Research Note/Note de recherche

A Theoretical Critique of Shift and Share Analysis: A General Equilibrium Approach

Sten E. Drugge
Department of Economics, University of Alberta
Edmonton, Alberta T6G 2H4

Introduction

Shift-share analysis has generated a substantial amount of controversy regarding its theoretical validity. In spite of these criticisms, efforts have been made to improve its original purpose as a device for *ex post* analyses of the components of employment changes (Herzog and Olsen 1977) and its ability to forecast regional employment change (Stevens and Moore 1980).

The conventional criticisms leveled against the shift-share technique have largely stemmed from the structural form of the model, with its emphasis on employment change in the nation and resulting effects on the region (Houston 1967; Stilwell 1969), and on the functional form of the model in terms of additive versus multiplicative relationships and asymmetry between variables (Esteban-Marquillas 1972; Theil and Gosh 1980; Saskashita 1973).

A specific and complete critique of the shift-share analysis is contained in Martin (1976) and Beaudry and Martin (1979). The latter analysis indicates methods available to correct the problems of aggregation and interaction (interpenetration) of the structural and competitive effects. In particular, these authors argue (1979, 390) that the term "competitive advantage" is a misnomer because this expression is an unreliable sign of a region's competitive advantage. Their position is based on situations when measurements derived using the shift-share technique produce empirical results indicating a competitive advantage for an industry in a region, when in fact the industries under examina-

tion are producing non-traded goods. Beaudry and Martin (1979, 390) conclude that for industries that export to other regions the shift-share measure of competitive advantage is correct.

This paper will demonstrate on theoretical grounds that even in the case where industries are involved in producing traded goods, the shift-share method for measuring competitive advantage cannot be conceptually valid when commodities differ in their factor intensities and regions vary in their relative factor endowments.

The Shift-Share Model

The shift-share model may be stated in the form given by Stevens and Moore 1980):

$$e_i^t = e_i^{t-1} (E^t / E^{t-1}) + e_i^{t-1} (E_i^t / E_i^{t-1} - E^t / E^{t-1}) + e_i^{t-1} (e_i^t / e_i^{t-1} - E_i^t / E_i^{t-1}) \quad (1)$$

where e_i and E_i are regional and national employment in industry i; e and E are regional and national total employment in all industries; and t-1 and t are the beginning and end of the analysis period.

Equation (1) has three constituent elements that may be expressed as a rate of change:

National share: $NS_i = e_i^{t-1} (E^t / E^{t-1})$ (2)

Industry mix: $IM_i = e_i^{t-1} (E_i^t / E_i^{t-1} - E^t / E^{t-1})$ (3)

Regional shift: $RS_i = e_i^{t-1} (e_i^t / e_i^{t-1} - E_i^t / E_i^{t-1})(4)$ (4)

Equation (1) apportions an industry's employment change in a region to share effects ($RP_i = NS_i + IM_i$), and shift or competitive effect (RS_i).

The share component[1] of a region's employment change in a specific industry is standardized; that is, every industry in all regions in the analysis has precisely the same rate of employment change attributed to it on the basis of national aggregate employment growth rates (NS_i). As well, each region's specific industries have attributed to them the difference between the national growth rate of a specific industry and the national all-industry growth rate (IM_i). This standardization procedure regarding the two share-elements of regional growth is used as the conceptual basis for asserting that regional employment growth in excess of the national standardized values originates from region-specific competitive advantages such as regional factor supply

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[1]A disagreement exists between Stevens (1980) and Herzog and Olsen (1977) as to whether the element IM_i should be considered a component of share or shift effect. This paper treats IM_i as a share effect, because on conceptual grounds IM_i impacts all regions equally, and is therefore not region-specific.

changes, regional technical change, improved efficiency due to factor reallocation, and regional comparative locational advantage.

For purposes of further analysis, the shift-share identity can be expressed as relative rates of change indicated in equation (5):

$$d_{ei} = dE + dE_i / dE + de_i / dE_i \quad (5)$$

where de_i / dE_i is the shift component.

The Argument

The major purpose of literature utilizing shift-share analysis is to identify industries that have an economic competitive advantage in a region. As expressed by Steven and Moore (1980), the method is used:

> ... to emphasize, especially, the part of regional growth or decline in an industry which is region-specific. The regional shift component is intended to provide a measure of the relative performance of the region in a particular industry. *Positive shift could then be associated with the comparative locational advantage of the region for that industry* ... [emphasis mine].

This paper will demonstrate that the shift-share technique is not sufficiently generalized as to reliably identify industries in a region that have a competitive advantage. This specific analytical approach, emphasizing the shortcomings of the shift (competitive) element is an acceptable strategy; as Buck (1970) has pointed out, the shift-share equation is an identity, so it does not matter whether critical concentration is given the shift or share component, since if one is given the other is determined. Two cases specific to the shift component will be developed: the first critique will be based on labour-output transformation differences between industries on an intraregional basis; the second critique demonstrates intraindustry transformation differences between labour and output on an interregional basis under conditions of factor immobility and mobility between regions.

The Single-Region Case: A General Equilibrium Model

The intraregional general equilibrium model consists of region j=1, and two industries i=1, 2. Industry i=1 produces a labour-intensive commodity c_1, while i=2 produces a capital-intensive commodity c_2, and c_1 is more labour intensive at all factor price ratios. The regional production function is homogeneous of degree one, with pure and perfect competition in factor and commodity markets. Two factors of production exist, labour ($\bar{N}$), which is relatively abundant in the region, and

capital ($\bar{K}$), both of which are fixed in quantity and perfectly mobile between industires i=1, 2.

In output space an increase in demand for c_1 originated by a change in consumer preference will result in an increase in price and output of c_1. In factor markets the increase in p (c_1) produces a declining labour/capital ratio in the production of c_1, since changes in industry labour inputs (e) on the factor market contract curve are specified in relation to commodity price change as follows:

$$de/dp \ (c_1) > 0 \tag{6}$$

and

$$d_e^{i=1}/dp \ (c_1) < d_e^{i=2}/dp \ (c_2) \tag{7}$$

That is, as the increased demand for the labour-intensive c_1 causes its output to increase, the output of the capital-intensive c_2 must contract, freeing labour at a lesser rate than when the output of c_2 expands, contracting output of the labour-intensive c_1.[2]

The Analysis

To demonstrate a case in which the shift-share technique lacks general theoretical validity in identifying the industry having a competitive advantage in the region, specifically assume that factor and commodity markets are in equilibrium with p (c_2) > 1, indicating that consumer demand favours the consumption of the capital-intensive c_2. For purposes of analysis, assume that demand, price, and therefore output alternately grows for c_1, c_2 from this initial equilibrium position.

The relative impacts on industry labour employment resulting from alternate output growth of c_1, c_2 can be evaluated from equation (7), such that $d_e^{i=2}/dp \ (c_2) > d_e^{i=1}/dp \ (c_1)$.

That is, as the demand, price and output of c_2 increases, the output of the labour-intensive c_1 must decline, freeing relatively larger amounts of labour than capital. As the demand and price of c_1 increases, the output of the capital-intensive c_2 must decline, freeing relatively lesser amounts of labour.

Substituting these respective industry rates of change of labour inputs occurring over time into the shift element of equation (5), $de_i^{i=2}/dE_i > de_i^{i=1}/dE_i$, where dE_i is of common value. Shift-share analysis indicates that commodity c_2 of industry i=2 has a competitive advantage over commodity c_1 of i=1 in the region.

[2]Indicating an Edgeworth box with labour endowment on the horizontal axis as the contract curve is assumed concave from above; thus output of $c_1 \to 0$ in the lower left origin of the box.

The Critique: Output and Cost Response

Given the favourable endowment of labour in the region, and the initial assumption of demand conditions favouring the consumption of the capital-intensive c_2, the output response of c_1, c_2 to increased demand will differ, such that $dc_1/dp \ (c_1) > dc_2/dp \ (c_2)$, attributable to the marginal product of the intensively used labour factor rising when the demand for c_1 increases, and falling when the demand for c_2 increases.

This expression correctly identifies the labour-intensive commodity c_1 of industry i=1 as having a competitive output advantage in the region, since the region has a relatively favourable endowment of labour. Additionally, in terms of output costs, expansion of c_1 entails less outlays for given changes in output, since by previous assumption c_1 is more labour intensive and the region has cheap labour due to its relative abundance of labour.

This conceptually correct definition of economic efficiency encompassing relative input/output transformation rates correctly identifies this labour-abundant region as possessing a competitive efficiency advantage in the production of the labour-intensive c_1 of industry i=1, and not in the production of the capital-intensive commodity, c_2. Therefore, when it is assumed that demand conditions initially favour the capital-intensive c_2, the shift-share technique, in its use of comparative industry labour inputs as a basis for identifying competitive advantage, will incorrectly indicate that the capital-intensive commodity has a competitive advantage in a labour-abundant region.

However, if initially it is assumed that p (c_1) > 1 and alternate increases in demand for c_1, c_2 are assumed, then, as in the foregoing analysis, the labour input response will again be $de/dp \ (c_2) > de/dp \ (c_1)$; but in contrast to the previous analysis the relative output response in c_1, c_2 will be $dc_2/dp \ (c_2) > dc_2/dp \ (c_1)$, since under these demand assumptions the marginal product of the relatively intensively used capital factor will rise as the demand for c_2 rises, because a relatively greater amount of labour is released from the resultant contraction in output of labour-intensive c_1. This result indicates that shift-share, under these very specific commodity demand conditions, has in a casual sense correctly identified c_2 of i=2 as having a region-specific competitive advantage. Therefore, by initially and specifically assuming for purposes of analysis that p (c_2) > 1, the lack of generality of the shift-share technique is unequivocally identified.

The Two-Region Case: Interregional Factor Immobility

In order to provide a more generalized and realistic analysis, assume a general equilibrium model with two regions j=1,2, with equivalent tech-

nologies, but with differing endowments of capital and labour, such that $\bar{N}_1 > \bar{N}_2$, and $\bar{K}_1 < \bar{K}_2$, $j=1,2$. Two commodities c_1, c_2 are produced in $j=1,2$, possessing technologies as indicated in the previous intraregional case. Rates of change of labour inputs into the production of c_1, c_2 are expressed on the contract curve as functions of commodity prices, so that in $j=1,2$:

$$de/dp\,(c_1) > 0, \text{ and } de/dp\,(c_2) > 0. \tag{8}$$

and $de/dp\,(c_1) < de/dp\,(c_2)$, $j=1,2$, since any expansion of the output of commodity c_1 frees less labour and more capital as the output of the capital-intensive c_2 contracts. Because of the relative abundance of labour in $j=1$, any change in output levels of c_1, c_2 on the respective regional factor contract curves will produce the following industry employment effects; if for example the demand for c_1 expands in both regions:

$$\overset{j=1}{de}/dp\,(c_1) > \overset{j=2}{de}/dp\,(c_1) \tag{9a}$$

or, if the demand for c_2 expands in both regions:

$$\overset{j=1}{de}/dp\,(c_2) > \overset{j=2}{de}/dp\,(c_2) \tag{9b}$$

That is, as the demand and price for commodity c_1 or c_2 increases equivalently in the two regions, the resultant rate of increase of labour employment will be greater in region $j=1$ because labour is cheaper in this relatively labour-abundant region.

The Analysis

To demonstrate that shift-share lacks theoretical generality in this interregional case, specifically assume that factor and commodity markets, $j=1,2$ are in general equilibrium with equivalent factor and commodity prices.

For purposes of analysis, assume that demand increases equivalently for c_2 in both regions $(dp\,(c_2) > 0)$ $j=1,2$. The relative impacts on regional labour employment resulting from the output increase in c_2 can be evaluated from equation 9(b) such that $\overset{j=1}{de}/\underset{j=2}{de} > 0$.

Substituting these results into the shift element of equation (5), shift-share will assign competitive advantage to the capital-intensive commodity c_2 of industry $i=2$ when located in the labour abundant $j=1$, on the basis of that industry's greater rate of change of labour inputs.

The Critique: Output and Cost Response

Given the assumptions regarding increased demand of the capital-intensive c_2, and the relative abundance of capital in $j=2$, output response in respect to the capital-intensive c_2 will differ in the two regions for equivalent increases in demand such that $\overset{j=2}{dc_2}/dp\,(c_2) > \overset{j=1}{dc_2}/dp\,(c_2)$, since region $j=2$ is relatively capital-abundant.

This result demonstrates that $j=2$ possesses a regional output advantage in the production of c_2. Moreover, given that commodity c_2 is more capital intensive than c_1 and that capital is cheaper in $j=2$ due to its relative abundance, less input costs per unit of output are incurred in this region when output for c_2 expands equivalently in both regions. This conceptually correct analysis establishes industry $i=2$, when producing in region $j=2$, as possessing a regional competitive efficiency advantage, contrary to the results obtained through the shift-share technique. This analysis demonstrates that shift-share analysis will always identify the relatively labour-abundant region as providing a competitive advantage regardless of the factor-intensity characteristics of the commodity or industry under consideration.

The Two-Region Case: Interregional Factor Mobility

The purpose of this anlaysis is to demonstrate that shift-share analysis lacks sufficient theoretical generality to consistently identify regions offering competitive advantage to an industry under the more realistic assumption of interregional factor mobility.

The Analysis

If, as noted in the previous model, the demand for the capital-intensive commodity c_2 increases equivalently in regions $j=1,2$, the labour-capital ratio rises in both regions since the expansion of industry c_2 causes a relatively greater release of labour than capital as the labour-intensive industry $i=1$ contracts. As a result, wage-rates decline in both regions; however, since region $j=1$ is relatively labour abundant, wage-rates will decline faster in that region (Rybczynski 1955). Therefore, given the assumption of interregional factor mobility, labour will flow from region $j=1$ to $j=2$, and capital will flow in the reverse direction (Borts 1960).

If the process of interregional factor transfers is realistically assumed not to be instantaneously complete, so that both regions do not immediately achieve equivalent factor endowments, then the relative rates of employment change in the two regions will again be characterized by the same inequality sign indicated in equation (9b), since region $i=1$ remains the relatively labour-

interregional factor endowments are equalized. This relative difference in the rate of change of labour employment between the two regions under conditions of interregional factor mobility will, however, be reduced compared to that of equation (9b), since labour flows to region j=2, increasing its relative labour abundance, and capital flows to region j=1, increasing its relative capital abundance. Until complete equality is achieved in factor endowments in both regions the inequality in equation (9b) must hold, so that substituting these relative regional rates of change of labour employment into the shift element of equation (5) again incorrectly identifies the labour-abundant region j=1 as providing a competitive advantage to the capital-intensive commodity c_2, contrary to the conclusions obtainable from the Hecksher-Ohlin hypothesis.

Conclusions

This paper has demonstrated that shift-share analysis is not sufficiently theoretically generalized to produce a consistent measure of competitive advantage of a specific industry in a region, or between regions. This lack of generality stems from the method's use of labour inputs as the sole measure of economic performance, while ignoring the theoretically superior approach contained in the Hecksher-Ohlin hypothesis, in which relative transformation rates of labour and capital are both related to output change in an industry.

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