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A New Constant Market Share Competitiveness Index

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ABSTRACT

Constant-market-share analysis (CMSA) is one of the most widely employed descriptive tool for measuring the export competitiveness of a country relative to other countries or regions of trade for goods and services. Typically, export growth is attributed to growth in the country's export competitiveness and also to the growth effect of the market itself. However, CMSA measurement is prone to a number of methodological short comings which stems from the CMS identities used in the analysis. Namely, the discrete approximation of continuously changing trade patterns, the interaction effects term residual from the CMS identity decomposition and the arbitrary choice of weights attached to base periods. This paper addresses some of the short comings of the classic CMSA approach. Within a geometric framework we reexamine the CMS decomposition and propose a new net-share approach that is easier to implement and interpret. For researchers and policy makers, this methodology presents a simpler but more consistent measurement for more accurate CMS measurement and interpretations of changing trade patterns.

Keywords: Constant Market Share analysis, competitiveness index, export competitiveness.

1. Introduction

In an increasingly globalised world in which there been a proliferation of regional trading agreements, it is increasingly important to be able to understand and document changing trade patterns and how this reflects changes in a country's competitiveness. Constant-market-share (CMS) analysis has long been used to analyse the export competitiveness of a country and has been used to measure competitiveness relative to the rest of the world or within a specific grouping of countries or well defined regional trading bloc such as the European Union (EU) or the North American Free Trade Area (NAFTA). Put simply, CMS analysis decomposes a country's export growth into a competitiveness effect (CE) and the total growth effect (GE). The competitiveness effect is defined as the increase in the quantity of a country's exports due to the increase in the country market share only (with global or regional exports remaining constant). The total export growth effect is defined as the increase in the quantity of a country's exports that are due to an increase in global or regional market share only (country exports share remaining constant).

CMS analysis was first introduced in the context of international trade by Tyszynski (1951) then applied to regional economics by Perloff et al. (1960) who used the term shift-share analysis. The technique's popularity in analysing regional economic performance is credited to Lowell D. Ashby who introduced it to government policymakers (Ashby, 1964). Shift-share analysis focuses on regional economic growth driven by employment growth decomposes this employment growth into several effects which is claimed to explain these regional disparities. The structural effect or growth effect which is also called the industry mix effect due to the structure of regional employment was the first decomposition (Dunmore, 1986 and Esteban-Marquillas, 1972). This was further expanded to include the competitiveness effect and the allocation effect which resulted from a residual term from the shift-share accounting identities (Esteban-Marquillas, 1972). Essentially, it seeks to understand the drivers of growth between different economic regions. Shift-share analysis was then extended to include new net change and net relative change identities to account for the dynamic nature of economic growth (Herzog and Olsen, 1977 and Kalbacher, 1979). The CMS methodology of analysis remains important and relevant today as shown by Artige and Neuss (2014) who propose a new shift-share decomposition that addresses shortcomings of traditional shift-share analysis. There is another approach to CMS as introduced by Fagerberg and Sollie (1987). Instead of decomposing the absolute change in exports they decomposes the change in market share into two static components, the product effect and market effects and three dynamic components, the competitiveness effect, the product (or commodity) adaptation effect and the geographical (or market) adaptation effect.

Shift-share analysis gradually expanded to explain patterns of international trade competitiveness and become known as CMS analysis that focuses on export shares of a focus country relative to the world. Applications of CMS analysis include Lombaerde and Verbeke (1989) in a study of international seaport competition, Leamer and Stern (1970) in a study of international marketing and international trade and Hoen and Leeuwen (1991) who used CMS to examine competitiveness in manufacturing trade of Eastern Europe. In similar studies, Skriner (2009) and Rahmaddi and Ichihashi (2012) used CMS to assess the performance of Austrian and Indonesian manufacturing exporters respectively. Jimenez and Martin (2010) used CMS to analyse the European export market shares for the period 1994-2007. Finally, Bonanno (2016) presents some applications of CMS to the Italian case.

However, CMS analysis being grounded on shift-share analysis, unfortunately shares its shortcomings as well. The chief problem is well known as the "CMS index number problem". The problem stems from the fact that both a country and world exports are changing continuously in time while CMS identities are merely discrete time approximations. This makes the decomposition of growth and competitiveness effects inconsistent. Numerous authors have attempted to provide the best discrete time CMS decomposition to account for the growth and competitiveness effects (Baldwin, 1958, Svennilson, 1954 and Tyszynski, 1951). These efforts however create an additional problem where a new "residual or interaction term" is created from these decompositions (Milana, 1988, Richardson, 1971). This interaction term was thought to be the interaction between the structural or growth and competitive change (Baldwin, 1958). But, it can also be thought of as measuring the growth of the country's export shares in rapidly expanding commodities and markets (Richardson, 1971). Hence, it is not subject to easy interpretation. Furthermore, similar to shift-share analysis, the researcher has to make an arbitrary choice. For CMS analysis, this relates to the choice of the base period of measurement which becomes the basis of weights to compute the structural and competitiveness effects. This arbitrary choice in turn leads to the appearance of the interaction term which one would hope to avoid.

The objective of this paper is to demonstrate how CMS can be reinterpreted using a simple geometric approach which might help overcome the "unsolvable" index number inconsistency problem. This leads us to the construction of a new index that we call the Constant-Market-Share Competitiveness (CMSC) index which we believe is able to capture the competitiveness performance of a country's exports relative to others which can be global or relative to a specific regional market. Our new index is motivated by the net relative change shift-share identities. We contribute by adapting the net relative change method to design a new net share approach to CMS analysis which does not create the interaction term. This will provide us a new solution that is easy to apply, understand and interpret. Our solution will be invaluable to the large number of academics and policymakers that want to illustrate changing patterns of competitiveness for countries or sectors both regionally and globally.

The remainder of the paper is organised as follows. Section 2 presents the basic CMS model and discusses the currently perceived problems within the existing CMS approach used in the literature. In Section 3 we present our geometric framework before we outline our proposed measure of export competitiveness derived from the results from Section 2. Section 4 presents a numerical example to demonstrate the applicability of our approach and Section 5 concludes.

2. The Basic CMS Model

It is useful to begin with a description of the basic CMS model and to outline the five key identities associated with CMS and described originally in Richardson (1971). Assume we are looking at world trade and we are looking at competitiveness from a home country perspective. Hence, let p = the total value of home exports and Q = the total value of world exports (home plus foreign exports). Hence, the share of exports of the home country(s) to the world exports is given by $s = \frac{p}{Q}$. The basic identity of the CMS can therefore be represented by;

$$\frac{dp}{dt} = s\frac{dQ}{dt} + Q\frac{ds}{dt} \tag{1}$$

Richardson (1971) points out that there is a problem with writing the CMS identity in the form of Equation (1) because it refers to an infinitesimally short time period whereas CMS analysis is usually performed over a discrete time period usually annual changes. To address this problem Richardson (1971) proposed a number of new CMS identities which take into account the discrete time issue.

These are given as follows where Δ represents a change and the superscripts represent the initial and subsequent time periods in total exports Q and the share of exports s and α is a constant.

$$\Delta p = s^0 \Delta Q + Q^1 \Delta s \tag{2}$$

$$\Delta p = s^1 \Delta Q + Q^0 \Delta s \tag{3}$$

$$\Delta p = s^0 \Delta Q + Q^0 \Delta s + \Delta s \Delta Q \tag{4}$$

$$\Delta p = (\alpha s^0 + (1-\alpha)s^1)\Delta Q + (\alpha Q^1 + (1-\alpha)Q^0)\Delta s \quad for \quad 0 < \alpha < 1 \tag{5}$$

Despite the work of Richardson (1971) above, the use of CMS has continued to attract criticism (Jepma, 1986, Milan, 1988 and Oldersma an Van Bergeijk, 1993). One of the main sticking points is what is called in the literature as the "index number problem" which is a problem that is related to the choice of an appropriate base year when one wants to study export competitiveness.

One of the contributions of this paper is to show how our geometric framework together with Milana's identity can be used to address this "index number problem" in particular highlighted by Richardson (1971) and Milana (1988). Flexibility for researchers in using any of the identities will result in inconsistency in the decomposition of identity (1), $Q^1\Delta s$ represents the CE and $s^0\Delta Q$ represents GE while identity (2), $Q^0\Delta s$ represents CE and $s^1\Delta Q$ represent GE. Identity (3) decomposes Δp into three parts separating the residual term $\Delta s\Delta Q$ from CE and GE. In identity (1) the residual $\Delta s\Delta Q$ is considered part of CE while in identity (2) it is considered part of GE.

Figure 1 demonstrate the decomposition of identity (3) using the area approach. In addition, although other authors suggest adjustments and extensions to the basic CMS methodology; these new identities instead led to further inconsistencies with the CMS analysis. The identity proposed by Milana (1988) helped in solving inconsistency caused by the residual $\Delta s\Delta Q$. Milana identified this inconsistency as the "index number problem of CMS analysis" or simply the "CMS problem" and he demonstrated that identity (5) with $\alpha = 0.5$ is the most accurate discrete-time approximation of which is the exact decomposition of total export change between period 0 and 1 (superscript t denotes period).

Setting identity (5) with $\alpha = 0.5$ as proposed by Milana (1988) we will have;

$$\Delta p = \frac{1}{2}\Delta Q(s^1 + s^0) + \frac{1}{2}\Delta s(Q^1 + Q^0) \tag{6}$$

Equation (6) which we now address as Milana's identity can also be obtained by adding identities (2) and (3) which follow Richardson (1971) who proposed using both identities to obtain improved results. This can be demonstrated geometrically by decomposing Δp into the sum of the areas of two trapeziums

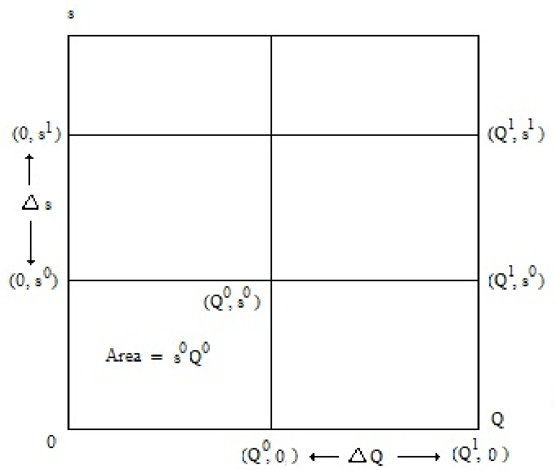

Figure 1: Area interpretation of the CMS components.

in the s versus Q graph as shown in Figure 2. The best solution is to divide the residual $\Delta s \Delta Q$ equally between the GE and CE which gives us the Milana's identity.

In this case, the area of the trapezium $\frac{1}{2}\Delta s(Q^1+Q^0)$ represents the growth effect (CE) while the area of the other trapezium given by $\frac{1}{2}\Delta Q(s^1+s^0)$ represents the competitive effect (GE). Hence, we have the following formulation;

$$\Delta p = \frac{1}{2}\Delta Q(s^1+s^0) + \frac{1}{2}\Delta s(Q^1+Q^0) = CE + GE \tag{7}$$

This formulation will be used in the construction of our geometric framework for CMS analysis in the next section.

3. A Geometric Framework for CMS Analysis

In this section we show how the CMS can possibly be translated into a geometric space. To do this we build on the original geometric framework of Azhar and Elliot (2003) to develop what we now call a Constant Market Share Space (CMSS). This new CMSS framework allows the researcher to visualize changes and differences in both the competitiveness effects and total growth

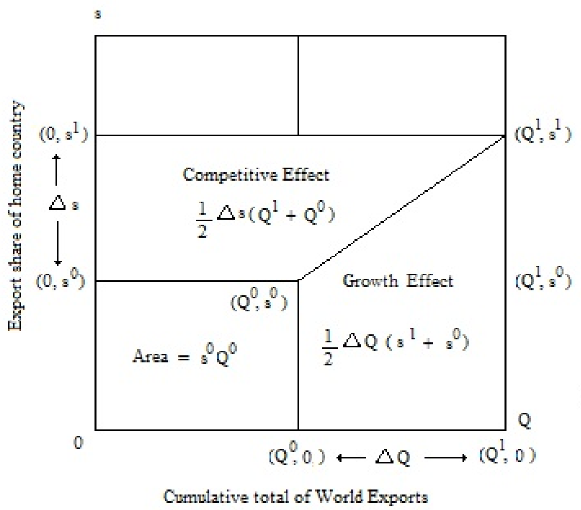

Figure 2: Area representation of Milana (1988)'s identity for $\Delta Q > 0$ and $\Delta s > 0$

effects between units of analysis (usually countries) and also between different time periods. The space in the CMSS can also be divided into several regions in which each region exhibits similar competitiveness characteristics.

To illustrate the applicability of our approach, assume a hypothetical CMS study of exports for n countries for a given period of time. The CMSS is a two-dimensional space that can capture each and every competitiveness effect (CE) and total growth effect (GE) for each of n countries for a given period where the CE and GE can be positive, negative or zero. We depict the competitiveness effects (CE) on the vertical axis (+/-CE) and the total growth effects (GE) on the horizontal axis (+/-GE).

The result is a two-dimensional space which is a square box with four quadrants. The lengths of the sides of the CMSS are given by twice the maximum of the largest absolute value of whichever is larger of the CE or GE for the period of study. Figure 3 presents a hypothetical CMSS.

For a given country in a given period the Competitiveness and Growth Effects for any of the n countries in the period of analysis can be represented by a single coordinate point in the CMSS. In Figure 3, points N and M are coordinates of two representative countries, one of which (N) has a positive CE and a positive GE while M has a fall in both CE and GE. Since the length of the vertical and horizontal axis are equal and each quadrant is a square it means that the positive and negative sides are equal in length with the maximum length of the side given by the absolute value of whichever is larger of CE or GE. Using set notation, a CMSS for n countries can be written as;

$$\begin{aligned} CMSS = & \{(x,y)| \quad -|max(CE_t, GE_t)| \leq x \leq max(CE_t, GE_t), \\ & -|max(CE_t, GE_t)| \leq y \leq \max(CE_t, GE_t), \\ & t = 1, 2, 3, ...m\} \end{aligned} \tag{8}$$

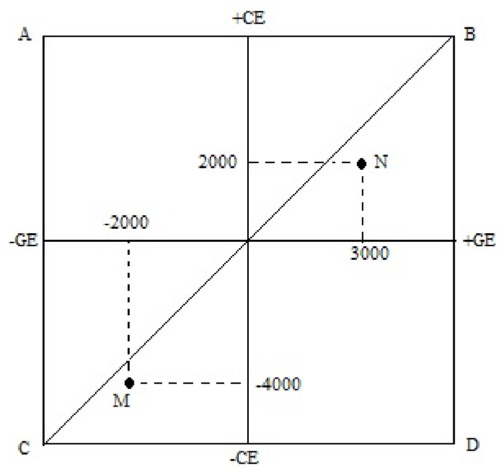

Figure 3: The Constant Market Share Space (CMSS).

This ensures that the CMSS is a square such that all values of CE and GE of the analysis are captured within the dimensions of the space. The axes are labelled in accordance with the Cartesian plane in which the centre is the origin, (0, 0) represents the unique position where (CE, GE) = (0, 0). Quadrant I contain all positive CE and GE values and quadrant III contains all negative CE and GE values. Quadrant II consists of positive CE and negative GE values while quadrant IV consists of negative CE and positive GE values. The diagonal line BOC is an isocline where the CE and GE are equal.

All the points in which the CE is greater than the GE are in the triangle ABC while points in which the CE is less than the GE are captured in the triangle BCD. Therefore, we have the following;

Proposition 1. The sum of all the CEs of the countries in the region of analysis which are below the x-axis is equal to the negative sum of all the CEs of the countries in the analysis which are above the x-axis.

Proof:

Assume a hypothetical CMS study of exports for n countries for a given number of years. Let CE_i be the competitive effect of country i and let $\sum_{t=1}^{k} CE_i$ be the sum of the CEs above the x-axis (which are all positive) and let $\sum_{t=1}^{n} CE_i$ be the sum of all the CEs below the x-axis (which are all negative). Given that the sum of all the CEs of the countries in a CMS analysis is equal to zero then;

$$\sum_{t=1}^{n} CE_i = 0 \quad \text{implies} \quad \sum_{t=1}^{k} CE_i + \sum_{t=k}^{n} CE_i = 0,$$

$$hence \quad \sum_{t=1}^{k} CE_i = -\sum_{t=k}^{n} CE_i \tag{9}$$

We now map the points in the CMSS where changes in p are equal. This means we are mapping the locus of equi-Δp. From equation (7), GE = -CE + Δp. In the CMSS this can be represented by a straight line with a slope of minus unity. Hence, the locus of equi-Δp are straight lines parallel to the diagonal AD of the CMSS as seen in Figure 4. For all of the locus of equi-Δp, its corresponding Δp is the vertical intercept where; $\forall \Delta p_t > \Delta p_{t-1}$ implies $(CE + GE)_t > (CE + GE)_{t-1} = \Delta p_{t-1}$. Figure 4 also shows the direction of increasing Δp isoclines within the CMSS. Using the CMSS and the simple proofs from Section 3 we are able to develop a new measure of constant market share that addresses the concerns raised by previous research in this area.

3.1 The Constant Market Share Competitiveness Index: The Net Share Approach

The next stage is to use the CMSS geometric framework to help propose a new CMS based competitiveness index. The competitiveness of a country's exports is a rather ambiguous concept in the economic literature. Some economists consider it similar to the concept of comparative advantage although this is not a view shared by all academic researchers (Krugman,1996). For example,a country may lose its competitiveness but still maintain its comparative

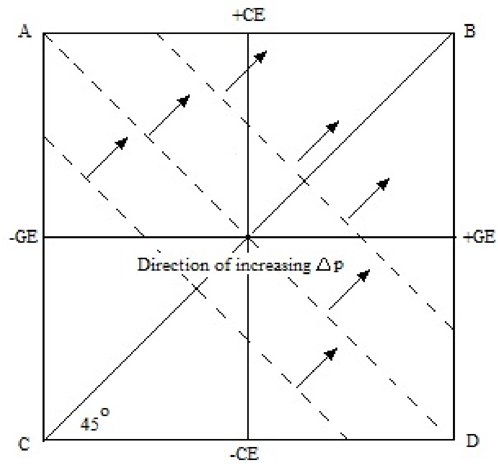

Figure 4: Total change in exports Δp isoclines.

advantage (Dunmore, 1986).

CMS measurement attempts to quantify the extent to which a country is competing in export markets relative to other countries in a given region. As competitiveness measures the performance of a country in terms of exports for a given period, the change in export share (either positive or negative) for a country can be considered as the competitiveness of the exports of that country. This is consistent with Porter et al. (2007). who stated that the most intuitive definition of competitiveness is a country's share of world markets for its products. This makes competitiveness a zero sum game, because one country's gain comes at the expense of others. Rosenfeld (1959) argued that the competitive effect should not be influenced by economic structure if we are to separate the growth of exports into a growth effect and a competitive effect. This view is shared by Artige and Neuss (2014) who presented a newshift share methodology which does not follow the basic identities of the traditional CMS approach. In their approach they proposed a method that separates the competitive effect from any influence of economic structure by associating a uniform distribution of sectors to sectoral growth rates. Their shift share identity decomposes the difference between national employment growth and regional employment growth into the structural and competitive effects relative to the national average.

In this paper we follow the Milana's identity in decomposing the change in exports of a country into the growth and competitive effects and propose a new competitiveness index that we call the CMSC index. We differentiate this CMSC index from the competitiveness effect. The CMSC index measures the competitiveness of the export of a country relative to the countries within the analysis. Our CMSC index is based on changes in the market share of acountry in a specific period. This index together with CE and GE will be analysed using the CMSS in determining the extent of export performance of a country in a region.

To develop our index, as before let p = the value of home exports, Q = the total value of regional exports (home plus foreign exports) and $s = \frac{p}{Q}$ represent the export share of the home country. Let the export share of the home country at the beginning of the analysing period be;

$$s^0 = \frac{p^0}{Q^0} \tag{10}$$

and the export share of the home country at the end of the analysing period be;

$$s^1 = \frac{p^1}{Q^1} \tag{11}$$

The change in the export share $\Delta s = s^1 - s^0$ measures the changes in export shares of countries in a region for a given period. Therefore, the term Δs can be defined as the "net share" of the share of exports for the focus country over the period of analysis from a defined base period. Thus, our approach to competitiveness measurement in the context of CMS analysis can be called the "net share approach" of CMS analysis similar to the "net relative change" measurement of shift-share analysis.

An increase in a country's export share Δs (change in export share)implies a decrease in the export share Δs of its competitors which is equal to the increase in the home country's market share. Although this is a zero sum game for any change in export share, we assume that winners are those with a positive Δs and the losers are those with negative Δs (it is a draw when $\Delta s = 0$). Given the properties described above a new competitiveness index can be based simply on the equation $\Delta s = s^1 - s^0$ but bounded by twice the largest export share value for any given country within the time periods analysed where time is once again indexed as $t = 1, 2, 3, ...m$. This gives us the new competitiveness index which we call the CMSC index. The CMSC index is given as;

$$\text{CMSS} = \frac{s^1 - s^0}{2max(s^1_m, s^0_m)} \tag{12}$$

With the use of our new CMSC index, the change in export share of a country Δs is bounded by -1 and 1 and the total of all Δs of the competing countries must be equal to zero. Note that Δs exhibits proportionate scaling since the rate of change of Δs with respect to s^0 is equal and opposite to the rate ofchange of Δs with respect to s^1 as shown by the following partial derivatives where; $\frac{\delta \Delta s}{\delta s^0} = 1$ and $\frac{\delta \Delta s}{\delta s^1} = -1$. To demonstrate how we move from this simple equation to an actionable index we first consider the locus of equal CMSC indices (equi-CMSC lines).

From $\Delta s = s^1 - s^0$ we have $s^1 = \Delta s + s^0$ which is a straight line in the graph of s^1 versus s^1 with slope 1 and vertical intercept of Δs. Hence,the locus of equi-Δs values are parallel lines to the main diagonal of the s^1 versus s^1 graph given in Figure 5. Note that Δs is positive for $s^1 > s^0$ and is negative for $s^1 < s^0$,thus it is positive above to the left of the diagonal AC and negative below (to the right of) the AC diagonal.

Finally, we consider the locus of equi-CMSC in the CMSS. From equation (7) the competitiveness effect is given by $CE = \frac{1}{2}\Delta s(Q^1 + Q^0)$, therefore;

$$\Delta s = \frac{2}{Q^1 + Q^0} CE \tag{13}$$

As stated earlier we defined CMSS $= \frac{s^1 - s^0}{2max(s_m^1, s_m^0)} \propto \Delta s$. Since Q^0 and Q^1 are constants and positive in the period of analysis, thus from equation (8) we have CMSC as a multiple of the CE and thus both are proportional to each other respectively. Proportionality of CMSC and CE implies that locus of equi-CMSC are the same as the locus for equi-CE and hence, are horizontal lines parallel to the x-axis as shown in figure 6. A CMSC index is positive above the horizontal axis and negative below.

Now that we have developed our new CMS index using a geometric approach that allows us to capture all the changes in export market share for a given period of time, we proceed to show its applicability in a simple numerical illustration. Since by definition CMSS capture all the CE and GE of the countries in the region, the CE and GE values of any country in an analysing period is represented as a coordinate in CMSS. The position of the coordinate in CMSS together with its CMSC index value expresses the competitiveness of the country in the period. CMSC index expresses the competitiveness of exports while CE expresses the effect of the competitiveness on the exports. On the other hand, GE reflects the change in exports due to growth (structural) effects. The CMSC index does not measure competitiveness relative to a base period but it illustrates the competitiveness of a country relative to all of the countries within the CMSS.

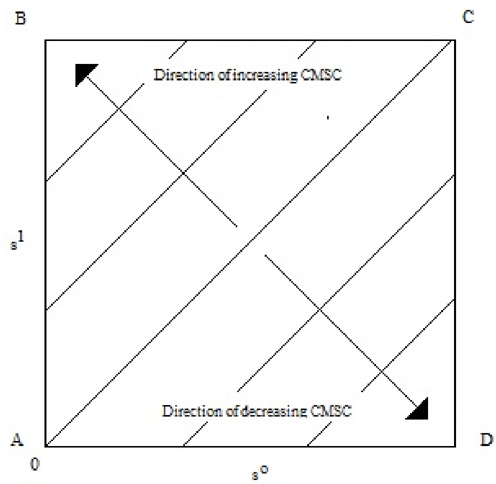

Figure 5: Isoclines of equi-CMSC in s^1 versus s^1 graph.

A country with equal CMSC indices in two different analysing periods might not indicate the same effect on the change in exports since the total exports of the two periods might be different. Even though a country can have the same competitiveness over two different periods but the effects of the competitiveness might be different which are shown by their CE values. This situation can be seen for countries D and E in the example given in the next section. The CMSC value for country D in the first period is the same as the CMSC value for country E in the second period but their CE values are different. Using the CMSC index and the CE values, we can compare the export's performance of countries over several different periods of analysis and can also analyse the change in exports on any particular sectors. It is very clear from the above explanation that we are differentiating between competitiveness and competitiveness effect. We define CMSC index as the measure of competitiveness and CE as the effect of the competitiveness. We illustrate the usefulness of our new approach using a simple numerical example. We compare our new index to the traditional CMS identities of Richardson (1971) and Milana (1988).

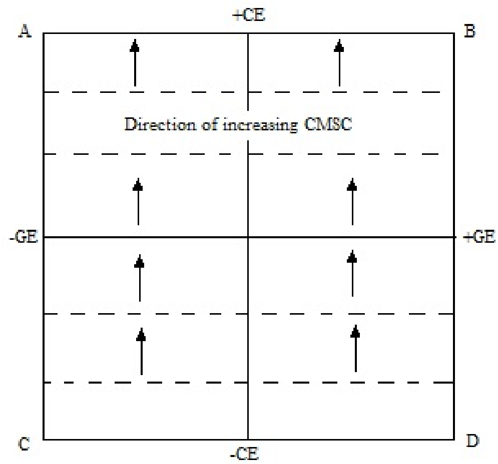

Figure 6: Competitiveness Index isoclines

4. Numerical Examples

In this section we provide a simple numerical example to show how the measures of competitiveness can differ depending on the index used. We compare the interpretation of our numerical simulation to Milana's CMS identity of equation (6) and the other traditional decompositions of equations (2), (3) and (4). The results are presented in Table 1. Assume there are five countries in a hypothetical trading bloc. Column (1) shows the initial value of exports. Column (2) shows the change in exports in the following year (Δp). Total exports are recorded in the final row of Table 1. The total of column (2) shows that total trade expanded by 115 units from 800 to 915 units as shown in the total of column (3) that adds initial exports to the change in exports. Columns (4) and (5) measure the share of the country's exports out of the total exports in the first period (s^0) and at the end of the second period (s^1) respectively. By definition the addition of these shares must be equal to 1. Columns (8) and (9) represent CE and GE calculations based on Milana's identity and Columns (10) to (14) are the traditional CMS identities from equations 2 to 4.

Our CMSC index is simply proportional to $s^1 - s^0$ and given that this is a zero sum game the total value of this unbounded index is zero as shown in the final row of column (6). Furthermore, this desirable and logical property extends to the CMSC index itself as shown in the final row of column (7) in both Table 1 and Table 2. In Table 1, the largest value of the share of export is 0.4809 between these this period. For the next subsequent period in Table 2, the largest share of export value is 0.4167. We use these largest values to bound the change in export share to calculate CMSC values in column (7) of both tables. Columns (10) and (11) disentangle the index into the CE and the GE respectively. The competitive effect is another zero sum game and must sum to zero as shown by the final row of column (8) while the sum of the GE in column (9) must sum to the total expansion in trade which in this case is 115 following from column(2).

The results for our hypothetical trading region can be presented in our CMSS framework. These are shown in Figure 7. Generally, we find that in Table 1, our new CMSC index seems to be consistent with the traditional identities. For instance, country A, B and C are shown to be increasing its export competitiveness by CMSC values. This is reflected by CE values in column (8),(11),and (13) calculated from traditional CMS identities. All calculated values indicate that countries A, B and C are becoming more competitive even though world export shares are increasing.

The ranking in exports competitiveness of the countries can be seen from their position in the CMSS. The higher is its position, the higher is its competitiveness. Country A exports is the most competitive since its coordinate is in the highest position in the CMSS. Country D is the least competitive since it is in the lowest position. The increase in exports for A is also the highest since the line parallel to the diagonal AD that passes through A is also the highest. Countries A, B and C have their CE higher than GE since these three coordinate are in triangle ADB where as countries D and E have their GE greater than CE since they are in triangle ACD.

In order to see the use of the competitive index in measuring the export competitiveness between two different periods we simulate another hypothetical trading of the same five countries in Table 2 (A_2 indicates second period analysis for country A, etc.). Table 1 shows an example of increasing world exports but Table 2 shows an example where world exports are decreasing.

Looking at this single CMSS (Figure 8) we can analyse the performance of any of the five countries exports in the first and the second period. In this case the locus of equi-CMSC index is applicable only to countries within the same period so there might be cases in which two countries from different period with the same CE but different CMSC index. This implies the two countries

Table 1: CMSC Index, Milana's Identity and other traditional CMS identities for five countries over the first time interval.

	1	2	3	4	5	6	7
Country	p	Δp	$p+\Delta p$	s^0	s^1	$\Delta s = s^1 - s^0$	CMSC
A	50	70	120	0.0625	0.1311	0.0686	0.018
B	30	15	45	0.0375	0.0492	0.0117	0.003
C	100	60	160	0.125	0.1749	0.0499	0.013
D	200	-50	150	0.25	0.1639	-0.0861	-0.023
E	420	20	440	0.525	0.4809	-0.0441	-0.012
Total	Q = 800	$\Delta Q = 115$	$Q+\Delta Q = 915$	1	1	0	0.000

	8	9	10	11	12	13	14
Country	$CE = \frac{1}{2}(Q^0 + Q^1)\Delta s$	$GE = \frac{1}{2}(s^0 + s^1)\Delta Q$	$GE = s^0 \Delta Q$	$CE = Q^1 \Delta s$	$GE = s^1 \Delta Q$	$CE = Q^0 \Delta s$	$\Delta Q \Delta s$
A	58.82	11.13	7.19	62.77	15.08	54.88	7.89
B	10.03	4.99	4.31	10.71	5.66	9.36	1.35
C	42.79	17.24	14.38	45.66	20.11	39.92	5.74
D	-73.83	23.80	28.75	-78.78	18.85	-68.88	-9.90
E	-37.82	57.84	60.38	-40.35	55.30	-35.28	-5.07
Total	0	115	115	0	115	0	0

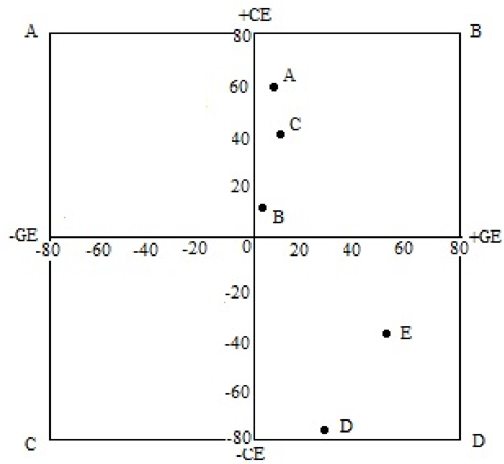

Figure 7: CMSS of simulated data from Table 1

produce the same competitive effect but different competitiveness level within their period. Table 2 also reveals the inconsistencies of the traditional CMS identities compared to our new index. For instance, the issue of inconsistent interpretation appears in our example. Countries A_2 and B_2 are reported by CMSC values as becoming more competitive with increasing export shares. CE figures of columns (8), (11) and (13) seem to agree but the interaction term is confusing and misleading with its negative figure. Furthermore, consider countries C_2, D_2 and E_2 which is deemed to be indecreasing competitiveness by CMSC calculations but is again not consistent with the interaction term although it is consistent with traditional CE values. Tables 1 and 2 highlight the usefulness of our new index. The researcher does not have to calculate all identities and the difficult to interpret interaction term does not appear. Thus, our new index does not presume a preferred or superior CMS identity, sparing the research of any philosophical entanglements. This is mainly a methodological argument where some authors like Richardson (1971) state that there is no a priori superiority of any identity while some like Milana (1988) suggest that equation (6) to be the closes discrete time approximation of the continuously changing export structure.

The same method can be used in analysing the performance of a country export over a period of several years. It can also be used in analysing the

Table 2: CMSC Index, Milana's Identity and other traditional CMS identities for five countries over the second time interval.

	1	2	3	4	5	6	7
Country	p	Δp	$p+\Delta p$	s^0	s^1	$\Delta s = s^1 - s^0$	CMSC
A_2	100	50	150	0.0833	0.1339	0.0506	0.011
B_2	200	150	350	0.1667	0.3125	0.1458	0.030
C_2	100	-60	40	0.0833	0.0357	-0.0476	10.010
D_2	500	-100	400	0.4167	0.3571	-0.0596	-0.012
E_2	300	-120	180	0.25	0.1607	-0.0893	-0.019
Total	Q = 1200	$\Delta Q = -80$	$Q + \Delta Q = 1120$	1	1	0	0.000

	8	9	10	11	12	13	14
Country	$CE = \frac{1}{2}(Q^0 + Q^1)\Delta s$	$GE = \frac{1}{2}(s^0 + s^1)\Delta Q$	$GE = s^0 \Delta Q$	$\cdot CE = Q^1 \Delta s$	$GE = s^1 \Delta Q$	$CE = Q^0 \Delta s$	$\Delta Q \Delta s$
A_2	58.70	-8.69	-6.66	56.672	-10.71	60.72	-4.05
B_2	169.13	-19.17	-13.34	163.296	-25.00	174.96	-11.66
C_2	-55.22	-4.76	-6.66	-53.312	-2.86	-57.12	3.81
D_2	-69.14	-30.59	-33.34	-66.752	-28.57	-71.52	4.77
E_2	-103.59	-16.43	-20.00	-100.016	-12.86	-107.16	7.14
Total	0	-80	-80	-0.112	-80	-0.12	0.01

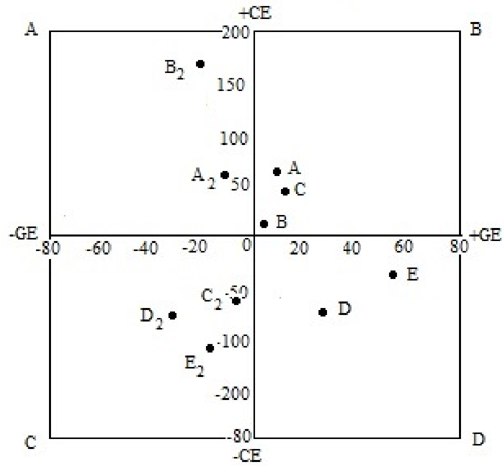

Figure 8: CMSS of simulated data from Table 1 and Table 2

performance of a sector over several years as well. For example, the illustrations in Table 1 and 2 use the example of multiple countries over two time periods which is equal to four years if we base our example on an annual basis. We can simply change the subject of focus in Table 1 and 2 to an individual country with five industrial sectors over four years or two time periods. We can then sum the sector export shares to arrive at country export shares which we can relate to total world export shares. The results of sectoral analysis would then be similar. We can then identify weak sectors or markets that are no longer competitive.

Finally, we show how CE and GE effects change along the diagonals represented by Δp isoclines. Let us refer to equation (9) and Table 3. From equation (9), we have the relation that Δp = CE + GE which we plot as diagonal isoclines that rise from the south east to north west direction on the CMSS. We now consider how these effects change on equivalent Δp isoclines over a time period of six years for one country in Table 3 which completes our comparative statics illustration.

In Table 3, changes in exports are fixed to increments of 35 units every year for five years. The share of world exports is increasing in tandem with the country's share of exports. However, world exports are increasing at a

Table 3: Changes along the diagonals of Δp isoclines.

	t	t+1	t+2	t+3	t+4	t+5
p	50.00	85.00	120.00	155.00	190.00	225.00
Q	100.00	150.00	250.00	350.00	450.00	650.00
$s = \frac{p}{Q}$	0.50	0.57	0.48	0.44	0.42	0.35
Δp		35.00	35.00	35.00	35.00	35.00
ΔQ		50.00	100.00	100.00	100.00	200.00
$\Delta s = s^1 - s^0$		0.07	-0.09	-0.04	-0.02	-0.08
CMSC		0.06	−0.08	−0.04	−0.02	−0.09
$GE = s^0\Delta Q$		25.00	56.67	48.00	44.29	84.44
$CE = Q^1\Delta s$		10.00	-21.67	-13.00	-9.29	-49.44
$GE = s^1\Delta Q$		28.33	48.00	44.29	42.22	69.23
$CE = Q^0\Delta s$		6.67	-13.00	-9.29	-7.22	-34.23
$\Delta s\Delta Q$		3.33	-8.67	-3.71	-2.06	-15.21
$GE = \frac{1}{2}(s^0 + s^1)\Delta Q$		26.67	52.33	46.14	43.25	76.84
$CE = \frac{1}{2}(Q^0 + Q^1)\Delta s$		8.33	-17.33	-11.14	-8.25	-41.84

much faster pace than country exports. Unequivocally, CMSC values show that the country's exports are losing its international competitiveness. Once again, the advantage of CMSC in providing easy to interpret values is clear. CMSC is able to provide a quick guide to competitiveness without computing the traditional CMS identities. Generally, CE figures provided by traditional identities and Milana's identity agree with the CMSC that exports are losing its competitiveness. Nonetheless, let us consider CE values from $t + 4$ to $t + 5$. These CE values show a large disproportionate response to changes in the export structure while CMSC values only show a small change from-0.02 to -0.09, a mere 0.07 units of change. Thus, while traditional CMS identities may classify this change as a large decrease of competitiveness, our CMSC index would instead present us with values that are proportional to changes in both world and country exports.

5. Conclusions

This paper presents a modest but useful geometric device for visualising CMS analysis, named as the Constant Market Share Space, CMSS. The positions of the coordinates representing the countries in CMSS give much information about the countries competitiveness, competitiveness effects and the growth effects. We also introduced a new index as an indicator of the competitiveness of the exports of a country, CMSC which is based on the change of the export share within the period of analysis. Competitiveness of the exports of a country (CMSC) is defined differently from its competitiveness effect(CE). These two measures are useful in analysing exports competitiveness across different periods. Our approach is general and is applicable across products, sectors, or industries and for any number of years. This paper also exhibits the proposed geometric framework in tandem with Milana (1988) identity which is useful in visualizing and solving the inconsistency in CMS analysis.

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