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STORAGE OF MAIZE IN MOZAMBIQUE UNDER DUALISTIC CREDIT MARKETS: A SPATIAL AND TEMPORAL ANALYSIS

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Abstract:

The paper examines marketing patterns when interest and storage loss rates are greater in rural zones, representing informal sector storage usually on-farm, than in urban zones, representing formal sector storage off-farm. Empirical results indicate that divergences in interest and storage loss rates across space have significant impacts on marketing patterns. Reductions in rural rates improve welfare, and these welfare gains tend to accrue primarily to rural inhabitants-- a group that is poor. These results suggest that efforts to improve the efficiency of rural storage should be given priority as opposed to the creation of large, formal sector grain collection centers. The benefits of formal sector grain collection centers tend to be offset in large part by the transport costs necessary to deliver grain to the centers plus accrued interest on these transport costs. This aspect is particularly costly if interest differentials are sufficiently large to generate incentives to transport to grain storage sites after harvest and then back to productive rural zones later on for consumption.

MAIZE MARKETS AND RURAL STORAGE IN MOZAMBIQUE: A SPATIAL AND TEMPORAL ANALYSIS

1. Introduction

For many agricultural commodities, three facts dominate the process of marketing. First, agricultural commodities tend to be produced a considerable distance from centers of consumption. Second, agricultural commodities are often harvested within a distinct and short interval of time. Third, consumption tends to be relatively evenly spaced in time. These three facts are particularly relevant for maize marketing in Mozambique. The distance by road between Lichinga, the provincial capital of Niassa province-- a major maize producing province in the north-- to Maputo, the national capital and major consumption center, exceeds 2800 kilometers. Currently, the only available means for transporting maize from north to south is by truck. Even at low per kilometer trucking rates, the cost of transporting maize over this distance represents more than half of the import parity white maize price.[1]

While dispersion of production through space requires transport to bring maize to consumption centers, concentration of the harvest period in time requires storage to allow for a relatively smooth consumption pattern over time. Storage of maize implies opportunity forgone in terms of consumption or sale to a third party. This opportunity cost of holding maize from one period to the next rather than selling it in the current period is best represented by the opportunity cost of capital. Strictly speaking, the opportunity cost of capital is unobservable; consequently, one uses the interest rate as a proxy in empirical analyses. Recently in Mozambique, real interest rates have been extremely high and dualistic. Moll (1996) calculates that, in 1994, real interest rates to small borrowers, including formal sector borrowers, were in excess of 100% on a yearly basis. At the same time, they were low to negative for some favored large borrowers. Since then, preferential rates to favored large borrowers have been largely eliminated and interest rate differentials have declined. However, for traders operating in rural areas, credit constraints remain severe; and significant interest rate differentials between formal and informal sector borrowers persist (Miller, 1996; Moll, 1996; Coulter, 1996; Strachan, 1994; and Donovan, 1996).

Recent developments in the theory of spatial and temporal price determination for agricultural commodities illustrate that transport costs and interest rates *interact* in important ways in the determination of marketing patterns over space and time (Benirschka and Binkley, 1995). In developing countries such as Mozambique, where interest rates and transport costs tend to be high, these interactions can be expected to have significant impacts on grain marketing patterns. These patterns are often of significant interest to development economists. They are frequently modeled using an optimization approach of the form suggested by Takayama and Judge (1971) and applied examples are numerous. Recent applications include Nuppenau and Masters (1993); Arndt (1993); Mwanaumo, Masters, and Preckel (1997); Bivings (1997); and Brennan, Williams, and Wright (1997).

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[1] A map of Mozambique can be found at

Since maize is the staple grain in Mozambique, policy questions abound. This paper focusses on storage and transport patterns with explicit accounting for dualistic interest rate structures between the formal and informal sectors. Under the Takayama and Judge optimization approach, accounting for dualistic interest rate structures is hard since dualistic interest rates must be implemented as dualistic discount rates. Instead, we rely on a mixed complementarity problem (MCP) approach to a spatial and temporal equilibrium model of the maize market in Mozambique. The MCP approach captures the interactions between transport costs and interest rates, which may differ according to location, in a manner which is simple to program and solve (for a review of MCP approaches, see Ferris and Pang). To the authors' knowledge, this represents the first detailed examination of the effect of dualistic interest rate structures on marketing patterns and the first application of the MCP approach to an examination of marketing patterns for an agricultural commodity.[2]

The remainder of this article is organized as follows. Section two explains the implications of interactions between tranport costs and interest rates for agricultural marketing patterns over space and time. In addition, it is shown how storage losses tend to reinforce these marketing patterns. Section two also contains a brief review of the above cited empirical studies in spatial and temporal price determination. In section three, background information on Mozambique is presented and the model, data, and underlying assumptions are introduced. The fourth section presents the alternative

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http://www.lib.utexas.edu/Libs/PCL/Map_collection/africa/Mozambique_rel95.jpg.

[2] That models of the Takayama and Judge form could be formulated as complementarity problems has been known for some time (Takayama and Uri, 1983).

simulations attempted and contains a discussion of model results. A final section concludes and suggests topics for future research.

2. Spatial and Temporal Price Determination: Theory and Application

2.1 Interactions Between Transport Costs and Interest Rates

In a recent article, Benirshcka and Binkley (1995) develop a theoretical model to examine the behavior of markets for an agricultural commodity when transport costs and interest rates are strictly positive. In the commodity market, production is dispersed in space, harvest takes place in a short time span, and demand is concentrated in space and relatively evenly distributed over time. The theoretical model predicts that storage durations should be positively correlated with transport costs to market. In other words, production that occurs further from market tends to be stored for longer periods of time.

The rationale is simple. Under competitive conditions, the value of a commodity tends to decline with distance to market due to transportation costs. Consequently, the opportunity cost of storage tends to decline as well. Consider two agents who inhabit an isotropic plain. Each possess a maize stock which are equivalent in every respect except in terms of distance to the (single) consumption center. If transport cost increases with distance, the nearby stock is more valuable than the distant one. Thus, the opportunity cost of holding onto the stock is greater for the nearby agent than for the distant agent. Consequently, competitive market conditions dictate that the nearby agent should sell first in time.

As Benirschka and Binkley make clear, this insight provides an elegant explanation for an apparent pricing paradox, known as backwardation, which was noticed as early as 1930 by Keynes (p. 143). Market theory implies that the difference between contemporaneous spot and futures prices for an agricultural commodity should be equal to the cost of storage defined as warehousing costs, insurance, and interest foregone. However, empirical studies tend to find that the implied cost of storage exceeds this price differential. The paradox is resolved if one accounts for the presence of transport costs in the spot market price. In empirical analyses, the spot market price typically employed is the consumption center price (Wright and Williams, 1989). This price is transport cost laden. Since rational agents wish to avoid paying interest on transport costs, they will tend to store at or near the place of production and then transport to the consumption center at or near the time of consumption as opposed to first transporting (thus incurring transport costs) and then storing. If one calculates the interest foregone component of the cost of storage on the basis of the consumption center spot price, one has used a price which is transport laden and thus too high. Consequently, one overestimates storage costs and the illusion of a pricing paradox is created.

Benirschka and Binkley go on to present empirical evidence for the United States that 1) the quantity of storage capacity in a region tends to be positively related to transport cost to market, 2) farmers in regions relatively distant from major markets tend to store their production for longer durations of time than farmers located relatively close to major markets, and 3) the rate of appreciation of U.S. maize and soybean prices over time in specific markets tends to be negatively related to distance of the market from major production zones. They found the rate of appreciation to be lowest at the Gulf ports-- the "consumption center" furthest from production zones in the data set employed. All of these empirical observations are consistent with the theoretical model.

2.2 Interactions Between Transport Cost and Storage Losses

Storage losses reinforce the positive relationship between cost to market (distance) and storage duration since they create similar incentives to those engendered by interest rates. In order to abstract from the impact of interest rates, a market disequilibrium case provides the clearest example. Consider two stocks of maize (q_i , i=1,2) which are equivalent in every aspect except that one is located further from the single market center. Assuming no additions or subtractions to the stock from the initial period t=0, the quantity of the stocks at time t can be described as:

$$q_{1t} = q_{2t} = q_{i0}\, e^{-\delta t}$$

where q_{i0} is the initial stock and $\delta>0$ is the rate of storage loss. Suppose that the agent has just received information that the market price of the commodity in the single market center will remain constant. Because of storage losses (time preference is ignored), the agent possesses, in such a case, wasting assets which are optimal to sell. Further, suppose that the agent can only sell one of the stocks due to institutional barriers. In this situation, the value of the stock at time t, V_{it}, and the rate of depreciation of the value of the stocks over time can be described as:

$$V_{it} = (p - c_i)\, q_{i0} e^{-\delta t}$$
$$\dot{V}_{it} = -\delta(p - c_i)\, q_{i0} e^{-\delta t}$$

where p represents the (constant) price in the market center and c_i represents the per unit transport cost from location i to the market center. The value of the stocks and the rate of decline in the value of the stocks differ only by transport cost. The stock closer to market (i.e., the stock with a lower transport cost, c_i) is losing value at a more rapid rate. Consequently, it is optimal for the agent to sell the stock which is closer to market first.

More generally, given a constant and strictly positive storage loss rate regardless of location in space or time, storage durations under competitive conditions will be longest where the value of commodity is lowest. Spatial arbitrage ensures that value of commodity is lowest in regions where transport cost to market is highest. Consequently, storage durations should tend to increase with increasing distance to market on the basis of storage losses alone. Alternatively, it is rational to store and then transport rather than transport and then store even when abstracting from time preferences.

In the United States, interest rates are low, transport infrastructure excellent, and storage facilities efficient in comparison with many other countries. Nevertheless, Benirschka and Binkley find that these interactions have a significant impact on marketing patterns and the distribution of storage infrastructure in the United States. In Mozambique, as in many other African countries, distances are large, interest rates high and variable both through space and time, transport infrastructure poor, and storage facilities often rudimentary. Due to their magnitudes, these effects can be expected to have a profound impact on marketing patterns. The finding also has potential equity implications. Benirschka and Binkley conclude that "[producing] areas far from market have a comparative advantage in commodity storage." In Mozambique as well as many parts of Africa, inhabitants of distant production zones tend to be poor. Thus, efforts to increase the efficiency of rural storage have the potential to simultaneously improve efficiency and equity.

2.3 Modeling Spatial and Temporal Price Determination in Agriculture

The Takayama and Judge framework has been applied frequently in a variety of context, and a number of applications are now available in the literature. Masters and Nuppenau (1993) examine panterritorial versus regional pricing for maize in Zimbabwe. Their model focusses on spatial equilibrium and does not include a time dimension. Arndt (1993) examines wheat trade policy options in a two commodity (hard and soft wheat) spatial/temporal model for Morocco. The model is solved repeatedly to obtain a distribution of prices contingent upon alternative wheat production and world price scenarios. Mwanaumo, Masters, and Preckel (1997) develop and apply a continuous space analog of the Takayama and Judge form to maize market liberalization in Zambia. Estimates of welfare benefits of liberalization in the continuous space model substantially exceed estimates of welfare benefits in the traditional discrete space form. However, their model does not include a time dimension. Bivings (1997) constructs a spatial/temporal model to examine deregulation of the sorghum market in Mexico. Her model explains the sharp drop in post-harvest prices experienced in Mexico following deregulation of the sorghum market in 1990.[3] Brennan, Williams, and Wright (1997) show how the presence

[3]For a more general overview of models of the Takayama and Judge form, see Harker (1986) who describes several spatial equilibrium models with imperfect competition and Thompson (1989) who provides an overview of applications to the agricultural sector.

of capacity constraints on storage and transport, combined with time preferences, can generate the backwardation pricing paradox in a spatially diffuse market.

This diversity of models and the variety of issues examined points to the enormous flexibility of models of the Takayama and Judge form. The solution reflects a competitive market outcome (Samuelson, 1952; Takayama and Judge, 1971). In addition, the impacts of a large variety of policies and market structures can be examined. This list includes, among other items, specific taxes on transport, tariffs on trade with the rest of the world, and a wide array of quantitative restrictions. Despite this flexibility, the non-linear programming approach to solving models of the Takayama and Judge form is not straightforward for some situations. For example, the presence of ad-valorem taxes on trade flows between regions in the model forces the analyst to solve a sequence of non-linear programming problems (Rutherford,1995). Formally, the presence of ad-valorem taxes destroys integrability. In these instances, setting up and solving the model as a mixed complementarity problem is likely to be more efficient and transparent (Rutherford, 1995).

As shown in Appendix A, differentials in interest rates through space also destroys integrability. Intuitively, one could view an interest rate as an ad-valorem tariff on flows through time. While one can cope with a single interest rate (across space) in a classical Takayama and Judge optimization formulation by discounting the objective function, the presence of interest rate differentials through space causes difficulties very analogous to the presence of ad-valorem tariffs on trade flows. Since the dimensionality of spatial/temporal models tends to be high, solving a sequence of optimization problems is computationally expensive and lacks transparency.[4] Consequently, the MCP approach is employed here.

3. Background and Model

3.1 Background on Mozambique

Mozambique is one of the poorest countries in the world. The economy inherited deep structural problems upon independence from Portugal in 1975. Economic difficulties deepened due to an unsuccesful attempt at transformation to a socialist economy shortly after independence. Evidence exists that, by the early 1980s, top political leaders had recognized the failure of command type economic policies. However, before market oriented reform measures could be put in place, a brutal civil war erupted. Over the course of this conflict, which lasted nearly ten years, an estimated one million people were killed and five million displaced (Moll, 1996). The combination of war and inefficient socialist policies paved the way to complete economic collapse in 1986.

In early 1987, a stabilization and structural adjustment programme-- the ERP (Economic Rehabilitation Programme)-- was launched with the assistance of the International Monetary Fund and the World Bank. The programme as designed was relatively standard and included measures such as fiscal adjustments, monetary restraint, devaluation of the exchange rate, privatisation, and substantial price and trade liberalization. Nevertheless, the ongoing civil war severely limited the scope and impact

[4] The model employed here contains 20 locations in space and 12 locations in time with manifold options

of the initial reform measures under the ERP. Meanwhile, war continued to devastate the agricultural sector. The rebel movement, RENAMO, never attained sufficient power to threaten major urban areas. Instead, unrest played itself out in the countryside destabilising rural areas and population. Critical components of the marketing system such as roads, railways, storage depots, and shops were destroyed. One third of all health posts and half the primary schools were closed or destroyed (USAID, 1995). Livestock populations were literally decimated (Ministry of Agriculture, 1994). By the cessation of hostilities in 1992, Mozambique faced massive reconstruction needs. In addition, implementation of the ERP, particularly at the microeconomic level, had barely begun.

Since the cessation of hostilities in 1992, the economic picture has changed considerably. Economic growth has returned with the economy registering real GDP growth of about 7% in 1995 (National Institute of Statistics, 1997). In addition, the major elements of the ERP are now in place. This is particularly true of the agricultural sector. In the immediate post civil war period, severe resource contraints resulted in *de facto* low levels of government involvement in the agricultural sector. The government maintained *de jure* minimum prices for key agricultural commodities, including maize, and owned a para-statal, AGRICOM, which had a broad mandate to intervene in agricultural markets, particularly the market for maize. However, enforcement of minimum prices was sporadic at best; and budget constraints rendered AGRICOM essentially inoperative (Strachan, 1994).

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for moving maize through space or time.

By 1996-97, the government had abandoned minimum prices and transformed AGRICOM into the *Instituto de Cereais de Moçambique* (ICM). At that time, ICM remained state owned but received no budget support. ICM activities focussed on purchase and storage of grain. ICM maintained good access to formal sector credit. It is unclear whether ICM's status as a state owned entity allowed it to borrow at preferential rates, implying an implicit subsidy. Overall, government role in the agricultural sector, *de jure* as well as *de facto*, was minimal. International and domestic trade in maize was almost completely free of legislative barriers and taxation. In this environment, spatial maize price arbitrage appears to have been active at least in the southern and central portions of the country. A detailed study by Donovan (1996) found significant price linkages between maize markets in Maputo and Chimoio-- capital of a major surplus production region (Manica) located more than 1,100 kilometers north of Maputo.

Exogenous factors have over the years perturbed maize markets in Mozambique. In particular, large volumes of food aid arrived in the early post-war period. Coulter (1996) calculates that food aid represented nearly three-fourths of total cereals availability in the drought stricken 1992-93 marketing year. However, as shown in Table 1, domestic production of maize in the 1996-97 marketing year was nearly sufficient to meet domestic demand substantially reducing the volume of and need for food aid. Food aid shipments in the 1996-97 marketing year amounted to about only 20,000 tonnes (not all of it maize) representing less than 2% of total maize supply (FAO, 1997). Finally, the vast bulk of food aid arrived in Maputo, a structural importing region, and was sold at import parity prices. This is consistent with the modeling approach followed here.

While the policy agenda of the ERP has been essentially completed, the reconstruction/development agenda remains massive. For example, secondary and tertiary roads are few and poorly maintained, ports inefficient, and coastal shipping capacity non-operational (Coulter, 1996). Maize production is dominated by subsistence smallholders. Means for delivering formal credit to smallholders in rural areas are practically non-existent (Donovan, 1996). In addition, the continued extreme asset poverty of rural inhabitants, as a result of economic collapse and war, militates against the informal sector filling the breech (Moll, 1996). Consequently, rural inhabitants face severe credit constraints.

3.2 Model Structure

The model contains ten regions, corresponding to the ten provinces in Mozambique, with each region containing an urban and rural zone. Thus, a total of 20 locations in space are present in the model. The time span considered is 12 months. The beginning time period is March, corresponding to the beginning of the maize harvest season.[5] Southern regions harvest 85% of their production in March and 15% in April. Northern regions harvest a bit later with 85% of their production arriving in April and 15% in March. Production occurs exclusively in rural zones. Domestic transport is possible between urban and rural zones in the same region and between urban zones of different regions. This implies that rural production must first incur costs to enter the marketing system (represented as the urban zone) and then additional fixed and variable costs to be distributed to other regions. Storage is permitted in all regions and zones.

[5] The model is restricted to a single year since inter-annual storage volumes tend to be small (FAO, 1997).

International trade in the form of imports and exports of maize is permitted. International trade occurs in the urban zone of the three regions containing major international ports: Maputo, Beira (in Sofala province), and Nacala (in Nampula province).[6] Coastal shipping is also possible between these three major ports. Demand and supply functions are linear; consequently, the non-linear programming manifestation of the model (when interest rates are constant across space) is a quadratic program and the MCP manifestation of the model is a linear complementarity problem. MCP equations are listed, in GAMS notation, in Appendix B. The model is solved using GAMS/PATH (Brooke, Kendrick, and Meeraus, 1992; and Dirkse and Ferris, 1996).

3.3 Data

Economic collapse and war have not been kind to data gathering and analysis systems in Mozambique. As one might expect, data quality is often exceedingly poor and large information holes persist. Nevertheless, enormous efforts have been made to collect and analyze data since the cessation of hostilities in 1992. For the benchmark period, which starts with the 1996 harvest, data is available on production of maize by province, unit road transport costs, distances between regions, and retail prices of maize in urban zones by province. In addition, even though the coastal shipping industry is essentially

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[6]International trade of maize with neighboring countries is not modeled explicitly. Unrecorded maize trade with neighboring countries, especially with the northern provinces, undoubtedly exists. Yet, solid data on these maize trade magnitudes is practically non-existent. Poor cross border transport infrastructure as well as the presence of trade barriers in some neighboring countries (Zimbabwe and Malawi) indicate that unrecorded trade flows could be relatively light; however, it is important to emphasize that the magnitudes are simply not known.

inactive, studies have been undertaken to estimate unit sea transport costs in the presence of a reasonably efficient coastal shipping industry (Oceano Consultores, 1996).

As is often the case, demand patterns (let alone the elasticity of demand) are less well known. A per capita consumption level of 57 kg per annum is employed, along with statistics on population, to develop benchmark demand functions.[7] The figure is calculated from famine early warning system food balance sheets (Famine Early Warning System, 1997). We follow Nuppenau and Masters and assume an elasticity of demand of -0.3. Linear supply functions are benchmarked in order to recreate production patterns in the 1996-97 marketing year assuming an elasticity of supply of 0.6 for the more favorable northern regions plus Manica and an elasticity 0.3 for the drier southern regions. Region location (north or south), benchmark demand and supply quantities, and benchmark price levels are shown in Table 1. The Table indicates that only Niassa and Manica are major surplus production regions. In addition, the northern provinces, which are often referred to as major surplus regions, produced only a very mild surplus in the 1996-97 marketing year.

Quality data on real interest rates are very difficult to obtain. Existing data are obscured by the banking practice of forcing borrowers to pay a portion (if not all) of the "interest" on a loan up front (Moll, 1996). This practice drives up the true real interest rate substantially. In addition, since stockholding of maize by consumers can reduce risk, it is unlikely that data on real interest rates reflect time preferences. The values are set to

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[7]This approach has obvious drawbacks. However, quality information on maize consumption is sparse. A national household survey has been conducted; however, figures have not yet been released. Previous household surveys concentrate on urban areas and supply budget shares (maize is not broken out) as opposed to quantity information.

2% and 3% per month for urban and rural zones respectively. These values reflect judgement of the authors and an effort to calibrate model results to available base year data. Storage loss rates are set to 0.5% and 1% per month for urban and rural zones respectively. These values are comparable to those employed by Masters and Nuppenau (1993).[8]

The exchange rate is set at 12,000 Meticais per US dollar which reflects a weighted average of available exchange rate information (National Institute of Statistics, 1997). Transport cost over land and sea are set to 480 Meticais per kilometer per tonne. Loading/unloading costs are 60,000 and 132,000 Meticais per tonne for truck and ship respectively (Abt Associates, 1992; Coulter, 1996; and Miller, 1996; Oceano Consultores, 1996). At these values, sea transport costs are prohibitive reflecting the non-operation of the coastal shipping industry. Regarding trucking, per kilometer trucking rates from South to North are set at twice the above values to reflect differences in up-haul and back-haul rates (Coulter, 1996). Also, a transport loss of 1% is assumed to occur with each shipment. The total cost of moving maize between urban and rural zones is assumed to be 73,000 Meticais per tonne.[9] Export (FOB) and import (CIF) prices are set at $125 and $180 per tonne reflecting available data on actual export and import prices for white maize (Coulter, 1996 and Miller, 1996).

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[8] Coulter (1995) asserts that, based on experience in East Africa, storage losses could be as low as 4% of the volume stored.

[9] This amount reflects loading and unloading charges plus 10 kilometers at an increased per kilometer charge (1,300 Meticais per tonne nearly three times the regular road rate) corresponding to the lower quality of secondary and tertiary roads.

It is worth noting that large changes in world maize prices occurred during the 1996-97 marketing year. Bellweather U.S. yellow maize prices dropped by about 40% between July and December 1996 (National Agricultural Statistics Service, 1997). No attempt is made here to recreate this world price decline. Instead, the above cited world prices are employed as reasonable expected price levels for white maize which allows for a more general analysis. The tariff laden import price is $183 reflecting the tariff rate on maize (1.7%) registered in national accounts data for 1996 (National Institute of Statistics, 1997). Maize arriving by ship, either coastal shipping or internationally, is assumed to suffer a 5% loss reflecting high levels of theft (Castro, 1995 and Coulter, 1996). Exports and imports pay half of the loading/unloading cost charged to coastal shipping. The gap between prices received for exports net of loading costs and prices paid for imports including unloading costs, tariffs, and losses amounts to about $78 per ton.

4. Simulations and Results

4.1 Simulation Cases

The alternative simulations performed are presented in Table 2. The base case scenario is run with parameters set at benchmark values. In the remaining simulations, all parameters are set at benchmark values except those explicitly changed to analyze the case. All scenarios aim to examine what would have happened in the 1996-97 marketing year under alternative values for rural interest rates and storage losses. Case 1 examines the implications of more efficient rural storage. Case 2 examines the implications of an equi-proportionate reduction in interest and storage loss rates for both urban and rural zones. Case 3 examines the implications of a reduction in interest and storage loss rates for urban zones only. In case 3, the relative magnitudes of interest and storage loss rate reductions for urban zones are set to the same proportionate change levels as the relative magnitudes for rural zones examined in Case 1.

4.2 Simulation Results

A summary of results for the alternative cases is shown in Table 3. In the base case, production quantities and prices reflect benchmark values. The base case reasonably matches observed supply prices and demand prices for the first two thrids of the marketing year. Due to the above mentioned decline in world market prices for maize during the 1996-97 marketing year, model predicted prices diverge somewhat from observed prices especially in import dependent regions, such as Maputo, in the final third of the marketing year. As in the 1996-97 marketing season, exports of maize are very small and imports fill the gap between supply and demand. All imports in the model base case scenario arrive through the port of Maputo, which is consistent with actual import patterns. Coastal shipping does not occur, in line with the situation in 1996-97.

More than half of the total commodity volume stored in the month of May is located in rural zones. Recall that, regarding storage, the rural zone is conceived of as on-farm storage while the urban zone is conceived of as more efficient (lower interest and storage loss rates) off-farm storage. Transport costs between rural and urban zones (and interest charges on transport costs) are sufficiently high to deter movement of most maize to more efficient off-farm storage sites. Transport of this sort occurs primarily in the southern provinces where maize prices, and consequently opportunity costs of capital, are relatively high. This accords with empirical observation and results in a relatively high value for total transport cost.

Case 1 lowers interest rates and storage losses in rural zones such that values for these parameters are equalized between zones. As one might expect, the impact of lower interest and storage loss rates in rural zones is almost uniformly positive. Average consumption prices decline and consumption increases accordingly. At the same time, average harvest prices increase and supply responds accordingly. The reduction in the rate of growth of prices affords this simultaneous benefit on the demand and supply side. Due to reduced interest and storage loss rates, those wishing to stock maize are willing to pay more at harvest; and growth in prices throughout the marketing year is reduced. This reduction in the rate of growth in prices lowers average demand prices even though the initial base for price increases, harvest prices, are higher.

Impacts on prices are strongest, in relative terms, in rural areas with surplus production which are distant from consumption centers. In these areas, maize prices are low; consequently, the opportunity cost of storage is low and the option of transporting maize to a more efficient storage site is least attractive due to the high relative price of transport costs.[10] In the rural zone of Niassa, hungry season (February) maize prices are 16% lower in case 1 compared with the base case. In contrast, hungry season prices in rural Inhambane, a deficit located near Maputo (the major consumption center), register only a minute decline.

The only welfare decreasing impact in case 1 is a mild increase in the average urban price paid for maize. As Table 3 illustrates, the increase in urban prices is confined to the southern provinces. The increase in average prices in Maputo is a particularly strong driver of this result since Maputo is both a relatively high priced region and by far the largest center of urban consumption. Maputo depends primarily upon imports from the rest of the world for maize supplies. In both the base case and case 1, imports to Maputo begin in September. The import price, which is constant across the scenarios, anchors prices for earlier periods. Lower storage costs imply that prices do not need to fall as far below the import parity price level in the immediate post-harvest periods in order to compensate for the costs of storage. Consequently, average maize prices in southern urban regions rise. The price increase, however, is not large. Prices in Maputo in March, the period for which this effect would be strongest, are lower in the base case relative to case 1 by less than 1%.

Export volumes increase and imports decline due to increased total production and reduced storage losses. Also, as predicted by theory, maize storage occurs completely in rural zones.[11] Equalization of interest and storage loss rates between zones eliminates any incentive to transport and then store. Rural storage volumes for the month of May, the first non-harvest month of the marketing year, almost double in case 1 relative to the base case. Equalization of interest rates and storage loss rates between zones eliminates any incentive to transport and then store. Consequently, trucking

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[10] Distance to urban (formal sector) storage sites is probably greater as well which would tend to reinforce this effect. Due to a lack of data, cost of transport between rural and urban zones of the same province is assumed to be constant across provinces in the model.

[11] Urban purchasers of maize, such as millers, stock no more than one month's supply.

volumes (not shown), defined as the sum of all transport variables, fall by about 217 thousand tonnes. This implies, in very rough terms, that approximately 108 thousand tonnes (half the decline in trucking volume), was first transported out of rural zones and then transported back later in the marketing season in the base case.[12]

The presence of differential interest rates between urban and rural zones complicates welfare analysis (also see Appendix A). Interpretation of the nature of the interest rate differential influences results. If the interest rate differential represents real costs associated with delivering credit to rural borrowers, then transportation to lower cost storage in urban zones saves real resources as long as the total savings on storage exceed the total cost of transport. However, the interest rate differentials might also reflect market distortions such as interest rate subsidies, imperfect competition in credit delivery to rural areas, and/or simple market inefficiency. In this case, transport to avoid high cost rural storage could be inefficient.

All of these credit market distortions are arguably present in Mozambique. As mentioned above, one of the major stocking organizations, ICM, is owned by the state and enjoys good relationships with the banking system. A case could be made that ICM benefits from implicit interest rate subsidies. In addition, smallholders tend to be highly dispersed and rural agents dispensing credit very few, creating conditions conducive to the exercise of market power in credit delivery. Finally, information on rural markets is

[12] At the moment, the exact empirical importance of this circular transport flow is not known. Discussions with individuals familiar with maize markets and rural household in Mozambique behavior indicate that these figures are plausible. National accounts data also offer some support. This circular flow estimate represents about 13% of benchmark rural maize demand. National accounts data for 1995 indicates that about 19% of the value of rural maize consumption is purchased while the remaining 81% is home consumption of own production.

scarce. Investors could easily content themselves with urban markets, where returns are quite adequate, even if risk/reward ratios for delivering credit to rural areas are very favorable. Accounting for distortions in credit delivery would imply that the market overstates the ratio of cost of rural storage to cost of urban storage (including interest costs).

In addition, the market price of road transport quite likely understates the total cost of road transport. Mozambique has embarked on a major roads and coastal shipping (ROCS) investment program. To date, the emphasis of the program has been on road construction. These roads require constant and expensive maintenance, which existing taxes (on road use, vehicles, and fuel) are unlikely to cover in full. In light of this, one might view road transport costs as understated.[13] Overstatement of rural storage costs and understatement of transport costs would imply efficiency gains associated with any shock which increased volumes of rural storage and reduced transport volumes. As shown below, reductions in rural interest and storage loss rates engenders both of these effects.

In the welfare analysis, interest rate differentials and transport costs are assumed to fully reflect real resource costs. Thus, the welfare measure most favorable to urban storage is chosen. Welfare is calculated from the Takayama and Judge measure which would have prevailed if an iterative non-linear programming optimization scheme had been employed. Once the equilibrium has been derived via the MCP formulation, it is straightforward to derive this welfare measure. Specifically, a single arbitrary discount rate of 1% per month is applied to the welfare measure. To arrive at rates of price

[13] Alternatively, one might consider that the development benefits of roads merit a subsidy.

increase which are consistent with higher and differential interest rates using a non-linear programming approach, monthly per unit storage costs are calculated which yield the same equilibrium as derived by the MCP formulation (see Appendix A). This welfare measure is presented in Table 3.

Table 4 presents a decomposition of the welfare changes for each experiment relative to the base. Each element of the decomposition is a component of the Takayama and Judge measure. The Takayama and Judge welfare measure maximizes consumer and producer surplus less costs. The surplus measure is arrived at by substracting the area under the supply curve from the area under the demand curve. In the decomposition, the areas under the supply and demand curves are separately presented.[14] In addition, the major cost posts-- transport cost, storage cost, and value of exports less value of imports-- are presented. All figures are presented as differences from the base case. As one would expect, the welfare impact for case 1 is positive regardless of the discount rate employed. Reductions in storage costs, transport costs and imports all contribute to the welfare gain.

In case 2, interest and storage loss rates are reduced relative to the base case by 25% and 33% respectively for both rural and urban zones. Relative to the base case, average purchase prices decline while average harvest prices increase. Production, demand, exports and rural storage volumes increase while imports, trucking volume, and urban storage volumes decrease. The reasons for these impacts are very similar to the reasons cited for the impacts in case 1. These changes result in welfare gains relative to the base case.

The total welfare gain and the source of the welfare gain between case 1 and case 2 form an interesting comparison. In case 2, agents have access to urban interest and storage loss rates which are 25% and 33% lower, respectively, than in case 1. Rural interest and storage loss rates are 12.5% and 33% higher in case 2 as compared with case 1 (see Table 2). Even though very efficient storage, relative to case 1, is available in the urban zones, the welfare increase is higher in case 1 compared with case 2. The primary contributor to the difference is transport cost. Case 1 obtains a much higher welfare gain from reduced transport cost than case 2. This occurs because, in order to profit from urban storage, transport cost must be incurred. As a result, while case 2 reaps large welfare gains from less costly storage, these gains are partially offset by higher transport costs.

In case 3, urban interest and storage loss rates are reduced in the same proportions as rural rates in Case 1. As in the preceding two cases, average consumption prices fall and harvest prices rise. However, welfare gains are more than 40% greater in case 1 compared with case 3. Two factors drive this difference. First, the same proportionate decline in interest and storage loss rates leads to a larger absolute decline in rural rates since rural rates started at higher levels. Second, as in case 2, maize must be tranported from rural zones to urban zones in order to profit from lower interest and storage loss rates in urban zones. Total transport costs increase by 18% relative to the base case. The increase in transport costs offsets about two thirds of the benefits of lower urban interest rates.

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[14] Note that the change in the area under the demand and supply curves shown in Table 4 for each case

These results indicate that establishing a relatively few, but very efficient, grain storage locales while ignoring rural storage technology and credit constraints might not be the best policy. Often, efforts are made to support more formalized storage depots--presumably at the expense of programs to develop and extend more efficient on-farm storage. As in case 3, this policy could serve mainly to increase transport volumes, with transport costs and interest charges on grain which has been transported and then stocked largely offsetting the increases in urban zone storage efficiency. In general, these policies are inconsistent with the inherent advantages of storage on or near farm. The presence of the distortions mentioned above would further bolster the case for efforts to enhance the viability of rural storage.

The results obtained in these cases have distributional consequences as well. While poverty certainly exists in urban areas, rural poverty in Mozambique is more acute (Addison and McDonald, 1995). In addition, the rural population is approximately four times the size of the urban population (Bardalez, 1996). Table 5 illustrates producer and consumer surplus measures with the consumer surplus measure divided into rural and urban zones. When only urban interest and storage loss rates decline (case 3), rural consumers benefit relatively little. The Table also indicates that elimination of the interest rate differential between urban and rural zones (case 1) benefits rural zones exclusively in the form of increased producer and consumer surplus. Producers are particularly large gainers. Urban zones actually experience a mild decline in consumer surplus. This indicates that the benefits of reduced rural interest and storage loss rates tend to accrue to

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relative to the base is not equivalent to the change in consumer and producer surplus.

rural household rather than get passed on to urban households in the form of lower maize prices.

The intuition behind these results is as follows. With friction free credit markets (i.e., no interest rate differentials) and reasonably efficient rural storage technologies, the bulk of storage would tend to take place on-farm or near farm in rural zones. In the presence of impediments to delivering credit to rural zones, substantial storage can occur in urban zones in order to take advantage of lower costs of credit. To compensate for these credit impediments, rural producers must sell at a lower price in order to either cover high rural storage costs or the costs of transport (plus accrued interest on that transport cost over the duration of storage) to lower cost storage sites. In the periods immediately following harvest, rural zones will tend to rely on local stocks; consequently, price increases must be sufficiently high to cover the costs associated with inefficient rural storage. As the marketing season progresses, the rapid rate of price increase in rural zones may push rural prices sufficiently high to cover costs of transport back from urban zones. Only then do rural household begin to enjoy the benefits of moderate price increases associated with urban storage. Consequently, rural consumers reap a relatively small share of the benefits from lower urban interest and storage loss rates.

If interest rate differentials are eliminated and rural households have access to reasonably efficient storage technology, self-sufficient rural regions pay no transport cost at all (abstracting from movements within that region's rural zone) and all rural households benefit from efficient storage immediately. In contrast, regardless of the presence or absence of an interest rate differential, urban households pay transport costs once and benefit immediately from the most efficient storage option. Given this disparity of impacts of dualistic interest rate structures between urban and rural zones, it is not surprising that rural households reap the lionshare (if not all) of the benefits from reduced or eliminated interest rate differentials.

4. Conclusions and Suggestions for Future Research

A mixed complementarity problem approach was applied to a spatial/temporal equilibrium model of maize markets in Mozambique. Relative to traditional optimization approaches, the MCP approach permits examination of the impact of dualistic interest rate structures on maize marketing patterns in a manner which is simple to program and solve. Empirical results indicate that divergences in interest rates and storage loss rates across space have significant impacts on marketing patterns. Reductions in these divergences improve welfare, and these welfare gains tend to accrue primarily to rural inhabitants-- a group that is poor. These results suggest that efforts to improve the efficiency of rural storage should be given priority as opposed to the creation of large, formal sector grain collection centers. The benefits of formal sector grain collection centers tend to be offset in large part by the transport costs necessary to deliver grain to the centers plus accrued interest on these transport costs. This aspect is particularly costly if interest and storage loss rate differentials are sufficiently large to generate incentives to transport to grain storage sites after harvest and then back to productive rural zones later on for consumption.

Farmers, particularly those in distant rural areas, have a natural comparative advantage in storage. However, in Mozambique, high costs of delivering credit to distant zones and rudimentary storage technology in these zones hampers full realization of this natural advantage. In terms of future research, these results highlight the need to study rural credit markets, storage technology, and access to market information. In addition, detailed examination of actual marketing patterns would help in refining analytical approaches and strengthening the empirical basis for parameter values employed. Finally, the role of risk in influencing storage behavior and marketing patterns needs to be examined.

Table 1: Demand and supply quantity and prices for the 1996-97 marketing year.[1]

Province	Location	Demand Quantity Tonnes		Demand Price Mt/Kg		Supply Quantity Tonnes	Supply Price Mt/Kg	Surplus Tonnes
		Rural	Urban	Rural	Urban			
Cabo Delgado	north	70,625	9,505	1,262	1,402	81,000	1,134	870
Niassa	north	47,456	9,158	791	879	163,000	952	106,386
Nampula	north	149,676	39,535	1,257	1,143	101,000	1,338	(88,210)
Zambezia	north	185,732	22,251	1,038	1,153	184,000	1,340	(23,983)
Tete	north	59,065	8,291	850	944	92,000	1,285	24,644
Manica	south	34,183	11,893	1,183	1,314	155,000	1,423	108,924
Sofala	south	63,390	23,102	1,355	1,505	64,000	1,565	(22,492)
Inhambane	south	73,346	8,861	2,761	2,510	65,000	1,781	(17,206)
Gaza	south	74,817	16,127	2,984	2,713	27,000	2,021	(63,944)
Maputo	south	29,260	86,489	2,811	2,555	15,000	2,049	(100,749)
Total	north	512,554	88,739			621,000		19,707
Total	south	274,994	146,473			326,000		(95,467)
Total	all	787,549	235,211			947,000		(75,760)

Table 2: List of simulations.

Case	Description	Parameter Values			
		Interest Rates (% Monthly)		Storage Loss Rates (% Monthly)	
		Urban	Rural	Urban	Rural
Base	Base case.	2.00	3.00	0.50	1.00
Case 1	More efficient rural storage.	2.00	2.00	0.50	0.50
Case 2	More efficient storage.	1.50	2.25	0.33	0.67
Case 3	More efficient urban storage.	1.33	3.00	0.25	1.00

Table 3: Selected simulation results.

		Base	Case 1	Case 2	Case 3
Avg. Price[1]	Mt/Kg	1,829	1,803	1,799	1,815
Avg. Harvest Price	Mt/Kg	1,340	1,377	1,369	1,369
Avg. Harvest Price South	Mt/Kg	1,600	1,662	1,650	1,654
Avg. Harvest Price North	Mt/Kg	1,203	1,228	1,220	1,219
Avg. Rural Price	Mt/Kg	1,782	1,746	1,746	1,769
Avg. Urban Price	Mt/Kg	1,980	1,986	1,967	1,960
Avg. Urban Price South	Mt/Kg	2,216	2,227	2,215	2,210
Avg. Urban Price North	Mt/Kg	1,539	1,536	1,509	1,499
Total Production	Tonne	947,000	957,374	956,063	956,659
Total Demand	Tonne	938,573	949,116	947,591	942,714
Total Exports	Tonne	33,876	39,695	34,477	35,492
Total Imports	Tonne	66,222	62,413	58,052	52,011
Urban Storage May	Tonne	340,367	0	279,623	491,838
Rural Storage May	Tonne	398,815	748,587	470,059	255,745
Transport Cost	Mt 10^9	166.0	149.8	159.5	196.4
Welfare Change from Base	Mt 10^9	0.0	52.8	49.9	37.4

[1]Average prices are calculated by taking a consumption weighted average across all time periods for the relevant regions.

Table 4: Welfare contribution by component – difference from base case (billions of Meticais)

	Case 1	Case 2	Case 3
Area under demand curve	16.4	14.6	7.5
Area under supply curve	-18.0	-15.5	-16.0
Transport Cost	18.3	6.1	-36.9
Storage Cost	22.3	26.4	43.9
Exports – Imports	16.0	18.0	32.4
Total	55.0	49.6	30.9

Table 5: Producer surplus and consumer surplus by zone-- difference from base case (billions of Meticais)

		Case 1	Case 2	Case 3
Producer Surplus		31.6	24.3	25.1
Consumer Surplus	Rural	22.6	23.3	8.6
	Urban	-1.3	2.3	3.7
Total		52.8	49.9	37.4

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Appendix A: Integrability, Welfare, and Differential Discount Rates Across Space

Consider the classic single commodity spatial/temporal equilibrium problem in the optimization form propounded by Harker (1986).

$$\underset{QS_{rt},QD_{rt},TR_{(ijt)},ST_{rt},M_{rt},X_{rt}}{\text{Max}}$$

$$\sum_{t=1}^{T}\left(\frac{1}{(1+\delta)}\right)^{1}\left(\sum_{r\in R}\int_{0}^{QD_{rt}}\Theta_{rt}(s)ds-\sum_{r\in R}\int_{0}^{QS_{rt}}\Psi_{rt}(s)ds-\sum_{(ij)\in W}\int_{0}^{TR_{(ijt)}}tc_{(ij)}(s)ds-\sum_{r\in R}\int_{0}^{ST_{rt}}sc_{rt}(s)ds-\sum_{r\in R}\int_{0}^{M_{rt}}pm(s)ds+\sum_{r\in R}\int_{0}^{X_{rt}}px(s)ds\right)$$

s.t.

$$ST_{rt+1}\leq ST_{rt}-QD_{rt}+QS_{rt}-\sum_{(ri)\in W}TR_{(rit)}+\sum_{(jr)\in W}TR_{(jrt)}-X_{rt}+M_{rt},\quad \forall\ r\in R,\ t\in T$$

$$QD_{rt},QS_{rt},ST_{rt},X_{rt},M_{rt}\geq 0,\quad \forall\ r\in R, t\in T$$

$$TR_{(jit)}\geq 0,\quad \forall\ (ij)\in W$$

$$QS_{rt}=0,\quad \forall\ r\in R^{u}$$

$$QS_{rt}=0,\quad \forall\ r\in R^{r},\ \forall\ t\in T^{*}$$

$$X_{rt},M_{rt}=0,\quad \forall\ t\in T,\ \forall\ r\in R^{*}$$

Note: Storage and transport loss factors have been excluded for simplicity.

where:

Sets

R	set of regions
R^*	set of non-importing/non-exporting regions (a subset of R)
R^r	set of rural regions (a subset of R)
R^u	set of urban regions (a subset of R)
T	set of time periods (1,2,...,T)
T^*	set of non-harvest time periods (a subset of T)
W	set of origin destination pairs

Functions

Θ_{rt}	inverse demand function
Ψ_{rt}	inverse supply function

Variables

QD_{rt}	quantity demanded
QS_{rt}	quantity supplied
TR_{ijt}	quantity transported
ST_{rt}	quantity stocked
X_{rt}	quantity exported
M_{rt}	quantity imported

Parameters

tc_{ij}	total transport cost between regions i and j
sc_{rt}	unit storage cost
δ	discount factor (rate of interest)
px	export price net of loading
pm	import price including unloading and tariffs

Now, consider the partial Lagrangean with respect to strictly positive values for the variables QD, QS, and TR.

$$\frac{\partial L}{\partial QD_{rt}} = \theta_r(QD_{rt}) - \lambda_{rt}(1+\delta)^t = 0$$

$$\frac{\partial L}{\partial QS_{rt}} = \psi_r(QS_{rt}) - \lambda_{rt}(1+\delta)^t = 0$$

$$\frac{\partial L}{\partial TR_{ij}} = -tc_{ij} + (\lambda_{jt} - \lambda_{it})(1+\delta)^t = 0$$

where λ represents the Lagrange multipliers on the storage constraints. The first order condition with respect to QD states that the interest rate inflated value of the Lagrange multiplier on the storage constraints, λ, must satisfy the inverse demand relationship. In other words, $\lambda_{rt}(1+\delta)^t$ equals the market price in period t and region r. The first order condition with respect to QS states that the inverse supply condition must be satisfied. Finally, the first order condition for the transport variable, TR, states that the market price in destination region j must exceed the market price in source region i by the unit cost of transport.

Note the difficulties which arise in this formulation if the discount rate, δ, varies across space. If the discount rate differs between region i and region j, it is not straightforward to specify the price differential relationship in the first order condition on the transport variable TR. In the abstract, one could view the difference in the discount rates between region i and region j as an ad-valorem tax (subsidy) on storage in one of the two regions. Just as an ad-valorem tax on transport destroys integrability in a spatial model, the distortion on storage destroys integrability in a spatial/temporal model.

The inability to integrate the system of equations into a single objective function has implications for welfare analysis. In the non-linear programming Takayama and Judge formulation, the maximand is a measure of welfare in the form of Marshallian surplus. This is the measure of welfare almost invariably used with this type of model. Though not as theoretically rigorous as equivalent or compensating variation, error bound measures on the Marshallian surplus measure as well as empirical experience indicate that this measure is robust and suitable for this analysis (Willig, 1976). With integrability gone, this measure is not available directly. The approach taken here is to calculate, for the equilibrium derived via the MCP formulation, the Takayama and Judge welfare measure which would have prevailed if an iterative optimization approach had been chosen. A constant discount rate of 1% per month was applied. Unit storage costs, sc_{rt}, are then calculated such that the non-linear programming Takayama and Judge formulation yields the same equilibrium as the equilibrium derived via the MCP formulation. This objective is then used as the welfare measure.

B. Appendix B: GAMS/MCP Formulation of the Model

SETS

r,ra	regions
z,za	zones
t	time periods

PARAMETERS

c(r,z,ra,za)	variable road transport cost
c2(r,z,ra,za)	variable coastal ship transport cost
alpha(r,z)	slope of demand function
k1(r,z)	intercept of demand function
beta(r,z,t)	slope of supply function
k2(r,z,t)	intercept of supply function
sloss(z)	monthly storage loss rate
rint(z)	rate of interest
exp	price received for exports
imp	price paid for imports
load1	loading costs for trucks
seaload(r)	loading costs for ship
scost	storage costs
tloss	road transport loss
sealoss	percentage lost at sea

VARIABLES

x1(r,z,t,ra,za)	quantity transported over land
x2(r,z,t,ra,za)	quantity transported via sea
imps(r,z,t)	imports
exps(r,z,t)	exports
dem(r,z,t)	demand
stock(r,z,t)	stocks
price(r,z,t)	price
qs(r,z,t)	production

EQUATIONS

quants(r,z,t)	price quantity relationship in supply
supply(r,z,t)	stock accounting equation
demand(r,z,t)	price quantity relationship in demand
land(r,z,t,ra,za)	land transport condition
sea(r,z,t,ra,za)	sea transport condition

```
store(r,z,t)               storage condition
import(r,z,t)              import condition
export(r,z,t)              export condition
```

Note that individual equations are dropped if the relevant variable is fixed. For example, the equation quants(r,z,t) is only relevant for rural zones in harvest months.

```
quants(r,z,t) .. k2(r,z,t)+beta(r,z,t)*qs(r,z,t)=e=price(r,z,t);

supply(r,z,t).. -dem(r,z,t) + (1-sloss(z))*stock(r,z,t) + qs(r,z,t)
        - stock(r,z,t+1)
        - sum((ra,za),x1(r,z,t,ra,za))
        + sum((ra,za),x1(ra,za,t,r,z))*(1-tloss)
        - sum((ha,za),x2(r,z,t,ha,za))
        + sum((ha,za),x2(ha,za,t-1,r,z)*(1-sealoss))
        - exps(r,z,t) + imps(r,z,t)*(1-sealoss)=g=0;

demand(r,z,t) .. k1(r,z)+alpha(r,z)*dem(r,z,t) =e= price(r,z,t);

land(r,z,t,ra,za) .. c(r,z,ra,za)+load1 =g=
                price(ra,za,t)*(1-tloss)-price(r,z,t);

sea(r,z,t,ra,za) .. c2(r,z,ra,za) + seaload(r) + price(r,z,t) + scost =g=
        price(ra,za,t+1)*(1-sealoss)/(1+rint(z)) ;

store(r,z,t) .. scost + price(r,z,t-1)*(1+rint(z))
                  =g= price(r,z,t)*(1-sloss(z)) ;

export(r,z,t) .. price(r,z,t) =g= exp-seaload(r)/2;

import(r,z,t) .. imp+seaload(r)/2 =g= price(r,z,t)*(1-sealoss);


MODEL spatmcp  base case model

     /quants, demand, land.x1, sea.x2, store.stock, export.exps
          import.imps, supply.price/;
```