# Chapter 12

# Partial Equilibrium Multi-Market Analysis

Jehan Arulpragasam and Patrick Conway

## 12.1. Introduction

This chapter presents a technique that links household incomes and expenditures to changes in a limited number of markets in an economy. Hence, it uses partial equilibrium analysis of changes in prices and quantities in markets affected by a change in economic policies.

Analysts tasked with providing ex ante estimates of the impact of policy reform on the incidence and depth of poverty know that the phrase "ceteris paribus" can be an especially worrisome part of the analysis. The reason is simple: each policy reform has both direct effects and indirect effects on wages, prices and private income. These indirect effects will alter the incidence and depth of changes in poverty due to the policy reform. If the analyst reports estimates of policy effects that are derived for unchanging wages, prices and private income, the estimates will be biased in unknown directions.

There have been two dominant responses to this conundrum in the policy analysis literature, and each is well-represented in this volume. One response has been to create sophisticated computable general equilibrium (CGE) models of the economies in question, with goods and factor markets modeled explicitly and wages, prices and private income determined endogenously– see chapters 13 and 15 in this volume. While these meet the "ceteris paribus" critique head-on, they have large data requirements and are quite involved to develop. The second response has been to assume away the indirect effects through benefit incidence studies of the direct effect in isolation – to take "ceteris paribus" literally. This has the advantages of simplicity and relatively small data demands, but retains the disadvantage – of unknown size – of assuming away potentially large indirect effects.

Multi-market models are intermediate responses to this conundrum. Whether they are called "limited general equilibrium" as in Mosley (1999) or "multi-market partial equilibrium" as in Arulpragasam (1994), they focus the analysis on the combination of direct effects and indirect

effects through price and quantity changes in a small group of commodities or factors with strong interlinked supply and demand. They are most appropriate for the evaluation of policies that change the relative price of a specific good -- for example, the removal of a subsidy or the elimination of a tariff or quota. The indirect effects explicitly modeled are those due to relative price-responsiveness of demand and supply in markets for substitute goods.

These models are improvements over the benefit –incidence studies: the indirect effects of the policy reform on poverty are explicitly traced through the supply and demand responses for substitute and complement goods. In this regard, by endogenizing prices through the equating of supply and demand in key markets, this approach goes a step beyond standard benefit incidence analysis that sets elasticities to zero. They fall short of the general-equilibrium models: the impacts of policy reform on government budgets and on prices and quantities outside the group explicitly considered are treated as unchanged. In short, “ceteris paribus” is relaxed, but not eliminated, in the analysis. This class of models will be most useful in analysis when the policy reform under consideration is targeted to one commodity or factor for which there is a well-defined set of close substitutes or complements.

## 12.2. The technique

The use of multi-market models in the economic-development context can probably be traced to the estimation of agricultural household models in the 1980s. These were integrated models of production and consumption of multiple crops by agricultural households, and were estimated econometrically on agricultural sector surveys. The multi-market models of the 1980s, as for example in the World Bank-sponsored research of A. Braverman and J. Hammer, expanded this basis to include non-agricultural demands for these crops and a definition of market equilibrium for each crop. While the treatment of the non-agricultural actors in the economy was rudimentary at first, the growing availability of Living Standards Measurement Surveys has made accurate modeling possible in both agricultural and non-agricultural sectors. Sadoulet and de Janvry (1995, chapter 11) provides an introduction to this technique. They also compare the data requirements and computational difficulty of multi-market models to both agricultural household and CGE models.

Multi-market models have grown markedly in detail and sophistication since those early efforts. The early analyses focused upon the substitution effects among a small number of agricultural products in household demand in response to relative price changes, using demand and supply elasticities culled from others’ work. The more recent analyses (as in Dorosh et al. (1995) and

Minot and Goletti (1999)) have introduced market-clearing conditions in a greater number of goods, sophisticated econometric estimation of demand and supply parameters, and an explicit consideration of the link between policy reform and poverty. These more recent analyses have also gone beyond reform of a price-based policy to consider quantity restrictions in markets, technological improvements, and internal trading restrictions. The spatial multi-market analysis of Minot and Goletti (1999) extends the concept of markets to include arbitrage conditions in individual goods across geographic regions, thus admitting the possibility of partially integrated markets in a single commodity.

With a multi-market model, the analyst expands traditional benefit incidence analysis to capture the induced substitution effects across selected goods in response to policy reform. There is a four-step procedure:

**Step 1:** The analyst begins with the policy reform to be evaluated. She identifies the market (or markets) in which this policy reform will have its direct effect. She also identifies (through data examination, survey of experts, or other prior knowledge) those markets strongly interlinked in demand or supply with the markets in which the direct effect is measured.

**Step 2:** Household survey information is used to derive estimates of income, own-price and cross-price elasticities of demand for the entire set of interlinked markets. Producer survey information is used to derive estimates of own-price and cross-price elasticities of supply for the set of interlinked markets. These estimates are combined to create a system of demand and supply functions.

**Step 3:** Market closure (either price or quantity-clearing) is imposed for each good in the system of equations. This closure is made consistent with the observed macroeconomic outcomes through requiring the resulting equilibrium to duplicate international relative prices and trade flows in each good and other national statistics for the base year chosen. The impact of the policy reform in this system of equations is then calculated by introducing the desired policy change. Relative prices and quantities produced and consumed domestically are derived for this new equilibrium.

**Step 4:** The derived relative prices and quantities are combined with household survey information, in which households can be consumers and producers, to determine the marginal impact of the policy reform on the incidence and depth of poverty.

### 12.3. Data requirements for the technique

The data requirements for a multi-market analysis of the impact of policy reform can be thought of as an extension of the data requirement for standard incidence analysis.

- A disaggregated set of data on income or consumption distribution across households to measure the incidence and depth of poverty: aAlso, a defined poverty line. These are common to all policy-evaluation measures in this volume.

- Complete parameterization for supply and demand functions in the market directly affected by policy reform. Also, supply and demand functions for goods in which strong interlinkages to the "direct" market are conjectured or known to exist. Also necessary are the relative prices of the goods and the quantities imported and exported at any relative price – these may be exogenous (as for some prices of tradeable goods) or endogenously determined (as for the prices of non-traded goods or labor).

- A determination of the closures of the markets being modeled. For example, are they traded or non-traded goods? Is rationing a feature of equilibrium? This determination is used to build market equilibrium conditions from the supply and demand functions. This requires aggregated data for the relevant factors and commodities.

- Software to solve a system of potentially non-linear equations for the endogenous prices and quantities.

- A quantitative mapping of these endogenous variables into the income and consumption of households.

It will be rare to find all these data requirements in place for the country and policy reform under study. In that case, the researcher must devote time to the development of these components. The critical difference in practice between this approach and other approaches is the complete specification of the supply and demand behavior and the characteristics of market equilibrium for all the goods or factors closely interlinked with the market in which reform occurs. Those researchers with interest in an illustrative calibration of such interlinkages could construct the supply and demand functions using parameters found in research on similar countries: for these, the entire exercise could require less than a week's effort. For those researchers with an interest in more precise quantitative measurement, analysis of supply and demand behavior will require a detailed dataset on prices, quantities produced and consumed and inputs into production for each

of the interlinked goods. These data can then be analyzed through systems estimation to derive the appropriate supply and demand functions. This will typically require months of research effort. The "best practice" case studies by Dorosh, del Ninno and Sahn (1995) and Minot and Goletti (1998) illustrate the application of this more accurate approach. The greater time commitment leads to greater confidence in the results of the study, but as Sadoulet and de Janvry (1995) note, even the most rudimentary multi-market analysis performs a consistency check that is not available from other partial-equilibrium models.

There is no theoretical limit on the number of interlinked goods or factors that can be considered in a multi-market model. However, the practical data requirements in terms of accurate supply and demand conditions for each interlinked good place an upper bound on the number of simultaneously estimated functions. Analyses of agricultural-market reforms have introduced the largest multi-market models, and these have typically included no more than ten closely substitutable foodstuffs. As institutional complexities (e.g., regionally distinct markets) are introduced, researchers have generally narrowed the number of interlinked goods or factors considered. Ultimately, it also needs to be recognized that there is a trade-off between the complexity of a more comprehensive system of equations with more inter-linked markets and that of expositional simplicity, focused on capturing the main indirect effects of most relevant inter-linked markets. Indeed one of the strengths of multi-market models are their potential simplicity as expositional tools upon which to base policy dialogue.

Arulpragasam *et al.* [2002] are working on a generic multi-market template that can be re-parameterized quickly for analysis on various countries. This promises to capture some of the economies of scale for future users, and may reduce the time commitment to such a study to a matter of weeks. *<Luiz, Should we leave this. Again, this refers to a future product! >*

The advantages and disadvantages of multi-market analysis will be examined in more detail below but are evident from the simple example in Box 12.1 below. The key advantage is the ability to include the interlinked nature of markets in policy evaluation: here, recognition that meat and bread are substitute goods corrects a bias in attributing poverty increases to remo_val of the subsidy. The disadvantage of multi-market analysis is the exclusion, or assumption of "ceteris paribus", of the remaining markets. In this case, the price in the housing market is treated as unchanging in the multi-market analysis. The full-system analysis endogenizes the price in the housing market as well, and it is in this case quite responsive to the policy reform. Holding $P_H$ constant leaves biases in policy evaluation, although these biases are less pronounced as price

elasticities of demand approach zero.[1] Also ignored are the impact on the government budget and upon the external account of the economy.

[1] It appears from the change in the poverty measure from multi-market analysis to full system analysis that the bias is minimal. In fact, this is an artifact of the calculation of the consumption basket for each individual. Given the $P_H$ assumed in the multi-market analysis, $X_H$ = 2283 and aggregate demand as given by equation (4) is $C_H$ = 2417. There will be excess demand for the non-traded housing good at that price. If a proportional rationing rule were imposed on all consumers, those below the poverty line would rise from 37 to 39.

**Box 12.1: A Simple Application of the Multi-Market Model**

Critical components in a multi-market model's application to the incidence of policy reform on poverty are (a) a description of the current income distribution, (b) a description of the supply characteristics for the goods produced in the interlinked markets, (c) a description of the preferences for those represented in the income distribution, (d) definition of market-clearing conditions and (e) a proposed policy reform. To illustrate the technique, consider the following simple economy.

- Current income distribution: There are 100 individuals in the economy, and they have integer values of real income ranging from 11 to 110 real pesos. The poverty line is defined in consumption terms: an individual falls below the poverty line if $(M^{.2}B^{.4}H^{.4}) < 50$.

- Production characteristics: There are three goods produced and consumed: meat (M), bread (B) and housing (H). Bread is produced domestically, and also imported. Meat and housing are produced domestically and are non-traded goods. Each producer is assumed to have a non-zero supply elasticity $\sigma_i$ (for i = M, B, H). The exchange rate is set equal to one as a normalization and there is an ad valorem subsidy (s) to bread consumption, so that $P^B = (1\text{-}s)P^{B*}$ where $P^{B*}$ is the international price. Scaling factors are chosen to calibrate the model:

(1) $M^s = 1247 \cdot P_M^{\sigma_M}$ ~~Pmσ~~

(2) $B^s = 572\, P_B^{\sigma_B}$ ~~Pbσ~~

(3) $H^s = 1213\, P_H^{\sigma_H}$ ~~PHσ~~

- All individuals k in the economy are assumed to have identical preferences over the three goods. These are summarized in the Almost Ideal Demand System of Deaton and Muellbauer (1980) as shares ($W_i$) of total expenditure. $X_k$ is the nominal ~~wealth~~ income of individual k. P is the appropriate consumption-weighted price index of the three consumer goods. Appropriate cross-equation restrictions on the $\alpha_i$, $\beta_i$, and $\gamma_{ji}$ are imposed.

(4) $W_{ik} = \alpha_i + \Sigma_j \gamma_{ji} \ln(P_j) + \beta_i \ln (X_k/P)$ for i, j = M, B, H

- The markets for these three goods are governed by market-clearing conditions.

(5) $M^s = \Sigma_k W_{Mk} X_k / P_M$
(6) $B^s = \Sigma_k W_{Bk} X_k / P_B + IM_B$
(7) $H^s = \Sigma_k W_{hk} X_k / P_H$

with imports of bread ($IM_B$) clearing the market of this traded good, and price adjusting in the other two markets. In addition to the income distribution and poverty line, then, the analyst will need estimates of $\sigma_i$, $\alpha_i$, $\beta_i$, and $\gamma_{ji}$. Equations (5), (6) and (7) are solved for $P_M$, $P_H$ and $IM_B$ as functions of s.

- The policy reform in this example will be to shift the consumption subsidy s to zero.

The table below summarizes the results of this exercise for one set of parameters characterized by rather large own- and cross-elasticities in price between bread and the other two goods (*)

---

(*) The parameter values chosen are $\alpha_M = .2$, $\alpha_B = .4$, $\alpha_H = .4$, $\beta_M = .05$, $\beta_B = 0$, $\beta_H = -.05$, $\gamma_{MM} = \gamma_{HH} = -.2$, $\gamma_{BB} = -.28$, $\gamma_{MB} = \gamma_{BM} = .14$, $\gamma_{MH} = \gamma_{HM} = .06$, $\gamma_{BH} = \gamma_{HB} = .14$. These values are consistent with a bread

**Box 12.1 (cont'ed)**

Table Box 12.1

| | Initial equilibrium | Single-market analysis | Multi-market analysis | Full system analysis |
|---|---|---|---|---|
| $P_B$ | 7 | 8 | 8 | 8 |
| $P_M$ | 8.25 | 8.25 | 8.75 | 8.87 |
| $P_H$ | 8.24 | 8.24 | 8.24 | 8.86 |
| $X_M$ | 2348 | 2348 | 2390 | 2401 |
| $X_B$ | 1026 | 1068 | 1068 | 1068 |
| $X_H$ | 2283 | 2283 | 2283 | 2334 |
| $IM_B$ | 392.6 | 124.4 | 174.2 | 247.6 |
| **Number below poverty line** | 36 | 43 | 37 | 37 |

The initial equilibrium is characterized by a 12.5 percent subsidy in bread, with endogenous values given in the first column. Bread is imported in that equilibrium. Meat and housing prices adjust to clear their respective markets. Of the 100 people in the economy, 36 have afforded consumption bundles below the poverty line. If the bread subsidy is removed but other prices are assumed unchanging, the results of the single-market analysis of column two are derived. Bread is exported, and 43 of the population fall below the poverty line. A multi-market analysis can be represented by a modeling exercise that investigates the impact of removing the subsidy while allowing the price of meat to clear its market – but ignoring the market-clearing condition for housing. As is evident in the third column, the impact on poverty is smaller: the spillover effect of bread price increases in the meat market leads to higher $P_M$ and a supply response in that market as well. Of the population, 37 fall below the poverty line in this exercise. In the final column the results are reported if both meat and housing markets are required to clear. Note that all prices rise in this case relative to the initial equilibrium, and all production rises as well.

## 12.4. Application ~~of the technique~~: three examples of use of multi-market modeling.

*a) Three case studies*

The three studies cited below illustrate the application of multi-market analysis, and also the evolution of the use of this technique in the literature. The basic concept has not changed: there are always consistency conditions in interlinked markets that determine endogenously relative prices and quantities. The change over time has come in the focus of analysis – from government expenditure to the incidence of poverty – in the sophistication of estimation

techniques for the parameters of the model and in the complexity of the market closure conditions imposed.

Braverman, Hammer and Gron (1986) note that in Cyprus in 1985 the government sold barley as a feedstock for the livestock sector. The sales price to the livestock sector was 49 percent of the price on world markets for barley. The government justified this subsidy by noting its indirect effect in reducing consumer prices of foodstuffs. The authors consider the impact of removing this subsidy to barley on Cypriot welfare.

The authors construct equilibrium conditions for markets in beef, fresh lamb, frozen lamb, milk, pork, poultry, wheat, barley and hay. They obtain estimates of own-price and cross-price elasticities of demand from agricultural sector surveys, and infer estimates of supply elasticities from studies for neighboring countries. By equating supply and demand, they calculate the percentage change in relative prices in the agricultural sector and the supply responses predicted for a one-percent reduction in the barley subsidy.

The authors do not examine the incidence of poverty. They examine the budgetary saving associated with a reduction in the barley subsidy. The authors conclude that if the analysis is limited to the market for barley, then there will be budgetary savings of 1.21 percent for every one percent reduction in per-unit subsidy. However, once the interlinked markets are considered, the budgetary savings shrink to 1.02 percent for every one percent reduction. While still sizeable, the quantitative impact is greatly altered by the consideration of interlinked markets.

Dorosh, del Ninno and Sahn (1995) examines the impact of food aid on the incidence of poverty in Mozambique. The proposal is to increase the sale of donated foreign yellow maize at below-world price in the markets of the capital, Maputo. This is anticipated to have a direct positive effect in reducing poverty, due to the expected reduction to urban residents in the cost of purchasing the poverty-line bundle of commodities and services. The authors also anticipate that there could be negative consequences from the policy through impoverishing the rural small-holders producing agricultural substitutes for the yellow maize.

The key indirect effects of the policy work through the channels of consumer substitution among foodstuffs and supply responsiveness in domestic agriculturalists. The authors thus build a multi-market model of the food sector of Mozambique. Demand functions for yellow maize, white maize, rice, wheat, meat and vegetables are derived from a theoretically consistent preference ordering. The parameters of the demand system are estimated using data from a survey of households in Maputo. These estimated demand functions are equated to supply functions to

determine endogenously the quantities produced domestically and the quantity imported/exported (for traded goods) or the quantities produced domestically and the market price (for non-traded goods). These effects, both direct and indirect, are then incorporated in a simulation study to determine the impact of the yellow maize distribution on the incidence and depth of poverty.

The multi-market structure of the study provides important information to the ex ante evaluation of the food-aid policy. Most critical is the finding that yellow maize is (1) not a close substitute in demand for any of the other foodstuffs, and (2) an inferior good for the more affluent urban residents, while a normal good with small income elasticity for the poor. These features of the Maputo consumer ensure that the negative indirect effects of the food-aid program are minimal. The authors find that a 15 percent increase in food-aid sales in Maputo will raise the real incomes of the urban poor by 3.6 percent. The incomes of the urban non-poor rise only slightly, while the incomes of the rural residents fall slightly. Using a caloric-intake poverty line, the authors find that the number of households below the poverty lines falls from 34 percent to 23 percent.

This study illustrates both the advantages (relative to incidence analysis) and drawbacks (relative to general-equilibrium modeling) of the multi-market approach. The striking advantage is the explicit attention to the potential for poverty effects through interlinked markets. While an incidence analysis will simply assume that there are no substitute foodstuffs for yellow maize, this study investigated the possibility systematically. The striking drawback is the lack of attention to alternative uses of scarce government funds or foreign aid. A general-equilibrium model will consider those resources as fungible, so that the benefits from the food-aid program could be weighed against the opportunity cost of the scarce aid resources..

Minot and Goletti (1998) notes that a binding export quota on rice in Vietnam in the mid-1990s had the effect of subsidizing domestic consumption of rice. They estimate that the quota led to roughly 30 percent subsidy to consumers, and address the impact of removal of such a subsidy on the incidence of poverty in Vietnam. They consider a multi-market analysis with four commodities (rice, maize, sweet potatoes and cassava) modeled explicitly. They also introduce an important innovation – they allow regional disparities in prices through explicit modeling of transport costs for the foodstuffs. The demand interlinkages among markets are represented by the cross-price elasticities of the Almost Ideal Demand System of Deaton and Muellbauer (1980), with parameters of the demand system estimated using household survey data. The supply decision for each region for each foodstuff is assumed to respond to both own-price and cross-price effects, and the parameters of the supply functions are derived from separate analysis by Khiem and Pingali (1995). Welfare is measured through use of a net benefit metric as in Deaton

(1989b), with disaggregation by household category (urban/ rural or quintile of the income distribution) and by region of the country.

The authors begin with the presumption that those households with net sales of rice (i.e., production by the household exceeds the consumption of the household) will be made better off by an increase in rice price, while those with net purchases will be disadvantaged. They reach a paradoxical conclusion: "less than a third of the households in Vietnam have net sales of rice, and yet the rice price increases associated with export liberalization tend to reduce (slightly) the incidence and depth of poverty." (p. 745) One reason is straightforward : those households with net sales of rice are disproportionately found among the poor. The second reason relies upon the interlinkages captured in the multi-market model: the ability to substitute demand away from the higher-priced rice to substitute foodstuffs provides households with the opportunity to avoid poverty.

The advantage of the multi-market modeling approach is evident in the second effect: the demand substitution effect will not be measured if a multi-market analysis is not done. The disadvantage can only be inferred: there is no attention given to the impact of the policy on decisions in labor or credit markets, for example, nor is there consideration of the impact of the policy on the government budget or external balances.

*b) Operational Hints*

Consider a simple example, expanding upon the description of demand for foodstuffs in Cote d'Ivoire from Deaton (1989a). Suppose that the government provides a subsidy to rice consumption: it buys rice at the world market price, and then provides it to consumers at a lower price. It absorbs the difference into its budget deficit. Domestic producers provide some of the rice, but the remainder is imported. Through the subsidy, some of those otherwise below the poverty line are raised above that line.

Removal of the rice subsidy will certainly affect the depth and incidence of poverty. There are clear direct effects on those above the poverty line who must pay more for rice: these will, ceteris paribus, drop into poverty. Those already below the poverty line will sink further, increasing the depth of poverty.

This calculation will be an overstatement of the negative policy impact, however, if agricultural commodity markets are interlinked. Removal of the subsidy will raise the consumer price of rice, and will thus encourage substitution of yams or cassava in the diet. The demand substitution will

lessen the welfare impact of the rice price increase, while the resulting increase in prices of substitute goods will induce a supply response among agriculturalists producing these substitute foodstuffs. The consumer's ability to remain above the poverty line is enhanced by this substitution, while the increased prices of substitute foodstuffs will raise incomes of agriculturalists and perhaps reduce poverty in that cohort.

The analyst in this instance runs through four steps:

1) The policy reform will have its direct impact in the domestic market for rice. However, since rice consumption is potentially substitutable for yams, cassava and other starches, it will be important to model the indirect impacts of policy reform in those markets as well. She can determine whether or not many markets are important to the analysis through estimation of a system of demand equations from household survey data. If cross-elasticities of demand or supply are significant, then the added complexity will be worthwhile.

2) The analyst will build a model of these interlinked agricultural markets through a series of market equilibrium conditions. There will be one for each good included: here it will include rice, yams and cassava. The estimates from systems estimation of demand and supply behavior can be used, or the analyst can use her own judgment or evidence from other countries to proxy for the unknown behavioral parameters. While it is common to model these as neoclassical flexible-price markets, there are also techniques available for handling multi-market disequilibrium models.

3) The rice subsidy will be a parameter in this system of equations. The analyst will then remove the subsidy (i.e., change it to zero) and resolve the system of interlinked equations. The resulting solution will provide estimates of the relative prices of rice, yams and cassava as well as the quantities supplied and demanded in equilibrium. These equilibrium values will reflect both direct and indirect effects of the policy reform.

4) The analyst already has a definition of the poverty line and a representative sample of households for which the incidence and depth of poverty can be calculated. She will introduce this new set of equilibrium values into the sample, and recalculate the poverty line and the distribution of households relative to that poverty line based upon the new equilibrium values. the substitution away from rice in this example could indeed fall on non-foodstuffs. If so, and if the analyst has defined the poverty line in caloric terms, then the cost of the market basket that satisfies the poverty line could well rise with the reform.

The change in the number of households falling below the poverty line and the changed depth of poverty for those below will be the ex ante forecast of the marginal impact of removing the rice subsidy.

### 12.5. Conclusions and evaluation ~~of the technique~~

Multi-market analysis as applied in the literature has been an effective tool for ex ante analysis of policy reforms that involve changing the relative price of a good in the economy. It is preferred to incidence analysis or to single-market analysis in cases when the good directly affected by the reform is a close substitute or complement, either on demand or supply side, with other goods. The transmission of the effects of the policy through these other markets will then be an important component of policy evaluation.

The most impressive examples of the technique are currently found in analyzing policy reforms to agricultural pricing or consumer subsidies. This is a natural application of the technique, as agricultural goods are substitutes both in household consumption and in farm land allocation. Poverty lines are also sensitive to prices of agricultural products, with some poverty lines defined explicitly in term of calories consumed. Policy choices that result in changing food prices, whether through elimination of consumer subsidies or provision of food aid, will be naturally modeled in this framework.

The technique can be compared either to ex ante incidence analysis or to CGE modeling. Relative to incidence analysis, multi-market modeling offers the greater precision of accounting for interlinked markets. It also permits analyzing situations where price changes are non-marginal and the first order approximation used in tax-incidence analysis –see chapter 1 - is grossly unsatisfactory. -B~~b~~ut multi-market modeling has the additional data cost of requiring knowledge of supply and demand functions in the interlinked markets. Relative to CGE modeling, multi-market modeling is more transparent in application and has less-demanding data requirements but neglects the inter-linkages from the highlighted markets to all others, both through cross-price substitution and through budget and external account balances.

While the technique has been most carefully developed in agricultural-sector models, its potential application is much wider. One application is suggested by Mosley (1999) in his analysis of the impact of financial liberalization on formal and informal credit markets. He discusses the interlinked nature of the formal and informal credit markets and the participation in each by the

poor. If he were to model explicitly the supply and demand for credit in each market, he could then provide an analysis similar to those cited earlier. The policy reform in this instance is the change in the real interest rate on formal-sector credit. As has been evident since Buffie (1984) and van Wijnbergen (1983), the interaction of the formal-sector credit rate with the rate on informal credit markets is central to the effect of the policy reform on real incomes. Explicit consideration of this inter-linkage will improve the standard incidence analysis of financial liberalization reforms. Another application could be to evaluate the effect of removal of a formal-sector minimum wage in the presence of a large informal labor market. The interlinked nature of these markets implies that evaluation of policy reform should model the spillovers explicitly.

To have confidence in the results of multi-market modeling, two sets of parameters must be estimated with precision.

- The parameters of the demand and supply functions for the goods explicitly modeled.
- The parameters of the mapping from relative prices of these goods to the consumption or real income index to be compared to the poverty line.

The greatest confidence will of course come from econometric estimation on household and producer surveys for the country under consideration. Estimation can be either parametric or non-parametric, and can be based on either linear or non-linear supply and demand functions. If the data are not available for such econometric work, or if an initial analysis needs to be completed under severe time pressure, it is also possible (although with less confidence) to use parameters derived for supply and demand in other countries. Clearly, such a short-cut would circumvent the micro-level data and analysis requirements otherwise necessary to undertake this approach. The sole requirement is that the estimation, modeling or borrowing yields an explicit quantitative prediction for quantities demanded and supplied that can be used in imposing a market-clearing closure. The resulting relative prices are then used with the consumption index to derive the incidence and depth of poverty.

It is also prudent for the analyst to conduct a sensitivity analysis of the results for different values of these parameters. Estimation will define confidence bounds of the coefficients, and these bounds can be used to define alternate values for sensitivity analysis. If there is no estimation to guide the analyst, substantial changes to parameters should be introduced. The goal is to observe whether the policy evaluation is sensitive to the specific parameters estimated (or chosen).

## 12.6. References

Arulpragasam, J. and C. del Ninno: "Do Cheap Imports Harm the Poor? Rural-Urban Tradeoffs in Guinea", chapter 13 in D. Sahn, ed.: Economic Reform and the Poor in Africa. Oxford, UK: Oxford University Press, 1996.

Arulpragasam, J. and D. Sahn: Economic Transition in Guinea: Implications for Growth and Poverty. New York, NY: New York University Press, 1997.

Braverman, A. and J. Hammer: "Multimarket Analysis of Agricultural Pricing Policies in Senegal", in I. Singh, L. Squire and J. Strauss, eds.: Agricultural Household Models: Extensions, Applications and Policy. Baltimore, MD: Johns Hopkins University Press, 1986.

Braverman, A., J. Hammer and A. Gron: "Multimarket Analysis of Agricultural Price Policies in an Operational Context: The Case of Cyprus", World Bank Economic Review 1 / 2, 1987, pp. 337-356.

Buffie, E.: "Financial Repression, the New Structuralists, and Stabilization Policy in Semi-Industrialized Countries", Journal of Development Economics 14, 1984.

Deaton, A.: "Household Survey Data and Pricing Policies in Developing Countries", World Bank Economic Review 3/2, 1989a, pp. 183-210.

Deaton, A.: "Rice Prices and Income Distribution in Thailand: A Non-Parametric Analysis", Economic Journal 99, 1989b, pp. 1-37.

Deaton, A. and J. Muellbauer: "An Almost Ideal Demand System", American Economic Review 70/3, 1980, pp. 312-326.

Dorosh, P., C. del Ninno and D. Sahn: "Poverty Alleviation in Mozambique: a multi-market analysis of the role of food aid", Agricultural Economics 13, 1995, pp. 89-99.

Goletti, F., K. Rich, and C. Wheatley (2001). "The Cassava Starch Industry in Viet Nam: Can Small Firms Survive and Prosper?" International Food and Agribusiness Management Review 2 (3/4).

Khiem, N. and P. Pingali: "Supply Response of Rice and Three Foodcrops in Vietnam", in G. Denning and V. Xuan, eds.: Vietnam and IRRI: A Partnership in Rice Research. IRRI: Manila, 1995.

Laroque, G. and B. Salanie: "Estimation of Multi□Market Fix□Price Models: An Application of Pseudo Maximum Likelihood Methods", Econometrica 57/4, 1989, pp. 831□860.

Mills, B. and D. Sahn: "Life after Public Sector Job Loss in Guinea", chapter 7 in D. Sahn, ed.: Economic Reform and the Poor in Africa. Oxford, UK: Oxford University Press, 1996.

Minot, N. and F. Goletti: "Export Liberalization and Household Welfare: The Case of Rice in Vietnam", American Journal of Agricultural Economics 80/3, 1998, pp. 738-749.

Mosley, P. "Micro-Macro Linkages in Financial Markets: the Impact of Financial Liberalization on Access to Rural Credit in Four African Countries", Finance and Development Research Programme Working Paper 4, University of Manchester (UK), 1999.

Omoregie, E. M. and Thomson, K.(2001). "Measuring Regional Competitiveness in Oilseeds Production and Processing in Nigeria: A Spatial Equilibrium Modelling Approach," Agricultural Economics 26 (3): 281-294.

Quizón, J. and H. Binswanger: "Modeling the Impact of Agricultural Growth and Government Policy on Income Distribution in India", World Bank Economic Review 1/1, 1986, pp. 103-148.

Sadoulet, E. and A. de Janvry: Quantitative Development Policy Analysis. Baltimore, MD: The Johns Hopkins University Press, 1995.

Sahn, D., ed.: Adjusting to Policy Failure in African Economies. Ithaca, NY: Cornell University Press, 1994.

Singh, I., L. Squire and J. Strauss: "A Survey of Agricultural Household Models: Recent Findings and Policy Implications", World Bank Economic Review 1/1, 1986, pp. 149-180.

Van Wijnbergen, S.: "Credit Policy, Inflation and Growth in a Financially Repressed Economy", Journal of Development Economics 13, 1983.