

THE PEDAGOGY FOR TEACHING INTERREGIONAL INCOME DETERMINATION FOR INTERDEPENDENT ECONOMIES

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Introduction

For more than a half century the Hicks-Hansen IS-LM paradigm has been a resilient pedagogical tool for teaching macroeconomic relationships, although it generally has not been used to teach regional economic relationships per se. A commodity market generally is specified from which an IS curve is derived; then a money market is specified from which an LM curve is derived. The IS curve typically is represented (although not always) as negatively sloped, whereas the LM curve typically is represented as positively sloped. Synthesizing the two markets (curves) generates a general equilibrium for the system. Various monetary and fiscal policies then are examined within such a framework. In addition, researchers often have couched empirical studies of the effects of various government policies, such as deficit spending within such frameworks.

As a rule, the IS-LM model is nested within the context of a *small country case* (a situation in which the effects of changes within the country do not spill into other economies in such a way as to significantly affect those economies and thereby cause feedback effects). That is, if country 1 experiences economic growth, its imports from country 2 may increase but not enough to raise country 2's income sufficiently to create a feedback that would influence country 1's income in a significant way. Thus, country 1's economy is so small that it has negligible effects on other economies, which in turn do not significantly impact country 1's economy.

But in the reality of regional economic systems within the same nation, feedbacks are common because regional economies tend to be linked significantly through export-import relationships (Siebert, 1969; Hoover and Giarratani, 1984), through financial markets (Barth, 1991; Cebula and Zaharoff, 1974), or through other mechanisms (Vedder, 1976). There are many varieties of spillovers and subsequent feedback effects between regional systems. Although such relationships can be represented in a proximal fashion mathematically, mathematics can fail to provide the regional economics student with a comprehensible picture and fundamental appreciation of the economic interrelationships between regions.

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Regional economics textbooks and related teaching materials generally do not treat regional income determination in a way that meaningfully reflects interregional feedbacks and spillovers; rather, they typically use a simple open-economy, small country case Keynesian model to reflect the determination of income within a region (Nourse, 1968; Richardson, 1969). Alternatively, the determination of a region's income is treated mathematically in way that is beyond the comprehension of many undergraduate students, even advanced undergraduates (Siebert, 1969).

The present paper argues that the basic IS-LM framework can be recast to provide the regional economics student with a straightforward picture of regional income determination and interregional economic interdependence, complete with both economic spillovers and feedbacks. This note seeks to develop such a framework, which we argue will be able to demonstrate interregional economic interdependence, spillovers, and feedbacks to the student without the use of relatively complex mathematics beyond the scope of many undergraduate students. The analysis provided below is aimed at students in advanced undergraduate or beginning graduate regional economics courses.

A Simple Model

Let the economy consist of two interdependent regions, region 1 and region 2. These two regions are economically interdependent in both the commodity and financial markets through import-export relationships and through interregional flows of loanable funds. We assume perfect interregional capital mobility: over time, interregional interest rate differentials elicit flows of funds that continue until the incentive to move between the regions is eliminated (i.e., until the interest rate differentials are eliminated). International economic relations are not included in the model in the interest of simplicity; they easily could be, although at the risk of making the model cumbersome.

In region 1, the level of aggregate income (Y_1) is equal in equilibrium to the sum of region 1's aggregate consumer spending within region 1 by region 1's inhabitants (C_1) plus aggregate investment in new plant and equipment within region 1 (I_1) plus local government outlays within region 1 (L_1G) plus federal government outlays within region 1 (F_1G) plus exports from region 1 to region 2 (X_{12}) minus imports from region 2 into region 1 (R_{21}). This commodity market equilibrium condition is given in equation (1):

$$(1) Y_1 = C_1 + I_1 + L_1G + F_1G + X_{12} - R_{21}.$$

Following the usual analysis of macroeconomic relationships, it is expected that consumer spending in region 1 (C_1) is related directly to the level of aggregate disposable income in region 1 (Y_{d1}) and related

inversely to the interest rate prevailing in region 1 (i_1), whereas investment in region 1 (I_1) is related inversely to the region 1 interest rate:

$$(2) C_1 = C_1(Y_{d1}, i_1), \quad 1 > C_{1Y_{d1}} > 0, \quad C_{1i_1} < 0$$

$$(3) I_1 = I_1(i_1), \quad I_1'(i_1) < 0.$$

where subscripts represent partial derivatives.

In addition, consistent with traditional macroeconomic analysis, it is expected that local government outlays in region 1 (L_1G) and federal government outlays in region 1 (F_1G) are both exogenous:

$$(4) L_1G = L_1G_0$$

$$(5) F_1G = F_1G_0.$$

Next, also consistent with conventional macroeconomic analysis, it is hypothesized that region 1's imports from region 2 (R_{21}) are related directly to region 1's aggregate income (Y_1) and that region 1's exports to region 2 (X_{12}) are related directly to region 2's aggregate income (Y_2), such that:

$$(6) X_{12} = X_{12}(Y_2), \quad 1 > X_{12}'(Y_2) > 0$$

$$(7) R_{21} = R_{21}(Y_1), \quad 1 > R_{21}'(Y_1) > 0.$$

The IS curve for region 1 corresponding to equations (1) through (7) above is given in the left panel of Figure 1. The IS curve (IS_1 in this instance) is shown to be downward sloping.

The financial market for region 1 is represented in equations (8) through (10). In this market, the supply of funds/money available within region 1 (SF_1) is equal to the demand for funds/money from within region 1 (DF_1) in equilibrium:

$$(8) SF_1 = DF_1.$$

In this market, the supply of funds within region 1 (SF_1) consists of an exogenous (public policy) component (S_1) and an endogenous component ($SF_1(i_1, i_2)$). With respect to the latter, an increase in region 1's interest rate (i_1), *ceteris paribus*, induces an increase in the supply of available funds from within region 1 (as the opportunity cost of holding idle funds increases) and also attracts funds into region 1 from region 2, as the owners of said funds send those funds to the area offering the highest return (interest rate). Similarly, as the interest rate in region 2 (i_2) rises, *ceteris paribus*, the supply of funds available within region 1

declines (as the owners of those funds send them to region 2, where a higher rate of interest can be earned):

$$(9) SF_1 = S_1 + SF_1(i_1, i_2), SF_{1i_1} > 0, SF_{1i_2} < 0.$$

Finally, in accord with conventional macroeconomics, the demand for funds from within region 1 (DF1) is related directly to region 1's aggregate income (Y1) and related inversely to region 1's interest rate:

$$(10) DF_1 = DF_1(Y_1, i_1), DF_{1Y_1} > 0, DF_{1i_1} < 0.$$

The money market equilibrium curve (LM curve) for region 1 is given in the left panel of Figure 1 by curve LM1'. In accordance with standard macroeconomic analysis, this curve is positively sloped.

Region 2's economy is constructed in a parallel fashion to region 1's. In the case of region 2, Y2 is the aggregate income in region 2, C2 is aggregate consumption within region 2 by region 2 inhabitants, I2 is aggregate investment in new plant and equipment within region 2, L2G is local government outlays in region 2, F2G represents federal government outlays in region 2, X21 is exports from region 2 into region 1, R12 is imports from region 1 into region 2, SF2 is the supply of available funds in region 2, S2 is the exogenous component of SF2, and DF2 is the demand for funds in region 2.

The commodity market for region 2 is given by:

$$(11) Y_2 = C_2 + I_2 + L_2G + F_2G + X_{21} - R_{12}$$

$$(12) C_2 = C_2(Y_{d2}, i_2), 1 > C_{2Y_{d2}} > 0, C_{2i_2} < 0$$

$$(13) I_2 = I_2(i_2), I_2'(i_2) < 0$$

$$(14) L_2G = L_2G_0$$

$$(15) F_2G = F_2G_0$$

$$(16) X_{21} = X_{21}(Y_1), 1 > X_{21}'(Y_1) > 0$$

$$(17) R_{12} = R_{12}(Y_2), 1 > R_{12}'(Y_2) > 0.$$

The IS curve for this region initially is provided in the right panel of Table 1 by the negatively sloped curve IS2'.

Similarly, region 2's financial market is constructed in a parallel fashion to region 1's and is described by:

$$(18) SF_2 = DF_2$$

$$(19) SF2 = S2 + SF2(i1, i2), SF2_{i1} < 0, SF2_{i2} > 0$$

$$(20) DF2 = DF2(Y2, i2), DF2_{Y2} > 0, DF2_{i2} < 0.$$

The LM curve for region 2 is provided in the right panel of Figure 1 by curve LM2'. LM2' is positively sloped, in accordance with the conventional wisdom.

Combined, the right and left panels of Figure 1 represent the jointly determined full general equilibrium among the markets in the two interdependent economies. Region 1 is in equilibrium at $(Y1', i1')$ at the intersection of curves IS1' and LM1'. Region 2 is in equilibrium at $(Y2', i2')$ at the intersection of curves LM2' and IS2'. Given perfect capital mobility, $i1' = i2'$ in a state of full equilibrium.

The key to this system is the interdependence between the regions, as reflected in large measure by the interdependence of the IS and LM curves. Thus, for example, a change in $Y2$ shifts the IS curve in region 1:

- As $Y2$ rises, IS1 shifts to the right as region 2 imports more from region 1;
- As $Y2$ declines, IS1 shifts to the left as region 2 reduces its imports from region 1.

Naturally, changes in region 1's income will exercise similar effects on region 2:

- As $Y1$ rises (falls), region 2's IS curve shifts to the right (left) as region 1 imports more (less) from region 2.

In the financial markets, interregional linkages shift the LM schedules. For instance, if $i2$ rises (starting from an equilibrium state), funds move from region 1 to region 2. This shifts LM1 to the left and LM2 to the right. Alternatively, if $i1$ rises (starting from an equilibrium state), funds move from region 2 to region 1, shifting LM1 to the right and LM2 to the left.

Finally, we observe that this analysis treats the interest rate within each region as being at least partially endogenous. Such endogeneity is suggested in the literature (Barth, 1991; Belton and Cebula, 1993; Cebula and Zaharoff, 1974; Chou, *et al.* 1994) and in the data sources (OTS, 1989).

An Application

To illustrate the use (application) of this model, consider Figure 2, where the economy is initially in equilibrium at point A with coordinates $(Y1', i1')$ for region 1 and at point A' with coordinates $(Y2', i2')$ for region 2 with perfect capital mobility so that $i1' = i2'$. To provide the student with a proximal grasp of economic spillovers and feedbacks, let the exoge-

nous level of federal government spending in region 2 (F2G) rise from F2G0 to F2G1. This policy initially shifts IS2 from IS2' to IS2".

Region 2 initially moves toward a higher interest rate (i_2'') and a higher income level (Y_2''). The rising income level in region 2 results in increased imports into region 2 from region 1. This increased importing by region 2 in turn shifts the IS schedule in region 1 to the right, say, from IS1' to IS1". This change (increase) in region 1's exports to region 2 is equal to:

$$R_{12}'(Y_2) \times (Y_2'' - Y_2')$$

Region 1's IS schedule shifts to the right by the amount

$$R_{12}'(Y_2) \times (Y_2'' - Y_2') \times (\text{region 1' simple spending multiplier}).$$

At the same time, the rising interest rate level being generated in region 2 acts to attract funds from region 1, thereby shifting curve LM1' to the left and curve LM2' equally to the right.

The nature and extent of subsequent economic feedbacks will depend on whether the new IS-LM intersection in region 1 lies to the right, above, or to the left of income level Y_1' . If the new IS1-LM1 intersection lies to the right of Y_1' , then the increased income in region 1 will stimulate imports from region 2 into region 1, thereby further shifting the IS2 schedule to the right of IS2". As region 2's income grows, imports from region 1 to region 2 will grow further, shifting the IS1 curve still further to the right (of IS1"). The final outcome will involve interest rates

$$i_1^* = i_2^* \text{ such that } i_2'' > i_1^* = i_2^* > i_1' = i_2'.$$

In region 1, the final outcome likely will lie within the boundaries of triangle ABC. That is, given the assumption that the new IS1 = LM1 intersection lies at an income level in excess of Y_1' , that the final equilibrium IS1 - LM1 intersection must lie below i_2'' and above i_1' (which = i_2'), and that the final LM1 curve must lie to the left of LM1', the final solution for region 1 likely will be within the area bounded by ABC.

In region 2, the final solution under these conditions lies at an interest rate i_2 between i_2' and i_2'' , along an IS curve to the right of IS2", and along an LM curve to the right of LM2'; most likely, this final equilibrium will lie within the shaded area in the right panel of Figure 2.

Extensions

The model could be extended to allow for interregional interest rate differentials resulting from perceived risk differentials, information costs, lock-in effects of capital gains taxation, and other impediments to perfect capital mobility. Such an analysis could be couched within the

context of a mobility cost constraint, such as that found in the studies by Gatons and Cebula (1972) and Gallaway and Cebula (1973). Moreover, with modifications, such a framework could be useful in helping to demonstrate potential effects of international trade agreements, such as a NAFTA.

References

1. Barth, James R., *The Great Savings and Loan Debacle* (Washington, D.C.: AEI, 1991).
2. Belton, Willie J., and Richard J. Cebula, *Crisis in Commercial Banking* (Dubuque, IA: Kendall/Hunt Publishing Co., 1993).
3. Cebula, Richard J., and Mik Zaharoff, "Interregional Capital Transfers and Interest Rate Differentials," *Annals of Regional Science* (February 1974).
4. Chou, Raymond Y, Richard J. Cebula, and William Schaffer, "Determinants of Geographic Differentials in the Savings and Loan Failure Rate," need name of publication in which this appeared (1994).
5. Gallaway. Lowell, and Richard J. Cebula, "Differentials and Indeterminacy in Wage Rate Analysis: An Empirical; Note," *Industrial and Labor Relations Review* (April 1973).
6. Gatons, Paul K., and Richard J. Cebula, "Wage Rate Analysis: Differentials and Indeterminacy," *Industrial and Labor Relations Review* (January 1972).
7. Hoover, Edgar, and Frank Giarratani, *An Introduction to Regional Economics*, 3rd ed. (New York: Alfred Knopf, 1984).
8. Nourse, Hugh, *Regional Economics* (New York: McGraw-Hill, 1968).
9. Office of Thrift Supervision, *Savings and Home Financing Source Book* (Washington, D.C.: U.S. Government Printing Office, 1989).
10. Richardson, Harry W., *Elements of Regional Economics* (Baltimore, MD: Penguin Books, 1969).
11. Siebert, Horst, *Regional Economic Growth: Theory and Policy* (Scranton, PA: International Textbook Co., 1969).
12. Vedder, Richard K., *The American Economy in Historical Perspective* (Belmont, CA: Wadsworth Publishing Co., 1976).

Figure 1—Interregional Equilibrium

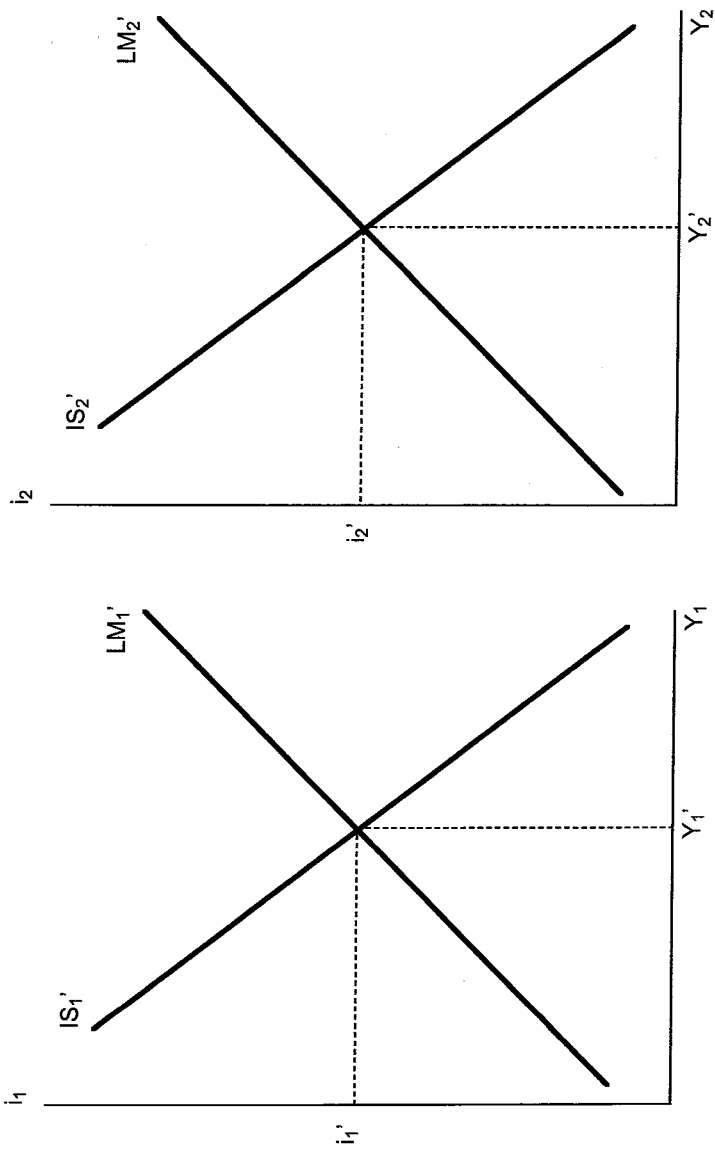
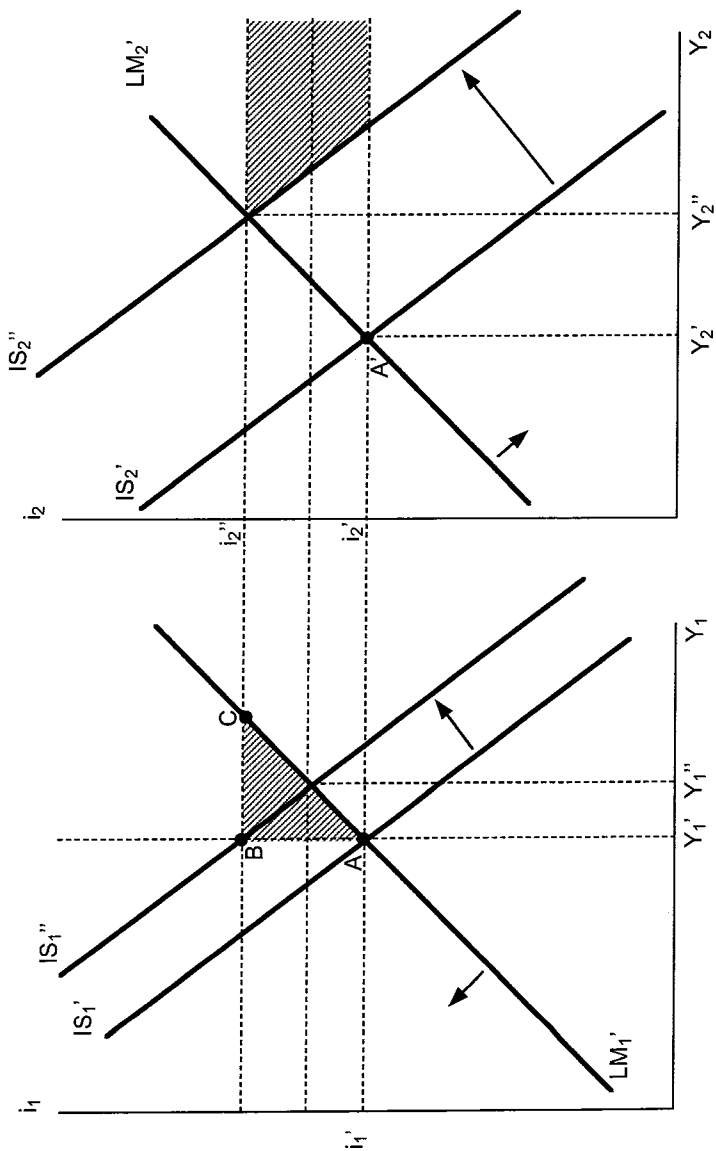


Figure 2—Interregional Responses



PEDAGOGY

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