Regional Trade and Adjustment with Expenditure Effects

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In a broad sense, regions can be viewed from two perspectives. From one perspective, regions are highly integrated with the wider national and world economies through trade and factor flows that firmly lock each region's technology, goods and services prices, and factor prices into the larger whole. Standard Heckscher-Ohlin-Samuelson (HOS) trade theory is the paradigm for the "highly integrated" approach, which has common technical knowledge, combined with constant returns to scale and perfect substitution of goods and factors across regional boundaries, as its hallmarks. Helpman and Krugman (1985), for example, characterize interregional trade patterns by superimposing arbitrary regional factor endowments on a fully integrated national or international price system. Over a range of relative endowments, all the standard trade theorems apply, including factor-price equalization (FPE).

The Keynesian-style income-expenditure perspective, by contrast, grants a high degree of independence to individual regions: exogenous spending shocks are frequently region-specific and set up complementary multiplier responses that cause particular regions to expand or contract relative to other regions. In contrast to HOS models, income-expenditure models avoid explicit references to factor endowments, relative factor intensities in different sectors, and the details of the interregional price system. The traditional staples theory approach to Canadian regional development and input-output impact models are firmly in the income-expenditure tradition.

This paper was presented at the Canadian Regional Science Association meetings in Victoria, B.C., June 1990. The author is indebted to Michael Bradfield, Kenneth Chan, Curtis Eaton, and J. S. Stabler for helpful comments on earlier drafts. The usual caveat applies.

ISSN: 0705-4580 Printed in Canada/Imprimé au Canada

Reconciliation of these approaches frequently follows the standard macroeconomic paradigm. In the short run, regions live in an income-expenditure world; in the long run, the highly integrated HOS framework comes into its own. The development of "booming sector" models in the early 1980s suggests that a fuller, more explicit synthesis of traditional trade theory with income-expenditure theory is possible and worthwhile in short-run models (Salter 1959; Corden and Neary 1982; Neary and van Wijnbergen 1986—also see Merrifield 1987). In this synthetic sense, this article is out of the "booming sector" mold. The emphasis in what follows is on real wage determination with expenditure effects playing an important role in the *long-run* regional adjustment process. The use of the real wage as a centrepiece agrees with a public policy emphasis on interregional labour market disparities and ties regional labour market performance to regional growth or decline through migration (an excellent migration survey is found in Vanderkamp 1986). Real wage-centred models include Anderson (1976), Swan and Kovacs (1981), and Norrie and Percy (1984).

The model described here is deliberately structured for comparison with the standard HOS framework. It seems unlikely that any long-run model of regional factor pricing and trade could be accepted without an explicit link with conventional trade theory. As in the standard HOS model, a region produces two distinct goods, x and y. Both sectors are populated by zero-profit firms operating at minimum efficient scale (MES). The x sector is a specialized export sector producing a commodity that is a perfect substitute for the same commodity produced elsewhere. The region's y-sector firms produce a variety of goods and services that are treated as a composite commodity by assuming identical factor proportions. Unlike in the HOS model, y goods are not perfect substitutes for importables. This imperfect substitution assumption (Armington 1969) in the y sector is responsible for the presence of expenditure effects in much the same way that the appearance of nontraded goods generates expenditure effects in booming sector models. The Armington assumption in the y sector is, of course, consistent with newer general equilibrium (GE) trade models (Harris 1984; Srinivasan and Whalley 1986). In addition to its consumption of x and y goods, a region is assumed to import a range of goods that it does not produce. Some imports are more efficiently produced elsewhere. Other goods are imported because the region lacks the essential factors needed to produce them. The region is a price-taker on world markets for its exports of x goods and for all its imports.

Although it departs from standard long-run HOS on the demand side, this article holds fast to the familiar HOS supply-side structure. The region's x and y sectors produce using fixed and homogeneous endowments of three factors of production: labour, natural resources, and capital. Free entry and exit ensure that price equals long-run marginal and average costs. Consistent with HOS, labour, natural resources, and capital are all perfectly mobile among the region's x and y sectors. Capital is also perfectly mobile across regions at a fixed rental rate. Natural resource endowments are strictly immobile interregionally. Labour is conditionally mobile interregionally in the sense that the effects of migration in response to changes in natural resource endowments, terms-of-trade changes, and efficiency changes are examined explicitly. The present model has no theory of labour migration other than the prediction that an increase in a region's real wage relative to those of other regions generates some inmigration and vice versa.

As for the various factor-intensity and trade pattern assumptions possible, this model structures such assumptions to reproduce a hinterland-style resource-exporting region. Thus, the x sector produces a natural resource-intensive good, most of which is exported to other domestic regions or to the rest of the world. The y sector consists of a variety of manufactures, which are labour-intensive relative to x. The y sector produces import-competing goods, non-traded goods, and possibly some exports as well.

The first major section of this article sets out the basic model. Its comparative statics are addressed in the second section, where three types of shocks are examined: the impact of improvements in the terms of trade through a rise in the price of x, exogenous changes in regional factor endowments, and (Hicks-neutral) efficiency changes in either sector or both sectors. These shocks affect the region's real wage and set up the preconditions for migration movements that alter factor endowments in the long run. Expenditure effects play a crucial role in the regional adjustment process. In each case, the predictions of the model are compared to standard HOS results. In general, the HOS model fails to pick up important long-run real wage impacts and feedbacks between real wages and regional labour supply. The third section of this article ties the comparative static results together to form a loose-jointed approach to economic adjustment involving interactions among expenditure effects, migration flows, the size of the domestic economy, and economic efficiency.

The Basic Model

The region consists of two sectors, x and y, as described above. Following HOS conventions, the x-sector price is determined exogenously in world markets. In contrast to HOS, the price of the y good is endoge-

nous and requires explicit attention to market-clearing behaviour. The demand side of the y market is represented by

$$y^d = f(p^x, p^y, m) \quad (1)$$

where y^d is final demand for good y, p^x is the relative price of good x measured in constant-priced imports to the region, p^y is the relative price of good y in constant-priced imports, and m is regional real income, also measured in terms of imports. Price effects on y^d ($\partial y^d/\partial p^x = f_x$ and $\partial y^d/\partial p^y = f_y$) reflect standard demand theory, as discussed below. The marginal propensity to consume y out of real income ($\partial y^d/\partial m = f_m$) is assumed to be independent of the distribution of real income (m) in the domestic economy. Assuming y is normal, $f_m > 0$. Demand functions for x and for imports are not stated explicitly but are assumed to be consistent with (1) in the sense that total final demand in the domestic economy is constrained by real income (m).

As indicated above, the supply side of the model is formally identical to the usual HOS supply side. Final outputs of both x and y are produced with continuous and differentiable constant returns-to-scale production functions, using privately owned inputs of labour (L), natural resources (N), and capital. Inputs are perfectly mobile between the region's sectors. Regional endowments of natural resources and labour are fixed. Capital is pefectly mobile among regions at a fixed rental rate. The assumption of a fixed endowment of labour in the region is taken to be conditional. Depending on its real wage in equilibrium relative to real wages elsewhere, the region's labour endowment can change through migration to set up a new regional labour endowment that feeds back into the real wage determination process. In this section, however, the labour endowment is held strictly constant. Later the implications of changing regional labour endowments through migration are discussed. In each sector, replication of firms equates product price to minimum long-run average cost. The natural resources-labour ratio in the x sector exceeds the natural resources-labour ratio in the y sector. The domestic economy's transformation frontier linking final outputs x^s and y^s is, therefore, strictly concave in the presence of fixed endowments of labour and natural resources (Figure 1). Changes in regional technology shift the transformation frontier as described below.

The long-run supply functions for each sector can be written as

$$x^s = x(p^y/p^x, L, N, T) \quad (2)$$

$$y^s = y(p^y/p^x, L, N, T) \quad (3)$$

where the partial derivatives of the x and y functions with respect to p^y/p^x (denoted henceforth as x_p and y_p) reflect strict concavity of the

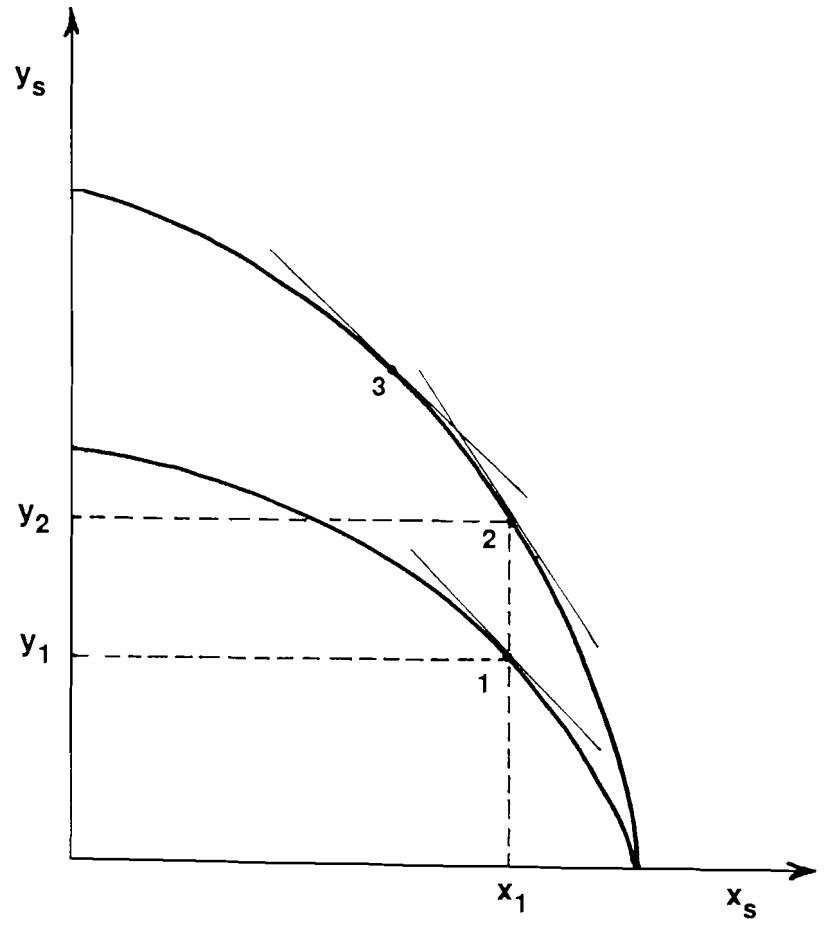

FIGURE 1 Productivity increase in the y sector

transformation frontier—that is, $x_p < 0$ and $y_p > 0$. The partial derivatives x_L, y_L, x_N, and y_N indicate the effects of changes in aggregate factor endowments L and N on x^s and y^s, *given the price of y in terms of x*. Thus, x_L, y_L, x_N, and y_N capture Rybczynski effects in the model. Since y is the relatively labour-intensive sector, $x_L < 0$, $y_L > 0$, $x_N > 0$, and $y_N < 0$ (Rybczynski 1955). To minimize notation, the whole range of possible technical changes in the model is incorporated in the shift parameter T. For simplicity, assume that a technical change in either the x or the y sector is Hicks-neutral. The Hicks-neutrality assumption means that the ratio of marginal factor products depends

only on relative factor intensity in each of the sectors and is not affected by changes in T. Suppose there is a Hicks-neutral productivity improvement in the y sector, for example, with no change in factor allocation. Output in the y sector increases from point 1 to point 2 in Figure 1 with an accompanying decrease in p^y/p^x as indicated by the steeper slope of the price line at point 2 relative to point 1. If p^y/p^x is held constant, the final equilibrium output mix is at point 3 where the price line at point 3 is parallel to the price line at point 1. The outward shift of the parallel price line measures the increase in real income that occurs at relative output prices corresponding to point 1. The change in the output mix due to the Hicks-neutral improvement in the y sector at constant relative output prices is captured in equations (2) and (3) by setting $x_T < 0$ in equation (2) and $y_T > 0$ in equation (3). Denoting the increase in real income measured in importables that results from changes in the shift parameter T as dm^*,

$$dm^* = (p^x x_T + p^y y_T)\, dT > 0 \tag{4}$$

where x_T and y_T are partial derivatives of the x and y functions with respect to T.

The same general type of argument applies to any (Hicks-neutral) productivity improvement in either sector. If productivity improves in the x sector, an analogous argument leads to (4) with $x_T > 0$ and $y_T < 0$. If productivity advance occurs in both x and y sectors and is biased to neither sector, then the transformation frontier in Figure 1 expands radially, relative output prices are unchanged, and $x_T > 0$, $y_T > 0$.

Market-clearing equilibrium in the y sector requires that the quantity demanded from equation (1) equal the quantity supplied from equation (3):

$$f(p^x, p^y, m) = y(p^y/p^x, L, N, T) \tag{5}$$

Taking total differentials of (5),

$$f_x dp^x + f_y dp^y + f_m dm = y_p d(p^y/p^x) + y_L dL + y_N dN + y_T dT \tag{6}$$

The economy's real income constraint is

$$m = p^x x^s + p^y y^s \tag{7}$$

Taking total differentials of (7),

$$dm = p^x dx^s + x^s dp^x + p^y dy^s + y^s dp^y \tag{8}$$

Taking total differentials of the supply functions (2) and (3) and substituting the resulting values for dx^S and dy^S into (8),

$$\begin{aligned} dm = {} & p^x [x_p d(p^y/p^x) + x_L dL + x_N dN + x_T dT] + x^s dp^x \\ & + p^y [y_p d(p^y/p^x) + y_L dL + y_N dN + y_T dT] + y^s dp^y \end{aligned} \tag{9}$$

Since price-taking producers satisfy the condition $y_p/x_p = -p^x/p^y$ along the transformation frontier, this envelope condition implies that $p^x x_p d(p^y/p^x) = -p^y y_p d(p^y/p^x)$ in (9). Cancelling these terms, substituting from (4), and rearranging,

$$\begin{aligned} dm = {} & x^s dp^x + y^s dp^y + (p^x x_L + p^y y_L)\, dL \\ & + (p^x x_N + p^y y_N)\, dN + dm^* \end{aligned} \tag{10}$$

Equation (10) categorizes the three sources of real income change (measured in terms of imports) in the model. The first two terms capture real income changes that proceed from price changes in the two sectors; the next two terms capture real income changes due to changes in the size of the region's endowments of labour and resources; and the last term measures real income changes due to productivity shifts. Substituting (10) into (6),

$$\begin{aligned} & (f_x + f_m x^s)\, dp^x + (f_y + f_m y^s)\, dp^y + f_m (p^x x_L + p^y y_L) dL \\ & + f_m (p^x x_N + p^y y_N)\, dN + f_m dm^* \\ & = y_p d(p^y/p^x) + y_L dL + y_N dN + y_T dT \end{aligned} \tag{11}$$

Equation (11) implies that the real income term in the demand function for y is being constrained to equal real income produced on the economy's transformation frontier.[1]

The exogenous variables in equation (11) are changes in the price of the export good, dp^x; endowment changes, dL and dN; and the change in the efficiency index, dT, which also generates the real income shift dm^* using equation (4). The endogenous variable is the change in the price of y, dp^y, with the associated change in the price of y relative to x denoted by $d(p^y/p^x)$. All exogenous variables influence quantities both supplied and demanded in the y sector either directly or indirectly through effects on real income. Utilizing Slutsky equations for good y,

1. A discussion of this approach to demand functions can be found in Bailey (1954). Note that the assumption of mobile capital means that two concepts of real income are involved in the model: GDP and GNP, with the difference between the two (GDP – GNP) equal to net investment income received by non-residents. The GNP approach to m applies to equation (1) since we assume that it is the real income of residents that affects demand for y-sector goods. On the other hand, it is the GDP approach to m that applies to income changes in equation (10). To reconcile the two, we make the following assumptions in equation (10): changes in real GDP due to price changes (dp^x and dp^y) accrue to residents (see also equations (19) and (20), and changes in real income due to endowment changes (dL and dN) are assumed not to be accompanied by any net change in regional capital stocks held by residents of other regions. The same assumptions apply to changes in real GDP due to productivity changes (dm^*). If these assumptions had to be altered, a real income transfer term could be added to equation (10) to translate GDP changes into GNP changes.

$$f_x + f_m x^s = f_x^* - f_m x^d + f_m x^s = f_x^* + f_m(x^s - x^d) \quad (12)$$

$$f_y + f_m y^s = f_y^* - f_m y^d + f_m y^s = f_y^* + f_m(y^s - y^d) \quad (13)$$

where f_x^*, f_y^* are the appropriate (Hicksian) substitution effects and x^d,y^d are quantities of x and y consumed domestically. Thus, $(x^s - x^d)$ and $(y^s - y^d)$ are the export quantities of the two goods. Provided x and y are Hicks-Allen substitutes such that $f_x^* > 0$, then $(f_x + f_m x^s) > 0$ if y is normal ($f_m > 0$). Since $f_y^* < 0$, the sign of $(f_y + f_m y^s)$ turns on a comparison of substitution and income effects. In principle, the sign of $(f_y + f_m y^s)$ could be positive for "large enough" values of $(y^s - y^d)$. Plausible stability requirements in the market for y can be used to assert that $(f_y + f_m y^s) < 0$, however. Consider Walrasian adjustment in the market period when x^s, y^s are fixed. Static stability in the market for y requires a negative slope for the y demand curve—that is, $dy^d/dp^y = f_y + f_m y^s = f_y^* + f_m(y^s - y^d) < 0$. Denote $f_y + f_m y^s$ as B. In the long run, when price-taking firms choose profit-maximizing values for x^s and y^s along the transformation frontier, it is straightforward to show that either Walrasian or Marshallian long-run static stability requires $y_p (Bp^x)^{-1} - 1 < 0$. With $B < 0$, this condition amounts to $(y_p - Bp^x) > 0$. This latter requirement implies correspondence between stability in the y sector and the comparative static results of the next section.

Comparative Statics

Three types of exogenous impacts on the region are examined in this section, each of which is a particular application of equation (11): (1) improvement in the terms of trade initiated by an increase in p^x; (2) factor endowment changes brought about by changes in regional natural resource supplies (dN) or labour migration (dL); and (3) efficiency changes in one or both sectors (dT and associated dm^*).

Improvement in the Terms of Trade

This section focuses on the impact on long-run regional prices and outputs of an improvement in the terms of trade brought about by an exogenous increase in p^x. As shown below, $dp^x > 0$ implies that $dp^y \geq 0$ in the present model. Thus, it is legitimate to say that $dp^x > 0$ leads to an increase in the overall regional terms of trade if y-sector goods form part of the region's exportables. (Note, however, that $dp^y > 0$ does not necessarily imply an increase in real export revenue in the y sector since y exports contract when $dp^y > 0$ in accordance with the Armington

assumption.) For changes in p^x, with $dL = dN = dT = dm^* = 0$, equation (11) becomes

$$(f_x + f_m x^s)\, dp^x + (f_y + f_m y^s)\, dp^y = y_p d(p^y/p^x) \quad (14)$$

Denoting $(f_x + f_m x^s)$ as A and $(f_y + f_m y^s)$ as B and solving for dp^y/dp^x,

$$dp^y/dp^x = [Ap^x + y_p(p^y/p^x)]\,(y_p - Bp^x)^{-1} \quad (15)$$

Substituting the value of dp^y from (15) into (14),

$$d(p^y/p^x)/dp^x = [A + B(p^y/p^x)]\,(y_p - Bp^x)^{-1} \quad (16)$$

Equations (15) and (16) indicate the comparative static responses of p^y and p^y/p^x to a change in p^x. Referring to the stability conditions at the end of the previous section, $B < 0$ and $(y_p - Bp^x) > 0$. Since $A > 0$ and $y_p > 0$, it follows that $dp^y/dp^x > 0$ in equation (15). In equation (16), the sign of $d(p^y/p^x)/dp^x$ can be positive or negative. Note that the output response in the two sectors depends on the sign of $d(p^y/p^x)/dp^x$: if it is positive, equilibrium y sector output expands and x sector output falls and vice versa.

The impact of $dp^x > 0$ on the y sector is as follows. Since x is exported, a positive expenditure effect on y^d operates through the income term $f_m(x^s - x^d)$ in equation (12). The increase in p^x also increases y^d through the Hicks-Allen cross-substitution effect ($f_x^* > 0$). The quantity of y supplied (y^s) declines as profit-maximizing producers shift in favour of x along the transformation frontier. These effects combine to produce $(y^d - y^s) > 0$. The excess demand for y drives up p^y until (stable) equilibrium is re-established in the y market.

Figure 2 illustrates these effects. Denoting the demand curve for y goods in equation (1) as DD and the supply curve in equation (3) as SS, the increase in p^x shifts SS to the left to S'S'. DD shifts to the right to D'D' because of the expenditure effect on y caused by the increased price of $x[f_m(x^s - x^d)]$ and the Hicksian cross-substitution effect (f_x^*). At the initial equilibrium price of y, p_0^y, excess demand for y is equal to ab. With the stability conditions in place, p^y increases to its new equilibrium value at p_1^y. The slopes of DD and D'D' reflect both the Hicksian own-substitution effect (f_y^*) and the expenditure effect $[f_m(y^s - y^d)]$. Thus, if y is exported such that $f_m(y^s - y^d) > 0$, the DD and D'D' curves are less elastic than otherwise, since an increase in the price of y produces positive expenditure effects on y_d. This, in turn, leads to a larger increase in p^y moving to the new equilibrium at p_1^y. The increase in p^y means that all goods in the regional economy have increased in price relative to goods outside the region: thus, an appreciation of the regional economy's real exchange rate accompanies the improvement in its terms of trade. Note that expenditure effects

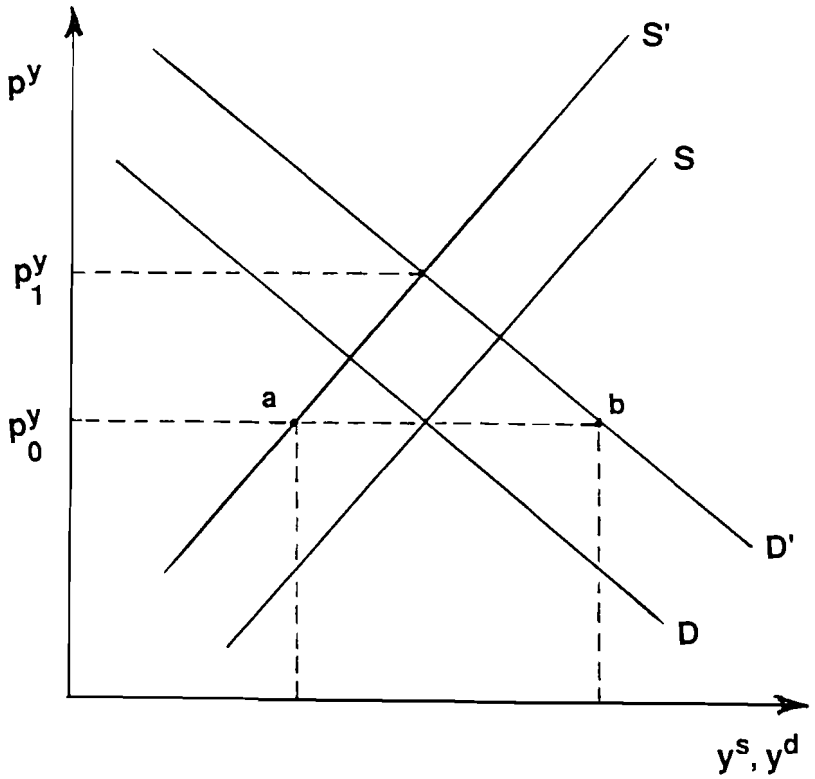

FIGURE 2 Improvement in the terms of trade *or* increased resource endowment

could be strong enough in the region's y sector to produce an increase in p^y/p^x in final equilibrium with an associated increase in y-sector output and a decrease in x-sector output.[2]

The results in Figure 2 can be compared to the standard HOS approach. In the HOS model, re-establishment of equilibrium in the y market occurs with no increase in p^y because y goods are perfect (Hicksian) substitutes for identical goods produced outside the region. In this special case, $f_y^* = -\infty$, and thus $B = -\infty$, provided the regional economy is simultaneously producing y and importing identical goods produced elsewhere. With $B = -\infty$, $dp^y/dp^x = 0$ in equation (15). DD is perfectly elastic in Figure 2 and $p^y_0 = p^y_1$. An alternative version of the

2. This result was noted in the simulation results carried out by Norrie and Percy (1984). They found that the energy price increases of the 1970s could, with constant Alberta factor endowments, cause such large expenditure-induced expansionary effects in the y sector that output of the energy sector tended to contract.

perfect substitution assumption—also in the HOS tradition—occurs when a subset of y goods is exported as a perfect substitute for identical goods produced outside the region. Again, DD is perfectly elastic. A y subset of this kind is an extreme version of what has been referred to as a "lagging" sector in long-run booming-sector models (Corden and Neary 1982). The leftward shift of SS to S'S', with DD perfectly elastic, ensures that y-sector output declines when p^x increases—hence the application of the term *lagging sector* in this context. The perfect substitution assumption for y, either in its role as an import-competing sector (HOS model) or in its role as an export sector (booming-sector models), also has been referred to as a "gadget" assumption (see Chambers and Gordon 1966; Lewis 1975; Copithorne 1981; Norrie and Percy 1984). The HOS/gadget result is just a special case of the present model.

Terms of Trade and Regional Real Wages

Imperfect substitution among goods produced in different regions in a trading system means that there is no direct commodity market mechanism aligning relative goods prices across the system. There is, therefore, no commodity market basis for factor price equalization (FPE). In fact, the ambiguous effect of changes in p^x on p^y/p^x in equation (16) suggests ambiguity in the effects of terms-of-trade changes on relative regional factor prices when y goods are imperfect substitutes for goods produced outside the regional economy. Since later in this article the real wage will be used to link terms-of-trade impacts with migration changes, the likely effect of the terms-of-trade change on the real wage is adopted as the focus of this discussion.

Consider the conventional (HOS) zero-profit equations for the x and y sectors, including the assumed fixed rental on mobile capital,

$$p^x = a^x w + b^x R + c^x r \tag{17}$$

$$p^y = a^y w + b^y R + c^y r \tag{18}$$

where a^x and a^y are the quantities of labour per unit of x and y; b^x and b^y are the quantities of natural resources per unit of x and y; and c^x and c^y are capital inputs per unit of x and y. As before, all factor prices are expressed in imported goods: the real wage in imported goods is w; real rent per unit of natural resources is R; and the real rental rate on mobile capital is r. Totally differentiating (17) and (18) with input coefficients optimally adjusted and the rental rate on capital fixed by the mobility assumption,

$$dp^x = a^x dw + b^x dR \tag{19}$$

$$dp^y = a^y dw + b^y dR \tag{20}$$

The real wage changes are dw in terms of imports, $d(w/p^x)$ in terms of x-sector goods, and $d(w/p^y)$ in terms of y-sector goods. Since it is assumed that x is a natural resource-intensive export good, the relative factor intensities are $a^x/b^x < a^y/b^y$. The real wage change measured in imports is

$$dw/dp^x = [b^y - (dp^y/dp^x)b^x]/D \quad (21)$$

where D denotes the determinant $(a^xb^y - a^yb^x) < 0$. Thus, $dw/dp^x > 0$ requires that $dp^y/dp^x > b^y/b^x$. This obviously cannot be satisfied under the HOS/gadget assumption since $dp^y/dp^x = 0$, such that $dw/dp^x < 0$ in (21). Under the more general assumptions of the present model, however, $dp^y/dp^x > 0$ (previous subsection). Suppose that a region's natural resources enter to a fairly modest extent into its production of y goods so that b^y is close to zero or at least small relative to $(dp^y/dp^x)b^x$. Given the diversity of y goods produced in the region and the specialized nature of its resource-producing x sector, this is a plausible assumption. The result is that $[b^y - (dp^y/dp^x)b^x] < 0$ in equation (21) and the real wage rises in terms of imports when the terms of trade on resource exports improves (that is, $dw/dp^x > 0$). The explanation is as follows: the increase in p^x tends to lower the real wage when y-sector goods are perfect substitutes for imports since the x sector is relatively natural resource-intensive: the Stolper-Samuelson theorem. The negative impact on the real wage is less the smaller the amount of natural resources entering y-sector production (small b^y). Since, in general, y-sector goods are imperfect substitutes for imports, $dp^y/dp^x > 0$ as a result of cross-substitution and expenditure effects. The increase in the price of y-sector goods tends, by itself, to raise the real wage since the y sector is relatively labour intensive—the Stolper-Samuelson theorem again. Thus, there are opposing effects. But a small assumed value for b^y means that the latter effect dominates and the real wage in imports rises when p^x rises.

Stronger, but related, conditions can be adduced to support the idea that the real wage also increases in terms of x and y goods. Consider the response of the real wage expressed in y goods to dp^x,

$$d(w/p^y)/dp^x = [(dw/dp^x) - (w/p^y)(dp^y/dp^x)]/p^y \quad (22)$$

Substituting for dw/dp^x from (21),

$$d(w/p^y)/dp^x = [b^y/D - (b^x/D + w/p^y)dp^y/dp^x]/p^y \quad (23)$$

From (23), the condition for $d(w/p^y)/dp^x > 0$ is

$$dp^y/dp^x - b^y/[b^x + (wD)/p^y] > 0 \quad (24)$$

To obtain an increase in the real wage in y goods, it is necessary that $dp^y/dp^x > b^y/(b^x + wD/p^y)$, which is stronger than the previous condition $dp^y/dp^x > b^y/b^x$ (note that $[b^x + wD/p^y]) > 0$). Again, "small" values of b^y combined with a significant positive response of p^y to a rise in p^x will lead to an increase in the real wage expressed in y-sector goods. Measuring the real wage in x goods, one can show straightforwardly, analogously with (23), that

$$d(w/p^x)/dp^x = [b^y/D - b^x(dp^y/dp^x)/D - w/p^x]/p^x \quad (25)$$

Thus, for $d(w/p^x)/dp^x > 0$,

$$dp^y/dp^x - (b^y - wD/p^x)/b^x > 0 \quad (26)$$

In this case, it necessary that $dp^y/dp^x > b^y/b^x - wD/b^xp^x$. Again, a "small" b^y-"large" dp^y/dp^x combination helps obtain a positive real wage response to the increase in p^x, although in this case the real wage increase is less certain than in the previous cases. Note that in all cases an increase in the real wage is guaranteed if the increase in p^x leads to a rise in p^y/p^x in accordance with the Stolper-Samuelson theorem.

The significance of the emphasis on the region's real wage response to price shocks can be appreciated by contrasting the foregoing predictions with the HOS special case. In the HOS model, an increase in the price of the resource-intensive good leads to an unambiguous decline in real wages in all regions. There is no incentive for labour to migrate across regions. In the 1970s Alberta case, for example, the HOS model predicts downward pressure on real wages resulting from an increase in oil prices and no inmigration for Alberta or other oil-producing regions. This HOS scenario is inconsistent with what actually happened in Alberta during this period and inconsistent with the general equilibrium simulations on the provincial economy carried out by Norrie and Percy (1984). More generally, the thrust of the staples literature is that resource commodity price increases can stimulate movements of labour into regions specialized in these staples, leading to long-run regional expansion of the staples-producing regions. It is reasonable to argue that a trade and adjustment model that excludes this adjustment process by assumption does not provide a relevant framework for the analysis of long-run regional responses to exogenous price shocks. On this criterion, the present model outperforms the HOS model in the sense that it includes the possibility that regional real wages will respond positively to an increase in staple export prices. For regions with well-developed y-sector activities (such as Alberta), it seems clear that expenditure effects of the kind modelled by Norrie and Percy can be large enough to

generate a good deal of labour market tightness in response to higher world prices in the staples sector.[3]

Changes in Factor Endowments

This section and the next turn to the regional impact of exogenous changes in factor supplies on regional real wages. To determine the impact of changes in resource endowments, return to equation (11) and assume that $dp^x = 0$, $dL = 0$, and $dT = dm^* = 0$. With these assumptions, (11) becomes

$$(f_y + f_m y^s)dp^y + f_m(p^x x_N + p^y y_N)\,dN = y_p d\,(p^y/p^x) + y_N dN \qquad (27)$$

The term $(p^x x_N + p^y y_N)dN$ is the real income increase associated with a change in a region's endowment of natural resources (dN) evaluated at constant relative prices p^x and p^y. Since the x sector is resource-intensive, $dN > 0$ implies an increase in x-sector output ($x_N > 0$) and a decrease in y-sector output ($y_N < 0$) with relative factor prices constant (Rybczynski 1955). At constant prices, the new resources are absorbed at unchanged factor prices so that the increase in real income is simply RdN.[4] Substituting RdN for $(p^x x_N + p^y y_N)dN$ in (27),

$$(f_y + f_m y^s)dp^y + f_m RdN = y_p d(\,p^y/p^x) + y_N dN \qquad (28)$$

The term $f_m RdN$ is the initial expenditure effect in the y sector because of the region's increased natural resource endowment. Figure 2 again illustrates the comparative statics associated with equation (28). The initial expenditure effect, $f_m RdN$, shifts DD to D'D'. The term $y_N dN$ is the Rybczynski effect: it shows the impact on y^s of an increase in the natural resource endowment at constant prices

3. Another aspect of expenditure effects and real wages relates to transport costs. Hinterland regions exporting resource products must absorb most of the transport costs on both exports and imports (Anderson 1982). Region-specific transport costs lower p^x by reducing the netback price of exports and increasing the delivered cost of imports. The HOS model predicts that the reduction in p^x raises the hinterland region's real wage relative to other regions, leading to inmigration. Further, taking the HOS real wage prediction literally implies that a policy designed to narrow any observed real wage disparities between hinterland regions and other parts of the national economy might place taxes on the hinterland region's staple exports and tariffs on its imports. These counterintuitive results disappear if real wages are a positive function of the hinterland's terms of trade.

4. In fact, the increase in real GDP, $(p^x x_N + p^y y_N)dN$, equals the additional earnings of the new natural resources (RdN) plus any additional positive or negative earnings on capital due to differences in the capital-labour ratios in the expanding sector and the contracting sector. For simplicity we assume that the change in capital earnings is negligible so that the increase in real GDP can be closely approximated by RdN. The same assumption applies to a change in the labour endowment: the associated change in real income is approximated as wdL at constant output prices.

for x and y. Since the y sector has the higher labour-resources ratio, the Rybczynski effect implies $x_N > 0$, $y_N < 0$: output expands in the x sector and contracts in the y sector to accommodate the increased natural resource endowment with the labour endowment fixed. The Rybczynski effect is captured by the leftward shift of SS to S'S'. The resulting excess demand for y causes p^y to rise to its new (stable) equilibrium value at p_1^y. Again denoting $(f_y + f_m y^s)$ as B and solving for dp^y in equation (28),

$$dp^y = p^x[f_m R - y_N]\,(y_p - Bp^x)^{-1}\,dN \qquad (29)$$

Provided that $f_m > 0$ (y normal), $y_N < 0$, and $(y_p - Bp^x) > 0$ (stability), $dp^y/dN > 0$ as described. Since p^x is constant and p^y increases, it follows that $d(p^y/p^x)/dN > 0$ and the real wage increases in terms of all three goods (y- and x-sector goods and imports).

The final equilibrium impact on output in the y sector can be found by totally differentiating the y-sector supply function (3) with L and T constant:

$$dy^s/dN = y_p\,d\,(p^y/p^x)/dN + y_N \qquad (30)$$

Since $y_p > 0$ and $d(p^y/p^x)/dN > 0$ while $y_N < 0$, the sign of dy^s/dN is ambiguous. Again, using Figure 2, final equilibrium output in the y market can lie to the right of its initial equilibrium amount. Thus, although the Rybczynski effect is as expected—that is, $y_N < 0$—the Rybczynski theorem itself does not generalize to the present model. The increased natural resource endowment can increase equilibrium output in the relatively labour-intensive sector and reduce it in the relatively resource-intensive sector when expenditure effects are taken into account.

In the HOS special case, perfect substitution between y goods and imported goods implies $f_y^* = -\infty$. Therefore $B = -\infty$ such that $d(p^y/p^x)/dN = 0$. The DD curve is perfectly elastic in Figure 2 and the leftward shift of SS to S'S' reduces the equilibrium output of y as the Rybczynski theorem implies. In this case though, the real wage rate is constant in the face of increased natural resource endowments. Since the HOS special case does not generate labour market tightness (higher real wages) relative to other regions, it does not offer an explanation for inmigration and long-run expansion in staples-producing regions experiencing increases in their natural resources endowments.

Turning to the effect of labour supply shifts, the effect of an increase in labour supply can be found from equation (11) by holding p_x, N, and T fixed while L rises. Equation (11) then becomes

$$(f_y + f_m y^s)\,dp^y + f_m(p^x x_L + p^y y_L)\,dL = y_p d\,(p^y/p^x) + y_L dL \qquad (31)$$

which indicates the market-clearing y-sector response to a change in the labour endowment. In accordance with the Rybczynski effect, $x_L < 0$ and $y_L > 0$. The term $f_m(p^x x_L + p^y y_L)dL$ is the initial expenditure effect on the y market due to the increased labour endowment. Analogous to the previous discussion (see note 4), set $(p^x x_L + p^y y_L)dL = wdL$ to obtain

$$(f_y + f_m y^s)\, dp^y + f_m w dL = y_p d(p^y/p^x) + y_L dL \qquad (32)$$

According to the y-sector supply and demand conditions illustrated in Figure 3, the DD curve shifts to D'D' as a result of the expenditure effect associated with the increased endowment of labour ($f_m wdL$). Since $y_L dL > 0$, the Rybczynski effect shifts SS to the right to S'S' in Figure 3. In the absence of further restrictions, excess demand could be positive or negative at the initial equilibrium price p_0^y. It is negative if $f_m w - y_L < 0$. In this case, inward labour migration lowers the relative price of y goods ($p_1^y < p_0^y$) and real wages, a result that is consistent with the general neoclassical approach to migration in which interregional or international movements of labour are self-limiting through their induced real wage effects. If, however, $f_m w - y_L > 0$, the market-clearing equilibrium in Figure 3 would imply an increase in p^y. The consequence would be an increase in the real wage and an inducement to further inward migration. The migration-real wage feedback process then becomes unstable. Two effects are operating here: (1) the increased labour supply is expanding outputs of labour-intensive goods and reducing their prices, which puts downward pressure on regional real wages, and (2) at the same time, the new migrants are earning incomes (wdL) and undertaking expenditures ($f_m wdL$) that place upward pressure on the prices of labour-intensive goods and regional real wages. Notice that neither of these effects operate in the HOS special case: neither the supply-side Rybczynski effect nor the demand-side effect has any impact on y-sector prices since y goods are perfect substitutes for fixed-price imports.

To establish that an increase in a region's labour supply lowers its real wage in this model, it is essential that $f_m w - y_L < 0$. This condition is equivalent to the requirement $f_m p^y - (p^y y_L/w) < 0$. Since $f_m p^y$ is the marginal propensity to spend real income on y-sector goods, it is reasonable to assume that $f_m p^y < 1$. Since $p^y y_L + p^x x_L \equiv w$ (see note 4) and $p^y y_L > 0$ and $p^x x_L < 0$, it is also reasonable to assume that $(p^y y_L/w) > 1$. Thus, a reasonable expectation is that $f_m p^y - (p^y y_L/w) < 0$, as required for stability.[5]

5. Despite the *prima facie* case made here for stability in the real wage-migration process in the present model, it should be noted that this type of model makes no provision for induced regional investment expenditures. The conditions set out above are static in the sense that full adjustment of the regional capital stock is simply assumed to have occurred. While the region is adjusting to a previous (expansionary) shock, investment expenditures act to increase the demand for y goods. If these investment expenditures augment equation (1), the demand for y-sector goods will be increased along the adjustment path. The enlarged demand for y-sector goods will, in turn, place additional upward pressure on real wages and migration. Depending on the way expectations are modelled in determining investment and migration, as well as on the other parameters of the model, there can be scope for "overshooting". In a growth context, there would be a permanent demand for y-sector goods on account of capital investment. It is at least logically possible for a regional growth and migration process to continue at a real wage that is sufficiently high relative to the real wage in other regions to stimulate continuing inmigration. This is a case of self-sustaining regional growth. The plausibility of such self-sustaining investment-led growth was debated by North (1955, 1956) and Tiebout (1956a, 1956b) in which North defended export-led regional growth rather than endogenous investment-led regional growth. If North's view is correct, self-sustaining growth is unlikely at the regional level because of the magnitude of regional import leakages. As Hartman and Seckler (1967) pointed out in a subsequent model, the smaller the region, the smaller is f_m and the less likely it is that a region can break away from the growth patterns of its trading partners. The upside of this dependence is that regions are not vulnerable to independent cumulative collapse as a result of adverse expenditure shocks.

Improvements in Regional Efficiency

We now turn to the effects of regionally-specific efficiency changes. The efficiency index (T) is an omnibus shift parameter modelling Hicks-neutral productivity changes. Assuming $dp^x = dL = dN = 0$, equation (11) becomes

$$(f_y + f_m y^s)dp^y + f_m dm^* = y_p d(p^y/p^x) + y_T dT \qquad (33)$$

where $dm^* = (p^x x_T + p^y y_T)dT > 0$ from (4). Substituting for dm^* and solving for dp^y/dT,

$$dp^y/dT = p^x[-y_T(1 - f_m p^y) + f_m x_T p^x](y_p - Bp^x)^{-1} \qquad (34)$$

Suppose the efficiency improvement is in the y sector. At constant relative output prices, x-sector output declines and y-sector output rises ($x_T < 0$ and $y_T > 0$) as illustrated in Figure 1. The y-market stability condition is $(y_p - Bp^x) > 0$ from the first section of this article. Following the stability discussion of the previous section, assume $f_m p^y < 1$. Thus, $dp^y/dT < 0$ in equation (34).

Figure 3 can be used once again to illustrate the results. SS shifts to the right to S'S' because of the increase in y^s ($= y_T dT$). DD also shifts to the right to D'D' because of the expenditure effect on y^d: the size of this shift is $f_m(p^x x_T + p^y y_T)dT$.[6] Since $f_m p^y < 1$ and $x_T < 0$, the rightward shift of SS exceeds the rightward shift of DD, leaving excess supply in the y market at the initial price p_0^y. The equilibrium price falls from

6. It is being assumed here that the change in output composition at constant relative prices leads to a negligible change in the capital stock owned by non-residents so that dm^* measures the change in GNP in the region as indicated in note 1.

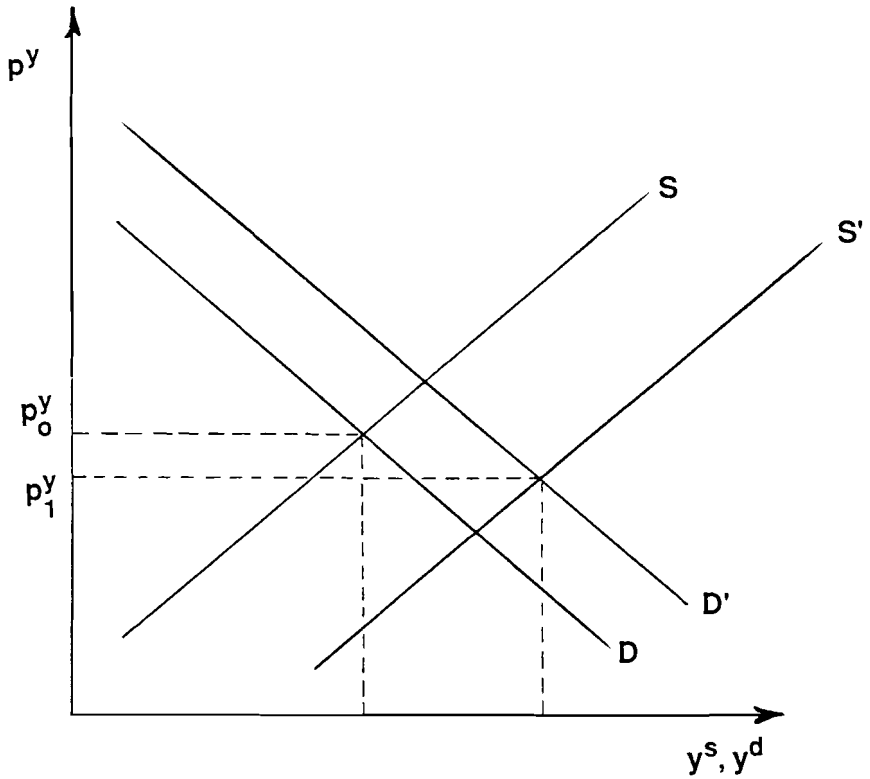

FIGURE 3 Increased labour endowment *or* y-sector productivity increase

p^y_0 to p^y_1. Notice that a large expenditure effect leads to a smaller decline in p^y.

The final impact of the efficiency change in the y sector on the real wage can be obtained by including T as the efficiency index in the y-sector zero-profit condition (18). The y-sector zero-profit condition becomes

$$p^y = (a^y w + b^y R + c^y r)/T \tag{35}$$

where a^y/T, b^y/T, and c^y/T incorporate the Hicks-neutral productivity index T. Totally differentiating zero-profit equations (17) and (35) with $dp^x = 0$,

$$dw/dT = -b^x (p^y + T\,dp^y/dT)/D \tag{36}$$

Since, from (41), $dp^y/dT < 0$ for an efficiency improvement in the y sector, the sign of the real wage change is ambiguous in (36). At constant prices, $dT > 0$ raises the real wage, as indicated in (36) by setting $dp^y/dT = 0$. As expected, the efficiency improvement in the relatively labour-intensive y sector raises the real return to labour at constant output prices. But the efficiency improvement also leads to an excess supply of y (Figure 3), which tends to reduce p^y. By itself, a fall in p^y reduces the real wage. In the standard HOS model, the latter effect is absent because of the perfect substitution assumption (p^y fixed). The likelihood that a productivity improvement in the y sector will increase the regional real wage is enhanced when f_m (the regional propensity to consume y-sector goods) is high and when y-sector goods are fairly close substitutes for similar goods produced outside the region (B is large negative). Both of these characteristics tend to prevent large declines in p^y as a result of the additional output in the y sector.

When the productivity improvement occurs in the x sector, equation (17) is replaced by

$$p^x = (a^x w + b^x R + c^x r)/T \tag{37}$$

Totally differentiating equations (18) and (37) with $dp^X = 0$,

$$dw/dT = (b^y p^x - b^x\,dp^y/dT)/D \tag{38}$$

The real wage declines as a result of an efficiency improvement in the resource-intensive x sector with prices constant, as expected. But $dp^y/dT > 0$ in this case, again producing an ambiguous result since the increase in y-sector prices, taken alone, raises the real wage. The likelihood that a productivity improvement in the x sector will increase the real wage is enhanced for a high value of f_m and when y-sector goods are relatively poor substitutes for similar goods produced outside the region (B is small negative). More important, note that a small value for b^y (see the discussion in "Terms of Trade and Regional Real Wages") virtually ensures that $dw/dT > 0$.

Clearly, the comparative statics of productivity changes are significantly influenced by expenditure effects. Imperfect substitution dampens real wage changes associated with productivity improvements biased toward either sector, in the sense that improvements biased toward the (labour-intensive) y sector may actually lower real wages because of endogenous relative price changes (p^y/p^x falls), while improvements biased to the natural resource-intensive x sector could raise real wages because of endogenous relative price changes (p^y/p^x rises). Note that simultaneous productivity improvement in both sectors and biased to neither will generate real

expenditure effects that raise p^y/p^x, leading to a further increase in the real wage. Referring to equations (35) and (37), a sectorally unbiased Hicks-neutral improvement in productivity is equivalent to equiproportional declines in p^x and p^y with no change in w and R. The real wage and real resource rent increase in the same proportion. The economy's transformation frontier shifts outward radially, and the implied increase in real income (dm^*) leads to a rightward shift in DD in the y sector through expenditure effects, which in turn increase p^y/p^x, leading to an additional positive impact on the regional real wage.

In summary, Hicks-neutral productivity improvements in the resource-exporting region's y sector are likely to raise real wages, but the effect is dampened and could be reversed if y-sector prices decline significantly as a result of the increased output of y goods. The decline in y-sector prices will be less if there are strong real expenditure effects in the region resulting from the productivity advance and if at least some y goods are close substitutes for importables. Productivity improvements in the natural-resource exporting sector tend to lower real wages, but this effect will not be large if natural resources enter y-sector production to an insignificant degree and will likely be overwhelmed by positive expenditure effects in the y sector (unless y-sector prices are tied very closely to the prices of importables). Unbiased productivity advances in both sectors raise the real wage, partly because the real returns to all factors in the region are increased and partly because of y-sector expenditure effects.

Linkages and Long-run Adjustment

The comparative static results in the previous sections can be tied together to construct a more flexible, realistic approach to long-run regional adjustment than the strict HOS model permits. Removal of the assumption that y-sector goods are perfect substitutes for imports grants a degree of regional autonomy to the y sector. The result is that exogenous changes in the natural resource-exporting region's terms of trade, supplies of natural resources and labour, and relative productivity have more complex impacts on the region's real wage relative to other regions than in the HOS model. The use of the real wage as the pivotal variable in the discussion reflects two aspects of regional analysis: (1) discussion of regional disparities usually focuses on labour market conditions, and (2) regional labour supplies are partly endogenous through migration processes that are sensitive to regional labour market variables.

Improvement in the resource-exporting region's terms of trade or an increase in its natural resource endowments can produce long-run increases in its real wage relative to that of other regions, given the region's endowments of labour and resources. These real wage results depend crucially on regionally specific expenditure effects and cannot be obtained from the strict HOS case. Expenditure-induced real wage increases in the region act as a migration signal. As inmigration gets under way, the economy's labour endowment expands and triggers rightward shifts in both the supply and demand curves for the region's y-sector goods. The rightward shift in the supply of y-sector goods reflects the impact of the region's increased labour supplies through the Rybczynski effect. The rightward shift of the demand curve reflects migration-induced expenditure effects in the region caused by the extra income earned by inmigrants. If migration is fairly sensitive to real wage differentials and y-sector expenditure effects are important, the initial terms of trade or resource endowment shock can lead to a substantial increase in regional size before real wages are brought back to the vicinity of real wages in other regions.

Expenditure effects play a double role in long-run adjustment processes. The first expenditure effect is captured by the initial y-sector demand shift stemming from the exogenous terms-of-trade or resource endowment shock. The second type of expenditure effect is the migration-induced one, which shifts the regional y-sector demand curve upward when the regional labour force expands because of inmigration or vice versa. When the real wage moves back to the vicinity of the real wage in other regions, both expenditure effects will have been incorporated as increases in the final equilibrium value of y-sector output.

Indeed, one of the most important differences between the regional adjustment process in this model and that of the strict HOS model lies in this long-run positive response of the size of the y sector to favourable shocks. In the standard HOS model, by contrast, the y sector actually contracts as a result of an increase in the prices of exportables or an increased natural resource endowment and there is no incentive for inmigration. Balanced expansion of exportables and y-sector activities is the type of complementarity typical of multiplier-style models of regional growth. In the present model, complementarity is the result of migration responses that occur within a basically neoclassical structure (also see Anderson 1976; Merrifield 1987). The price system acts to translate exogenous shocks into changes in relative commodity and factor prices within a trading region operating with fixed endowments of labour and natural resources. The resulting change in the real wage then operates to increase or decrease the trading region's labour "endowment" through migration responses.

If migration is highly elastic to interregional real wage differentials, the long-run size of a regional economy is driven largely by expenditure effects stemming from imperfect substitution between the region's y-sector goods and goods produced outside the region. At the same time, long-run real wages in any individual region can still be closely linked to real wages in other regions through interregional labour movements (Allen 1986).

The presence of expenditure effects, though, means that a fair amount of migration may be needed to eliminate shock-induced regional real wage differentials since each movement of labour into or out of the region shifts the region's y-sector demand curve in the same direction as the migration movement.[7] Regional real wage disparities could emerge and persist when specific areas in the interregional system experience adverse terms-of-trade shifts, relatively slow advances in productivity, or declining natural resource stocks, combined with sluggish outmigration of labour in response to interregional real wage differentials. Because outward movements of migrants generate adverse migration-induced expenditure effects, lagging regions may require a great deal of outmigration and downsizing to restore real wage parity (also see Polèse 1981). With slow outmigration responses and significant migration-induced expenditure effects, it is not surprising that wage disparities and other indicators of slackness in regional labour markets can persist over such lengthy periods of time.[8]

In addition to the real wage-migration link, the present framework is useful in analyzing the effects of connections between regional efficiency and migration or regional size. Suppose a larger y sector implies agglomeration economies that lead to y-sector productivity increases. Growth of the region also could lead to new entrepreneurial strength and innovations, resulting in higher productivity (the so-called Verdoorn law). These regionally-specific efficiency improvements could increase the region's real wage, depending on the sectoral composition of efficiency improvements and

7. The Alberta expansion of the 1970s involved wage gains in the province of 10-15 percent compared with those of Ontario, accompanied by inmigration that increased Alberta's labour force by nearly 30 percent (Anderson 1988: 171). Judging by the relatively balanced expansion of all sectors in Alberta over the decade, migration-induced expenditure effects must have been considerable (also see Norrie and Percy 1984).

8. Note that the model developed here shares the simple inelastic labour supply property of the HOS model. Workers supply the entire regional labour "endowment" independently of the regional real wage. It is, of course, possible to add more realistic labour supply behaviour to the model, leading to the prediction that lagging regions will experience higher long-run unemployment rates than those in other regions—see, for example, Anderson (1988: 64-73) and accompanying references.

accompanying expenditure effects (see the previous section "Improvements in Regional Efficiency"). Any real wage increases stemming from efficiency improvements in turn feed back into additional migration and further growth. In some cases, efficiency improvements in the y sector might be large enough to permit significant penetration of export markets. Increasing export activity in the y sector diversifies the region away from its natural resource export orientation. Just how much y-sector success leading to export diversification can be expected as a long-run result of resource-based export growth is a crucial but largely unresolved question (Economic Council of Canada 1984; Mansell 1985; Scarfe 1985).

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