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re food embargos a real threat to China?

Yongzheng Yang

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Yongzheng Yang is Senior Lecturer in the National Centre for Development Studies at the Australian National University.

Key to symbols used in tables

n.a.	not applicable
..	not available
-	zero
.	insignificant

Abbreviations

APEC	Asia Pacific Economic Cooperation
DFAT	Department of Foreign Affairs and Trade
EU	European Union
GDP	gross domestic product
GTAP	Global Trade Analysis Project
UK	United Kingdom
UNDP	United Nations Development Program
US	United States
USDA	United States Department of Agriculture
USSR	Union of Soviet Socialist Republics
WTO	World Trade Organisation

Food security has been the paramount objective of China's agricultural policy. Despite substantial improvement in agricultural production since the rural economic reform beginning in the late 1970s, concerns over food security in China have intensified as the Chinese economy has become increasingly integrated with the rest of the world. With remarkable growth in the past twenty years, the opportunity cost of agricultural production in China has increased substantially (Zhang 1999). China is therefore losing its comparative advantage in land-intensive agricultural commodities, especially grain. Economic efficiency dictates that China should import more grain, which would be paid for by foreign exchange earnings from its increasing exports of labour-intensive manufactured goods. Since 1994, domestic grain prices have approached or even exceeded their world levels. It was also at this time Lester Brown warned that China would have to increase its grain imports in such scale that it would cause major disruptions to the world grain market (Brown 1995).

These developments have coincided with China's ongoing effort to join the World Trade Organisation (WTO). With the successful conclusion of the Uruguay Round, agriculture is now in a process of liberalisation, and China has to be part of it if it wants to join the WTO. The WTO accession process has heightened the concern of food security in China. China has been reluctant to commit itself to liberal trade in agriculture. It would not be surprising that if other countries have increased concerns over their food security in the future as agricultural liberalisation proceeds and their grain imports increase over time. Thus, food security could be a major issue in the future rounds of multilateral trade negotiations.¹ Such an issue has already been examined in the context of the APEC process (DFAT 1996).

Aggravating China's food security concerns has been its increasing conflicts (real and perceived) with the United States over issues such as Taiwan, Tibet, human rights, religious rights, arms sales, trade and intellectual property rights. The rise of these conflicts between the United States and China seems to be an inevitable outcome of the end of the Cold War. With the collapse of the Former Soviet Union and its Eastern European allies, China is the only major country that has fundamental differences with the West in ideology. The growing influence of China can be easily seen as a threat to the US interests around the world. It happens to be that the United States is the world's largest grain exporter, and China has in the past imported large quantities of grain from it. In the past, the United States has indeed used grain embargos as a weapon to achieve its foreign policy objectives, most notably in 1980–81 when it imposed a grain embargo against the former Soviet Union following its invasion of Afghanistan.

This paper concerns with the likelihood of grain and food embargos against China, and evaluates the potential consequences of such embargos. Obviously, a clear understanding of these issues are of major interest to China and could be a useful input to the formation of its agricultural policy. It could also shed more light on the issue of using grain embargos as a foreign policy instrument from the perspective of Western countries, especially the United States.

The history of food embargos and its relevance for China

There are normally two motives to impose food embargos from the perspective of the sender country. One motive would be out of the consideration of economic interests in the sender country. Thus, the US embargo on soybean exports to Japan in 1973 was such an incident as it was primarily used to prevent soybean prices from increasing in the United States. The other motive is to bring about policy changes in the target country or to protest against the behaviour of the target country arising from domestic politics. The first type of motive normally results in general embargos, whereas the second type leads to targeted embargos against particular importing countries. In this paper, attention will be given only to targeted embargos, as this type of embargo is China's primary concern. In particular, we examine the likelihood of a food embargo against China and the chances of this being successful.

Food embargos as a means of reducing food supply to the target country are one particular type of economic sanction.² Economic sanctions are largely a modern phenomenon. In a world where individual countries are mutually independent of each other in trade and finance, economic sanctions have little effect on target countries, and hence are not often invoked. With increasing integration of the world economy, the occurrence of economic sanctions has increased substantially. In a comprehensive survey of economic sanctions, Hufbauer and Schott (1985) examined 103 economic sanctions between 1919 and 1984. There were 10 food embargos among these economic sanctions. Of these 10 food embargos, developing countries were the target countries for nine and the other one being the former Soviet Union. The United States was over-represented in these embargos (eight times). According to van Bergeijk (1995) and Hufbauer *et al.* (1999), there has been an increasing resort to economic sanctions in the 1990s, largely as a substitute for military actions. Multilateral economic sanctions imposed by the United Nations have been used more frequently. The most recent UN sanction has been imposed on Yugoslavia over the issue of Kosovo.

There is a debate over the effectiveness of economic sanctions. This largely results from different views on what constitutes a success or failure of an economic sanction. According to the traditional view of economic sanctions, often known as the 'instrumental theory', the objective of an economic sanction is to bring about policy change in the target country. Economic sanctions are simply an 'instrument' to achieve the intended objective of the sanction by inflicting the greatest possible economic harm on the target country. In this framework, economic sanctions are more likely to work, the more intensive the trade and other economic relations are between the target country and the sanctioning (sender) country (Hufbauer and Schott 1985, USDA 1986). According to the instrumental theory, economic sanctions tend to be ineffective, even though they can be costly to the sender country as well as the target country, because they often only divert trade and other economic relations. In other words, the target country can often find a substitute for the sender country in their external relations (Winters 1990). In addition, there are sometimes sanction 'busters' who come to the rescue of the target country because of some common interest with it. For these reasons, it has been widely accepted in the instrumental school of thought that economic sanctions are unlikely to work.

The other school of thought is premised on a different objective of economic sanctions, namely, to serve the interests of pressure groups in the sender country. According to this school of thought, even if economic sanctions do not inflict heavy economic losses on the target country, they can communicate signals or threats in order to produce policy change in the target country (Kaempfer and Lowenberg 1988). While this public choice approach can explain how an economic sanction may occur by examining the political equilibrium in the sender country and how economic sanctions can be made more effective by analysing the competition in the target country, it can hardly provide an objective assessment of the effectiveness of economic sanctions (Lu 1997). If, for example, the 'expressive' motive in the sender country is used for assessment, then there are probably more efficient actions that the sender country can take to register its disapproval of the behaviour of the target country, for example, by downgrading diplomatic relations.

The People's Republic of China has been subject to extensive economic sanctions in its 50 year history. In fact, sanctions against China imposed by the West were more extensive than those against any other country during the Cold War era (Evans 1987). However, there has been no explicit food embargo against China. Any assessment of the risk of food embargo against China will therefore have no empirical basis. The West may have had some success in depriving China of modern and military technology in the past. In the 1950s, China had access to such technology in the Former Soviet Bloc. The latter acted as a sanction 'buster'. China was forced to adopt a self-reliance policy after the relationship with the Soviet Bloc soured. Since then, however, the West has relaxed its controls on exports to China. Overall, economic sanctions and embargos against China by the West and the Former Soviet Bloc probably have had limited impact on economic performance in China, even though the isolation from both the West and the Former Soviet Bloc may have put China's technological development further behind the West. Some of these restrictions on technology transfers to China remain today. From this history, it is difficult to infer from this history the probability of food embargo against China and its chances of success, as food embargos have some different implications from other embargos.

Food is often regarded as more essential to human life and dignity. Inflicting starvation on a country is often regarded as inhuman in today's world, and such occurrences of starvation can easily be seen in other parts of the world and can often generate political pressure in the sender country. This is probably one factor that explains why food embargos have occurred much less frequently than other types of embargos. Food and medicine have been exempted from embargos in the most recent international economic sanctions, such as the ones against Iraq and Yugoslavia. In the US embargo against the former Soviet Union, the objective was not to deprive the Soviet people of the food, rather to 'punish the Soviet Union for its invasion of Afghanistan' (Paarlberg 1987). In the late 1970s, per capita food consumption in the Soviet Union was among the highest in the world, and the US embargos could never caused inadequate energy intake in the former Soviet Union. In fact, the US embargo was intended to punish the Soviet Union by *disrupting* its livestock production and hence consumption.

Unlike modern technology, food from various sources, and grain in particular, is highly substitutable. While one cannot make bread with rice, rice is a very good energy substitute for wheat. In a situation where the embargo is less than worldwide, food from different sources is also highly substitutable. It is therefore not surprising in economic research that grain is often assumed as a homogenous product. It is precisely for this reason that food embargos are difficult to implement.

There are, on the other hand, factors that may make food an easier target of embargo. Food products tend to be bulky, and hence it is more difficult to evade embargos in transport than is the case with many non-food products. It is also costly to store food for a long period of time, especially perishable food, such as vegetables, fruit and meats. The production of food is seasonal, and in cold climates one crop takes one year to grow before it can be harvested for human consumption. This means that in the short run, domestic food supply tends to be price-inelastic. Perhaps most importantly, demand for food is generally less elastic than for non-food products. With inelastic supply response in the short run, food embargos can cause large price increases in its wake. The timely release of stocks can alleviate the pressure on prices, but it cannot eliminate price increases altogether in the longer run—if the target country was importing food prior to an embargo, it is likely that it has a comparative disadvantage in food production. The withdrawal of food imports from the domestic market must induce increased production at higher marginal costs.

Now what is the chance of a food embargo against China occurring? China is opening up to the rest of the world and integrating into world economic and political systems. Integration on the economic front seems to have proceeded much more rapidly than that on the political front.³ This has one important implication. Ideological differences with the West are likely to be a major source of conflicts, which could result in food embargos against China. Ironically, conflicts in this area have been on the rise in the past decade since the collapse of the Soviet Bloc. During the Cold War era, the common strategic interests in containing the Soviet Bloc sidelined ideological differences between China and the West. Now that China is the only major power in the world that still holds a Communist ideology, it could be an easy target.⁴ It is therefore not surprising that in the West, especially in the United States, there is still a strong political force advocating the containment of China.

Strategic conflicts are likely to continue, but the chance of their escalating to major conflicts or food embargos is probably low. First, China has no territorial dispute with the West. Even though the end of the Cold War does not mean that major world powers will not try to seek advantage one over another, it is hard to imagine that another Cold War is inevitable. Even if there were another cold war, it would not necessarily lead to food embargos against China, as history has shown.

Trade conflicts seem to have been on the rise in recent years. This would appear to be inevitable given the rapid integration of the Chinese economy into the world market. Both the West and China have to deal with structural adjustment in this process. For the West, the key issues are access to the Chinese market and the accommodation of pressure from interest groups

that now face greater competition from China. China, on the other hand, has to address the issues of financial reform, farm income and competition in relation to state-owned enterprises. Trade disputes will undoubtedly flare up from time to time, but they are unlikely to lead to major conflicts involving food embargos. On the contrary, they are more likely to lead to restrictions on food imports rather than on exports.

The issue of Taiwan is the issue most likely lead to major conflicts between China and the West. As time elapses, there will probably be an increasing demand for self-determination in Taiwan. Given strong nationalistic sentiment in China, there is a real risk of a resort to force for the re-unification of China and Taiwan, and hence possible US intervention. It is difficult to judge whether such a conflict would result in a food embargo against China. Much will depend on how China sees the Taiwan issue over time and what role the United States will play in the region in the long run.

Any country or countries contemplating a food embargo must assess the probability of its success before it proceeds with it. China is not a super power, but it does have considerable political and military clout. In addition, China's political and military power is likely to grow over time given its rapid economic growth, which, short of domestic policy failures, should be ensured by the catching-up effect. It is more difficult to impose a food embargo against a large and strong country than against a small, weak one. A large country, especially a territorially large one, has less dependency on external economic relations, and a strong country is less likely to be a target of an embargo because of its greater influence in world politics. In the event of embargo, a strong country can more effectively defend itself.

China has common territorial borders with many countries. This would make a food embargo physically difficult to enforce. The improvement in diplomatic relations between China and the former Soviet Bloc countries render any Western embargo less likely to be successful. Indeed, if all these countries eventually recover from their current difficulties, they could well become an alternative source of food supply to the world market, including China (Tyers 1992). Despite its improved political relations with the West since the collapse of the Communist regime, Russia and its allies will try to maintain their independence from the West. Given their weaker position in dealing with the West, they may be more inclined to solicit China's support. China is in a similar position even though it does not want to form a formal alliance with Russia for fear of attracting adverse reaction from the West. Nevertheless, the current relationship between China and Russia can be (or can be seen as) a major deterrent to any food embargo against China, as well as against Russia.

To what extent can a food embargo against China cause damage? Food is not always absolutely essential (zero elasticity of demand with respect to price) once its consumption exceeds certain minimum level. It is true that at lower income levels, food is less elastic than at higher income levels. If food demand is very inelastic, its deprivation can cause severe damage to the well being of the people concerned. In economic terms, this means that the utility function of the consumers concerned is close to Leontief, and any significant reduction in food consumption will nullify most utility from consumption of other products, regardless their quantities. Winters

(1990) showed that in the UK, the elasticity of food demand was quite large even in the 1960s when income levels were much lower than today and that reductions in food consumption would not cause a particularly large decline in overall utility. China of course is at a lower income level than the UK was in the 1960s. To see how well Chinese consumers can cope with a food embargo, one needs to examine the dietary structure of Chinese consumers.

There are few reliable statistics on China's dietary structure. Wheat in China is used almost exclusively for direct human consumption. Rice is also produced mainly for direct human consumption. Corn is the only important crop for indirect human consumption (Tian 1999). China has an average food intake that is only just above the world average, but sufficient for energy requirements. Given the large variations in the level of food consumption across regions, food intake is undoubtedly insufficient in some regions. According to the UNDP (1996), there were 40 million Chinese still in poverty in 1996. Presumably, many of these people have insufficient food intake. Most of these people are located in remote areas.

Wheat and corn form the majority of China's food imports. In recent years, wheat has accounted for around two-thirds of total grain imports (in value terms). Corn imports have been highly volatile. Thus, in 1995 they accounted for 22 per cent of total grain imports, but this declined to just 2 per cent in 1996, despite a substantial fall in total grain imports. As corn is largely used as feed, and wheat is mostly used for direct consumption, it is likely that future demand for corn will grow more rapidly than for wheat (assuming income elasticities for meat are higher than for wheat). Indeed, if restrictions on corn imports are reduced, the pressure on wheat imports will be reduced as resources released from corn production can be used for wheat production. At the same time, abolishment of subsidies on wheat imports and consumption will reduce demand. This means that a food embargo in the future is unlikely to lead to substantial reductions in energy intake. In the event of an embargo, there would be a reduction in the consumption of livestock products, as these represent a far less efficient form of energy intake. China's own domestic production of grain would be more than sufficient to meet energy requirements.

It is often assumed in the discussions of food security in China that if China lifts its restrictions on grain imports, it will one day rely on the international market for most or a major part of its supply. Those who make such an assumption have failed to understand that comparative advantage is based on marginal cost. Given its limited per capita land resources, China will have a higher production cost per unit of output at the margin if imports are restricted. This means China's grain production will not be wiped out if free trade is allowed. Instead, grain production will only decline to the extent that the diminishing marginal cost (as output declines) becomes equal to the world price. It is therefore not surprising that most rigorous studies project that China's grain imports in a foreseeable future will account for much less than 10 per cent of its total consumption.

Is the risk of a food embargo sufficiently large to be worth being self-sufficient in food? In answering this question, one must remember that if free trade in grain is allowed, benefits are attainable at all times before an embargo. These benefits are also attainable after an grain

embargo. The second question to ask is: are there policy measures that can minimise the potential cost of an embargo while reaping the benefit of free trade in grain? We will return to these questions later in the paper.

Modelling food embargos

In the previous section, we identified various factors which make food embargos a potential threat to China and factors that make food embargos difficult to implement. The latter, in turn, would make food embargos less likely to occur if one believes the instrumental theory of food embargos. Even if the public choice theory were to be believed, one would imagine that a small chance of success is likely to reduce the probability of a food embargo being chosen as a policy instrument for 'expressive motive'. Such analysis provides important insights into the political economy in the world food market as well as in individual country markets. Whatever is the chance of a food embargo against China, it is worth evaluating the damage that it can cause to China if it does occur. In this section, we use the GTAP global general equilibrium model to simulate effects of several scenarios of hypothetical food embargos against China.⁵

China's concern over food embargos lies in the future when its dependency on grain imports is likely to increase. It is widely predicted that China will increase its grain imports in the future if import barriers do not increase (Rosegrant *et al.* 1995, Yang 1997, Mitchell *et al.* 1997). In the simulation exercise, we analyse the impact of grain and food embargos against China in an increasingly interdependent world economy, where China's grain self-sufficiency is lower than at present, both as a result of trade liberalisation and declining comparative advantage in grain production over time. To accomplish this task, a projection of the world economy to the year 2010 is first undertaken. Then, all distortions in the agricultural sector are reduced by half. The projection exercise follows the procedures widely used among CGE modellers (Hertel *et al.* 1996, Yang 1997). Various assumptions about population and GDP growth and factor accumulation from 1995 to 2010 are made and these assumptions are imposed as exogenous shocks to the model. Details of the projection are spelled out in the Appendix. The purpose of this exercise is not so much to forecast accurately China's future demand for various grain and other imports; rather, it is intended to create a database for the world economy where China's grain self-sufficiency has significantly declined from its present level. This enables us to analyse the impact of a food embargo against China in such a circumstance.

Our projection exercise concludes with China's grain self-sufficiency declining from its present 96 per cent to just about 92 per cent by 2010 (Table 1). The falls in the self-sufficiency rates for wheat and course grain are the most pronounced, but self-sufficiency rates for other primary commodities also decline considerably. For processed food products, however, dependence on the world market has diminished. Despite the crudeness of this projection, it is broadly consistent with most existing studies (Rosegrant *et al.* 1995, Vincent *et al.* 1999).

One would expect that with this increased dependency on grain imports, China would be more susceptible to grain and food embargos. In the following section, four experiments are undertaken. Our first scenario examines the possibility of a US grain embargo. It is assumed in

this scenario that the United States imposes a grain embargo against China by banning its grain exports to China. We perform a counterfactual experiment in which the United States reduces its grain (rice, wheat and corn) exports to China in 2010 to zero.⁶ From our earlier analysis, this seems to be an unlikely outcome as any grain embargo can hardly be enforced to such an extent. Nevertheless, this simple experiment is our starting point for illustrating how well China may fare under such a grain embargo and what the economic forces underlying the outcome are.

In an event of a major conflict between China and the United States, a grain embargo may not be seen as comprehensive enough to have the desired effect from the US perspective. Thus, the coverage of an embargo could be extended to food products other than grain. In this analysis, these other food commodities include all other agricultural and food products. The reason to include non-food agricultural commodities is that imports of these commodities can reduce the pressure on land use for food crops. Thus, in the second experiment, it is assumed that the United States imposes a complete ban on all food and agricultural exports to China.

In the third experiment, we examine the consequences of a concerted grain embargo against China by a Western coalition. If there were indeed a grain embargo against China, the United States would probably rally international support from its allies and form a coalition in order to make the embargo more effective, as well as to minimise its own losses. We assume such a coalition would include Australasia (Australia and New Zealand), the United States, Canada, the European Union, the European Free Trade Area, and Japan. All member states of the coalition would commit to impose a complete ban on grain exports to China. This assumption is somewhat unrealistic. In the embargo against the former Soviet Union in 1980–81, none of the major US allies was committed to withhold completely their grain exports to the Soviet Union. There is no reason to believe that any possible grain embargo against China would attract stronger support from US allies. Nevertheless, without prior knowledge of the extent of cooperation between the United States and its allies, we have decided to examine the worst scenario for China. The possibility of a coalition holding together is examined in the next section.

Table 1 Projected food self-sufficiency rates in 2010, compared to 1995 (per cent)

	1995	2010
Paddy rice	100	100
Wheat	83	75
Other grain	91	81
Other crops	97	81
Animal products	100	89
Other ag. products	93	89
Meats	93	94
Processed rice	98	99
Other food	96	95

Source: Based on the simulation as described in the text and Appendix.

In the last scenario, we assume that the coalition implements an embargo on all food and agricultural exports to China. The logical extension of such an embargo would be an all-out trade embargo from both sides. This would be necessarily devastating to the world economy. This very unlikely scenario is not examined in this paper.

In imposing an exogenous reduction in sender countries' exports in an embargo, we have endogenised the export barriers. Prohibitive export taxes are used as the policy instrument to enforce the embargos. These export taxes are commodity-specific in order to achieve the target of zero exports for all commodities involved.

Several assumptions are relevant for interpreting the simulation results later on. In case of an embargo, the prices for arable land would increase. This encourages marginal and non-arable land to be converted to arable land and such a response would increase domestic supply and hence reduce price hikes. In the extreme, backyard land plots could be used to produce more food. In the case of China, this is not an insignificant source of food supply, as farmers have traditionally grown food in their backyards. In addition, land productivity is likely to increase in response to higher domestic prices. Farmers would have greater incentive to seek better technology to increase output. However, this supply response is likely to take at least a couple of years, and would probably render only limited relief from short-term price increases. For this purpose, we have assumed in the simulations that arable land area will not change.⁷

Transshipment is assumed away in the model. As earlier analysis indicates, countries that do not participate in embargos are likely to transship grain or food from countries that impose embargos to the target country. However, the model does allow non-participant countries to increase their exports to the target country from their own production and meet their shortfalls from increased imports from countries that impose embargos. Although embargoing countries may attempt to withhold their exports to third countries in the short run, it is difficult to do so in the longer run as production in these countries has to be reduced or shocks have to increase permanently. Empirical evidence from the 1980–81 US grain embargo against the USSR suggests that embargoing countries tend to dispose their grain surplus to third country markets (Luttrell 1980, Schnittker and Associates 1982).

It is important to distinguish the long-run outcome of an embargo from its short-run consequences. In the short run, if an embargo occurs without warning, there will be little room for the target country to adjust and this can generate considerable dynamics in the domestic market. First, without sufficient information, consumers may start panic buying in the expectation of higher future prices. This can push up prices immediately even if there is sufficient domestic supply. Profit-driven stockholders will probably delay their sales until they are convinced that market prices have peaked. Thus, in the short run, the domestic market can be very volatile and prices can be pushed up very quickly. In such circumstances, state grain reserves can play an important role in stabilising the market. Of course, if there is sufficient supply, domestic prices will eventually fall as the market becomes better informed. To model the role of shocks in the event of an embargo would require a dynamic model that incorporates stockholding behaviour of the private sector, such as the Tyers–Anderson model (Tyers and Anderson 1992).

In this paper, we have ignored the stock issue for two reasons. First, the model employed here is a static one and hence it cannot capture the dynamics of stockholding behaviour. Second, short run performance of the domestic market in the event of an embargo depends critically on the role that state reserves can play, as well as on private market behaviour. China holds huge reserves, estimated at well above 100 million tonnes in the late 1990s (Zhou 1998). This is five times the volume of record grain imports in 1995. It is estimated that combined state reserves and commercial stocks amounted to about 280 million tonnes, in addition to an estimated 95 million tonnes of on-farm stocks held by farmers (Ke 1999).⁸ Although not all of the state reserves and grain stocks are price-responsive, a timely release of a small fraction of these reserves and stocks would be able to dampen *ex ante* price increases in the short run. Ke (1999) estimates that about 20 per cent of on-farm stocks are price responsive. Presumably, a larger portion of commercial grain stocks would be price responsive. Therefore, there would seem to be enough grain to dampen any large price increases in the event of an embargo. The only question is how to use state reserves properly and how to provide private stockholders with adequate information to avoid undesirable, irrational hoarding. The record shows that China has not been able to use its reserves and commercial stocks effectively to combat market instability (Ke 1999). The large cyclical volatility in the past two decades, as well as policy swings and errors, have reflected this inability. Lu (1999) provides a thorough survey of the policy cycles and errors of the past two decades.

Our simulations focus on the medium-run results. We assume that in the medium run, both the state and the private sector have restored their stocks to their desired levels, and for simplicity, to the pre-embargo levels. Given the time frame, labour and capital are fully mobile, while the transformation of arable land from one industry to another is 'sluggish', governed by a unitary elasticity of transformation. In the central scenarios, the standard GTAP elasticities of substitutions are adopted (See Appendix table).

The consequences of food embargos against China

In the event of an embargo against China, the desired outcome from the perspective of the sender country would be to reduce China's food consumption to a maximum extent and to cause food prices to rise as much as possible. This would hopefully exert sufficient political pressure on the Chinese Government. The results from first simulation show that if the United States alone imposes a grain embargo, its impact on food consumption in China is very limited (Table 2). Not surprisingly, the greatest impact occurs in the consumption of coarse grain, which was China's largest grain import from the United States. But even for coarse grain, the reduction in consumption is less than one per cent. Meat and other animal product consumption falls as well. This reflects the fact that as China's imports of coarse grain from the United States fall to zero, the price of feed grain goes up, which reduces the production of meat and other animal products. Falling livestock production pushes up prices and consumers react to this by purchasing less of these products.⁹

While meat production falls, grain output increases. Naturally, when imports become more expensive, domestic consumers begin to substitute domestically produced grain for imports. The resulting increases in production are considerable, with the largest rise occurring in the production of coarse grain. Rice production falls marginally as resources are competed away by the coarse grain and wheat production. Overall, China's grain production increases by just over 2 per cent.

If the United States extends its embargo to all other food and agricultural products, the impact on China's per capita consumption of all food products would be more significant, but for no product does consumption fall by more than two per cent (Table 3). For meat and other animal products, the reduction in consumption is comparatively large, mostly because these products are more price-elastic, rather than because their prices have risen more than those of grain. The impact of the food embargo on domestic production is similar to that of the grain embargo alone, except that meat and other crop production (mainly cotton and oilseeds) increases following the food embargo. China has significant imports of these products from the United States.

In the previous section, we mentioned that China's reliance on coarse grain imports makes it less susceptible to US embargos than if it relies on the imports of rice and wheat, both of which are staple food for direct consumption and have lower price elasticities. Even though this is true for the nation as a whole, coarse grain is an important staple food for many poor households. However, this is unlikely to exert much pressure on the Chinese Government as most of the country's poor is in the remote rural areas. On the other hand, the fall in the consumption of meat and other animal products would have a greater impact on more wealthy urban households, which tend to have a much greater weight in the Chinese political process. Thus, even a smaller negative impact on their living standards may lead to greater political pressure on the government.

Table 2 Changes in domestic consumption, prices and production in China as a result of a US grain export embargo, 2010 (per cent)

	Consumption	Price	Production
Paddy rice	-0.2	0.5	-0.2
Wheat	-0.4	2.0	4.7
Other grain	-0.7	3.6	10.0
Other crops	-0.3	0.3	-0.5
Animal products	-0.4	0.6	-0.5
Other ag. products	-0.2	0.1	-0.2
Meats	-0.3	0.4	-0.6
Processed rice	-0.1	0.3	-0.3
Other food	-0.4	1.1	-1.2

Source: Simulations of the GTAP model, Version 4.

One of the important factors preventing price hikes in China following the US embargos is the sharp increases in grain imports from other countries (Table 4). Wheat imports from these countries increase by about 40 per cent, while coarse grain imports rise by 145 per cent. In 2010, the United States is projected to account for 70 per cent of China's coarse grain imports and 32 per cent of wheat imports (in value terms).¹⁰ Much greater increases in imports are required to compensate for the lost coarse grain imports from the United States than for the lost wheat imports.

One would expect that a US-led coalition proposed in the previous section would substantially reduce China's ability to purchase grain from overseas. This is what our last two experiments are intended to show (Table 5). In the case of a grain embargo alone, wheat and coarse grain are again the most affected, but even in the worst case of wheat, consumption declines by less than 1.5 per cent. If a comprehensive food embargo is implemented, the impact on consumption increases considerably, not only on the consumption of grain, but also on all other commodities. When imports of food products other than grain are reduced to zero, there is an increasing demand for domestic grain to fill in the demand gap in industries producing these food products. Even though this induces larger increases in grain production, grain consumption falls more than in the case of grain embargo alone because of greater price hikes.

Since demand for grain is rather inelastic, domestic prices, especially those for wheat and coarse grain, increase substantially. The price for processed rice also increases, albeit much more moderately. In contrast, the price of paddy rice falls marginally. If price changes are used to measure the impact of food embargos, then a Western coalition can indeed exert some pressure on China.

Table 3 Changes in domestic consumption, prices and production in China as a result of a US food export embargo, 2010 (per cent)

	Consumption	Price	Production
Paddy rice	-0.7	2.3	-0.4
Wheat	-0.9	3.6	3.7
Other grain	-1.1	5.3	9.2
Other crops	-1.5	2.8	1.2
Animal products	-1.7	2.9	-0.1
Other ag. products	-0.9	0.3	-0.4
Meats	-1.7	2.1	1.3
Processed rice	-0.6	1.4	-0.7
Other food	-1.4	2.7	-1.8
Minerals	-0.9	-0.4	0.0
Manufactures	-0.9	0.0	-0.2
Services	-0.8	-0.2	-0.2

Source: Simulations of the GTAP model, Version 4.

The political economy of food embargos

We now return to the question whether US allies have incentives to join the United States in an embargo against China, and whether members of such a coalition, once formed, have any incentive to honour their commitment to concerted food embargos against China. We examine these two issues based on potential economic welfare changes for member states in an event of an embargo, leaving aside the possible political gains and losses.¹¹

Table 6 shows the welfare impact of the four scenarios that we have examined so far. China does suffer a welfare loss, but it is quite small in relation to its national income. On average, each Chinese citizen would lose less than US\$2 a year if the United States alone imposes a grain embargo. In the worse case scenario of a comprehensive food embargo by the Western coalition, each Chinese citizen would lose less than US\$10.

The United States would lose from the embargos as well, but by a smaller proportion of its GDP. This small loss is partly because food exports to China are a small proportion of the US economy, but more importantly because the United States maintained large subsidies on agricultural exports. The prohibition on agricultural exports to China improves US welfare. In addition, since agricultural production is also subsidised in the United States, the reduction in exports leads to further welfare improvement through the contraction of agricultural production.

This same second-best outcome also partly explains why the EU gains in joining the United States in the economic sanctions against China. In addition, there is a terms of trade gain to the EU as it is a net food importer. The EU imports large volumes of grain and other agricultural products from the United States. Embargos suppress domestic prices in the United States, and hence the price of exports to the EU. This terms of trade effect also explains why the EU gains as well from the United States embargos alone. Australasia and Canada would benefit from the US embargos as China switches its sourcing of imports from the United States to them. As net food

Table 4 Change in China's grain imports by source following a US grain embargo, 2010 (per cent)

	Austral- asia	Canada	USA	EU	Japan	ROW	Total
Paddy rice	0.7	1.6	-100.0	1.7	1.6	1.8	0.3
Wheat	42.4	29.1	-100.0	42.9	45	44.4	-16.9
Other grain	128.9	127	-100.0	156.2	162.6	159.8	-45.3
Other crops	-0.7	-3.8	3.0	-0.6	-0.3	-0.2	0.6
Animal products	-0.1	-5.0	5.9	0.1	0.7	0.6	1.6
Other ag. products	-0.3	-0.7	2.3	-0.2	0.0	0.0	-0.1
Meats	0.3	-1.2	2.9	0.4	0.6	0.6	0.4
Processed rice	1.6	3.0	-100.0	1.9	1.9	2.0	-0.9
Other food	1.9	1.2	3.2	2.2	2.5	2.5	1.6

Sources: Simulations of the GTAP model, Version 4.

Table 5 The impact of US-led Western embargos against China, 2010 (per cent)

	Grain embargo			Food embargo		
	Consumption	Consumer Price	Production	Consumption	Consumer Price	Production
Paddy rice	-0.4	1.5	-0.3	-1.5	5.5	-0.5
Wheat	-1.6	8.6	23	-2.6	13.0	22.0
Other grain	-1.3	6.6	16.5	-2.3	10.9	15.9
Other crops	-0.7	0.9	-1.4	-3.1	6.0	0.9
Animal products	-1.0	1.7	-1.4	-4.0	7.0	0.1
Other ag. products	-0.6	0.1	-0.5	-2.8	2.9	2.3
Meats	-0.8	1.1	-1.7	-3.7	5.6	0.5
Processed rice	-0.4	0.9	-0.3	-1.4	3.5	-0.9
Other food	-1.1	2.9	-3.2	-3.3	6.3	-2.5
Minerals	-0.6	-0.2	0.0	-2.0	-1.0	-0.1
Manufactures	-0.5	-0.1	0.0	-1.9	0.0	-0.7
Services	-0.5	-0.1	-0.1	-1.8	-0.4	-0.6

Source: Simulations of the GTAP model, Version 4.

exporters, however, they would lose from joining the Western embargos. Since Japan exports few agricultural commodities to China, it does not lose much from export restrictions, but it gains considerably from cheaper imports. Thus, like the EU, Japan would benefit irrespective of whether it joined the embargos.

Judging by the overall welfare results, it looks as if that the United States would have the support of its key allies—the EU and Japan. However, the importance of this support must be discounted by the fact that neither is an important supplier of food to China. Australasia and Canada are far more important food suppliers to China and they would not have the economic incentive to support any US-led embargo. The potential support by the EU and Japan must be further discounted by the fact that their policies towards food embargos would probably be influenced disproportionately by the farm lobby. This interest group would lose most from embargos (see below) and thus has the greatest incentive to oppose embargos, and their interest, moreover, has a disproportionate weight in the political process (Anderson and Hayami 1986, Tyers 1989).

Table 7 reports the impact of food embargos on grain production in various countries and regions. Although food embargos may bring overall economic benefits to some of the US allies, farmers in all coalition members stand to lose if their countries join the United States in embargos against China. On the other hand, all of them would gain from unilateral embargos by the United States. There is also a question whether US farmers would support embargos. After the 1980–81 grain embargo against the former USSR, various US farm bills stipulate hefty compensations for farmers in the event of grain embargos for national security or foreign policy reasons¹². Such compensations would impose a crippling cost on the US Federal budget (Paarlberg 1996). If any future US administration does choose to impose a grain embargo, it would have to raise enough revenue through increased taxes to cover these compensation demands. This is likely to be a huge political challenge. While compensations may secure short-term support from farmers, their

Table 6 Welfare effects of food embargos against China (US\$ billion)

EV	US grain	US food	Western grain	Western food
China	-2.2	-9.0	-5.6	-20.2
Australasia	0.0	0.2	-0.2	-1.4
Canada	0.3	0.6	-0.5	-0.9
United States	-1.2	-5.7	-0.8	-5.0
European Union	0.0	0.7	0.7	1.4
Japan	0.2	0.9	0.5	1.8
Rest of world	0.6	3.6	1.7	8.3
World	-2.1	-8.6	-4.2	-16.0

Source: Simulations of the GTAP model, Version 4.

Table 7 Changes in grain production following embargos, 2010 (per cent)

	US grain	US food	Western grain	Western food
Australasia	2.4	1.6	-6.4	-3.5
Canada	5.8	5.3	-15.2	-13.8
United States	-2.5	-1.4	-2.8	-1.6
European Union	1.8	1.4	-3.0	-4.2
Japan	0.0	0.0	-0.0	-0.2
China	1.9	1.5	5.1	4.7
Rest of world	0.0	-0.4	0.6	0.1

Sources: Simulations of the GTAP model, Version 4.

support in the longer term is difficult to maintain. Embargos can damage their commercial reputation as a reliable food supplier (USDA 1986). The very existence of food security concerns in China and other countries points to the mistrust that past economic sanctions may have helped to create. The prospects of a failed embargo would also reduce the support of farmers, as happened in the embargo against the USSR.

Turning to China, the political economy of food embargos goes beyond concern over food security. Officially, the grain self-sufficiency policy, which is partly designed to defeat any potential grain embargo, has two objectives. One is to ensure the country's food security and the other is to protect farm income. While both objectives are legitimate in their own right, it is questionable whether grain sufficiency would be able to achieve either, especially in the long run. It is obvious that Chinese farmers cannot get rich if all of them remain on the farm. Hence, their long run prosperity lies in non-farm employment opportunities. While a period of adjustment is necessary to allow such a structural change, protection itself is unlikely to ensure sufficient farm income. As argued by Yang and Huang (1997), increasing protection would eventually drive out all grain imports and once complete grain self-sufficiency is achieved, higher farm income has to come from farm price support, farm subsidies of various forms or direct income support. None of these policies is practical, as they are very expensive given the still very large farm sector. For the foreseeable future, it will remain politically difficult for the central government to raise

sufficient tax revenue to support such policies. Past experience has shown that the Government just cannot afford farm support yet. One of the central motives behind the so-called grain marketing reform in 1998 was to reduce budgetary pressure arising from the heavy losses that state grain agencies have suffered. There is a danger that grain self-sufficiency may become a substitute for more sensible policies for raising farm income. Ironically, Chinese farmers have not called for protection of agriculture. Rather, it is the agricultural bureaucrats and state grain marketing authorities that have been the strongest advocates for grain self-sufficiency. The former are concerned about the budgetary implications of declining agricultural support. As Winters (1990) points out in the context of EU agricultural protection, there is no better way to scare the public (and indeed the central government) into submission than to invoke threats to national security and rural stability. To be fair, agricultural bureaucrats may be genuinely concerned about rural unemployment and income, if not out of sympathy, then certainly out of concern over judgements of their performance by the State Council. The state grain marketing authorities, on the other hand, want to keep their monopoly, but this monopoly will end once free trade is allowed.

As far as food security is concerned, a critical question to be answered is whether self-sufficiency ensures food security. There is also the question of whose food security the government is concerned about. It may appear that food security is for all. However, the history of the People's Republic shows that the food security of urban people is the primary concern of the Chinese leadership. China's political process is heavily tilted towards its urban population. Ironically, urban consumers would benefit from freer trade in grain. From the government's point of view, however, higher grain prices resulting from grain protection would not threaten urban stability, but widespread food shortages sparked by foreign food embargos could. As a result, grain self-sufficiency policy is regarded as the safer option for urban stability. The compulsory state purchase of grain, which was introduced in the early 1950s, was a similar attempt to increase the food security of the urban population.

The essence of the grain self-sufficiency policy is to trade the costs of grain or agricultural protection for the perceived food security provided by self-sufficiency. Assuming for the moment that grain self-sufficiency does equate food security, what is the cost of this type of food security?

Simulation results show that it would cost China about \$400 million a year to maintain its 1995 level of grain self-sufficiency in 2010, or \$30 billion a year if the agricultural self-sufficiency rate (for every sector) is maintained at its 1995 level. These are annual costs, and they occur every year, as long as the self-sufficiency policy is in place. If the self-sufficiency policy is an insurance policy against potential food embargos, then it is indeed a very expensive insurance policy.

The question whether grain self-sufficiency will ensure food security is a complicated one and is not the focus of the present paper. However, several points are worth making in this regard. First, food security is a multi-dimensional issue. Merely having enough food within the country is not sufficient for food security. Efficient domestic distribution systems are necessary, as are adequate domestic transport networks. Second, variations in harvests in a single country tend to be more volatile than those in the world as a whole. A completely self-sufficient country may

still find it difficult to cope with major domestic disasters, as demonstrated by the 1959–62 famine. Finally, there are ways of minimising the risk of reliance on foreign markets. In addition to grain stocks, these include entering into long-term contracts with foreign suppliers, diversifying sources of supply and developing dependence of foreign suppliers on the domestic markets. Financial markets can also be used to minimise the financial risks associated with adverse terms of trade changes. The bottom line is that China should have a comprehensive and cost-effective strategy for food security, not a binding policy of grain self-sufficiency, whose benefits are doubtful at best.

Sensitivity analysis

We noted earlier that there could be a considerable price impact on China should there be a concerted Western food embargo against it. Such a result depends critically on the extent of substitution between domestic goods and imports (USDA 1986). If domestic goods can be just as good as imports, and if production can fully compensate for the lost imports, then embargos would have no impact on domestic prices except in cases where there are expectations of price increases and possibly delayed supply (including stock) response following an embargo.

There is considerable uncertainty about the magnitude of the elasticities of substitution between domestic goods and imports. In the extreme, one would argue that domestic food can be a perfect substitute for imports, especially for grain products. In modelling agricultural trade, there is a tradition in the literature to assume that domestic goods and imports are perfect substitutes. One can imagine that under such circumstances, increases in domestic prices in China following a food embargo would be similar to the general price increases in the world market. Such an assumption often leads to unrealistic results in empirical research (Thursby *et al.* 1986). Nevertheless, this suggests that agricultural commodities (especially grain) produced in different countries are good substitutes.

In a circumstance where food supply is perceived to fall, consumers are more likely and willing to substitute goods from one source for those from another. Webb *et al.* (1989) provide some statistical evidence to support this hypothesis. Bread made of Chinese wheat may not be as good as that made of Canadian wheat, but when the nation is in a major conflict and that is as good as one can get, consumers are probably more willing to sacrifice their preferred variety. In addition, technology may develop which makes it easier to substitute among different varieties. Producers may also respond in such a way to take advantage of the price increase for imported varieties.

Taking these into account, the elasticities of substitution we applied are likely to be on the conservative side, thus overstating the effects of embargos. For this reason, the four experiments undertaken in the previous section were repeated with higher elasticities. For the purpose of comparison, lower elasticities are also experimented on. In the higher elasticity scenarios, the elasticities of substitution for grain are quadrupled while those for processed food are doubled.¹³ The elasticities for manufactured goods and services remain unchanged. In the lower elasticity scenarios, all elasticities of substitution are halved. Tables 8 and 9 present the results of the four simulations based on the two sets of alternative elasticities.

Clearly, the results are highly sensitive to the magnitude of the elasticities of substitution, especially the domestic price responses to embargos. With lower elasticities, a US grain embargo alone would lead to an increase of 3 per cent in the wheat price and 6 per cent in the coarse grain price. As the extent of embargo increases, the price impact becomes much larger. In the case of a comprehensive Western embargo, the wheat price could increase by over 21 per cent and that of coarse grain by over 17 per cent. The price of meat could increase by 14 per cent. Such significant price increases could have major consequences for the Chinese economy.

As we argued earlier, however, such a scenario is unlikely to occur. If the elasticities of substitution are indeed much higher, then the impact of the embargos would be much more muted. Even in the worst case scenario—a comprehensive Western embargo—the largest price

Table 8 The price impact of food embargos on China under alternative assumptions of elasticities of substitution, 2010 (per cent)

Elasticities	US grain embargo		US food embargo		Western grain embargo		Western food embargo	
	Lower	Higher	Lower	Higher	Lower	Higher	Lower	Higher
Paddy rice	0.7	0.2	2.6	1.4	2.5	0.7	6.7	3.5
Wheat	3.0	1.1	4.8	1.9	15.7	4.9	21.3	7.1
Other grain	5.7	2.2	7.7	3.0	12.0	3.9	17.2	6.2
Other crops	0.4	0.1	3.4	1.8	1.3	0.4	7.3	3.9
Animal products	1.0	0.2	3.6	1.8	3.4	0.7	9.5	4.4
Other ag. products	0.0	0.0	-0.3	0.2	-0.2	0.0	2.4	2.2
Meats	0.7	0.2	2.9	1.3	2.2	0.4	8.4	3.4
Processed rice	0.5	0.1	1.5	0.8	1.6	0.4	4.4	2.2
Other food	2.6	0.4	5.3	1.3	8.3	1.0	14.0	3.0

Source: Simulations of the GTAP model, Version 4.

Table 9 The consumption impact of food embargos on China under alternative assumptions of elasticities of substitution, 2010 (per cent)

Elasticities	US grain embargo		US food embargo		Western grain embargo		Western food embargo	
	Lower	Higher	Lower	Higher	Lower	Higher	Lower	Higher
Paddy rice	-0.4	-0.1	-1.4	-0.3	-1.3	-0.1	-3.4	-0.8
Wheat	-1.0	-0.1	-2.0	-0.4	-4.4	-0.5	-6.5	-1.1
Other grain	-1.7	-0.2	-2.7	-0.5	-3.7	-0.4	-5.7	-1.0
Other crops	-0.7	-0.1	-3.2	-0.8	-2.2	-0.2	-7.1	-1.6
Animal products	-0.9	-0.1	-3.6	-0.9	-3.1	-0.3	-8.9	-2.0
Other ag. products	-0.6	-0.1	-2.2	-0.4	-2.0	-0.2	-6.7	-1.4
Meats	-0.8	-0.1	-3.8	-0.8	-2.5	-0.2	-8.6	-1.8
Processed rice	-0.4	0.0	-1.3	-0.3	-1.3	-0.1	-3.3	-0.7
Other food	-1.1	-0.1	-3.3	-0.7	-3.4	-0.3	-8.2	-1.5

Sources: Simulations of the GTAP model, Version 4.

increase, which occurs for wheat, would be just over 7 per cent. Although this is still a very significant increase in the price, it is of a manageable magnitude. In the past two decades, there have been several episodes of much larger price fluctuations induced by natural disasters, and, more often, by policy changes (see Lu 1999).

The variations in the magnitude of the elasticities do not, however, render the same extent of change in private consumption. This is also the reason why price response is so large in many cases. Nevertheless, consumption falls considerably for all food and agricultural products, especially for the more price-elastic ones. On the other hand, if, as we assumed, the elasticities of substitution are indeed larger, there would be limited impact on private consumption, and in no case would this impact be greater than 2 per cent. This extreme impact occurs in animal products, which would not have large adverse effect on energy intake.

Conclusion

The fear of food embargos by the West is one of the fundamental factors underlying China's grain self-sufficiency policy. However, discussions of the issue in China are often based on little rigorous empirical evidence. Any analysis of the potential threat of food embargos against China has to answer the following questions: What is the chance that a food embargo against China occurs? How likely can such an embargo be successfully implemented? What damage can an embargo inflict on China if it does occur? Is the risk associated with embargos worth the cost of a grain or indeed food self-sufficiency policy?

While such questions can never be answered with great certainty, some general observations are possible based on empirical evidence. Given China's growing influence over world politics commensurate with its economic power, any country contemplating a food embargo against China would have to think twice about its global implications and the chances of such an action being successful. The fear of food embargos seems to have been heightened by the growing disputes between China and the West over issues such as Taiwan, trade and human rights. Ironically, such disputes have mostly resulted in the threat of import restrictions, rather than export restrictions (except for military technology exports from the United States whose restrictions seem to have been tightened following the recent allegations of Chinese espionage). Short of an all-out military conflict, it seems unlikely that the West would impose a food embargo against China, as evidenced by the exemption of food from the recent United Nations economic sanctions against Iraq and Yugoslavia.¹⁴

Even if an embargo against China does occur, the damage it can inflict on China is likely to be limited. Based on our simulations, even with much greater reliance on world food market than at present, China would suffer small declines in food consumption and moderate increases in food prices except perhaps under the extreme (and unrealistic) assumption that the substitutability between food from the West and other countries is low and that embargos can be successfully implemented to its extreme—a complete and immediate ban on all food and agricultural exports to China.

This is an extreme and unlikely assumption, because different types of food are good energy substitutes and no food embargo can be implemented with such all-encompassing success. Like any type of cartel, an embargo inevitably creates a free-rider problem. Not only does a major food exporter benefit from an embargo that it does not participate in, but it also has an economic incentive to cheat or only commit itself to minimum export restrictions, as occurred during the US embargo against the former Soviet Union in 1980–81. Domestic politics in sender countries also tend to make food embargos difficult to sustain, as farmers fear losing long-term commercial opportunities in target countries, especially in a market as large as China. Compensation for farmers in exchange for their support for an embargo can be very expensive, as was also shown by the US embargo against the former Soviet Union.

China's concern over its food security is understandable given its long history of famines, with the most recent ones being the catastrophic 1959–62 starvation and the wide spread hunger which led to the rural economic reforms beginning in the late 1970s. However, China needs to consider the range of options available for increasing its food security. Each of these options needs to be assessed on the basis of its costs and benefits. On this criterion, food self-sufficiency is a very expensive option. It should be pointed out that this is the option that some domestic interest groups would prefer as it would help maintain their budgetary position or monopoly over grain marketing. The danger in such circumstances is that protectionist policy can be advocated under the guise of food security and national security.

Appendix: Projection of the world economy to the year 2010

As described in the text, all comparative static analysis of food embargos against China is counterfactual against the projected 2010 database. In the projection, an economy wide technological change variable is endogenised to reach the GDP forecast based on the World Bank. Forecasts of factor accumulation are based on Hertel *et al.* (1996). In addition to the endogenous technological change, sector-specific technological changes are also imposed. These include a 20 per cent improvement in land productivity in developing countries, including China, and a 20 per cent increase in the labour productivity in agriculture in industrial countries, based on the evidence provided by Hayami and Ruttan 1985, Fecher and Perelman 1992, Martin and Mitra 1993. In addition, total input productivity in Chinese agriculture is assumed to grow 0.8 per cent faster than the rest of the economy. This is to represent the effect of catching-up investment after the slow growth experienced since the mid-1980s. The following table shows the elasticities of substitution used in the projection (the same set is used for the central scenarios of embargo experiments). Details of the GTAP database and its elasticities of substitution can be found in McDougall *et al.* (1998).

Table A1 Elasticities of substitution used in the projection and central scenarios

	Between domestic goods and imports	Among imports from different regions
Paddy rice	2.2	4.4
Wheat	2.2	4.4
Other grain	2.2	4.4
Other crops	2.2	4.4
Animal products	2.8	5.6
Other ag. products	2.8	5.4
Meats	2.2	4.4
Processed rice	2.2	4.4
Other food	2.5	4.8
Minerals	2.8	5.6
Manufactures	2.9	6.4
Services	1.9	3.8

Source: GTAP database, version 4.

Notes

1 In a recent call for papers as part of a World Bank research program, food security and trade policy were among the list topics. The program is aimed at research and capacity building to strengthen the participation of developing countries in the next multilateral trade negotiations.

2 There is a vast economic literature on economic sanctions. For theoretical treatment of the issue, see, for example, Bhagwati and Srinivasan (1976), Mayer (1977); Tolley and Wilman (1977), Arad and Hillman (1979), Thomson (1979), Bergstrom *et al.* (1985), Eaton and Engers (1992) and Eaton and Engers (1999). For empirical studies, see Hufbauer and Schott (1985), Lundberg (1987), Leyton-Brown (1987), Hufbauer *et al.* (1990), Miyagawa (1992), Chatterji *et al.* (1994), Cortright and Lopez (1995), Hufbauer, *et al.* (1999) and Levy (1999).

3 Some may question whether China is integrating its political system with the rest of the world given its slow progress in political reform. Nevertheless, it seems inevitable that China will have to go down the path of political reform if its economic reform is to continue.

4 One can debate whether China is a Communist country in its traditional sense. The Chinese Government might just well be regarded as a totalitarian regime with the disguise of Communism. It would be difficult for the current Chinese leadership to break with its past even if it does not believe in Communism any more; to do that would be seen as a betrayal of their predecessors and 'loss of face' (admitting mistakes). It could also lead to a greater ideological vacuum, which could throw the country into even greater confusion.

5 Readers interested in the GTAP model are referred to Hertel (1997) for details.

6 If prior commercial contracts exist, it may not be possible for the United States to completely ban exports to China. For simplicity, this possibility is ignored here.

7 It is possible, and even likely, that land productivity will fall in the event of a complete trade embargo, as agricultural inputs become more expensive. The issue is not examined here.

8 There are several other estimates, included those by Cook (1994) and Huang (1995).

9 It is possible, or even likely, that the supply of meat and other animal products increases in the short run as high feed prices may force farmers to slaughter their animals prematurely. This occurred in the former Soviet Union when it was subject to the US grain embargo in 1980–81 (USDA 1986).

10 Compare these with 73 per cent and 35 per cent in 1995, respectively.

11 It is difficult to evaluate political gains or losses quantitatively, or even qualitatively, without strong assumptions about the circumstances under which an embargo arises. At the present political balance, US

allies would probably lose if they do not cooperate with the United States. As political balance changes in the future, however, political losses to them may diminish and their decisions are more likely to be determined by economic considerations.

12 A description of the embargo provisions in the 1996 Farm Act can be found in the following electronic document: <http://www.econ.ag.gov/epubs/pdf/aib729/aib729c.pdf>

13 In GTAP applications it is common to double the standard trade elasticities (Gehlhar 1994, Hertel *et al.* 1996). Given the greater disaggregation of agricultural commodities in this study, quadrupling the elasticities for grain is perhaps not unreasonable.

14 This also raises the question whether grain or food is the commodity that is most vulnerable to embargos (see Winters 1990).

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