Changes in China's urban food consumption and implications for trade

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Abstract

Detailed data from 3,500 urban Chinese households are used to estimate demand elasticities and the impacts of regional and demographic variables for 17 food products through a two-stage budgeting procedure with complete demand systems. Results suggest that China's food consumption patterns will continue to shift from grains to high value food products and the ongoing transition in food consumption will affect China's domestic food markets and trade behavior.

Introduction

China's economic reform has brought about significant changes in its food consumption patterns and trade behavior. In food consumption, there has been a significant transition from staple foods such as rice and wheat to high-value products (HVPs) such as meats, aquatic products, vegetable oils and dairy products. For example, per capita consumption of grains in urban China dropped steadily from 135 kg in 1985 to 79 kg in 2001. On the other hand, urban per capita consumption of poultry increased from 3.24 kg to 5.3 kg over the same period. In international trade, China was traditionally a major importer of only wheat but has significantly increased its import of a wide variety of agricultural products, especially HVPs such as poultry and vegetable oils. As China moves toward a market economy, its domestic market and international trade are increasingly determined by consumer demand. For example, a critical factor for China's increased import of barley in the past two decades was the increase in consumer demand for beer. While China's ongoing economic reform and its commitments and

benefits as a new member of the World Trade Organization (WTO) are expected to increase its trade, the U.S. as a large exporter of many agricultural products faces both opportunities and challenges in the Chinese market. This study is motivated by the growing need for information on Chinese consumer demand for food and the lack of studies based on detailed household survey data.

Studies on Chinese consumer demand were extremely limited prior to 1978 but have increased significantly in the past two decades (e.g., Chern and Wang 1994, Fan et al. 1995, Fan et al. 1994, Gao et al. 1994, Halbrendt et al. 1994, Cai et al. 1998, Wang et. al 1998). While these previous studies have provided useful information, this study contributes to the literature by examining Chinese urban consumer demand for a wide range of food products based on detailed household survey data. Specifically, this study uses recently available data from China's National Urban Household Survey to estimate urban consumer demands for eight major food commodity groups (grain, oil and fat, eggs, aquatic products, vegetables, fruits, meats, and dairy products) and specific commodities in three of the eight groups (grain, meats and dairy products). This study also examines the impacts of selected demographic and geographic variables. The following sections will introduce our data set and methods, present the estimated demand elasticities and impacts of regional and demographic factors, and summarize major conclusions and implications.

Data and methods

The data used in this study are a subset data from China's National Urban Household Survey conducted by the National Bureau of Statistics of China (NBSC) in 1998. While the national sample contains a total of 36,000 households from 226 cities, our data set includes 3,600

households from 30 cities covering all administrative regions (22 provinces, 5 autonomous regions and 4 municipalities directly under the central government) except Chongqing municipality. After 100 observations from Siping city of Jilin province were dropped due to obvious data reporting errors, the final sample used in this study includes 3,500 households from 29 cities.

According to our sample statistics, the average per capita disposable income in urban China was 6224.2 yuan in 1998 (1 USD = 8.279 yuan, China Statistical Yearbook, 1999), among which about 80% was spent on living expenditure. Food expenditure accounted for 46% of the living expenditure. Within food expenditure, Chinese urban consumers on average allocated the largest proportion of their food expenditure to meats (31.14%), followed by grain (16.32%) and vegetables (15.37%), and the least proportions to oil and fat (5.94%), eggs (5.05%) and dairy products (4.59%). Table 1 reports the average quantities, expenditures and budget shares for major commodities and commodity groups. For example, Chinese urban consumer spent an average of 242.43 yuan on grain consumption (86.48 kg) in 1998, among which 52.14% was allocated to rice, 16.7% to wheat, 12.84% to processed wheat and 18.32% to other grain products.

Following the classification used by NBSC, the 29 cities are grouped into six administrative regions (North China Plain [NCP], East, Middle South [MS], Southwest [SW], Northeast [NE] and Northwest [NW]) and four groups based on population: very large cities (2 million and over), large cities (1 to 2 million), medium cities (0.5 to 1 million) and small cities (under 0.5 million).

While the basic required data for demand analysis are consumption quantities and prices, the prices are often not directly reported in the household survey and certain estimates such as

unit values must be used in estimating the demand functions. The unit values derived from total expenditures and quantities are used as estimated prices in this study. Another common problem with our household survey data is the missing values for certain commodities (e.g., milk powder and yogurt). An effort has been made to reduce the impacts of this problem by aggregating some commodities with very small budget shares into broader commodity groups and using the mean price of a commodity to estimate the missing quantity or expenditure when one of them is missing for a particular city.

A two-stage budgeting procedure is used in this study to estimate demand elasticities. The procedure assumes that a consumer first allocates his or her total food expenditure among major food commodities or groups in the first stage and then distributes the expenditure to each major commodity group among disaggregated commodities within the commodity group in the second stage. Specifically, as depicted in Figure 1, a demand system of eight commodities and groups (grain, oil and fat, eggs, aquatic products, vegetables, fruits, meats and dairy products) is analyzed in the first budgeting stage. In the second stage, four commodities (rice, wheat, processed wheat, and other grain products) are included in the grain group, five (pork, beef and mutton [B&M], other meats, poultry, and other poultry products) are included in the meat group and three (fresh milk, milk powder and yogurt) are included in the dairy product group.

The almost ideal demand system (AIDS) of Deaton and Muellbauer (1980) is used in both budget stages in this study. Directly derived from a cost function, the AIDS satisfies the axioms of choice exactly, does not impose additive preference, and can be used to test the restrictions of homogeneity and symmetry through linear restrictions on fixed parameters (Deaton and Muellbauer 1980). Empirically, the AIDS has often been reduced to a linear form called linear approximate almost ideal demand system (LA/AIDS) and is used in this study.

Iterated Seemingly Unrelated Regression (ITSUR) method is used to estimate the LA/AIDS model with regional dummy variables and demographic variables incorporated. While the demand systems generate expenditure elasticities with respect to total expenditure on all food commodities (first stage) or a particular group of commodities (second stage), it is also desired to estimate the income elasticities for these commodities. A so called "zero-stage" of budgeting to determine food expenditure elasticities with respect to income is estimated and the results are used to derive the income elasticities.

Empirical results

This section first reports the estimation results from the second stage of budgeting and then presents the results from the first stage. In the second stage of budgeting, regional (six main administrative regions) and demographic variables (household size, urbanization level or city size, age and education level of the head of household) are incorporated in the LA/AIDS models for meats and dairy products. For the grain products, two alternative models or scenarios are estimated: (1) A regional dummy to separate China into North and South regions, and (2) the data set is divided into two subsets (North and South) and each subset is used to estimate the model separately. Due to the significant differences in grain consumption patterns between North and South, it is necessary to examine the two regions separately for grain product demand (Scenario 2a and 2b).

Grain products

While most of the estimated parameters for the two scenarios of grain product demand, not reported in this paper, are significant at the 95% confidence level, the estimates from

Scenario 1 show that large households tend to consume more rice and wheat but less processed wheat and other grain products. Per capita consumption of rice and wheat is generally higher in smaller cities, and the consumption of processed wheat and other grain products tends to be higher in large cities. While the age of household head doesn't seem to have any significant impact on the consumption of all grain products, the education level of household head is only significantly associated with wheat consumption (i.e., households with educated household heads tend to consume less wheat). The estimates from Scenario 1 also confirm a strong preference for rice over wheat by southern consumers and the exactly opposite taste for northern consumers. According to our sample data, a typical consumer in South consumed 66.04 kg of rice per year, more than twice of the average level in the North (29.87 kg), and only 3.31 kg of wheat and processed wheat, less than one-tenth of the level in the North (35.97 kg).

In both North and South, large households tend to eat more rice and wheat but less processed wheat and other grain products than smaller households. Consumers in small cities tend to consume more processed wheat and other grain products than those in large cities. Within the North region, however, consumers in large cities tend to consume more rice as compared to these in small cities, whereas consumers in large cities in the South consume less rice than consumers in small cities. Age of household head has significant impact on rice and processed wheat consumption in both regions: households with older household heads tend to consume more rice but less processed wheat in North, whereas their counterparts in South eat less rice but more processed wheat. Households with better-educated household heads tend to consume more rice in North but less rice in South.

Estimated income elasticities and expenditure elasticities with respect to total grain expenditure for all grain products are positive except the demand for processed wheat in South

(Table 2). The negative income elasticity for processed wheat in the South is quite different from our expectation. Demand responses to own prices of all grain products in South are generally not as strong as that in the North, possibly because of the better economic conditions in the South region. The estimated cross-price elasticities reported in the table suggest substitution relations between rice and wheat and between rice and processed wheat and this is consistent with the general expectation. A comparison of the results from Scenario 1 and a testing model with regional dummies for 6 main administrative regions suggest that the regional differences in grain consumption in urban China are mainly between the North and South regions and differences among sub-regions in North or South are relatively small.

Meats

While most of the estimated parameters for the meat demand model, not reported in this paper, are significant at the 95% confidence level, the estimated parameters for the demographic variables indicate that household size has a positive impact on per capita consumption of B&M but negative impacts on the demands for pork, other meats and other poultry products. Relatively small cities tend to consume more pork but less other meats and other poultry products. Both age and education level of household head present significant influences on meat consumption: households with younger household heads consume less pork but more of other varieties of meats and households with better-educated household heads consume less pork and B&M but more other meats and other poultry products. It appears that meat consumption by new generations and better-educated consumers in urban China is moving from pork to other varieties such as other meats and other poultry products. Regionally, MS consumes the highest of pork but the least of B&M, while NW consumes the highest level of B&M but the least of pork possibly due to religious diet. NCP consumes the highest level of other meat products but

the least of poultry, while MS consumes the most of poultry. East, followed by two southern regions, MS and SW, consumes the most of other poultry products. Northern regions, NW and NE tend to eat more B&M but less poultry than the eastern and southern regions.

As reported in Table 3, demands for poultry and B&M respond to changes in income the most among all meat products with income elasticities of 0.3284 and 0.3001, respectively, followed by pork (0.2532) and other poultry (0.24). The estimated expenditure elasticities are elastic for poultry (1.2427) and B&M (1.1355) and inelastic for pork (0.9579), indicating that, although the demand for all these three meat products will increase as the total meat expenditure rises, the demand for poultry and B&M will be increasing at a faster rate than pork. This may suggest a trend from traditional pork consumption to more poultry and B&M. All meat products have negative own-price elasticities and demand for pork responds to own price the most. The estimated cross-price elasticities do not suggest any substitution relation within the meat group except between other meats and other poultry products.

Dairy products

While most of the estimated parameters for the dairy product model, not reported in this paper, are significant at the 95% confidence level, age of household head doesn't influence dairy product consumption significantly. Education level affects consumption of milk powder and yogurt positively but affects fresh milk consumption negatively. This result doesn't seem very reasonable and is likely due to the overuse of mean prices to estimate the missing quantities or expenditures for the data set. Household size tends to affect fresh milk consumption positively and the consumption of milk powder and yogurt negatively. Consumers in large cities tend to consume more fresh milk and yogurt but their counterparts in small cities tend to consume more

milk powder. This is quite consistent with our expectation because, due to the perishable nature of fresh milk and yogurt, the availability and accessibility to these two commodities are highly associated with the development of infrastructure and channel of production and distribution which is only well satisfied in relatively larger cities.

Regionally, NCP consumes the least of fresh milk but leads the yogurt consumption among all the regions, SW consumes the most of milk powder followed by NW and MS, and NE, East and NW hold the highest levels of fresh milk consumption. Note that general observation and results from the food demand analysis in the first stage don't seem to support NE being the region with the highest consumption level of fresh milk. This estimation bias is very likely due to the data problem of high proportion of zero observations for milk powder and yogurt. On the other hand, the high consumption levels of fresh milk in the prosperous East and the highly self-sufficient, pastoral dairy production base of NW seem very reasonable.

As shown in Table 4, the estimated expenditure elasticity with respect to total dairy expenditure is elastic for fresh milk (1.2949). Fresh milk is also the most income elastic commodity in the dairy group followed by yogurt. Milk powder responds to the changes in income the least, indicating a weak growth potential for milk powder consumption relative to other dairy products as income grows. Demand for fresh milk is expected to respond to own price the most with an elastic own-price elasticity of -1.1993, while the demand for milk powder responds to its own price the least. It seems reasonable given that milk powder can be used as a substitute for fresh milk when the price goes up and fresh milk become less affordable.

Food commodities and commodity groups

In the first stage of budgeting, milk powder and yogurt are dropped from the food

demand system and only fresh milk is included due to the large proportion of zero observations for milk powder and yogurt. Same regional and demographic variables as in the second stage are incorporated.

While most of the estimated parameters, not reported in this paper, are significant at the 95% confidence level, the estimated parameters for the demographic variables show that household size affects the per capita consumption of grain and aquatic products positively but the per capita consumption of eggs, fruits, meats and fresh milk negatively. Per capita consumption of aquatic products, meats and fresh milk is relatively higher in large cities while consumption of grain, eggs and vegetables is relatively lower in small cities. Households with older household heads tend to consume more grain, oil and fat, meats and fresh milk, and households with better-educated household heads tend to consume significantly more vegetables, fruits and fresh milk.

Regionally, consumers in NW tend to consume the most of grain, oil and fat, and fresh milk but the least of meats and eggs compared to other regions. Consumers in East tend to eat the least of grain but the most of aquatic products. The East also consumes the second least of meats, indicating a preference of seafood over animal meats in the region. NE consumers consume the most of vegetables among six regions but the least of fresh milk possibly due to the deteriorated economic condition in the region since the reform of the state-owned enterprise in 1990s. Oil and fat consumption is the second least in NE and is only higher than NCP. Consumers in NCP tend to consume the most of fruits, the second most of fresh milk, and more eggs and vegetables but less aquatic products. MS consumers tend to eat more HVPs such as aquatic products and meats but less staple grains. On the other hand, MS consumers don't seem to favor fresh milk. SW consumers consume the least fruits but more oil and fat.

The estimated demand elasticities (Table 5) suggest elastic expenditure elasticities for fresh milk (1.1902), grain (1.1797), vegetables (1.1096), aquatic products (1.0491) and eggs (1.0434), and consequently, relatively higher income elasticities for them compared to other food commodities. Fresh milk consumption will increase most as total food expenditure and income rise, which is consistent with the ongoing milk consumption promotion campaign in China led by Chinese government to improve mass health through more milk drinking. The elastic expenditure elasticity for grain seems higher than the general expectation but is similar to the results by Liu and Chern (2001) using provincial sub-dataset from the same urban household survey data as used in this study. While possible data reporting errors related to grain consumption might have occurred, we recognize the need for further investigation. The estimated own-price elasticities for all commodities are negative which is very reasonable. Demand for aquatic products is the least responsive to own price (-0.3846). Since consumption of aquatic products in China is highly centered in the coastal provinces of East where people have a strong preference for seafood, demand for aquatic products is not very sensitive to price changes. Similar to the result from the dairy product demand model in the second stage, fresh milk has an elastic own-price elasticity of –1.074 indicating that fresh milk consumption is very sensitive to its own price. Positive cross-price elasticities are estimated for some HVPs such as meats, fresh milk, fruits and aquatic products. However, given the current level of economic development (note that almost half of living expenditure went to food expenditure in 1998 according to our sample statistics.), the positive cross-price elasticities here might not imply the actual substitution relation. Instead, it might indicate that Chinese consumers have to make trade-offs among HVPs given their budget constraint for food.

Conclusions and implications

Using detailed urban household survey data of 1998, this study has examined Chinese urban consumer demands for eight major food commodities or groups (grain, oil and fat, eggs, aquatic products, vegetables, fruits, meats and dairy) in the first stage of budgeting and specific commodities in three groups (grain, meats and dairy) using LA/AIDS. The study suggests several conclusions: First, Chinese urban consumer demand for most food commodities, especially non-staple and HVPs such as poultry, beef and mutton, oil and fat, eggs, aquatic products and fresh milk, will continue to increase at a significant rate as the average income increases. Although the relatively high expenditure elasticities for grain are different from the general expectation and need further investigation, the derived income elasticities for four specific grain commodities, rice, wheat, processed wheat and other grain products, are significantly lower than those for most non-staple food products. This may imply that food consumption pattern in urban China is shifting from staple grain commodities to non-staple and high-value food products as income increases.

Second, household demand for food products in urban China is highly determined by both own and cross prices. This may suggest that Chinese urban consumers are sensitive to changes in food prices. Our results also indicate that such responses to prices are quite different across commodities. For example, the price effects on the demand for B&M and aquatic products are relatively small as compared to other food products. This may imply that the consumption of B&M and aquatic products is more culture/religion and taste associated rather than price determined.

Third, in addition to income and prices, food demand in urban China is affected by regional and demographic variables such as household size, urbanization level, and age and

education of household head. Household size tends to affect the per capita consumption of oil and fat, eggs, vegetables, fruits, meats, and dairy products negatively but affects the per capita consumption of grain and aquatic products positively. City size has positive impacts on the demand for aquatic products, meats and dairy products. Regional differences in food consumption pattern in urban China are very significant, especially between North and South.

Fourth, the increasing per capita income, changing food consumption pattern, continuing urbanization, expanding influences of foreign food cultures, and improving market efficiency will all contribute to a continuous growth of demand for non-staple and high-value food products in China in the coming decade. Factors such as urbanization will also lead to a dynamic shifting of demand within commodity groups. For example, the South region has been known for a traditional preference for rice over wheat while North has the exactly opposite taste. This pattern, however, is less strong in relatively larger cities than in small cities according to our analysis, possibly because of the more diversified populations and commodities available in large cities. We expect the regional difference in rice and wheat consumption between North and South to gradually diminish along urbanization process.

At last, China is likely to become a significant importer of many food products, especially non-staple and high-value products as China enters the WTO. The U.S. as the largest producer of many agricultural products is in a good position to capture the great gains from expanding agricultural exports to China. Results from this study contributes to the U.S. agricultural sector in understanding the economic and non-economic (demographic and geographic) determinants of Chinese urban food demand under economic transition.

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Table 1. Per capita consumption and expenditure on major food commodities

Commodity (mean budget share)	Quantity		Expenditure	
	Mean	Std Dev	Mean	Std Dev
Grain (16.32%)	86.48	51.21	242.43	129.02
Rice (52.14%)	*48.98*	*39.06*	*118.61*	*92.67*
Wheat (16.7%)	*18.71*	*32.02*	*41.37*	*68.01*
Processed wheat (12.84%)	*5.57*	*9.39*	*26.15*	*38.44*
Other grain products (18.32%)	*9.76*	*9.02*	*35.82*	*33.27*
Oil and fat (5.94%)	8.84	6.48	83.18	60.27
Eggs (5.05%)	10.59	7.91	68.26	47.01
Aquatic products (10.85%)	13.62	14.00	195.62	259.17
Vegetables (15.37%)	118.30	64.8	224.3	126.49
Fruits (10.74%)	63.86	41.99	147.21	110.56
Meats (31.14%)	32.05	17.46	459.42	277.13
Pork (50.77%)	*17.12*	*11.23*	*223.87*	*152.78*
B&M (14.93%)	*4.58*	*6.96*	*63.51*	*98.19*
Other meats (12.28%)	*2.77*	*3.14*	*58.37*	*68.10*
Poultry (13.7%)	*5.30*	*5.39*	*70.14*	*78.97*
Other poultry (8.31%)	*2.22*	*2.95*	*42.91*	*61.16*
Dairy (4.59%)	15.95	21.93	70.77	89.89
Milk (53.18%)	*11.52*	*20.06*	*39.71*	*71.58*
Milk powder (33.24%)	*0.50*	*1.07*	*12.25*	*34.09*
Yogurt (13.58%)	*1.16*	*3.63*	*6.55*	*20.97*

Table 2. Estimated demand elasticities for grain products

			Uncompensated Price Elasticity of Good i w.r.t. Good j			
	Expenditure elasticity	Income elasticity	Rice	Wheat	Processed wheat	Other
Scenario 1. Demand model with regional dummy variable for North & South						
Rice	1.1726	0.4431	-1.2593	0.0658	0.0440	-0.1612
Wheat	1.4495	0.5478	0.4925	-1.9012	-0.1619	0.1211
Processed wheat	0.3756	0.1420	0.5941	-0.0313	-0.7709	-0.1675
Other	0.5366	0.2028	-0.1272	0.2628	-0.1380	-0.5342
Scenario 2a. Demand model for North						
Rice	1.2284	0.4642	-1.7936	0.3361	0.2285	-0.2409
Wheat	1.3357	0.5048	0.5381	-1.9450	-0.1369	0.2081
Processed wheat	0.5535	0.2092	0.5450	0.0412	-0.8211	-0.3186
Other	0.5108	0.1930	-0.2237	0.6475	-0.3919	-0.5426
Scenario 2b. Demand model for South						
Rice	1.1948	0.4515	-1.1677	0.0417	0.0236	-0.1218
Wheat	1.2870	0.4863	1.3169	-1.3464	-0.9427	-0.3148
Processed wheat	-0.0063	-0.0024	1.1594	-0.5793	-0.6312	0.0574
Other	0.5261	0.1988	0.0371	-0.0304	-0.0133	-0.5195

i=rows, j=columns.

Table 3. Estimated demand elasticities for meat products

			Uncompensated Price Elasticity of Good i w.r.t. Good j				
	Expenditure elasticity	Income elasticity	Pork	B&M	Other Meat	Poultry	Other poultry
Pork	0.9579	0.2532	-0.7164	-0.0478	-0.1000	-0.0414	-0.0523
B&M	1.1355	0.3001	-0.2530	-0.2692	-0.1542	-0.2995	-0.1597
Other Meat	0.8007	0.2116	-0.3338	-0.1375	-0.4386	0.0062	0.1029
Poultry	1.2427	0.3284	-0.2980	-0.3423	-0.0487	-0.5291	-0.0246
Other poultry	0.9082	0.2400	-0.2946	-0.2528	0.1388	0.0052	-0.5048

i=rows, j=columns.

Table 4. Estimated demand elasticities for dairy products

			Uncompensated Price Elasticity of Good i w.r.t. Good j		
	Expenditure elasticity	Income elasticity	Fresh milk	Milk powder	Yogurt
Fresh milk	1.2949	0.2710	-1.1993	-0.0782	-0.0173
Milk powder	0.5826	0.1219	0.2537	-0.8070	-0.0292
Yogurt	0.8671	0.1815	0.1597	-0.1660	-0.8608

i=rows, j=columns.

Table 5. Estimated demand elasticities for food

			Uncompensated Price Elasticity of Good i w.r.t. Good j							
	Expenditure elasticity	Income elasticity	Grain	Oil and fat	Eggs	Aquatic products	Vegetables	Fruits	Meats	Fresh milk
Grain	1.1797	0.3779	-0.754	-0.034	0.057	-0.237	-0.082	-0.063	-0.002	0.014
Oil and fat	0.9902	0.3172	-0.060	-0.535	0.236	-0.207	0.020	-0.186	-0.170	-0.088
Eggs	1.0434	0.3342	0.217	0.291	-0.846	-0.183	-0.093	-0.204	0.049	-0.274
Aquatic products	1.0491	0.3361	-0.352	-0.124	-0.086	-0.385	-0.094	0.183	-0.234	0.042
Vegetables	1.1096	0.3555	-0.076	0.000	-0.033	-0.070	-0.732	-0.123	-0.100	0.024
Fruits	0.9560	0.3062	-0.065	-0.110	-0.095	0.200	-0.163	-0.848	0.093	0.031
Meats	0.8252	0.2643	0.017	-0.023	0.019	-0.056	-0.005	0.044	-0.844	0.023
Fresh milk	1.1902	0.3812	0.093	-0.231	-0.556	0.165	0.136	0.103	0.173	-1.074

i=rows, j=columns.

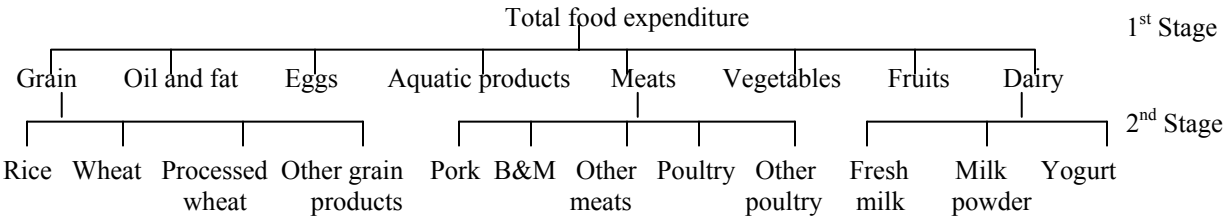

Figure 1. A two-stage budgeting procedure of food expenditures