Some Methodological Issues in the Measurement of Shadow Prices for a Centrally Planned Economy

by

Fredoun Ahmadi-Esfahani and Roland Stanmore
Department of Agricultural Economics
University of Sydney

Contributed Paper to be presented at the
37th Annual Conference of the
Australian Agricultural Economics Society,
The University of Sydney,
9-11 February, 1993.

ABSTRACT

Sweeping economic reforms are taking place across many centrally planned economies leading prices of inputs and outputs to approach their true values. Measuring the shadow prices of inputs and outputs is of fundamental importance to assess the impact of policy changes on these economies and their major trading partners. This paper seeks to analyse some of the methodological problems in the measurement of shadow prices for a centrally planned economy and to develop systematic approaches to this basic research question. A number of specific examples from selected industries are provided.

Some Methodological Issues in the Measurement of Shadow Prices for a Centrally Planned Economy

> *The most obvious difference between a centrally planned economy and a market economy is that, under central planning, producers are told what to produce and how much to charge for it: prices and quantities are fixed by decree, rather than by the interaction of demand and supply in the market. This is a profound difference. But a common misunderstanding is to think that this fixed-price system works like a distorted version of a market price system- in other words, that prices still act as signals to producers and consumers.*
>
> The Economist, 28 April 1990

Centrally Planned Economies (CPE's) are characterised by heavily distorted pricing systems. In China, which represents the world's largest CPE, large differences between the production and consumption prices of many domestically produced goods as well as those of imported goods exist. For instance, the grains industry of China is heavily subsidised as the costs of production are well above the retail prices (Johnson 1992). The extent of this is indicated by the Chinese government extending approximately 38 billion Yuan in 1988 to finance uncovered expenditures in the provision of urban food (World Bank 1991). There exist many forms of distortions and in some industries there are counteracting distortions such as, the taxes and subsidies in the Chinese pig market. That is, meat traders in China have to pay taxes in the marketing process yet they receive subsidies both direct and indirect through the Food Corporations (Bingsheng 1992).

Significant economic reforms are taking place across many CPE's. In China these reforms have included a decreased role of centralised production planning in agriculture, reducing the level of commodities procured by the government and making significant price changes. For instance, in the grain sector prices of rationed grain were increased by 40 per cent in all the country except Gaungdong and Fujian provinces where subsidies were removed totally (Johnson 1992). The reforms have led to an increased price incentive structure with greater market orientation and an increased role of producers in decision making. The reforms will lead prices to move towards their imputed or 'shadow' prices.

These reforms will have a significant impact on international trade for many commodities and services due to the underlying changes in the prices of factors of production which will lead resources to be allocated more towards the products in which China has a comparative advantage. The calculation of shadow prices is required so as to accurately measure the effects of reforms on CPE's and on their trading partners. The reforms may increase the supply of the commodity on the international market as the new undistorted (or less distorted) prices for the factors of production may make export of certain commodities viable. Alternatively, it may increase imports of certain commodities as factors of production are switched to more productive sectors of the economy.

The objective of this paper is to analyse some methodological and measurement issues in calculating the shadow prices of both factors of production and commodities in CPE's. The paper is structured in the following manner. Firstly, theoretical principles will be discussed. Then the likely methodological and measurement problems associated with calculating shadow prices for CPE's are outlined. Finally, examples of these problems are illustrated from the Chinese grain and pig industries prior to concluding comments.

Theoretical Considerations

The shadow price of a factor of production is equal to the opportunity cost of the resource; the opportunity cost being the value of its best alternative use elsewhere in the economy. That is, the shadow price of a factor of production is the increase in social welfare resulting from the availability of an extra unit of the resource. Alternatively, the shadow price is synonymous with the value of marginal product of the factor. For a commodity, the shadow price is equal to the combined opportunity cost of the factors of production used in producing that commodity.

The above definition of a shadow price is consistent with that provided in Mishan (1971). As an example, he defines the opportunity cost or true price of labour as the cost of labour that would otherwise remain idle, not its wage. Findlay and Wellisz (1976) also argue that a set of shadow prices should reflect the true costs and returns of the inputs and outputs. Similarly, Srinivasan and Bhagwati (1978) suggest that shadow prices are a social valuation criterion used in place of existing prices of inputs and outputs. They argue that existing prices are distorted and are therefore not an accurate measure of a commodity's scarcity. Thus, these existing prices would not prove to be effective signals in the decision making process.

Dreze and Stern (1990) extend this analysis and argue that the shadow price of a commodity is its social opportunity cost. The losses and gains have to be assessed in terms of a social welfare criterion. They define the shadow price of a commodity in terms of the marginal effect on social welfare of the availability of an extra unit.

Thus, the shadow price of a factor or a commodity is essentially its opportunity cost from a social point of view. The intriguing question for purposes of this paper, however, is how to measure the social opportunity cost, the shadow price, in a highly disorted economy. This question will be taken up below.

Shadow Prices in the Presence of Distortions

Little and Mirrlees (1969) suggest that the shadow prices of traded commodities should be evaluated at their respective international prices. Elaborating on the Little and Mirrlees empirical definition of a shadow price, Dasgupta and Stiglitz (1974) argue that world prices should be used for evaluating the best shadow prices for traded commodities, unless there is a government or budgeting constraint or quota. Srinivasan and Bhagwati (1978) similarly base their definition on the Little and Mirrless criterion and calculate the shadow prices for factors of production in the presence of distortions at their respective international prices.

Bhagwati (1984) extends the analysis to the shadow prices of nontraded factors and suggest that they should be derived from evaluating their marginal products at world prices. Findlay and Wellisz (1976) postulate creating a set of shadow prices that reflect the relevant costs and returns of inputs and outputs. They also use the Little and Mirrless criterion in their shadow price calculations.

It would thus appear that a standard rule for relative shadow prices of traded goods is that they should be based on world prices. Dreze and Stern (1990) suggest that the crucial attribute of this is that public production of any good can be seen as removing an equivalent amount of imports with the balance of payments adjusting for any equilibrium repercussions. However, when there is a direct effect of increased net imports somewhere else in the economy, then the world price will no longer be equal to the shadow price. An example of this complication would arise with an exported good for which the demand is less than perfectly elastic.

Dreze and Stern (1990) further argue that the valuation of shadow prices at world prices is not optimal but may be a good second best measure. They specify the conditions under which the shadow price of a traded good is equal to its world price. These conditions are as follows:

i. All goods be taxed fully by the central planner,
ii. Private production to be competitive,
iii. Private profit to be fully taxed, and
iv. Inputs not to be quantity rationed for the private producer.

Unless these constraints are met, Dreze and Stern assume that the second best price of a traded commodity is equal to the world price times the marginal social value of foreign exchange.

The valuation of traded goods at their relative world prices is also criticised by Weckstein (1972) on the grounds that they are optimal prices and are therefore irrelevant to an economy that does not, in practice, achieve an optimal allocation of resources. He recommends that in practice tradable commodities should be valued at their respective domestic prices even though these are known to be distorted by tariffs. Warr (1977) argues, to the contrary, that the correct shadow price valuation for a tradable good is its relevant world price when there are nontraded goods whose distorted prices are not directly affected by public production of tradable commodities, and it is assumed that distortions due to tariffs and quotas are incorporated in these prices.

In summary, although there may be other alternatives available, it appears that the most common and practical measurement for shadow prices in a distorted economy would be to base them on relevant international price data.

Conceptual Framework[a]

Utilising a two commodity, two factor model, the impact of distortions on factor prices can be illustrated graphically through production functions. Although a production function only deals indirectly with prices, the dual of a production function deals directly with prices. The dual of the production function for a commodity determines the isoprice

[a] This discussion draws heavily on Mussa (1979).

curve that represents the combinations of the wage rate and rental rate that are consistent with zero profits in producing the commodity at a given output price. For example, the isoprice curve for a commodity X at a given output price Px is represented by Px0 in Figure 1. A similar isoprice curve for the second commodity Z is represented by Pz0. The fact that Pz0 slopes more than Px0 means that industry Z is labour intensive and industry X is capital intensive relative to one another. If there were no distortions in the economy then equilibrium would be at point A where the two isoprice curves intersect. However, in a distorted economy where there is a subsidy/tax on output or on one of the individual factors of production, equilibrium will no longer be at point A. For instance, a subsidy on labour in producing X would result in equilibrium for the economy lying at points B and C where the rental rate is the same in both industries but the wage paid by firms in X (before subsidy) is below that paid by firms in Z. This subsidy of labour in the capital intensive industry X has the peculiar result of leading to lower wages (point C) than would be received if there were no distortions (point A). Alternatively the equilibrium of points B and C would also be achieved by applying a tax on labour in the production of Z, the labour intensive industry. In this case the net wage rate is point B which means the wage level has fallen by more (A-B) than the tax (C-B).

Returning to the case of a subsidy on labour in producing X, if there were also a subsidy to capital in X then the economy would be operating at points B and D where industry X pays lower rental and wage rates. Alternatively, points B and D would also be the equilibrium if there were a tax on both capital and labour in producing Z. A tax/subsidy simply applied on output is equivalent to an equal percentage tax/subsidy on both inputs in that industry. There could exist various combinations of factor distortions such as a tax on output for commodity X and a subsidy on labour in the production of Z.

To determine how output would be affected if the supply of a factor of production changed requires the calculation of shadow prices because the prices indicated by points B and D are not the marginal social values of each factor. The true opportunity costs of labour and capital are given by their shadow prices. Let Ws and Rs represent the shadow wage and shadow rental rates respectively. For each industry the quantity of labour and capital used is determined by the prices of output, distortions and the wage and rental rates in each industry. This can be represented by the following equations

$$a_{lx}\,Ws + a_{kx}\,Rs = PxO \qquad (1)$$

$$a_{lz}\,Ws + a_{kz}\,Rs = PzO \qquad (2)$$

where a_{lx} = amount of labour in industry X
a_{lz} = amount of labour in industry Z
a_{kx} = amount of capital in industry X
a_{kz} = amount of capital in industry Z

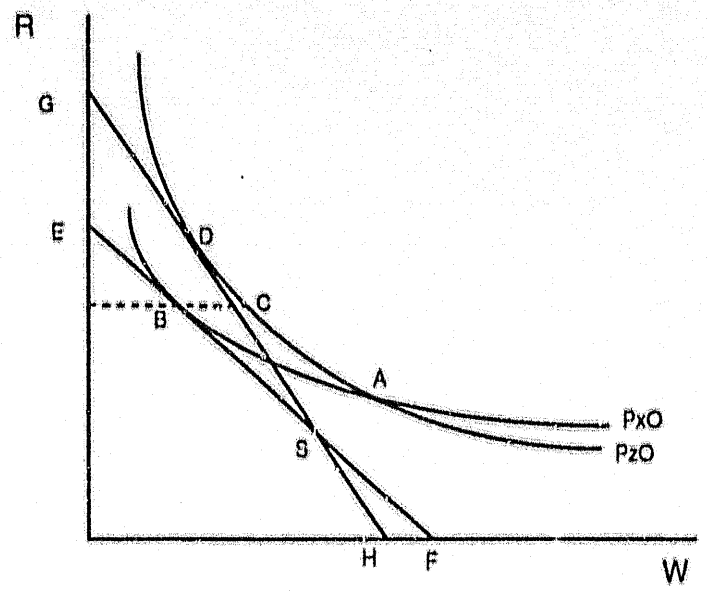

Figure 1: Shadow prices in a distorted economy

Given the distortions indicated by points B and D, equation (1) is satisfied for any combination of W and R along the tangent to point B as indicated by the line EF. Similarly, equation (2) is satisfied for any combination of W and R along the tangent to point D as indicated by the line GH. The only point where both these equations are satisfied is at the intersection of the two tangents, point S. The factor prices associated with point S represent the prices that measure the opportunity cost of each factor.

In a highly distorted economy where there are large divergences between factor returns in different industries, it is possible that one of the factors will have a negative shadow price. In this case there is such a serious misallocation of resources that removing a unit of the factor will result in a net gain (Bhagwati and Srinivasan 1984). The existence of

negative shadow prices leads to many peculiar results. These include immiserizing growth, counterintuitive policies and severe implications for the production of new commodities. Immiserizing growth occurs if the value of the economy's output drops when the supply of the factor with a negative shadow price increases. That is, if capital has a negative shadow price then an increase in capital stock will actually reduce the value of output due to the fact that capital has a negative social value.

The existence of negative shadow prices also leads to counterintuitive policy solutions. For instance, if the shadow price of capital is negative then increasing the percentage tax on capital in the labour intensive industry makes the economy less distorted. This is illustrated in Figure 2 where the initial distortion leads to shadow prices associated with point S where capital has a negative shadow price.

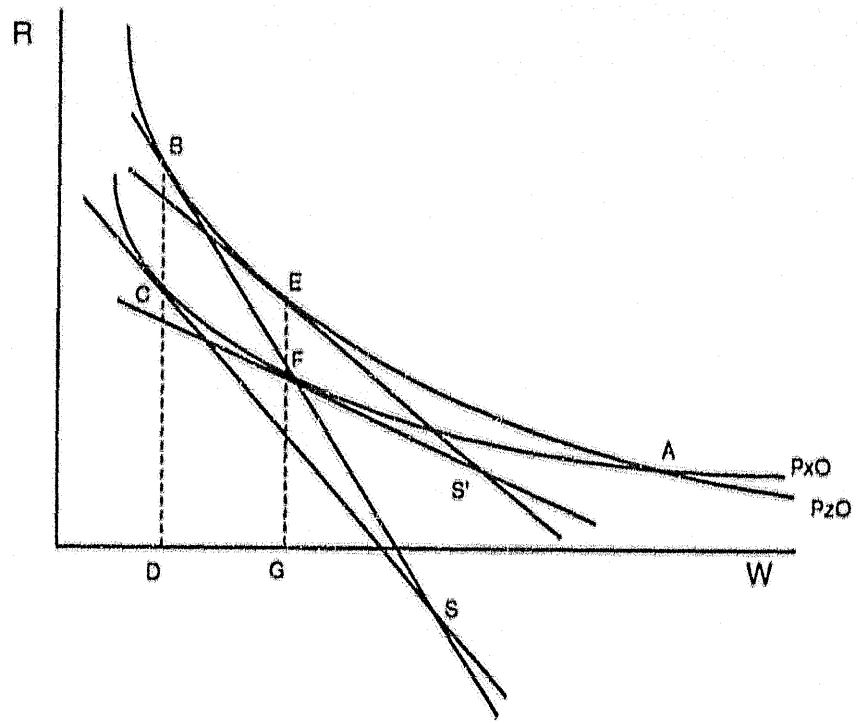

Figure 2: Negative shadow prices and a highly disorted economy

The percentage tax on capital is equal to BC/BD. Points E and F would represent an increase in percentage tax on capital in Z as EF/EG>BC/BD. Thus, the increase in percentage tax on Z has actually led to a less distorted economy as the new shadow prices associated with point S' are closer to point A. This effect is associated with many counterintuitive results as the increased percentage tax actually increases the wage rate and reduces the rental paid by capital users. The increased tax rate also leads to increased capital labour ratios in both industries. The reason for these results is that although the percentage tax on capital in Z has increased, the absolute tax has fallen. That is, EF<BC.

If there is a factor with a negative shadow price then it is desirable to produce any commodity that has a positive price as long as it requires a high ratio of this factor. In this case the gain to society includes the gain from the output of the new project plus the gain from the withdrawal of the factor from the existing production where it has a negative shadow price. This arises from the fact that any productive venture with a positive gain is better than using the factor elsewhere where it actually reduces the value of output.

Methods

The preceding discussion indicates the importance of developing procedures to calculate shadow prices. Two conventional methods by which shadow prices can be calculated are mathematical programming and the production function.

The mathematical programming technique involves determining the profit maximising level of output subject to the constraints on the available inputs. In this primal programming problem the value of output must equal the sum of the value of all inputs when these inputs are valued at their true opportunity cost. The problem can be solved by forming the Lagrangian expression where each constraint has associated with it a Lagrangian multiplier. These Lagrangian multipliers are actually the shadow prices. The solution to the problem is found by differentiating the expression with respect to the Lagrangian multipliers and constraints. In linear programming an optimal solution requires the second derivatives to be positive or negative depending on whether it is maximisation or minimisation. In non-linear programming an optimal solution can be achieved if the Kuhn Tucker conditions are satisfied. The Kuhn Tucker conditions deal with the negativity and nonnegativity of the derivatives of the Lagrangian expression with respect to the constraints and the Lagrangian multipliers (shadow prices).

For any primal problem there exists a dual which can be constructed with the objective of cost minimisation. The solution to the dual gives the dual variables which are the first derivative of the negative of the cost minimum with respect to the particular factor. That is, the dual allows calculation of the return that is due to each input in the production process and thus the dual variables represent the change in economic value as quantity changes by one unit which are the shadow prices and are equivalent to the Lagrangian multipliers. As mentioned above, the negative of these shadow prices represents the maximum amount by which the objective function could be increased if an additional unit of the resource were to become available (Hazell and Norton 1986).

An example is how the shadow prices of inputs can be calculated in the production of wheat which involves land, labour and capital. The availability of these factors is the constraint on the level of production. Mathematical programming will determine the levels of these factors that minimize the input costs while maximising wheat production. That is, the primal problem will be set up with the objective function of maximising wheat output which is constrained by the availability of land, labour and capital. It can be solved by forming the Lagrangian expression where a separate Lagrangian multiplier is associated with land, labour and capital. Alternatively, the dual can be constructed where the objective function will be cost minimisation. The dual variables associated with land, labour and capital can then be calculated and the negative of these represent their shadow prices. This approach is applicable to CPE's even though their explicit objective may not be that of profit maximisation, rather it is output maximisation.

The second method for calculating the shadow prices of factors of production is from the production function. The production function gives output as a function of its inputs such as capital and labour. The marginal product of each factor is calculated through estimating the parameters of the aggregate production function valued at world prices. The shadow price of each factor is equivalent to its marginal product. The first step is to specify the production function. Regressions can then be run to obtain the elasticities of output with respect to the particular factors. The marginal product (shadow price) of each factor is equal to this elasticity multiplied by the output -factor ratio. For instance, if the production function is specified as

$$Q = A^{t} K^{\alpha} L^{\beta}$$

where Q = output

K = capital

L = labour
A = constant
t = time which reflects technical progress

and α and β are the elasticities of output with respect to capital and labour respectively, then the marginal product of capital is equal to β (Q/K), while the marginal product of labour is equal to α (Q/L) (Shujuan 1991). That is, α and β are estimated from the regression and then multiplied by the output to capital and labour ratios.

In estimating the production function, there are many factors to consider. Most important is the specification of the function. Firstly, the factors of production have to be specified and whether capital includes everything other than labour. Also the relationship between the factors needs to be specified and this can take various forms including linear, Cobb-Douglas, CES and translog. For example, the Cobb-Douglas function, which was specified above, imposes a unitary elasticity of substitution between input pairs whereas the translog function allows the output elasticities of capital and labour to vary overtime. That is, the translog function allows the output elasticity of capital to grow relative to labour. In this case the increasing weight given to capital would cause the index of factor inputs to rise more rapidly (Shujuan 1991). There are also other factors to specify such as constant returns to scale which implies a combined elasticity of the factors with respect to output equal to one.

Additional Observations

In calculating shadow prices for CPE's, a number of additional problems will need to be addressed including the various forms of distortion, data availability and the appropriateness of a partial equilibrium approach.

The first aspect which requires a detailed analysis before calculating shadow prices is the structure of planning and distortions in the particular CPE. The distortions, both direct and indirect, can take various forms. For instance, conflicting types of distortions exist in the Chinese pig market with both taxes and subsidies. The distortions also come from various forms of government, such as food corporations and local government units. Calculation of the shadow prices requires detailed information on each type of distortion. There also exists the likelihood of high correlations between the allocation of capital and labour to different commodities by central planning authorities. This could lead to problems in econometric estimation such as multicollinearity.

Another major obstacle in calculating shadow prices in any situation is that of obtaining accurate data. The two approaches to calculating shadow prices, the production function approach and mathematical programming, require substantial quantities of accurate data. However, the availability of these data in an accurate form for CPE's may be quite limited. For instance, in China the data on fixed assets from cumulative new investment in successive years are valued at current prices. The data will only be accurate if the prices of capital goods remain constant. Also the investment data reported in China's national accounts include service facilities such as houses and schools and thus overestimate the amount of capital used directly in the production process. The same problem arises in the data for total labour input in state owned industries as it includes non-productive labour input employed in providing public services, whereas the national income generated from those non-productive sectors is excluded from total industrial output. The data therefore overestimate labour input and undervalues industrial output. Therefore, some manipulations of the data will be required such as indexing and decomposition (Shujuan 1991). The data may also need to be converted from nominal to real values which requires an accurate index over the appropriate time period. In China, there exists an index of rural retail prices which includes both consumer and agricultural producer goods. However, home produced and consumed products are not included and since nearly half of all food consumed is home produced, then the index may not be very accurate. Also, calculating shadow prices of traded commodities which can be estimated at international prices requires conversion through the exchange rate. If the exchange rate is not a true indication, such as the overvaluation of the Chinese Yuan in the 1980's (Johnson 1992), then a shadow exchange rate needs to be calculated.

To obtain the accurate data may be extremely difficult. Although labour figures may be available for different commodities, there is need to subtract the unutilised labour for which there may be little information. Knowing the availability of the factors of production for any particular commodity is extremely difficult. For labour the labour input could be measured as the number of employees or as the number of man hours employed each year. Capital is typically measured by gross capital stock or investment. The production level data may also be difficult to obtain.

A third obstacle is whether or not partial analysis is satisfactory. In most cases reforms in one sector will also impact other sectors by altering the prices of factors of production. That is, the availability of factors of production for various commodities at current prices

will increase or decrease depending on which commodities are labour or capital intensive. To attempt to estimate shadow prices under a partial equilibrium approach would only be appropriate, if the reforms did not impact other sectors, otherwise a general equilibrium approach is called for.

It is important to note that, although less complicated, the majority of these problems is also encountered in research pertaining to the measurement of shadow prices in free market economies. Thus, the two pricing systems share these methodological and data perplexities and there are few fundamental differences between them.

An Illustrative Example

As discussed earlier significant reforms have taken place in many CPE's and although China is no exception there still exists a high level of central planning with highly distorted prices. This is illustrated by two major agricultural industries in China. The grains industry is the largest industry in China, as well as being the largest grains industry in the world, while the pig industry is the next most important in China.

The Grains Industry

China's grains markets have undergone significant reforms over the previous decade. In the early eighties when free markets were being set up for farmers who produced above quota requirements, steps were taken to make the state markets more responsive to market forces. These included negotiated prices between the state and the producer for voluntary above quota deliveries (Sicular 1988). However, various problems arose such as storage facilities and different quota levels for different regions. Further reforms have led to elimination of the distinction between quota and above quota deliveries with new prices being set equal to 30% of the quota price plus 70% of the above quota price (Sicular 1988). In relation to urban prices the price of grain was about the only food price not liberalised in the early eighties but in April 1992 the price of rationed grain was increased by 40 per cent in most parts of China. However, the real or deflated price of rationed grain remains at or below its 1978 price and thus significant subsidies still exist (Johnson 1992).

The subsidies have led to a shortage of funds with many farmers recently receiving IOU's. These distorted prices cannot last forever if the government is short of funds.

"Commercialisation of the grain business may be a good way to relieve the pressure on the government" (Xiaozhong 1992, p4). To overcome this situation of IOU's and allow prices to reach their shadow prices, the rationed price of grain needs to be raised with the removal of controls on the urban price of grain. This will allow subsidies to be reduced with more funds for the government or the procurement price of grain can be raised (Johnson 1992). If the increased ration price for consumers is a problem then income subsidies could be paid which are superior to price subsidies as they let the market price signal the true indications to the farmers. Steps should also be taken to eliminate the large overhang of monetarised grain ration coupons with expiration dates being set on newly issued coupons (World Bank 1991).

The existence of significant subsidies and the previous quota system has also led to storage facilities being inundated. The removal of the subsidies, allowing the market to function freely in the pricing of all grains will lead storage to being a profitable activity and create an incentive for local villages and townships to hold stocks as seasonal price differentials will arise (Johnson 1992). This will also allow China to take full advantage of the fluctuations in the international price of grain.

Even though there has been a dramatic shift towards a market economy in recent years, the government still believes "that agriculture is the basis of the national economy" and is thus "reluctant to relinquish control over grain prices and still dominates the purchase and retail of most grains" (Xiaozhong 1992, p4). For instance, there exist price controls for grains in urban areas although there are no price controls on grains sold for consumption in rural areas or to the large urban population that is not registered under the ration scheme (Johnson 1992). The pricing system for grains currently involves a subsidy to farmers as the prices paid to farmers are higher than fixed urban retail prices for rationed grains. However, although certain grains may be subsidised under the ration scheme, when the prices are compared with international prices, the farmers may actually be able to receive higher prices than the subsidised ration price (Johnson 1992,). Thus, the current grains prices still do not reflect their true values. However, further reforms are to be undertaken in the grains sector as part of China's move towards a market economy which will lead grains prices towards their shadow prices.

In attempting to estimate the shadow prices for grains in China three major problems need to be overcome. These are the existence of various markets, the variation between regions and the lack of information on the quality of the grain.

One of the problems in estimating shadow prices is that there is a mixture of markets, both state planned and free, giving rise to different prices. Even the free market prices are not a true indication of opportunity cost, as they are not totally free because state commercial departments through market participation can exert influence on free market trends (Sicular 1988). Also, "during the period when there was difficulty in paying for the grain ... there is evidence that either the free markets were closed down nationally ... or various governmental units prevented the export of grain from their area until the procurement objectives were met" (Johnson 1992, p3). The existence of the various types of markets adversely affects data collection and accuracy. That is, even if they are obtainable from each market, the data may be inconsistent and therefore require manipulation which would inhibit the accuracy of the resulting shadow prices.

Another major problem with calculating shadow prices in China is the variations between regions. Different land and climatic conditions lead to different opportunity cost of factors of production. The regional differences in the level of development and growth rates in grain production are substantial and thus various shadow prices will exist for various regions (Carter and Zhong 1991). There also exist different government policies for different regions such as the removal of grain subsidies in the Guangdong and Fujian provinces and the increase in the prices of rationed grain by 40 per cent in the rest of the country (Johnson 1992). Local economic units tend to provide subsidies for large scale farms rather than the central government as the local government units are held responsible for grain deliveries (Johnson 1992). The variations between regions increase the complexity of shadow price calculations. It means that detailed information is required from each region so the impact of the reforms on each individual region can be estimated. That is, the production function approach or mathematical programming would need to be applied separately to each region. The overall impact of the reforms will require aggregation of the different shadow prices from different regions and appropriate weighting of each region's importance to China's trading partners for the particular grains.

A further problem is the lack of price differentials for quality. This makes the estimation of the degree of taxation or subsidy difficult as the effects of quality on price are unknown (Johnson 1992). As China moves towards a market economy and consumer demands determine production, a more sophisticated marketing system in relation to price differentials for quality will arise. It is likely that a uniform system will develop across

regions and producers will receive the appropriate information signals for the desired quality. The existence of diferent quality grains creates problems in using the production function or mathematical programming to calculate shadow prices as both procedures implicitly assume a homogeneous product.

The Pig Industry

The pig market is the most important market in China after grains. China has always been a net exporter of pig and pig meat products. There are two main types of traders in the pig market; private market agents and state run ones. Additionally there are a couple of co-operatives, but their percentage of the market is small. At present, the private sector has nearly half the market in purchasing hogs and 53 per cent of the domestic sales of pork (Bingsheng 1992, p92). There are hardly any business linkages between the private and state run firms as the state sector wants to protect itself from the private sector competition (Bingsheng 1992, p96). The competition between the private and state marketing sector is not on a par as the state marketing sector is much better equipped.

The state-run agents are called 'Food Corporations' with a separate corporation for every province and every county and every prefecture. Each level has different functions with the province level responsible for distributing subsidies (Bingsheng 1992). The private meat traders are mainly farmers and have no modern marketing facilities with no long distance wholesale activities. The majority of private traders have no division of labour with all undertaking purchasing, slaughtering and retailing activities.

In hog markets the development of private marketing has led to private traders stopping farmers outside state-run purchasing stations and sometimes offer higher prices. The degree of price differential and quantity traded in these markets is unclear (Bingsheng 1992). This creates significant problems in the calculation of shadow prices implying that the second best approach of using relative world prices may be necessary.

The existence of the various types of markets including the co-operatives increases the complexity of shadow price calculations. An accurate estimation of shadow prices requires consistent data from all these markets.

Since 1985 there has been no classification system for live pigs in terms of quality and thus the prices contained in the market information from different regions are not

comparable. For carcases at the wholesale level a uniform classification system has been established but this is only used in interregional trade. At the retail level there have been attempts to differentiate prices between different cuttings according to quality but the cutting schemes used in different cities and regions are not the same (Bingsheng 1992). However, as inter-regional trade develops and producers become more responsive to consumers desires, a uniform grading system may arise. The lack of consistency in the payment for quality creates problems in the application of mathematical programming or aproduction function to calculate shadow prices.

The currently applied policies of the state-run traders consists of price control, subvention, taxation and a ration system. The price policy which is aimed at keeping consumer prices low and stable is that of fixed prices at the retail level in the state-run meat shops. There also exist upper price limits for the private retailing activities at free markets (Bingsheng 1992). The market price tends to be above the state price because the supply from the state sector experiences shortages and the supply to the private sector is of better quality (Bingsheng 1992).

The subvention policy which is consistent with that of price stability increases producer prices while leaving the consumer price unchanged. The subvention is granted directly and exclusively to the state meat marketing enterprises in two forms; direct monetary subsidies and indirect through coupons. That is, farmers receive cards from the state allowing them to buy grains or certain other commodities at low state prices. Contrary to the subvention policy is that of taxation policy which tends to raise the consumer price and lower the producer price. The taxes are paid in the marketing process at slaughtering and at retailing. In the state sector the tax policy makes state marketing enterprises ask for more subvention. The government needs to eliminate these counteracting policies as they result in disguising the market signals. It should revert to one scheme of subsidies that are predominantly used for supporting investment efforts and producer prices only when substantial surpluses occur so that farmers have some income stability (Bingsheng 1992).

The different types of taxes and subsidies at different stages of the marketing chain increases the complexity of shadow price calculations. At what stage in the marketing process the data are collected needs to be clearly specified.

Concluding Comments

Shadow prices can be calculated via the production function approach or mathematical programming. The analysis indicates that relative world prices are a plausible proxy for shadow prices in a distorted economy. For CPE's, shadow price calculations are a complex issue as many perplexities have to be overcome. These include identifying the various forms of disortion, obtaining accuate and consistent data from the various types of markets that may exist for any one commodity and dealing with the differences that may exist between regions in the CPE. It does not, however, follow that the Economist's verdict on the differences in the pricing systems of CPE's and free market economies is a plausible one. Distortions in the two systems of pricing appear to differ only in magnitude but not in content. The underlying message of this paper is that our understanding of shadow prices is incomplete if they are limited to simple cases reflecting "best use of scarce resources". As argued by Koopmans (1977), "second best use of rersources", and "outright waseful uses", deserve equal attention and should be treated as the other side of the coin.

References

Baumol, W. J. (1965), *Economic Theory and Operations Analysis*., second ed Englewood Cliffs, NJ Prentice Hall.

Bhagwati, J. and Srinivasan, T. N. (1984), *Lectures on International Trade*, second ed Cambridge, London MIT Press.

Bingsheng, K. (1992), *Marketing of Pork and Vegetables in China*

Carter, C. A. and Zhong, F. N. (1991), "China's Past and Future Role in the Grain Trade", *Economic Development and Cultural Change*, 39(4), 791-814.

Dasgupta, P. and Stiglitz, J. (1974), "Benefit Cost Analysis and Trade Policies", *Journal of Political Economy*, 82(1), 1-33.

Dreze, J. and Stern, N. (1990), "Policy Reform, Shadow Pricing and Market Prices", *Journal of Public Economics*, 42(1), 1-45.

Findlay R. and Wellisz, (1976), "Project Evaluation, Shadow Prices and Trade Policy", *Journal of Political Economy*, 84(3), 543-552.

Hazell, P.B.and Norton, R.D. (1986), *Mathematical Programming for Economic Analysis in Agriculture*, New York Macmilllan Publishing.

Johnson, D.G. (1992), "Does China have a Grain Problem" Office for Agricultural Economics Research, University of Chicago Paper No 92:8.

Koopmans, T. C. (1977), "Concepts of Optimality and Their Uses", *American Economic Review* 67(3), 261-274.

Little, I.M. and Mirrlees, J.A. (1969), *Manual of Industrial Project Analysis in Developing Countries*, OECD, Paris.

Mishan, E.J. (1971), *Cost Benefit Analysis*, Georege, London, Allen and Unwin.

Mussa, M. (1979), "The Two Sector Model in Terms of its Dual: A Geometric Exposition", *Journal of International Economics*, 9(4), 513-526.

Shujuan, L., (1990),"Shadow Price of Capital in China", in Chinese Students Society for Economic Studies "China: Trade and Reform", Papers from a Workshop held in Sydney, November.

Sicular, T. (1988), "Plan and Market in China's Agricultural Commerce" *Journal of Political Economy*, 96(2), 283-307.

Srinivasan, T. and Bhagwati, J. (1978), "Shadow Prices for Project selection in the Presence of Distortions: Effective rates of Protection and Domestic Resource Costs", *Journal of Political Economy*,. 86(1), 97-116.

Warr, P. (1977), "On the Shadow Pricing of Traded Commodities", *Journal of Political Economy*, 85(4), 865-872.

Weckstein, R. (1972), "Shadow Pricing and Project Evaluation in Less-Developed Countries", *Economic Development and Cultural Change*, 20(3), 474-494.

World Bank (1991), *China: Options for Reform in the Grain Sector* , Washington D.C. The World Bank

Xiaozhong, W. (1992), "Grain Purchase Bogged Down by Fund Shortage", *Chinese Daily* December 18.