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Empirical Tests of Impacts of Rationing: The Case of Poland in Transition

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Abstract
This study tests the theory of rationing, examining changes in household consumption behavior during the transition to a market economy in Poland, 1987-92. Using pre-reform data from the Polish Household Budget Survey, Huffman and Johnson develop a model of consumption under rationing and derive virtual prices for food and housing. A pre-reform Almost Ideal Demand System (AIDS) model with rationing is then used to estimate plausible values for price and income elasticities. Comparing pre-reform and post-reform (without rationing) AIDS models shows that own-price elasticities for nonrational goods are larger after the reform, and there is increased complementarity and decreased substitutability for nonrationed goods. This comparison also shows a 75 percent decline in real household welfare over the transition to a market economy.

Keywords
AIDS model, Hicksian, Poland, rationing, transition

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Abstract

This study tests the theory of rationing, examining changes in household consumption behavior during the transition to a market economy in Poland, 1987–92. A model of consumption under rationing is developed and fitted to prereform quarterly data from the Polish Household Budget Survey. Virtual prices, prices at which consumers would have voluntarily chosen the rationed levels of goods, are derived for food and housing. The prereform Almost Ideal Demand System (AIDS) model with rationing is estimated. Estimates from the virtual AIDS yield plausible values for price and income elasticities. The AIDS model (without rationing) is also fitted to postreform quarterly household survey data for comparison and evaluation. When the two sets of results are compared, the impacts of rationing are consistent with the theory. Own-price elasticities for nonrationed goods are larger after the reform, and there is increased complementarity and decreased substitutability for the nonrationed goods. The results for Poland show a 75 percent decline in real household welfare over the transition and this welfare loss is one-third the value obtained using reported prices.

Key words: AIDS model, Hicksian, Poland, rationing, transition

EMPIRICAL TESTS OF IMPACTS OF RATIONING: THE CASE OF POLAND IN TRANSITION

Introduction

Under the centrally planned systems in the Central and Eastern European nations (in Poland, for example), many consumer goods were rationed. Available goods with artificially low prices were frequently allocated through waiting time in long queues and through waiting lists. Consumer goods ranging from necessities, such as housing, to luxuries, such as cars, were rationed or in short supply. Consumers could not buy the desired quantities of goods at the government-controlled prices. Podkaminer (1982, 1986, 1988) has documented these distortions in relative prices for Poland. The observed food shortages were caused in part by the spillovers from other markets of rationed but underpriced goods and services. Rationing may have led to increased demand for the goods that could be purchased freely, because consumers spent less than desired on the rationed goods. According to the World Bank, rationing of meat resulted in free market prices three to four times higher than the official prices in state shops in Poland during 1988 and 1989 (Atkinson and Micklewright 1992). Consumption subsidies represented about 11 percent of the gross domestic product (GDP) for 1987, including 3.4 percent for food, 2.9 percent for housing, 1.6 percent for transport, 1.3 percent for energy, and 0.9 percent for health and medicine (World Bank 1989).

During the period of transition, the supply and demand for consumer goods changed. Price and trade liberalization led to an improvement in the range and quality of available goods and services. Some of the expected benefits of freeing prices appeared quickly. For example, queues for the basic foodstuffs disappeared. How did households adjust their behavior when the opportunity sets of consumption goods changed? The consequences of removing non-price rationing for demands of food and other goods and services affected household consumption patterns and consumer welfare. Policies to compensate the particularly the disadvantaged for the costs of economic adjustment were put into place. All of these transition policies could have

benefited from a more complete understanding of consumer demand parameters and more reliable estimates of changes in the cost of living. Our analysis shows that these improved capacities for understanding consumer behavior are easily obtained for transition economies and that they can make a real difference in the assessment of the effects of reforms and in appropriate policy responses. Finally, little empirical evidence exists for price elasticities for transition economies that adequately reflect the choice environment.

A model of consumption under rationing is developed where household maximizes utility subject to budget and ration constraint. Following Neary and Roberts (1980) the main theoretical results under rationing are derived: rationing reduces the responsiveness of the demand for any nonrationed good to its own price, and increases in the rationed good decrease the demand for substitutes and increase the demand for complements. This study tests these hypotheses empirically using data for Polish households during the transition. Demand systems incorporating rationing effects before the reform using virtual prices and after the reform without rationing are estimated. Finally, welfare implications are developed to determine whether the consumers are better- or worse-off after the transformation from a centrally planned economy.

Rationing and Economic Transition

Research on quantity rationing has been primarily concerned with how the demands for nonrationed market goods were affected by the rationing. Tobin and Houthakker (1951) described how rationing a market good could create a short-run disequilibrium for a related Hicksian composite good. Neary and Roberts (1980) extended the work of Tobin and Houthakker (1951) deriving the properties of the demand systems under rationing and compared them to these without rationing. Specifically, Neary and Roberts (1980) used a virtual price framework to characterize consumption demand under rationing and derived the Slutsky equation analogue for a change in the rationing of a good. Led by Deaton and Muellbauer (1980a), empirical studies have followed for the developed and socialist economies. Deaton (1981) presented a technique for generating rationed from nonrationed demands and applied it to extended versions of the Linear Expenditure System (LES) and the Almost Ideal Demand System (AIDS). Wang and Chern (1992) used this method to estimate a complete demand system for China, incorporating rationing. Bettendorf and Barten (1995) refined the virtual

prices approach and applied Neary and Robert's (1980) model for rent controls. To date, however, no applications have focused on transition economies and the power of the virtual price approach to better define welfare and consumption pattern changes in these periods of major economic change.

Poland was the first Central and Eastern European nation to reestablish a market economy. The economic and political transformation in Poland commenced at the beginning of 1990. The goals of the first market-determined reform package were macroeconomic stabilization, rapid price liberalization, and a sharp reduction of subsidies. Economic growth resumed in 1992 when the economy started to rebound, spurred by the rapid expansion of a private sector that accounted for more than half of the GDP by 1994 (Strong et al. 1996). Economic growth has continued in Poland since 1992. Rates of unemployment have decreased, and average real wages have increased during the postreform period. Therefore, transition in Poland presents a particularly interesting case for behavior of households during transition, because the periods of adjustment and recovery were relatively short in duration—to an extent limiting the impacts of confounding events.

Demand Systems with Rationing

If there are limitations on the availability of goods and services, the household maximizes utility subject to both budget and ration constraints:

$$\max._{x1,x2} \quad \Phi = U(x_1, x_2)$$

subject to

$$p_1x_1 + p_2x_2 \leq I$$

$$\text{and} \quad x_1 \leq X_1, \tag{1}$$

where U is a strictly quasi-concave utility function; x_1 is a vector of quantities of rationed goods and services; x_2 is a vector of quantities of nonrationed goods and services; p_1 is the vector of prices for x_1; p_2 is the vector of prices for x_2; X_1 is a vector of ration levels for goods and services x_1; and I is household total expenditure. In this model we assume that the rationing constraints the household encounters are entirely beyond its influence.

From the duality theory this utility maximization problem can be solved by minimizing the following cost function,

$$C^R(U_0,p_1,p_2,X_1) = \min_{x2} \{p_1X_1 + p_2x_2 \text{ st. } U(X_1, x_2) \geq U_0\}$$
$$= p_1X_1 + \min_{x2} \{p_2x_2 \text{ st. } U(X_1, x_2) \geq U_0\}$$
$$= p_1X_1 + \gamma(U_0, X_1, p_2), \quad (2)$$

where $U(X_1, x_2) = \max U(x_1, x_2)$; $C^R(U_0,p_1,p_2,X_1)$ is the rationed cost function, which gives the minimum cost for reaching U_0 at p_1 and p_2, in the presence of rationed goods and services $x_1 = X_1$; and the function $\gamma(U_0, X_1, p_2)$ has the usual properties of the cost function (Deaton 1981).

The contribution of Neary and Roberts (1980) was to introduce the concept of virtual prices as a tool for showing the equivalence between the demand models with and without rationing. The virtual price vector p_1^* is the price vector for the goods and services quantity vector x_1 at which the consumer optimally and voluntarily chooses the ration level of goods and services X_1,

$$X_1 = x_1^c(U_0, p_1^*, p_2). \quad (3)$$

The virtual price is defined as an implicit function of the ration level of goods and services and prices of nonrationed goods and services. The implicit function will exist and yield a unique vector p_1^* if the utility function is strictly quasi-concave, continuous, and strictly monotonic (Neary and Roberts 1980).

Neary and Roberts (1980) and Deaton (1981) have used the duality theory and virtual prices to derive the properties of the demand system with rationing in terms of the traditional unconstrained demand system. From Equations (2) and (3) these authors obtained the following main result, showing the relationship between nonrationed and rationed expenditure functions:

$$C^R(U_0, p_1, p_2, X_1) = [p_1 - f(U_0, X_1, p_2)]X_1 + C(U_0, f(U_0, X_1, p_2), p_2)$$
$$= [p_1 - p_1^*]X_1 + C(U_0, f(U_0, X_1, p_2), p_2). \quad (4)$$

The impact of the rationed goods and services on the demands for other goods and services, following Neary and Roberts (1980) and given that the virtual prices exist, is

$$x_2^{Rc}(U_0, p_1, p_2, X_1) = x_2^c(U_0, p_1^*, p_2). \quad (5)$$

Differentiating Equation (5) with respect to X_1, we obtain,

$$[\partial x_2^{Rc}/\partial X_1] = [\partial x_2^c/\partial p_1]/[\partial x_1^c/\partial p_1], \quad (6)$$

where x_1^c and x_2^c are Hicksian demand functions without rationing, and x_2^{Rc} is a Hicksian demand function with rationing. If the cross-price substitution term $\partial x_2^c/\partial p_1 > 0$ given that $[\partial x_1^c/\partial p_1]$ is always negative, then $[\partial x_2^{Rc}/\partial X_1] < 0$. This means that an increase in the ration level X_1 will decrease the demand for the substitute goods and services. If the cross-price

substitution term $\partial x_2^c/\partial p_1 < 0$, then $[\partial x_2^{Rc}/\partial X_1] > 0$, implying that an increase in the ration level X_1 will increase the demand for goods and services that are complements.

From Equation (4) we observe that the expenditure necessary to reach utility level U_0 when the household faces virtual prices p_1^* and observed p_2 is equal to the actual expenditure function under rationing $C^R = I$ plus a household compensation for the rationed goods and services $[p_1^* - p_1]X_1$,

$$C(U_0, p_1^*, p_2) = I + [p_1^* - p_1]X_1.$$

The Marshallian demand functions under rationing and nonrationing are equal when the minimum cost to reach utility level U_0 is $C(U_0, p_1^*, p_2)$ and the demand function without rationing is evaluated at the virtual prices p_1^*,

$$x_2^R(p_1, p_2, X_1, I) = x_2(p_1, p_2, I+[p_1^* - p_1]X_1), \quad (7)$$

$$\text{and } X_1 = x_1(p_1^*, p_2, I+[p_1^* - p_1]X_1). \quad (8)$$

Differentiating Equation (7) with respect to I yields,

$$\partial x_2^R/\partial I = \partial x_2/\partial I - (\partial x_2^{Rc}/\partial X_1)(\partial x_1/\partial I). \quad (9)$$

Thus, the effect of a change in total expenditure can be decomposed into the normal effect without rationing and a "spillover" effect of rationing. The sign of the latter depends on the substitute or complement relationships among the goods and services. If all goods are normal, an increase in income will increase the demand for substitute goods and services and decrease the demand for complement goods and services.

Neary and Roberts (1980) also derived the relationship between the own-price derivative of demand for the rationed goods and services to the own-price derivative of demand for the nonrationed goods and services. Differentiating Equation (5) with respect to p_2 and using Equation (3) yields,

$$\partial x_2^{Rc}/\partial p_2 = \partial x_2^c/\partial p_2 - (\partial x_1^c/\partial p_2)(\partial x_2^{Rc}/\partial X_1). \quad (10)$$

Thus, price changes in the case of rationing have direct and indirect effects. From Equation (6) and using that $\partial x_1^c/\partial p_2 = \partial x_2^c/\partial p_1$, the symmetry of the Slutsky substitution matrix, and substituting in Equation (10) yields,

$$\partial x_2^{Rc}/\partial p_2 - \partial x_2^c/\partial p_2 = -(\partial x_1^c/\partial p_2)(\partial x_1^c/\partial p_1)^{-1}(\partial x_1^c/\partial p_2) > 0. \quad (11)$$

Because $(\partial x_1^c/\partial p_1) < 0$ and $(\partial x_1^c/\partial p_2)$ is squared, $\partial x_2^{Rc}/\partial p_2 > \partial x_2^c/\partial p_2$. Rationing reduces the responsiveness of the demand for any nonrationed commodity to its own price. Price elasticities

of demand are lower when there is rationing than in the absence of rationing—demands are less elastic.

Empirical Specification, Data, and Estimation

The AIDS Demand System with Virtual Prices

The virtual price form of the AIDS cost function in logarithmic form is,

$$\log C(U, p, p^V) = (1 - U) \log[a(p, p^V)] + U \log[b(p, p^V)], \quad (12)$$

where $C(U, p, p^V)$ is the cost function, p is a vector of market prices, p^V is a vector of virtual prices (prices of the rationed goods and services), and U is the utility level. For $a(p, p^V)$ and $b(p, p^V)$ specific functional forms are introduced. These are positive, linearly homogeneous concave functions in prices. Following Deaton and Muellbauer (1980b), a translog flexible functional form is chosen for $a(p, p^V)$,

$$\begin{aligned}\log a(p, p^V) = {} & \alpha^0 + \sum\sum_j \alpha_j \log p_j + \sum_j \alpha_{Vj} \log p^V_j \\ & + 1/2[\sum_i \sum_j \gamma_{i\,j}^{*} \log p_i \log p_j \\ & + \sum_i \sum_j \gamma_{ViVj}^{*} \log p^V_i \log p^V_j \\ & + \sum_i \sum_j \gamma_{iVj}^{*} \log p_i \log p^V_j \\ & + \sum_i \sum_j \gamma_{Vi\,j}^{*} \log p^V_i \log p_j]. \end{aligned} \quad (13)$$

Compared to the standard AIDS model, the linear component for Equation (13) contains an extra term $\sum_j \alpha_{Vj} \log p^V_j$ in virtual prices and the quadratic component includes extra cross-product terms. The function $b(p, p^V)$ is defined as,

$$\log b(p, p^V) = \log a(p, p^V) + \prod\prod p_j^{\beta j}. \quad (14)$$

Substituting the expressions for $a(p, p^V)$ and $b(p, p^V)$ into the cost function (12) and applying Shephard's lemma yields the budget shares $\partial \log C / \partial \log p_i = w_i$. These shares are from the virtual cost function (12). Therefore, they are functions of virtual prices, market prices, and the utility level. Substituting the expression for utility from the cost function into the virtual share equations gives,

$$w_i \mid_{pV} = \alpha_i + \sum_j \gamma_{ij} \log p_j + \sum_j \gamma_{iVj} \log p^V_j + \beta_i \log [\, I^V / a(p, p^V)], \quad (15)$$

where I^V is the virtual total expenditure, and $\gamma_{ij} = 1/2(\gamma_{ij}^{*} + \gamma_{ji}^{*})$ and $\gamma_{iVj} = 1/2(\gamma_{ViVj}^{*} + \gamma_{VjVi}^{*})$. When the price index $\log a(p, p^V)$ is replaced by the Stone index $\log P(p, p^V) = \sum_i w_i \log p_i$, the virtual share equations become linear, i.e.,

$$w_i \mid_{pV} = \alpha_i + \sum_j \gamma_{ij} \log p_j + \sum_j \gamma_{iVj} \log p^V_j + \beta_i \log [I^V / P(p, p^V)]. \quad (16)$$

Qualitative demographic and other "translating" variables can be introduced into the demand systems model to examine effects for households with different observable characteristics, e.g.,

$$w_i \mid_{pV} = \alpha_i^{**} + \sum_j \gamma_{ij} \log p_j + \sum_j \gamma_{iVj} \log p^V_j + \beta_i \log [I^V / P(p, p^V)], \quad (17)$$

where $\alpha_i^{**} = \alpha_{io} + \sum_{s=1}^{S} \delta_{is} D_s$ for s = 1,..., S and D_s are the translating variables. The restrictions on the parameters required to satisfy theoretical properties of utility maximization are the following: homogeneity $\sum_j \gamma_{ij} = 0$ and $\sum_j \gamma_{iVj} = 0$; symmetry $\gamma_{ij} = \gamma_{ji}$ and $\gamma_{iVj} = \gamma_{jVi}$; and adding up $\sum_i \alpha_i^{**} = 1$, $\sum_i \delta_{is} = 0$, $\sum_i \gamma_{ij} = 0$, $\sum_I \gamma_{iVj} = 0$, and $\sum_i \beta_i = 0$.

Data

The data for this analysis are a subsample of the Polish Household Budget Survey conducted by the Central Statistical Office of Poland (GUS) during the years 1987–1992 (obtained from the World Bank). The survey is part of a long-term series of annual household budget surveys in Poland, consisting of both cross-sectional and panel data. The survey provides extensive information on household size, household composition, the age, gender, and occupational status of household members, sources of income, and expenditure patterns. The surveys are conducted quarterly, but each household is surveyed only once per year (Goreski and Peczkowski 1992). The expenditure data are quarterly. Detailed information on the survey is given in Adam (1993). For the present analysis, the years 1987, 1988, and 1989 were defined as the "prereform" period (18,682 observations), and the years 1990, 1991, and 1992 were defined as the "postreform" period (14,303 observations). The sample was representative of the population of non-privately employed households.

In the application of AIDS, the dependent variables are the budgeted shares for the six expenditure groups: food (including the value of self-consumption); alcohol and tobacco; clothing and footwear; housing (actual implicit rental); fuel, electricity, communication, i.e., household utilities and transport; and other. Expenditures include household spending on all consumer goods and services plus the money value of goods and services bought on credit or received for free. In the prereform demand model, food and housing are the rationed goods. The explanatory variables for the AIDS model are logarithms of prices (virtual prices for the rationed

goods and actual prices for nonrationed goods) and total household expenditure. Table 1 summarizes the household expenditure patterns for the six groups of goods and services (authors' calculations) used for the empirical analysis.

Food was the most important expenditure category for all years, accounting for approximately 45 percent of total expenditure. The second most important expenditure share before the reform was clothing and footwear, approximately 16 percent. Shares for housing, fuel, electricity, transport, and communication were smaller. These reported expenditures were impacted by price controls during the prereform period. The expenditure shares for alcohol and tobacco, clothing and footwear, and housing were lower postreform, but the shares for fuel, electricity, transport and communication, and other were larger. Facing declining real incomes, consumers tried to maintain their level of food consumption by increasing the share of income spent on food.

A practical approach was taken to find the virtual prices, arguing that the prices in Germany provided a good measure of nonrationed prices of goods consumed in Poland. The two countries are geographically close, and Germany is a major trading partner. The unregulated prices in Poland and Germany moved together during the period 1987–89. A high positive correlation existed between the relative price of clothing (nonrationed good) in Germany and in Poland. If the prices move together, the markets are not separated (Mundlak and Larson 1992). The quality differences due to the higher incomes in Germany will "cancel out" if relative prices are used. The basic issue was to construct an estimate of how much the relative prices of rationed goods were distorted in Poland.

To derive the relative price effect of rationing on food we computed,

$$\ln RP_F = \ln[(p_F^G/p_{OG}^G)/(p_F^P/p_{OG}^P)] = (\sum_{i=1}^{4}\alpha_i^P \ln p_i^G - \sum_{j=5}^{11}\alpha_j^P \ln p_j^G) - (\sum_{i=1}^{4}\alpha_i^P \ln p_i^P - \sum_{j=5}^{11}\alpha_j^P \ln p_j^P)$$

$$= \sum_{i=1}^{4} \alpha_i^P \ln(p_i^G/p_i^P) - \sum_{j=5}^{11} \alpha_j^P \ln(p_j^G/p_j^P), \qquad (18)$$

where $\sum_{i=1}^{4}\alpha_i^P = 1$, $\sum_{j=5}^{11}\alpha_j^P = 1$, and p_F^G/p_{OG}^G and p_F^P/p_{OG}^P are the relative prices of food with respect to the other goods for Germany and Poland, respectively. The prices for good i for Germany and Poland are, respectively, p_i^G and p_i^P; α_i^P are the relative expenditure shares in the Polish food category; and α_j^P are the relative expenditure shares for nonrationed goods. LnRP^F was then the proportional increase in the relative price of food in Germany compared to Poland.

The virtual food price in Poland was then defined to be $(1 + \ln RP^F)$ multiplied by the actual Polish food price.

The related price for housing was computed using the same procedure,

$$\ln RP_H = \ln[(p_H^G/p_{OG}^G)/(p_H^P/p_{OG}^P)] = (\ln p_H^G - \sum_{j=5}^{11}\alpha_j^P \ln p_j^G) - (\ln p_H^P - \sum_{j=5}^{11}\alpha_j^P \ln p_j^P)$$

$$= \ln(p_H^G/p_H^P) - \sum_{j=5}^{11}\alpha_j^P \ln(p_j^G/p_j^P), \quad (19)$$

where $\sum_{j=5}^{11}\alpha j^P = 1$, and p_H^G/p_{OG}^G and p_H^P/p_{OG}^P are the relative prices of housing with respect to the other goods in Germany and Poland, respectively. The virtual price of housing in Poland was then defined to be $(1 + \ln RP^H)$ multiplied by the actual Polish housing price index.

Two types of price indices were constructed and used in estimation of the complete demand system for Poland—the Törnqvist price index, defined as $\log P(p^t, p^{t-1}; T) = \sum_k 1/2(w_{t,k} + w_{t-1,k})\log(p_{t,k}/p_{t-1,k})$,

where $w_{t,k}$ and $w_{t-1,k}$ are the budget shares for good k in two different periods t and t-1, and Laspeyres index, defined as $P_t = \sum_g w_{gt}p_{gt}$. Quarterly price indices were constructed using the data on quarterly inflation rates (obtained from GUS) in Poland for 1987 to 1992. Regional price variation for food items before and after the reform was recorded by GUS (1993 and 1994). The indices were also computed regionally, based on results from earlier studies indicating this factor as important (World Bank 1995).

Estimation

The empirical specification of the demand system with virtual prices is,

$$w_{it}|_{pV} = \alpha_{io} + \sum_s \delta_{is} D_{st} + \sum_j \gamma_{ij} \log p_{jt} + \sum_j \gamma_{iVj} \log p^V_{jt} + \beta_i \log[I_t^V/P(p_t, p_t^V)] + u_{it}, \quad (20)$$

where i = 1, ..., n goods, and t = 1, ..., T observations. For comparison, the related specification for the standard demand system is,

$$w_{it} = \alpha_{io}^* + \sum_s \delta_{is}^* D_{st} + \sum_j \gamma_{ij}^* \log p_{jt} + \beta_i^* \log(I_t/P_t) + u_{it}^*. \quad (21)$$

If the disturbance terms $u_{i\,t}$ in Equations (20) and (21) satisfy the usual stochastic assumptions (the errors are identically and independently distributed with zero mean and constant variance), ordinary least squares can be applied directly to estimate the expenditure share equations. However, if the errors are contemporaneously correlated across equations, then generalized least squares can be used to gain asymptotic efficiency. The seemingly unrelated regression specification was used for this analysis. Because the error variance-covariance matrix of the full

model is singular, the share equation for other goods was dropped from the estimation and its parameters recovered using the adding up restrictions.

To compare how the demanded quantity changes in response to the changes in prices and income, elasticities were computed for the two AIDS specifications. The virtual uncompensated expenditure elasticity of demand for good i is,

$$\varepsilon_{Ei}^{V} = \beta_i/w_i + 1.$$

The virtual uncompensated price elasticity with respect to the market price is,

$$\varepsilon_{ij}^{V} = -\delta_{ij} + (\gamma_{ij} - \beta_i w_j)/w_i ,$$

where δ_{ij} is equal to 1 when i = j and 0 otherwise, ε_{ij}^{V} is the elasticity of good i with respect to the market price of good j, and w_i and w_j are (the mean) budget shares of goods i and j. The virtual uncompensated price elasticity i with respect to the virtual price j is,

$$\varepsilon_{iVj}^{V} = -\delta_{ij} + (\gamma_{iVj} - \beta_i w_j)/w_i.$$

The virtual compensated price elasticities are,

$$\varepsilon_{ij}^{V*} = \varepsilon_{ij}^{V} + w_j \varepsilon_{E}^{V} \text{ and } \varepsilon_{iVj}^{V*} = \varepsilon_{iVj}^{V} + w_j \varepsilon_{E}^{V}.$$

Empirical Results

Price and Expenditure Elasticities

First, the prereform AIDS model was estimated, ignoring rationing effects. The results were erratic, with high compensated own-price elasticities and positive signs for food, alcohol and tobacco, clothing and footwear, and housing (Table 2). Hence, the model ignoring rationing did not fit the data well. The AIDS model with virtual prices was then estimated, and the parameters from the share equations were used to compute a set of associated demand elasticities.[1] Table 3 presents the own- and cross-price elasticities. All the compensated and uncompensated own-price elasticities are negative and their standard errors are relatively small, with the exception of fuel, making them significant at the conventional levels. The own-price elasticities for food and fuel are less than one whereas for alcohol, clothing, housing, and other goods they are bigger than one, suggesting elastic demand. The estimates from the virtual AIDS then give plausible values for price and income elasticities.

The postreform AIDS model was estimated for the years 1990, 1991, and 1992.[2] Table 4 presents the associated values for Marshallian and Hicksian own- and cross-price elasticities.

All own-price elasticities are negative as expected and their standard errors are relatively small, making all of them significant at the conventional levels. The own-price elasticities for alcohol and tobacco, clothing and footwear, housing, and other are larger than one, whereas the price elasticity of demand for food and fuel, which includes electricity, transport, and communication, is the lowest of all commodities. This is expected considering the importance of these items in the Poland's consumer basket. The demand for food and fuel, electricity, transport, and communication is price inelastic, whereas the rest of the commodities are price elastic. Food is the most price inelastic; clothing and footwear are the most price elastic. Most of the cross-price elasticities are small. The lower values of cross-price effects indicate that consumers are more responsive to own-price rather than prices of other commodities. For the translating variables (see Tables 5 and 6), the adult equivalents[3] in the households had a positive effect on food and a negative effect on the rest of the budget shares. The negative sign of the coefficients for the number of adult equivalents per household suggests economies of size. Age and education level of the head of household variables had small effects on the estimated budget shares. Finally, we performed a Chow test for structural change comparing the post- and prereform results. We reject the hypothesis equality of the coefficients between pre- and postreform specifications.

The results from the Polish study are similar to the results from the study on Belgium using the data for the Interwar period presented by Bettendorf and Barten (1995), who estimated the Rotterdam demand system under rationing of housing. For both countries, the income elasticities for food were positive but significantly less than 1, and for the other groups were luxury goods. All compensated demands were rather sensitive to own-price changes in Belgium. In Poland the compensated demands for food and fuel were not sensitive to own-price changes but the demands for the other groups were very sensitive to own-price changes.

Empirical Tests of Rationing Effects

The classic literature on rationing by Tobin and Houthakker (1951) followed by Neary and Roberts (1980) discussed the main relationships between the effects on demand during rationing of changes in prices, incomes, and ration levels and the effects on demand without rationing of changes in prices and incomes. These authors showed that the demand elasticities in a free market situation could be compared with those in a regime of rationing. In this section we

empirically test the main theoretical propositions from the demand model under rationing. Rationing changes the comparative static results, and pre- and postreform cross-price elasticities can be compared.

From Equation (6) an increase in the rationed goods and services decreases the demand for substitutes and increases the demand for goods and services that are complements. Rationing reduces the responsiveness of demand for any nonrationed commodity to its own-price (Equation 11). Results comparing the two AIDS models, incorporating rationing effects in the prereform period and without rationing in the postreform period, confirm the following:

a) Decreased substitutability in the postreform period as indicated by the cross-price elasticities, i.e., decreased cross-price elasticities of demand for the substitute goods for food—alcohol and tobacco, clothing and footwear—and decreased cross-price elasticity of demand for the substitute goods for housing—fuel, electricity, transport, and communication.

b) Increased complementarity after the reform: increased cross-price elasticity of demand for the complementary goods for food—fuel, electricity, transport, and communication.

c) Demands for nonrationed goods and services (clothing and footwear, fuel, electricity, transport, and communication) are less elastic in the prereform period. The observed increase in own-price elasticities (in absolute values) reflects an increase in responsiveness as a result of removing the rationing system.

There are, however, a few contradictions.

Welfare Implications

One of the main issues for the estimation of the Polish household demand system was to determine if the households were better or worse off as a result of the transformation from the centrally planned to market economy. With the estimated coefficients from the virtual AIDS before the reform and the standard AIDS after the reform we calculated the compensating variations given by the differences in cost function or $CV = C(p^1, U^0) - C(p^0, U^0)$ for each household in the final quarter, the fourth quarter of 1992. The base period was the fourth quarter of 1987. The compensating variation was estimated as the income change necessary to compensate the household for the price changes, while holding utility constant. The calculated

compensating variations were positive for every family indicating that each household experienced a welfare loss at given utility as a result of the price liberalization.

The alternative estimates of total welfare loss for Poland are computed and reported in Table 7. We make two calculations for comparison, one allowing for rationing and a second ignoring rationing. The compensating variation is three times higher in the case ignoring rationing. However, to know whether the household was better or worse off after the reform, we need to know how much the income changed. Table 7 shows this as the expenditure change. Finally, the ratio of total welfare loss to the 1987 real total expenditures was computed. The total welfare loss over the transition period 1987–92 was 10.51 million zlotys, or 75 percent of the 1987 average income. This estimated loss was roughly three times higher when ignoring rationing than when allowing for it. Specifically, the total welfare loss was 36.73 million zlotys when we did not consider rationing effects versus 10.51 million zlotys when we allowed for the effects of rationing. Using virtual prices rather than actual prices for the rationed goods reduces greatly (by a factor of three) the estimated welfare loss during the transition.

Conclusions

The study has applied the theory of rationing for an economy in transition using the experience of Poland. An AIDS model of consumption under rationing was applied. For the prereform sample, the AIDS model with virtual prices was estimated. The resulting demand elasticities had the anticipated signs (negative) for the compensated own-price elasticities and were of reasonable magnitude. The estimated virtual AIDS also gave plausible values for cross-price and income elasticities. Compared to other studies of consumer demand in Poland and for other transition economies, the results were remarkably good. They are, for example, appropriate for making cost-of-living comparisons, pre- and postreform. The postreform AIDS model was estimated and income and price elasticities were computed. We found the following:

- Demands were less elastic when there was rationing.
- An increase in the quantity of rationed goods and services increased the demand for goods and services that are complements.
- An increase in the quantity of rationed goods and services decreased the demand for goods and services that are substitutes.

Assessing the effects of the transition on the market economy of Poland requires careful analysis of consumption patterns, total expenditure, rationing, and prices. More accurately reflecting rationing and incorporating the effects of rationing before the reform yielded estimates of welfare loss that were orders of magnitude lower than those commonly reported. The virtual prices were much larger than the actual or reported prices for the rationed goods during the prereform period. The actual prices for rationed goods increased much more than the virtual prices as reforms progressed. Therefore, changes in real GDP per capita overestimated the welfare loss during the transition. The results for Poland showed a 211 percent decline in real household welfare using the CPI, which did not account for costs of shortages/rationing, compared to a 75 percent decline using virtual prices. These results provide a more complete appreciation for the consumption patterns observed during the economic transition in Poland.

Table 1. Household expenditure patterns (share of total expenditures) for Poland, 1987–1992

Expenditure Group	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**
Food	0.46	0.43	0.47	0.51	0.45	0.42
Alcohol and tobacco	0.04	0.04	0.04	0.03	0.03	0.03
Clothing and footwear	0.14	0.15	0.16	0.10	0.09	0.08
Housing	0.12	0.12	0.12	0.10	0.10	0.10
Fuel, electricity, transport, and communication	0.09	0.10	0.08	0.11	0.15	0.17
Other	0.15	0.16	0.13	0.15	0.17	0.20

Source: Polish Household Budget Survey 1987–92.

Table 2. Estimated demand elasticities: AIDS before the reforms[a]

Group[b]	Food	Alcohol	Clothing	Housing	Fuel	Other
		Marshallian	Elasticities			
Food	-0.11 (0.02)	0.06 (0.01)	-0.30 (0.02)	-0.34 (0.02)	-0.29 (0.02)	0.31
Alcohol	0.55 (0.12)	9.98 (1.83)	-35.28 (4.78)	20.64 (2.64)	-1.12 (0.62)	4.15
Clothing	-1.28 (0.08)	-10.08 (1.36)	24.90 (3.74)	-13.03 (2.09)	0.44 (0.45)	-2.09
Housing	-1.94 (0.10)	7.49 (0.96)	-16.64 (2.66)	7.68 (1.54)	1.48 (0.39)	0.39
Fuel	-2.13 (0.12)	-0.57 (0.31)	0.74 (0.79)	2.03 (0.53)	-4.64 (0.45)	3.16
Other	0.76	1.18	-2.12	0.34	1.80	-3.30
		Hicksian	Elasticities			
Food	0.21 (0.02)	0.09 (0.01)	-0.21 (0.02)	-0.27 (0.02)	-0.23 (0.02)	0.41
Alcohol	1.08 (0.12)	10.02 (1.83)	-35.13 (4.78)	20.76 (2.65)	-1.04 (0.62)	4.30
Clothing	-0.72 (0.08)	-10.04 (1.37)	25.06 (3.74)	-12.90 (2.09)	0.53 (0.45)	-1.93
Housing	-1.18 (0.09)	7.55 (0.96)	-16.42 (2.66)	7.85 (1.54)	1.60 (0.39)	0.61
Fuel	-1.44 (0.12)	-0.52 (0.31)	0.93 (0.79)	2.19 (0.53)	-4.53 (0.45)	3.36
Other	1.42	1.23	-1.93	0.49	1.91	-3.11
		Income Elasticities		Mean shares		
Food		0.67 (0.004)		0.49		
Alcohol		1.08 (0.006)		0.04		
Clothing		1.14 (0.004)		0.14		
Housing		1.54 (0.021)		0.11		
Fuel		1.41 (0.007)		0.08		
Other		1.34		0.14		

Notes: [a]-Figures in parentheses are the estimated standard errors of elasticities.
[b]-Alcohol includes tobacco; Clothing includes footwear; Fuel includes electricity, transport, and communication.

Table 3. Estimated demand elasticities: AIDS before the reforms with virtual prices[a]

Group[b]	**Food**	**Alcohol**	**Clothing**	**Housing**	**Fuel**	**Other**
		Marshallian	Elasticities			
Food	-0.64 (0.02)	0.01(0.002)	-0.03 (0.01)	-0.20 (0.02)	-0.04 (0.01)	0.08
Alcohol	0.27 (0.13)	-1.91(0.82)	1.18 (0.85)	-0.57 (0.28)	2.93 (0.43)	-3.16
Clothing	-0.80 (0.09)	0.32(0.23)	-2.03 (0.29)	1.88 (0.18)	-0.51 (0.17)	-0.20
Housing	-1.22 (0.06)	-0.04(0.02)	0.45 (0.04)	-1.30 (0.09)	0.02 (0.05)	0.60
Fuel	-1.29 (0.13)	1.32(0.20)	-0.83 (0.28)	0.21 (0.31)	-0.04 (0.46)	-0.65
Other	0.97	-0.92	-0.21	2.60	-0.39	-3.34
		Hicksian	Elasticities			
Food	-0.08 (0.01)	0.02(0.002)	0.01 (0.01)	-0.05 (0.02)	-0.02 (0.01)	0.11
Alcohol	1.14 (0.13)	-1.90(0.82)	1.23 (0.85)	-0.34 (0.28)	2.96 (0.44)	-3.10
Clothing	0.12 (0.09)	0.34(0.24)	-1.97 (0.29)	2.13 (0.18)	-0.48 (0.17)	-0.14
Housing	-0.19 (0.06)	-0.02(0.02)	0.52 (0.04)	-1.03 (0.09)	0.06 (0.05)	0.66
Fuel	-0.40 (0.13)	1.34(0.20)	-0.78 (0.28)	0.44 (0.31)	-0.01 (0.46)	-0.59
Other	1.86	-0.90	-0.15	2.83	-0.36	-3.28

	Income Elasticities	Mean Shares
Food	0.82 (0.003)	0.69
Alcohol	1.26 (0.019)	0.01
Clothing	1.33 (0.014)	0.04
Housing	1.49 (0.013)	0.18
Fuel	1.28 (0.020)	0.03
Other	1.27	0.04

Notes: [a]-Figures in parentheses are the estimated standard errors of elasticities.

[b]-Alcohol includes tobacco; Clothing includes footwear; Fuel includes electricity, transport, and communication.

Table 4. Estimated demand elasticities: AIDS after the reforms[a]

Group[b]	Food	Alcohol	Clothing	Housing	Fuel	Other
		Marshallian	Elasticities			
Food	-0.62 (0.02)	-0.01 (0.01)	-0.08 (0.02)	0.01 (0.02)	-0.14 (0.01)	0.16
Alcohol	-0.43 (0.15)	-1.70 (0.36)	1.07 (0.46)	0.27 (0.37)	-0.20 (0.20)	-0.20
Clothing	-0.85 (0.10)	0.40 (0.17)	-2.95 (0.49)	1.34 (0.22)	-0.19 (0.19)	0.92
Housing	-0.32 (0.11)	0.08 (0.12)	1.18 (0.20)	-1.70 (0.28)	-0.28 (0.10)	-0.39
Fuel	-0.75 (0.04)	-0.04 (0.05)	-0.10 (0.11)	-0.16 (0.07)	-0.42 (0.05)	0.39
Other	0.07	-0.05	0.45	-0.23	0.26	-2.02
		Hicksian	Elasticities			
Food	-0.27 (0.02)	0.01 (0.01)	-0.03 (0.02)	0.07 (0.02)	-0.05 (0.01)	0.26
Alcohol	0.18 (0.15)	-1.67 (0.36)	1.16 (0.47)	0.38 (0.37)	-0.04 (0.20)	-0.01
Clothing	-0.17 (0.10)	0.44 (0.17)	-2.85 (0.49)	1.46 (0.22)	-0.02 (0.19)	1.13
Housing	0.41 (0.11)	0.13 (0.12)	1.30 (0.20)	-1.57 (0.28)	-0.10 (0.10)	-0.16
Fuel	-0.19 (0.04)	-0.01 (0.05)	-0.01 (0.11)	-0.07 (0.07)	-0.28 (0.05)	0.56
Other	0.84	-0.002	0.57	-0.09	0.46	-1.78

	Income Elasticities	Mean Shares
Food	0.68 (0.004)	0.51
Alcohol	1.20 (0.008)	0.03
Clothing	1.35 (0.008)	0.08
Housing	1.42 (0.026)	0.09
Fuel	1.09 (0.004)	0.13
Other	1.51	0.16

Notes: [a]-Figures in parentheses are the estimated standard errors of elasticities.
[b]-Alcohol includes tobacco; Clothing includes footwear; Fuel includes electricity, transport and communication.

Table 5. Demand system parameter estimates and t-ratios: AIDS with virtual prices

	Food	**Alcohol**	**Clothing**	**Housing**	**Fuel**
Constant	1.902	-0.025	-0.215	-0.292	-0.019
	(71.53)	(-3.16)	(-11.15)	(-7.25)	(-0.96)
Food price	0.160	0.005	-0.025	-0.160	-0.030
	(16.03)	(3.47)	(-6.22)	(-14.67)	(-8.74)
Alcohol price	0.005	-0.011	0.015	-0.006	0.036
	(3.47)	(-1.11)	(1.40)	(-1.84)	(6.71)
Clothing price	-0.025	0.015	-0.045	0.086	-0.022
	(-6.22)	(1.40)	(-3.46)	(10.69)	(-2.91)
Housing price	-0.160	-0.006	0.086	-0.038	0.006
	(-14.67)	(-1.84)	(10.69)	(-2.24)	(0.72)
Fuel price	-0.030	0.036	-0.022	0.006	0.027
	(-8.74)	(6.71)	(-2.91)	(0.72)	(2.16)
Lnexpenditure	-0.125	0.003	0.015	0.089	0.007
	(-59.66)	(13.85)	(23.90)	(38.53)	(13.92)
Adult equivalents	0.043	-0.002	-0.003	-0.003	-0.003
	(32.31)	(-11.42)	(-7.87)	(-10.26)	(-10.26)
Age	0.003	-4E-05	-6E-05	-0.003	-9E-05
	(7.68)	(-0.97)	(-0.53)	(-6.74)	(-1.01)
Age squared	-3E-05	-1E-06	-2E-06	3E-05	2E-06
	(-6.71)	(-3.17)	(-1.89)	(-6.74)	(2.54)
Education	0.009	0.001	-2E-04	-0.005	-0.001
	(16.84)	(12.59)	(-1.30)	(-8.57)	(-7.23)

Notes: All prices in logarithms.

Table 6. Demand system parameter estimates and t-ratios: AIDS after the reforms

	Food	**Alcohol**	**Clothing**	**Housing**	**Fuel**
Constant	2.031	-0.034	-0.203	-0.229	0.031
	(75.56)	(-4.38)	(-15.77)	(-11.59)	(1.63)
Food price	0.111	-0.010	-0.054	-0.009	-0.091
	(9.27)	(-2.24)	(-6.94)	(-0.92)	(-18.21)
Alcohol price	-0.010	-0.021	0.032	0.009	-0.005
	(-2.24)	(-1.96)	(2.33)	(0.78)	(0.84)
Clothing price	-0.054	0.032	-0.154	0.110	-0.012
	(-6.94)	(2.33)	(-3.94)	(6.19)	(0.80)
Housing price	-0.009	0.009	0.110	-0.060	-0.020
	(-0.92)	(0.78)	(6.19)	(-2.40)	(-2.23)
Fuel price	-0.091	-0.005	-0.012	-0.020	0.092
	(-18.21)	(0.84)	(0.80)	(-2.23)	(13.13)
Lnexpenditure	-0.165	0.006	0.028	0.038	0.011
	(-67.34)	(8.47)	(23.90)	(20.89)	(6.52)
Adult	0.066	-0.003	-0.002	-0.019	-0.009
equivalents	(45.41)	(-8.19)	(-15.77)	(-17.93)	(-8.52)
Age	0.003	4E-04	-2-04	-0.001	-0.001
	(6.91)	(3.30)	(-0.83)	(-4.90)	(-3.12)
Age squared	-2E-05	-8E-06	-1E-06	1E-05	1E-05
	(-5.81)	(-7.30)	(-0.71)	(4.74)	(4.89)
Education	0.013	0.002	4E-04	-0.002	-0.004
	(-18.21)	(12.65)	(1.39)	(-5.55)	(-10.25)

Notes: All prices in logarithms.

Table 7. Alternative estimated welfare losses for Poland (in million zlotys)

	Loss With Rationing Effects	**Loss Without Rationing Effects**
Compensating variation	9.56	32.46
Expenditure change[a]	-0.92	-4.27
Total loss[b]	-10.51	-36.73
Real total expenditure in 1987	14.05	17.41
Relative loss[c]	0.75	2.11

Notes: [a]- Mean real expenditure in 1992 less mean virtual real total expenditure in 1987 at 1992 prices when incorporating rationing, and less mean real expenditures in 1987 at 1992 prices, when ignoring rationing.

[b]- Total measured loss = - CV + change in virtual real total expenditure at 1992 prices in the case with rationing, and total measured loss = - CV + change in real total expenditure at 1992 prices in the case without rationing.

[c]- Total welfare loss relative to virtual real total expenditures in 1987 at 1992 prices in the case with rationing, and relative to real total expenditures in 1987 at 1992 prices in the case without rationing.

Endnotes

1. The parameter estimates and their t statistics are presented in Table 5.
2. The parameter estimates and their t statistics are presented in Table 6.
3. Household composition is taken into account by using the adult-equivalent scale, which is based on the Organization for Economic Cooperation and Development (OECD) scale.

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