Constant Market Shares Analysis:

Uses, Limitations and Prospects

Fredoun Ahmadi-Esfahani

and

Glenn Michael Anderson

Department of Agricultural Economics
The University of Sydney
New South Wales 2006
Australia

Contributed paper presented at the 43rd Annual Conference of the Australian Agricultural and Resource Economics Society. Held at the Christchurch Convention Centre and Town Hall (20-22 January 1999). This paper stems from a project supported by the Rural Industries Research and Development Corporation.

Constant Market Shares Analysis: Uses, Limitations and Prospects

Fredoun Ahmadi-Esfahani and Glenn Michael Anderson

Abstract: Constant market shares (CMS) analysis compares the actual export growth performance of a country with the performance that would have been achieved if the country had maintained its exports relative to some standard. The approach was first applied to international trade in the 1950s and has generally been used to analyse trading patterns and, in particular, the extent to which poor export performance can be attributed to a loss of 'competitiveness'. However, the approach has been open to objections as a tool of description and diagnosis. Recent revisions appear to meet objections concerning its role as a descriptive tool. However, CMS analysis remains open to objections as a diagnostic tool owing to the strict theoretical conditions required to yield an unambiguous interpretation.

In this paper we generalise the constant market share framework based on recent revisions by Jepma (1986). Alternative models are derived and interpreted with particular attention to the underlying theoretical conditions required for diagnostic interpretation. We conclude that the prospects for CMS analysis as a diagnostic tool depend upon further research into its theoretical foundations, the extent to which the implicit aggregation assumptions can be tested and, of immediate concern, development of a computer program.

Keywords: CMS analysis, trade, aggregation, Armington model.

Constant market shares analysis (CMS) is a method intended to shed light on the reasons underlying a country's comparative export performance. The method requires a standard for comparison which, depending on the purposes of the analysis, may be "the world" or a set of similar or closely competitive countries. Further, total exports are generally disaggregated into categories defined in terms of product-type and country of destination. The method has generally been used to at least provide an indication of whether a country's comparative export performance reflects changing market shares or global trends in demand. The more ambitious would want the method to indicate the factors underlying these shifts such as relative prices and income.

The questions the method is intended to answer include whether a country's exports have grown in line with its main competitors (that is, a scale effect) and whether a country's comparative performance reflects a strong presence in high-growth regions or products (product and regional effects, respectively) or competitive gains in individual markets.

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

(1) $$s \equiv \frac{q}{Q}$$

where s is the measure defined as the ratio of exports of a 'focus country', q, to Q, the exports of some standard of comparison. For instance Australia's export performance may be compared with the United States, the European Union and Canada on the world wheat market. The (proportional) change in exports may then be decomposed into three terms in order that we may gain some insight into the reasons behind the focus country's export performance:

(2) $$\dot{q} \equiv \dot{Q} + \dot{s} + \dot{s}\dot{Q},$$

where the dots denote proportional changes for each variable over a discrete period of time. From one perspective, the decomposition into the three effects is a matter of definition because it 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 which is *diagnostic*. Will a change in the country's comparative performance, ***s***, reflect purely competitive conditions or are distributive factors likely to play a part? While the former yields an unambiguous interpretation, in practice the actual data will not generally conform to the requisite 'aggregation conditions'. The prospects for CMS analysis will hinge on how one is able to bridge the gap between theory and practice.

The aim of this paper is to highlight the limitations and assess the potential of CMS analysis both as a tool for description and a tool for diagnosis. Section 1 shows how a change in a country's exports over a period can be decomposed, at first, into three effects: a scale effect, a competitiveness effect and a second-order effect. Section 2 introduces the issues concerning interpretation for diagnostic and policy purposes. Section 3 introduces a level-two model and interprets what we have described as the 'market effect'. Section 4 demonstrates that the market effect can be further decomposed into product and regional effects as well as an interaction effect. Based on Jepma (1986), the model is a revision the traditional model and overcomes a major hurdle for descriptive analysis: the order-problem. Section 5 assesses the extent to which CMS analysis is a viable method for exploratory analysis and how it can be used to complement other methods such as regression analysis. Appendix A outlines the theoretical model used in this paper for diagnostic purposes, while Appendix B describes an alternative procedure for avoiding the order-problem. We conclude that to fulfil its original promise as a diagnostic tool, CMS analysis requires efficient empirical tests for consistent aggregation, further research into the theoretical foundations and, of immediate concern, its own computer package to reduce computation costs.

1 Basic Model

CMS analysis is a technique for describing trading patterns and trends for the purpose of policy formulation[1]. The traditional model was first applied to the study of international trade by Tyszynski (1951) but has been subject to a number of criticisms regarding its use as a descriptive tool (Richardson 1971a,b). Jepma (1986) developed a revised approach which overcomes the most serious of these problems: the 'order problem' (see Section 4.1). 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. Drysdale and Lu (1996) use the traditional model to assess Australia's overall export performance over the decade to 1994. Brownie and Dalziel use the traditional model to analyse New Zealand's export performance over the period 1970 to 1984. A comprehensive list of previous applications and appraisals can be found in Merkies and van der Meer (1988).

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

[1] For an introduction to the traditional model see Richardson 1971b or Leamer and Stern chapter 7.

(3) $$\dot{q}_{ij} \equiv \dot{Q}_{ij} + \dot{s}_{ij} + \dot{s}_{ij}\dot{Q}_{ij}$$

where

$\dot{q}_{ij} = \dfrac{\Delta q_{ij}}{q_{0ij}}$ = growth in exports of Australia for the (i,j)th commodity,

$\dot{Q}_{ij} = \dfrac{\Delta Q_{ij}}{Q_{0ij}}$ = growth in exports of reference group or standard[2], and

$\dot{s}_{ij} = \dfrac{\Delta s_{ij}}{s_{0ij}}$ = growth in the export ratio for the (i,j)th commodity.

The aggregate export growth, is a weighted average of growth over the *IJ* markets:

(3a) $$\dot{q} = \sum_i \sum_j w_{0ij}\dot{q}_{ij}$$

where

$q = \sum_i \sum_j q_{ij}$, $\dot{q} = \dfrac{\Delta q}{q_0}$ and $w_{0ij} = \dfrac{q_{0ij}}{q_0}$.

The weights, ***w*₀ᵢⱼ**, represent the composition of exports for the focus country. Substituting (3) into (3a) we derive an expression for the *basic* CMS model:

(3b) $$\dot{q} = \sum_i \sum_j w_{0ij}\dot{q}_{ij} = \sum_i \sum_j w_{0ij}\dot{Q}_{ij} + \sum_i \sum_j w_{0ij}\dot{s}_{ij} + \sum_i \sum_j w_{0ij}\dot{s}_{ij}\dot{Q}_{ij}$$

We are now in a position to define and consider the interpretation of the three components of the level-one model.

2 Defining and Interpreting the Basic Model

The three components of the basic model are defined as follows:

[2] Richardson, 1971a, and Jepma, 1986. The standard, as the name implies, is the set of countries against which the focus country's export performance is compared. Therefore, the results are likely to be of more practical import if countries included in the standard are close competitors in the markets concerned.

Scale effect: $SE = \sum_i \sum_j w_{0ij} \dot{Q}_{ij}$. The growth in exports that would have taken place if individual market shares had remained unchanged.

Competitive effect: $CE = \sum_i \sum_j w_{0ij} \dot{s}_{ij}$ The change in exports if only individual market shares had changed.

Second-order effect: $SOE = \sum_i \sum_j w_{0ij} \dot{s}_{ij} \dot{Q}_{ij}$. A term which captures the effect of changes in both level of standard exports and market share during the period.

The issue of interpretation has always been at the centre of dispute concerning the usefulness of CMS analysis. As with any statistical tool 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 (such as regression analysis) is that it is based on an identity and not derived from an explicit theory. CMS analysis involves a decomposition of terms of an identity and, as a result, the empirical results can be consistent with any number of underlying theories.

What has been defined as the ‘market-shares norm’ (Junz and Rhomberg, 1965) allows us to ‘identify’ the 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,

(4a) $$\frac{x_{ij}}{X_{ij}} = f\left(\frac{p_{ij}}{P_{ij}}\right),$$

where $\frac{x_{ij}}{X_{ij}}$, is the ratio of exports of focus country to those of the standard and $\frac{p_{ij}}{P_{ij}}$ 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 ought not be too short (Jepma, 1986). Jepma

(1986), as well as revising the CMS framework, 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 budget procedure, along the same lines as Armington (1969). We shall use their model as the basis of our own interpretation (see below and Appendix A).

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 have an effect through an income effect which changes the total, but not the composition, of a good consumed. In order to demonstrate the potential of CMS as a diagnostic tool we assume these conditions can be met. Following Merkies and van der Meer (1988), the scale and competitive effects can be expressed as follows:

(4b) Scale Effect in market *ij*:.

$$SE_{ij} \equiv \dot{Q}_{ij} = \dot{Q}_j + (1-\sigma_j)(\dot{P}_{ij} - \dot{P}_j)$$

(4c) Competitive Effect in market *ij*:

$$CE_{ij} \equiv \dot{s}_{ij} = (1-\sigma_{ij})(\dot{p}_{ij} - \dot{P}_{ij})$$

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 (a general price index). The parameter, σ_j is the constant elasticity of substitution of a CES model. Notice that he competitive effect in market *ij* is a function of relative prices alone.

While (4) yields an unambiguous interpretation, the stringency of the conditions means the interpretation will not generally be valid. Three features of (5) will have a bearing on the interpretation and viability of CMS as a diagnostic tool. Firstly, the model assumes that demand for exports of the focus country depends on real expenditure of the standard and the price ratio between the competing suppliers. This implies that consumers utility-maximising procedure can be represented by a two-stage process and the choice of standard will have an important bearing on whether the Armington conditions can be met. Further, 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 (between suppliers of the same commodity) *within* regions and product groups is required if the relationships postulated by Armington at the micro-level are to be translated into the same relationships between linear aggregates. These issues need to be borne in mind when interpreting the CMS model for diagnostic purposes.

The question which most concerns the analyst is in which markets are scale and competitive effects the greatest and whether they are being targeted by the country's exporters. In the following sections we show how the framework may be refined further to provide a more detailed picture for analysis and policy.

3 Market Effects and their Interpretation

A level-two analysis decomposes both the scale and competitive effects into a growth effect and a market effect. For the second-order effect, this implies a decomposition into at most four effects (see equation (7) below). We begin with the decomposition of the *scale* effect into an aggregate growth effect (*SAGE*) and a market effect (*SME*). The decomposition occurs at the level of the individual market in the following manner:

$$\begin{aligned} \dot{Q}_{ij} &= \dot{Q} + \left(\dot{Q}_{ij} - \dot{Q}\right) \\ SE_{ij} &= SAGE_{ij} + SME_{ij} \end{aligned} \tag{5a}$$

where

$\dot{Q} = \dfrac{\sum_i \sum_j \Delta Q_{ij}}{\sum_i \sum_j Q_{0ij}}$, growth in aggregate standard exports.

Averaging over all markets, the scale effect is expressed as the sum of the aggregate growth effect and a weighted average of the individual scale market effect:

$$\begin{aligned}(5b)\qquad \sum_{j}\sum_{j} w_{0ij}\dot{Q}_{ij} &= \dot{Q} + \sum_{i}\sum_{j} w_{ij}\left(\dot{Q}_{ij} - \dot{Q}\right) \\ SE &= SAGE + SME\end{aligned}$$

As an aid to interpretation, the scale market effect can be expressed in the following form:

$$(5c)\qquad SME_{kl} = \dot{Q}_{kl} - \dot{Q} = \sum_{i}\sum_{j} W_{0ij}\left(\dot{Q}_{kl} - \dot{Q}_{ij}\right) \qquad k{=}1,\ldots I.; \qquad l{=}\ 1,\ldots,\mathrm{J}.$$

where

$$W_{0ij} = \frac{Q_{0ij}}{\sum_{i}\sum_{j} Q_{0ij}}\ .$$

Equation (5c) is a weighted average of growth differentials between the (k,l)th market and all markets. A positive scale market effect in the (k,l)th market would indicate that, on average, growth in this market exceeds growth in other markets. The market effect would improve the performance of the focus country if its exports are favourably weighted in this market. Such a weighting would imply a positive market effect for the focus country.

A market effect for the competitive effect may be defined in a similar fashion. Firstly, the growth in the export ratio can be expressed as the sum of the growth for the aggregate (competitive aggregate growth effect, *CAGE*) and a competitive market effect (*CME*):

$$\begin{aligned}(6a)\qquad \dot{s}_{ij} &= \dot{s} + \left(\dot{s}_{ij} - \dot{s}\right) \\ CE_{ij} &= CAG + CME_{ij}\end{aligned}$$

where

$$s = \frac{\sum_{i}\sum_{j} q_{ij}}{\sum_{i}\sum_{j} Q_{ij}}$$ export ratio for the aggregate model (2), above.

Averaging over all markets, the competitive effect is expressed as the sum of the aggregate growth effect and a weighted average of the individual competitive market effects:

(6b)

$$\sum_j \sum_j w_{0ij}\dot{s}_{ij} = \dot{s} + \sum_i \sum_j w_{ij}\left(\dot{s}_{ij} - \dot{s}\right)$$
$$CE = CAGE + CME$$

Once again, where a market effect does exist, its significance for the focus country will depend on the weighting the market receives in the country's total exports. The competitive market effect therefore indicates the significance of individual competitive market effects for the focus country's overall export performance. Further, as an aid to interpretation, the competitive market effect for the (*k*,*l*)th market can be expressed in the following form:

(6c) $$CME_{kl} = \dot{s}_{kl} - \dot{s} = \sum_i \sum_j w_{0ij}\left(\dot{s}_{kl} - \dot{s}_{ij}\right) \quad k=1,\ldots I.; \qquad l=1,\ldots,J.$$

where (as in (4a), above)

$$w_{0ij} = \frac{q_{0ij}}{\sum_i \sum_j q_{0ij}}.$$

The competitive market effect in the (*k*,*l*)th market is a weighted average of differentials between the growth in market share in this market and growth in market share in all other markets.

Finally, the decomposition for the second-order effect is derived by taking the weighted average of individual effects derived from the product of equations (5a) and (6a):

(7)

$$SOE = \dot{s}\dot{Q} + \dot{Q}\sum_i \sum_j w_{ij}\left(\dot{s}_{ij} - \dot{s}\right) + \dot{s}\sum_i \sum_j w_{ij}\left(\dot{Q}_{ij} - \dot{Q}\right) + \sum_i \sum_j w_{ij}\left(\dot{s}_{ij} - \dot{s}\right)\left(\dot{Q}_{ij} - \dot{Q}\right)$$

Interpretation, for descriptive purposes, of the components of the second-order effect draws upon interpretation of the components of the scale and competitive effects. For instance, the first component on the right hand side of (7) is the second-order effect for the aggregate model ((2), above). The second term, considers the impact of aggregation bias over standard exports (assuming bias is absent from the export ratios). The third effect indicates the effect of aggregation bias in the export ratio assuming growth in standard exports are uniform across markets. Finally, the fourth term indicates the significance of the presence of market effects for both the scale and competitive effects for the focus country's export performance.

When we turn to the diagnostic interpretation of the market effect then the same basic forces are at work. The functional form for each of the market effects is derived by substituting (4b) into (5c) and (4c) into (6c), respectively:

Scale Market Effect in market *kl*:

$$SME_{kl} \equiv \hat{Q}_{kl} - \hat{Q} = \sum_i \sum_j \left(\hat{Q}_l - \hat{Q}_j\right) + \sum_i \sum_j W_{0ij} \left[(1-\sigma_l)(\hat{P}_{kl} - \hat{P}_l) - (1-\sigma_j)(\hat{P}_{ij} - \hat{P}_j)\right] \tag{5d}$$

Competitive Market Effect in market *kl*:

$$CME_{kl} \equiv \hat{s}_{kl} - \hat{s} = \sum_i \sum_j w_{0ij} \left[(1-\sigma_{kl})(\hat{p}_{kl} - \hat{P}_{kl}) - (1-\sigma_{ij})(\hat{p}_{ij} - \hat{P}_{ij})\right] \tag{6d}$$

The scale market effect for market *lk* will depend, firstly, on whether, on average the market has been growing by more or less than other markets. Secondly, the market may grow because it is gaining in market share from other markets which in turn depends on the underlying relation between relative prices and elasticities of substitution across products and regions. Even if growth is uniform across regions and relative prices all change in the same proportion a positive (negative) scale market effect may result if the elasticity of substitution in the *j*th region is generally above that for other regions. Alternatively, if growth and elasticities of substitution are uniform across regions, the scale effect need not be zero due to the possibility of price discrimination among markets as well as the presumed lack of homogeneity between products.

The competitive market effect in market *lk* will not depend on growth, or its distribution across regions, but on the differentials in changing relative prices and the elasticities of substitution. A non-zero effect could be explained by price discrimination across regions, the lack of homogeneity across products or different elasticities of substitution. The importance of both market effects for the focus country will of course depend on the relative importance of each market in the country's total exports (through (5b) and (6b)).

In the next section we show that a third level of decomposition is possible. Each market effect can be decomposed into a regional effect, a product effect and a further interaction effect. The result is a fully generalised framework for CMS analysis.

4 Two Methods for a Consistent Decomposition of the Markets Effects

A level-three decomposition of the market effect follows on from Jepma's(1986) resolution of a problem for descriptive analysis. Following on from a discussion of the 'order-problem', we demonstrate that there are two ways for avoiding the problem or, in other words, for consistent decomposition of the market effect. The first approach is based on Jepma's (1986) work and is referred to as the unconditional effects model. A second approach also provides a consistent decomposition of the market effects and is referred to as the conditional effects model (see Appendix B). Since an interpretation of both models under the market-shares norm would be repetitive and would not enhance our understanding of the main issues, only the unconditional effects model is interpreted.

4.1 The 'order problem'

The order-problem derives its name from the manner in which the scale market effect is decomposed. Traditionally, in order to be able to discern the extent to which the market effect could be attributed to a lack of uniformity in growth over products or regions, the market effect was further decomposed into a regional effect and a product effect. However, the order in which the decomposition proceeded would generally lead to different measures for the same (regional or product) effect. Therefore, CMS analysis was open to the criticism that, even for descriptive purposes, it was seriously flawed (Richardson 1971a).

The order-problem is illustrated below. The decomposition of the (*i*,*j*)th market effect may take two forms. In the first equation the regional effect, SRE_j^C, is said to be decomposed before the product effect, SPE_{ij}:

(8a)
$$\dot{Q}_{ij} - \dot{Q} = \left(\dot{Q}_j - \dot{Q}\right) + \left(\dot{Q}_{ij} - \dot{Q}_j\right)$$
$$SME_{ij} \;=\; SRE_j^C \;+\; SPE_{ij}$$

where

$$\dot{Q}_j = \frac{\sum_i \Delta Q_{ij}}{\sum_i Q_{0ij}}\,,$$ growth in standard exports in the *j*th region, and

$$\dot{Q}_i = \frac{\sum_j \Delta Q_{ij}}{\sum_j Q_{0ij}}\,,$$ growth in standard exports in the *i*th product market.

In (8a),the regional effect can be interpreted as the market effect under the assumption that for each region, growth across products is uniform. This can be seen by setting the second term on the right-hand-side of (8a), representing the product effect, equal to zero.

A second decomposition is possible if, this time, the product effect is defined 'first':

(8b)
$$\dot{Q}_{ij} - \dot{Q} = \left(\dot{Q}_i - \dot{Q}\right) + \left(\dot{Q}_{ij} - \dot{Q}_i\right)$$
$$SME_{ij} \;=\; SPE_i^C \;+\; SRE_{ij}$$

Notice, that the definition of the product effect in (8b) below is not the same as in (8a). Similarly, the regional effect is also defined differently in the two equations. Each form of decomposing the market effect involves a decomposition of the market effect into a regional effect (SRE_j^C in (8a) and SRE_i in (8b)) and a product effect (SPE_{ij} in (8a) and SPE_i^C in (8b)). In (8a), for example, the regional effect can be interpreted as the difference between two hypothetical magnitudes: the growth in standard exports if growth had been uniform across products, $\dot{Q}_j$, and the growth in standard exports if growth had, *in addition*, been uniform across regions, $\dot{Q}$. On the other hand, the regional effect in (8b) could be interpreted as the difference between the actual growth in standard exports, $\dot{Q}_{ij}$, and the growth that would have been, if growth in a given product had been uniform across all regions, $\dot{Q}_i$. Because the first regional effect, SRE_j^C, of (8a) is defined on the condition that growth is uniform across products we shall refer to it as the *conditional* regional effect. The regional effect of (8b), SPE_i^C, will be referred to as the unconditional regional effect. Similarly, the product effect of equation (8b), SPE_i^C,will be referred to as the conditional product effect and the product effect of equation (8a), SPE_{ij}, will be referred to as the unconditional product effect. Appendix B illustrates the relation between both types of effects in terms of a Venn diagram.

Generally, conditional and unconditional effects will not be the same. For the traditional model, this has meant that the order in which the market effect was decomposed could effect the conclusions derived from a CMS model (see Richardson, 1971b). In the next section we show how Jepma (1986) has resolved the order-problem and we provide a generalisation of his approach. The model based on Jepmas' decomposition is described as an unconditional effects model to distinguish it from an alternative means for *consistently* decomposing the market effects (see Appendix B)[3].

4.2 Jepma's Decomposition and the Unconditional Effects Model

What will be referred to as the unconditional effects model is based on a decomposition of the market effect suggested by Jepma (1986). Jepma suggested decomposing the scale market effect into three terms intended to capture the impact of disparities in growth across regions and products as well as a third term referred to as the scale interaction effect.

4.2.1 Decomposition of the Scale Market Effect

Based on Jepma (1986), the scale market effect in the (*i*,*j*)th market is decomposed in the following fashion:

[3] For a detailed discussion of the order problem and other issues, as well as an extensive bibliography, see Jepma 1986.

$$\text{(9)} \qquad \begin{array}{ccccccc} \dot{Q}_{ij} - \dot{Q} & \equiv & (\dot{Q}_{ij} - \dot{Q}_i) & + & (\dot{Q}_{ij} - \dot{Q}_j) & - & [(\dot{Q}_{ij} - \dot{Q}_j) - (\dot{Q}_i - \dot{Q})] \\ SME_{ij} & \equiv & SRE_{ij} & + & SPE_{ij} & - & SIE_{ij} \end{array}$$

where

SRE_{ij} = scale regional effect for the (i,j)th market,

SPE_{ij} = scale product effect for the (i,j)th market, and

SIE_{ij} = scale interaction effect for the (i,j)th market.

A scale regional effect is defined for each product and is the difference between the actual growth in standard exports and the growth that would have taken place if product *i*'s growth had been uniform across regions. An alternative expression indicates the precise interpretation (for descriptive analysis):

$$\text{(9a)} \qquad \dot{Q}_{il} - \dot{Q}_i = \sum_j W^i_{0j} \left(\dot{Q}_{il} - \dot{Q}_{ij}\right) \qquad l=1,\ldots J.$$

where

$$W^i_{0j} = \frac{Q_{0ij}}{\sum_j Q_{0ij}} .$$

Equation (9a) is the weighted average of growth differentials between region *l* and *all* regions in terms of product type *i*. Therefore, a positive (negative) scale regional effect, $\dot{Q}_{ij} - \dot{Q}_i$, would indicate that the growth differential between region *l* and each of the other regions is, on average, positive (negative) for the *i*th product market. For example, if the growth in standard exports of wheat to Japan exceeded those of its neighbours then this would lead to a positive scale regional effect for wheat in Japan. The impact on the focus country will depend on the relative weighting of wheat to Japan in its exports. The scale regional effect for the *j*th region therefore indicates the weighted average of the scale regional effects for the focus country:

$$\text{(9a.1)} \qquad SRE_j = \sum_i w_{0ij} \left(\dot{Q}_{ij} - \dot{Q}_i\right)$$

The total regional effect is the summation of the effect for each region:

(9a.2) $$SRE = \sum_j \sum_i w_{0ij} \left(\dot{Q}_{ij} - \dot{Q}_i \right)$$

For diagnostic purposes, the functional form of the scale regional effect is derived by substituting (4b) into (9a):

(9a.3) Scale Regional Effect in market *il*:

$$SRE_{il} \equiv \dot{Q}_{il} - \dot{Q}_i = \sum_j W_{0j}^i \left[\left(\dot{Q}_{il} - \dot{Q}_{ij} \right) + \left(1 - \sigma_l \right) \left(\dot{P}_{il} - \dot{P}_l \right) - \left(1 - \sigma_j \right) \left(\dot{P}_{ij} - \dot{P}_j \right) \right]$$

In terms of the model, the scale regional effect will depend on relative grow rates in expenditure on product *i* across regions, the extent to which price discrimination is apparent between region *l* and other regions and the disparity between regions in terms of the elasticities of substitution. Therefore three factors can account for a non-zero scale region effect.

Turning to the scale *product* effect and its descriptive interpretation, for the *k*th product in region *j* the effect can be rewritten as follows:

(9b) $$\dot{Q}_{kj} - \dot{Q}_j = \sum_i W_{0i}^j \left(\dot{Q}_{kj} - \dot{Q}_{ij} \right) \qquad k=1,\ldots I.$$

where

$$W_{0i}^j = \frac{Q_{0ij}}{\sum_i Q_{0ij}}.$$

Therefore, generally we would expect a positive product effect to reflect positive growth differentials between the *k*th product and each of the other products in the region. The significance of the *i*th product effect for the focus country is derived by weighted sum over all regions:

(9b.1) $$SPE_i = \sum_j w_{0ij} \left(\dot{Q}_{ij} - \dot{Q}_j \right)$$

For example if the scale product effect, (9b.1), for wheat is negative, then this indicates that growth in wheat across all regions has generally been negative; at least in those markets regions which are of importance to wheat exporters of the focus country. Aggregating over the scale product effects, we derived the total scale product effect:

(9b.2) $$SPE = \sum_i \sum_j w_{0ij} \left(\dot{Q}_{ij} - \dot{Q}_j\right)$$

For example, if the total scale product effect is positive, despite a negative effect for wheat, then this indicates a weighting in favour other products, such as beef, with positive scale product effects.

Interpretation of the scale product effect for diagnostic purposes is straight-forward under the assumed model. From (4b), we derive the following:

(9b.3) Scale Product Effect in market *kj*:

$$SPE_{kj} \equiv \dot{Q}_{kj} - \dot{Q}_j = (1-\sigma_j)(P_{kj} - \dot{P}_j)$$

Under the model, the scale product effect for each product in region *l* reflects changes in the relative price of the product. Unless the product is highly differentiated, a fall in relative prices will yield a positive scale product effect.

Finally, the scale interaction effect is interpreted as the combined effect of non-uniformity of growth across regions and product types. To interpret the scale interaction effect for descriptive purposes, it is best rewritten as follows:

(9c.1) $$SIE_{ij} = SME_{ij} - \left(\dot{Q}_j - \dot{Q}\right) - \left(\dot{Q}_i - \dot{Q}\right)$$

The last two terms were defined in the previous section as the conditional regional effect, SRE_j^C, and conditional product effect, SPE_i^C (see Section 4.1, above, or Appendix B). Whereas the unconditional scale regional effect, SRE_{ij}, makes no assumption regarding the uniformity, or otherwise, of growth across products, the corresponding conditional effect, SRE_j^C, assumes that growth for regions in aggregate is an unbiased measure of growth for each region. In other words if growth across products were assumed uniform, then the market effect in the (*i*,*j*)th market would be equal to SRE_j^C. Alternatively, if growth is assumed uniform across regions then the market effect becomes, SPE_i^C. The scale interaction effect is simply the difference between the actual market effect and the two conditional effects:

$$\text{(9c.2)} \qquad SIE = \sum_i \sum_j w_{0ij} \left[\left(\dot{Q}_{ij} - \dot{Q} \right) - \left(\dot{Q}_j - \dot{Q} \right) - \left(\dot{Q}_i - \dot{Q} \right) \right]$$

Finally, it can be confirmed that by substituting (9) into (3b) the scale effect of the original model is decomposed into the three effects: (9a.2), (9b.2) and (9c.2).

4.2.2 Decomposition of the Competitive Market Effect

The competitive market effect may be subject to a similar decomposition:

$$\text{(10)} \qquad \begin{array}{ccccccc} \dot{s}_{ij} - \dot{s} & \equiv & \left(\dot{s}_{ij} - \dot{s}_i \right) & + & \left(\dot{s}_{ij} - \dot{s}_j \right) & - & \left[\left(\dot{s}_{ij} - \dot{s}_j \right) - \left(\dot{s}_i - \dot{s} \right) \right] \\ CME_{ij} & \equiv & CRE_{ij} & + & CPE_{ij} & - & CIE_{ij} \end{array}$$

where

$$s_i = \frac{\sum_j q_{ij}}{\sum_j Q_{ij}} \quad , \quad i\text{th product export ratio.}$$

$$s_j = \frac{\sum_i q_{ij}}{\sum_i Q_{ij}} \quad , \quad j\text{th regional export ratio,}$$

and

CRE_{ij} = competitive regional effect for the (*i*,*j*)th market,

CPE_{ij} = competitive product effect for the (*i*,*j*)th market,

CIE_{ij} = competitive interaction effect for the (*i*,*j*)th market.

Once again the regional and product effects are amenable to a consistent descriptive interpretation. The regional effect in region *k*, given product *i*, can be expressed as the weighted average of the differentials in market share growth between region *k* and all regions:

(10a) $$\dot{s}_{ik} - \dot{s}_i = \sum_j w^i_{0j} \left(\dot{s}_{ik} - \dot{s}_{ij} \right)$$

where

$$w^i_{0j} = \frac{q_{0ij}}{\sum_j q_{0ij}}$$[4].

For example, if Japan is the region and beef the product, then a positive regional effect indicates that, on average, the comparative performance of the focus country has increased more in Japan than other regions. The competitive regional effect can be defined for the *j*th region by summing over products:

(10a.1) $$CRE_j = \sum_i w_{0ij} \left(\dot{s}_{ij} - \dot{s}_i \right)$$

A positive regional effect for the *j*th region indicates that over the period the focus country has been able to concentrate its exports to the region in those products in which improvement in comparative performance was above average. We derive the competitive regional effect by summing (10a.1) over products:

(10a.2) $$CRE = \sum_j \sum_i w_{0ij} \left(\dot{s}_{ij} - \dot{s}_i \right)$$

In terms of the model, the competitive regional effect reflects the extent to which the focus country has been able to concentrate it exports in a manner which takes advantage of any price discrimination (see 10a.3, below). Otherwise, if the change in relative price for each product is uniform across regions then a competitive regional effect would reflect different degrees of product differentiation across regions. The functional form under the model is as follows[5]:

(10a.3) Competitive Regional Effect in market *il*:

$$CRE_{il} \equiv \dot{s}_{il} - s_i = \sum_j w^i_{0j} \left[(1-\sigma_{il})(\dot{p}_{il} - \dot{P}_{il}) - (1-\sigma_{ij})(\dot{p}_{ij} - \dot{P}_{ij}) \right]$$

[4] The reader should note that the weights here are in terms of the exports of the focus country and not the standard.

[5] Substitute (4c) into (10a.1).

Turning to the competitive product effect, each product effect, for a given region, can be expressed as the average of growth differentials in market share between product *k* and all other products:

(10b) $$\dot{s}_{kj} - \dot{s}_{j} = \sum_i w_{0i}^{j} \left(\dot{s}_{kj} - \dot{s}_{ij}\right)$$

where

$$w_{0i}^{j} = \frac{q_{0ij}}{\sum_i q_{0ij}}.$$

Therefore, the competitive product effect will be positive if the growth in market share in product *k* is greater, on average, than for other products.

A competitive product effect can be defined for each of the *I* products as follows:

(10b.1) $$CPE_i = \sum_j w_{0ij} \left(\dot{s}_{ij} - \dot{s}_{j}\right)$$

The competitive product effect measures the significance for the focus country of a lack of uniformity across products in the changes in the export ratio. The total effect is simply the aggregate over the regions:

(10b.2) $$CPE = \sum_i \sum_j w_{0ij} \left(\dot{s}_{ij} - \dot{s}_{j}\right)$$

Once more, for diagnostic purposes, we can derive a functional form for the competitive product effect, which is consistent with the market-shares norm[6]:

(10b.3) Competitive Product Effect in market *kj*:

$$CPE_{kj} \equiv \dot{s}_{kj} - s_j = \sum_i w_{0i}^{j} \left[(1-\sigma_{kj})(\dot{p}_{kj} - \dot{P}_{kj}) - (1-\sigma_{ij})(\dot{p}_{ij} - \dot{P}_{ij})\right]$$

[6] Substitute (4c) into (10b.1).

The competitive product effect may reflect the lack of homogeneity across products of any one region or the different degrees to which the focus country has been able to differentiate itself from rivals across products (as measured by the elasticity of substitution).

Finally, the decomposition of the competitive market effect will entail a third, interaction effect with an interpretation analogous to that for the scale effect (see, (9c.1) and (9c.2), respectively):

(10c.1) $$CIE_{ij} = CME_{ij} - \left(\acute{s}_j - \hat{s}\right) - \left(\acute{s}_i - \hat{s}\right)$$

(10c.2) $$CIE = \sum_i \sum_j w_{0ij} \left[\left(\acute{s}_{ij} - \hat{s}\right) - \left(\acute{s}_j - \hat{s}\right) - \left(\acute{s}_i - \hat{s}\right)\right]$$

In this case, the interaction effect measures the combined impact of a regional effect and product effect The individual effect, (10c.1), indicates the extent to which both effects occur in the one market over the period. A positive value implies that a positive (negative) product effect is combined with a positive (negative) regional effect over the period. Conversely, a negative value indicates a negative association. The weighted average of these effects indicates the significance of the individual interaction effects for the focus country.

We may derive a further decomposition of the second-order effect along the same lines as was done for market effects in the previous section (see equation (7)). The maximum number of effects into which the second-order effect can be decomposed becomes sixteen for a level-three analysis. Since the scale and competitive effects are each decomposed into four effects, the model allows a maximum of twenty-four effects *for each of the IJ markets*. Of course, it is not necessary to include all these effects. Much will depend on the purpose of the analysis and computation costs. A problem for those interested in doing a comprehensive set of analyses is the lack of a ready-made soft-ware package.

5 An Assessment

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 literature has been what Richardson (1971a,b) has called the index-problem: the choice of an appropriate base year. Jepma (1986) has suggested a method of shifting weights (that is, the $\boldsymbol{w}$'s) to allow for changes in export composition over time. In our own empirical analysis, we have calculated the CMS model on an annual basis and taken the average over a period or four or five years, with due account for any outlying years.

On the other hand, the issue of diagnostic interpretation remains open with few attempts to explore the theoretical foundations of the CMS model. We saw that an unambiguous interpretation requires the market-shares norm, which assumes that market shares depend only on the prices of competing suppliers within a market. The market-shares norm places CMS analysis squarely within the same class as the Armington models and shares in its flaws as well as its benefits.

The benefits include the relative simplicity of diagnostic interpretation. However, as we have seen, further analysis would be required to determine, for instance, whether competitive effects were due to price or non-price factors. The advantage of CMS analysis is that it is able to yield quite precise hypotheses and thereby indicate the direction for further research using other quantitative, as well as qualitative, methods. The potential drawback is the inapplicability of the strong separability assumptions required by the model (for a critical study, see Alston, Carter and Pick 1990). In fact, the issue is really one of being able to measure any bias that the model may render to the 'true' interpretation. An explicit model, such as the one used in this paper, at least yields a set of refutable maintained hypotheses, such as the presumed two-stage budgeting process.

Another set of issues revolve around the applicability of the three aggregation conditions: the definition of regions, products and the standard. Is it appropriate, for example, to treat East Asia, or even Japan, as one region, or should they be disaggregated? The answer will depend on the similarity of consumers *within* regions and the absence of distribution effects. For instance, we need to be sure the manner in which growth is distributed across consumers *within* any one region will not affect market shares. Further, the relative prices of goods within a product category would need to be reasonably fixed to assure the analyst that distributional factors did not influence product shares. The choice of standard may also be classed as an aggregation problem. To what extent will the choice of countries to be included or excluded from the standard affect the results? Much work needs to be done to clarify the issues underlying the diagnostic interpretation of the CMS model.

Through-out the analysis, we have assumed quantities to be demand-determined. Assuming constant costs allows us to take relative prices as determined by the cost-conditions in the supplying region in which case a change in relative prices can be unambiguously associated with differential wage, productivity or technological growth. The supply conditions, at least, limits analysis to changes over the medium to long run, while demand conditions may place an upper limit on the length of the period (due to changing tastes).

Concerning the prospects for further research, given the stringent conditions underlying the market-shares norm, it is not surprising that the CMS framework has come under attack for lacking an unambiguous interpretation (Houston, 1967; Ooms, 1967). The most important issue appears to be selecting an appropriate level of disaggregation by region and product type. One the other hand, the CMS model may itself yield such criteria.(Leamer and Stern, 1971). For instance, a reasonably straight-forward algorithm for choosing the level of disaggregation may be as follows: select the level of disaggregation for which marginal increase in the product (regional) effect from disaggregation of products (regions) was zero. Unfortunately, there may be no reason to expect such a relationship even if the data were available. Houston (1968), for example, found that there was no monotonic relation between the level of disaggregation and the structural effects to be found in his data.

Clustering methods may be another way of tackling 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, Carter, Green and Pick (1990) points the way to apparently more generalised investigation of the structure of consumer preferences. The tests involve non-parametric analysis of consumption patterns to determine whether they are consistent with the axioms of revealed preference and, in particular, the implications of homothetic preferences. Further, testing for cointegration among prices to ascertain whether any two products can be grouped promises to provide a more reliable and efficient method for dealing with the problem of product aggregation.

Although we have only touched on what appear to be the main outstanding issues, it is apparent that there is much scope for further theoretical and applied research. However, there remains a practical hurdle. The analyst needs to be able to enter a large amount of data and produce a number of models differing in terms of the level of disaggregation and decomposition. In order to pay due attention to the issues raised above, and combine CMS analysis with other statical tools such as regression analysis, CMS analysis requires its own software package. Otherwise the prospect for CMS analysis is severely limited.

6 Conclusions

In this paper we have shown that the CMS model, based on Jepma's revised framework, can be generalised and extended to exploit to the full its descriptive and diagnostic potential. An important contribution of this paper has been to provide a general framework for descriptive analysis. Further, we have highlighted the potential role for CMS in suggesting hypotheses and complementing other methods of quantitative analysis.

For descriptive analysis, 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 effect for the country's export performance. A level-two analysis indicates the relative importance of growth or market effects. Further, if a market effect appears significant, it can be decomposed into regional and product effects as part of a level-three analysis.

While Jepma's revised framework places descriptive analysis on surer foundations, diagnosis and policy analysis will remain open to dispute. We have demonstrated how the various scale and competitive effects may be interpreted under the market-shares norm using Armington's suggestion for modelling products differentiated by country of origin. The interpretation of CMS in terms of the market-shares norm generates a set of well-defined hypotheses given the assumptions underlying the market-shares norm. For instance, CMS may tell us that there has been a significant competitive effect over a period, but it will *not* indicate the extent to which price or non-price competition is responsible. Therefore, there is scope for further applied work in testing the hypotheses generated through CMS analysis, as well as testing the extent to which the market-shares norm is applicable to the data on hand.

CMS analysis will generate hypotheses which are refutable, if 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. However, without a standard computer package, the costs of CMS will limit applied research and, as a likely consequence, also limit research into its theoretical foundations. For these reasons the potential for CMS analysis, particularly as a tool for diagnosis, has yet to be fully explored and exploited.

References:

Ahmadi-Esfahani F.Z. 1993, 'An analysis of Egyptian wheat exports: a constant market shares approach', *Oxford Agrarian Studies,* Vol. 21, pp31-39.

Ahmadi-Esfahani F.Z. and Jenson, P.H. 1994, 'Impact of the US-EC price war on major wheat exporters' shares of the Chinese market' *Agricultural Economics*, Vol. 10, pp61-70.

Ahmadi-Esfahani F.Z. 1995, 'Wheat market shares in the presence of Japanese import quotas' *Journal of Policy Modeling,* Vol. 17, pp315-23.

Alston, J.M., Carter, C.A, Green, R. and Pick, D. 1990, 'Whither Armington trade models', *American Journal of Agricultural Economics*, pp455-467.

Armington, 1969, 'A theory of demand for products distinguished by place and production', *IMF Staff Papers*, 16, pp159-76.

Brownie, S. Dalziel, P. 1993, 'Shift-Share Analyses of New Zealand Exports, 1970-1984' *New Zealand Economic Papers,* Vol. 27, pp233-49.

Drysdale, P. and Lu, W. 1996, Australia's Export Performance in East Asia, Pacific Economic Paper, No. 259, Australia-Japanese Research Centre.

Green, H.A.J. 1964, *Aggregation in Economic Analysis*, Princeton, N.J: Princeton University Press.

Hoen, H.W. and Wagener, H.-J. 1989, 'Hungary's exports to the OECD: A CMS analysis' *Acta Oeconomica,* Vol. 40, pp65-77.

Houston, D.B. 1967, 'The shift and share analysis of regional growth: a critique' Southern Economic Journal, Vol. 33, pp577-81.

Jepma, C.J. 1986, Extensions and Application Possibilities of the Constant-Market-Shares Analysis, Rijkusuniversiteit, Groningen.

Jepma, C.J. 1988 'Extensions of the Constant-Market-Shares analysis with an application to long-term export data of developing countries', in J.G. Williamson and V.R. Panchamukhi 1988-89, *The Balance between Industry and Agriculture in Economic development, Vol. 2: Sector Porportions*:

proceedings of the Eighth World Congress of the International Economic Association, Delhi, India. New York : St. Martin's Press.

Junz, H.B. and Rhomberg, R.R. 1965, ‘Prices and Export Performance of Industrial Countries, 1953-63’, IMF Staff Papers, pp224-269.

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

Merkies, A.H.Q.M. and van der Meer, T. 1988, ‘A theoretical foundation for CMS analysis’ Empirical Economics, Vol. 13, pp65-80.

Ooms, V.D. 1967, ‘Models of comparative export performance’ Yale Economic essays,7, pp103-41.Pudney, S.E. 1981, ‘An empirical method of approximating the separable structure of consumer preferences’ *Review of Economic Studies*, pp561-577.

Richardson, J.D. 1971a, ‘Constant-market-shares analysis of export growth’ *Journal of International Economics*, Vol. 1. pp227-39.

Richardson, J.D. 1971b, ‘Some sensitivity tests for a “constant-market-shares” analysis of export growth’ *Review of Economics and Statistics*, LIII, pp300-4.

Tyszynski, H. 1951, ‘World Trade in manufactured commodities, 1899-1950’ *The Manchester School of Economic and Social Studies* Vol. 19, pp272-304.

Appendix A

Interpretation of Unconditional Model under the CES Armington Model

(Based on a model derived in Merkies and van der Meer,1988)

- Interpretation of Level One Model

Scale Effect in market *ij*:

$$SE_{ij} \equiv \hat{Q}_{ij} = \hat{Q}_j + (1-\sigma_j)(\hat{P}_{ij} - \hat{P}_j)$$

Competitive Effect in market *ij*:

$$CE_{ij} \equiv \hat{s}_{ij} = (1-\sigma_{ij})(\hat{p}_{ij} - \hat{P}_{ij})$$

- Interpretation of Level Two Model

Scale Market Effect in market *kl*:

$$SME_{kl} \equiv \hat{Q}_{kl} - \hat{Q} = \sum_i \sum_j W_{0ij} \left[\left(\hat{Q}_l - \hat{Q}_j \right) + (1-\sigma_l)(\hat{P}_{kl} - \hat{P}_l) - (1-\sigma_j)(\hat{P}_{ij} - \hat{P}_j) \right]$$

Competitive Market Effect in market *kl*:

$$CME_{kl} \equiv \hat{s}_{kl} - \hat{s} = \sum_i \sum_j w_{0ij} \left[(1-\sigma_{kl})(\hat{p}_{kl} - \hat{P}_{kl}) - (1-\sigma_{ij})(\hat{p}_{ij} - \hat{P}_{ij}) \right]$$

- Interpretation of Level Three Model

Scale Regional Effect in market *il*:

$$SRE_{il} \equiv \hat{Q}_{il} - \hat{Q}_i = \sum_j W^i_{0j} \left(\hat{Q}_{il} - \hat{Q}_{ij} \right) = \sum_j W^i_{0j} \left[\left(\hat{Q}_{il} - \hat{Q}_{ij} \right) + (1-\sigma_l)\left(\hat{P}_{il} - \hat{P}_l\right) - (1-\sigma_j)\left(\hat{P}_{ij} - \hat{P}_j\right) \right]$$

Scale Product Effect in market *kj*:

$$SPE_{kj} \equiv \hat{Q}_{kj} - \hat{Q}_j = (1-\sigma_j)(P_{kj} - \hat{P}_j)$$

Competitive Regional Effect in market *ik*:

$$CRE_{il} \equiv \dot{s}_{il} - \dot{s}_{i} = \sum_{j} w^{i}_{0j} \left[(1-\sigma_{il})(\dot{p}_{il} - \dot{P}_{il}) - (1-\sigma_{ij})(\dot{p}_{ij} - \dot{P}_{ij}) \right]$$

Competitive Product Effect in market *kj*:

$$CPE_{kj} \equiv \dot{s}_{kj} - \dot{s}_{j} = \sum_{i} w^{j}_{0i} \left[(1-\sigma_{kj})(\dot{p}_{kj} - \dot{P}_{kj}) - (1-\sigma_{ij})(\dot{p}_{ij} - \dot{P}_{ij}) \right]$$

Appendix B

The Conditional Effects Model

The decomposition suggested by Jepma (1986) was based on the unconditional regional and product effects. An alternative model, which also decomposes the market effect consistently, will be introduced in this appendix. In the conditional effect model, the market effects are decomposed into *conditional* product and regional effects as well as an interaction term. However, the interaction effects defined in the previous section are common for both models.

The scale and competitive effects for each market are defined in (B.1) and (B.2) below. Since the complete model is derived in the same manner as for the unconditional effects we will not repeat the steps here.

Decomposition of the scale market effect:

$$\text{(B.1)} \qquad \begin{array}{ccccccc} \dot{Q}_{ij} - \dot{Q} & = & (\dot{Q}_{j} - \dot{Q}) & + & (\dot{Q}_{i} - \dot{Q}) & + & \left[(\dot{Q}_{ij} - \dot{Q}) - (\dot{Q}_{j} - \dot{Q}) - (\dot{Q}_{i} - \dot{Q}) \right] \\ ME_{ij} & = & SRE^{C}_{j} & + & SPE^{C}_{i} & + & SIE_{ij} \end{array}$$

Decomposition of the competitive market effect:

$$\text{(B.2)} \qquad \begin{array}{ccccccc} \dot{s}_{ij} - \dot{s} & = & (\dot{s}_{ij} - \dot{s}_{i}) & + & (\dot{s}_{ij} - \dot{s}_{j}) & + & \left[(\dot{s}_{i} - \dot{s}) - (\dot{s}_{ij} - \dot{s}_{j}) \right] \\ CME & = & CRE^{C}_{j} & + & CPE^{C}_{i} & + & CIE \end{array}$$

where

CRE_j^C	=	conditional competitive regional effect for the (i,j)th market,
CPE_i^C	=	conditional competitive product effect for the (i,j)th market, and
CIE_{ij}	=	competitive interaction effect for the (i,j)th market.

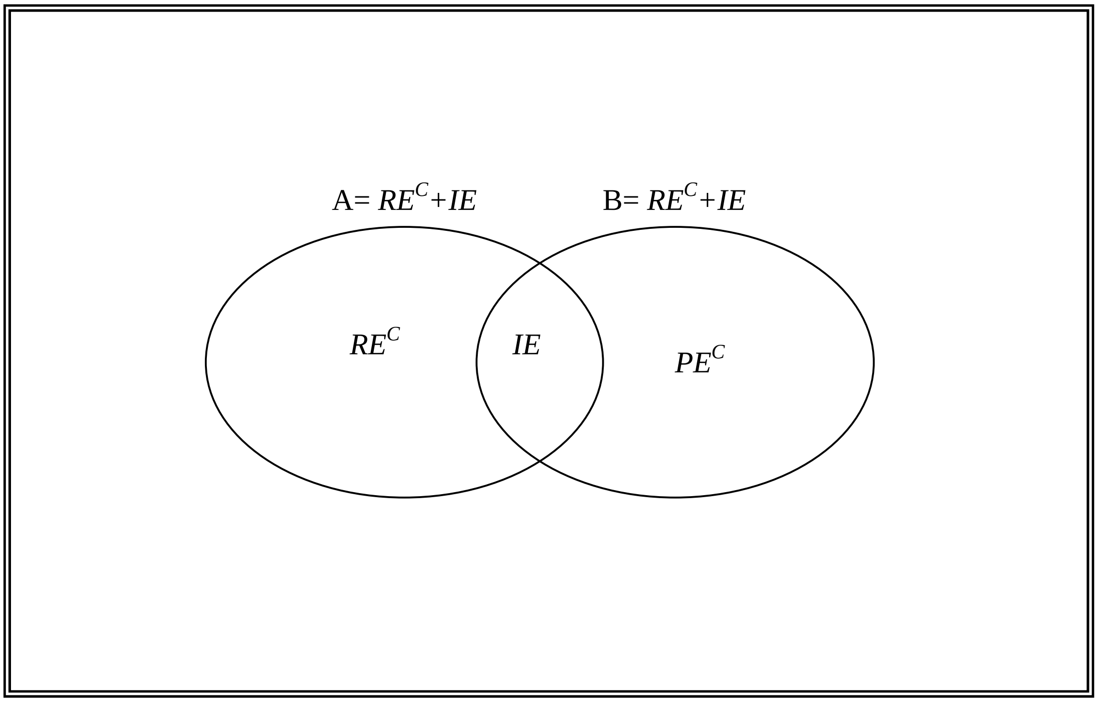
Unlike its counterpart in the unconditional effects model, the conditional regional effect for the scale (competitive) effect assumes standard exports (export ratios) grow uniformly across products and measures the extent of aggregation bias across regions. Similarly the conditional product effect for the scale (competitive) effect assumes that standard exports (export ratios) grow uniformly across regions and measures the extent of aggregation bias across products.

It is beyond the scope of this paper to attempt any clear judgement as to which of the two models one ought to choose. The relation between the conditional and unconditional effects may be represented through a Venn diagram (Fig. B.1). In the Venn diagram below, the area of each circle, *A* and *B*, respectively represents the regional and product effects. Their union represents the market effect and the intersection of the two circles represents the interaction effect.

The conditional regional effect is derived under the assumption that, for each region, growth is uniform across products. This is equivalent to assuming that the (unconditional) product effect is zero which excludes the whole area *B*. The remainder of the area (*A*+*B* complement *B*), represents the conditional regional effect.

In addition, the diagram demonstrates that it is possible for the interaction effect to be zero while the regional and product effects are non-zero. This would be the case if some markets experienced one effect or the other, but not both. In this case, the conditional and unconditional effect would be the same.

Figure B.1: Relation between Conditional and Unconditional Effects



Finally, the relation between the components of the unconditional effects model and the conditional effects model are summarised below:

$$ME = RE + PE - IE = RE^C + PE^C + IE,$$
$$RE^C = RE - IE, \text{ and}$$
$$CE^C = CE - IE.$$