade Analysis Project (GTAP) Conference, Canberra, April, CC BY 4.0.
https://doi.org/10.25814/5ea10298dcd61

ISBN 978-1-74323-480-8

ISSN 1447-3666

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Acknowledgements

The authors thank Dr Jared Greenville and Dr Caroline Gunning-Trant of ABARES for their review of and valuable comments on this paper. All errors in the report remain the authors'.

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Summary

This study uses a dynamic global trade analysis project (GTAP)-type computable general equilibrium (CGE) model to simulate the economic effects of different agricultural support policies to the price volatility of agristaples including rice, wheat and coarse grains, using China as a case study. The model is based on a model developed by researchers at the Partnership for Economic Policy (PEP). Several modifications were made to the PEP model for this study. The main ones include:

- the splitting of China's households into agricultural and non-agricultural households
- the introduction of a more flexible way for global investment allocation
- the replacement of production nesting structures and production functions with a single level nesting and a translog unit cost function for all sectors
- the introduction of various Chinese agricultural policies; and
- a reformulation of the model as a mixed complimentary problem (MCP).

The modelling captured China's agricultural policies which provide a price band for rice and wheat, that is, a floor price for producers and a ceiling price for consumers. Various policies were examined, including the existing policies, deficiency payments, various land subsidies, lump sum transfers as well as the removal of all policies. To examine these policies, a baseline was first developed, which calibrated the model to exogenous projections on gross domestic product (GDP), population and other variables to 2050. For each policy option, a number of temporary shocks on domestic and world production of rice, wheat and coarse grains were used to induce price volatility, with the aim of assessing the performance of each policy at managing the impacts of price volatility on farmers and households.

The combined modelling results from all shocks present a clear picture: overall, the existing policy settings in China have adverse impacts on food security and there are better alternatives available to help address rural-urban income disparities. The non-distortionary policies examined (i.e., deficiency payments, food vouchers, lump sum transfers to agricultural households, and the 'removal of all policies') improve the efficiency of the overall Chinese economy. Among these policy alternatives, the 'removal of all policies' option offers the highest potential economic gains. However, if applied in isolation, it also creates the largest adverse effects on agricultural households. Despite this finding, such adverse effects can be addressed through a direct lump sum transfer to agricultural households. Such a policy with the direct lump sum transfer also has limited negative effects on the potential efficiency gains possible, resulting in a win-win policy for all households and China overall.

The modelling also provided insights on the effects of changes in Chinese policy on Australia's exports of coarse grains and wheat. Australia's exports respond to price changes in the export markets. Price shocks and policy combinations that lead to higher domestic prices in China generally lead to their demand for more imports, thus more exports from Australia. Likewise, price shocks and policy combinations that lead to lower domestic prices in China generally lead to their demand for less imports, thus less exports from Australia. Furthermore, the baseline assumes that the government uses purchases rather than subsidies to support the minimum support price for producers. Because of this, consumers have to pay higher prices under the existing policy than under alternative policies, leading to Australia exports less under alternative

Chinese policies. The results about the direction of trade for Australia also hold for other countries which export coarse grains and wheat to China.

Introduction

Rural issues and the welfare of the rural population are of paramount importance to the Chinese government. Reflecting that, agriculture in the country is undergoing significant structural reform. The coexistence of high domestic outputs, high imports and high domestic stocks has been labelled the challenge of the "triple high" phenomenon in agricultural policy debates in China (Yu 2017) and has provided a major impetus to policy change.

Major changes began in 2016 with the removal of a corn minimum price and planned reductions in the corn stockpile (Fell & Waring 2017). In 2017 the Chinese government released its *No. 1 Central Document*, which focussed on supply-side structural reform of Chinese agriculture (CPC and State Council 2017). Detailed information on China's current agricultural policies are available in Kimura, Gay and Yu (2019), Fell (2018) and Fell & Waring (2017). The most notable of China's policies are minimum support prices for rice and wheat. The government also pays a range of subsidies, from input subsidies to crop-specific production subsidies.

This paper examines how hypothetical but realistic future policy changes in China might affect agricultural markets, Chinese economy and Australian exports. The effects of policy changes on income transfers between producers and consumers, and the distribution of income between agricultural and non-agricultural households, are also important given the significance paid to maintaining social stability and the government's rural revitalisation agenda in China.

1 Context and research questions

The Chinese government has used various support policies targeting supply responses to achieve its policy objectives. Understanding the distributional implications of these policy options in a context of managing price shocks is important. Sudden movements in prices in either direction can have negative consequences for certain groups in society. For this paper, a computable general equilibrium (CGE) model has been adapted to examine different policy options for managing either exogenous domestic or world agricultural price shocks.

This paper complements a recent partial equilibrium study by Kimura, Gay & Yu (2019) by assessing the economy-wide effects of hypothetical policy reforms using a CGE model. In particular, this paper focusses on three things:

1) the distributional effects in China across household groups (namely agricultural or non-agricultural households)
2) the income transfer between agricultural producers and households, and
3) the effects across sectors.

Non-agricultural linkages and bilateral trade linkages are also included.

Specifically, this paper assesses the economic implications of key policies for managing the impacts of shocks to coarse grains, rice and wheat prices. The effects on domestic food consumption, farm sector incomes, key macroeconomic aspects, production, relevant prices and welfare of households are assessed across the short (2020), medium (2025) and long (2050) terms. Hypothetical scenarios are modelled to illustrate the implications of the existing and alternative policies. There are two specific research questions:

1) how do price shocks affect producers and consumers, as well as the economy as a whole, under different hypothetical policy environments? Answering this question has the potential to support policy development processes in China
2) how will potential reforms of China’s grain support policies affect other countries' grain exports and production? A better understanding of the potential impact on other countries’ grains trade from such reforms would inform policy makers in Australia.

2 Modelling approach

A GTAP-type dynamic CGE model was chosen for this study. The model is a modified version of the original PEP-w-t model developed by the Partnership for Economic Policy. The model code in GAMS and documentation are publically available (Robichaud et al. 2014).

A number of modifications were made to the PEP model for this study. They include:

- the introduction of
  - agricultural and non-agricultural household types for China
  - a relatively more flexible way for global investment allocation to each region. The way is similar to that used in the Global Trade and Environment Model (GTEM) (Pant 2007)
  - agricultural support policies, including minimum support price through government stockpiling
  - a present value measure to compare the present value of consumption and the trade-off between consumption, capital and grain stocks over time across policy and shock scenarios
- the adoption of
  - a single level nesting translog function for modelling demand by each region from all sources including domestic and import sources
  - a single level nesting translog unit cost function for modelling demand by sectors for inputs into production
- the recalibration of the household utility function (Linear Expenditure System) for each region based on estimated elasticities from an Implicit, Directly Additive Demand System (AIDADS). The method for estimation of elasticities of AIDADS is similar to GTAP's (Hertel & van der Mensbrugghe 2019)
- the allocation of land use across agricultural activities based on a constant elasticity of transformation (CET) function, noting that allocated land linearly adds up to the total physical land; and
- the re-formulation of the model as a mixed complementarity problem (MCP) to incorporate relatively complex policies.

Some of the above modifications and existing features in the PEP model relevant to this study are further discussed below. Details on the original PEP-w-t model can be found in Robichaud et al. (2014).

2.1 Overview of the model

The model is a multi-region, multi-sector, multi-household and recursively dynamic model. It is a modified version of the PEP-w-t model. The model allows flexible regional and sectoral aggregations. Chinese households are disaggregated into agricultural and non-agricultural households, where agricultural households are defined as those earning income from agricultural sectors and non-agricultural households earn income from non-agricultural sectors.

Each sector, except the capital-producing sector, produces a single tradable commodity, which is either consumed domestically or exported. The capital-producing sector is treated differently, because it produces capital goods only for domestic use. Regions are connected through

commodity trade as well as financial capital flow. Each commodity consumed by households, government and sectors (including commodity-producing and capital-producing sectors for intermediate inputs) is a composite commodity sourced domestically and from abroad.

Saving rates of households are fixed as a share of their after-tax incomes. The government's savings are specified through assumed fiscal rules. All consumers pay a consumption tax on goods and services they consume. Firms or sectors pay a payroll tax on labour they employ and a capital tax on capital they use. Capital is sector-specific once it is allocated to each sector. However, when new capital is created, it is available at the economy-wide level in each region and perfectly mobile across all sectors within a region before it is allocated to each sector.

Government in each region collect all taxes and consume commodities by maximising their utility. Government utility takes an assumed functional form given an allocated consumption budget through assumed fiscal rules. In this model, government consumption can be considered wasteful, as there is no direct feedback from government consumption to any productivity in the economy or household utilities. Households pay income taxes and consume commodities by maximising their utilities according to a linear expenditure system, given total expenditure of after-tax incomes less saving.

The model solves for prices through market clearing conditions in each region, that is, supply equals demand. At the global level, world exports must equal world imports, that is, world net export is zero. Global investment must equal global saving.

In this model, the consumer price index is chosen as the numeraire for each region. The exchange rate of a reference region is chosen as the global numeraire. The United States is chosen as the reference region in this model.

2.2 Household types

One of the objectives in this study is to understand the distributional impacts on different types of households in China from a policy change or a price shock. Distributional impacts are of particular interest to the Chinese government, as they develop policies in addressing the challenging issue of income disparities between rural and urban households.

In this model, Chinese households are disaggregated into agricultural and non-agricultural households. The agricultural households are actual households participating in farming activities. The non-agricultural households are everyone else. This household split departs from the typical split of rural and urban households based on Chinese "Hu-Kou" registration. Because of the growing rural to urban migration, "Hu-Kou"-registered rural residents do not necessarily work in rural areas. A significant proportion of them actually work in urban areas and earn income from non-agricultural activities.

For this study, the impact of domestic agricultural policy changes on rural-to-urban migrants would be similar to urban "Hu-Kou" holders, while the impact on rural residents who earn their income from farming would be different. For this reason, it is sensible to split households in China according to their income sources, either agricultural income or non-agricultural income.

2.3 Recalibration of the household utility function

Over the long term, households will experience significant income growth and their composites of consumption demand will vary as their incomes rise over time. The modelling therefore needs to take this into account, requiring proper calibration of the model so that it projects plausible expenditure shares of households on each commodity over time.

In this model, the household utility function is recalibrated in two steps in a method similar to Hertel & van der Mensbrugghe (2019):

1) an Implicit, Directly Additive Demand System (AIDADS) is fitted to the GTAP database based on error minimisation. This provides estimates of various demand elasticities, which are then used as targets in the second step of calibration
2) demand derived from a linear expenditure system (LES) is then calibrated to the data for each commodity, household type and region, while at the same time minimising the error between the demand elasticities given by LES and the targeted ones from the first step.

With the above two steps, the LES used in the model is calibrated properly to the GTAP database, and all elasticities (including income elasticity) are derived and reasonably aligned with those from the AIDADS system.

2.4 Land use modelling

This study assesses existing and alternative policies in specific agricultural industries. Hence, a robust accounting of land use and its responsiveness to changes in returns to different agricultural industries need to be modelled. This requires that land use for each disaggregated agricultural industry is appropriately represented in the model. Depending on the substitutability of land across agricultural industries, rational agricultural producers will allocate their land to those activities which maximise profits, given input and output prices.[1]

Land is an important input to agricultural production. In the original PEP-w-t model (Robichaud et al. 2014), land is simply treated as a type of physical capital and bundled with other types of capital for creation of the capital composite which is used in production. In the modified model developed for this study, the demand for land is derived from the translog unit cost function, as is any other input to production (for details, see Section 2.6 below).

On the supply side, a simple constant elasticity of transformation (CET) function is used to allocate the fixed supply of land, as in the standard GTAP model (but not the original PEP-w-t model). That is, land owners allocate their land across production activities by maximising total revenue according to a CET aggregation function and the real world constraint on the total amount of land. The real world constraint specifies that land supplied to all agricultural activities must linearly sum to the total amount of land available (this real world constraint is not imposed in the standard GTAP model).

[1] Other non-agricultural activities of land use, such as forestry, are not directly modelled.

As in the PEP-w-t model, land rent for each activity continues to be determined by market clearing conditions: demand for land for each activity must be equal to the supply of land for that activity.

These changes to how land is modelled are critical for analysing agricultural policies that subsidise land at different rates according to activity or at a common rate across all agricultural activities.

2.5 Capital formation and adjustment cost

As in any recursive dynamic model, modelling investment (i.e. new capital) requires assumptions, because new capital realises its economic value only in the future when it becomes ready to use. This means investors make their investment decisions based on expected future rates of return on the new capital. In recursive dynamic models, a typical assumption is that the expected future rates of return are the same as the rates of return in the current period (i.e. static expectations).

Another important consideration related to capital investment decisions is the changes in the cost of producing a unit of new capital as demand for new capital increases. In the standard GTAP model, the unit cost of capital formation is constant regardless of the volume of investment. This is not realistic because the resources required to produce capital are scarce and the costs are likely to rise as demand for capital increases. Not accounting for these higher unit investment costs underestimates the economic costs of a price shock or policy change because it underestimates the costs of changes in economic activities. Therefore, adjustment costs for capital formation are explicitly modelled in this study.

The existing investment allocation in the PEP-w-t model reflects what is discussed above. This study has made further modifications for modelling investment both at international level and sectoral level within regions. Instead of fixing the real current account in each region for determining international investment flows, this paper uses a flexible but stylised functional form for allocating global investment to each region. The functional form for global investment allocation is adapted from the GTEM model (Pant 2007). The allocation of investment across sectors is similar to the PEP-w-t, but it is made explicitly dependent on the investment-to-capital ratio, in addition to relative returns to capital in each sector.

2.6 Modelling unit costs of production

Translog unit cost functions with single level nesting are used in the model for this study, replacing the PEP-w-t's original production functions. This is because a translog unit cost function is flexible, representing a second-order approximation to a general unit cost function. Translog demand for production inputs is derived using duality theory. The translog function is also less restrictive in constraining potential modelling outcomes than many other popular unit cost forms. For example, the function does not prevent an initial tiny share of a production input (or of imports) from growing to a large share over time if that is economically optimal. Furthermore, with a translog unit cost function, use of any input or import from any source can also fall to zero. In this paper, parameters for the translog functions are calibrated to the assumed Allen-Uzawa partial elasticities of substitution and expenditure cost shares in the base year.

2.7 Modelling complex policy characteristics

An appropriate representation of key features of China's agricultural policy environment is important for the model-based economic assessment. Features such as minimum producer prices are therefore incorporated in the model. A hypothetical price ceiling is also modelled on the assumption that the Chinese government would not allow prices to rise above some certain level. These policies are triggered when the market price increases or decreases to a target set by the government.

These features are specified in the model as mixed complementarity problems (MCP) (see, for example, Rutherford 1995). MCPs are also specified wherever they are necessary in the model, that is, in general wherever imposition of an inequality constraint is required.

3 Data sources

This paper is based on the GTAP database: version 9 and base year 2011 (Angel, Narayanan & McDougall 2016). For this study, GTAP sectors and regions are aggregated into 15 sectors, including key staple grains[2] and 14 regions, respectively. The choice of these aggregations was made with consideration of the purpose of this study and computational efficiency. Appendix A: aggregations of regions and sectors, provides more details about the aggregations.

The GTAP database does not have data for multiple households. Consequently, splitting China's households into multiple households required innovation and additional data. For income, the GTAP database on factor incomes by sector is used to allocate income to agricultural and non-agricultural households in China. That is, all factor incomes generated by agricultural sectors are allocated to agricultural households' incomes and the remaining factor incomes are allocated to the non-agricultural households.

The splits of expenditure by household type and by commodity are more complex and require the use of China Year Book data compiled by the National Bureau of Statistics of China (NBS 2013). The key step is to map GTAP commodities to the China Year Book commodities. A GAMS code was developed to perform the split.

[2] It is noted that in GTAP database version 9 (as well as earlier versions) there is a significant share of usage of wheat for feed input to livestock production in China. This does not seem to align with observed data for wheat usage in China. Hence, any future adjustments to wheat usage shares in China may result in considerable changes to the modelling results presented in this study. In fact, wheat usage shares in China has already been adjusted in the latest release of GTAP database (version 10a).

4 Baseline scenario

In this study, the baseline is the projected evolution of the economies of China and other countries/regions over the period to 2050. Key assumptions that are used to construct the baseline are discussed below.

4.1 Gross domestic product (GDP) and population

In developing the baseline, GDP and population are assumed exogenous. To achieve this, a uniform productivity is endogenised for all primary factors (i.e. labour, capital, land and natural resources). GDP projections are sourced from OECD & FAO (2019) and China's National Food and Strategic Reserves Administration (unpublished 2019).

Population projections serve a role in the model for labour supply growth and for reporting of various per capita related variables. Population projections are the same across all scenarios. The population data and projections are sourced from United Nations (2017).

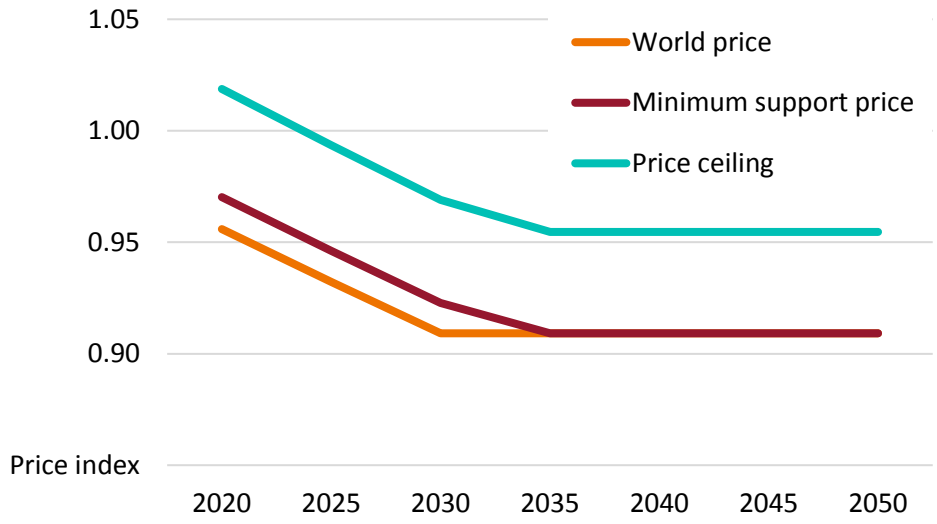
4.2 World price indices and China's minimum support prices of rice and wheat

Stylised facts on China's domestic prices relative to world prices need to be reflected in the baseline to simulate effects on prices for key agricultural staple products. This is particularly important because China currently has minimum support prices for rice and wheat, and previously also for corn.

In the model, commodities produced by different regions are not homogeneous. As a result, the model does not have a well-defined world price for each commodity. A world price index representing the trade value share weighted average world price for each commodity is used as a proxy for the world price. Figure 1 and Figure 2 show the assumed paths for the world price index and China's minimum support price and ceiling price in the baseline for rice and wheat, respectively.

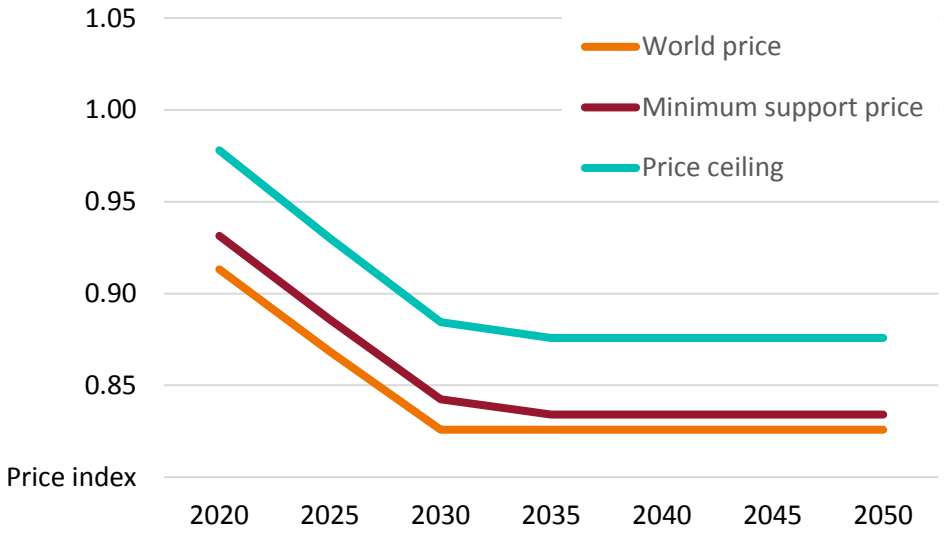
It is important to note in Figure 1 and Figure 2 that China's domestic prices of the staple grains are assumed to approach the world price indices in the long run (i.e. in 2050). The justification for this assumption is that China would continue its minimum support price reforms over time. Recent developments support this assumption, since minimum support prices for some grains have recently been removed. Hence it is appropriate to reflect this reform trend in the baseline.

Figure 1 Price indices, rice, China



Note: Basic price=1 in 2011 for all exporters. Taxes and subsidies are then added to the basic price. World price is a trade value share-weighted average of the individual country prices in international dollars.
Source: Authors' own assumptions[3]

Figure 2 Price indices, wheat, China



Source: Authors' own assumptions

[3] When the simulations were run for wheat only, the price paths for rice were not imposed in the baseline. These paths were imposed when the simulations were run for rice, wheat and coarse grains together.

4.3 China's expenditure shares of coarse grains, rice and wheat from Australia

To better understand the impacts of China's policies on other countries, e.g. Australia, it is important for the model to reflect the value of China's agricultural commodity imports from that country relative to China's total expenditure in the baseline. Table 1 presents the assumptions for China's expenditure shares of coarse grains, rice and wheat from Australia.

Table 1 China's shares of total expenditure for imports of grains from Australia

Year	Coarse grains	Rice	Wheat
2020	0.8%	0%	0.8%
2025	0.8%	0%	0.9%
2030	0.9%	0%	1.0%
2035	0.9%	0%	1.1%
2040	1.0%	0%	1.2%
2045	1.0%	0%	1.3%
2050	1.1%	0%	1.5%

Note: Each share represents the proportion of supply from Australia of total supply for China's consumption from all sources, including China's domestic and import sources.
Source: Authors' own estimates and assumption[4]

4.4 China's value-added share of service sector

Another important trend that needs to be reflected in the baseline is China's economic structural change over time as its per capita income continues to rise. Over the long term, Chinese households will experience significant income growth. The expenditure share of households' consumption on food would decline because of a physical level of satiation of food consumption when the incomes become sufficiently high. On the other hand, consumers' demand for services can continue to grow as per capita income rises. It is therefore important to capture the growing service sector in the baseline. These changes occur within the assumed GDP growth rates described above. Table 2 shows the assumed path of the value-added share of a subset of the service sector in China.

[4] Similar to footnote 4, the expenditure shares for coarse grains and rice were not imposed in the baseline when the simulations were run for wheat only. They were imposed in the baseline when the simulations were run for coarse grains, rice and wheat together.

Table 2 Selected service sector valued-added as a share of China's gross value added

Year	Share
2020	29%
2025	30%
2030	31%
2035	32%
2040	33%
2045	34%
2050	35%

Note: The selected service sectors includes 'other services' from the GTAP database. It excludes electricity, transport, construction and public services. The value-added shares shown in this table reflect only the value-added share of the mentioned subset.
Source: Authors' own estimates and assumptions

The assumptions reflect the general but likely trend over time in China. Faster or slower growth of the service sector in China can be examined through sensitivity analysis. Reflecting all the assumptions discussed above, the model baseline projects the share of value-added of all service sectors—including electricity, transport, construction, public services and other services—to increase from 51% in 2017 to 62% by 2050.

5 Policies and scenarios

5.1 Description of scenarios and policies

A number of scenarios are simulated to illustrate the effects of alternative policies to manage price shocks on farmers, households and the Chinese economy using the CGE model. Listed below are the first set of scenarios representing shocks on the production of agricultural commodities:

1) no shock to production
2) higher domestic productivity on the value added
3) lower domestic productivity on the value added
4) higher productivity of the world excluding China on the value added, and
5) lower productivity of the world excluding China on the value added.

The second set of scenarios include varying policies for each of the above shocks, that is, combining policy changes with shocks to explore the way different policies perform under price volatility.

Within the policy set there are seven policy options. Each policy option has two parts: one for supporting producers and the other for consumers. They are:

1) existing policy
2) deficiency payment for producers and subsidy for consumers
3) deficiency payment for producers and food voucher for consumers
4) commodity-specific land subsidy for producers and subsidy for consumers
5) non-commodity-specific land subsidy for producers and subsidy for consumers
6) no producer support but a direct lump sum transfer to agricultural households, and
7) removal of all support policies.

It should be noted that some policy options or elements for specific scenarios may be redundant (i.e. not activated by design) when the price band becomes non-binding[5]. Policies that support consumers are mostly not activated in the scenarios in this study since the market prices for consumers are below the price ceiling.

To ensure interpretation of the modelling results is relatively easy, and to gain economic insights from this modelling exercise, the scenarios and results reported will focus on wheat-only price

[5] The price band is created by the existence of minimum support prices for agricultural producers and a hypothetical price ceiling that is assumed in this modelling.

shocks. To show that the key policy messages from the modelling remain the same with price volatility on other agricultural commodities, further parallel scenarios were simulated by the authors with simultaneous shocks on China's key agristaples: coarse grains, rice and wheat together. Table 3 describes the policy options simulated for each scenario.

Table 3 Policy and shock scenario matrix

Policy	Productivity shock on value added				
	No shock	Domestic shocks		World shocks	
	0%	+15%	–15%	+15%	–15%
Existing policy	Baseline	✓	✓	✓	✓
Deficiency payment for producers and subsidy for consumers	✓	✓	✓	✓	✓
Deficiency payment for producers and food voucher for consumers	✓		✓		✓
Commodity specific land subsidy for producers and subsidy for consumers	✓	✓		✓	
Non-commodity specific land subsidy for producers and subsidy for consumers	✓	✓		✓	
No producer support; lump sum income transfer to agricultural households	✓	✓	✓	✓	✓
Remove all policies	✓	✓	✓	✓	✓

Note: Each tick indicates the shocks that are simulated under each corresponding policy. Policy elements for supporting consumers are not activated in the scenarios where market prices for consumers fall due to positive productivity impacts and are thus not explored. Similarly, land subsidy options are not simulated when there is a negative productivity shock because the market prices for producers rise, leading to the minimum support prices not binding.

5.2 Scenario comparisons

With the two sets of scenarios and the baseline, the following comparisons can be made to illustrate the policy effects with and without shocks:

1) comparing a scenario with a policy change but no shocks with the baseline shows the effects of only a policy change
2) comparing a scenario with a policy change but also shocks with the baseline shows the combined effects of a policy change and price shocks
3) comparing a scenario with a policy change but no shocks with a scenario with the same policy and shocks shows the effects of only price shocks under the same policy. This comparison could be used to illustrate which policy would be robust for managing agricultural price volatility.

5.3 Scenario implementation

Implementation of these scenarios requires a proper design of the model closure. That is, it is important to consider what variables should be kept fixed between scenarios to ensure the scenarios are comparable. To eliminate any effects of changes in real government consumption and real public savings on the economy between scenarios, these two variables are fixed at the baseline levels in all scenarios. This ensures that the changes between scenarios are only the result of the policies themselves or of the imposed shocks on prices of grains.

The scenarios without shocks maintain a business-as-usual setting, except they replace the existing policy with the alternative policy. The scenarios with shocks have the same settings as the scenarios without shocks, except that productivity levels of either domestic or rest of the world's value added for targeted grains (i.e. wheat only; or coarse grains, rice and wheat together) are shocked (also see Table 3).

6 Modelling results

This section describes the results of the simulations where shocks[6] and alternative policies are introduced for wheat only. The results and accompanying explanations for simultaneously running shocks and alternative policies on coarse grains, rice and wheat together are similar. These are not explored here for brevity purposes, but the key messages from those simulations are similar to those below. Detailed results are available from the authors on request.

Results are summarised in Table 4 to Table 6 under different shocks, which use a green up-arrow where a policy option together with a shock (if relevant) shows an improvement or no change relative to the baseline in 2020 and a red down-arrow where a policy option together with a shock (if relevant) provides results that are worse than those in the baseline in 2020.

Results in Table 4 show that all alternative policies perform better on overall efficiency grounds (measured by the effects on GDP and aggregate household consumption) than the existing policy when there is no shock (i.e. the change between runs is only due to the policy). The results on overall equity (measured by the effects on aggregate consumption for each type of household) differ across policies, showing distributional impacts of policy changes on individual household groups.

When there are shocks, similar findings are also shown in the results (Table 5 and Table 6). There is one exception that GDP under the existing policy is better than under alternative policies when there is a negative domestic productivity shock, i.e. a lower domestic productivity and a higher domestic price. This can be seen in the detailed results on GDP shown in Table 7. This exception arises because, under the existing policy, when the government sells grains from stockpiles, it serves to inject real income into the economy (see further discussions later).

The outcomes under the alternative policies for agricultural household consumption are mixed. A land subsidy policy (less distorting when it is non-commodity-specific) gives the best outcome for agricultural households under different price shocks scenarios. However, this is different for non-agricultural households, where the best outcome is under the 'Remove all policies' scenario or policies which are non-distortionary—such as the combination of a deficiency payment and food voucher. The commodity-specific land subsidy policy gives the worst outcome for non-agricultural households because the income transfer is the largest from non-agricultural households to agricultural households in this case.

[6] The shocks presented in this report are all temporary at 2020.

Table 4 Overall assessment of policy responses with no price shock, 2020, compared with baseline

	Equity measures		Efficiency measures	
	Aggregate agricultural household consumption	**Aggregate non-agricultural household consumption**	**Aggregate household consumption**	**GDP**
Existing policy				
Deficiency payment for producers and subsidy for consumers	↓	↑	↑	↑
Deficiency payment for producers and food voucher for consumers	↓	↑	↑	↑
Commodity-specific land subsidy for producers and subsidy for consumers	↑	↑	↑	↑
Non-commodity-specific land subsidy for producers and subsidy for consumers	↑	↑	↑	↑
No producer support; lump sum income transfer to agricultural households	↑	↑	↑	↑
Remove all policies	↓	↑	↑	↑

Note: Existing policy represents the baseline when there is no shock. Green up-arrow for better than or equal to baseline in 2020. Red down-arrow for worse than baseline in 2020.

Table 5 Overall assessment of policy responses with higher domestic price (lower productivity), 2020, compared with baseline

	Equity measures		Efficiency measures	
	Aggregate agricultural household consumption	Aggregate non-agricultural household consumption	Aggregate household consumption	GDP
Existing policy	↓	↑	↑	↑
Deficiency payment for producers and subsidy for consumers	↓	↑	↑	↑
Deficiency payment for producers and food voucher for consumers	↓	↑	↑	↑
No producer support; lump sum income transfer to agricultural households	↑	↑	↑	↑
Remove all policies	↓	↑	↑	↑

Note: Green up-arrow for better than or equal to baseline. Red down-arrow for worse than baseline. Baseline is the scenario with existing policy but without any shocks.

Table 6 Overall assessment of policy responses with lower domestic price (higher productivity), 2020, compared with baseline

	Equity measures		Efficiency measures	
	Aggregate agricultural household consumption	Aggregate non-agricultural household consumption	Aggregate household consumption	GDP
Existing policy	↑	↓	↓	↓
Deficiency payment for producers and subsidy for consumers	↑	↑	↑	↑
Commodity-specific land subsidy for producers and subsidy for consumers	↑	↓	↑	↑
Non-commodity-specific land subsidy for producers and subsidy for consumers	↑	↓	↑	↑
No producer support, lump sum income transfer to agricultural households	↑	↑	↑	↑
Remove all policies	↓	↑	↑	↑

Note: Green up-arrow for better than or equal to baseline. Red down-arrow for worse than baseline.

It is worth noting the following for interpreting the results:

1) the results reported are only for specific years
2) the shocks simulated are temporary
3) when the government purchases grains from the market and stores it, the volume that is put into storage can be considered an investment made in that year, and
4) when the government sells grains from storage, the amount sold contributes to the GDP for that year. However, the resource costs for the amount sold that were incurred when the same amount of grains were purchased for storing are not subtracted from GDP. Hence, under the existing policy, when the government sells grains from storage, it serves to inject

real income into the economy. If this occurs, GDP may perform better than under other policies in the specific year (for example, see Table 7 for the case of a domestic lower productivity shock).

6.1 Overall assessment of policy options

The model simulation results suggest:

1) the greatest gains for the Chinese economy occur when all agricultural support policies are removed. However, in this case China's objective of reducing disparities between agricultural and non-agricultural households is not met as non-agricultural households become better off while agricultural households become worse off (in terms of their respective aggregate consumption, a measure of welfare)
2) replacing the existing policies with non-distortionary alternatives leads to gains in the Chinese economy, albeit lower than under removing all support policies. In general these alternatives fail to address the issue of income disparities between agricultural and non-agricultural households
3) replacing the minimum price support to producers with a direct lump sum income transfer to agricultural households results in a gain in the Chinese economy and prevents rising income disparities between agricultural and non-agricultural households. However, the overall gain for the Chinese economy is lower than under some of the alternatives.

These main messages are derived from a consideration of variables that are likely to be important to the Chinese government, namely GDP (Table 7), household consumption as an aggregate (Table 8), household consumption of agricultural staples[7] under various price shocks (Table 9) as well as domestic agristaple production (Table 10).

[7] Results are shown for wheat only. Results for other agricultural staples are available from the authors on request.

Table 7 Real GDP, China, policy changes and shocks applied only to wheat

Scenarios	Real GDP 2020	2025	2050
		(US$b, 2011)	
Business-as-usual (BAU)	13,768	17,909	48,666
No shock		*(% deviation from BAU)*	
Existing policy	0.000%	0.000%	0.000%
Deficiency payment for producers and subsidy for consumers	+0.132%	+0.178%	+0.110%
Deficiency payment for producers and food voucher for consumers	+0.132%	+0.178%	+0.110%
Commodity-specific land subsidy for producers and subsidy for consumers	+0.114%	+0.149%	+0.085%
Non-commodity-specific land subsidy for producers and subsidy for consumers	+0.130%	+0.176%	+0.106%
No producer support, lump sum income transfer to agricultural households	+0.131%	+0.178%	+0.109%
Remove all policies	+0.132%	+0.179%	+0.110%
Domestic lower productivity shock (–15%)			
Existing policy	+0.079%	+0.018%	+0.012%
Deficiency payment for producers and subsidy for consumers	+0.078%	+0.162%	+0.107%
Deficiency payment for producers and food voucher for consumers	+0.078%	+0.162%	+0.107%
No producer support, lump sum income transfer to agricultural households	+0.076%	+0.161%	+0.106%
Remove all policies	+0.078%	+0.163%	+0.107%
Domestic higher productivity shock (+15%)			
Existing policy	−0.258%	−0.061%	−0.033%
Deficiency payment for producers and subsidy for consumers	+0.172%	+0.191%	+0.112%
Commodity-specific land subsidy for producers and subsidy for consumers	+0.118%	+0.144%	+0.081%
Non-commodity-specific land subsidy for producers and subsidy for consumers	+0.166%	+0.186%	+0.107%
No producer support, lump sum income transfer to agricultural households	+0.173%	+0.191%	+0.112%
Remove all policies	+0.173%	+0.192%	+0.113%
World lower productivity shock (–15%)			
Existing policy	+0.019%	+0.014%	+0.003%
Deficiency payment for producers and subsidy for consumers	+0.111%	+0.187%	+0.110%
Deficiency payment for producers and food voucher for consumers	+0.111%	+0.187%	+0.110%
No producer support, lump sum income transfer to agricultural households	+0.111%	+0.186%	+0.109%
Remove all policies	+0.111%	+0.187%	+0.111%
World higher productivity shock (+15%)			
Existing policy	−0.002%	−0.008%	−0.001%
Deficiency payment for producers and subsidy for consumers	+0.147%	+0.172%	+0.110%
Commodity-specific land subsidy for producers and subsidy for consumers	+0.128%	+0.142%	+0.084%
Non-commodity-specific land subsidy for producers and subsidy for consumers	+0.145%	+0.170%	+0.106%
No producer support, lump sum income transfer to agricultural households	+0.146%	+0.171%	+0.109%
Remove all policies	+0.147%	+0.173%	+0.110%

Note: Business-as-usual scenario is shown in levels. Results for other scenarios are shown as the percentage deviation from business-as-usual.

Table 8 Household aggregate consumption, China, policy changes and shocks applied only to wheat

Scenarios	Agricultural households			Other households		
	2020	2025	2050	2020	2025	2050
	(US$b, 2011)			*(US$b, 2011)*		
Business-as-usual (BAU)	646	813	1,914	4,427	5,722	15,726
No shock	*(% deviation from BAU)*			*(% deviation from BAU)*		
Existing policy	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Deficiency payment for producers and subsidy for consumers	−0.20%	−0.28%	−0.01%	+0.17%	+0.23%	+0.11%
Deficiency payment for producers and food voucher for consumers	−0.20%	−0.28%	−0.01%	+0.17%	+0.23%	+0.11%
Commodity-specific land subsidy for producers and subsidy for consumers	+0.58%	+0.72%	+0.18%	+0.06%	+0.08%	+0.06%
Non-commodity-specific land subsidy for producers and subsidy for consumers	+0.65%	+0.81%	+0.22%	+0.07%	+0.10%	+0.08%
No producer support, lump sum income transfer to agricultural households	0.00%	0.00%	0.00%	+0.15%	+0.20%	+0.10%
Remove all policies	−0.39%	−0.49%	−0.02%	+0.19%	+0.25%	+0.11%
Domestic lower productivity shock (–15%)						
Existing policy	−0.63%	−0.06%	+0.00%	+0.16%	+0.03%	+0.01%
Deficiency payment for producers and subsidy for consumers	−0.62%	−0.30%	−0.01%	+0.15%	+0.21%	+0.10%
Deficiency payment for producers and food voucher for consumers	−0.63%	−0.30%	−0.01%	+0.15%	+0.21%	+0.10%
No producer support, lump sum income transfer to agricultural households	0.00%	0.00%	0.00%	+0.08%	+0.18%	+0.10%
Remove all policies	−0.63%	−0.51%	−0.02%	+0.15%	+0.24%	+0.10%
Domestic higher productivity shock (+15%)						
Existing policy	+1.31%	+0.11%	−0.01%	−0.43%	−0.08%	−0.03%
Deficiency payment for producers and subsidy for consumers	+0.39%	−0.26%	−0.01%	+0.16%	+0.24%	+0.11%
Commodity-specific land subsidy for producers and subsidy for consumers	+3.20%	+0.99%	+0.22%	−0.24%	+0.04%	+0.05%
Non-commodity-specific land subsidy for producers and subsidy for consumers	+3.44%	+1.12%	+0.26%	−0.20%	+0.08%	+0.08%
No producer support, lump sum income transfer to agricultural households	0.00%	0.00%	0.00%	+0.20%	+0.21%	+0.11%
Remove all policies	−0.17%	−0.47%	−0.01%	+0.22%	+0.26%	+0.11%
World lower productivity shock (–15%)						
Existing policy	+0.22%	+0.02%	+0.00%	+0.01%	+0.01%	+0.00%
Deficiency payment for producers and subsidy for consumers	+0.09%	−0.25%	−0.01%	+0.13%	+0.23%	+0.11%
Deficiency payment for producers and food voucher for consumers	+0.09%	−0.25%	−0.01%	+0.13%	+0.23%	+0.11%
No producer support, lump sum income transfer to agricultural households	0.00%	0.00%	0.00%	+0.14%	+0.20%	+0.10%
Remove all policies	−0.05%	−0.47%	−0.02%	+0.14%	+0.26%	+0.11%
World higher productivity shock (+15%)						
Existing policy	−0.14%	−0.01%	−0.00%	+0.01%	−0.01%	−0.00%
Deficiency payment for producers and subsidy for consumers	−0.39%	−0.30%	−0.01%	+0.20%	+0.22%	+0.11%
Commodity-specific land subsidy for producers and subsidy for consumers	+0.44%	+0.70%	+0.18%	+0.08%	+0.08%	+0.06%
Non-commodity-specific land subsidy for producers and subsidy for consumers	+0.55%	+0.80%	+0.22%	+0.09%	+0.10%	+0.08%
No producer support, lump sum income transfer to agricultural households	0.00%	0.00%	0.00%	+0.16%	+0.19%	+0.10%
Remove all policies	−0.61%	−0.50%	−0.02%	+0.23%	+0.25%	+0.11%

Note: Business-as-usual scenario is shown in levels. Results for other scenarios are shown as the percentage deviation from business-as-usual.

Table 9 Wheat consumption, China, policy changes and shocks applied only to wheat

	Agricultural households			Other households		
Scenarios	**2020**	**2025**	**2050**	**2020**	**2025**	**2050**
	(US$b, 2011)			*(US$b, 2011)*		
Business-as-usual (BAU)	0.87	1.09	2.45	1.29	1.62	3.95
No shock	*(% deviation from BAU)*			*(% deviation from BAU)*		
Existing policy	0%	0%	0%	0%	0%	0%
Deficiency payment for producers and subsidy for consumers	+3%	+3%	+0%	+3%	+4%	+0%
Deficiency payment for producers and food voucher for consumers	+3%	+3%	+0%	+3%	+4%	+0%
Commodity-specific land subsidy for producers and subsidy for consumers	+6%	+7%	+1%	+6%	+7%	+1%
Non-commodity-specific land subsidy for producers and subsidy for consumers	+3%	+4%	+0%	+3%	+4%	+0%
No producer support, lump sum income transfer to agricultural households	+3%	+3%	+0%	+3%	+4%	+0%
Remove all policies	+3%	+3%	+0%	+3%	+4%	+0%
Domestic lower productivity shock (–15%)						
Existing policy	–4%	–0%	+0%	–3%	+0%	+0%
Deficiency payment for producers and subsidy for consumers	–4%	+3%	+0%	–3%	+4%	+0%
Deficiency payment for producers and food voucher for consumers	–4%	+3%	+0%	–3%	+4%	+0%
No producer support, lump sum income transfer to agricultural households	–3%	+3%	+0%	–3%	+4%	+0%
Remove all policies	–4%	+3%	+0%	–3%	+4%	+0%
Domestic higher productivity shock (+15%)						
Existing policy	+1%	+0%	–0%	–0%	–0%	–0%
Deficiency payment for producers and subsidy for consumers	+8%	+3%	+0%	+8%	+4%	+0%
Commodity-specific land subsidy for producers and subsidy for consumers	+17%	+8%	+2%	+14%	+7%	+1%
Non-commodity-specific land subsidy for producers and subsidy for consumers	+11%	+4%	+0%	+8%	+3%	+0%
No producer support, lump sum income transfer to agricultural households	+8%	+3%	+0%	+8%	+4%	+0%
Remove all policies	+8%	+3%	+0%	+8%	+4%	+0%
World lower productivity shock (–15%)						
Existing policy	+0%	+0%	+0%	–0%	+0%	+0%
Deficiency payment for producers and subsidy for consumers	+2%	+3%	+0%	+2%	+4%	+0%
Deficiency payment for producers and food voucher for consumers	+2%	+3%	+0%	+2%	+4%	+0%
No producer support, lump sum income transfer to agricultural households	+2%	+3%	+0%	+2%	+4%	+0%
Remove all policies	+2%	+3%	+0%	+2%	+4%	+0%
World higher productivity shock (+15%)						
Existing policy	+0%	–0%	–0%	+0%	–0%	–0%
Deficiency payment for producers and subsidy for consumers	+3%	+3%	+0%	+4%	+4%	+0%
Commodity-specific land subsidy for producers and subsidy for consumers	+7%	+7%	+1%	+7%	+7%	+1%
Non-commodity-specific land subsidy for producers and subsidy for consumers	+4%	+4%	+0%	+4%	+3%	+0%
No producer support, lump sum income transfer to agricultural households	+4%	+3%	+0%	+4%	+4%	+0%
Remove all policies	+3%	+3%	+0%	+4%	+4%	+0%

Note: Business-as-usual scenario is shown in levels. Results for other scenarios are shown as the percentage deviation from business-as-usual.

Table 10 Production, China, policy changes and shocks applied only to wheat

Scenarios	Wheat 2020	2025	2050
	(US$b, 2011)		
Business-as-usual (BAU)	82	112	204
No shock	*(% deviation from BAU)*		
Existing policy	0%	0%	0%
Deficiency payment for producers and subsidy for consumers	−17%	−21%	−6%
Deficiency payment for producers and food voucher for consumers	−17%	−21%	−6%
Commodity-specific land subsidy for producers and subsidy for consumers	−12%	−16%	−4%
Non-commodity-specific land subsidy for producers and subsidy for consumers	−17%	−21%	−6%
No producer support, lump sum income transfer to agricultural households	−17%	−21%	−6%
Remove all policies	−17%	−21%	−6%
Domestic lower productivity shock (−15%)			
Existing policy	−26%	−3%	−0%
Deficiency payment for producers and subsidy for consumers	−26%	−21%	−6%
Deficiency payment for producers and food voucher for consumers	−26%	−21%	−6%
No producer support, lump sum income transfer to agricultural households	−26%	−21%	−6%
Remove all policies	−26%	−21%	−6%
Domestic higher productivity shock (+15%)			
Existing policy	+55%	+6%	+1%
Deficiency payment for producers and subsidy for consumers	−7%	−21%	−6%
Commodity-specific land subsidy for producers and subsidy for consumers	+4%	−15%	−4%
Non-commodity-specific land subsidy for producers and subsidy for consumers	−7%	−21%	−6%
No producer support, lump sum income transfer to agricultural households	−7%	−21%	−6%
Remove all policies	−7%	−21%	−6%
World lower productivity shock (−15%)			
Existing policy	−0%	−0%	−0%
Deficiency payment for producers and subsidy for consumers	−12%	−21%	−6%
Deficiency payment for producers and food voucher for consumers	−12%	−21%	−6%
No producer support, lump sum income transfer to agricultural households	−12%	−21%	−6%
Remove all policies	−12%	−21%	−6%
World higher productivity shock (+15%)			
Existing policy	+0%	+0%	+0%
Deficiency payment for producers and subsidy for consumers	−20%	−21%	−6%
Commodity-specific land subsidy for producers and subsidy for consumers	−16%	−16%	−4%
Non-commodity-specific land subsidy for producers and subsidy for consumers	−20%	−21%	−6%
No producer support, lump sum income transfer to agricultural households	−20%	−21%	−6%
Remove all policies	−20%	−21%	−6%

Note: Business-as-usual scenario is shown in levels. Results for other scenarios are shown as the percentage deviation from business-as-usual.

6.1.1 Present value measure

Because the model used is recursive dynamic, the government's buying and selling of grain stocks in a given year reflects only current circumstances that are specific to meet the price band target at the time. The government's decisions modelled do not take intertemporal effects into

consideration when they are made. However, they have intertemporal implications for the welfare of households and the economy more broadly.

As such, this modelling also measures intertemporal effects of policy changes and price shocks on the present value of welfare. The key aspects explored relate to the accounting for future stock values, opportunity costs of stock holding and ongoing versus one-off impacts on household welfare.

The intertemporal effects from stock holding can be best measured by considering the trade-off between grains stocks and physical capital stocks. When the government invests more in grain stocks (i.e. purchases more), it leads to less saving or funds available for investment in capital, contributing to lower capital stocks, assuming everything else is unchanged. Over the time horizon simulated, the net effects on the grains stocks and capital stocks are reflected by both types of stocks left over at the terminal year, 2050, and their initial levels adjusted by a discount factor. As the initial levels of both types of stocks are the same across all scenarios, differences in stock levels at the terminal year represent the policy change and shock effects between scenarios. On top of changes in stock levels, changes in the welfare of households, as measured by real consumption, needs to be captured since there is also a trade-off between household/private consumption and capital stocks. Hence, the following metric measuring present value of welfare and stocks is introduced in this study and is used for comparison of intertemporal effects between scenarios:

$$PV(z,sim) = \sum_{hh,t} \frac{\log(cth\_real\_h(hh,z,t,sim))}{[1+r]^{(t-1)}} + \frac{P_K(z,T,sim)\cdot K(z,T,sim) + P_{GS}(z,T,sim)\cdot GS(z,T,sim)}{[1+r]^{(T-1)}}$$

where

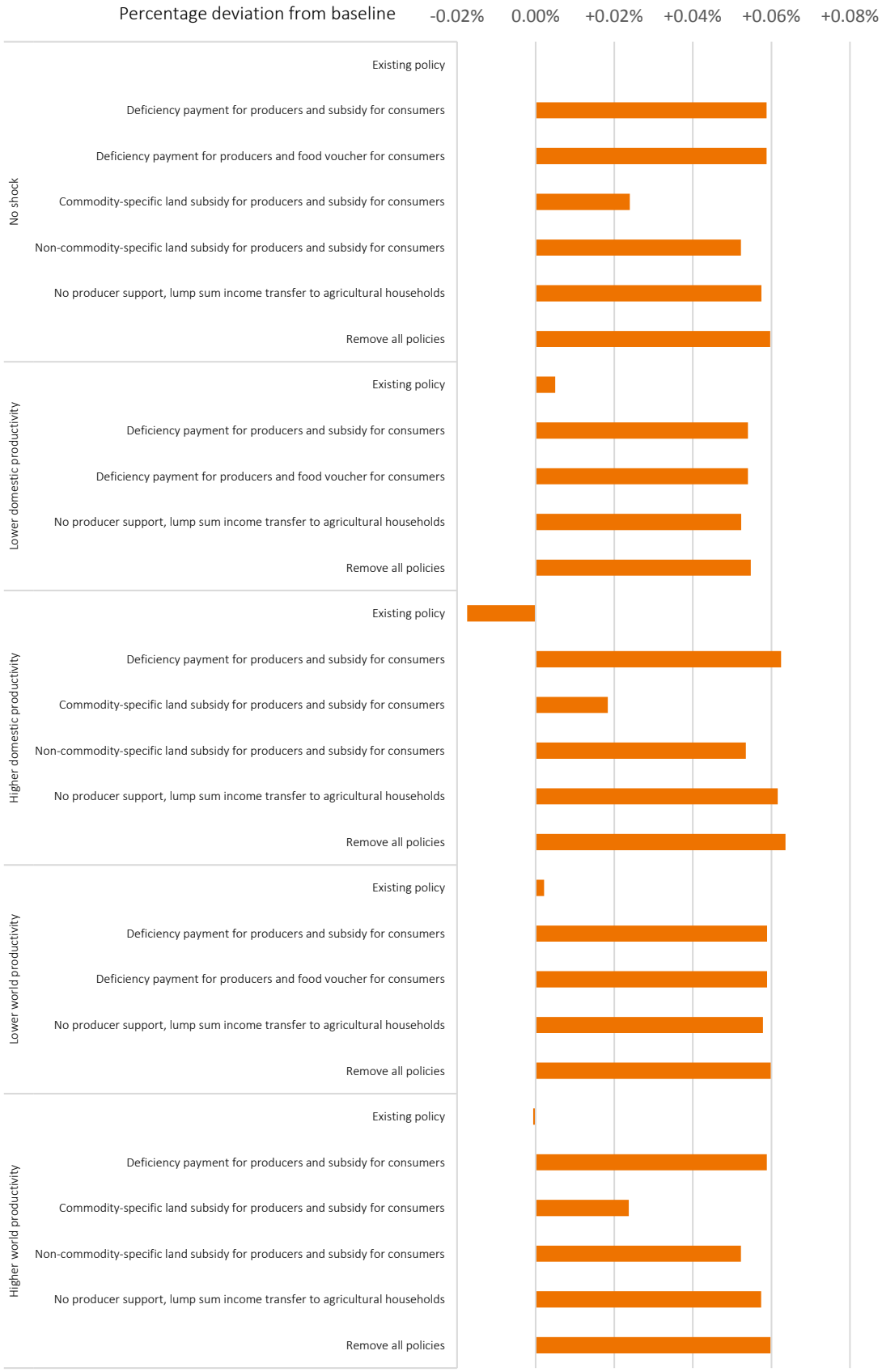
- *PV*: present value by region and scenario
- *z*: regions (i.e. China)
- *sim*: scenarios
- *hh*: household types (i.e. agricultural and non-agricultural)
- *t*: years (i.e. 2011, 2012, …, 2050)
- *T*: terminal year (i.e. 2050)
- *cth_real_h*: real consumption by household type, region, year and scenario
- *r*: real discount factor (4% is assumed)
- *K*: capital stock by region, year and scenario
- P_K: price of capital stock by region, year and scenario
- *GS*: grains stock by region, year and scenario, and
- P_{GS}: price of grains stock by region, year and scenario.

Given the fixed time horizon modelled, the values of capital and grains stocks at the terminal year are included to reflect the uncaptured future value of welfare. That is, the PV defined in this way is used to approximate the welfare over an infinite time horizon. The first component in the PV formula represents the present value of welfare over the finite time horizon simulated. The second and third components represent the discounted terminal values of capital and grains stock, respectively, which are included to approximate the uncaptured future welfare value because the simulations only run for a finite time horizon.

The results of the present value (PV) analysis are shown in Figure 3. The PV numbers show aggregate effects on the combined welfare of two types of households over the simulated time horizon. This PV analysis provides additional overall assessment to those already shown in Table 4 to Table 6. The policy messages are consistent across the two measures (PV and efficiency measure in 2020):

1) removal of all policies brings the greatest gain to the Chinese economy as well as the greatest gain to the overall PV
2) non-distortionary policies such as a deficiency payment for producers provide higher gains in the overall PV than distortionary policies such as a commodity-specific land subsidy
3) no producer support but a lump sum transfer to agricultural households brings comparably positive gains in the PV, albeit lower than that of some non-distortionary policies. Despite this, it protects incomes and aggregate consumption of agricultural households, and at the same time incomes and aggregate consumption of non-agricultural households remain improved from their baseline levels.

Figure 3 Present value of different policy options, compared with baseline



6.2 Effect on external market

China is a large producer and also a large exporter and importer of agricultural commodities in the global market. Consequently China's domestic policies significantly influence the world market and may affect open economies that are major grain exporters.

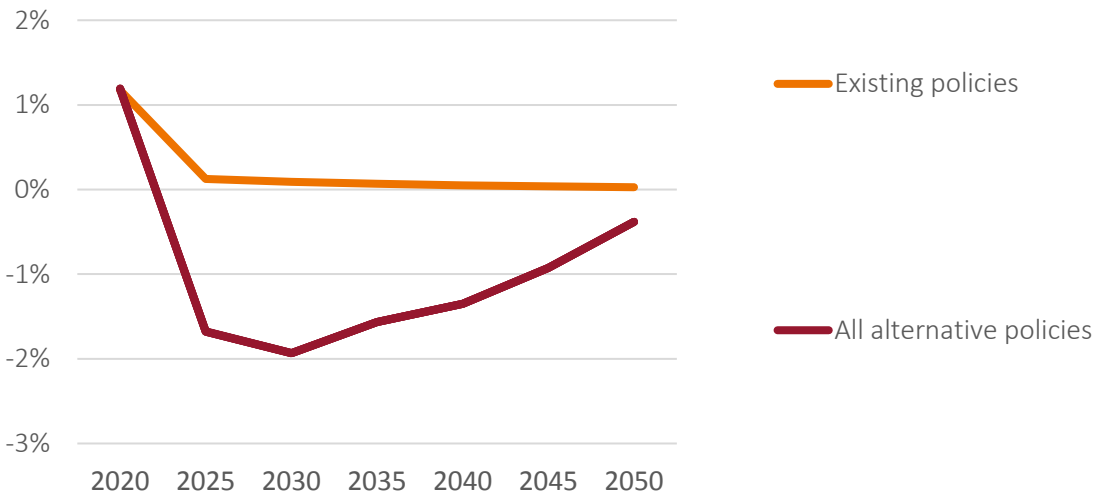
Exports of coarse grains and wheat from Australia (one of these major grain-exporting open economies) to the world respond to the prices in export markets in the simulations. These prices are influenced by China's import demand, China's exports and exogenous productivity shocks. In the absence of shocks, Australia's exports decrease when China chooses alternative policies, reflecting a lower domestic price under alternative policies in China. The lower domestic price contributes to decreased imports to and/or increased exports from China, and reduces Australia's exports. Further discussion is also provided in Box 1.

The greatest gains for Australia's exports are seen when there is a higher world productivity shock. In contrast, the greatest losses for Australia's exports are seen when there is a lower world productivity shock. The changes in Australia's exports are predictably similar to the size of the world productivity shock.

When there is a negative productivity shock in China, Australia benefits and exports more. Similarly, when there is a higher productivity shock in China, Australia exports less. The policy alternative in China that has the biggest impact on Australia's exports is the commodity-specific land subsidy. This policy which targets a specific commodity leads to a significant increase in China's production of that commodity, hence adversely affecting Australia's exports.

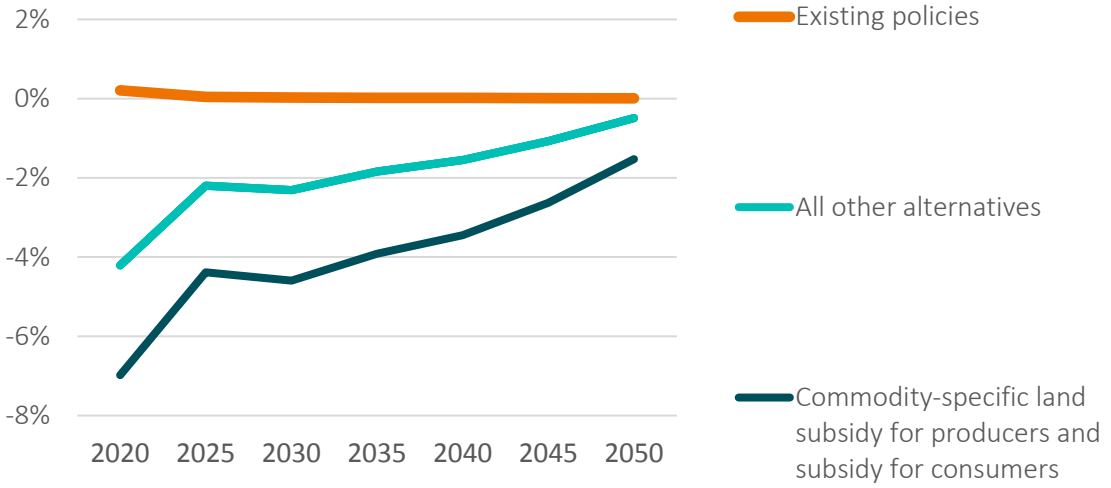
These results are summarised in Figure 4 and Figure 5.

Figure 4 Wheat exports, Australia to world, negative Chinese domestic productivity shock applied to wheat at 2020, percentage deviation from baseline



Note: With this particular shock, the modelling results show that all alternative policies simulated have the same effect on Australia's exports (also see Table 11). When domestic price in China rises due to a negative productivity shock at 2020, the market price becomes higher than the minimum support price. As a result, all policies including the existing policy are inactive at 2020, leading to the same effects across all policies at 2020. For other years, Chinese domestic prices facing Australian exporters are the same under all alternative policies shown because these alternative policies do not affect market prices. However, the domestic price in China is higher under the existing policy due to the minimum support price, leading to higher exports from Australia compared to that under the alternative policies.

Figure 5 Wheat exports, Australia to world, positive Chinese domestic productivity shock applied to wheat at 2020, percentage deviation from baseline



Note: all alternative policies simulated except the commodity-specific land subsidy have the same effect on Australia's wheat exports (the same reason discussed in the note for Figure 4 applies). Under the existing policy, the Chinese domestic price facing Australian exporters is almost the same as that in the baseline because it is set by the minimum support price, leading to no change from the baseline. For the case of the commodity-specific land subsidy policy which targets wheat, there is a significant increase in China's production of wheat, adversely affecting Australia's exports.

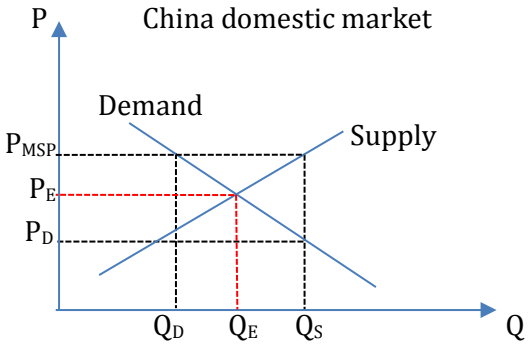
Table 11 Exports, Australia, policy changes and shocks applied only to wheat

Scenarios	Wheat 2020	2025	2050
	(US$b, 2011)		
Business-as-usual (BAU)	9	11	25
No shock	*(% deviation from BAU)*		
Existing policy	0.0%	0.0%	0.0%
Deficiency payment for producers and subsidy for consumers	−1.6%	−2.0%	−0.4%
Deficiency payment for producers and food voucher for consumers	−1.6%	−2.0%	−0.4%
Commodity-specific land subsidy for producers and subsidy for consumers	−3.0%	−3.8%	−1.3%
Non-commodity-specific land subsidy for producers and subsidy for consumers	−1.5%	−2.0%	−0.4%
No producer support, lump sum income transfer to agricultural households	−1.6%	−2.0%	−0.4%
Remove all policies	−1.6%	−2.0%	−0.4%
Domestic lower productivity shock (–15%)			
Existing policy	+1.2%	+0.1%	+0.0%
Deficiency payment for producers and subsidy for consumers	+1.2%	−1.7%	−0.4%
Deficiency payment for producers and food voucher for consumers	+1.2%	−1.7%	−0.4%
No producer support, lump sum income transfer to agricultural households	+1.2%	−1.7%	−0.4%
Remove all policies	+1.2%	−1.7%	−0.4%
Domestic higher productivity shock (+15%)			
Existing policy	+0.2%	+0.0%	+0.0%
Deficiency payment for producers and subsidy for consumers	−4.2%	−2.2%	−0.5%
Commodity-specific land subsidy for producers and subsidy for consumers	−7.0%	−4.4%	−1.5%
Non-commodity-specific land subsidy for producers and subsidy for consumers	−4.2%	−2.2%	−0.5%
No producer support, lump sum income transfer to agricultural households	−4.2%	−2.2%	−0.5%
Remove all policies	−4.2%	−2.2%	−0.5%
World lower productivity shock (–15%)			
Existing policy	−14.1%	−0.5%	−0.1%
Deficiency payment for producers and subsidy for consumers	−15.1%	−2.4%	−0.6%
Deficiency payment for producers and food voucher for consumers	−15.1%	−2.4%	−0.6%
No producer support, lump sum income transfer to agricultural households	−15.1%	−2.4%	−0.6%
Remove all policies	−15.1%	−2.4%	−0.6%
World higher productivity shock (+15%)			
Existing policy	+12.5%	+0.4%	+0.1%
Deficiency payment for producers and subsidy for consumers	+10.9%	−1.6%	−0.3%
Commodity-specific land subsidy for producers and subsidy for consumers	+9.5%	−3.4%	−1.2%
Non-commodity-specific land subsidy for producers and subsidy for consumers	+10.9%	−1.6%	−0.3%
No producer support, lump sum income transfer to agricultural households	+10.9%	−1.6%	−0.3%
Remove all policies	+10.9%	−1.6%	−0.3%

Note: Business-as-usual scenario is shown in levels. Results for other scenarios are shown as the percentage deviation from business-as-usual.

Box 1 Understanding modelling results for Australia's exports and China's imports

In this modelling, China's minimum support price is implemented through government purchases for stockpiles when the market price falls below the support price. This is reflected in the baseline where the Chinese government uses purchases to push up the market price to the minimum support price, as illustrated in the diagram below:



where

- P_{MSP} represents the minimum support price,
- Q_D is the demand at the minimum support price,
- Q_s is the supply at the minimum support price,
- P_D is the price consumers pay at the supply volume Q_S,
- P_E is the domestic equilibrium price when there is no government intervention, and
- Q_E is the volume at the domestic equilibrium.

Case 1- Domestic market: minimum price supported by government purchases

In the baseline, it is assumed that the domestic equilibrium price is below the minimum support price as illustrated in the diagram above, which is for the domestic market only. The government purchases the excess supply for stockpiles at the minimum support price, with the volume represented by $Q_s - Q_D$.

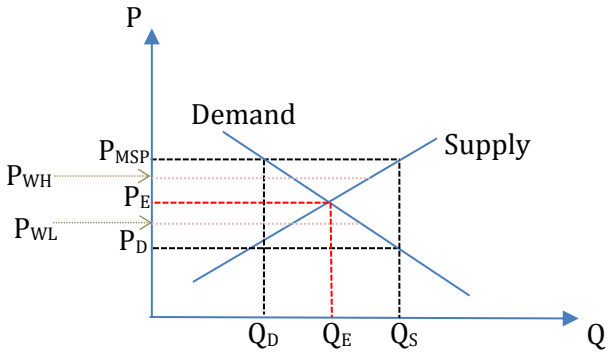
Case 1- Imports: domestic and imported wheats are heterogeneous

While the diagram illustrates supply and demand in the domestic market only, China also imports. This modelling study assumes imperfect substitution between domestic and imported wheat, implying differentiated prices for domestic and imported products. This leads to substitution towards domestic wheat if the domestic price for consumers under alternative policies becomes lower than that in the baseline, i.e. China importing less. This is why Australia exports less under alternative policies in China.

Case 2 - Domestic market: minimum price supported by government subsidy

If China's minimum support price were to be modelled through a government subsidy in the baseline, that is, producers supplying a volume of Q_s, consumers paying a price of P_D, and government paying a subsidy equating to $P_{MSP} - P_D$ to the producer, the modelling results on Australia's exports would be different under alternative policies in China. In this case, the price paid by consumers under alternative policies without the subsidy would be higher than in the baseline, leading to China importing more and therefore Australia exporting more under alternative policies. This contrasts to the modelling results shown in this report.

Case 3 - Imports: domestic and imported wheats are homogenous



where

- P_{WH} is an illustrative world price above the domestic equilibrium price, and
- P_{WL} is an illustrative world price below the domestic equilibrium price.

Yet, if in the baseline the modelling were to assume China's domestic and imported wheat is perfectly substitutable, that is, China's domestic price and world price are equalised without the government intervention, then China's imports of wheat could be higher or lower under alternative policies than that in the baseline, depending on whether the world price is higher or lower than China's own domestic market equilibrium price. As illustrated in the diagram above, if the world price is P_{WH}, then China would export more under alternative policies—implying Australia would export less; if the world price is P_{WL}, then China would import more under alternative policies—implying Australia would export more.

Case 4 - Imports: Australian wheat is of high quality

The other case which could be more realistic is that Australian wheat is considered of high quality, which attracts a premium in China. If this case were to be modelled, Australian exports to China are unlikely to be affected when China changes its policy, because Australian wheat is seen as not substitutable with domestic product. In fact, alternative policies which improve China's economic outcome would increase China's demand for high quality Australian products, because of the resultant higher income in China. This case is being considered for future study.

In summary, the modelling results on Australian exports depend on how China's current policy is implemented in the baseline. Supporting a minimum price through government purchases for a stockpile leads to a different result on Australian exports compared to a government subsidy to producers. If Australian products are seen of high quality and less substitutable with domestic product, then Australian exports are unlikely to be affected by a change in the minimum price support policy in China.

7 Discussion and conclusion

In recent years the Chinese government has strengthened its commitment to improving rural welfare. How the Chinese economy responds is of interest not just domestically but also externally in countries like Australia. This is because policy changes in China can affect world markets, and prices received by farmers in open economies are largely determined by world markets.

This paper has considered how price shocks affect producers and consumers, as well as the whole economy under different policy alternatives. It has also considered how policy alternatives would affect the grain exports of an open economy, such as Australia.

A computable general equilibrium model was adapted from a GTAP-type PEP model and used to answer these questions. A number of new features were added to the model to ensure it was suitable. Specifically, the model incorporates different household types for simulating distributional impacts. It also incorporates complex policy characteristics, such as price floors and ceilings and government buying and selling. Land supply and allocation across all land-based activities were also introduced into the model, while maintaining the land allocated to all activities summing up linearly to the total amount of land available.

When different policy settings were considered in the absence of price shocks, the existing policies generally raise prices for consumers because the government imposes the minimum support prices for producers. By changing policies, the modelling showed that better outcomes can be achieved.

When different policy settings were considered in the presence of price shocks, it is clear that alternative policy options achieve better outcomes for agricultural household incomes, GDP and food security. In general, non-distortionary policies provided good alternatives to existing policies because they promoted GDP growth and aggregate household consumption growth.

On equity measures, different policies yielded mixed results. The non-commodity-specific land subsidy appears to provide favourable results for agricultural households because it enables agricultural households to use their land optimally. However, it causes relatively big income transfers from non-agricultural households to agricultural households. For non-agricultural households, the most favourable policy is to remove all support policies. When all support policies to producers are removed, the results indicate that improved equity can be achieved with a direct lump sum transfer to agricultural households. At the same time, this policy option with a direct lump sum transfer to agricultural households also brings a similar gain in economic efficiency to the most efficient alternative, which is removing all policies. Hence the direct lump sum transfer policy is a win-win policy for all households and China overall.

The modelling also provides insights on food security under different policies and price shocks. Access to food is improved under all alternative policies in all circumstances with and without price shocks for agricultural households. Alternative policies generally achieve stronger food security outcomes for non-agricultural households.

The modelling provided insights on the effects of Chinese policy changes on Australia's exports. Predictably, price shock and policy combinations that lead to higher prices in China generally lead to higher exports from Australia and vice versa.

Appendix A: aggregations of regions and sectors

In this paper 14 regions and 15 commodity groups were modelled, which were aggregated from 140 standard regions and 57 standard commodities in the GTAP database (version 9), respectively. The mappings for the region and commodity aggregations are as follows.

Table A1 Mapping for aggregation of regions

Regions modelled	GTAP regions
1. AUS	*Australia*
2. CHINAHK	*China, Hong Kong (SAR of China)*
3. BRAZ	*Brazil*
4. EU-27	*Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Bulgaria, Croatia, Romania*
5. FSU	*Belarus, Russian Federation, Ukraine, Rest of Eastern Europe, Kazakhstan, Kyrgyzstan, Rest of Former Soviet Union, Armenia, Azerbaijan, Georgia*
6. GBR	*United Kingdom*
7. INDIA	*India*
8. INDON	*Indonesia*
9. JPNKOR	*Japan, South Korea*
10. NZL	*New Zealand*
11. USA	*United States of America*
12. ROASEAN	*Brunei Darussalam, Cambodia, Laos, Malaysia, Philippines, Singapore, Thailand, Vietnam, Rest of Southeast Asia*
13. RONAM	*Canada, Rest of North America*
14. ROW	*All remaining regions in GTAP database*

Table A2 Mapping for aggregation of commodities

Commodities modelled	GTAP commodities
1. RICE	*Paddy rice, processed rice*
2. WHEAT	*Wheat*
3. OCERL	*Cereal grains NEC*
4. OSEED	*Oilseeds*
5. OCROP	*Vegetables, fruit, nuts, sugar cane, sugar beet, plant-based fibres, crops NEC*
6. BFDYOP	*Cattle, sheep and goats, horses, raw milk, bovine meat products, dairy products*
7. OLIVOP	*Animal products NEC, wool, silk-worm cocoons, meat products NEC*
8. EXTRCN	*Forestry, fishing, coal, oil, gas, minerals NEC*
9. OPROCFOOD	*Vegetable oils and fats, sugar, food products NEC, beverages and tobacco products*
10. CRPX	*Chemical, rubber, plastic products*
11. MANUFACTG	*Textiles, wearing apparel, leather products, wood products, paper products, publishing, petroleum, coal products, mineral products NEC, ferrous metals, metals NEC, metal products, motor vehicles and parts, transport equipment NEC, electronic equipment, machinery and equipment NEC, manufactures NEC*
12. UTILCONS	*Electricity, gas manufacture and distribution, water, construction*
13. TRANSPORT	*Transport NEC, water transport, air transport*
14. ADMIN	*Public administration, defence, education, health*
15. OTHSVC	*Trade, communication, financial services NEC, insurance, business services NEC, recreational and other services, dwellings*

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