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Structural Change in Commodity Markets

HAVE AGRICULTURAL MARKETS BECOME THINNER?

Peter S. Liapis

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Abstract

Structural Change in Commodity Markets: Have Agricultural Markets Become Thinner?

Peter Liapis, OECD

It is generally asserted that markets of internationally traded agricultural commodities are thin and more volatile, but with little supporting evidence. For internationally traded agricultural products, it is not clear what constitutes "thin" markets and how this "thinness" contributes to price volatility. Nonetheless, in the current atmosphere of high food and agricultural prices, the sentiment that international prices are more volatile because agricultural markets are thin, is widely shared. This study examines whether selected agricultural markets have become thinner using a particular notion of market thinness relevant for internationally traded goods – exports as a share of production. The results suggest that for most of the commodities examined from 1970 to 2010 the answer is that markets have not become thinner. To support this conclusion, two other measures are used for a robustness check to round out the analysis and provide a multidimensional picture. These two measures are the number of participants (countries) trading in any market and the level of market concentration as revealed by the Herfindahl Index.

Key words: Agricultural exports, variability, grains (wheat, rice, maize), sugar, soybeans, beef, dairy products.

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Executive Summary

This study focuses on a factual and empirically based assessment as to whether or not agricultural markets have become thinner using a particular notion of market thinness used primarily to describe internationally traded agricultural products. This report is intended as a companion to an earlier OECD paper (OECD *Food, Agricultural and Fisheries Working Paper N°52)* that examined whether agricultural prices have become more volatile. That study examined price volatility using monthly and annual prices. It failed to find evidence of any general increase in price volatility for the range of commodities examined. But, when focusing on 2006-10 period, the report finds that price variability during that time was higher than in the 1990s, but in general, not higher than that of the 1970s except for wheat and rice. The present study examines whether, over the same time period, international markets of agricultural products have become thinner. The results suggest that for most of the commodities examined, the answer is no; markets have not become thinner.

Trade helps smooth production and consumption across space by moving goods from surplus to deficit regions thus mitigating price movements. It is often postulated that agricultural markets are "thin" and this causes price swings that are larger than would be expected in more liquid or deeper markets. A thin market is a market with few buying and selling offers and is characterised by low trading volume, high volatility, and high bid-ask spreads. Thin markets are problematic because they can result in some agents obtaining market power and price concessions. In addition to market power, other factors that can result in thin or illiquid markets are; asymmetric information, high transaction costs and spatial considerations, among others. Although the concept is general, it has mostly been used in the context of financial markets.

Agricultural economists that have delved into thin markets for agricultural commodities have been mostly concerned with price discovery and the effects of thin markets on price efficiency. Although not explicitly stated, the concept of thin markets for internationally traded agricultural commodities is related to the volume transacted. Explicitly or implicitly, the volume traded (usually global exports) as a share of world production is the metric used. Thus, for example, the international rice market is the classic example because only 5% to 7% of global production is exported even though the rice market consists of many different traders undertaking many transactions. Other agricultural commodities are also considered thin because the ratio of exports to global production is deemed low.

When it comes to markets of internationally traded commodities, the concept of market thinness has not been examined in any detail. Usually it is generally asserted that markets of internationally traded agricultural commodities are thin and more volatile. This general sentiment is stated without supporting evidence-in most cases. Whether or not the observed volume traded as a share of world production reflects market fundamentals or other reasons is hardly examined nor other aspects of market thinness

such as market power, price efficiency or transaction costs. Clearly, the concept of market thinness is subjective. For internationally traded agricultural products, it is not clear what constitutes "thin" markets and how this "thinness" contributes to price volatility. Nonetheless, in the current atmosphere of high food and agricultural prices, the sentiment that international prices are more volatile because agricultural markets are thin, is widely shared. Hence, this study examines whether selected agricultural markets have become thinner.

Because of relatively inelastic supply and demand of agricultural goods, small changes in demand or supply, if not smoothed through additional trade can result in large price swings. However, it is not clear that trade has to attain a certain percent of production or that the number of participants must not be less than X or that concentration must not exceed Y to lead to lower price volatility. Most of the consumption in some agricultural markets, for example rice, occurs in countries that are also major producers. In such cases, trade to balance international demand and supply can be a small share of world production. For other products it can be the case that a large share of consumption occurs in countries with relatively little production and in such cases, trade to balance international markets can be a sizeable share of world production. In both cases however, because of relatively inelastic demand and supply, trade disruptions following unexpected events can lead to sizeable price swings and volatile prices irrespective of the absolute volume that is normally traded.

For this study, in addition to exports as a share of production as an indication of market thinness, two other measures are used for a robustness check, to round out the analysis and provide a multidimensional picture. These are; the number of participants (countries) trading in any market and the level of market concentration as revealed by the Herfindahl Index. Although the later two indicators would be more illuminating based on data of individual transactions, such data are lacking. Nonetheless, observations at the country level provide useful information that should not be ignored. In addition to soybeans, the commodities examined are the same as in the recent OECD study on price volatility - wheat, maize, rice, sugar, beef, butter, whole milk powder and soybean oil. These products (other than soybeans) and time period were chosen to enable the interested reader to compare the evolution of price volatility with the evolution of market thinness.

To better understand exports as a share of production, the report first looks at worldwide evolution of production and consumption for the selected commodities. During the period 1970 to 1994, the rate of growth of production of the selected commodities varied ranging from 1.1% per year (butter) to 5.1% per year (soybean oil). But, in the later period from 1995, the rate of growth of production declined relative to the total period for all commodities examined except butter and maize. As expected, the rates of growth in production and consumption were quite similar for the commodities examined.

Global production variability was also computed. For the commodities covered, production variability was relatively low with beef production exhibiting the lowest and soybeans the highest. Surprisingly, production variability does not seem to depend on whether the commodity is a field crop closely dependent on weather conditions or its production is further from the farm gate. Production variability fell over time with the period since 1995 exhibiting lower variability compared with the1970-94 period for these commodities except sugar and butter.

Globalisation and policy reform, including less distorting domestic policies, and more liberal trading regimes through lower tariffs and subsidised exports opened international markets and trade expanded deepening international markets. Exports (in physical units) grew over this time period with soybean oil leading the way with an average growth rate of 6% a year. Butter exports were the least dynamic with an average growth rate of 0.4% a year. Rice exports, a market often cited as "thin", exhibited an average growth rate of 3.7% a year, a growth rate higher than wheat, maize or sugar. But, exports as a share of production for all products other than butter and maize were either constant or increased slightly. Comparing the ratio among the selected commodities, rice had the lowest share of production exported while whole milk powder had the highest. For the selected commodities, the ratio of exports to production does not seem out of line when compared to the share of exports for all manufactured goods, for high tech products or for all raw agricultural products. In all cases examined, most of the production is consumed locally while the share traded varies depending on the product.

For each country, the share of production to consumption for each of the selected products was calculated generating an index of a country's demand deficit (volume needed to satisfy domestic demand) or supply surplus (volume in excess of domestic demand). The results indicate that the various products differ in the share of world production that crosses borders to equilibrate demand with supply. By this metric, the rice market stands out among the selected crops as the market in which most of the production is consumed locally, requiring relatively small volumes of trade to satisfy demand in deficit countries. This finding provides one possible rational for the relatively small share of rice production that is traded even as that share has expanded somewhat in recent years.

However, this finding does not imply that trade is unimportant in rice or in any other market. Even though trade may represent a relatively small share of world supply, it still fulfils the function of balancing international markets. Unforeseen disruptions to those trade flows irrespective of the volume, combined with relatively inelastic demand and supply for a staple good can lead to large price swings.

The study results indicate that since 1970, the selected agricultural markets (other than butter and maize) have not become thinner, at least as measured by any of the measures used in this analysis. Exports as a share of production for most of the commodities covered has increased or remained fairly stable. Moreover, the number of market participants (for the selected commodities) has increased over time while the level of market concentration (market share among participants) has declined.

Trade helps moderate price swings by balancing global demand and supply. Given relatively inelastic demand and supply small changes in trade can lead to significant price changes regardless of the underlying share of production that is traded. It may not be very meaningful therefore to compare the share of production exported between various products as that share may reflect market, biological or climatic fundamentals What may be crucial to alleviating large price swings is enabling trade to flow unburdened by domestic and border policies allowing each market to adjust within the boundaries of those fundamentals. Government policies blocking or restricting the free flow of goods to international markets, increase uncertainty, add to the vulnerability of the supply chain especially when stockholding is low, shake confidence that produce will be supplied when needed and contribute to higher and more volatile world prices (if the country is a major trader). Such actions contribute to making markets thinner, at least temporarily, relative to the underlying fundamentals. Although outright bans are relatively infrequent

and they tend to be of limited duration, they can have dramatic consequences. The impacts on world markets may be examined under future work on export restrictions.

The origin of the instability can condition the results. If the origin of the instability is from exogenous shocks such as changes in demand or in supply than more trade implies less instability. If, the origin of the instability is endogenous from risk aversion under incomplete markets or backward-looking expectations which correspond to second best situations, liberalising trade does not necessarily improve welfare (Gouel 2010). However, "the evidence regarding the link between trade and volatility tends to confirm the hypothesis of a dynamics driven by external shocks that would be smoothed by the presence of a larger market" (Gouel 2010, pg. 17).

Introduction

Most agricultural markets by their nature are volatile since the amount produced in any year is somewhat random from unexpected climatic events. The price oscillation of several important food commodities during the recent three to four year period, characterised by fast rising prices peaking at very high levels, followed by equally rapid price declines and subsequent increases, have caused heightened concern among the populace and policy makers that the world may be entering a period of sustainably higher average food prices which has negative implications for hunger and food security as the poor cannot easily adapt to the higher prices. Many are asking whether recent developments are an aberration or is the world entering a new, less stable price regime?

Several reports have been prepared in the recent past attempting to analyse whether agricultural prices are more volatile now. The findings have predominately supported the notion that most agricultural prices are not more volatile now, although a few have concluded the opposite. Differences in the findings are mostly due to differences in the time period examined (how far into the past), the periodicity of the prices (weekly, monthly or annually), the measure of volatility used and the commodities examined. For example, the FAO (2010) using data from the mid-1980s concludes that price volatility has increased. In contrast a recent OECD (2011) study using data from January 1957 to February 2010 failed to find evidence of any general increase in price volatility for the range of commodities examined. But, focusing on 2006-10 period, the report finds that price variability during that time was higher than in the 1990s, but in general, not higher than that of the 1970s except for wheat and rice. Findings from studies examining rather longer time periods mostly conclude that price volatility has not increased. In a paper by Jacks, O'Rourke and Williamson (2011) using monthly agricultural prices since 1700, the authors conclude that there is no evidence that agricultural prices today are more volatile than in the past, a conclusion also reached by Balcombe (2009) using data starting in the 1960s. Similarly, Diaz-Bonilla and Ron (2010) conclude that although recent price volatility is higher than the 1990s, it has not reached the magnitude of the food price crisis in the seventies, a conclusion also reached by Sumner (2009) using wheat and maize price data from 1866 to 2008 who found that the three year period 2006 to 2008 was among a handful of periods when prices were above the post-war trend with the previous one being in the 1970s. Gilbert and Morgan (2010) that find although current volatility is not higher by historical standards it is higher than the 1980s or 1990s for some commodities. As concluded in OECD (2011, page 9), a short literature review reveals a lack of complete consensus on the conclusions about the evolution of agricultural commodity price volatility.

In addition, several authors have attempted to identify causes for the recent run-up in prices and to discern whether or not these represent structural changes that would lead to higher volatility in the future. Among the variables that have been identified are: 1) weather related shocks (the fear here is that climate change may cause more frequent and extreme weather shocks in the future, 2) higher input costs due to energy price shocks (is the era of cheap fossil fuels over?), 3) lower stocks,4) the high and persistent income growth in high population countries such as China and India and the associated increased demand for commodities, and for grains not only direct affect of human consumption but indirectly though higher consumption of livestock products[1], 5) biofuel demand and the direct substitution of food products for energy production and indirect substitution of land area for crops to produce energy, 6) scarcity of key inputs such as land and water, 7) exchange rate movements, 8) border policies in exporting and importing countries, and 9) speculation and the financialisation of agricultural markets, among others. The non-exhaustive list of papers includes the sources cited above plus Wright (2008), Roache (2010), Imai, Gaiha, and Thapa (2008). OECD-FAO (2011) Tangermann (2011), Trostle (2008) Trostle *et al* (2011), Abbott, Hurt and Tyner (2011), Asian Development Bank (2011). Most of these sources cite many of the key drivers listed above, but the relative importance to the price spikes attributed to the various drivers varies by author.

Trade or more specifically lack of it has also been mentioned as a contributor to higher and more volatile international prices. The world has become more interconnected and trade helps smooth production and consumption across space by moving goods from surplus to deficit regions thus mitigating price movements, hence when it's disrupted by policy or other man-made or natural events, prices can spike and become more volatile (Abbott, Hurt and Tyner (2011), Jacks, O'Rourke and Williamson (2011), Anderson and Nelgen (2010), Heady (2011), Martin and Anderson ((2011), OECD-FAO (2011), Tangermann (2011). Hence, in cases where the origin of the instability is from exogenous shocks such as changes in demand or supply, more trade implies less instability (Gouel 2010). Because of relatively inelastic supply and demand of agricultural goods, small changes in demand or supply, if not smoothed through additional trade could result in large price swings. But, there may be cases where markets are not perfect. In second best situations when the source of the instability is endogenous due to risk aversion under incomplete markets or backward-looking expectations for example, liberalising trade does not improve welfare (Gouel 2010). However, "the evidence regarding the link between trade and volatility tends to confirm the hypothesis of a dynamics driven by external shocks that would be smoothed by the presence of a larger market" (Gouel 2010, p. 17).

It is often postulated that agricultural markets are "thin" and this causes price swings that are larger than would be expected in more liquid or deeper markets[2] Abbott, Hurt and Tyner (2011), OECD-FAO (2011), Tangermann (2011), Anderson and Nelgen (2010), Childs and Baldwin (2010), Diaz-Bonilla and Ron (2010) FAO *et al* (2011). According to Rostek and Weretka (2008) in the New Palgrave Dictionary of Economics, a thin market is a market with few buying and selling offers and is characterised by low trading

1. There seems to be less unanimity in the literature that this factor was a significant driver to the price spikes. For example, OECD-FAO (2011) heavily discounts increased demand in China and India as a significant factor in rising prices, while Abbott, Hurt and Tyner (2011) have a more nuanced explanation of China's role.

2. To reduce the frequency of using the term less thin to indicate the opposite of thin markets, the terms deep, liquid, or fat are used interchangeably.

volume, high volatility, and high bid-ask spreads. Thin markets are problematic because thin markets can result in some agents obtaining market power and price concessions. In addition to market power, other factors that can result in thin or illiquid markets are; asymmetric information, high transaction costs and spatial considerations, among others. They further state that the concept of thin markets is general, but has mostly been used in the context of financial markets and the market power exercised by institutional investors.

Agricultural economists that have delved into thin markets for agricultural commodities have been mostly concerned with price discovery and the effects on thin markets on price efficiency. Using trading volumes or number of transactions as a criterion for market thinness (without explicitly specifying the cut-off point distinguishing thin from liquid markets), Mattos and Garcia (2004) find that futures prices play a major role on the price process in the cash market, but in thinly traded markets the results were mixed with the price discovery function performing well in some but not in others. A similar result is reported in Anderson et al (2007). Nelson and Turner (1995) report that in the context of a market that has evolved from having many buyers and sellers to having only a few buyers, the pricing behaviour in thin markets is not necessarily inferior to that in a larger market. Evolving market structure of several agricultural commodities have led Anderson *et al* (2007) to conclude that the traditional conception of thin markets, relating primarily to the number of transactions in a given period of time no longer adequately frames the thin market issue. Market structure is also important in framing the results in Thompson and Sonka (1997). They define a thin market as a market whose structure prevents or inhibits prices across space, time and form from attaining the relationship characteristic of a perfect market. The high transaction costs associated with thin markets makes conventional arbitrage risky or costly resulting in prices that are not efficient.

This brief review illustrates that characterisation of thin markets is evolving, seems to be subjective, and any deleterious effects may or may not be present. When it comes to markets of internationally traded commodities, the concept of market thinness has not been examined in any detail. Usually, as in the sources cited previously, it is generally asserted that markets of internationally traded agricultural commodities are thin and more volatile. This general sentiment is stated without supporting evidence-in most cases because determining whether the market is thin or not and whether the price is efficient or not-is not the primary purpose of these reports. Nonetheless, in the current atmosphere of high food and agricultural prices, the sentiment that international prices are more volatility because agricultural markets are thin, is widely shared. Hence, in this study, we examine whether selected agricultural markets have become thinner.

Although not explicitly stated, the concept of thin markets for internationally traded agricultural commodities is related to the volume transacted. Explicitly or implicitly, the volume traded (usually global exports) as a share of world production is the metric used. Thus, for example, the international rice market is the classic example because only 5% to 7% of global production is exported (see for example Childs and Baldwin (2010) and Rapsomanakis (2011) among others) even though as reported in Timmer (2009) the rice market consists of many different agents. Other agricultural commodities are also considered thin because the ratio of exports to global production is deemed low. Whether or not the observed volume traded as a share of world production reflects market fundamentals or other reasons is hardly examined nor other aspects of market thinness such as market power or transaction costs. The idea that trade helps smooth out supply and demand through space thus mitigating price swings is not contestable (see for example Anderson and Nelgen (2010), Jacks, O'Rourke and Williamson (2011), Martin

and Anderson (2010). However, it is not clear that trade has to attain a certain percent of production or that the number of participants must not be less than X or that concentration must not exceed Y to lead to lower price volatility. As a matter of fact, Rapsomanakis (2011) reports that the rice market, even though thin, was characterised by low price volatility until 2007. Clearly, the concept of market thinness is subjective. In general literature analysing the relationship between market thinness and price volatility in international agricultural markets is lacking. It is not clear what constitutes "thin" markets and how this "thinness" contributes to price volatility.

The purpose of this study is to provide factual information on production, consumption and trade of several agricultural commodities in order to examine whether the agricultural markets have become thinner using the definition of market thinness as the ratio of exports to world production. Are agricultural markets thinner now compared to earlier periods when the world was less concerned with price volatility? During the last 40 odd years, has the ratio of world exports to global production for each of the selected commodities decreased signalling "thinner" markets, or not? For robustness, two other aspects of market thinness, the number of participating agents or transactions and market power are also examined. Ideally, the number of market participants and market concentration would be based on observations of actual transactions by the countless market participants. But, in international trade, it is not possible to have information on the myriad of transactions occurring each year in the various markets. Lacking this, the latter two are calculated from observations at the country level. Although information on the number of countries participating in international trade is less informative than firm level trade data, country level observations nonetheless provide useful information. The fact that additional countries participate in international agricultural markets increases liquidity. It can be assumed that the higher the share of production exported, or the more numerous the participants, or the lower the trade concentration index, the deeper are the markets and prices are more representative and possibly less volatile. It is beyond the scope of the present study to examine the recent price swings or the causes of price volatility. The study is a companion to the price volatility paper (OECD, 2011), and in addition to soybeans, it uses the same set of agricultural products identified in that study (wheat, maize (corn), rice, sugar, beef, butter, whole milk powder, and soybean oil). Market thinness is calculated in different ways and its evolution over time is examined. This enables the interested reader to compare the evolution of price volatility and market thinness for the selected set of products.

The paper next describes the data, followed by an examination of the evolution of production and consumption of the selected commodities along with their volatility. The volatility or variability of a variable is measured by the coefficient of variation (the standard deviation divided by the mean), and as in the price volatility paper (OECD 2011) it is based on a moving five year average (interested readers can refer to OECD (2011) for the rational. Measures of market thinness are then presented. The last section concludes.

Data

Production, consumption and export data are from USDA, Production, Supply and Utilisation Database except for whole milk powder which comes from the AGLINK-COSIMO database. Bilateral trade data are from UNCOMTRADE accessed through the World Bank's World Integrated Trade Solution (WITS) and are based on SITC Rev 1 to maximise the available number of years. Data on total manufactured exports, exports of

high technology products, GDP, and agricultural value added are from the World Bank's World Development Indicators database.

Evolution of production and consumption and their variability

Obviously the amount produced and consumed each year helps determine the price level and changes in production and consumption from one year to the next contributes to price volatility over time. Among the factors listed above suspected of contributing to the recent price spikes and volatility, is the high and persistent demand growth in developing countries not accompanied by equivalent increases in production. Trade helps smooth out price fluctuations in any year by shifting goods from surplus areas to deficit areas with trade volumes partly determined by production and demand. To put trade data and one of the thinness measure presented below in perspective, the evolution of worldwide production and consumption is briefly examined. This is followed by an examination of the number of countries that are structural importers and structural exporters along with overall deficits or surpluses. If most of the demand is met through local consumption, then trade may not consist of a large share of global production. Trade as a share of global production may be small because demand on the world market may be small with trade serving as a residual market. Do deficits and surpluses differ among the selected commodities and is this related to the share of global production that is traded?

On the world level, has consumption and production followed a smooth growth or has there been a lot of variability? Figure 1 shows the evolution of production and consumption of the selected products starting in 1965 (1979 for whole milk powder). For all except butter[3], the figure illustrates a relatively smooth upward trend even though over the more than 40 years there have been many shocks to the system including severe weather, strong economic growth mixed with occasional recessions, financial crisis, and volatile exchange rates among others. This relatively smooth progression at the global level illustrates that local production or consumption shortfalls that occurred throughout the period were adequately compensated for by surpluses in other regions[4]. Wheat production (consumption) over the period expanded at an average annual rate of 1.8% (1.9%), maize production (consumption) expanded at an average annual rate of 2.6% (2.6%), while rice and sugar production (consumption) each increased at an average rate of 2.1% (2.1%) per year. Soybean production on the other hand grew at a more robust 4.7% annual rate. For the selected crops, it seems that on average, production and consumption grew at roughly equal rates. But, as illustrated in the figure, this does not mean that there were not years during which there were surpluses and years in which there were shortages leading to price swings.

For the selected products with more value added, and that are relatively less reliant on climatic conditions, and are further removed from the farm gate, average production and consumption also grew. Production (consumption) of soybean oil increased at the fastest rate among all of the selected commodities averaging an annual growth rate of 5.1% (5%) per year, followed by whole milk powder with an average growth rate for both production and consumption of about 3.1% per year (over a shorter time horizon). Beef production

3. There may be problems with the butter data in the late 1990s. FAO data also reveal a similar decline in production and consumption but not the sudden and large increase in 1999.

4. A linear trend explains 93% and 96% of wheat production and consumption, 95% and 97% of maize production and consumption, and 98% and 99% of rice production and consumption variability respectively.

and consumption grew an average of 1.4% a year, while butter exhibited the lowest growth rate with production and consumption increasing about 1.1% per year.

Focusing on the last 16 years, the time since 1995, how have the relative growth rates changed? For all products other than maize and butter, production grew at a slower pace relative to the entire period but so did consumption. Again, this does not imply that there were not years with shortages or surpluses, but in general, the markets adjusted more or less equilibrating the growth rates over time. Of course one cannot consume what is not produced and released from storage therefore consumption in physical units cannot diverge from production for very long. To the extent that there is strong demand, prices must rise to equilibrate.

Although the general pattern indicated in Figure 1 appears relatively smooth, how variable was production and consumption over this time period and did it change over time? For most commodities, production variability as measured by its coefficient of variation[5] (CV) seems relatively low. Over the entire period, beef production is the least volatile which is perhaps not too surprising given that it is less dependent on climatic conditions (Figure 2). Among the selected crops, soybean production followed by maize production was the most variable and rice the least. Among the more processed products, the production of soybean oil was the most volatile in the early years, while butter exhibited the largest volatility in the late 1990s and the early part of this century[6] (Figure 2). In general, comparing the selected agricultural products over the 40 some years of data indicate that production variability can be high for products not directly depended on climatic conditions and it can be small even for products subject to the vagaries of the weather. This suggests that the type of product - whether more or less reliant on climatic conditions or whether it is close to or further from the farm gate - is not crucial to the volatility of its global production over time.

Average variability based on the five year rolling CV method for the entire period and each decade is reported in Table 1. This shows that over the entire period, soybean production on average, was the most volatile followed by soybean oil, maize and butter. As indicated, beef production was the least volatile averaging 3% for the entire period, while rice production was the second least volatile at almost 4%.

Comparing production variability exhibited in the 1970s relative to the 2000s, it declined for all commodities except sugar and butter. For five commodities; wheat, rice, beef, whole milk powder and soybean oil, production volatility was at its highest in the 1970s, while for maize and soybeans this occurred in the 1980s, while only for two commodities, sugar and butter was observed production variability the highest in the 2000s.

5. CV in any year is the ratio of the standard deviation to the mean with the standard deviation and the mean calculated on a five-year moving basis by dropping the earliest year when a new year is added.

6. The butter volatility may be more a reflection of data problem alluded above rather than real volatility.

Figure 1. Production and consumption of selected agricultural commodities 1965-2010

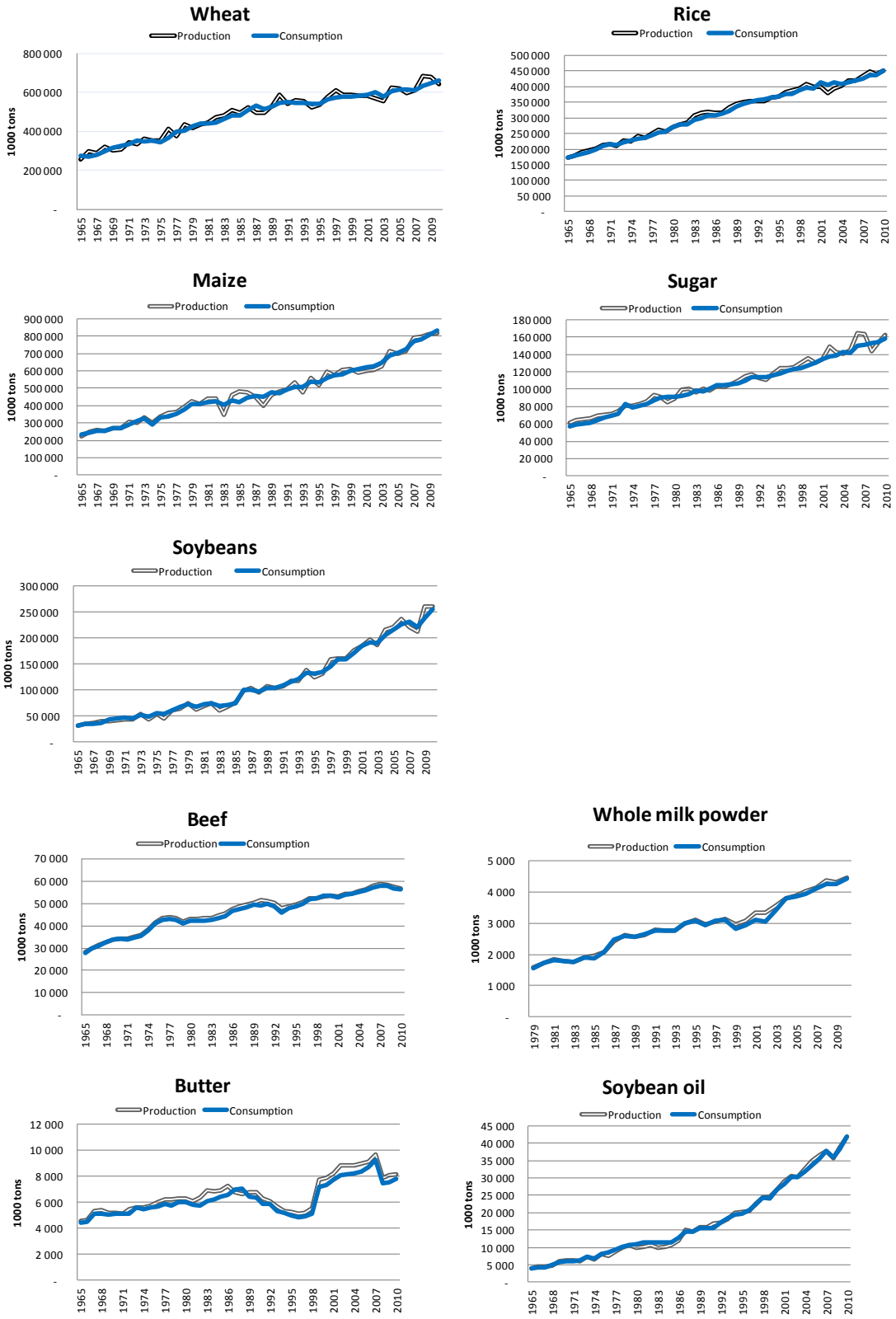


Figure 2. Production variability of selected agricultural products

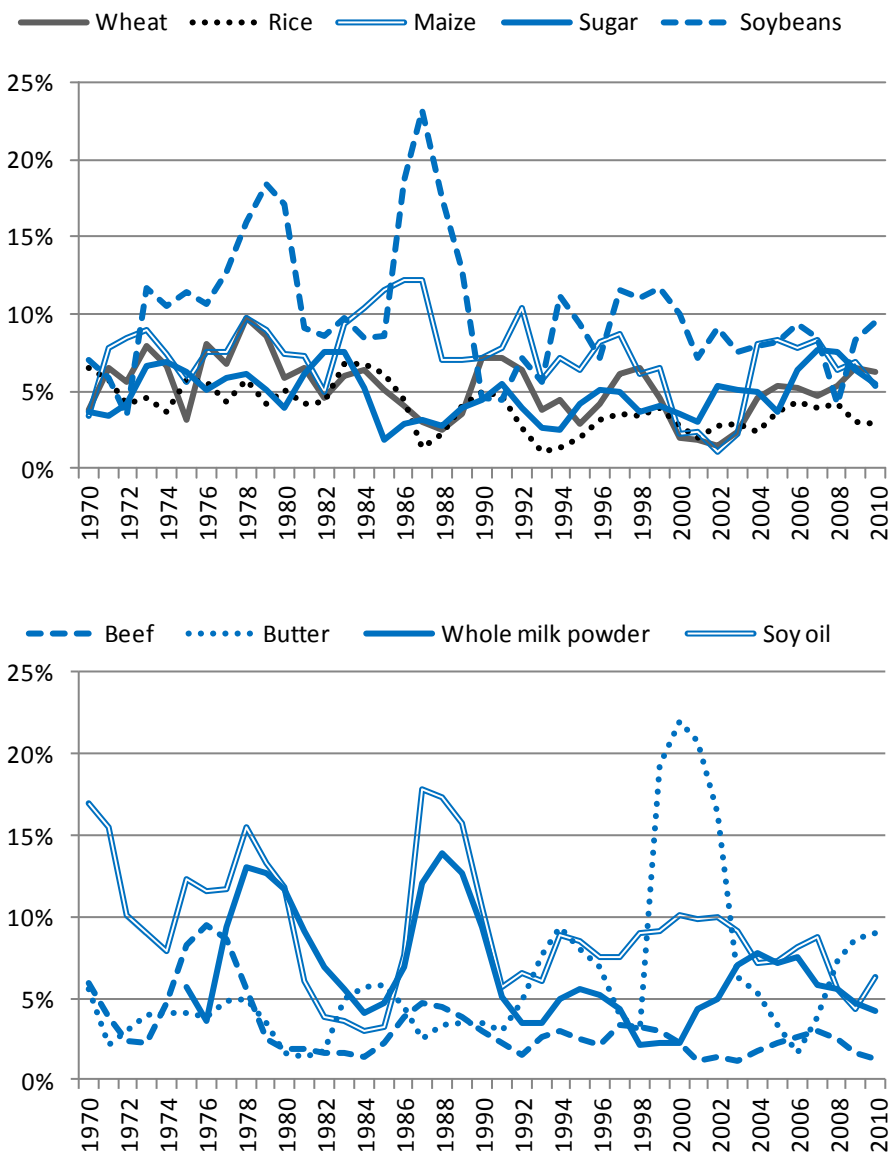


Table 1. Average variability for production and consumption

Period	Wheat		Rice		Maize	
	Production	Consumption	Production	Consumption	Production	consumption
1970 to 2010	5.19%	3.48%	3.93%	3.42%	7.28%	5.02%
1970 to 1979	6.66%	5.48%	5.03%	4.45%	7.57%	7.09%
1980 to 1989	4.73%	4.48%	4.54%	4.20%	8.94%	4.29%
1990 to 1999	5.32%	2.13%	3.06%	2.99%	7.43%	4.01%
2000 to 2010	4.15%	2.00%	3.15%	2.17%	5.38%	4.72%
1970 to 1994	5.71%	4.42%	4.42%	4.18%	8.14%	5.32%
1995 to 2010	4.37%	2.03%	3.16%	2.24%	5.95%	4.54%
	Soybeans		**Sugar**		**Beef**	
	Production	Consumption	Production	Consumption	Production	Consumption
1970 to 2010	10.11%	8.30%	4.84%	3.83%	3.12%	3.15%
1970 to 1979	10.75%	9.95%	5.32%	6.31%	5.35%	5.12%
1980 to 1989	13.36%	9.65%	4.52%	3.09%	2.74%	2.69%
1990 to 1999	8.38%	6.77%	4.10%	2.69%	2.64%	3.08%
2000 to 2010	8.15%	6.98%	5.38%	3.27%	1.90%	1.85%
1970 to 1994	10.97%	9.01%	4.70%	4.29%	3.72%	3.61%
1995 to 2010	8.77%	7.20%	5.07%	3.10%	2.19%	2.44%
	Whole milk powder		**Butter**		**Soy oil**	
	Production	Consumption	Production	Consumption	Production	Consumption
1970 to 2010	6.63%	6.45%	6.06%	6.15%	9.26%	8.64%
1970 to 1979	8.88%	---	3.98%	3.14%	12.37%	12.16%
1980 to 1989	8.74%	9.09%	3.50%	3.81%	9.01%	6.96%
1990 to 1999	4.58%	4.56%	6.94%	7.62%	7.93%	7.76%
2000 to 2010	5.55%	6.48%	9.47%	9.68%	7.85%	7.75%
1970 to 1994	7.91%	7.37%	4.12%	4.22%	10.06%	9.05%
1995 to 2010	5.04%	5.76%	9.09%	9.16%	8.00%	7.99%

The sample was also segregated into two sub-periods comprising of the years prior to the beginning of the implementation of the Uruguay Round Agreement on Agriculture (URAA) that is, prior to 1994; while the second period comprises the period since to 2010.[7] The URAA was a landmark agreement bringing agriculture into the rules of the world trading system, lowering domestic support, reducing export subsidies and lowering tariffs. How does production variability compare between the two periods? As indicated in Table 1, production variability was lower in the period since the start of the implementation period for seven of the nine commodities - each of the grains; (wheat, rice, and maize), soybeans, beef, whole milk powder and soybean oil. For sugar and butter however, the results were reversed with increased volatility in the period since the start of the implementation.

7. This is not intended to infer causation between the implementation of the URAA and subsequent developments in production or consumption volatility. Many other events occurred during this time that influence markets. This demarcation is just a handy convenience to indicate the more recent period.

Although the demarcation is somewhat arbitrary, is the difference in average production variability between the two periods statistically significant? The null hypothesis is that average production variability for each of the selected products in the period 1970 to 1994 ($\overline{X_1}$) is equal to the mean production variability in the period 1995 to 2010 ($\overline{X_2}$), i.e., $H_o : \overline{X_1} = \overline{X_2}$.

The computed statistic can be written: $t = (\overline{X_1} - \overline{X_2}) / (\sqrt{s_1^2 / n_1 + s_2^2 / n_2})$

With s the standard deviation and n the number of observations in each period. The computed t-statistic is compared to a Student with ($n_1 + n_2 - 2$) degrees of freedom.

The results[8] indicate that the null hypothesis that the average production variability is the same in both periods can be rejected at the 5% level for wheat, maize, rice, beef, whole milk powder and butter. For these products, other than butter, mean variability is statistically lower post 1994, while for butter it is the opposite. For soybeans, soybean oil and sugar, average production variability between the two periods was not statistically different indicating that one cannot reject the null hypothesis that average production variability in the two periods is the same.

A quick overview of consumption variability for the same set of commodities over the same time period is shown in Figure 3. For most commodities, the variability in world consumption is lower than the variability in production suggesting that on the demand side, short term production shortfalls maybe smoothed by adjustments in stocks or through trade. Overall, beef consumption is the least volatile while soybean seeds and soybean oil are the most volatile (Table 1).

As was the case for production, consumption was more volatile in the 1970s than in the 2000s for all but butter. It is also the case that consumption volatility has declined since the start of the URAA implementation for all commodities except butter.

The coefficient of variation measured illustrated in Figures 2 and 3 above is a useful indicator of a variable's variability relative to its medium term mean and variance. Additional information can be gleaned by looking at the annual changes in production (production in period t minus production in period t-1). How has this behaved over the time period examined?

Figure 4 below is a graphic illustration of the annual variation in the production for the selected products. This shows more clearly the annual change in production resulting from the usual economic factors (planting and harvesting decisions) along with unforeseen climatic events. By this metric, soybean production is the most variable, and its variability is especially high in the mid-1970s to the early 1980s. The annual variation in soybean production for the entire period averaged 10%. Among crops, rice production was the least variable with a 3% average annual change in production. Among all the selected products, beef production was the least variable with annual average production change of some 2%.

8. For all products other than whole milk powder, the degree of freedom is 39 and the critical value for Student t statistic for a 95% confidence level is 2.023. For whole milk powder the degrees of freedom and critical t value is 34 and 2.042 respectively. The calculated t statistic is: wheat (2.274), rice (2.90), maize (2.94), soybean (1.65), sugar (-0.76), beef (2.58), butter (-3.55), whole milk powder (2.86) and soybean oil (1.69).

Figure 3. Consumption volatility of selected agricultural commodities

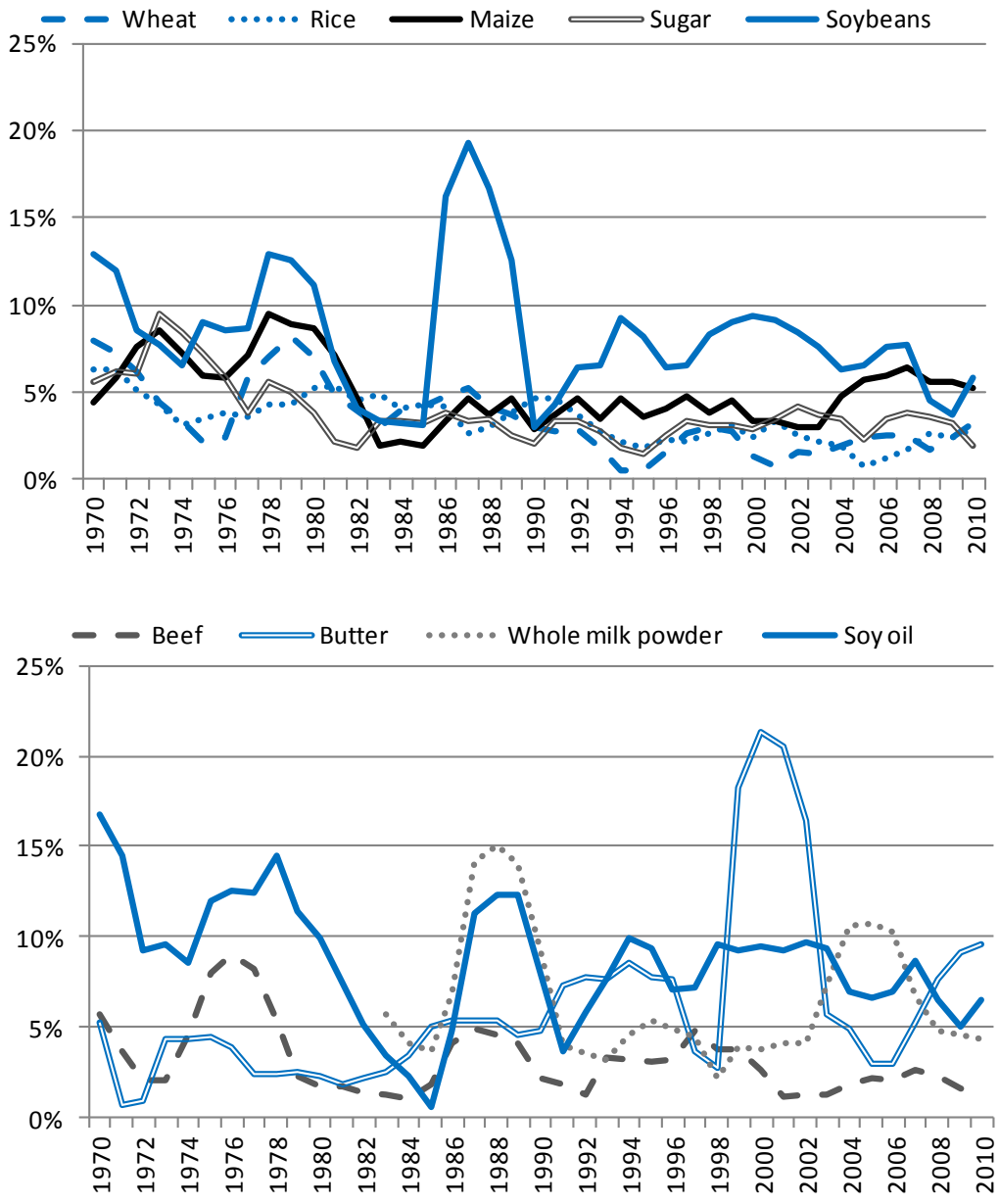
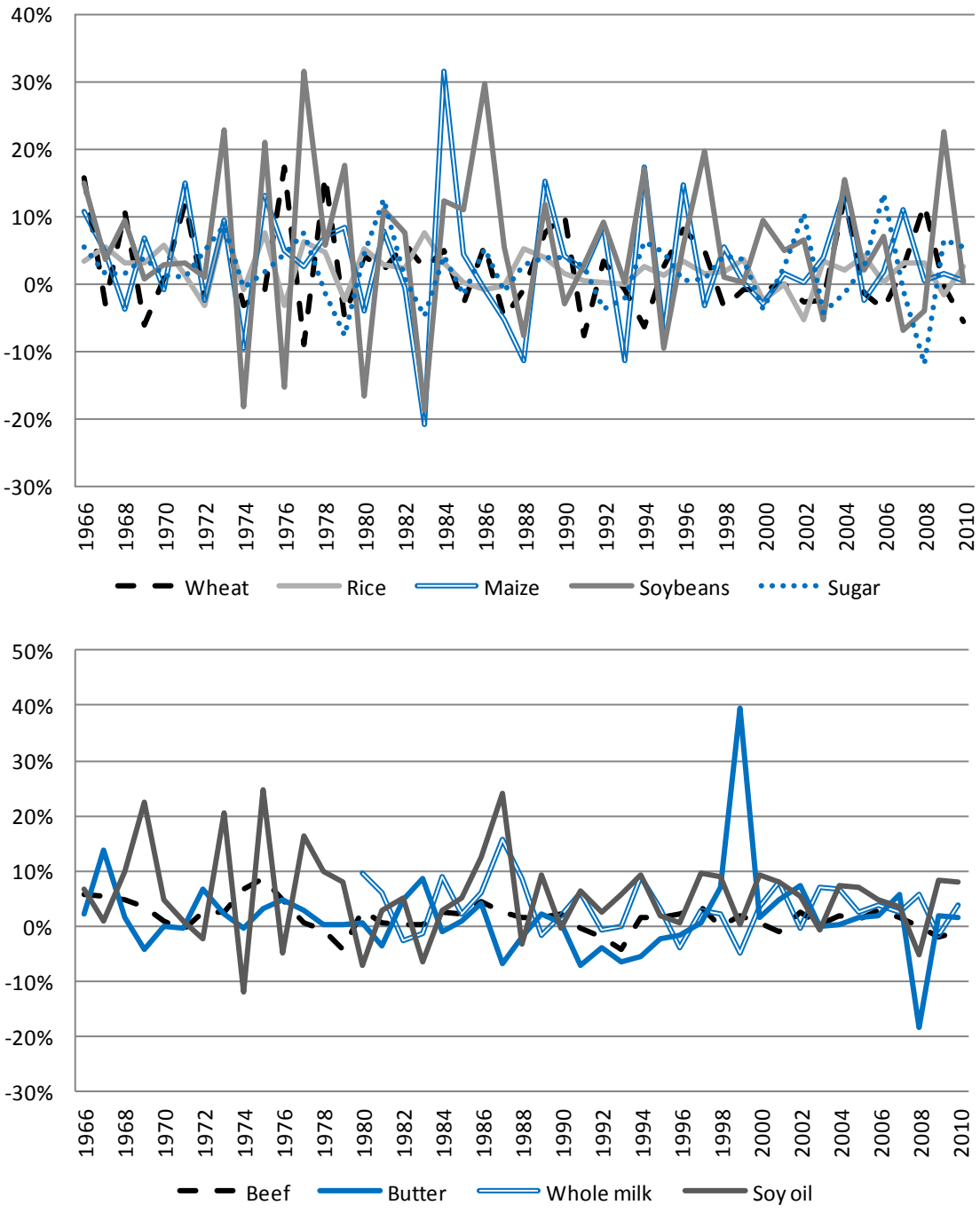


Figure 4. Annual variation in the production of selected commodities: per cent change from previous year



Not surprisingly, given that overall production of each product increased over the time frame, in most years and for all of the selected products, the variation in production is positive meaning that production in year t was greater than production in year t-1. Wheat seems to be the crop with the highest frequency of negative production events. In 22 of the 45 years examined, wheat production in year t was lower than production in year t-1. Maize is the crop with the second highest number of negative production events

as its production was below the previous year's level in 15 of the 45 years, while this happened only 9 times in rice. Interestingly, most of the negative growth in the selected commodities occurred prior to 1995. In the 2005-10 period the most recent era of price peaks in some commodities, production shortfalls occurred in four of the six years in wheat, two of the six years in soybeans and only once in each of the other selected products.

Evolution of exports and their variability

How has trade evolved over the time period for the selected commodities and how volatile has it been? To answer this question, exports from USDAs PS&D database are used. They are measured, as was production and consumption, in physical units to avoid the volatility introduced through evolving price changes. Information on the number of countries participating in international trade and calculations of the trade concentration index comes from UNCOMTRADEs bilateral trade data. The two data sources serve different purposes and are not strictly comparable.

The evolution of exports of the selected commodities is shown in Figure 5 with the top panel representing the crop products and the bottom panel showing exports of beef, dairy products and soybean oil. All products, except butter, show a rising trend with some variability probably reflecting changing economic and policy environment over the time frame. Export growth, was the fastest for soybean oil with an average annual growth of more than 6% a year (calculated by least squares) while butter exports hardly grew, averaging about 0.4% per year. One of the markets often cited as "thin", rice, trailed only soybeans (average export growth rate of 5%) among the crop products with an average export growth rate of almost 3.7% a year even with the disruption in the world rice market in 2008 when export restrictions and other policies contributed to a drop in exports of more than 2 mt (7%) relative to 2007. Exports of the other crops included in the analysis on average grew around 2% a year.

How volatile are the exports of these products? One may suspect trade of a particular product to be more volatile than either production or consumption of that product since trade responds to the volatility of production and consumption along with changes in border and other policies. A cursory glance at Figure 6, compared to Figure 2 or Figure 3 indicates that exports are more volatile than either production or consumption. The top part of the figure shows the volatility of the selected crops and the bottom part the other commodities[9]. As was the case for production and consumption, realised variability exhibits mostly a declining trend and, although there has been an uptick in volatility for most commodities in recent years, peak volatility was in the earlier period. In only one case, butter did the recent upticks in volatility surpass the previous volatility peak resulting in higher volatility in the 2000s compared with the 1970s.

9. As previously, volatility or variability is based on the five-year rolling CV method.

Figure 5. Exports of selected agricultural commodities

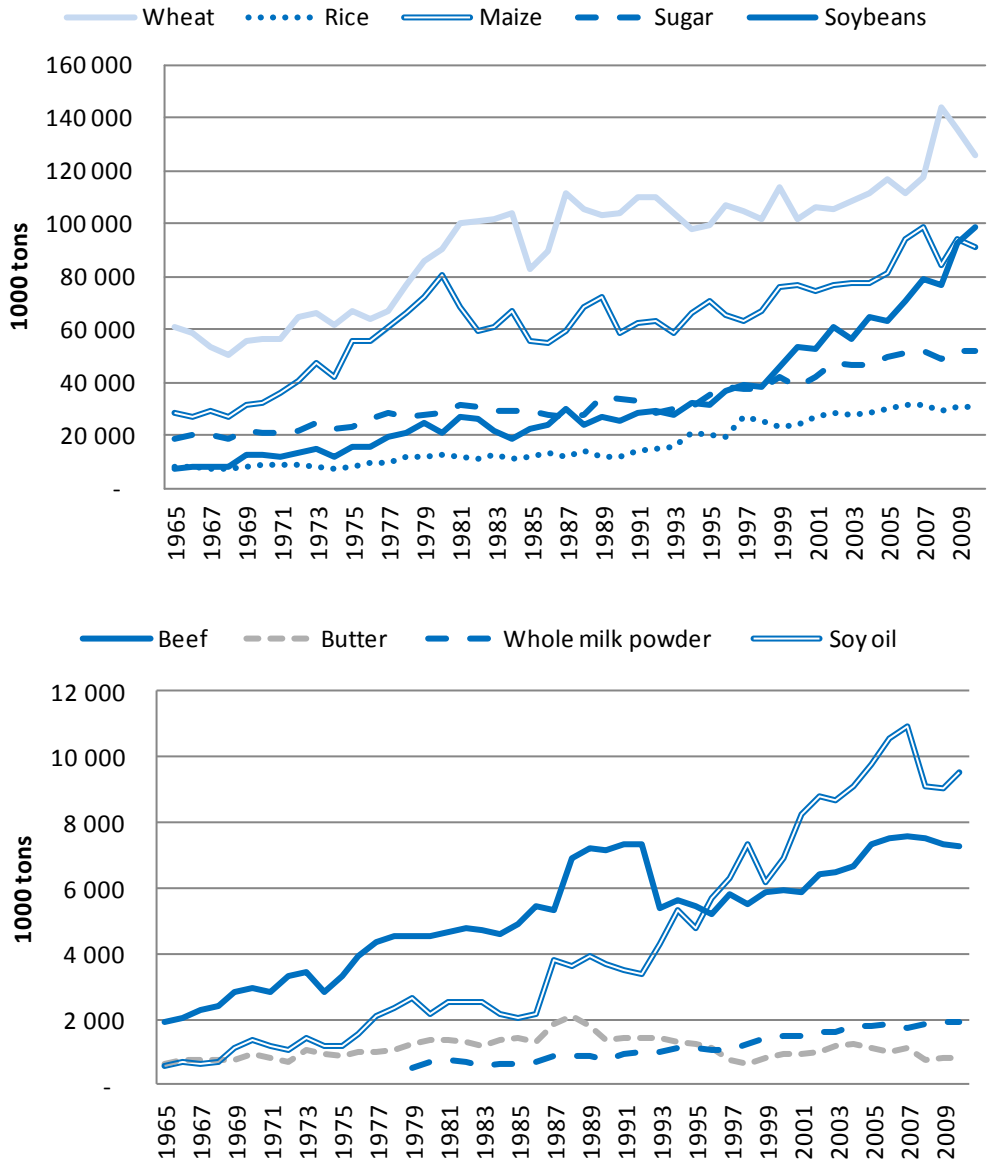
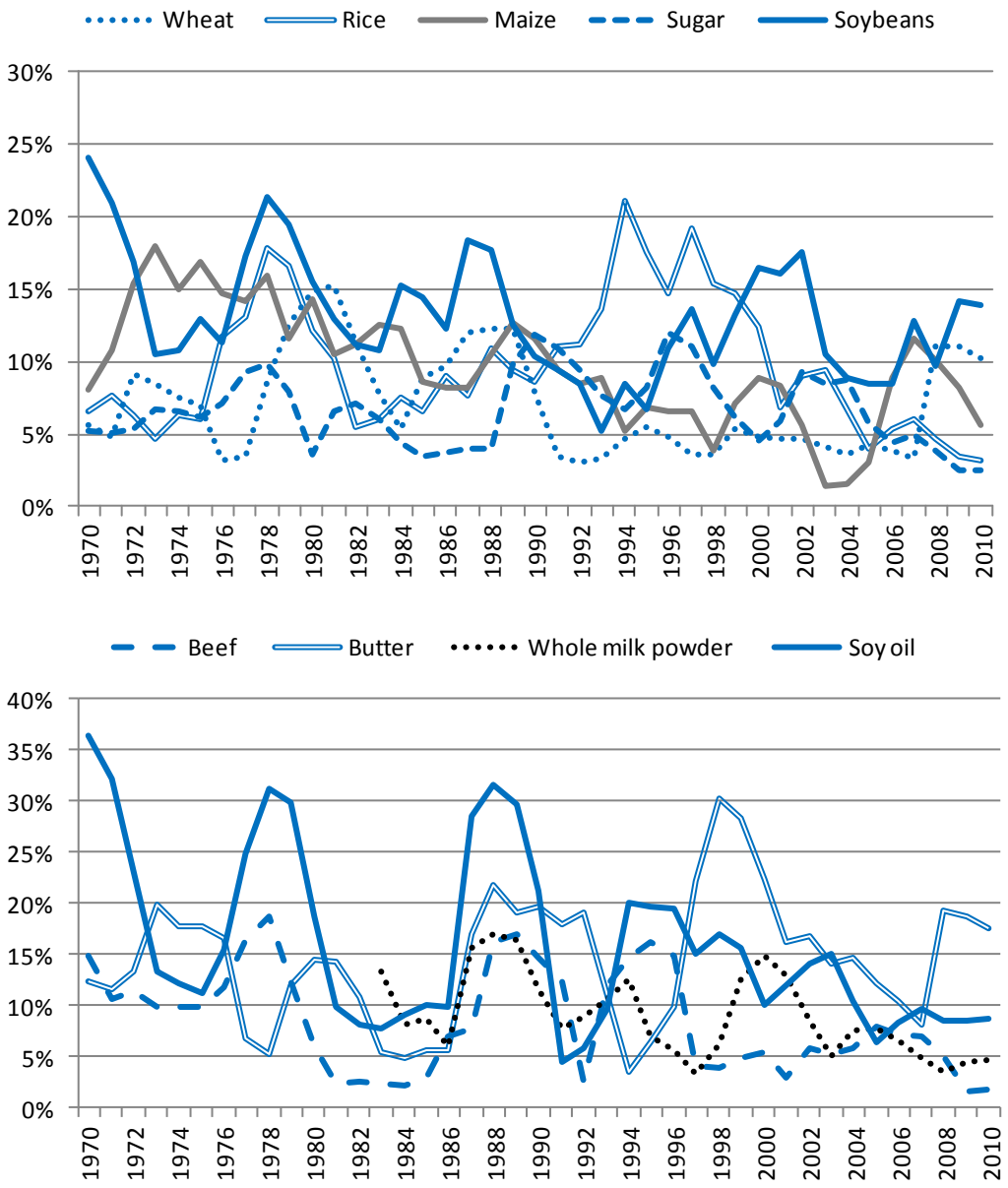


Figure 6. Variability of exports



Among the crops, sugar exports are the least volatile and soybean exports the most. Among the various decades covered the volatility of rice sugar and butter exports were the highest in the 1990s wheat exports were more volatile in the 1980s, while maize, soybeans, beef and soybean oil were more volatile in the 1970s. In none of the cases examined was export variability greater in the 2000 to 2010 period.

How "thin" are the selected markets?

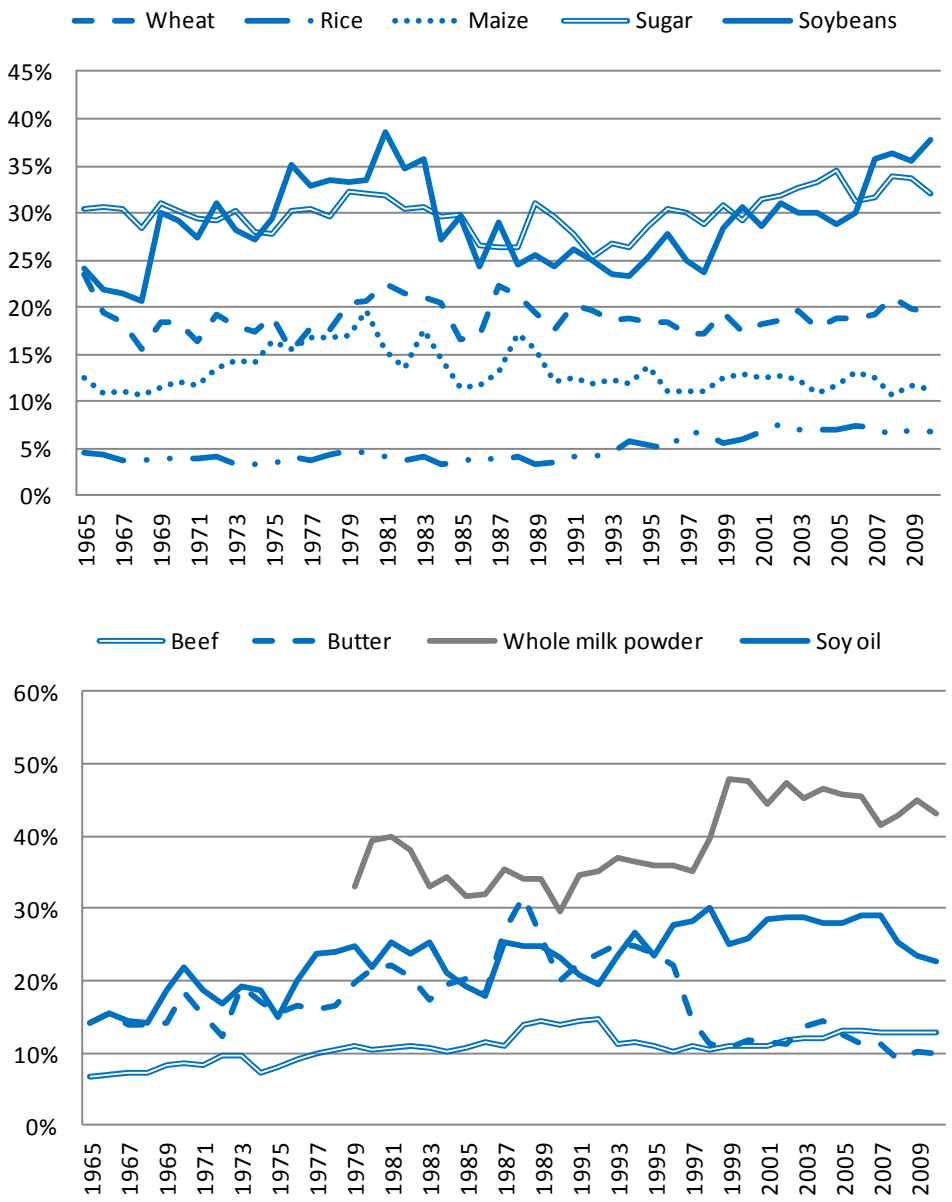
It is often stated that international agricultural markets are more volatile because they are thin - a relatively small share of world production is traded or a small number of buyers and sellers trade a small proportion of production or consumption. But as already

stated, information on the number of firms engaged in buying and selling on the international agricultural markets is lacking. However, as illustrated above, production, consumption and exports of the selected products expanded during the period examined. Thus one can calculate the proportion of production traded from available data such as PS&D enabling to answer questions such as have exports kept pace with production? Have agricultural markets become thinner (have total exports as a share of global production become smaller) and is there a difference in the thinness among the selected products? How does the "thinness" of agricultural markets compare to the thinness of other markets?

Exports as a rising share or production implies that international markets are becoming more liquid and that trade is increasing its importance in meeting the world's consumption needs. Such increased liquidity implies that international markets can more easily absorb production or consumption shocks reducing the amplitude of price fluctuations. A declining share on the other hand, (given that both production and trade have increased over time) implies that countries are providing more of their domestic needs locally, or are increasing their self-sufficiency. Whether increasing self-sufficiency is rational for an individual country's food security objectives depends on whether countries are exploiting their comparative advantage in an open, distortion-free policy environment. Previous work OECD (2010) suggests that many lower middle and low income countries have increased their comparative advantage in agriculture. This implies an expanding export supply from these countries which can either increase world exportable surplus or reduce world demand deficit depending on local demand conditions. Of course, one may argue that increased specialisation in agricultural goods may expose individual countries to increase price volatility from external shocks. This assumes that price volatility is the same for each individual commodity and over time, an assumption that does not hold (OECD, 2011). That freer trade leads to lower price variability was reported in a landmark study by Tyers and Anderson (1992) who found that price variability of international prices in the 1980s was three times greater than it would have been under free trade in those products, while Abbott Hurt and Tyner (2011), and Martin and Anderson (2010), among others, state that international trade unconstrained by government policies, can mitigate price volatility.

The top panel of Figure 7 shows exports as a share of production for the five crops while the bottom shows the same ratio for the other products (the reader is reminded that these are based on physical units thus abstracting from changing prices and their influence on the ratios). For most of the selected products, the share over the 40 plus years is rather constant. Among the crops, soybeans and sugar are the deepest (most "liquid") or least "thin" products with exports representing between 30% to 35% of production between 2000 and 2010 while rice is the "thinnest" with exports representing around 5% of production, although in the more recent years, the share has increased slightly to around 7%. The two other crops in the dataset that are generally considered among the most traded commodities, wheat and maize, are "fatter" than rice but "thinner" than soybeans and sugar with wheat exports representing a little less than 20% of world production and maize about 12% of world production since the mid-1990s. Interestingly, maize exports as a share of world production peaked in 1980 at about 20% and has since reached a lower plateau that is comparable to the level in the mid 1960s.

Figure 7. Exports as a share of world production (1965-2010)



Whole milk powder seems to be the "fattest" market with more than 40% of world production exported in recent years. Exports as a share of soybean oil production have exhibited a persistent increasing trend, rising to about 30% until the recent downturn in 2008. Butter exports as a share of production have exhibited the largest decline falling from a peak of more than 30% in 1988 to around 10% in the more recent years, with the steepest decline occurring between 1988 and 1990.

Various snapshots of exports as a share of production are shown in Table 2 which numerically summarises the visual picture presented in Figure 7. As suggested in Figure 7 and demonstrated in Table 2, the variation of exports as a share of production is rather low in most markets as suggested by the standard deviation. In most markets and in most cases the export share of production has not changed dramatically between decades. Table 2 summarises the degree that the rice market has become more liquid over time,

albeit from a rather small base, in contrast to the maize market which seems to have become slightly less liquid in the last decade relative to earlier periods.

The summary statistics reported in Table 2 indicate how exports as a share of production, or market thinness, has varied over the specified time periods. One can test whether the calculated values differ between any two time periods using a t test. For this, to save space and minimise repetition, we focus on the period from 1970 to 1994 and the period since 1995, the time when agriculture became more integrated in the rules governing world trade. The null hypothesis is that the average ratio of exports to world production from 1970 to 1994 is the same as the ratio from 1995 to 2010, *i.e.* market thinness has not changed. The degrees of freedom and critical Student t are the same as reported in footnote 8. The results suggest that markets have not become thinner for all except maize and butter. For wheat, soybeans and beef, one cannot reject the null hypothesis of equal ratios in the two periods. This means that market thinness of these three markets has not changed - they have not become thinner, but neither did they become more liquid. Two markets, maize and butter have become thinner with average exports as a share of production statistically lower in the second period compared to the first. The other markets, rice, sugar, whole milk powder and soybean oil became more liquid with the average ratio of exports to global production statistically significant higher in the second period compared to the first.[10]

Are there structural underlying causes for the differences in the share of production that is exported for a given commodity over time and among the selected commodities? Although examination of structural reasons for why exports represent a varying share of production among the various commodities is beyond the scope of this paper, the USDAs PS&D data are used to generate indicators enabling comparisons among the selected commodities. The USDAs PS&D data, in addition to providing data on world totals used above, also provide supply and utilisation data for individual countries over the same time span. Using these data, countries were classified into four broad categories based on their apparent trade status. For each country, the ratio of its production (five year total) to its consumption (five year total) was calculated. Countries with a ratio exceeding 1.25 are classified as *surplus exporters* since their production is more than sufficient to satisfy local needs and have exportable surplus. Countries with a ratio greater than .75 but less than or equal to 1.25 are classified as *self sufficient*. These countries at time may enter international markets as suppliers in cases when domestic production exceeds local needs or as buyers in cases when local production is short of domestic needs, or they may not enter international markets at all. The third group of countries are classified as *producing importers*. These countries have a production to consumption ratio greater than .25 but less than or equal to .75. They are in international markets each year because they do not produce enough to satisfy local needs, but they may have a sizeable local production. The final group of countries named *deficit importers* have limited if any local production and are persistently in international markets for their consumption needs (production to consumption ratio of .25 or less).[11]

10. Calculated t statistics are as follows: wheat (0.71), rice (-12.73), maize (3.91), soybeans (-0.74), sugar (-3.93), beef (-1.73), butter (5.29), whole milk powder (-6.47) and soybean oil (-5.67). These values should be compared to the critical Student t values reported in footnote 9.

11. The cut off point for classifying countries is somewhat arbitrary. The values were chosen to provide large enough bands to reduce the number of countries shifting among the groups from year to year.

Table 2. Exports as a share of production for various periods: 1970-2010

Period	Wheat				Rice			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
1970 to 2010	18.9%	1.6%	15.4%	22.6%	5.0%	1.4%	3.2%	7.6%
1970 to 1979	17.9%	1.5%	15.4%	20.5%	3.9%	0.5%	3.2%	4.7%
1980 to 1989	20.3%	2.0%	16.7%	22.6%	3.9%	0.4%	3.3%	4.6%
1990 to 1999	18.5%	1.0%	17.1%	20.2%	5.1%	1.1%	3.4%	6.9%
2000 to 2010	19.0%	1.0%	17.4%	21.0%	6.9%	0.4%	6.0%	7.6%
1970 to 1994	19.1%	1.9%	15.4%	22.6%	4.0%	0.6%	3.2%	5.8%
1995 to 2010	18.7%	1.1%	17.1%	21.0%	6.6%	0.7%	5.0%	7.6%
	Maize				**Soybeans**			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
1970 to 2010	13.4%	2.2%	10.6%	19.6%	29.7%	4.3%	23.2%	38.5%
1970 to 1979	14.8%	2.0%	11.6%	17.0%	30.7%	2.8%	27.3%	35.0%
1980 to 1989	15.0%	2.6%	11.5%	19.6%	30.3%	5.1%	24.4%	38.5%
1990 to 1999	12.0%	0.8%	11.0%	13.6%	25.3%	1.8%	23.2%	28.5%
2000 to 2010	12.0%	0.9%	10.6%	13.2%	32.2%	3.4%	28.6%	37.7%
1970 to 1994	14.3%	2.3%	11.5%	19.6%	29.3%	4.3%	23.2%	38.5%
1995 to 2010	11.9%	0.9%	10.6%	13.6%	30.3%	4.2%	23.7%	37.7%
	Sugar				**Soy oil**			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
1970 to 2010	30.0%	2.2%	25.4%	34.5%	23.8%	3.8%	15.0%	30.0%
1970 to 1979	29.7%	1.3%	27.8%	32.3%	20.3%	3.2%	15.0%	24.9%
1980 to 1989	29.5%	2.2%	26.2%	32.0%	22.9%	2.8%	17.8%	25.4%
1990 to 1999	28.4%	1.8%	25.4%	30.8%	24.8%	3.4%	19.5%	30.0%
2000 to 2010	32.3%	1.5%	29.3%	34.5%	27.0%	2.3%	22.7%	29.0%
1970 to 1994	29.1%	2.0%	25.4%	32.3%	21.8%	3.1%	15.0%	26.7%
1995 to 2010	31.5%	1.8%	28.5%	34.5%	27.0%	2.3%	22.7%	30.0%
	Beef				**Butter**			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
1970 to 2010	11.2%	1.7%	7.4%	14.6%	17.5%	5.5%	9.2%	31.6%
1970 to 1979	9.2%	1.1%	7.4%	10.9%	16.7%	2.2%	12.3%	19.7%
1980 to 1989	11.5%	1.4%	10.3%	14.3%	22.4%	4.5%	17.3%	31.6%
1990 to 1999	12.0%	1.7%	10.3%	14.6%	19.8%	5.6%	10.6%	25.1%
2000 to 2010	12.3%	0.7%	11.1%	13.0%	11.5%	1.5%	9.2%	14.3%
1970 to 1994	10.9%	2.0%	7.4%	14.6%	20.3%	4.4%	12.3%	31.6%
1995 to 2010	11.8%	1.0%	10.3%	13.0%	13.1%	4.1%	9.2%	23.6%
	Whole milk powder							
	Mean	Std. Dev.	Min	Max				
1980 to 2010	39.0%	5.5%	29.4%	47.9%				
1970 to 1979								
1980 to 1989	35.2%	2.9%	31.7%	39.9%				
1990 to 1999	36.8%	4.7%	29.4%	47.9%				
2000 to 2010	45.0%	1.9%	41.6%	47.6%				
1970 to 1994	34.9%	2.8%	29.4%	39.9%				
1995 to 2010	43.1%	4.3%	35.3%	47.9%				

In order to reduce clutter, the time period is broken into five-year intervals and the number of countries and the average annual deficit or surplus for countries within a category is calculated for each of the five years as an indication of potential trade. Table 3 reports the results for selected commodities. Comparing the field crops, one notices a striking difference in the number of countries in the various categories. For example, commodities with relatively small share of production that is traded (rice, and maize) have a relatively large number of countries that are in the self sufficient category, while products with relatively large share of production traded (wheat, and soybeans), have a relatively large number of countries that must import to satisfy domestic consumption on a consistent basis (countries in the deficit and producing importers categories). And, as indicated in the table, the average annual volume that must be displaced to balance world production and consumption differs materially among these crops. For example, rice production between 1970 and 1974 averaged around 218 mt, but as indicated in Table 3, about 3 mt on average were sufficient to balance the consumption requirements of deficit countries. Wheat production on the other hand averaged almost 342 mt per year during the same period while deficit countries had an average production shortfall of about 42 mt. The soybean market where an even larger proportion of production is exported is also characterised by countries where most of the consumption is produced by other countries as illustrated in Table 3. Soybean production averaged almost 46 mt per year from 1970 to 1974 while as indicated in Table 3, production shortfalls in consuming countries averaged almost 14 mt per year resulting in a relatively large share of world production that must be displaced through trade to balance demand and supply.

The results for the selected processed products also provide a similar picture. For products with a relatively high export to production ratio (sugar, soybean oil) there are more countries with production shortfalls and those shortfalls are a sizeable share of world production leading to larger share of production that is traded. For example, in the sugar market between 1970 and 1974, 78% of the countries producing and consuming sugar had production shortfall that averaged almost 17 mt a year out of total world production that averaged some 76 mt while 59% of the countries producing and consuming soybean oil had production shortfall averaging about 1 mt while supply averaged some 7 mt. In contrast, the beef market where relatively smaller share of production was traded, average production shortfall was about 1.7 mt while production averaged some 39 mt tons a year.

As illustrated previously, for the selected products, during the period examined, production consumption and trade increased while exports as a share of production followed a less predictable pattern. The results in Table 3 illustrate that the underlining structure of the markets did not change substantially. Countries in the markets with a relatively large share of production that is exported (wheat, soybeans, sugar, soybean oil (Figure 7) persistently have production shortfalls and the shortfalls are sizeable relative to world production. Countries in the markets with relatively low exports as a share of production on the other hand (rice maize beef and butter), have relatively smaller share of countries that are persistent importers and their production shortfall is small relative to world production. The results suggest that the various markets differ on the volume of trade needed to balance world demand and supply. It also suggests that most of these markets have not become thinner. As indicated above, volumes of production consumption and trade have increased during the more than 40 years examined and as illustrated in Table 3 the volume of production shortfalls has also increased confirming rising trade.

Table 3. Annual average deficit or surplus in 5-year increments for selected agricultural products

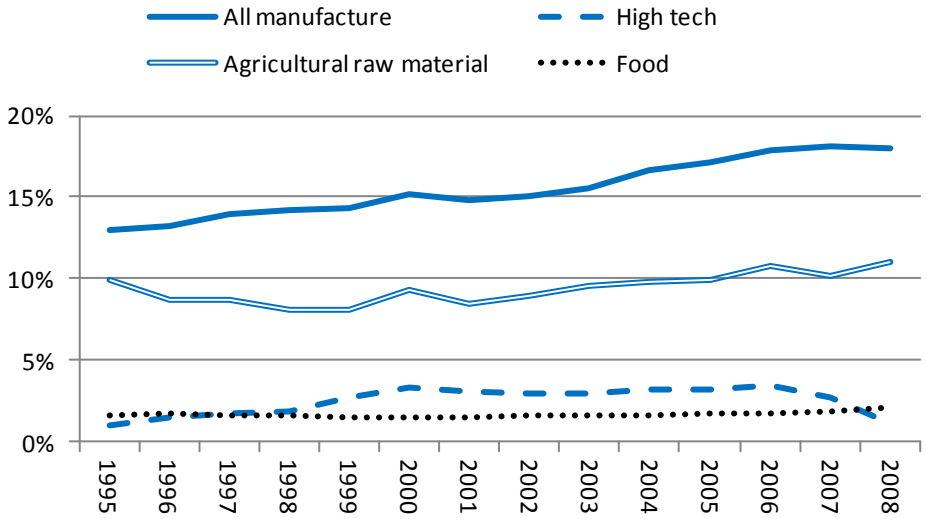
	Rice		Maize		Wheat		Soybeans	
	Number of countries	Average deficit/surplus (1000 metric tons)	Number of countries	Average deficit/surplus (1000 metric tons)	Number of countries	Average deficit/surplus (1000 metric tons)	Number of countries	Average deficit/surplus (1000 metric tons)
1970-74								
Deficit importers	35	(1 770)	19	(9 260)	55	(18 897)	29	(13 035)
Producing importers	14	(1 015)	14	(17 299)	19	(9 705)	5	(632)
Self-sufficient	56	1 341	60	20 883	25	(13 161)	20	40
Surplus exporters	7	2 060	4	9 461	4	39 209	3	12 306
1985-89								
Deficit importers	34	(3 867)	29	(32 685)	73	(39 091)	31	(20 931)
Producing importers	21	(2 194)	20	(13 882)	23	(25 383)	15	(4 137)
Self-sufficient	52	5 461	73	2 070	24	(11 091)	16	1 153
Surplus exporters	8	8 735	3	47 376	7	69 604	9	26 641
1995-99								
Deficit importers	34	(5 334)	25	(37 401)	63	(38 171)	29	(29 373)
Producing importers	26	(5 446)	21	(12 508)	25	(34 603)	7	(1 905)
Self-sufficient	44	5 011	74	3 245	25	4 993	17	(818)
Surplus exporters	8	12 707	3	58 006	6	76 885	5	33 991
2005-2010								
Deficit importers	41	(9 465)	26	(45 011)	65	(48 056)	28	(33 649)
Producing importers	27	(9 302)	22	(27 236)	29	(45 417)	7	(40 396)
Self-sufficient	39	2 285	64	53 258	16	11 151	16	(99)
Surplus exporters	8	22 287	8	19 891	9	90 242	7	77 989

	Sugar		Beef		Butter		Soybean oil	
	Number of countries	Average deficit/surplus (1000 metric tons)	Number of countries	Average deficit/surplus (1000 metric tons)	Number of countries	Average deficit/surplus (1000 metric tons)	Number of countries	Average deficit/surplus (1000 metric tons)
1970-74								
Deficit importers	62	(6 974)	-	-	3	(374)	33	(818)
Producing importers	23	(7 441)	3	(459)	6	(81)	8	(98)
Self-sufficient	30	(2 250)	37	(1 148)	23	38	23	538
Surplus exporters	33	17 281	16	5 436	7	2 010	6	879
1985-89								
Deficit importers	66	(9 245)	3	(134)	5	(234)	36	(1 863)
Producing importers	27	(9 091)	13	(1 417)	8	(548)	14	(943)
Self-sufficient	38	(1 176)	32	(1 368)	23	89	21	672
Surplus exporters	27	19 850	24	8 333	14	2 389	12	2 712
1995-99								
Deficit importers	74	(13 486)	9	(305)	1	(44)	39	(3 083)
Producing importers	27	(11 099)	13	(2 449)	2	(178)	12	(1 982)
Self-sufficient	31	(480)	35	651	10	207	12	829
Surplus exporters	31	30 264	5	1 833	3	418	8	4 536
2005-2010								
Deficit importers	77	(18 466)	11	(731)	2	(24)	33	(3 260)
Producing importers	20	(11 501)	21	(3 368)	2	(167)	16	(2 552)
Self-sufficient	27	(5 250)	21	(749)	7	131	16	(1 598)
Surplus exporters	26	37 017	8	5 403	3	479	7	7 840

Figure 7 also illustrates the subjectivity that may be involved in determining which markets to classify as thin and which markets to classify as deep or liquid. Perhaps

reference to other markets may provide guidance. How do exports of the selected agricultural products compare to trade of non-agricultural or other agricultural products? Unfortunately, production of non-agricultural products in volume terms is not readily available. To get a sense of the share of non-agricultural goods exported, GDP, and agricultural value added (AVA), data for individual countries (as a proxy for production) along with information on value of exports of all manufactured goods, high technology goods, agricultural raw material[12] and food[13], from the World Bank is used. The data are aggregated for all countries in the database to calculate the value of exports of each category as a share of world GDP except for agricultural raw material which is relative to world AVA. The data are for a shorter period of time (1995-2007) but include the large increase in world trade resulting from globalisation and the policy reform from the URAA. The results are shown in Figure 8.

Figure 8. Exports of all manufactured goods, high technology, raw agricultural products and food as a share of world GDP (agriculture value added for raw agricultural goods) 1995-2008



International trade expanded substantially since the mid 1990s reflecting, globalisation, technological improvements in communication and transportation, the integration of new participants in world markets from the demise of the iron curtain, the increasing use of supply chains or the segmentation of production into components that are shipped around the world prior to final assembly, and the reform of agricultural markets as a result of the URAA and the proliferation of regional trade agreements. The result as shown in Figure 8 is an increase in manufactured exports as a share of world GDP rising from a little more than13% to 18% of world GDP. Although not strictly comparable with the results for the individual products since the data represent products that are grouped and aggregated and include both changing volumes and changing prices,

12. Agricultural raw materials comprise SITC section 2 (crude materials except fuels) excluding divisions 22, 27 (crude fertilisers and minerals excluding coal, petroleum, and precious stones), and 28 (metalliferous ores and scrap).

13. Food comprises the commodities in SITC sections 0 (food and live animals), 1 (beverages and tobacco), and 4 (animal and vegetable oils and fats) and SITC division 22 (oil seeds, oil nuts, and oil kernels).

they nonetheless do suggest the relative importance of exports as a share of global output. As illustrated in Figures 7 and 8, the patterns are similar. The "thinness" of manufactured exports seems comparable to several of the individual products in Figure 7. In contrast, high tech and food markets seem much thinner with exports representing 2% to 4% of world GDP while exports of agricultural raw material capture the middle, ranging between an 8% to 10% share of world AVA. Based on this metric, for agricultural products that could be deemed thin, it seems that the performance of their exports as a share of production is not exceptional.

One reason why thin markets raise concern, especially with respect to price volatility is that with thin markets, a small number of transactions can lead to widely variable prices. Another possible metric that suggests competitiveness of markets is to look at the number of participants. The larger the number of agents competing in any market, the more liquid the market, the less likelihood that any one agent has market power and the less likelihood that few transactions will unduly influence the outcome.

The relevant metric therefore is the number of firms participating in world markets. But, this information is not readily available. Hence, to get an impression of the number of participants in each of the selected markets, the number of countries trading a particular product from the bilateral trade data from UNCOMTRADE is used. Countries as observational units are often used in trade, especially to determine world equilibrium prices in partial equilibrium models. The data used include all reported trade irrespective of the volume. How much each country trades is captured by the concentration index reported below. Information is based on exporting countries as reporters. Importer information is calculated from the bilateral exports. This may bias importer information when countries import from non-reporting exporters. Since most of the countries are covered in the data this is not expected to be a serious problem. Table 4 shows the average number of exporters and importers participating in the selected markets in each decade since 1970 (Annex Table 1 contains information for each year).

Table 4. Average number of exporters and importers for selected agricultural commodities

	Average1970's		Average 1980's		Average 1990's		Average 2000's	
	Number of exporters	Number of importers	Number of exporters	Number of importers	Number of exporters	Number of importers	Number of exporters	Number of importers
Wheat - including spelt - and meslin	36	136	40	146	61	162	91	177
Maize - corn - unmilled	58	142	55	149	80	169	102	196
Rice	63	175	61	175	90	202	114	219
Raw sugar,beet and cane	44	93	49	117	81	164	100	183
Refined sugar and other products of refin	60	165	56	174	81	207	111	222
Meat of bovine animals, fresh,chilled or frozen	62	159	64	175	82	202	109	216
Butter	52	178	56	183	77	199	105	216
Milk and cream - in solid form,blocks	48	184	49	186	81	206	116	219
soya beans	30	71	38	91	63	118	87	161
Soya bean oil	32	155	41	166	67	191	87	206

As indicated in Table 4, there are multiple more countries demanding (importing) a particular good than are countries supplying (exporting) them, consistent with results presented in Table 3. The table also illustrates the impact of globalisation on market participants as the number of exporting and importing countries expanded materially especially since the 1990s. The data in Table 4 further illustrate that trade participation especially during the 2000s is not materially different among the selected commodities. From this set of data, it is difficult to discern differences in the "thinness" of the various markets. The rice market, often cited as an example of a thin market, has more participants (exporters and importers) than either wheat or maize markets, in each decade

and soybean seeds and soybean oil, among the "fattest" markets when measured by exports as a share of production, are exported by fewer countries than the other products.

Of course, the number of participants is partly indicative of the degree of competition in a market and the potential for few transactions to dominate and skew the results. Many participants may not be indicative of competition if most are marginal participants with trade dominated by few major players. Another indication is gleaned by computing a Herfindahl index for each commodity. The Herfindahl index is computed as the sum of the square of each participant's market share. Ideally, this index should be computed from data on individual trading firms and their market share. Since this data is not available, the index is computed from of each country's market share. This is an indication of market concentration, and can be computed to show exporter or importer concentration. Small values of the index indicate a competitive market with each participant holding a small share while large values indicate the opposite.[14] In cases where all participant have equal shares, the index is equal to one divided by the number of participants. Relating this to thin markets, how does the Herfindahl Index compare for the various selected commodities?

Table 5 reports the computed average Herfindahl Index for each of the selected commodities for each decade since 1970. Note that the Herfindahl Index for exporters is larger than for importers suggesting that on the exporting side, there are a few participants with relatively large market share whereas importing countries tend to each import a relatively small share of the total.

Table 5. Average Herfindahl Index for selected agricultural commodities

	Average 1970's		Average 1980's		Average 1990's		Average 2000's	
	Herfindahl Index							
	Exporters	Importers	Exporters	Importers	Exporters	Importers	Exporters	Importers
Wheat - including spelt - and meslin	0.27	0.05	0.22	0.06	0.17	0.05	0.11	0.04
Maize - corn - unmilled	0.44	0.08	0.45	0.08	0.38	0.07	0.28	0.05
Rice	0.19	0.04	0.18	0.03	0.14	0.03	0.14	0.02
Raw sugar,beet and cane	0.20	0.23	0.13	0.15	0.13	0.11	0.20	0.08
Refined sugar and other products of refin	0.18	0.05	0.17	0.05	0.12	0.04	0.09	0.02
Meat of bovine animals, fresh,chilled or frozen	0.10	0.13	0.08	0.09	0.09	0.08	0.08	0.06
Butter	0.14	0.19	0.13	0.09	0.10	0.08	0.09	0.05
Milk and cream -in solid form,blocks	0.11	0.05	0.13	0.06	0.10	0.05	0.09	0.03
soya beans	0.77	0.11	0.64	0.09	0.47	0.09	0.34	0.16
Soya bean oil	0.25	0.06	0.16	0.05	0.16	0.05	0.21	0.06

But, for all commodities other than raw sugar, the Herfindahl Index for exporters fell during the last 40 years indicating that along with a larger number of participants over time, concentration fell as market share of each exporter declined and international markets became more competitive. On the import side as well, increased number of participants resulted in lower concentration but from a much smaller level suggesting that competition in import markets increased.

Comparing the index among the different commodities, the international soybean market is the most concentrated while meat of bovine animals is the least concentrated. Over the time period examined however, differences in the concentration ratio among the

14. The US Department of Justice uses the Herfindahl index to determine an industry's competitiveness. A Herfindahl Index above 0.18 indicates an industry that is very concentrated.

selected products has narrowed especially for exporters. The rice market does not stand out as exceptional by this metric. Its concentration ratio on both the export and import side is neither the highest nor the lowest. In fact, among the selected importing markets, the rice market (along with refined sugar market) has the lowest concentration ratio implying that it is more competitive than the other markets. This finding is consistent with the structure of rice production and marketing which is characterised by very large number of farmers, traders, processors, retailers and consumers (Timmer 2009).

Conclusions

Most agricultural markets are naturally volatile given the relative dependence of production on climatic conditions. With relatively inelastic demand and supply, shortages or abundance relative to the underlying trend leads to relatively large price swings. Abbott, Hurt and Tyner (2011) indicate that many agricultural commodities have become more inelastic suggesting larger price swings from a given supply shock. Trade is an avenue that can mitigate large price variability as it equilibrates demand and supply through space, moving goods from surplus areas to deficit areas with higher demand. For this to work efficiently it is supposed that markets must not be thin or in other words must be deep or liquid. Thin markets are characterised by relatively low volumes, asymmetric information, few agents or transactions per period, with market power and high transaction costs. The presence of any of these characteristics leads to inefficient and volatile prices. It is often stated that agricultural markets are thin and more volatile. In internationally traded agricultural commodities, the metric often used to indicate market thinness is exports as a share of production. This metric is used in this study to measure market thinness of selected agricultural commodities. For robustness, two other indicators are used, the number of traders and market power. As information of the number of transactions and their associated prices is difficult to find, the number of countries participating in trade of a particular product is used as a proxy. To measure market power, the Herfindahl Index for each exporter or importer is calculated. The three measures are then examined to determine whether the selected markets have become thinner.

Definition of thin markets is rather subjective however as there's no information or analysis on the ideal level of the indicator variables. Is there a particular share of exports or number of participants or concentration index that distinguishes thin from liquid markets? Is this a universal ratio or does it depend on the market? The results from this study suggest that the answer is no.

The results suggest that the volume that must be displaced from surplus producers to deficit consumers to equilibrate world demand and supply seems to be product specific. Some markets, like rice, a relatively small fraction of world production needs to cross borders to equilibrate demand and supply as most of the consumption occurs in countries that produce most of the product. Other markets, say whole milk powder, sugar or soybeans, most of the production occurs in countries that are geographically separated from countries with most of the consumption and a larger share of world production crosses borders to balance demand with supply. And, this seems to have changed little over the 40 some years examined. Demand for each of the selected products has increased consistent with rising incomes and world population but in many cases so has local supply, rendering a rather stable or even increasing export to production ratio over time.

Thus, the results suggest that by most measures used in the analysis, agricultural markets have not become thinner. For most products examined, exports as a share of production have either remained stable or increased over time. In only two cases - maize

and butter - is there statistical evidence that exports as a share of production on average were lower in the 1995-2010 period compared to 1970-94 period. Furthermore, the number of participants in the selected markets both as suppliers and as recipients has increased while trade has become less concentrated. All three indicators therefore point to markets that are not becoming thinner. OECD (2011) reports that price volatility varies by commodity and over time with the general conclusion that price volatility is higher in 2006-10 then in the 1990s, but not necessarily higher than that of the 1970s. Given that most of the selected agricultural markets have not become thinner during this time period, the assertion that prices are now more volatile because of the thinness of agricultural markets may need to be re-evaluated.

The results indicate that production grew at a slower pace since 1995 for many of the products examined. Faster productivity growth can help mitigate price rises for products with strong demand growth. Trade can also help moderate price swings by balancing global demand and supply. Given relatively inelastic demand and supply small changes in trade can lead to significant price changes regardless of the underlying share of production that is traded. It may not be very meaningful therefore to compare the share of production exported between various products as that share may reflect market, biological or climatic fundamentals. One of the crucial factors for alleviating large price swings from unexpected shocks is to allow trade to flow unburdened by domestic and border policies allowing each market to adjust within the boundaries of those fundamentals. Government policies suddenly blocking or restricting the free flow of goods to international markets, increase uncertainty, add to the vulnerability of the supply chain especially during periods of low stockholding, shake confidence that produce will be supplied when needed and contribute to higher and more volatile world prices (if the country is a major trader). Such actions contribute to making markets thinner, at least temporarily, relative to the underlying fundamentals. Although, outright bans are relatively infrequent and they tend to be of limited duration they can have dramatic consequences. The impacts on world markets will be examined under future work on export restrictions.

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Annex Table 1. Number of exporters, importers and Herfindahl Index for selected commodities

Year	Wheat				Maize			
	Exporters	Importers	Herfindahl Index		Exporters	Importers	Herfindahl Index	
	Number		Exporters	Importers	Number		Exporters	Importers
1965	26	120	0.234	0.061	42	114	0.426	0.101
1966	30	119	0.294	0.062	39	125	0.416	0.098
1967	29	120	0.270	0.061	44	118	0.330	0.095
1968	33	118	0.248	0.057	48	119	0.362	0.093
1969	34	120	0.201	0.060	47	122	0.331	0.089
1970	37	134	0.234	0.048	57	132	0.316	0.101
1971	34	137	0.258	0.043	61	134	0.258	0.086
1972	37	137	0.248	0.051	57	136	0.407	0.088
1973	36	139	0.370	0.047	58	143	0.500	0.080
1974	36	131	0.290	0.041	59	153	0.411	0.072
1975	33	139	0.297	0.049	59	146	0.452	0.071
1976	40	139	0.259	0.048	60	146	0.518	0.084
1977	37	133	0.219	0.046	58	141	0.478	0.067
1978	32	135	0.287	0.041	55	143	0.495	0.073
1979	38	140	0.266	0.043	56	149	0.555	0.070
1980	39	140	0.245	0.056	61	154	0.554	0.058
1981	39	145	0.284	0.059	58	148	0.485	0.078
1982	38	148	0.260	0.069	61	145	0.454	0.071
1983	42	150	0.244	0.075	55	149	0.478	0.066
1984	41	149	0.233	0.082	53	153	0.525	0.090
1985	37	140	0.188	0.066	50	148	0.421	0.091
1986	38	151	0.181	0.050	56	149	0.245	0.059
1987	41	147	0.186	0.051	49	148	0.340	0.073
1988	40	144	0.213	0.060	50	150	0.450	0.091
1989	45	149	0.201	0.054	57	145	0.514	0.104
1990	45	147	0.172	0.050	66	153	0.477	0.074
1991	44	152	0.174	0.058	67	154	0.402	0.090
1992	47	161	0.174	0.052	70	169	0.313	0.064
1993	52	165	0.188	0.035	65	174	0.340	0.070
1994	57	158	0.175	0.043	77	168	0.296	0.070
1995	63	174	0.177	0.038	88	172	0.510	0.064
1996	73	165	0.172	0.049	89	169	0.479	0.075
1997	71	167	0.155	0.053	89	175	0.327	0.066
1998	79	167	0.141	0.042	92	178	0.309	0.062
1999	80	162	0.145	0.044	96	180	0.382	0.055
2000	89	173	0.131	0.043	103	189	0.327	0.055
2001	88	173	0.121	0.042	96	191	0.316	0.057
2002	96	181	0.107	0.041	100	193	0.299	0.054
2003	92	177	0.110	0.032	102	197	0.251	0.054
2004	98	179	0.129	0.045	105	194	0.300	0.054
2005	90	173	0.113	0.037	105	195	0.240	0.052
2006	88	175	0.102	0.033	104	199	0.325	0.051
2007	92	172	0.123	0.026	108	201	0.268	0.045
2008	98	182	0.108	0.027	107	200	0.284	0.048
2009	82	183	0.094	0.024	94	202	0.231	0.046

Year	Rice				Sugar (Raw)			
	Exporters	Importers	Herfindahl Index		Exporters	Importers	Herfindahl Index	
	Number		Exporters	Importers	Number		Exporters	Importers
1965	47	148	0.174	0.049	28	83	0.159	0.416
1966	49	150	0.170	0.043	27	62	0.143	0.449
1967	44	142	0.209	0.047	33	64	0.133	0.476
1968	49	145	0.200	0.044	33	101	0.112	0.432
1969	50	145	0.188	0.074	34	92	0.103	0.395
1970	61	172	0.178	0.065	39	66	0.099	0.366
1971	56	170	0.160	0.054	38	80	0.089	0.365
1972	58	175	0.235	0.042	40	83	0.108	0.225
1973	63	173	0.210	0.045	42	93	0.116	0.169
1974	65	178	0.197	0.034	44	99	0.116	0.206
1975	60	172	0.238	0.038	49	92	0.172	0.130
1976	69	172	0.177	0.040	50	99	0.252	0.162
1977	67	175	0.198	0.042	45	98	0.235	0.177
1978	67	180	0.184	0.044	46	103	0.386	0.270
1979	67	178	0.155	0.033	48	112	0.392	0.256
1980	71	178	0.184	0.036	46	113	0.256	0.162
1981	64	178	0.175	0.054	47	111	0.112	0.178
1982	61	175	0.186	0.029	48	116	0.121	0.092
1983	60	173	0.196	0.030	52	115	0.096	0.135
1984	59	175	0.204	0.029	42	108	0.115	0.139
1985	57	178	0.158	0.029	48	113	0.080	0.185
1986	65	172	0.151	0.033	52	126	0.100	0.146
1987	61	171	0.153	0.028	49	116	0.117	0.139
1988	55	171	0.164	0.037	51	130	0.115	0.159
1989	59	177	0.225	0.025	56	117	0.145	0.141
1990	71	182	0.164	0.026	64	132	0.117	0.151
1991	78	186	0.144	0.025	64	131	0.093	0.132
1992	78	206	0.146	0.028	70	164	0.102	0.107
1993	80	203	0.140	0.029	75	165	0.124	0.124
1994	87	204	0.153	0.051	81	164	0.146	0.129
1995	87	210	0.163	0.031	86	174	0.153	0.090
1996	100	207	0.153	0.025	92	169	0.117	0.067
1997	106	206	0.131	0.023	92	179	0.117	0.079
1998	102	206	0.120	0.034	91	179	0.140	0.095
1999	113	210	0.122	0.025	97	184	0.153	0.134
2000	115	215	0.121	0.023	100	185	0.099	0.098
2001	111	218	0.113	0.036	103	183	0.134	0.115
2002	112	219	0.132	0.025	101	177	0.131	0.100
2003	122	216	0.127	0.022	101	180	0.141	0.106
2004	122	219	0.155	0.021	103	180	0.158	0.073
2005	114	220	0.133	0.021	112	180	0.217	0.083
2006	112	221	0.128	0.021	97	178	0.296	0.071
2007	115	222	0.140	0.021	94	192	0.227	0.058
2008	111	221	0.154	0.025	99	192	0.242	0.057
2009	107	221	0.174	0.026	91	184	0.391	0.053

	Sugar (Refined)				Beef			
Year	Exporters	Importers	Herfindahl Index		Exporters	Importers	Herfindahl Index	
	Number		Exporters	Importers	Number		Exporters	Importers
1965	43	128	0.162	0.048	42	130	0.135	0.146
1966	50	136	0.125	0.087	44	129	0.136	0.153
1967	45	134	0.097	0.087	46	123	0.116	0.158
1968	43	129	0.113	0.081	53	132	0.098	0.173
1969	44	134	0.204	0.083	53	137	0.101	0.168
1970	54	163	0.219	0.084	63	148	0.098	0.168
1971	58	160	0.230	0.073	60	153	0.094	0.163
1972	59	168	0.230	0.049	65	154	0.105	0.143
1973	58	162	0.262	0.049	62	157	0.122	0.142
1974	66	169	0.124	0.051	62	160	0.091	0.132
1975	64	168	0.112	0.051	64	162	0.097	0.123
1976	61	171	0.136	0.031	62	155	0.089	0.106
1977	62	171	0.145	0.040	62	162	0.090	0.097
1978	58	155	0.172	0.044	60	170	0.092	0.110
1979	56	167	0.168	0.039	59	170	0.104	0.109
1980	55	173	0.187	0.054	60	169	0.091	0.096
1981	53	168	0.155	0.050	66	173	0.083	0.085
1982	56	170	0.154	0.044	67	171	0.085	0.091
1983	59	166	0.144	0.046	66	169	0.082	0.092
1984	56	176	0.158	0.034	62	172	0.081	0.092
1985	56	172	0.149	0.043	66	173	0.079	0.095
1986	57	171	0.157	0.037	61	175	0.088	0.095
1987	52	183	0.124	0.033	63	181	0.085	0.092
1988	57	175	0.239	0.075	64	182	0.083	0.085
1989	62	188	0.204	0.085	67	185	0.085	0.085
1990	66	184	0.144	0.034	72	183	0.088	0.085
1991	61	186	0.154	0.036	68	182	0.094	0.082
1992	69	210	0.119	0.045	77	205	0.091	0.083
1993	73	212	0.121	0.046	74	208	0.090	0.086
1994	82	215	0.122	0.039	77	210	0.090	0.084
1995	88	213	0.134	0.038	84	211	0.089	0.083
1996	88	210	0.105	0.033	91	203	0.086	0.075
1997	92	209	0.104	0.032	90	202	0.088	0.074
1998	93	212	0.101	0.031	94	206	0.086	0.078
1999	101	214	0.110	0.033	96	207	0.091	0.077
2000	108	220	0.111	0.027	108	207	0.093	0.076
2001	112	219	0.104	0.024	111	210	0.100	0.088
2002	114	220	0.094	0.026	107	219	0.087	0.071
2003	114	224	0.088	0.025	112	213	0.086	0.069
2004	114	224	0.086	0.029	116	218	0.079	0.070
2005	113	222	0.086	0.023	115	216	0.074	0.065
2006	117	222	0.091	0.020	113	218	0.073	0.057
2007	111	225	0.074	0.022	107	218	0.071	0.052
2008	112	222	0.070	0.021	106	222	0.066	0.049
2009	97	223	0.092	0.021	95	220	0.062	0.047

Year	Butter				Milk and Cream in solid form				Soya bean oil			
	Exporters	Importers	Herfindahl Index		Exporters	Importers	Herfindahl Index		Exporters	Importers	Herfindahl Index	
	Number		Exporters	Importers	Number		Exporters	Importers	Number		Exporters	Importers
1965	44	139	0.154	0.437	28	155	0.158	0.034	21	117	0.651	0.053
1966	44	135	0.170	0.470	29	154	0.106	0.034	22	119	0.629	0.041
1967	47	141	0.169	0.486	33	157	0.108	0.036	24	123	0.628	0.076
1968	51	145	0.147	0.360	37	158	0.114	0.035	24	123	0.568	0.068
1969	44	144	0.161	0.360	39	156	0.124	0.053	27	129	0.438	0.064
1970	48	173	0.155	0.250	43	182	0.120	0.035	31	138	0.402	0.051
1971	49	175	0.124	0.221	48	182	0.108	0.040	30	145	0.358	0.051
1972	52	182	0.139	0.234	44	183	0.101	0.045	28	155	0.327	0.043
1973	52	179	0.140	0.130	46	185	0.105	0.056	34	149	0.209	0.051
1974	45	179	0.142	0.210	47	190	0.113	0.047	31	163	0.281	0.050
1975	53	173	0.147	0.270	57	184	0.102	0.050	28	156	0.178	0.058
1976	55	178	0.145	0.191	47	186	0.112	0.067	31	159	0.178	0.051
1977	60	181	0.135	0.153	50	181	0.111	0.052	33	159	0.213	0.073
1978	53	182	0.127	0.123	47	180	0.126	0.057	33	161	0.195	0.070
1979	53	177	0.130	0.099	46	182	0.138	0.051	37	164	0.208	0.063
1980	58	186	0.130	0.079	46	184	0.136	0.049	38	163	0.192	0.064
1981	59	182	0.131	0.072	48	186	0.124	0.035	39	165	0.206	0.055
1982	56	183	0.131	0.074	49	186	0.117	0.040	37	163	0.162	0.043
1983	47	182	0.127	0.077	49	182	0.115	0.052	36	164	0.154	0.049
1984	59	184	0.126	0.069	50	183	0.118	0.053	41	167	0.157	0.060
1985	57	185	0.126	0.073	50	186	0.115	0.045	36	166	0.152	0.047
1986	55	183	0.129	0.086	48	186	0.121	0.070	44	161	0.122	0.039
1987	54	180	0.134	0.113	47	188	0.138	0.094	40	167	0.132	0.049
1988	53	183	0.131	0.119	48	190	0.170	0.095	50	171	0.162	0.045
1989	63	180	0.117	0.104	52	193	0.115	0.073	52	172	0.147	0.047
1990	61	182	0.103	0.086	60	194	0.111	0.062	52	176	0.144	0.049
1991	62	183	0.117	0.092	60	188	0.121	0.053	52	173	0.153	0.035
1992	70	199	0.112	0.087	66	209	0.110	0.058	63	191	0.152	0.034
1993	66	208	0.108	0.084	69	212	0.103	0.058	62	194	0.173	0.033
1994	76	206	0.103	0.084	86	211	0.095	0.057	67	197	0.184	0.058
1995	86	207	0.100	0.089	86	212	0.089	0.071	67	197	0.169	0.074
1996	83	203	0.094	0.075	94	208	0.096	0.051	70	196	0.166	0.066
1997	84	202	0.099	0.082	94	210	0.089	0.042	75	194	0.144	0.075
1998	88	202	0.099	0.079	92	208	0.087	0.041	77	197	0.171	0.049
1999	97	202	0.100	0.072	101	208	0.083	0.034	83	193	0.186	0.045
2000	101	213	0.086	0.055	114	220	0.095	0.032	83	204	0.160	0.037
2001	99	213	0.085	0.057	117	220	0.092	0.028	83	202	0.161	0.046
2002	102	209	0.091	0.055	111	220	0.093	0.028	84	201	0.162	0.045
2003	110	215	0.099	0.057	122	214	0.094	0.028	90	205	0.203	0.065
2004	106	218	0.090	0.046	116	220	0.088	0.028	93	207	0.229	0.076
2005	110	215	0.085	0.043	117	220	0.081	0.027	92	211	0.237	0.062
2006	106	218	0.086	0.048	116	219	0.083	0.025	88	210	0.270	0.052
2007	111	221	0.081	0.047	121	220	0.086	0.029	90	207	0.284	0.073
2008	107	217	0.084	0.042	115	222	0.085	0.031	88	207	0.205	0.057
2009	93	216	0.089	0.043	106	219	0.101	0.026	81	207	0.212	0.078