On the Measurement of Trade-Induced Adjustment

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ABSTRACT

Globalisation and closer regional integration has led to significant increases in trade between nations that in turn impacts on existing long standing trade partnerships. A consequence of changing trade patterns is an increase in the pressure for resources to reallocate between industries and sectors. This paper provides an integrated approach to the analysis of trade-induced adjustment that complements the existing literature. Adjustment pressures are documented in accordance with the theoretical underpinnings of the smooth adjustment hypothesis and satisfy a number of desirable criteria, monotonicity, consistency and country specificity. The applicability of our approach is examined using UK manufacturing data.

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1 Introduction

A considerable literature on intra-industry trade (the simultaneous import and export of goods from the same industry) has accumulated over the previous twenty years.[1] More recent developments concentrate on the relationship between intra-industry trade (IIT) and the costs of adjustment associated with changes in trade patterns.

An increase in *inter*-industry trade means import and export changes are unmatched and it is likely that there will be a requirement for resources to be transferred between industries most commonly from those contracting to those expanding. The greater the factor requirement differences between industries and the more geographically dispersed the production the more severe the adjustment implications. If increases in trade are *intra*-industry in nature however, the standard assumption is that adjustment costs will be less forbidding. This is because resource transfers as a result of sectorally matched increases in imports and exports can be contained within individual industries or possibly firms. This proposition has become known as the smooth adjustment hypothesis (SAH).[2]

There have been relatively few attempts to integrate the SAH into a fully specified theoretical framework. Placing the SAH within the context of traditional models of IIT such as Krugman (1981), Falvey (1981) and Brander and Krugman (1983) has been considered although the most appropriate approach is perhaps to employ two-country, two-sector, two-

[1] Grubel and Lloyd (1975) published a comprehensive study of empirical, methodological and theoretical aspects of IIT. Other surveys include Greenaway and Milner (1986) and Greenaway and Torstensson (1997).

[2] Balassa (1966) was the first to mention the SAH directly although many authors including Krugman (1981), OCED (1994) and Cadot *et al* (1995) have since alluded to it directly or indirectly.

factor models of small open economies within a Jones-Samuelson specific factors framework (Neary 1985).[3]

The specific-factors model suggests two sources of adjustment costs, factor-price rigidity and factor specificity with the empirical manifestations being unemployment and factor-price disparities respectively. In practice we are likely to find both phenomena occurring but it is necessarily an empirical issue as to whether adjustment costs are lower if trade changes are intra-industry in nature.

Direct empirical support for the SAH, however, is not extensive. Greenaway and Hine (1991) concluded that the evidence to date is suggestive rather than conclusive and that adjustment costs are possibly lower but not higher if trade expansion is intra-industry in nature. Studies such as Brülhart (2000), Haynes *et al.* (2000), Haynes *et al*. (2002) and Greenaway *et al*. (2002) make a useful contribution towards an empirical step forward but on the whole do not provide satisfactorily conclusive evidence that is supported by the discussion in Lovely and Nelson (2002).

This paper builds upon a strand of the recent literature that evolved from the static nature of the traditional Grubel and Lloyd (GL) share measure of IIT. When Hamilton and Kniest (1991) considered the possible adjustment implications of IIT they concluded that the level of IIT has no *a priori* predictive power of future change in trade patterns. The dynamic nature of any reallocation of resources means that an observed change in a measure of static IIT (measured by the GL index) can mask a range of different trade flows that may be inter-industry in nature but actually cause an increase in intra-industry trade. Various proposals for a measure of dynamic or marginal intra-industry trade (MIIT) have been suggested, Hamilton and Kniest (1991), Greenaway *et al.* (1994), Brülhart (1994), Menon and Dixon (1997) and

[3] A recent study by Loverly and Nelson (2000) adapts an Either (1982) trade model to examine the relationship between changes in IIT and adjustment.

Azhar *et al.* (1998). Dixon and Menon (1997) and a number of country specific studies in Brülhart and Hine (1999) apply a range of measures to the estimation of the adjustment effects of increased integration in Australia and selected EU countries respectively.

From the specific factors model we propose that the construction of a measure of trade-induced adjustment that best satisfies the requirements of the SAH should comply with four simple criteria; (1) the greater the sectoral disparity in trade flows the greater the factor market disruption and therefore the greater the adjustment costs and means that an index should be an increasing function of the net change in trade (montonicity); (2) the factor reallocation requirements associated with a given level of unmatched trade changes are equal and opposite for bilateral trade partners and means that adjustment costs associated with an industry expansion are equal to those associated with an industry contraction (consistency); (3) to be able to recognise if a country is specialising "into" or "out of" an industry is important if we want to know whether the subsequent adjustment costs are associated with an industry expansion or contraction which will have further implications for example for policymakers looking at industrial and competition policy and reacting to the pleas of lobby groups (country specificity); (4) if firms have identical factor requirements then matched trade changes will have no resource reallocation costs because matched increases or decreases in exports and imports (total IIT) means that an industry's total demand *ceteris paribus* is unaffected and hence no resource reallocation is required.[4]

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[4] The standard definition in the literature is that sectorally matched increases in trade flows result in "smoother" resource reallocation that are interpreted as lower (but non-zero) adjustment service costs. Our measure is theoretically consistent with the specific-factors framework and assumes these "lower" costs to be zero. This simplification does not affect the interpretative power of our results and is consistent with the existing definitions of the "adjustment hypothesis".

The rest of the paper is organised as follows. Section 2 derives our methodology and constructs our alternative measure while Section 3 tests our measure on UK data during a period of significant structural change. Section 4 summarises and concludes.

2 Methodological Framework

2.1 The Trade Adjustment Space

In Section 2.1 we present a geometric device (the trade adjustment space) that allows a visualisation of the evolution of trade flows that is also able to bring to light the potential adjustment pressures associated with trade pattern changes. Moreover, the trade adjustment space (TAS) is theoretically and empirically linked with a measure of trade-induced adjustment based on our four criteria presented in Section 2.2. The relationship between the index and visual tool should facilitate the intelligibility of applied work and make the comprehension of the performance of previous measures easier.

Consider a square two-dimensional space that captures all changes in exports (*X*) and imports (*M*) for any industry (*i*), for any period where a change in *X* (ΔX) and *M* (ΔM) can be positive, negative or zero.[5] Let the trade flows for a hypothetical industry *i* consist of the set of all ΔX and ΔM for *n* years ($n = \{1,2,3,.....n\}$).[6] The dimensions of the TAS are central to the adjustment index derived in Section 2.2. The essential ingredient is that the length of any side

[5] Given this papers emphasis on IIT it is easiest to think of this methodology in terms an industry although as we shall see in Section 3 it is equally applicable for any level of aggregation such as country, sector or even product.

[6] Trade values are usually available at uniform (discreet) time intervals, annually, quarterly or monthly. Changes in *X* and *M* are analysed from an initial starting point $t=0$. All data should be deflated to obtain trade flow values in constant prices.

is set at two times the maximum of the largest absolute value of whichever is bigger from the import and export values recorded during the considered time period. Correspondingly, the total area of the TAS is $2*\max|\Delta X_t|^2$ if the largest absolute value is any year is an export or $2*\max|\Delta M_t|^2$ if the largest value is an import. Exports are depicted on the vertical axis (+/-ΔX) and imports on the horizontal axis (+/-ΔM).[7] Each TAS depicts the relationship between a home (H) and foreign (F) country. See Appendix 1 for identities and proof of construction. Figure 1 presents a hypothetical trade adjustment space.

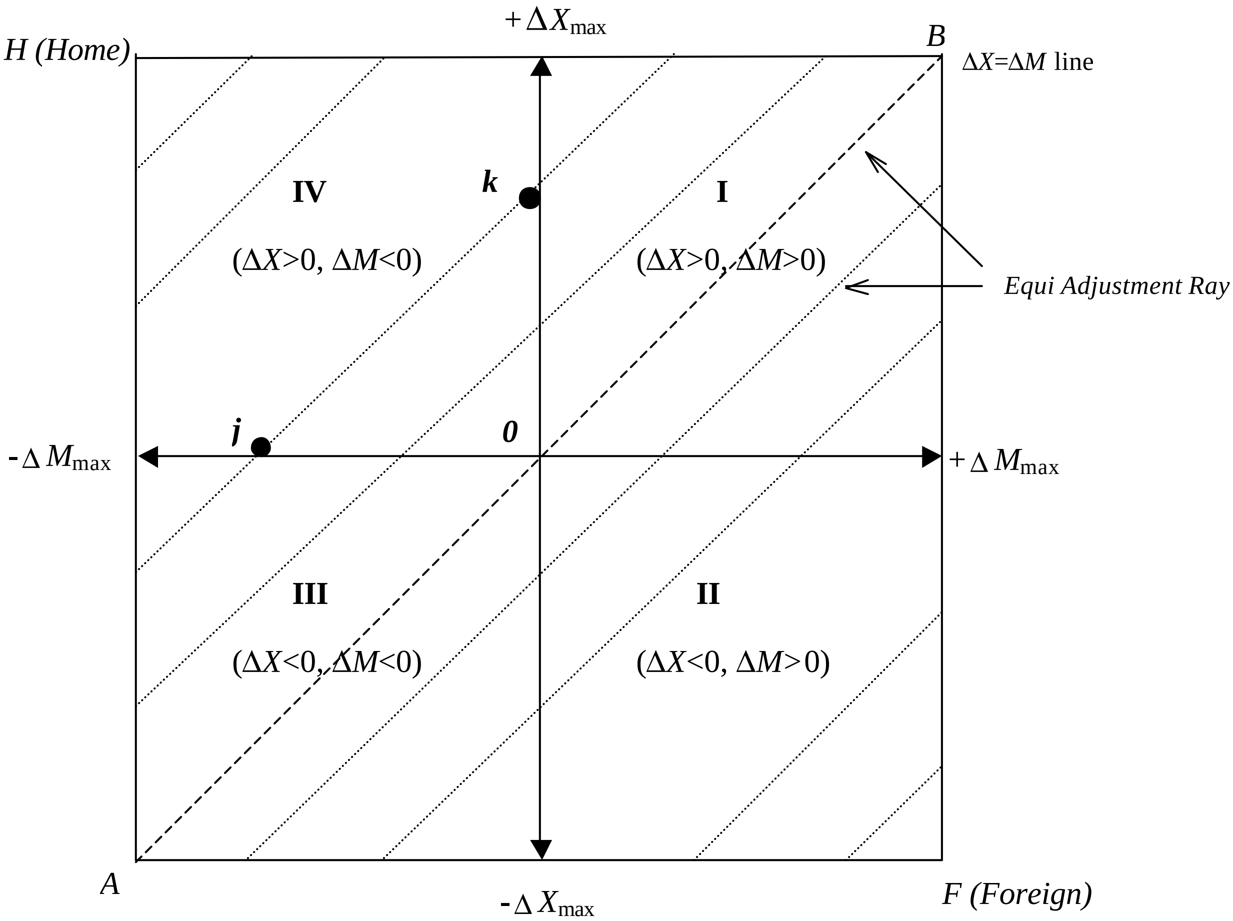

Figure 1. The Industry Trade Adjustment Space

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[7] Observe that the axes in Figure 1 are labeled (+/-ΔM_{max}) and (+/-ΔX_{max}) for convenience. In practice the actual value depends on which of the two is the largest and this value is then applied to both axes to ensure a perfect square. For example, if ΔM_{max}=5 and ΔM_{max}=10 then the dimensions of the TAS will be 20 by 20.

Consider the location of an arbitrary trade change co-ordinate (ΔX, ΔM) from a Home country perspective. The upper and lower triangles (*AHB)* and (*AFB*) define the net exporter (*NE*) and net importer (*NI*) planes respectively. The axes are labelled in accordance with the Cartesian plane so the TAS consists of four quadrants I-IV. The origin (0) represents the unique (ΔX, ΔM)=0 case. Quadrants I contains all positive and quadrant III all negative changes. Quadrant II consists of negative ΔX and positive ΔM while quadrant IV contains negative ΔM and positive ΔX. The 45-degree *A0B* line is that of perfectly matched trade changes and hence from criterion (4) zero adjustment. Following our definition, lines parallel to the *A0B* line are termed equi-adjustment lines. Any two points, such as *j* and *k* (in figure 1), on an equi-adjustment line share equal adjustment pressures. Imports fell and exports remained unchanged in period *j* while exports rose and imports remained unchanged in period *k*. Everything else staying the same, both periods result in demand increases for the Home country's products from that industry and should therefore experience the same expansion associated adjustment pressures.

For either country, the further a point such as *j* or *k* is away from the *A0B* line the greater the adjustment pressure. Criteria (1) and (2) assume that (1) costs are a monotonically increasing function of the degree of resource reallocation required and (2) that adjustment requirements for both the home (*H*) and foreign (*F*) countries are equal. From criterion (3) however, points to the right of the *A0B* line have different implications for the home country and consequently have a different interpretation. This time industry exports are falling relative to imports so adjustment for example might require firms to layoff workers that will result in an increase in temporary unemployment known as contraction associated adjustment costs.[8]

A measure of trade-induced adjustment that matches the construction of the trade adjustment space therefore has to embody the properties of criteria (1)-(4). Ideally any measure should also be easy to calculate and provide intelligible results.

2.2 A Proposed Measure of Trade Induced Adjustment

A measure of adjustment costs that satisfies criteria (1)-(4) is given by:

$$S = \frac{1}{2L}(\Delta X - \Delta M) = \frac{\Delta X - \Delta M}{2\left(\max\left\{|\Delta X|_t, |\Delta M|_t\right\}\right)} \text{ for } t \in N, N = \{1,2,3,.....n\}$$

where L is the length of one side of a TAS. The index has a range of $-1 \leq S \leq 1$. Each trade pattern change (represented by a cartesian point in the *TAS)* has a corresponding adjustment value where we define S_H to be the index value from the perspective of the home country. Therefore, S_H is a simple monotonically increasing function of $\Delta X - \Delta M$ that also satisfies consistency and now country specificity. The relationship between the Home and Foreign country is given by $S_F = -S_H$.

One of the primary innovations of the *S* index is the scaling factor that stems directly from the TAS construction and is two times the absolute maximum of the largest yearly change for the period of study that is equal to the length of *A0B* (in figure 1) equivalent to

[8] If we weaken our assumption of symmetry across expanding and contracting sectors (criterion 2) so we assume it is easier for an economy to adapt to expansions rather than contractions then the lines of equi-adjustment become non-linear and non-symmetric.

2*L*.[9] Scaling by the largest value for a given time scale (that could be months, years or even decades) allows us to observe the progress of adjustment pressures over time.[10]

In appendix 2 we compare the *S* index with existing indices. The most widely employed of these marginal measures of IIT are the *A*, *B* and *C* family of indices of Brülhart (1994) and the Menon and Dixon (1997) UMCIT index. The former measures are discussed in more detail in Oliveras and Terra (1997), Brülhart and Hine (1999) and Thom and McDowell (1999). Other notable indices are those described in Greenaway *et al*. (1994) and Azhar *et al.* (1998).

Whilst we recognise that each measure outlined in appendix 2 is useful in its own right, we propose that the *S* index provides a versatile and potentially useful addition to the family of trade induced adjustment indicators. To investigate the properties and applicability of this index and related methodology we examine UK manufacturing data for the 1980's and also provide some comparisons with the other indices outlined in this section.

3 Trade Induced Adjustment: The UK experience

[9] Note that the *DX* or *DM* value in the denominator and numerator will only be equal when either *DX* or *DM* is also the largest change during the period of study.

[10] This index allows us to compare, for example, the trade induced adjustment pressures for the US that resulted from the global slowdowns of the 1930's and the 1980's. When examined separately standard year on year index values may appear similar although there is no doubt that the S_{US} index would be larger in magnitude (either positive or negative) for the latter period under our methodology as the larger trade volumes are taken into consideration in the generation of the index values.

The UK economy of the 1980's was a well-documented decade of immense industrial and structural change with periods of substantial economic contraction and expansion. The resulting trade flows were highly variable and consequently provides a good test for the applicability of our integrated methodology. Figure 2 generates a TAS for year on year trade changes between UK manufactures and the rest of the world between 1979 and 1991 while Table 2 reports *S* index values at the aggregate and two-digit level both using the same UK Standard Industrial Classification SIC(80) data.[11] Following Section 2 each side is twice the maximum value of the greatest absolute change.

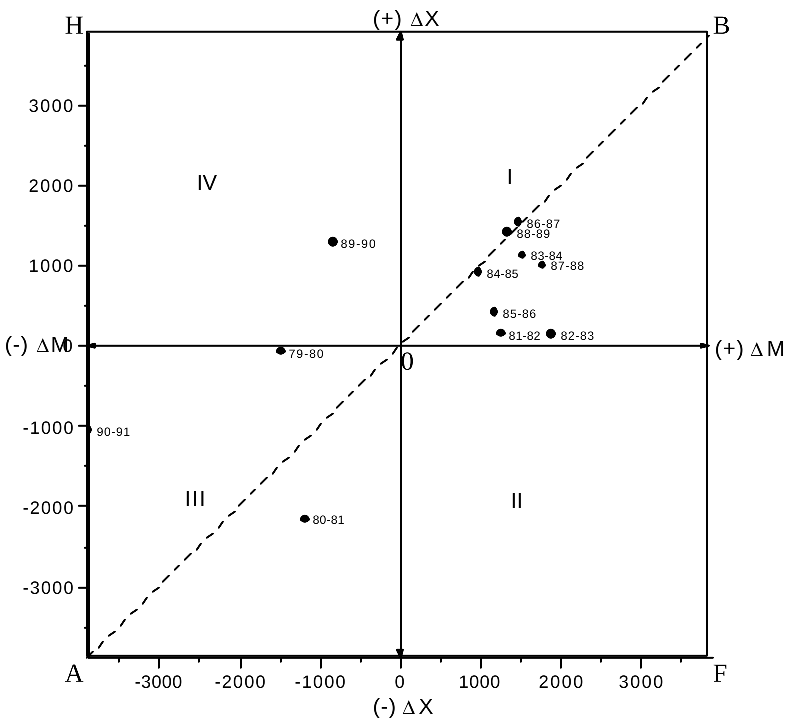

Figure 2. Trade Adjustment Space for Changes in UK Manufacturing Trade, 1979-1991 (£000's)

Assuming the UK is the home country, co-ordinates to the right of the leading diagonal (*A0B*) record negative *S* index values and the further a co-ordinate is away from the

[11] All data is deflated using GDP deflators in 1979 prices in (000's) sterling. Whilst our methodology thus far has been couched in terms of an industry figure 2 can be treated as a highly aggregated case.

central zero adjustment line the greater the trade induced adjustment pressure. For the majority of year on year changes (scaled by the 1990-1991 value of £38876505) both ΔX and ΔM were positive (quadrant I) and relatively close to the $\Delta X=\Delta M$ line suggesting relatively benign adjustment implications under standard SAH assumptions.

The most volatile years seem to be at the start (1979-1982) and the end of the period (1988-1991) and seem to reflect the macroeconomic turmoil associated with the extremes of the UK business cycle at these times. The largest negative value from the UK perspective (measured as the greatest perpendicular-distance to the right of the central zero adjustment line) was 1982-83 (-0.23) where the largest yearly increase in imports was paired with a correspondingly small increase in exports. *Ceteris paribus*, we would expect a contraction of UK manufacturing and an increase in the worker displacement.[12]

Considering *S* index values in conjunction with figure 2 enables us to exactly capture the trade induced adjustment implications for the UK for this period. Table 2 presents *S* index values for the aggregate and 2-digit sectors. The whole period 1979-1991 (final column) records a small positive value (0.07) while splitting the period into 1979-1985 and 1985-1991 (second and third to last columns) reveals *S* index values of -0.49 and 0.39 respectively, matching the remarkable turn around in the fortunes of British industry during the final years of the decade. The final row gives the index values when each yearly change is scaled by the whole period and are the values plotted in figure 1 (the values in the second to last row are scaled by just that year). Thus 1982-1983 was the worst performer (-0.23) and 1990-1991 was the best (0.36). As expected year on year index values tend to be more volatile and emphasises the usefulness of being to able to select any length of period as the scaling factor and as a reference point.

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[12] This certainly fits our knowledge of events at the time when manufacturing suffered huge losses in employment, decreased union power and significant structural change.

At the 2-digit level, 41% (69%) of industries had a positive (negative) *S* index for the whole period. In order of magnitude, the most severe (contracting) trade induced adjustment pressures were experienced by SIC 43 (textiles), SIC 49 (other manufactured goods), SIC 23 (extraction of minerals), SIC 46 (timber and wooden goods) and SIC 24 (manufacture of non-metallic minerals). In contrast, the largest adjustment costs associated with expanding sectors are for SIC 32 (Mechanical Engineering), SIC 41 (food processing), SIC 35 (manufacture of motor vehicles) and SIC 33 (manufacture of office machinery). Based on employment figures and the anecdotal evidence of the time, these results fit our priors for the performance of these sectors.[13] Again the difference between the early and late periods is striking with 89% of sectors recording a negative *S* index value for the first period but only 11% for the second.

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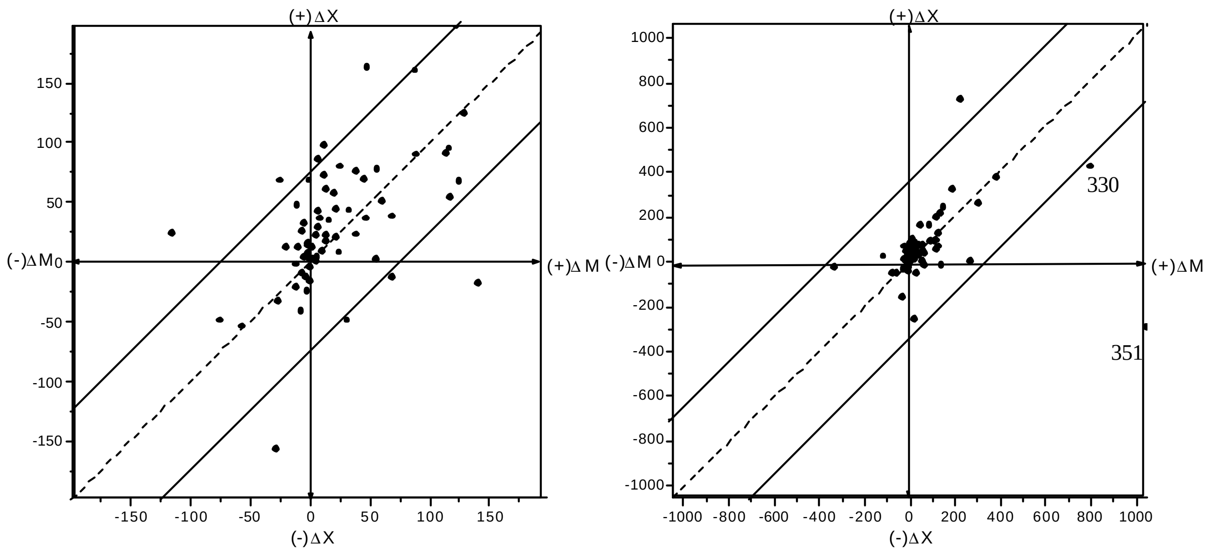
[13] Note that trade changes are not the direct cause of industry restructuring but merely act as the channel by which competitive and other effects assert themselves.

Table 2
Trade Induced Adjustment (S index) for the UK at the 2-digit SIC level

SIC		79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90	90/91	79/85	85/91	79/91
22	Metal manufactures	-0.52	0.26	-0.04	-0.62	0.17	0.58	0.85	-0.12	-0.24	0.18	0.48	-0.12	0.42	0.38	0.10
23	Extraction of minerals	0.54	-0.55	0.19	-0.46	-0.59	-0.55	-0.44	0.02	-0.62	0.01	0.54	0.80	-0.67	0.17	-0.55
24	Man. of non-metallic minerals	0.69	-0.41	-0.58	-0.94	-0.39	-0.32	-0.23	-0.25	0.06	-0.22	0.88	0.38	-0.88	0.30	-0.39
25	Chemical industry	0.44	-0.85	-0.44	-0.29	-0.04	0.30	-0.54	-0.25	0.26	0.14	0.61	0.00	-0.25	0.12	-0.17
31	Man. of metal goods n.e.s	0.76	-0.23	-0.57	-0.41	0.01	0.26	-0.91	-0.39	-0.10	0.06	0.40	0.39	-0.41	-0.16	-0.23
32	Mechanical engineering	0.50	-0.13	-0.55	-0.97	-0.35	-0.19	0.02	0.08	-0.40	0.01	0.87	0.36	-0.93	0.68	0.71
33	Man. of office machinery	0.55	-0.66	-0.07	-0.25	0.29	-0.76	-0.47	0.01	0.54	0.38	-0.30	-0.12	-0.34	0.43	0.23
34	Electrical & electronic engineering.	0.68	-0.41	-0.42	-0.38	-0.87	0.08	-0.29	-0.04	0.38	0.29	0.50	0.04	-0.48	0.22	-0.11
35	Man. of motor vehicles and parts	0.42	-0.07	-0.51	-0.57	0.69	-0.34	-0.36	-0.08	-0.35	0.01	0.94	0.60	-0.67	0.46	0.33
37	Instrument engineering	0.61	-0.36	0.27	0.00	0.26	0.41	-0.81	0.29	-0.90	-0.70	0.50	0.68	0.27	-0.49	0.06
41	Food, processing.	0.54	-0.22	-0.25	-0.01	-0.70	0.61	0.29	0.45	-0.44	0.18	-0.24	0.55	-0.75	0.69	0.62
42	Food, drink and tobacco	0.57	0.32	-0.73	-0.53	-0.41	-0.26	-0.36	0.26	0.13	-0.30	-0.09	0.86	-0.43	0.19	0.04
43	Textile industry	0.47	-0.59	-0.93	-0.51	-0.38	-0.31	-0.02	0.16	-0.06	0.40	0.78	0.45	-0.65	0.68	-0.78
45	Footwear and clothing	0.40	-0.52	-0.47	-0.49	-0.36	-0.08	-0.25	0.59	-0.38	-0.77	-0.02	0.73	-0.72	0.20	-0.18
46	Timber and Wooden furniture	0.45	-0.50	-0.42	-0.53	-0.47	-0.64	-0.40	-0.21	-0.20	0.57	0.84	0.51	-0.64	0.95	-0.50
47	Paper and publishing	0.75	-0.51	-0.31	-0.41	-0.29	-0.33	-0.16	-0.14	-0.38	0.01	0.55	0.36	-0.44	0.13	-0.19
48	Rubber and plastics	0.47	-0.48	-0.30	-0.45	-0.27	-0.29	0.25	0.26	-0.54	-0.02	0.49	0.38	-0.46	0.01	-0.20
49	Other manufactured goods	-0.78	-0.48	0.49	-0.46	-0.12	0.41	0.34	0.43	-0.18	-0.31	-0.48	0.13	-0.40	0.46	-0.62
	Total[1]	0.47	-0.23	-0.44	-0.46	-0.21	0.03	-0.32	0.02	-0.22	0.07	0.82	0.36	-0.49	0.39	0.07
	Total (TAS 1979-91)	0.18	-0.13	-0.14	-0.23	-0.05	-0.01	-0.10	0.01	-0.10	0.01	0.27	0.36			

1. Note that the 2-digit values are calculated at yearly intervals so are not scaled by the maximum for any set time period. Totals are given for single and 10 year intervals.

A detailed performance of UK manufacturing is presented in Figures 3(a) and 3(b) by examining 80 industries at the three-digit SIC level.[14] Figure 3(b) includes all industries while figure 3(a) excludes extreme cases to enable a more detailed visualisation of the central cluster dispersion. Note the difference in the scale for the two figures.



(a) (b)

Figure 3. Relationship Between Imports and Exports for SIC 3-digit Industries 1979-1991

The main observation from Figure 3(a) is that most industries are located in quadrant 1 reinforcing the standard result in the literature that IIT has been generally increasing. Figure 3(b) shows that the majority of points lie within a reasonable proximity of the central, zero adjustment line with potential problem industries lying outside the central strip.[15] One possible benefit of the TAS methodology is that it allows us to quickly identify where trade changes have been the largest and therefore which the potential

[14] See appendix 3 for the *S* and alternative trade induced adjustment index values at the 3-digit level.

[15] The central strip is arbitrarily set at approximately plus or minus 25% of the scaling value (maximum change of either *M* or *X*) and is provided for illustrative purposes only.

problem industries might be. The scaling industry in figure 3(b) is SIC 351 (Motor Vehicles and Engines) which experienced a considerable increase in imports and a reduction in exports during this period. The other industry to the right of the central strip in figure 3(b) is SIC 330 (Manufacture of Office Machinery) that shows that although all trade is increasing in this industry, imports have risen faster than exports. Two of the best performing industries for the UK were SIC 353 (Motor Vehicle parts) and SIC 251 (Basic Industrial Chemicals) where the former showed a large growth in exports relative to the increase in imports and the latter had stable exports but a significant decline in imports.[16]

We now compare the *S* index with its closest alternative, the Brülhart *B* index (described in appendix 2) to demonstrate the effect of having a sub-set of trade changes that are undefined. Figures 4(a) and 4(b) present scatter plots of the indices against the change in employment, a basic measure of adjustment pressure. Although crude, the change in employment as a measure of adjustment serves as an illustrative example only. See Brülhart (2000) for a discussion of possible alternatives.

[16] The other potential problem industries (in a sense that adjustment costs are likely to be more important to the economy as a whole) include SIC's 412 (Slaughter of Animals and Meat Production), 221 (Steel Tubes), 483 (Processing of Plastics) and 373 (Optical Precision Instruments) as they exhibit changes of magnitude some fifty percent higher than the remaining SIC's. They are subsequently excluded from figure 3(a).

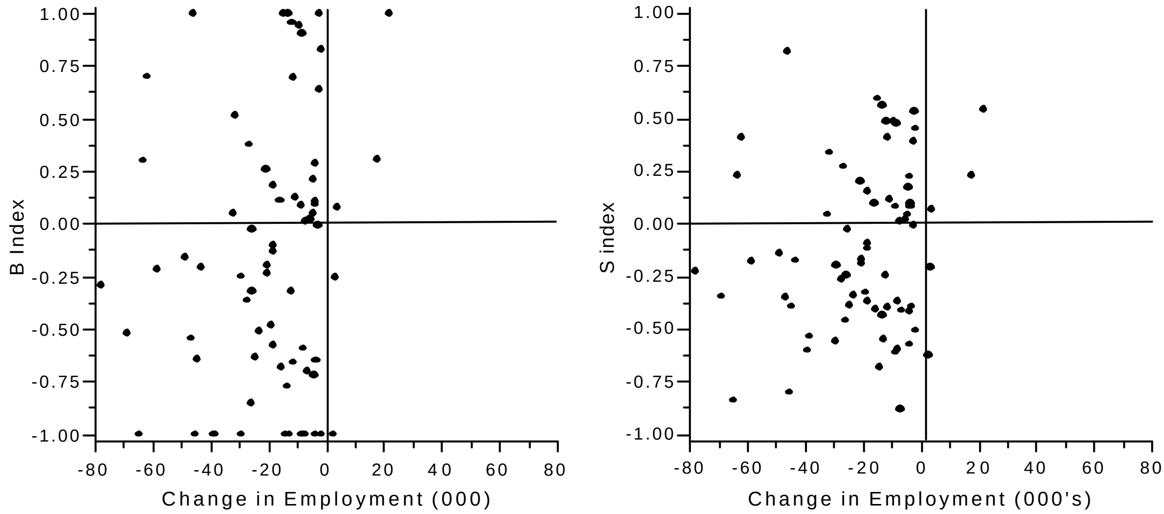


Figure 4(a) and 4(b). The Relationship Between the S and B indices and Employment Change

A relatively large number of industries under the *B* index regime are categorised by either a minus or plus one value in figure 4(a) where undefined regions will result in an under or over statement of the true value of adjustment pressure and introduces measurement bias. Of all the three-digit industries 25% fall into one of these two categories (see appendix 3 for details). In comparison the *S* index is fully defined for all trade changes in all quadrants and provides a consistent indicator of the adjustment implications.

Finally, we briefly reflect on how this measure could be used in future empirical work. One possibility is to present simple correlations between a range of indices and measures of performance and structural change such as employment and output changes. The natural extension is to employ the *S* index as a dependent variable in multivariate regressions analysis in a similar framework to existing studies that employ the Brulhart's *A* index or UMCIT.

4 Summary and Conclusions

This paper presents a methodology and measure of trade induced adjustment that satisfies our theoretical priors and captures diagrammatically the adjustment implications from trade. By closely defining what we mean by trade induced adjustment we develop a tool that allows us to visually represent changes in trade patterns for any period and at any level of aggregation. This is coupled with an index that is both intuitive and easy to calculate. This means we can examine time series or cross sectional data for multilateral or bilateral trade flows and identify industries that, given existing trends, are likely to come under pressure from even greater import competition. This is potentially useful information for policy makers that will be able to direct retraining funds efficiently and pre-empt lobby group action.

Preliminary evidence for the UK is encouraging and demonstrates the applicability of our index presenting constructive results that support the evidence of the time. An examination of the largest negative values in Table 2 support our priors from anecdotal evidence about the changing structure of UK industry during the 1980's with mining and textiles performing badly and basic industrial chemicals and motor vehicles performing positively. At the aggregate level the largest *S* value in 1982/83 coincides with the peak of the recession in the UK during the early 1980's.

The evidence from Figure 3 is that those industries, where imports have risen, are where government aid could be most usefully targeted at areas such as family support and guidance in searching for jobs and how to retrain effectively. In contrast, for expanding sectors money could be targeted at the content of training courses that emphasise the skill requirements of the developing sectors such as IT and communication skills. Finally, figure 4 demonstrates that the majority of UK industries shed labor during this period, an indication of the strength of the capital substitution and structural changes bought on by the recession of the early 1980’s.

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Appendix 1

Proof:

Consider total trade (TT), net trade (NT), and intra-industry trade (IIT) where,

$$TT = X + M \quad (1)$$

$$NT = |X - M| \quad (2)$$

$$IIT = (X + M) - |X - M| \quad (3)$$

Consider (a) $\forall \Delta X, \Delta M > 0$, (Quadrant 1 in figure 1).

From (1), (2), and (3), we have

$$\max(\Delta TT) = \max(\Delta X) + \max(\Delta M) \quad (4)$$

$$\max(\Delta NT) = \max\left(|\Delta X - \Delta M|\right) \quad (5)$$

$$\max(\Delta IIT) = \max\left((2\min(\Delta X, \Delta M)\right) \quad (6)$$

From (6)

$$\max\left(|\Delta X - \Delta M|\right) = \left[\max(\Delta X) - \min(\Delta M)\right] \text{ or } \left[\max(\Delta M) - \min(\Delta X)\right] \quad (7)$$

Suppose that $\forall\ t \in N$, $\max(\Delta X_t) > \max(\Delta M_t)$,

Let (4) be ΔTT, (5) be ΔNT, (6) be ΔIIT, and $\max(\Delta M_t)$ be ΔM, and $\max(\Delta X_t)$ be ΔX. Then if $\Delta X > \Delta M \Rightarrow \Delta X \Delta X = \Delta X^2 > \Delta M \Delta M = \Delta M^2$

$\Rightarrow \Delta X^2 > \Delta M \Delta X$; $\Delta X^2 > \Delta NT$; $\Delta X^2 > \Delta IIT$

$\Rightarrow (4), (5), (6) \subset \Delta X^2 = \max(\Delta X_t) \max(\Delta X_t)$.

Similar reasoning follows for cases of (b) $\Delta M < 0, \Delta X \geq 0$ (Quadrant IV), (c) $\Delta X, \Delta M < 0$ (Quadrant III), and (d) $\Delta X < 0, \Delta M \geq 0$ (Quadrant II) ■.

Appendix 2

The two-dimensional *B* index most closely resembles our *S* index and contains information about the proportion of sectorally matched changes and an element of country specific sectoral performance (and is in fact a sub-set of the *S* index that is undefined for quadrants II and IV in the TAS). The *B* index is given by;

$$B = \frac{\Delta X - \Delta M}{|\Delta X| + |\Delta M|}$$

where B lies between -1 and 1 where the upper and lower bounds represent trade changes that are entirely inter-industry in nature. Analogous to the *S* index, if *DX* > *DM* the *B* index will be positive and if *DM* > *DX* it will be negative reflecting the type of adjustment pressure (linked to expansion or contraction) felt by the home country.

The more widely used *A* index is related to the *B* index where;

$$A = 1 - \frac{|\Delta X - \Delta M|}{|\Delta X| + |\Delta M|}$$

and $|B| = 1 - A$ and measures the share of new trade flows that are intra-industry in nature. The *C* index is a transformation of the *A* index and is the share of *C* in $|\Delta X| + |\Delta M|$ where $C = |\Delta X| + |\Delta M| - |\Delta X - \Delta M|$ and provides an un-scaled measure of matched trade.

The Menon and Dixon (1997) index is the absolute value of the numerator of the *S* index where $UMCIT = |\Delta X - \Delta M|$ and measures the amount of unmatched (net) trade change that require inter-industry factor reallocation. The argument is that inter-industry trade changes are what directly effects the magnitude of adjustment.

It is important to note that the authors of these measures did not consider montonicity and country specificity to be an important ingredient of their measures (although Brülhart included the B index in his family of measures to pick up the country specificity effect). It is useful however to benchmark them against our criteria of monotonicity and country specificity.

Starting with the A index, when $\Delta M < 0, \Delta X \geq 0$ or $\Delta X < 0, \Delta M \geq 0$ the A index = 0 and therefore undefined for quadrants II and IV in the TAS. Moreover, assume $\Delta X, \Delta M > 0$, then if $\Delta X > \Delta M$ or $\Delta M > \Delta X$ the A index is invariant under the exchange of ΔX and ΔM .

The UMCIT measure suffers from a similar problem where, following an equal change in imports and exports $UMCIT = |\Delta X - \Delta M| = |\Delta M - \Delta X|$ so it is not possible to tell whether an industry is suffering adjustment pressures due to an expansion or contraction. By similar reasoning it follows that the B index is insensitive to variations in ΔX and ΔM when ΔX and ΔM have opposite signs.

Table 1 provides some hypothetical examples to help highlight these differences.

Table 1.

A comparison of hypothetical values for trade-induced adjustment indices.

	DX	*DM*	*S* index (Quadrant)	*A* index	*B* index	*UMCIT*
A	9	4	0.277 (I)	0.615	0.385	5
B	5	10	-0.250 (I)	0.666	-0.333	5
C	-6	11	-0.772 (II)	1	-1	17
D	-12	7	-0.791 (II)	1	-1	19
E	-14	-8	-0.214 (III)	0.727	-0.273	6
F	-9	-15	0.200 (III)	0.750	0.250	6
G	10	-16	0.813 (IV)	1	1	26
H	17	-11	0.823 (IV)	1	1	28

By construction, different values of the changes in *X* and *M* and differences between changes have been chosen in each row. Intuitively, absolute and relative differences in trade flows should mean that the adjustment implications are not equal in each case. Comparing rows A and B the absolute values of both *X* and *M* are greater in row B and that in row A exports rose more than imports and in row B the reverse was true. Both the *S* and *B* indices record dissimilar values for rows A and B but UMCIT does not record any difference. Looking at rows C and D suggests that there are likely to be detrimental employment effects for the home country as exports are falling and imports rising. However, this time the *B* index fails to record any difference in index values and returns a value of –1 for both rows (this property of the *B* index is investigated further in Section 3). The final observation is that in rows G and H (a potentially positive employment scenario for the home country) where the magnitudes of trade flows are higher than in rows D and E the *A* and *B* indices return the same absolute values. The *S* index identifies and flags these differences in volume changes as relevant to the adjustment issue with higher absolute values for rows G and H against rows D and E as expected.

Appendix 3

Three-digit adjustment indices 1979-1991 (SIC 80).

SIC3	*Description*	*S index*	*B index*	*A index*	UMCIT	C index
221	iron & steel industry	0.49	0.97	0.03	267870.8	7419.72
222	steel tubes	-0.46	-0.85	0.15	78534.05	13802.88
223	drawing, cold rolling & cold forming of steel	-0.37	-0.58	0.42	15890.52	11737.79
224	non-ferrous metals industry	-0.60	-1.00	0.00	138898.4	0
231	extraction of stone, clay, sand & gravel	-0.55	-1.00	0.00	5750.269	0
241	structural clay products	-0.59	-1.00	0.00	7433.081	0
242	cement, lime & plaster	-0.37	-0.59	0.41	21074.39	14620.06
243	building products, concrete, cement, plaster	-0.40	-0.68	0.32	9891.386	4661.564
244	asbestos goods	-0.40	-0.66	0.34	8882.714	4633.469
245	working stone & other non-metallic minerals	-0.62	-1.00	0.00	31186.7	0
246	abrasive products	0.05	0.05	0.95	234.1576	4726.015
247	glass & glassware	-0.12	-0.13	0.87	10043.48	65998.57
248	refractory & ceramic goods	-0.39	-0.64	0.36	28262.63	16145.15
251	basic industrial chemicals	-0.47	-0.87	0.13	306553	45688.95
255	paints, varnishes & printing ink	0.08	0.09	0.91	10000.52	102187.3
256	specialised chemical products (industry/ag)	0.60	1.00	0.00	81994.17	0
257	pharmaceutical products	0.07	0.07	0.93	42281.75	522920.7
258	soap & toilet preparations	0.00	0.00	1.00	832.6037	178172.6
259	specialised chemical products (house/office)	0.02	0.02	0.98	4431.848	248964.5
311	foundries	-0.84	-1.00	0.00	8121.688	0
312	forging, pressing & stamping	-0.20	-0.25	0.75	9022.526	27168.44
313	bolts, nuts etc; springs; non precision chains	0.16	0.19	0.81	1898.801	8332.234
316	hand tools & finished metal goods	-0.22	-0.29	0.71	72016.32	176273.9
320	industrial plant & steelwork	-0.39	-0.65	0.35	47491.68	26076.98
321	agricultural machinery & tractors	-0.02	-0.03	0.97	2800.498	108204.4
322	metal-working machine & engineer's tools	0.82	1.00	0.00	80185.31	0
323	textile machinery	0.10	0.11	0.89	6524.843	52203.73
324	machinery for the food, chemical & industry	-0.54	-1.00	0.00	16418.27	0
325	mining machine, construction & mechanical	0.41	0.70	0.30	33812.43	14485.06
326	mechanical power transmission equipment	0.34	0.51	0.49	16636.32	15746.15
327	machinery for the printing, paper, wood etc.	0.27	0.38	0.62	64345.54	106816.3
330	manufacture of office machinery	0.23	0.30	0.70	370757.9	852544.9
341	insulated wires & cables	-0.24	-0.32	0.68	36986.84	77516.88
342	basic electrical equipment	-0.18	-0.22	0.78	77628.9	278473
343	electrical equipment industry use & batteries	0.04	0.05	0.95	1958.478	40211.75
344	telecommunication equipment, electrical eq.	0.23	0.30	0.70	57773.43	134767.3
346	domestic-type electric appliances	-0.17	-0.20	0.80	22974.51	91971.8
347	electric lamps & other electric lighting eq.	-0.41	-0.70	0.30	34353.81	14705.17
351	motor vehicles and engines	0.64	1.00	0.00	1338470	0
352	motor vehicle bodies, trailers & caravans	-0.09	-0.10	0.90	3193.715	27355.03
353	motor vehicle parts	-0.34	-0.52	0.48	495985.7	453053.3
371	measure, checking & precision instruments	0.09	0.10	0.90	21841.98	189811.2
372	medical & surgical equipment	0.22	0.29	0.71	30994.95	76152.61
373	optical precision instruments & photo eq.	0.01	0.01	0.99	6311.723	753123.3
374	clocks, watches & other timing devices	0.24	0.31	0.69	9959.2	22343.39
411	organic oils & fats (other than animal fats)	-0.57	-1.00	0.00	36587.09	0
412	slaughtering of animals & meat production	0.54	1.00	0.00	276134.4	0
413	preparation of milk & milk products	0.41	0.70	0.30	129106.5	56251.22
414	processing of fruit & vegetables	-0.61	-1.00	0.00	57883.74	0
415	fish processing	0.11	0.13	0.87	10653.3	72701.35

416	grain milling	0.08	0.09	0.91	1717.126	17032.98
419	bread, biscuits & flour confectionery	-0.33	-0.48	0.52	37119.95	39769.24
421	ice cream, cocoa, chocolate & sugar sweets	-0.34	-0.51	0.49	53880.3	51626.02
422	animal feeding stuffs	0.49	0.94	0.06	53769.44	3165.93
424	spirit distilling & compounding	0.56	1.00	0.00	158467.9	0
426	wines, cider & perry	-0.51	-1.00	0.00	68912.44	0
427	brewing & malting	-0.24	-0.32	0.68	21158.09	44632.59
428	soft drinks	-0.42	-0.72	0.28	60803.22	23898.5
429	tobacco industry	0.21	0.26	0.74	16267	45509.27
431	woollen & worsted industry	-0.17	-0.21	0.79	25800.99	98114.38
432	cotton & silk industries	-0.80	-1.00	0.00	31538.16	0
434	spinning & weaving of flax, hemp & ramie	0.53	1.00	0.00	5120.273	0
435	jute & polypropylene yarns & fabrics	0.17	0.21	0.79	1271.349	4831.845
436	hosiery & other knitted goods	-0.14	-0.16	0.84	21382.4	112958.3
438	carpets & other textile floor coverings	-0.68	-1.00	0.00	92788.82	0
451	Footwear	-0.27	-0.36	0.64	18441.74	32193.35
453	clothing, hats & gloves	-0.19	-0.24	0.76	76125.5	244713.40
455	household textiles & other made-up textiles	0.49	0.96	0.04	15632.96	729.6401
461	sawmilling, planing, etc of wood	0.20	0.26	0.74	4009.222	11645.92
462	manufacture of semi-finished wood products	0.45	0.83	0.17	22495.17	4677.314
463	builders' carpentry & joinery	-0.88	-1.00	0.00	21462.23	0
464	wooden containers	0.47	0.90	0.10	4907.502	541.4378
466	articles of cork & plaiting materials, brushes	-0.39	-0.65	0.35	1788.737	971.5109
467	wooden & upholstered furniture	-0.44	-0.77	0.23	85352.52	25033.53
471	pulp, paper & board	-0.19	-0.23	0.77	92243.32	300851
472	conversion of paper & board	-0.35	-0.54	0.46	114738.3	95866.63
483	processing of plastics	-0.20	-0.26	0.74	132555.2	384288.5
492	musical instruments	0.39	0.64	0.36	9779.109	5569.962
494	toys & sports goods	-0.56	-1.00	0.00	15305.07	0