Fragmenting markets and quality change in New Zealand foods: empirical analysis with a Rotterdam model

Segmentierte Märkte und Qualitätsänderungen bei Lebensmitteln in Neuseeland: Empirische Analyse mit einem Rotterdam-Modell

Mohammed Khaled
Victoria University of Wellington, New Zealand

Vhari McWha
New Zealand Institute of Economic Research, Wellington, New Zealand

and Ralph Lattimore
Nelson Marlborough Institute of Technology, Nelson, New Zealand

Abstract

Very little is known about changes in the demand characteristics of food in New Zealand. As far as we can determine, there has never been a complete disaggregated food demand model estimated for New Zealand. 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 magnitude of food demand elasticities in New Zealand. To this end, a Rotterdam food demand system is estimated using time series data. 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. Fish, poultry, meat, farm products, cereals and meals away from home are all more price elastic than earlier estimates.

Key words

consumer behaviour; food demand; agricultural and food policy; Rotterdam model; food quality; New Zealand

Zusammenfassung

Es ist aus empirischen Nachfrageanalysen sehr wenig darüber bekannt, wie sich die Nahrungsmittelnachfrage in Neuseeland im Zeitablauf verändert hat. Unseres Wissens ist bisher kein disaggregiertes Nachfragesystem für die Gruppe der Nahrungsmittel am Beispiel Neuseelands geschätzt worden. Zielsetzung dieses Beitrags ist, frühere empirische Nachfrageanalysen zu aktualisieren, indem neuere Daten verwendet werden. Dabei wird der Frage nachgegangen, ob der Strukturwandel im Nahrungsmittelverbrauch in den letzten zwei Jahrzehnten Wirkungen auf die Größenordnung der Nachfrageelastizitäten bei Nahrungsmitteln in Neuseeland hatte. Zu diesem Zweck wird ein Nachfragesystem vom Rotterdam-Typ auf der Grundlage von Zeitreihendaten geschätzt. Die Ergebnisse zeigen, dass der Verbrauch der privaten Haushalte bei Früchten und Gemüse, Geflügelfleisch, im Außer-Haus-Verzehr, bei Süßwaren, Getränken und anderen Nahrungsmitteln über die letzten 20 Jahre angestiegen ist. Hier haben sich im Zeitablauf die Präferenzen geändert, und vieles deutet auf veränderte Qualitätseinschätzungen der Verbraucher gegenüber diesen Produkten hin. Die Nachfrage nach Fisch, Geflügelfleisch, Fleisch, landwirtschaftlichen Produkten, Getreide und nach Mahlzeiten außer Haus ist jeweils preiselastischer, als es nach früheren Schätzungen zu erwarten war.

Schlüsselwörter

Verbraucherverhalten; Nahrungsmittelnachfrage; Ernährungspolitik; Rotterdam-Modell; Nahrungsmittelqualität; Neuseeland

1. Introduction

Market fragmentation is a phenomenon associated with the development of increasingly heterogeneous markets – an increasing focus on quality and variety that appeals to higher-income consumers and the broadening sets of preferences this reveals. Fragmentation has important implications for the structure of food markets and for food market competition. 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 can 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.

The formal econometric search entailed in this exercise can also enable us to say something about changing quality perceptions of consumers. Our model is designed to pick up trend elements that are not associated with price and income effects. We attribute these broadly to quality effects.

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), MICHELINI and CHATTERJEE (1997), MICHELINI (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). The only exception is the COURT (1967) estimate for pigmeat, a luxury meat item at that time.

Table 1. Past estimates of NZ food demand elasticities

		Elasticities			
		Own price	Cross price		Expenditure[1]
MCDOUGALL, ELBEBRI and TRUONG	Grains	-0.06			0.09
	Other food	-0.27			0.41
	Meat	-0.06			0.09
	Dairy	-0.06			0.09
	Beverages & tobacco	-0.55			0.89
OECD	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
	Sheep meat	-0.34	0.79 (pig)	-0.30 (beef)	0.42
	Pig meat	-1.25	0.55 (beef)	0.79 (sheep)	0.97
GILES and HAMPTON[2]	Food				0.6 – 0.9
CHATTERJEE, MICHELINI and RAY[3]	Food	-0.7			0.9
MICHELINI and CHATTERJEE[4]	Food	-0.32			-0.35
MICHELINI[5]	Food	-0.17			0.56
GIBSON and SCOBIE	Food	-0.34			0.57

Footnotes:
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).

Source: authors' computation

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.

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 and any quality changes that trend elements can pick up.

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 on other festive occasions. Poultry (at least chicken) consumption increased rapidly from that period.

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. Dairies and small 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. 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.

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, red 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 the price of a subgroup belonging to any of the other groups (e.g. meat with respect to the price of, 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). The further inclusion of an intercept in each of the equations in the Rotterdam model allows trend-like changes in tastes over time:

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

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 ith 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 α_{iA} measures the difference between the marginal and average budget shares of good i in group A, while the price coefficients γ_{ij} represents 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 $\sum_{i\in A}\tau_i = 0$, $\sum_{i\in A}\alpha_{iA} = 0$, $\gamma_{ij} = \gamma_{ji}$ and $\sum_{j\in A}\gamma_{ij} = 0$. Concavity requires the additional restriction that the matrix of the γ_{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.[1] Compared to a general matrix Σ 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 Σ.

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 $g = A,...,G$. If consumer preferences are weakly separable in these groups, the absolute price version of the Rotterdam model at this level of aggregation is:

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

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 τ_g satisfying the restriction $\sum_g \tau_g = 0$. The difference between marginal and average budget shares of group g is given by α_g such that $\sum_g \alpha_g = 0$. The group demands are also subject to the restrictions $\sum_h \gamma_{gh} = 0$, with the matrix of γ_{gh} values being symmetric negative semi-definite.

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

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

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:

(4) $$E_{ij}^* = (\gamma_{ij}/s_{iA}) + (\gamma_{AA}\beta_{iA}\beta_{jA})/(s_{iA}s_A)$$
for all $i, j\in A$

(5) $$E_{ij}^* = (\gamma_{Ah}\beta_{iA}\beta_{jh})/(s_{iA}s_A)$$
for all $i\in A$ and $j\in h\neq A$

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

[1] Another advantage of the Rotterdam model over the equally flexible models like AIDS is that the variables appear in their first differences. Typically, this makes the variables in a regression stationary in order to allow the standard asymptotic tests of hypotheses.

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

Note that the group demand system (2) can be estimated only if the Frisch price indices are available. This requires prior estimation of all α_{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 (18 after differencing) are inadequate to allow successful maximum likelihood estimation of the demand system with a full error covariance matrix.[2] 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.

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.[3] Information on food expenditure is collected principally by way of a 14-day diary. Non-sampling errors arise in the HES in a variety of ways including through the exclusion of people not living in private permanent dwellings, the omission of some purchases by 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.[4] 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 using appropriate versions of equation (1) were estimated allowing for first-order serial correlation as the data were time series.[5] Assuming normally distributed additive errors in these equations, the method of estimation was maximum likelihood as formulated by WHISTLER et al. (2001) in their econometric program, SHAZAM. The resulting price coefficient estimates for the food group are not reported here in the interests of space. However, the implied price elasticity estimates are reported in table 6. There, the asymptotic t-ratios are approximately standard normal, and these ratios can be compared with the 5% two-sided critical values of ± 1.96. Coefficients that are significantly different from zero by this criterion are indicated by an asterisk.

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 (τ_i) and the difference between marginal and average budget shares (α_i = marginal share – average share) are shown in table 2.

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2 KELLER and DRIEL (1985: 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.

3 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.

4 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 http://www.stats.govt.nz.

5 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-ρ) where ρ is the serial correlation coefficient in the levels data. Unless ρ = 1, serial correlation in differenced data is always negative. The dependent variables in our model are share-weighted first differences.

Table 2. Trend and excess marginal share coefficients in a Rotterdam model of food for New Zealand, 1981-2001

	Trend	Excess of marginal over average expenditure share
Fruits & vegetables	0.0015[#] (1.68)	-0.0539 (-1.55)
Red 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 foods	0.0003 (0.19)	0.3004* (4.98)

* and # indicate that the coefficient is significantly different from 0 at the 5% and 10% level respectively. Values within parentheses are the t-ratios.

Source: authors' computations

The trend coefficients represent the effect on demands by time-related factors other than real total expenditure and relative prices. These trends are expected to include quality influences, mostly driven by consumer demand for such characteristics. 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.[6] 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 2 suggesting that consumers devote an increasing share of their extra incomes to this item.

Given the marginal budget share estimates from the six conditional demand systems, Frisch price indices were calculated for each of the six consumption groups.[7] A demand system for the six groups was then estimated using equations (2). Estimates of this system (with t-ratios in parentheses) are reported in tables 3, 4 and 5.

Table 3. Trend and excess marginal share coefficients in a Rotterdam model of consumption for New Zealand, 1981-2001

	Trend	Excess of marginal over average expenditure share
Food	≈ 0 (-0.01)	-0.0877* (-3.81)
Housing	0.0072* (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)	0.1835* (2.28)
Other	-0.0012 (-1.20)	0.0198 (0.83)

* indicates that the coefficient is significantly different from 0 at the 5% level. Values within parentheses are the t-ratios.

Source: authors' computations

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.

Table 4. 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	-0.800* (-3.12)	1.142* (6.66)

* indicates that the elasticity differs significantly from 0 at the 5% level. Values within parentheses are the t-ratios. # indicates that the elasticity (or its absolute value) differs significantly from 1 at the 5% level.

Source: authors' computations

6 The decline in demand for red meat is likely to have occurred primarily at the expense of lower quality red meat. Greater health consciousness over time would have led consumers to switch to lean red meats. A characteristics approach to demand, making demand for goods dependent on 'consumption technology' relating goods to characteristics besides the commodity prices and income, might actually show an increase in demand for goods with a larger share of the desired characteristics. Incorporating this feature into the conventional approach to demand would require further chacteristics-based product differentiation (ANDERSON et al., 1989) or adjustment of the goods using an index of quality.

7 A list of items belonging to the five non-food consumption groups appears in table 7.

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, MICHELINI (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 4, differ significantly from 1 for the food and transport aggregates only (below 1 and above 1 respectively).

The price coefficients estimated in the group demand system, shown in table 5, indicate that food and housing are substitutes at the group level, while transport and other goods & services may be complements to food.

Table 5. Price coefficients in a Rotterdam model of consumption for New Zealand, 1981-2001

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

* and # indicate that the coefficient is significantly different from 0 at the 5% and 10% level respectively. Values within parentheses are the t-ratios.

Source: authors' computations

The own price elasticities of the groups (with respect to the Frisch price indices) implied by the estimates in table 5 were included in table 4. As might be expected, food, housing and transport demands are price inelastic, with food being the most price inelastic.[8] 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 (3) – (6) are presented in table 6.

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, 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. This is not a surprising development, as cereals figure towards the bottom of the widely promoted NZ food pyramid. An increased demand for convenience foods can explain the large price elasticity in the case of meals eaten away from home & ready-to-eat food. Demand for fish is also own price elastic, this item, although a bit pricey, being considered a healthy alternative to meat. Demand for fruits & vegetables, on the other hand, seems to be characterized by inelastic response to own price changes. The "5 + a day" campaign for this item of food in New Zealand may have raised the subsistence component of this item considerably relative to the price sensitive component.

Several of the cross-price elasticities are also large, the larger ones being observed for fish and cereals, both items deemed to be part of a healthy food regime. 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%, and demand for cereals by about 2.7%. A trade-off between convenience and healthy eating may be driving this phenomenon.

The elasticities reported in table 6 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 (5) and (6) and the budget shares in 2001, are shown in table 7. 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

8 For comparability with other studies, we also estimated the own price elasticity of food with respect to a Divisia food price index that uses average budget shares of the various food items as the weights. A similar estimate was obtained, –0.0867 with standard error 0.083. It doesn't differ significantly from 0, and is likely to be within 0 to –0.23 (as values on the other side of –0.23 have a probability of less than 5%). MICHELINI (1999) reported an estimate that didn't differ significantly from 0 either (–0.17 with standard error 0.20). GIBSON and SCOBIE's (2002) initial estimate of –0.38 was also subject to a wide sampling error; their suggested likely range of –0.3 to –0.4 was based on the assumption of additive preferences and a range of alternative values of income flexibility.

Table 6. Elasticities of demand for the food subgroups in New Zealand (calculated at share values in 2001)

	Fruits & vegetables	Red meat	Poultry	Fish	Farm products, fats & oils	Cereals	Sweets & other	Restaurant foods
Fruit & 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)
Red meat	-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)
Poultry	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)
Fish	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)
Farm	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)
Cereals	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)
Sweets & 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)
Restaurant foods	-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. Values within parentheses are the t-ratios.

Source: authors' computations

Table 7. Elasticities of demand for restaurant foods with respect to non-food prices in New Zealand (calculated at share values in 2001)

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. Values within parentheses are the t-ratios.

Source: authors' computations

groups, to which these items belong, appear to be complements to the food group as indicated by the group price coefficients in table 5. 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. Summary and conclusions

The trend coefficients in table 2 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 signaled by the budget share difference. With rising incomes, convenience and eating away from home have become important factors in current consumer spending in New Zealand.

Red meat and poultry consumption are trending in opposite directions, as expected owing to increased health awareness. 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 ≈ 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, which may itself have been driven by increased consumer demand for quality in product variants. 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, red meat, farm products and restaurant meals are all greater than 0.5 (table 6).

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. High responsiveness is likely to be quality driven, at least in part. 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 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 suppliers to sustain price-gouging strategies when consumers are prepared to switch expenditures between product groupings to the extent shown in these estimates. This begs questions regarding the structure of the food supply chain and in particular the relationship between food manufacturers and food retailers. This needs to be the subject of further research because a wide range of factors affects the market power of retailers including consumer travel habits and the spatial characteristics of markets. Factors such as these can be expected to vary across national jurisdictions.

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.

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Corresponding author:
DR. RALPH LATTIMORE
Nelson Marlborough Institute of Technology
322 Hardy Street, Nelson, New Zealand
phone: +(64)-3-544 52 46
e-mail: Ralph.Lattimore@xtra.con.nz