

Khaled, Mohammed; McWha, Vhari; Lattimore, Ralph

**Working Paper**

## Fragmenting food markets: Some New Zealand evidence from a two-stage budget model

NZ Trade Consortium Working Paper, No. 30

**Provided in Cooperation with:**

New Zealand Institute of Economic Research (NZIER), Wellington

*Suggested Citation:* Khaled, Mohammed; McWha, Vhari; Lattimore, Ralph (2004) : Fragmenting food markets: Some New Zealand evidence from a two-stage budget model, NZ Trade Consortium Working Paper, No. 30, New Zealand Institute of Economic Research (NZIER), Wellington

This Version is available at:

<https://hdl.handle.net/10419/66074>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*

# **Fragmenting Food Markets: Some New Zealand evidence from a Two-Stage Budget Model**

---

**Mohammed Khaled\*, Vhari McWha and Ralph  
Lattimore\*\***

---

NZ Trade Consortium working paper no 30

6 March 2004

**The New Zealand Trade Consortium**

**in association with the**

**New Zealand Institute of Economic Research (Inc)**

\*\* Senior Economist (Email: [vhari.mcwha@nzier.org.nz](mailto:vhari.mcwha@nzier.org.nz)) and Senior Fellow (Email: [ralph.lattimore@nzier.org.nz](mailto:ralph.lattimore@nzier.org.nz)), New Zealand Institute of Economic Research, PO Box 3479, Wellington, New Zealand, Phone: 64-4-472-1880, Fax: 64-4-472-1211.

## Contents

<b>Demand for Food in New Zealand in a Two-Stage Budget Model .....</b>	<b>1</b>
Abstract .....	1
<b>1. Introduction .....</b>	<b>2</b>
<b>2. A Two-Stage Rotterdam Model of Food expenditures .....</b>	<b>4</b>
<b>3. Data .....</b>	<b>7</b>
<b>4. Estimation and Results.....</b>	<b>9</b>
<b>5. Conclusions.....</b>	<b>17</b>
<b>6. References.....</b>	<b>19</b>

## Tables

<i>Table 1 Past Estimates of NZ Food Demand Elasticities.....</i>	<i>3</i>
Table 2 Consumption groups and sub-groups.....	8
Table 3 Trend and Excess Marginal Share Coefficients .....	10
Table 4 Price Coefficients of a Rotterdam Model of Food for New Zealand, 1980-2001.....	11
Table 5 Trend and Excess Marginal Share Coefficients .....	12
Table 6 Elasticities of Group Demand .....	13
Table 7 Price Coefficients in a Rotterdam Model of Consumption for New Zealand, 1980-2001.....	14
Table 8 Elasticities of Demand for the Food Subgroups in New Zealand.....	15
Table 9 Elasticities of Demand for Meals Away from Home with respect to Non-Food Prices in New Zealand .....	18



# Demand for Food in New Zealand in a Two-Stage Budget Model

## Abstract

Very little is known about the basic income and price responsiveness of New Zealand food markets. As far as we can determine, there has never been a complete disaggregated food demand model estimated for New Zealand. In a famous article, Court (1967) estimated a demand system for three red meats. Since then there have been a number of demand systems estimated which included food in the aggregate, but the focus in these studies was primarily on the substitution possibilities between food as a whole and other items of household expenditure. The object of this paper is to update these estimates using more recent data to see whether there are grounds for believing that the structural changes that occurred primarily during the last two decades are having effects on the size of these food demand elasticities in New Zealand. To this end, a Rotterdam food demand system is estimated for this paper using time series data from the household economic surveys, 1981 to 2001. The results indicate that over the last 20 years household consumption has increased for fruit and vegetables, poultry, food eaten away from home, and sweet products, drinks and other foods owing to time related changes in preferences and/or income growth. Fish, poultry, meat, farm products, cereals and meals away from home are all more price elastic than earlier estimates would indicate.

JEL: C32 (Time series models), D12 (consumer economics), L66 (Food), Q18 (food policy) and R22 (other household demand).

# 1. Introduction

Food market fragmentation is a phenomenon associated with the development of increasingly heterogeneous markets – an increasing array of products and services that appeal to higher income consumers and broadening sets of preferences. Fragmentation has important implications for the structure of food markets and for food market competition policy. Food market fragmentation is likely to be associated with increasing substitutability amongst products and coupled with an increasing diversity of retail outlets. Substitutability within the food group could result in a reduction in the market power of any particular manufacturer or retailer – in short, market definitions for competition policy matters may now be (considerably) wider than was previously the case. This paper is aimed at testing the basis for these assertions.

Very little is known about the detailed income and price responsiveness of New Zealand (NZ) food markets. As far as we can determine, there has never been a complete disaggregated food demand model estimated for NZ. In a famous article, Court (1967) estimated a demand system for three red meats. Since then there have been a number of demand systems estimated which included food in the aggregate but the focus in these studies was primarily on the substitution possibilities between food as a whole and other items of household expenditure. These studies included NZ Department of Statistics (1980), Giles and Hampton (1985), Chatterjee et al (1994), Micheline et al (1997), Micheline (1999) and Gibson and Scobie (2002).

There have been a couple of cross country studies, which included NZ, that have estimated price and income elasticities for food or food ingredients. Two of these studies are the base for demand elasticity estimates used in the global trade model system, GTAP, McDougall et al (1998). Table 1 provides a selection of parameter estimates from these and other sources. They generally show that own price elasticities are inelastic for food products and often very inelastic (less than 0.1 in absolute value). The only exception is the Court (1967) estimate for pigmeat, a luxury meat item at that time.

Expenditure or income elasticities, in previous studies, are all less than one corresponding to a view that food is a basic need in the context of Engel's Law. Cross price elasticities within the meats tend to be positive in Court's study and usually greater than 0.5 indicating strong substitution effects.

**Table 1 Past Estimates of NZ Food Demand Elasticities**

		Elasticities			
		Own Price	Cross Price		Expenditure <sup>1</sup>
McDougall et al	Grains	-0.06			0.09
	Other Food	-0.27			0.41
	Meat	-0.06			0.09
	Dairy	-0.06			0.09
	Beverages, Tob.	-0.55			0.89
OCED	Butter	0.037			0.25
	Cheese	-0.25			0.25
	Milk	-0.09			0.20
Court	Beef	-0.78	0.61 (sheep)	0.05 (pig)	-0.23
	Sheepmeat	-0.34	0.79 (pig)	-0.30 (beef)	0.42
	Pigmeat	-1.25	0.55 (beef)	0.79 (sheep)	0.97
Giles et al <sup>2</sup>	Food				0.6 – 0.9
Chatterjee et al <sup>3</sup>	Food	-0.7			0.9
Michellini et al <sup>4</sup>	Food	-0.32			-0.35
Michellini <sup>5</sup>	Food	-0.17			0.56
Gibson et al	Food	-0.34			0.57

- Notes: 1 Expenditure elasticities refer to different commodity groupings.  
2 Cross section study based on 1982 HES data.  
3 Mid range estimates from mixed cross section, time series (1984-91).  
4 Mixed cross section, time series (1984-92).  
5 Mixed cross section, time series (1984-92).

The specific objective of this paper is to update these estimates using more recent data to see whether there are grounds for believing that the structural changes that occurred primarily during the last two decades are having effects on the size of these food demand elasticities in NZ. With this purpose, the next section reports on the results of estimating a Rotterdam demand system for an eight-product classification of food expenditures in NZ using time series data from the household expenditure surveys, 1981 to 2001.

There have been a number of important changes in the composition of food demand in recent decades that we expect to see being reflected in the parameter estimates. Anecdotal evidence suggests that some NZ food consumers have become more health conscious over time and this is reflected in increasing budget shares for fruit and vegetables in the food



group, decreasing shares for (red) meats and an increasing share for fish. Poultry has gained budget share at the expense of (red) meat on relative price grounds perhaps more than for health considerations. Court did not even include poultry in his meat study in the 1960's. At that time poultry was a luxury meat item eaten mainly at Christmas and on other festive occasions. Poultry (at least chicken) consumption increased rapidly from that period and it will be very interesting to see how current meat consumption patterns are now reflected in the demand parameters.

Convenience has also played an increasing role and we expect to see an elastic demand for food eaten away from home. The increased variety of products available to consumers is likely to result in high cross price as well as own price elasticities stemming from greater substitution possibilities. This food market fragmentation in combination with a wide range of food "concerns" also increases the possibility that consumers are mixing and matching niche products more than they used to – that complementary relationships have also increased.

Food markets have undergone significant structural change over the last 50 years. Corner grocery stores were largely replaced by supermarkets, and supermarkets are in the process of being replaced by specialty food stores to some degree, at least. Petrol station shops, bread shops and delis are gaining market share. There has also been a very large increase in the variety of products produced. Much of this supply side change has been driven by higher income consumers on the demand side with their increasing demands for variety, sophistication and convenience. In other words, food markets have become fragmented. Similar developments have occurred in other retail markets as well.

## **2.A Two-Stage Rotterdam Model of Food expenditures**

The NZ Household Expenditure Survey (HES) classifies total consumer spending into seven groups: food, housing, household operation, apparel, transport, other goods, and other services. Each of these groups is classified further into subgroups. The ten subgroups of food are: fruits, vegetables, meat, poultry, fish, farm products-fats-oils, cereals, sweet products-spreads-beverages, other foodstuffs, and meals away from home and ready to eat food. Each subgroup consists of sub-subgroups and individual items. For example, the farm products-fats-oils subgroup branches into nine categories: eggs, milk, cream, yogurt, dairy dessert, butter & cheese, other milk products, vegetable oils & fats, and animal fats.

If consumer preferences were weakly separable in food and the other groups at that level of aggregation, and preferences over food were in turn weakly separable in the food subgroups listed above, demand for items belonging to

any of the food subgroups can be analysed conditional on the budget allocated to that subgroup. If we want to focus just on the ten subgroups of the food group, all we need to assume is weak separability of consumer preferences in food. However, if we need to estimate elasticities of demand for any of the food subgroups with respect to price of a subgroup belonging to any of the other groups (e.g. meat with respect to price, say, fuel & power), then a two-stage budget model can be used for this purpose if consumer preferences were weakly separable in food and in the other groups.

Demand for any of the food subgroups conditional on budget allocated to this group (say group A) can be estimated by using an absolute price version of the Rotterdam model (as reformulated by Theil and Clements (1987) in order to incorporate Working's (1943) non-linear specification of the Engel curves). A further inclusion of an intercept in each of the equations in the Rotterdam model allows trend-like changes in tastes over time:

$$s_{iA} \Delta \ln \frac{x_i}{X_A} = \tau_i + \alpha_{iA} \Delta \ln X_A + \sum_{j \in A} \gamma_{ij} \Delta \ln p_j, \quad i \in A \quad (1)$$

where  $p_i$ ,  $x_i$  and  $s_{iA}$  ( $= p_i x_i / \sum_{j \in A} p_j x_j$ ) represent price, quantity demanded per capita, and budget share respectively of the  $i$ th commodity in group A, and  $\Delta \ln X_A = \sum_{j \in A} s_{jA} \Delta \ln x_j$  is the Divisia aggregate quantity index of group A in the percentage change form. The variable  $X_A$  itself, implied by this aggregation, is a measure of the total quantity of food expressed as a composite commodity.

The coefficient  $\alpha_{iA}$  measures the difference between marginal and average budget share of good  $i$  in group A, while the price coefficients  $\gamma_{ij}$  represent the substitution effects conditional on the budget allocated to this group. The adding up, symmetry and homogeneity restrictions of consumer

demand theory are satisfied when the coefficients are such that  $\sum_{i \in A} \tau_i = 0$ ,

$$\sum_{i \in A} \alpha_{iA} = 0, \quad \gamma_{ij} = \gamma_{ji} \quad \text{and} \quad \sum_{j \in A} \gamma_{ij} = 0.$$

Concavity requires the additional restriction that the matrix of the  $\gamma_{ij}$  coefficients be negative semi-definite. An advantage of the Rotterdam model of consumer demand is that the matrix of substitution effects, say  $\Sigma = (\gamma_{ij})$ , can be easily required to be negative semi definite during estimation by being formulated as  $\Sigma = -U'U$  where  $U$  is an upper triangular matrix of coefficients. Compared to a general matrix  $\Sigma$  satisfying the restrictions of utility maximising behaviour, there is no loss of flexibility of the substitution effects by the formulation above as  $U$  contains the same number of free coefficients as  $\Sigma$ .

The elasticities of demand for goods in group F with respect to the group expenditure at fixed prices are given by:

$$\varepsilon_{iA} = (\alpha_{iA} + s_{iA}) / s_{iA}, \quad i \in A \quad (2)$$

The conditional price elasticities of demand for goods in A incorporating both the income and substitution effects of a price change are:

$$\varepsilon_{ij} = (\gamma_{ij} / s_{iA}) - s_{jA} \varepsilon_{iA}, \quad \text{for all } i, j \in A \quad (3)$$

Elasticities of demand for goods in group A with respect to the overall consumption expenditure requires estimation of the demand system at the next higher level of aggregation, i.e. a demand system for the seven expenditure groups, say  $g = A, \dots, G$ . If consumer preferences are weakly separable in these groups, the absolute price version of the Rotterdam model at this level of aggregation is:

$$s_g \Delta \ln \frac{X_g}{X} = \tau_g + \alpha_g \Delta \ln X + \sum_{h=A}^G \gamma_{gh} \Delta \ln p_h^*, \quad g = A, \dots, G \quad (4)$$

where  $s_g$  = average budget share of group  $g$  in total expenditure on

consumption,  $\Delta \ln X = \sum_{h=A}^G s_h \Delta \ln X_h$  is the Divisia aggregate of consumption

in the percentage change form, and  $\Delta \ln p_h^* = \sum_{j \in h} \beta_{jh} \Delta \ln p_j$  is the *Frisch* price

index of group  $h$  with  $\beta_{jh} = \alpha_{jh} + s_{jh}$  being the marginal budget share of good  $j$  in group  $h$ . Trends in consumption at the group level are represented by the parameters  $\tau_g$  satisfying the restriction  $\sum \tau_g = 0$ . The difference between marginal and average budget shares of group  $g$  is given by  $\alpha_g$  such that  $\sum \alpha_g$

= 0. The group demands are also subject to the restrictions  $\sum_h \gamma_{gh} = 0$ , with

the matrix of  $\gamma_{gh}$  values being symmetric negative semi-definite.

The  $\gamma_{gh}$  coefficients can be related to the marginal budget shares of the groups  $\beta_g$  (which equals  $\alpha_g + s_g$ ) as  $\gamma_{gh} = \phi(\theta_{gh} - \beta_g \beta_h)$  where  $\phi$ , known as ‘income flexibility’, is the reciprocal of income elasticity of the marginal utility of money. This parameter is not identified in the absence of further restrictions on the  $\theta_{gh}$  values. A frequently used restriction, which usually turns out to be a good approximation in the case of broad aggregates, is to assume that consumer preferences are block additive (i.e. strongly separable) in broad commodity groups ( $\theta_{gh} = 0$  for  $g \neq h$ ).

The elasticities of demand for goods in group A with respect to the overall consumption budget ( $y$ ) are given by:

$$\varepsilon_{iy} = (\alpha_{iA} + s_{iA})(\alpha_A + s_A) / (s_{iA} s_A), \quad i \in A \quad (5)$$

The compensated price elasticities of demand for goods in A, allowing real group expenditure allocation to change owing to price changes relative to the other groups but still holding real total expenditure the same, are:

$$E^*_{ij} = (\gamma_{ij} / s_{iA}) + (\gamma_{AA}\beta_{iA}\beta_{jA}) / s_{iA} s_A \text{ for all } i, j \in A \quad (6)$$

$$E^*_{ij} = (\gamma_{Ah}\beta_{iA}\beta_{jh}) / s_{iA} s_A \text{ for all } i \in A \text{ and } j \in h \neq A. \quad (7)$$

The overall price elasticities of demand for goods in A including both income and substitution effects are:

$$E_{ij} = E^*_{ij} - s_{jh} s_h \varepsilon_{iy}, \text{ for all } i \in A \text{ and } j \in h = A, \dots, G \quad (8)$$

Note that the group demand system (4) can be estimated only if the Frisch price indices are available. This requires prior estimation of all  $\alpha_{jh}$  values, i.e. estimation of demand systems for each of the consumption groups.

### 3. Data

A Rotterdam model for the ten subgroups of food in New Zealand, with trend coefficients allowed, requires estimation of 63 free coefficients. Available New Zealand data with just 19 annual observations (of which 18 could be used after differencing) are inadequate to allow successful maximum likelihood estimation of the demand system with a full error covariance matrix.<sup>1</sup> To reduce the information requirement from the limited data available, fruits and vegetables were combined into one commodity, and sweet products, spreads, beverages and other foodstuffs were combined into another commodity. The resulting eight-commodity classification of food along with the classifications used for all the other consumption groups are laid out in table 2. Thus, a six-group classification of total consumption is further classified into a total of 36 commodity subgroups.

---

<sup>1</sup> Keller and Driel (1985, p. 382) point out that, unless we are prepared to restrict the covariance matrix, we need  $T > 2N + 1$ , where T is the number of observations available for each demand equation and N is the number of goods. Thus, successful estimation of a demand model with 10 goods would require at least 22 observations for each demand equation.

---

**Table 2 Consumption groups and sub-groups**

<u>Groups</u>	<u>Subgroups</u>
Food	fruits & vegetables meat poultry fish farm products, fats & oils cereals & cereal products sweet products, spreads, beverages & other foodstuffs meals away from home & ready to eat food.
Housing	rental housing owner occupied housing
Household Operation	fuel & power home appliances, household equipment & utensils furniture & furnishings floor coverings household textiles household supplies household services
Apparel	men's clothing women's clothing children's clothing clothing not elsewhere classified clothing supplies & services men's footwear women's footwear children's footwear
Transport	public transport overseas travel private transport
Other Goods & Services	tobacco alcohol medical toiletries & cosmetics personal goods leisure & recreational goods & recreational vehicles health services personal services

---

Data on weekly expenditure per household, average household size and prices were obtained from Statistics NZ. The household economic survey (HES) was used for expenditure data from 1981-2001, while the consumer price index (CPI) provided data on prices. The HES surveys approximately 3,000 private households in NZ. Data were collected annually until 1998 when the survey switched to once every three years.<sup>2</sup> Information on food expenditure is collected principally by way of a 14-day diary. The HES is subject to sampling and non-sampling error. Non-sampling error arises in a variety of ways including through the exclusion of people not living in private permanent dwellings, the omission of some purchases by

---

<sup>2</sup> Since there is a three year gap between the observations in 1998 and 2001, the 2001 values were expressed in terms of their annual equivalents: value in 1998 + (value in 2001 - value in 1998)/3.

respondents (e.g. alcoholic drinks and confectionery) and the exclusion of expenditure by children under 15 years.

There are two breaks in the HES data. The first is between 1989 and 1990 when the system used to weight the survey to the total population was changed. Statistics New Zealand introduced integrated weighting to the HES in the 2000/01 survey. It has revised the series back to 1990. Integrated weighting is a method of applying linear weights, which are consistent at an individual and household level, to calibrate estimates from a survey with independent population benchmarks. Prior to the introduction of integrated weighting it was known that the HES persistently underestimated the total number of people and households in NZ.<sup>3</sup> The average expenditure per household tends to be less affected by this than total expenditure, as it depends on the extent to which under-represented groups have different income or expenditure levels or patterns to the rest of the population. As we have used average expenditure per household, we have minimised this concern. The second break occurs in the movement to a three yearly cycle of surveys. Statistics NZ switched from a March year to a June year survey with the 2001 survey. This is not a substantial problem because it can be allowed for in the corresponding price data. Standard INFOS series were used for price data. Where necessary these were weighted together using the weights from the CPI.

## 4. Estimation and Results

Six conditional demand systems (corresponding to the six groups listed in table 2) using appropriate versions of equation (1) were estimated allowing for first order serial correlation as the data were time series.<sup>4</sup> Assuming normally distributed additive errors in these equations, the method of estimation was maximum likelihood as formulated by Whistler, White, Wong and Bates (2001) in their econometric program, SHAZAM. The resulting coefficient estimates (with asymptotic t-ratios within parentheses) for the food group are reported in Tables 3 and 4. Since the asymptotic t-ratios are approximately standard normal, these ratios can be compared with the 5% two-sided critical values of  $\pm 1.96$ . Coefficients that are significantly different from zero by this criterion are indicated by an asterisk.

---

<sup>3</sup> Further detail is available in the information paper *The introduction of integrated weighting to the 2000/2001 Household Economic Survey* released by Statistics NZ on 18 June 2001, and available on their website [www.stats.govt.nz](http://www.stats.govt.nz).

<sup>4</sup> A singular system like ours, where the dependent variables add up to one of the explanatory variables, requires that the autocorrelation coefficients estimated be the same for all the equations (Berndt and Savin, 1975). The estimated serial coefficients were significantly negative in all the conditional demand systems. It may be noted that with first differenced data serial correlation coefficient equals  $-0.5(1-\rho)$  where  $\rho$  is the serial correlation coefficient in the levels data. Unless  $\rho = 1$ , serial correlation in differenced data is always negative. The dependent variables in our model are share weighted first differences.

Diagnostic tests indicate that the estimated model fits the data very well. Overall goodness of fit is tested by comparing the log likelihood value of the estimated model with that of a model without real expenditure and prices to explain demands. The likelihood ratio test statistic is Chi-square with 35 degrees of freedom. The value of the test statistic is 149.45 with a p-value approximately equal to 0 indicating that the estimated model explains demands very well. The model was estimated allowing errors to be autocorrelated to the first order. Further autocorrelation is not indicated by autocorrelation tests of residuals in each equation at the 5% level of significance. The White test of heteroscedasticity was carried out in each equation allowing error variance to depend on all the squared regressors. No heteroscedasticity was detected at the 5% level of significance.

The coefficients representing trend ( $\tau_i$ ) and the difference between marginal and average budget shares ( $\alpha_i = \text{marginal share} - \text{average share}$ ) are shown in Table 3.

**Table 3 Trend and Excess Marginal Share Coefficients in a Rotterdam Model of Food for New Zealand, 1980-2001**

	Trend	Excess of marginal over average expenditure share
Fruits & vegetables	0.0015# (1.68)	-0.0539 (-1.55)
Meat	-0.0049* (-4.53)	0.0460 (1.09)
Poultry	0.0010* (2.54)	-0.0260* (-2.27)
Fish	0.0003 (0.74)	-0.0047 (-0.41)
Farm products, fats & oils	-0.0008 (-0.85)	-0.0793* (-2.05)
Cereals	-0.0010 (-1.20)	-0.1407* (-5.07)
Sweets, spreads, drinks & other foods	0.0036* (2.65)	-0.0418 (-0.72)
Restaurant & ready to eat foods	0.0003 (0.19)	0.3004* (4.98)

Notes: (1) \* and # indicate that the coefficient is significantly different from 0 at the 5% and 10% level respectively.

The trend coefficients represent the effect on demands by time related factors other than real total expenditure and relative prices. The estimates suggest that consumer tastes changed slowly over time to favour fruits & vegetables, poultry, and sweet products-spreads-drinks & other foodstuffs. It is notable that the latter category included several convenience food items. The demand for red meat trended in the opposite direction, while demands for fish, farm products-fats & oils, cereals, and meals eaten away from home remained fairly steady over time. The excess marginal share coefficients

suggest that the considerable increase in the budget share of meals eaten away from home & ready to eat food was driven primarily by the increased ability to spend more. The significant positive share difference for this item of food is notable in Table 3 suggests that consumers devote an increasing share of their extra incomes to this item.

The estimated price coefficients for the food group are reported in Table 4 as an upper triangular matrix as it is symmetric. These coefficients represent the own and cross substitution effects. All the own substitution effects are non-positive as required theoretically. The cross substitution effects that are positive at the 5 and/or 10 percent level of significance indicate product pairs that are likely to be Hicksian substitutes. As expected, meat, poultry and fish appear as substitutes. Fruits & vegetables seem to be substitutes for poultry, farm products-fats & oils, and cereals. Fish is seen to be a substitute for farm products-fats & oils, sweets-spreads-drinks & other foodstuffs, and for restaurant & ready to eat food. Cereals come out as substitutes for meat, farm products, and restaurant food. The product pairs that are likely to be Hicksian complements are: (fruits & vegetables, restaurant & ready to eat food), (poultry, cereals), (fish, cereals), and (farm products-fats & oils, sweets-spreads-drinks & other foodstuffs).

**Table 4 Price Coefficients of a Rotterdam Model of Food for New Zealand, 1980-2001**

	Fruits & veg.	Meat	Poultry	Fish	Farm products	Cereals	Sweets & other	Restaurant food
Fruits & veg.	-0.0348# (-1.90)	-0.0193 (-1.47)	0.0170* (2.69)	0.0046 (0.62)	0.0370* (3.31)	0.0291# (1.93)	0.0112 (0.60)	-0.0447* (-2.60)
Meat		-0.0885* (-5.68)	0.0217* (4.94)	0.0085* (2.04)	0.0127 (1.02)	0.0629* (5.81)	0.0161 (0.92)	-0.0142 (-0.68)
Poultry			-0.0388* (-3.68)	0.0071 (1.46)	0.0099 (1.49)	-0.0431* (-3.67)	0.0110 (1.18)	0.0152 (1.15)
Fish				-0.0300* (-5.39)	0.0173* (2.76)	-0.0741* (-8.88)	0.0172# (1.93)	0.0494* (4.15)
Farm products					-0.1099* (-6.34)	0.1162* (9.42)	-0.0453* (-3.01)	-0.0378# (-1.80)
Cereals						-0.4312* (-13.36)	0.0057 (0.33)	0.3346* (13.52)
Sweets & other							-0.0763* (-2.36)	0.0604* (1.97)
Restaurant food								-0.3628* (-7.90)

Notes: (1) \* and # indicate that the coefficient is significantly different from 0 at the 5% and 10% level respectively.

Given the marginal budget share estimates from the six conditional demand systems, Frisch price indices were calculated for each of the six consumption groups. A demand system for the six groups was then



estimated using equations (4). Estimates of this system (with t-ratios in parentheses) are reported in tables 5 and 7.

**Table 5 Trend and Excess Marginal Share Coefficients in a Rotterdam Model of Consumption for New Zealand, 1980-2001**

	Trend	Excess of marginal over average expenditure share
Food	$\approx 0$ (-0.01)	<b>-0.0877*</b> (-3.81)
Housing	<b>0.0072*</b> (5.28)	-0.0646 (-1.52)
Housing Operation	-0.0017 (-1.22)	-0.0279 (-0.76)
Apparel	-0.0012 (-1.45)	-0.0231 (-0.99)
Transport	-0.0030 (-1.07)	<b>0.1835*</b> (2.28)
Other Goods & Services	-0.0012 (-1.20)	0.0198 (0.83)

Notes: (1) \* indicates that the coefficient is significantly different from 0 at the 5% level.

The only trend coefficient that is significant at the 5% level indicates a change in tastes over time in favour of housing. As for the budget share differentials, at the 5% level, food and transport are the only commodity aggregates with marginal budget shares differing significantly from the average. The estimated difference in the case of food implies an expenditure elasticity of 0.577 in 2001. Using mixed cross section-time series and micro data respectively, Micheline (1999) and Gibson and Scobie (2002) reported similar estimates for New Zealand (0.56 and 0.57 respectively). It may also be noted that the expenditure elasticities at the group level, reported in table 6, differ significantly from 1 for the food and transport aggregates only (below 1 and above 1 respectively).

**Table 6 Elasticities of Group Demand  
in a Rotterdam Model of Consumption for New Zealand  
(Calculated at share values in 2001)**

	Own Frisch-Price Elasticity	Expenditure Elasticity
Food	-0.089# (-1.22)	0.577*# (5.19)
Housing	-0.621*# (-10.61)	0.718* (3.86)
Housing Operation	-1.135* (-4.01)	0.834* (3.83)
Apparel	-2.757*# (-3.91)	0.462 (0.85)
Transport	-0.382*# (-1.54)	1.857*# (4.93)
Other Goods & Services	-0.800* (-3.12)	1.142* (6.66)

\* indicates that the elasticity differs significantly from 0 at the 5% level.

# indicates that the elasticity (or its absolute value) differs significantly from 1 at the 5% level.

The income flexibility estimate of  $-0.7705$  obtained by imposing block additivity of preferences is highly significant ( $t = -7.94$ ). The reciprocal of this value (approximately  $-1.3$ ) is a measure of the income elasticity of marginal utility of money. Thus, a 1% rise in income is estimated to lower the marginal utility of money by 1.3%. Our estimate of income flexibility is within the range of  $-0.65$  reported by Wong and McDermott (1990) for NZ and  $-0.82$  reported by Adams, Chung and Powell (1988) for Australia. Block additivity in our model required 14 fewer coefficients to be estimated. The chi-square test statistic had a p-value of 0.061. Thus, block additivity cannot be rejected at the 5% level of significance, but the support for this hypothesis is not overwhelming. Hence, we chose not to impose this restriction in estimating the demand elasticities. The price coefficients estimated in this representation, which are shown in table 7, indicate that food and housing are substitutes at the group level, while transport and other goods & services may be complements to food.

**Table 7 Price Coefficients in a Rotterdam Model of Consumption for New Zealand, 1980-2001**

	Food	Housing	Housing Operation	Apparel	Transport	Other
Food	-0.0183 (-1.22)	<b>0.0245*</b> (2.99)	0.0256 (0.89)	0.0146 (0.60)	-0.0197 (-1.30)	-0.0266 (-1.56)
Housing		<b>-0.1420*</b> (-10.61)	<b>0.0507*</b> (3.74)	0.0060 (0.82)	<b>0.0471*</b> (2.03)	<b>0.0137#</b> (1.64)
Housing Operation			<b>-0.1908*</b> (-4.01)	<b>0.0543*</b> (2.00)	-0.0161 (-0.54)	<b>0.0762*</b> (2.28)
Apparel				<b>-0.1184*</b> (-3.91)	<b>0.0330#</b> (1.79)	0.0105 (0.42)
Transport					-0.0817 (-1.54)	<b>0.0374#</b> (1.78)
Other						<b>-0.1112*</b> (-3.12)

\* and # indicate that the coefficient is significantly different from 0 at the 5% and 10% level respectively.

The own price elasticities of the groups (with respect to the Frisch price indices) implied by the estimates in table 7 were included in table 6. As might be expected, food, housing and transport demands are price inelastic, with food being the most price inelastic. In contrast, the demand for apparel is highly price elastic.

The expenditure and price elasticities of demand for the food subgroups evaluated at the observed budget shares in the year 2000/01 and using the formulae (5) – (8) are presented in Table 8.

**Table 8 Elasticities of Demand for the Food Subgroups in New Zealand at the Share values in 2001 (Asymptotic t-ratios within parentheses)**

	fruits veg	& meat	poultry	fish	farm	cereals	sweets & other	restr. food
Pfruit&veg	-0.253* (-1.96)	-0.220# (-1.69)	0.523* (2.59)	0.218 (0.56)	0.330* (3.16)	0.235# (1.89)	0.027 (0.33)	-0.255* (-3.25)
Pmeat	-0.147 (-1.60)	-0.877* (-5.74)	0.669* (4.79)	0.424# (1.91)	0.109 (0.94)	0.504* (5.66)	0.049 (0.62)	-0.122 (-1.34)
Ppoultry	0.112* (2.60)	0.200* (4.70)	-1.205* (-3.68)	0.367 (1.44)	0.089 (1.46)	-0.343* (-3.65)	0.044 (1.09)	0.056 (0.97)
Pfish	0.029 (0.57)	0.076# (1.89)	0.221 (1.46)	-1.562* (-5.41)	0.157* (2.75)	-0.590* (-8.91)	0.072# (1.87)	0.207* (4.00)
Pfarm	0.240* (3.21)	0.098 (0.82)	0.304 (1.47)	0.888* (2.72)	-1.007* (-6.40)	0.927* (9.49)	-0.210* (-3.23)	-0.201* (-2.18)
pcereals	0.188# (1.86)	0.577* (5.62)	-1.340* (-3.70)	-3.859* (-8.99)	1.055* (9.50)	-3.433* (-13.42)	0.014 (0.18)	1.425* (13.18)
psweets & other	0.048 (0.38)	0.089 (0.53)	0.333 (1.16)	0.859# (1.88)	-0.426* (-3.07)	0.051 (0.37)	-0.367* (-2.63)	0.161 (1.19)
prestr. food	-0.350* (-2.88)	-0.242 (-1.24)	0.457 (1.11)	2.508* (4.06)	-0.365# (-1.89)	2.673* (13.32)	0.201 (1.49)	-1.751* (-8.72)
expenditure	0.366* (2.70)	0.828* (3.61)	0.111 (0.54)	0.436 (1.26)	0.160 (0.79)	-0.069 (-0.55)	0.472* (3.26)	1.331* (8.78)

\* and # indicate that the elasticity is significantly different from 0 at the 5% and 10% level respectively.

The estimated expenditure elasticities indicate that meals eaten away from home & ready to eat food are highly sensitive to income. Other things remaining the same, demand for this item may rise by 1.33% if total consumption expenditures increased by 1%. This is very close to the corresponding estimate of 1.3 reported by Gibson and Scobie (2002). With its expenditure elasticity not being significantly below 1, the demand for red meat appears to increase proportionately to income, but demands for the other food subgroups are likely to be income inelastic. Cereals appear to be an inferior good, but the estimated expenditure elasticity is not significantly negative. We may conclude that the demand per capita for cereals is not influenced by income.

Demands for cereals and meals eaten away from home & ready to eat food are the most responsive to their own prices. A 1% fall in the price of cereals and cereal products is likely to cause a 3.4% rise in its demand per capita, other things remaining the same. Demand for fish is also own price elastic. With approximately unitary own price elasticities, demands for meat, poultry and farm products-fats & oils are also fairly responsive to their own prices, while demands for fruits & vegetables and sweet products-spreads-drinks & other foodstuffs seem to be characterized by inelastic response to own price changes.

The size and significance of the estimates suggest that the demand for fruits & vegetables, red meat, farm products-fats & oils, sweets-spreads-drinks & other foods and for meals away from home are not very sensitive to other prices except that demand for meals away from home and ready to eat food and for farm products-fats & oils responds strongly to the price of cereals. The larger cross elasticities are observed for fish and cereals. Demand for fish appears to be particularly responsive to the price of cereals; other prices and nominal food expenditures remaining the same, a 1% fall in the latter may increase demand for fish by about 3.9%. Similarly, a 1% increase in the price of restaurant and ready to eat foods is likely to increase demand for fish by about 2.5%. Demand for cereals and cereal products also responds forcefully to a change in the prices of restaurant & ready to eat foods and farm products-fats & oils. A 1% growth in either of these cross prices may raise demand for cereals per capita by about 2.7% and 0.9% respectively. Of all the food prices, the price of cereals appears to have the most influence on demand for the other food items (besides its strong effect on demand for fish). A rise in the price of cereals by 1% may cause demand for farm products-fats & oils and for meals eaten away from home to increase by about 1% and 1.4% respectively, while reducing the demand for poultry by about 1.3%. Finally, the demand for poultry can be expected to rise by about 0.67% if price of red meat increased by 1%, in the absence of any other influences.

The elasticities reported in table 8 include only those with respect to the food prices, but the demand for any of the food items can also respond to changes in the prices of goods belonging to any of the other groups. For example, elasticities of demand for eating out with respect to all the non-food prices, calculated using appropriate versions of formulae (7) and (8) and the budget shares in 2001, are shown in table 9. An increase in a non-food price can influence demand for eating out by lowering real income and/or by influencing the allocation of that income to the food group as a whole as this group becomes relatively cheaper. Most of these price effects are small in magnitude. Only four out of the twenty eight elasticities have an absolute value of 0.1 or more – overseas travel (-0.145), private transport (-0.336), alcohol (-0.105) and leisure & recreation (-0.169). The transport and other goods & services groups, to which these items belong, appear to be complements to the food group as indicated by the group price

coefficients in table 7. Thus, an increase in the prices of these items lowers the demand for eating out by lowering real income and by reducing the budget allocated to the food group.

## 5. Conclusions

The trend coefficients in Table 3 demonstrate movements over the last 20 years towards increased household consumption of fruits and vegetables, poultry and sweet products-spreads-drinks and other foodstuffs. The sweet products category includes carbonated drinks, juices and water where we might expect to see increases in market shares. The expenditure elasticity estimates confirm that restaurant foods have a very elastic demand (1.3) that was signalled by the budget share difference. Convenience and eating away from home are important factors in current consumer spending.

Meat and poultry consumption are trending in opposite directions, as expected. However, the expenditure elasticities indicate that income is offsetting the trend effects to some extent. The expenditure elasticity for poultry is estimated to be close to zero while meat has a more elastic expenditure effect (elasticity  $\approx 1$ ). This is much higher than was estimated by Court (1967). Meat (red) appears to have ‘carved out’ a high quality niche at the expense of poultry. Poultry now appears to be a “basic need” meat with its marginal budget share falling short of its average budget share.

A number of product groups are now quite price elastic. Fish, poultry, meat, farm products (eggs, dairy products, vegetable oils and fats), cereals (and bakery products) and meals away from home are all more price elastic than earlier estimates would indicate. Cereals (and bakery products) are estimated to be particularly price elastic. These estimates may reflect the increased variety of products in these groupings. Coupled with these own price elasticities, cross price elasticities are also estimated to be high for both substitutes and complements. If we take the demand for cereals & cereal products as an example, the cross price elasticities for the three estimated substitutes, meat, farm products and restaurant meals are all greater than 0.5 (Table 8).

Retail food markets in NZ would appear, on this evidence, to be very elastic as compared to earlier views. A number of implications stem from this. Investment in food product development will tend to be subject to more market risk than was historically the case. Considerable care is required to target changing consumer requirements. Secondly, consumers are less exposed to retail food market exploitation. One may infer from these elasticity estimates that competition policy concerns ought to be much less than previously. It is much harder for manufacturers or retailers to sustain price gouging strategies when consumers are prepared to switch expenditures between product groupings to the extent shown in these

estimates. Nevertheless, further research is needed to support these conclusions. Cross sectional data are available by household income groups, and this data could be valuable in verifying the expenditure elasticities at the level of disaggregation used in this paper. However, the results reported in this work are likely to be reliable as our key estimates at the aggregate level are in line with those reported for New Zealand using mixed cross section-time series and micro data.

**Table 9 Elasticities of Demand for Meals Away from Home with respect to Non-Food Prices in New Zealand at Share values in 2001 (Asymptotic t-ratios within parentheses)**

	With respect to price of:	
Rental housing	-0.032* (-2.26)	Men's footwear 0.008# (1.84)
Owner-occupied housing	≈ 0 (0.02)	Women's footwear 0.015* (2.81)
Fuel & power	-0.009 (-1.33)	Children's footwear 0.007 (1.34)
Home appliances & utensils	0.010 (0.78)	Public transport -0.023* (-7.45)
Furniture & furnishings	0.014 (1.14)	Overseas travel -0.145* (-6.68)
Floor coverings	0.022* (2.19)	Private transport -0.336* (-8.30)
Household textiles	0.003 (0.42)	Tobacco -0.019# (-1.74)
Household supplies	-0.024* (-2.38)	Alcohol -0.105* (-5.22)
Household services	0.045* (2.24)	Medical -0.034* (-5.45)
Men's clothing	0.002 (0.17)	Toiletries & cosmetics -0.025* (-2.67)
Women's clothing	0.062* (2.55)	Personal goods -0.023 (-1.61)
Children's clothing	0.033* (3.33)	Leisure & recreation -0.169* (-5.16)
Other clothing	-0.021 (-0.89)	Health services -0.086* (-4.81)
Clothing supplies & services	≈ 0 (0.01)	Personal services -0.020* (-2.84)

\* and # indicate that the elasticity is significantly different from 0 at the 5% and 10% level respectively.

## 6. References

- Adams, P. D., C-F. Chung and A. A. Powell (1988), "Australian Estimates of Working's Model Under Additive Preferences", Working Paper No. 0-61, Impact Research Centre, The University of Melbourne.
- Berndt, Ernst R. and N. Eugene Savin (1975), "Estimation and Hypothesis Testing in Singular Equation Systems with Autoregressive Disturbances", Econometrica, 43 (5-6), 937-957.
- Chatterjee, Srikanta, Claudio Michelini and Ranjan Ray (1994), "Expenditure Patterns and Aggregate consumer Behaviour; Some Experiments with Australian and New Zealand Data, Economic Record, 70, 278-291.
- Court, Robin (1967), "Utility Maximisation and the Demand for New Zealand Meats", Econometrica, 35 (3-4), 424-446.
- Gibson, J. and G. Scobie (2002), "Are We Growing Faster than We Think? An Estimate of 'CPI bias' for New Zealand", Paper presented at the New Zealand Association of Economists conference, Wellington, New Zealand.
- Giles, David and Peter Hampton (1985), "An Engel Curve Analysis of Household Expenditure in New Zealand", Economic Record, 61, 450-462.
- Keller, W. J. and J. Van Driel (1985), "Differential Consumer Demand Systems", European Economic Review, 27, 375-390.
- McDougall, Robert, Aziz Elbebri and Truong P. Truong (1998) eds., The GTAP Database, West Layayette, Indiana: Center for Global Trade Analysis, Purdue University.
- Michelini, Claudio (1999), "New Zealand Household Consumption Patterns, 1983-92: An Application of the Almost Ideal Demand System", N.Z. Economic Papers, 33 (2), 15-26.
- Michelini, Claudio and Srikanta Chatterjee (1997), "Demographic Variables in Demand Systems: An Analysis of New Zealand Household Expenditures, 1984-92", N.Z. Economic Papers, 31 (2), 153-173.
- NZ Department of Statistics (1980), "Application of Engel Curves to NZ Household Expenditures and the Estimation of Simple Equivalence Scales", New Zealand Department of Statistics, Wellington.
- OECD (2001), Pers. Comm., Agriculture Division, Organisation for Economic Cooperation and Development, Paris.



- Theil, H. and K. W. Clements (1987), Applied Demand Analysis: Results from System-Wide Approaches, Cambridge, Mass.: Ballinger Publishing Company.
- Whistler, D., White, K. J., Wong S. D. and Bates D., (2001), SHAZAM User's Reference Manual Version 9.0, Vancouver, B.C.: Northwest Econometrics Ltd.
- Wong, A. Y-T. and C. J. McDermott (1990), "Consumption of Durables, Non-durables and Services in New Zealand: A Systemwide Analysis", N.Z. Economic Papers, 24 (2), 115-127.
- Working, H. (1943), "Statistical Laws of Family Expenditure", Journal of the American Statistical Association, 38, 43-56.