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Constant market shares analysis: uses, limitations and prospects*

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In this paper, we generalise the constant market shares (CMS) framework, with particular attention to the underlying theoretical conditions required for diagnostic interpretation. The approach is applied to the analysis of the export performance of the Australian processed food sector in South-East Asia over the period 1980–2003. We conclude that the usefulness of CMS analysis for evaluating a country's international trade performance depends upon the empirical validity of the aggregation assumptions implicit in the diagnostic interpretation.

Key words: aggregation, Armington model, competitiveness, constant market shares.

1. Introduction

Constant market shares (CMS) analysis is a technique for analysing trading patterns and trends for the purpose of policy formulation. The technique is intended to shed light on the factors underlying a country's comparative export performance. Based on an identity, the method is first and foremost a descriptive tool indicating whether or not a country's comparative export performance reflects changing market shares or total market growth. The more ambitious would want the method to specify the factors underlying these shifts, such as relative prices and income. However, the shift from descriptive to diagnostic analysis requires a clear understanding of the theoretical model implicit in the presumption that market shares only reflect a country's international competitive performance.

The traditional CMS model was first applied to the study of international trade by Tyszynski (1951). Some recent studies still use this model despite the problems widely documented by, among others, Richardson (1971a,b), Jepma (1986), and Oldersma and Van Bergeijk (1993). For example, Drysdale and Lu (1996) use the traditional model to assess Australia's overall export performance over the decade to 1994. Brownie and Dalziel (1993) employ the traditional model to analyse New Zealand's export performance

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over the period 1970–1984. A comprehensive list of previous applications and appraisals can be found in Merkies and van der Meer (1988).

An alternative model was proposed by Jepma (1986), which overcomes some of the traditional model's problems. Applications of Jepma's revised model include Jepma (1986, 1988) and Hoen and Wagener (1989). Ahmadi-Esfahani (1993, 1995) and Ahmadi-Esfahani and Jensen (1994) use Jepma's model to analyse Australian wheat exports to Egypt, Japan, and China, respectively. However, resorting to the traditional model, while Jepma's model is available, implies that Jepma's model is probably still far from satisfactory. Indeed, it is very difficult to interpret various components of the model.

This paper is meant to provide a generalised CMS framework based on Jepma's revision, and assess the extent to which CMS analysis is a viable method for exploratory analysis. It discusses the assumption underlying CMS, the 'market share norm', and then CMS's limitations and potential both as a tool for description and a tool for diagnosis. An application of the generalised framework to the export performance of Australia's food producers in South-East Asia (SEA) is presented.

2. Basic model

As indicated, CMS analysis involves decomposition of an identity. For a measure of a country's comparative export performance, we take the ratio of its exports to those of a standard:

$$S \equiv \frac{x}{X} \tag{1}$$

where S is the ratio of exports of a 'focus country', x to X, the exports of one or more countries that serve as a standard of comparison. For some insight into the factors underlying the competitive performance of a country, the (proportional) change in exports, q, is decomposed into three terms: a scale effect, Q, a competitive effect, s, and a second-order effect, sQ:

$$q \equiv Q + s + sQ \tag{2}$$

where q, Q and s are the proportional changes of x, X and S, respectively, over a discrete period of time.

From one perspective, the decomposition into the three effects is a matter of definition, as Equation (2) is based on an identity. To this extent, interpretation involves a description of past trading patterns. However, description inevitably leads to inferences regarding the forces underlying the country's export performance and, thereby, an interpretation that is diagnostic. At the heart of the diagnostic interpretation is the market-shares norm, or the presumption that changes in market share, s, reflect purely competitive conditions (Junz and Rhomberg 1965). Although the market shares norm yields an immediate and unambiguous interpretation of the three terms, in practice the actual data will not generally conform to the requisite aggregation conditions. The usefulness of CMS analysis as a diagnostic tool hinges on the extent to which the market-shares norm is empirically acceptable.

The model above, Equation (2), can be thought of as the aggregate version of Equation (3) below. That is, when exports are differentiated in terms of product type ($i = 1, \ldots, I$) and regional destination ($j = 1, \ldots, J$), the export growth for the focus country, say Australia, in market ij can be written as follows:

$$q_{ij} \equiv Q_{ij} + s_{ij} + s_{ij}Q_{ij} \tag{3}$$

where $q_{ij} = \Delta x_{ij}/x_{0ij}$ is the growth in exports of Australia for the (i, j)th commodity; $Q_{ij} = \Delta X_{ij}/X_{0ij}$ is the growth in exports of the set of countries against which the focus country's export performance is compared, herein called the reference group or standard; and $s_{ij} = \Delta S_{ij}/S_{0ij}$ is the growth in the export ratio for the (ij)th commodity.

Therefore, CMS analysis can be applied to each predefined market. Aggregate export growth is, then, a weighted average of growth over the IJ markets:

$$q = \sum_{ij} w_{0ij} q_{ij} \tag{3a}$$

where $w_{0ij} = x_{0ij}/x_0$; $x = \sum_{ij} X_{ij}$; and $q = \Delta x/x_0$.

The weights, w_{0ij}, represent the composition of exports from the focus country. Substituting (3) into (3a), we derive an expression for what can be called the *basic* CMS model:

$$q = \sum_{j} w_{ij} q_{ij} = \sum_{ij} w_{0ij} Q_{ij} + \sum_{ij} w_{0ij} s_{ij} + \sum_{ij} w_{0ij} s_{ij} Q_{ij} \tag{3b}$$

Table 1 provides the interpretation of the three components. The scale effect (SE) is the growth in exports if individual market shares were constant, whereas the competitive effect (CE) assumes imports are fixed. The second-order effect (SOE) indicates how well the exporting country has adapted its export share to make use of the import growth of its trading partner (Fagerberg and Sollie 1987). A negative SOE means that the exporter has lost market share in markets that grow quickly, and gain market share in markets that grow slowly.

Table 1 First-level analysis

Name	Formula	Interpretation
Scale effect (SE)	$\sum_{ij} w_{0ij} Q_{ij}$	Average growth in Australian exports if individual market shares are constant
Competitive effect (CE)	$\sum_{ij} w_{0ij} s_{ij}$	Average growth in Australian exports if imports are fixed
Second-order effect (SOE)	$\sum_{ij} w_{0ij} Q_{ij} s_{ij}$	Residual term, reflecting the average correlation between export growth and market share growth

Table 2a Second-level analysis – decomposition of the scale effect

Name	Formula	Interpretation
Scale-aggregate growth effect (SAGE)	$Q = \Sigma_{ij}\Delta X_{ij}/\Sigma_{ij}X_{0ij}$	Average scale effect if scale effects are uniform across markets
Scale-market effect (SME)	$\Sigma_{ij}w_{0ij}(Q_{ij} - Q)$	Average impact of differential scale effects across markets

Table 2b Second-level analysis – decomposition of competitive effect

Name	Formula	Interpretation
Competitive aggregrate growth effect (CAGE)	$s = \Sigma_{ij}\Delta S_{ij}/\Sigma_{ij}S_{0ij}$	Average competitive effect if competitive effects are uniform across markets
Competitive market effect (CME)	$\Sigma_{ij}w_{0ij}(s_{ij} - s)$	Average impact of differential competitive effects across markets

3. Extensions to the basic model

The scale effect and competitive effect in the basic model can be further decomposed to provide insights into whether they are due to the general growth in all markets or due mostly to the growth in some markets. This decomposition at the second level is presented in Tables 2a and 2b. The aggregate effects (SAGE and CAGE) assume that the scale or competitive effect is uniform across markets, whereas the market effects (SME and CME) measure the resulting aggregation bias, averaged across all markets. The market effects indicate whether or not export structure (represented by the weights, w) can have an influence on the country's export growth. A positive market effect suggests that the exporter has been targeting the 'right' markets.

A third-level analysis goes further and decomposes the market effects according to whether or not market-specific effects arise from the product markets (SPE and CPE), the regions (SRE and CRE) and whether or not there is a combination of the two (SIE and CIE). The product effects will be positive if the export structure favours those markets in which market growth is above average (for the SPE) or growth in market share is above average (for the CPE). The interaction terms, SIE and CIE, indicate whether product and regional effects reinforce or offset one another. If the product and regional effects reinforce each other, part of the export growth attributed to the regional effect will also have been accounted for under the produce effect, which needs to be corrected by the interaction terms.

This CMS model differs from the traditional model in a number of ways. In the traditional model, as presented in Leamer and Stern (1970), there is no interaction term, the second-order effect (SOE). The SOE is effectively combined with the competitive effect. As discussed, the SOE has its own meaning and the inclusion of all three effects provides what one would expect to be a useful method for descriptive analysis.

Table 3a Third-level analysis – decomposition of the scale market effect

Name	Formula	Interpretation
Scale regional effect (SRE)	$\sum_{ij} w_{0ij}(Q_{ij} - Q_i)$	Average scale market effect if scale market effects differ across regions alone
Scale product effect (SPE)	$\sum_{ij} w_{0ij}(Q_{ij} - Q_j)$	Average scale market effect if scale market effects differ across products alone
Scale interaction effect (SIE)	$\sum_{i} w_{0ij}(SME_{ij} - SRE_{ij} - SPE_{ij})$	Average impact of differential import growth across both regions and products (negative if the product/regional effect reinforces the regional/product effect)

Table 3b Third-level analysis – decomposition of competitive market effect

Name	Formula	Interpretation
Competitive regional effect (CRE)	$\sum_{ij} w_{0ij}(s_{ij} - s_i)$	Average competitive market effect if competitive market effects differ across regions alone
Competitive product effect (CPE)	$\sum_{ij} w_{0ij}(s_{ij} - s_j)$	Average competitive market effect if competitive market effects differ across products alone
Competitive interaction effect (CIE)	$\sum_{ij} w_{0ij}(CME_{ij} - CRE_{ij} - CPE_{ij})$	Average impact of differential growth in shares across both regions and products (negative if the product/regional effect reinforces the regional/product effect)

A second important issue is the order problem. At the third level of decomposition, the traditional model would accept the scale product effect to be either $\sum_{ij} w_{0ij}(Q_{ij} - Q_j)$ or $\sum_{ij} w_{0ij}(Q_i - Q)$. These two terms are not equal and create inconsistency (Richardson 1971a). Jepma (1986) argues that if the product effect is represented by $\sum_{ij} w_{0ij}(Q_i - Q)$, the exporting country is compared to the standard country with the implicit assumption that the two have the same geographical distribution of commodity (no regional effects are taken into account). However, real data show that there are rigidities in export structure and the commodity composition of the export country cannot always adjust exactly to that of the standard country, which falsifies the above assumption (Jepma 1986, p. 23). Therefore, the product effect should be represented by $\sum_{ij} w_{0ij}(Q_{ij} - Q_j)$ and the regional effect should be represented by $\sum_{ij} w_{0ij}(Q_{ij} - Q_i)$.

The third advantage is that following the framework of the three levels presented can help provide better insights into what contributes to the export growth. This will be illustrated in the last section.

4. Market-shares norm

The primary source of dispute has been the use of CMS as a diagnostic tool (Houston 1967; Ooms 1967; Richardson 1971a,b). As with any empirical analysis, interpretation depends on theory and CMS is no exception. Perhaps the reason for CMS attracting greater attention over the question of interpretation than other methods (based on explicit empirical models) is that it is based on an identity and is not derived from an explicit theory. CMS analysis involves a decomposition of terms of an identity and, as such, the empirical results can be consistent with any number of theories.

What we have referred to as the market-shares norm, allows us to 'identify' an underlying class of theoretical models, provided certain assumptions are met. The norm asserts that a country's export performance, vis-à-vis some standard, will depend solely on its competitiveness. Following Leamer and Stern (1970), the comparative performance of the focus country will depend solely on relative prices:

$$x_{ij}/X_{ij} = f(pr_{ij}/PR_{ij}) \tag{4a}$$

where x_{ij}/X_{ij} is the ratio of exports of the focus country to those of the standard and pr_{ij}/PR_{ij} is the relative price between the two suppliers. Very few attempts have been made to address the issue of the type of theoretical model entailed by the market-shares norm. Ooms (1967) demonstrates the consequences of not assuming constant costs with the implication that the chosen period should not be too short. Jepma (1986) defines four models under progressively less restrictive assumptions starting with constant income, constant relative prices, uniform income elasticities, and constant costs. Merkies and van der Meer (1988) explicitly model the underlying process in terms of a two-stage budgeting procedure, along the same lines suggested by Armington (1969).

In the Armington two-stage procedure, a given amount of import expenditure is allocated across goods and then across the suppliers of these goods. The expenditure to be allocated in the second stage is determined at the first stage. Assuming, in addition, uniform income elasticities of goods within a group, prices of goods outside the group will only affect real expenditure of the group (and not its composition). Following Merkies and van der Meer (1988), the scale and competitive effects can be expressed as follows:

Scale effect in market *ij*: $$SE_{ij} \equiv Q_j + (1 - \sigma_j)(P_{ij} - P_j) \tag{4b}$$

Competitive effect in market *ij*: $$S_{ij} \equiv (1 - \sigma_{ij})(P_{ij} - P_j) \tag{4c}$$

The scale effect in market *ij* will be a function of the growth in total expenditure, Q_j, and the change in the price of the product, i, P_{ij}, relative to all other products of region j, P_j. The parameter, σ_j, is the elasticity of substitution of a constant elasticity of substitution (CES) model. The competitive effect in market *ij* is a function of relative prices alone as long as σ_{ij} is independent of market size. Furthermore, the scale effect will be influenced by the relative prices of the commodity group, as well as the scale of the overall market.

5. Additional theoretical and operational problems

As a descriptive tool, the main hurdle for CMS analysis appears to have been resolved with Jepma's (1986) revision. Apart from the order problem, the other problem cited in the published work has been what Richardson (1971a,b) termed the index problem; the choice of an appropriate base year. Jepma (1986) suggested using a continually shifting base rather than using fixed weights from a unique base year. Jepma's method allows for changes in export composition (that is, the *w*s) over time and also allows for fluctuations arising from potential supply constraints to be smoothed out. For the empirical analysis of this study, the CMS was estimated on an annual basis and the average was taken over successive 5-year periods.

Another set of issues revolves around the applicability of the three aggregation conditions to the regions, products, and standard. Is it appropriate, for example, to treat East Asia, or even a country like Japan, as one region, or should they be disaggregated? It has been suggested that the CMS model may itself yield such criteria for determining the appropriate level of aggregation (Leamer and Stern 1970). For instance, a reasonably straight-forward algorithm for choosing the level of disaggregation is where the marginal increase in the product (regional) effect from disaggregation of products (regions) is zero. Unfortunately, there may be no reason to expect such an algorithm to converge to a unique solution. Houston (1967), for example, found that there was no monotonic relationship between the level of disaggregation and the structural effects to be found in his data. Some criteria developed from the theory underlying CMS are needed for aggregation.

The use of CMS analysis as a diagnostic tool depends on three features of the market-shares norm for its interpretation and viability. The model assumes that the demand for exports of the focus country depends on real expenditure on standard exports and the price ratio between the competing suppliers. This implies that each consumer's utility-maximising procedure may be represented by a two-stage budgeting process *à la* Armington (1969). The Armington conditions depend on how the standard is selected (all or only a selection of suppliers) and how products are classified. Each product type is an aggregate over a number of products and each region represents a large number of consumers. Uniformity of income elasticities and elasticities of substitution (among suppliers of the same commodity) within regions and product groups is therefore required if the relationships postulated by Armington (1969) at the microlevel are to be translated into the same relationships between (linear) aggregates (Green 1964). The answer to the aggregation problem therefore depends on the similarity of consumer preferences within regions and the absence of distribution effects.

Clustering methods may be a way of dealing with the problem of aggregating over products and consumers. Pudney (1981) applies cluster analysis to the task of grouping goods according to their estimated elasticities of substitution. The work of Alston *et al*. (1990) focuses on the structure of consumer preferences. Their tests involve non-parametric analysis of consumption patterns to determine whether or not they are consistent with the axioms of revealed preference and, in particular, the implications of homothetic preferences. Clustering methods can help to construct optimal groups where products within each group are inseparable, whereas any two products belonging to two different groups are separable. However, they require extensive calculations and a detailed data set that includes all goods (domestic and imported goods), all prices, and budgets.

Testing for cointegration among prices to ascertain whether or not any two products can be grouped may provide a more efficient method for addressing the problem of product aggregation. Two products should be grouped only if their prices behave in a similar way, that is, they should cointegrate. Examples include Jung *et al*. (1997) using cointegration to test regional and product aggregation biases in the composite price of forestry products, and Martin-Alvarez *et al*. (1999) testing aggregation bias in a farm price index.

As indicated above, the standard selection can affect the satisfaction of the Armington conditions. The standard can be global exports that include all exporters in the world or the imports of the market studied that include only exporters supplying that market. World exports are used as the standard to examine OECD countries' export performance in Fagerberg and Sollie (1987), and the UK's export performance in Irwin (1995). World exports are a convenient standard when a study deals with many focus countries, but it makes the results less meaningful. As Richardson (1971a) argues, because CMS's objective is to examine competitiveness, the standard should be the sum of all competitors of the focus country, not the world exports. This approach has been followed by Jepma (1986), Oldersma and Van Bergeijk (1993), Ahmadi-Esfahani (1993, 1995), and Ahmadi-Esfahani and Jensen (1994).

The issue of determining the appropriate length of time over which CMS is applied should also depend on the market-shares norm. Assuming costs in each country are constant, relative prices can be taken as determined solely by the cost conditions in the supplying country. In this case, a change in relative prices may be unambiguously associated with differential growth rates in wages or productivity, as well as relative improvements in technology. The supply conditions therefore limit applied analysis to changes over the medium to long run, whereas the demand conditions may place an upper limit on the length of the period (due to changing tastes).

Finally, the currency used in the CMS analysis can affect the size of different effects. As Oldersma and Van Bergeijk (1993) demonstrate, using different currencies can reverse the sign of the effects. In the CMS model, changes in exchange rate will change the relative competitiveness of the commodities and therefore CMS analysis should utilise the currency that is most popular in transactions of the commodities. In the empirical work, because most of the studied countries have weak currencies, trade is performed mostly in US currency. All values were therefore in US dollars.

These issues need to be borne in mind when interpreting the CMS model for diagnostic purposes. An unambiguous interpretation requires the market-shares norm, which assumes that market shares are independent of total imports, prices are cost-determined, and the only source of product differentiation is in terms of country of origin. The relative simplicity of the diagnostic interpretation under the market-shares norm can breed complacency and misconceived policy conclusions. Alston *et al*. (1990) is one study that has cast serious doubts over the Armington (1969) assumptions and, by implication, the market-shares norm.

Although much work needs to be carried out to clarify the issues underlying the diagnostic interpretation of the CMS model, the model's advantages should not be lost. CMS analysis is able to yield quite precise hypotheses and, thereby, indicate the direction for further research using other quantitative, as well as qualitative, methods. An explicit recognition of the limitations of the market-shares norm at least yields a set of refutable maintained hypotheses, indicating possible avenues for further research. In fact, the issue is really one of being able to correct for the bias arising from an interpretation based on the market-shares norm, and this requires a case-by-case assessment of the extent to which the norm holds. The CMS framework provides a useful avenue for structuring empirical research into the competitiveness of countries.

6. An illustration

In this section, the CMS framework outlined above is applied to an analysis of Australian food export performance in South-East Asia (SEA). This is a major market for Australia, importing 11.2 per cent of Australian 2003 merchandise exports. Although it is lower than the import share of EU (14.1 per cent), the high growth rate averaging 9.7 per cent over 1993–2003 makes SEA an increasingly important trading partner (DFAT 2005).

We selected four key destinations for Australian food exports to the region, namely: Indonesia, Singapore, the Philippines, and Malaysia. Three products were selected based on their importance in the overall performance of the Australian food economy; namely milk, beef, and cheese. In 2003, these products accounted for 28.2, 6.6, and 2.6 per cent of Australian food import to the region (OECD 2005).

6.1 Data

The data, for the period 1980–2003, were taken from *Source OECD International Trade by Commodity Statistics* (SITC). The database arranges data in the SITC Rev.2 for the period 1980–1990, in the HS code for the period 1990–2000 and in the SITC Rev.3 for the period 1990–2003. To harmonise the differences among database systems, ice cream (SITC Rev302233) was taken out of the milk product class (SITC Rev3022).

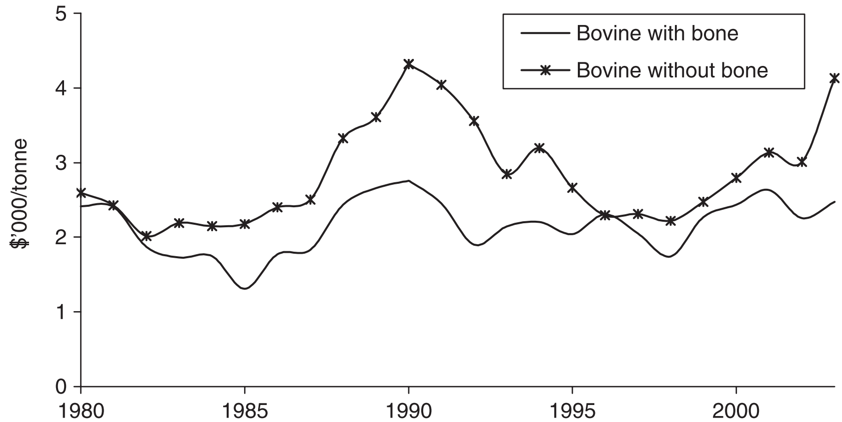

Figure 1 Price of Australian bovine meat in Singapore, 1980–2003.

The three products derived from this database are the following. Beef (SITC Rev3 classification 011: 'bovine meat') consists of fresh, chilled, and frozen beef. Cheese (SITC Rev3024: 'cheese and curd') consists of powdered and grated cheese; whole processed cheese; other cheese and curd. Milk consists of fresh and preserved milk and cream (SITC Rev3022: 'milk and cream').

6.2 Aggregation bias

The aggregation bias is checked by testing the cointegration between sub-products' annual prices. These tests are limited by the fact that the SITC Rev.2 only disaggregates the first product class into bovine meat with bone and bovine meat without bone; the third product class into fresh milk and cream, and preserved milk and cream, whereas the second product class is not disaggregated at all. In addition, historical data on prices of disaggregated commodities exported to the other three countries are available for only the recent 10 years from 1993 to 2003 in the form of annual data, which is too short for cointegration tests. Tests were therefore carried out for prices of commodities exported to Singapore only. There is, however, no guarantee that the test results for Singapore will represent the situation in the other three countries and this lack of cointegration tests remains the caveat of the empirical analysis.

As shown in Figure 1, the prices of bovine meat with bone and bovine meat without bone have very similar patterns of movement. Further examination shows that these two series are non-stationary, but cointegrated with each other (Table 4). The aggregation of these two products into one product does not lose any information on each series and therefore does not create aggregation bias.

To cross-check this cointegration result, the Johansen cointegration test was carried out for these two price series. The test uses the vector error-correction

Table 4 Cointegration test of bovine prices

Test	Regression results	Conclusion
Unit root test of bovine with bone price (P_{bt})	$\Delta P_{bt} = 0.87 + 0.01t - 0.52P_{bt-1} + 0.26\Delta P_{bt-1}$ (2.07) (1.1) (−2.69) (1.18) $n = 23$, at level of significance of 5%, $\tau = -3.6$	Non-stationary
Unit root test of boneless bovine price (P_{lt})	$\Delta P_{lt} = 0.47 + 0.004t - 0.19P_{bt-1} + 0.31\Delta P_{bt-1}$ (1.2) (0.33) (−1.65) (1.5) $n = 23$, at level of significance of 5%, $\tau = -3.6$	Non-stationary
Cointegration test of P_{bt} and P_{lt}	$P_{bt} = -12 + 0.007t + 0.37P_{lt} + \hat{\varepsilon}_t$ (−0.74) (0.81) (4.6) $\Delta\hat{\varepsilon}_t = -0.68\hat{\varepsilon}_{t-1} + 0.14\Delta\hat{\varepsilon}_{t-1}$ (−3.1) (0.65) $n = 23$, at level of significance of 5%, $\tau = -1.96$	P_{bt} and P_{lt} are cointegrated

*t statistics are in parentheses.

model (VECM) and a null hypothesis that there is no cointegration. To use the test, extra care must be taken to avoid Johansen likelihood ratio test's pitfalls (Gonzalo and Lee 1998). For example, if no lags are included in the VECM, and there is at least one variable, that is, I(2), the likelihood ratios will converge to zero, when the sample size increases, leading to a conclusion of no cointegration when there may be in fact cointegration. Or if the VECM does not include any deterministic trend, the likelihood ratios will not converge, as the sample size increases. Accordingly, the null hypothesis will eventually be rejected, although there is no cointegration. Gonzalo and Lee (1998) also show that the Engle and Granger test is more robust and not subject to these pitfalls.

The Johansen test results for the price of bovine meat with bone and bovine meat without bone indicate that at 5 per cent significance level, there are two cointegration equations. The first likelihood ratio is 18.97 and the second is 4.09, both of which exceed their critical values of 18.17 and 3.74, respectively.

Fresh milk and cream, and preserved milk and cream also have prices moving together, although the similarity of the movement is less obvious (Figure 2). Unit root test results in Table 5 indicate that both series are non-stationary and they are cointegrated. Therefore, the aggregation of the two products does not cause aggregation bias.

A Johansen cointegration test is also applied to these series. The results indicate that there are two cointegration equations at 5 per cent significance level. The likelihood ratios are 18.5 and 7.37, which exceed their critical values of 18.17 and 3.74, respectively.

The CMS calculation was organised in two steps. The CMS effects were first calculated on an annual basis, and then averaged over 5-year periods. This was performed to smooth out fluctuations arising from potential supply constraints. The CMS effects for SEA include both regional and product

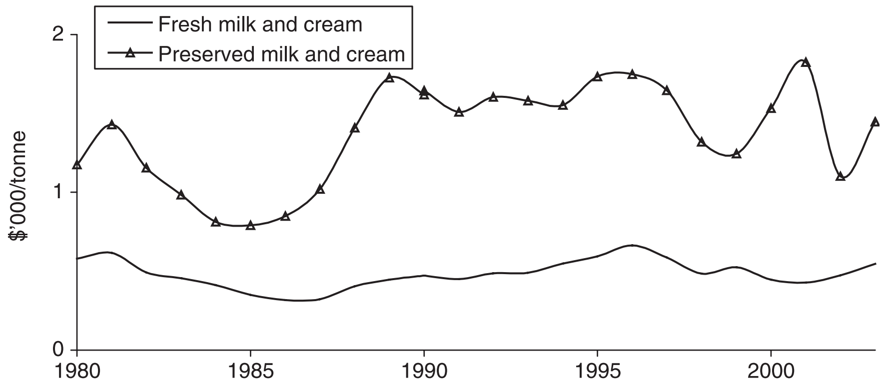

Figure 2 Price of Australian milk and cream exported to Singapore, 1980–2003.

Table 5 Cointegration test of fresh and preserved milk and cream prices

Test	Regression results	Conclusion
Unit root test of fresh milk and cream price (P_{ft})	$\Delta P_{ft} = \underset{(3.26)}{0.16} + \underset{(0.44)}{0.0006t} - \underset{(-3.11)}{0.37P_{ft-1}} + \underset{(2.01)}{0.36\Delta P_{ft-1}}$ n = 29, at level of significance of 5%, $\tau = -3.5$	Non-stationary
Unit root test of preserved milk and cream price (P_{pt})	$\Delta P_{pt} = \underset{(2.4)}{0.36} + \underset{(1.6)}{0.01t} - \underset{(-2.5)}{0.49P_{pt-1}} + \underset{(1.58)}{0.37\Delta P_{pt-1}}$ n = 29, at level of significance of 5%, $\tau = -3.5$	Non-stationary
Cointegration test of P_{ft} and P_{pt}	$P_{pt} = \underset{(-4.74)}{-55} + \underset{(4.77)}{0.028t} + \underset{(2)}{0.97P_{ft}} + \hat{\varepsilon}_t$ $\Delta\hat{\varepsilon}_t = \underset{(-2.87)}{-0.55\hat{\varepsilon}_{t-1}} + \underset{(1.36)}{0.32\Delta\hat{\varepsilon}_{t-1}}$ n = 29, at level of significance of 5%, $\tau = -1.95$	P_{ft} and P_{pt} are cointegrated

*t-statistics are in parentheses.

effects. The import and export shares, reported alongside the results, are averages taken over each of the 5-year periods.

6.3 Results

In the last two decades, the development of Australian food exports to the SEA region appears to indicate a similar trend to the growth of SEA food imports (Figure 3). Australia has gained an increasingly more important role in supplying food to the region, as indicated by its import shares (Table 6). The five periods in Table 6 characterise four distinct stages of Australian export to SEA: the early stage with low growth (1980–1985), the fast-growing stage (1985–1990 and 1990–1997), the crisis stage with negative growth (1997–1998), and the recovering stage (1998–2003). The sharp contrast among the fast-growing stage, the crisis stage, and the recovering stage will help demonstrate the method more clearly. Therefore, the discussion below will focus on these three stages.

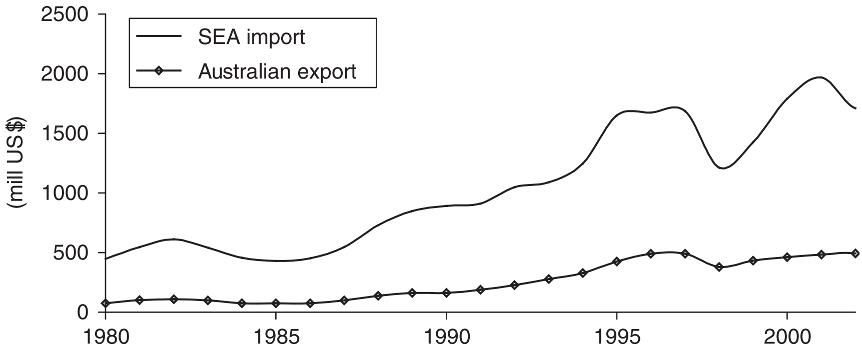

Figure 3 Australian food export and South-East Asia (SEA) food import, 1980–2003.

Table 6 First-level analysis

Period	Import shares	Import growth	Actual export growth	Scale effect	Competitive effect	Second-order effect
1980–1985	0.18	0.00	0.02	0.01	0.02	–0.02
1985–1990	0.18	0.16	0.18	0.20	0.00	–0.02
1990–1997	0.25	0.10	0.17	0.12	0.08	–0.02
1997–1998	0.31	–0.28	–0.22	–0.31	0.09	–0.01
1998–2003	0.27	0.09	0.02	0.09	–0.03	–0.04

In the two fast-growing periods, 1985–1990 and 1990–1997, the scale effect plays an important role (Table 6). If Australia had maintained its market share in all markets, it would have had an export growth rate of 20 and 12 per cent a year, respectively. In 1985–1990, Australia's weighted market share did not change, but in 1990–1997, the weighted market share improved significantly, contributing eight percentage points to export growth. The negative SOEs for the two periods indicate that Australia was gaining market share in slow-growing markets, whereas losing in fast-growing ones. However, this should not be perceived as a problem, because the SOE (–2 per cent) was insignificant compared to the competitive effect (8 per cent) in 1990–1997. After all, the change in market share contributed to an increase in export growth. The comparison between the scale effects and the average growth of import by SEA shows that in these two periods, Australia had a favourable export structure that focused more on high-growth markets.

The advantage of Australia's export structure can be seen more clearly in the second-level analysis results presented in Table 7. The scale aggregate growth effect is actually the average growth of import by the SEA. The scale market effect represents the extra growth impacts of having an export structure that puts more weight on higher-growth markets. In this sense, the export structure has contributed 3 and 2 percentage points to export growth in the period 1985–1990 and 1990–1997, respectively. The decomposition of

Table 7 Second- and third-level analyses of scale effect

Period	Decomposition of the scale effect		Decomposition of the scale market effect		
	Aggregate growth effect	Market effect	Regional effect	Product effect	Interaction effect
1980–1985	0.00	0.01	0.00	0.01	0.00
1985–1990	0.16	0.03	0.01	0.02	0.00
1990–1997	0.10	0.02	0.02	0.01	–0.01
1997–1998	–0.28	–0.03	–0.03	–0.02	0.02
1998–2003	0.09	0.00	0.00	0.00	0.00

Table 8 Second- and third-level analyses of competitive effect

Period	Decomposition of the competitive effect		Decomposition of the competitive market effect		
	Aggregate growth effect	Market effect	Regional effect	Product effect	Interaction effect
1980–1985	–0.05	0.07	0.00	0.06	0.01
1985–1990	–0.01	0.01	0.00	0.00	0.01
1990–1997	0.08	–0.01	–0.01	0.03	–0.03
1997–1998	–0.19	0.28	0.12	0.07	0.09
1998–2003	0.02	–0.05	–0.02	0.00	–0.02

the scale-market effect into regional effect and product effect at the third level shows that the product effect dominates in the first period and the regional effect dominates in the second period (Table 7).

When the large gain in competitiveness of 8 per cent in the period 1990–1997 is decomposed at the second level, it can be seen that the competitiveness is improved almost uniformly across markets (CAGE ≈ CE). The differential competitive effect across markets was low and negative (CME = −0.01) (Table 8). Australia gained more market share in unimportant (in terms of weight) markets and less in important markets. The decomposition of CME at the third level shows that Australia gained its competitiveness in low-weighted regions, but gained competitiveness in high-weighted products. The positive product effect is, however, negated by the interaction term that indicates the reinforcement of product effect and regional effect.

The SEA region was seriously influenced by the Asian crisis in 1997–1998. The export structure of Australia, which was favourable in the previous period, then exacerbated the crisis's impact. The scale effect was inflated to –31 per cent from the region's average growth of –28 per cent (Table 6). The differential effect SME of –3 per cent was due to both the regional effect and product effect. In other words, markets that Australia targeted, both in geographical distribution and in terms of commodity distribution, were hard hit by the crisis.

Contrary to the scale effect, Australia's competitiveness improved significantly during the crisis. Although competitiveness improved more in harder hit markets (SOE < 0), the improvement alleviated the crisis's effect significantly. Australia's exports fell by only 22 per cent compared with the region's import reduction of 28 per cent. The second- and third-level decomposition of the competitive effect (CE) shows that Australia's average market share actually decreased, but the market shares in important importing countries and important products improved remarkably.

In the recent period, 1998–2003, the SEA's import recovered to the growth level of period 1990–1997 with an average growth rate of 9 per cent per year. Australia's exports, however, grew at only 2 per cent a year. This is due to the loss in competitiveness and the fact that Australia lost more market share in higher-growth markets (Table 6). The second- and third-level decompositions further show that Australia's average market share grew at 2 per cent, but it suffered serious losses of market shares in important importing countries. This may have been due to new discriminatory trade barriers imposed by importing countries or exchange rate depreciation or the introduction of export subsidies that aim at restoring the country's economy after the crisis. Further research is required to investigate the causes of this negative regional effect to prevent Australian exporters from being disadvantaged by foreign trade policies.

7. Conclusion

In this paper, we have shown that the CMS model, based on Jepma's (1986) revised framework, can be generalised and extended to fully exploit its descriptive potential. An important contribution of this paper has been to provide a general framework for descriptive analysis. Furthermore, we have highlighted a role for CMS in formulating hypotheses and complementing other methods of empirical trade analysis.

For descriptive purposes, the CMS framework enables a progressively more detailed examination of trading patterns. Starting with a level-one analysis, the analyst can gain an idea of the relative importance of scale, competitive, and second-order effects. A level-two analysis indicates the relative importance of growth or market effects. Furthermore, if a market effect appears significant, it can be decomposed into regional and product effects to identify the source of growth differentials across markets (a level-three analysis). Accordingly, the three levels are complementary, and differ from one another only in terms of the information details provided.

Although Jepma's (1988) revised framework places descriptive analysis on solid foundations, diagnostic and policy analyses will remain open to dispute. We have demonstrated how the various scale and competitive effects may be interpreted under the market-shares norm. CMS analysis will generate hypotheses that are refutable, provided that the model used for diagnostic interpretation is explicitly specified. In this way, the maintained hypotheses of the market-shares norm, as well as those suggested by CMS analysis, can be tested.

We have argued that the CMS framework provides an efficient method of structuring applied research into a nation's international competitiveness. Within this framework, a number of empirical techniques may be applied, with the simple CMS model and market-shares norm as the starting point, providing indications for the direction of more rigorous empirical research. Although we have discussed some of the more important problems, the potential for CMS analysis, as a tool for diagnosis and a framework for the application of several empirical tools, has yet to be fully explored and exploited.

We conclude therefore that the results of CMS analysis will have to be combined with those generated by other methods, such as regression analysis, to provide a more rigorous investigation of a nation's international competitiveness.

References

Ahmadi-Esfahani, F.Z. (1993). An analysis of Egyptian wheat imports: a constant market shares approach, *Oxford Agrarian Studies* 21, 31–39.

Ahmadi-Esfahani, F.Z. (1995). Wheat market shares in the presence of Japanese import quotas, *Journal of Policy Modeling* 17, 315–323.

Ahmadi-Esfahani, F.Z. (2001). *Australia in East Asian Food Markets: the Impact of Trade Impediments, Quality Attributes and Multinational Strategies, RIRDC Project US-40A*. Rural Industries Research and Development Corporation, Barton.

Ahmadi-Esfahani, F.Z. and Jensen, P.H. (1994). Impact of the US–EC price war on major wheat exporters' shares of the Chinese market, *Agricultural Economics* 10, 61–70.

Alston, J.M., Carter, C.A., Green, R. and Pick, D. (1990). Whither Armington trade models, *American Journal of Agricultural Economics* 72, 455–467.

Armington, P.S. (1969). A theory of demand for products distinguished by place of production, *IMF Staff Papers* 16, 159–176.

Brownie, S. and Dalziel, P. (1993). Shift-share analyses of New Zealand exports, 1970–84, *New Zealand Economic Papers* 27, 233–249.

Department of Foreign Affairs and Trade (2005). Australia – ASEAN – Building economic cooperation. Available from URL: *www.dfat.gov.au/trade/fta/asean/aust-trade.html* [accessed 10 April 2005].

Drysdale, P. and Lu, W. (1996). Australia's export performance in East Asia, *Pacific Economic Paper*. Australia–Japanese Research Centre, no. 259, Canberra.

Fagerberg, J. and Sollie, G. (1987). The method of constant market shares analysis reconsidered, *Applied Economics* 19, 157–183.

Gonzalo, J. and Lee, T. (1998). Pitfalls in testing for long-run relationships, *Journal of Econometrics* 86, 129–154.

Green, H.A.J. (1964). *Aggregation in Economic Analysis.* Princeton University Press, Princeton, New Jersey.

Hoen, H.W. and Wagener, H.J. (1989). Hungary's exports to the OECD: a constant market shares analysis, *Acta Oeconomic* 40, 65–77.

Houston, D.B. (1967). The shift and share analysis of regional growth: A critique, *Southern Economic Journal* 33, 577–581.

Irwin, D.A. (1995). The lion's share: Britain's export performance revisited, 1899–1929, *Structural Change and Economic Dynamics* 6, 97–109.

Jepma, C.J. (1986). *Extensions and Application Possibilities of the Constant Market Shares Analysis.* Rijkusiniversiteit, Groningen.

Jepma, C.J. (1988). Extensions of the constant market shares analysis with an application to long-term export data of developing countries, *The Balance Between Industry and Agriculture in*

Economic Development, Williamson, J.G. and Panchamukhi, V.R. (eds). St. Martin's Press, New York.

Jung, C., Krutilla, K. and Boyd, R. (1997). Aggregation bias in natural resource price composites: the forestry case, *Resource and Energy Economics* 20, 65–73.

Junz, H.B. and Rhomberg, R.R. (1965). Prices and export performance of industrial countries, 1953–1963, *IMF Staff Papers* 12, 224–269.

Leamer, E.E. and Stern, R.M. (1970). *Quantitative International Economics*. Allen & Bacon, Boston.

Martin-Alvarez, F.J., Cano-Ferandez, V.J. and Caceres-Hernandez, J.J. (1999). The introduction of seasonal unit roots and cointegration to test index aggregation optimality: an application to a Spanish farm price index, *Empirical Economics* 24, 403–414.

Merkies, A.H.Q.M. and van der Meer, T. (1988). A theoretical foundation for constant market shares analysis, *Empirical Economics* 13, 65–80.

OECD (2005). *Source OECD ITCS International Trade by Commodities Statistics*, *Version 2001 release 01*. Paris Organisation for Economic Co-operation and Development.

Oldersma, H. and Van Bergeijk, P.A.G. (1993). Not so constant! The constant market share analysis and the exchange rate, *De Economist* 141, 380–401.

Ooms, V.D. (1967). Models of comparative export performance, *Yale Economic Essays* 7, 103–141.

Pudney, S.E. (1981). An empirical method of approximating the separable structure of consumer preferences, *Review of Economic Studies* 48, 561–577.

Richardson, J.D. (1971a). Constant market shares analysis of export growth, *Journal of International Economics* 1, 227–239.

Richardson, J.D. (1971b). Some sensitivity tests for a constant market shares analysis of export growth, *Review of Economics and Statistics* 53, 300–304.

Tyszynski, H. (1951). World trade in manufactured commodities, 1899–1950, *The Manchester School of Economic Social Studies* 19, 272–304.