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Monetary and Exchange Rate Arrangements for NAFTA

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Abstract

This paper considers the extent to which the North American Free Trade Area (NAFTA) meets the criteria for a common currency area. NAFTA is compared with the EC, a regional grouping for which initial plans for a monetary union are already in place. Most of the anticipated benefits from a monetary union in the EC apply with equal force to NAFTA. However, because the underlying disturbances are more diverse across members of NAFTA, the costs of abandoning the exchange rate instrument are likely to be higher. This is particularly true when NAFTA is compared to the EC's continental core.

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1/ International Monetary Fund and the University of California at Berkeley and NBER, respectively. An earlier version of this paper was given at the Interamerican seminar on Macroeconomics at Buenos Aries, May 7-9, 1992, and is forthcoming in the Journal of Development Economics.

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Summary

This paper considers the advisability of having a single currency across the North American Free Trade Area (NAFTA)--comprising the United States, Canada, and Mexico--through the dual lenses offered by the theory of optimum currency areas and the experience of the European Community (EC). In the EC, the Single Market Program has created growing momentum for deeper economic integration, of which a single European currency is regarded as an integral part. In North America, by contrast, the debate over economic integration has barely touched on altering current monetary arrangements.

In principle, the paper finds that the European Commission's argument that reaping the full benefits of economic integration requires firmly fixed exchange rates, and ultimately a single currency for Europe, applies with equal force to North America. But the benefits of permanently fixing the exchange rate must be weighed against the costs of relinquishing it as an instrument of adjustment. To gain insight into these comparative costs, the paper analyzes the incidence of supply and demand disturbances to different North American regions and EC member countries.

The analysis suggests that the costs of truly fixed exchange rates (or monetary union) are likely to be higher for North America than for the EC's continental core (Germany, France, Belgium, the Netherlands, and Denmark). Even when the entire EC is used for the comparison, the negative correlation of underlying shocks in Mexico with those to the industrial regions of the United States, and the exceptionally large magnitude of Mexico's shocks, suggest that Mexico would incur higher costs than Southern Europe from a rigid currency link. This, the authors suggest, reflects the importance of petroleum production in the Mexican economy.

Of course, energy production is also important to the South Western United States and to Western Canada. The correlation between their shocks and those to their respective currency areas is also strikingly low, which is where other elements of optimum currency area theory come into play. Labor mobility between the South West and the rest of the United States and between Western and Eastern Canada is high and accompanied by relatively little social and political strain. Similarly, the United States and Canada both possess highly articulated systems of fiscal federalism that work to minimize the dislocations caused by region-specific shocks. While fiscal federalism is under active discussion in the EC, the creation of such institutions at the North American level has not been broached in NAFTA negotiations. For all these reasons, the paper concludes that North America is less of an optimum currency area than the EC.

I. Introduction

In a series of recent articles (e.g., Cooper, 1989), Richard Cooper has expounded the case for a single world currency. His point is not that a global currency is feasible or desirable in the foreseeable future, but that policymakers should incorporate into their short- to medium-run monetary plans the likely long-term evolution of international monetary arrangements. In this spirit, the present paper considers the extent to which the North American Free Trade Area comprised of the United States, Canada, and Mexico meets the criterion for a common currency area.

One development motivating this analysis is the trend toward economic integration in Europe. The Single Market Program there has created growing momentum for deeper economic integration, of which a single European currency is regarded as an integral part. In North America, by comparison, the debate over economic integration has been accompanied by virtually no discussion of altering current monetary arrangements. 1/ The contrast between the two approaches is striking. While the difference may reflect the fact that European integration extends to the creation of single markets in capital and labor as well as commodities, whereas North American economic integration as currently envisaged entails free trade in commodities alone, the possibility that NAFTA may lead eventually to more comprehensive economic integration suggests that it would be useful to analyze the viability of a North American Monetary Union.

This is not the first time the issue of monetary arrangements for an integrated North American economy has been raised. In his seminal article on the theory of optimum currency areas, Mundell (1961) suggested that there was a sense in which Eastern Canada and the Eastern U.S. comprised one logical currency area, and that Western Canada and the Western U.S. comprised another. Since there was no prospect of the United States splitting into several distinct currency zones, the implication was that the two countries might as well be combined into a single currency area.

There are two reasons for revisiting this question. First, Mundell's conjecture was never investigated systematically. Second, when Mundell wrote more than 30 years ago, there was no reason to ask whether Mexico might be incorporated into a North American monetary union. The accession of Mexico to the free trade agreement with its neighbors to the north thus opens up a new set of considerations for analysts of currency areas.

1/ Schott and Smith (1988) note that the AFL-CIO and a few other U.S. organizations argued at an early stage in Canadian-U.S. free trade negotiations that an undervalued Canadian dollar was a hidden nontariff barrier, and pressed for eventual 1-1 parity, but these authors conclude that this was an isolated exception to general neglect of the exchange rate issue. A comprehensive recent analysis of Canadian exchange rate policy (Harris, 1991) contains only one reference to the option of fixing the rate and no mention of NAFTA. Similarly, the negotiation and discussion regarding a free trade agreement with Mexico has not elicited much discussion of the exchange rate. We cite a few additional exceptions below.

We show that many of the arguments advanced in Europe that reaping the full benefits of economic integration requires firmly fixed exchange rates, and ultimately a single currency, apply to North American as well. However, we find that the costs of monetary union due to relinquishing the exchange rate as an instrument of adjustment are likely to be higher in North America. Supply shocks are more correlated across European countries than in the different parts of North America. The negative correlation of supply shocks to Mexico with those to the industrial regions of the United States suggests that Mexico would incur higher costs than Southern Europe from a rigid currency link. Thus, we see little prospect for a currency union, even in the very long-run, in North America.

We structure our discussion as follows. Section II reviews the literature on optimum currency areas, relating its concepts to the processes of economic integration underway in North America and Europe. Section III presents new evidence that is relevant for the estimating the costs and benefits of North American monetary integration. It asks whether the evidence supports the notion that Europe comprises a more logical currency area than North America. Section IV, in concluding, asks how future economic integration could alter the costs and benefits of fixed exchanges between the currencies of the three NAFTA partners and ultimately a North American monetary union.

II. After NAFTA

1. Optimum currency area theory and practice

The theory of optimum currency areas is an exercise in weighing the benefits and costs of extending the zone over which monetary uniformity and stability prevail. There has been surprisingly little empirical study of these questions of a sort that would lend itself to systematic cost-benefit analysis. While there is a general view that the costs of changing one national money into another are a source of welfare loss that can be eliminated through currency unification, attempts to quantify these transactions costs yield small numbers that would seem to be dwarfed by the uncertainties and risks associated with the transition. The European Commission (1990), for example, estimates that European monetary unification would eliminate transactions costs amounting to at most 0.4 percent of EC GDP.

Starting with McKinnon (1963), economists have sought therefore to identify other costs of distinct national currencies and of the exchange-rate risk they entail. These arguments, which have been adopted in European Commission (1990), suggest that reaping the full benefits of economic integration requires firmly fixed exchange rates and ultimately a common currency. Without the stability and certainty fixed rates provide, regions will fail to specialize completely along lines of comparative advantage, and economic integration will remain incomplete. Exchange rate uncertainty, it is alleged, discourages trade and investment. McKinnon argued that the adverse effects of this uncertainty are likely to be increasing functions of

the openness of an economy. Yet the vast majority of studies of exchange rate uncertainty and trade find little evidence of an economically important link (see the survey by IMF, 1983, and Gagnon, 1993). Similarly, studies of the relationship between investment and exchange rate volatility (e.g., Kenen, 1979) do not document a statistically significant effect. 1/

The recent literature has also emphasized the advantages of an exchange rate peg as an anti-inflationary commitment mechanism. Much of this literature is based on recent European experience. Once the more inflation-prone countries of Europe committed themselves to pegging their currencies to the deutsche mark, they were forced to reduce inflation to German levels. They were thus able to finesse the time-consistency problem for monetary policy highlighted by Barro and Gordon (1981) and to reign in the inflationary wage demands of unions and other distributional interests (Kydland and Prescott, 1977; Horn and Persson, 1988). However, this commitment to the defense of the exchange rate peg, and hence to price stability, was not always regarded as credible. As will be no surprise to Latin American observers, where the commitment was imperfectly credible (as in Italy) the policy failed to restrain public and private sector wage demands, leading to overvaluation of the exchange rate and difficulties in maintaining internal and external balance (De Grauwe and Gros, 1991; Froot and Rogoff, 1991). The eventual result, at least in the case of Italy, being the recent withdrawal of the lira from the exchange rate system.

These considerations suggest why a single currency might be preferred to pegged exchange rates between distinct national monies. Given the sunk costs of establishing a single currency and the institutional reforms by which it will be accompanied, commitment to it should be regarded as beyond question. If the new European Central Bank charged with issuing the single currency is credibly committed to price stability, nominal income claims should quickly adjust to the new regime. Thus, the advantage of a single currency over pegging the exchange rate to the currency of an inflation-adverse country is greater credibility, since it minimizes scope for altering exchange rate policy in the future. The cost is that it eliminates once and for all exchange rate changes as an instrument of adjustment.

Efforts to gauge this cost have followed Mundell in analyzing the incidence of disturbances. Mundell observed that insofar as two regions experience common disturbances, a common monetary policy response would suffice. Only if disturbances are distributed asymmetrically across countries would the absence of distinct national monies with an adjustable exchange rate between them be a binding constraint. Kenen (1969) sought to make this argument operational by suggesting that more diversified economies are less likely to experience asymmetric shocks. The fact that automobile production (by many of the same firms) takes place on both sides of the U.S.-Canadian border has been taken to imply, for example, that changes in

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1/ Morsink and Molle (1991) present some evidence that the magnitude of intra-European direct foreign investment is affected by currency stability, but the coefficients on the exchange rate variability terms in their investment equations are marginally significant at best.

the U.S.-Canadian exchange rate cannot to contribute importantly to adjustment (Rogoff, 1991). One might conjecture that with the growth of manquiladora industry in Mexico, the same argument might apply.

In efforts to implement this idea, Cohen and Wyplosz (1989), Weber (1990) and Bayoumi and Eichengreen (1993a,b) have all attempted to estimate the incidence of shocks across different European countries more systematically. Not only do they distinguish symmetric from asymmetric shocks for the reasons described above, but they also seek to differentiate temporary from permanent disturbances. There is some disagreement over whether devaluation is of more use for adjusting to temporary or permanent shocks. Some argue that devaluation is superfluous in response to temporary shocks, since governments (or firms and households) can borrow externally to smooth their consumption over time. Others respond that credit rationing or statutory restrictions on borrowing by states constrain this response, so that a devaluation that temporarily reduces real product wages can be useful. 1/ Alternatively it is argued that devaluation is undesirable in response to permanent shocks because a change in the nominal exchange rate can affect real variables only temporarily and a permanent shocks requires a permanent adjustment. To this, the response is that devaluation helps to solve the coordination problems that delay the adjustment of real wages. Our view is that devaluation is of some use as a response to both permanent and temporary disturbances.

Mundell's other condition for minimizing the costs of currency unification was high levels of factor mobility throughout the currency area. Even when shocks are asymmetrically distributed across member countries, their costs (in terms of concentrations of high unemployment) will be minimized if factors of production move fluidly between depressed and booming regions. Practically speaking, the issue hinges on the extent of labor mobility. Eichengreen (1990, Appendix A) shows that for full allocational efficiency modern theories of trade and growth require the mobility of both capital and labor; in practice, labor mobility is likely to be the binding constraint. Blanchard and Katz (1992), in an empirical analysis of U.S. regions, show that capital displays at best a weak tendency to move into depressed regions despite the availability there of idle labor; again, the implication is that the binding constraint is the willingness of workers to move out.

However, as one of us has suggested elsewhere (e.g., Eichengreen, 1992), labor mobility can also generate negative externalities. 2/ If, for example, migrants benefit from their movement but others, such as the residents of the recipient regions, incur costs, perhaps political or social as well as narrowly economic ones, then the more mobile is labor, the less desirable it may be to eliminate the exchange rate as an instrument of adjustment. The negative reaction to east-west migration in the former

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1/ For discussions of this literature, see Bayoumi (1992b), Goldstein and Woglom (1991) and Eichengreen (1992).

2/ A formal treatment of this problem is provided by Straubhaar and Zimmerman (1992).

German Federal Republic following economic and monetary unification in 1990 can be interpreted in this light.

Another strand of literature on European monetary unification emphasizes the need for fiscal federalism within the currency area. Both the U.S. and the Canadian monetary areas operate smoothly, according to this view, because federal tax and expenditure programs transfer resources toward temporarily depressed states. Sachs and Sala-i-Martin (1992) suggest that U.S. fiscal federalism offsets fully a third of a decline in a state's income relative to the national average, automatically providing substantial insurance against regional shocks, and thus substituting for both discretionary policy and interregional. 1/ Bayoumi and Masson (1992) find that larger secular transfers and somewhat smaller regional coinsurance in Canada. By implication, monetary unions which do not possess fiscal mechanisms of this sort will experience more persistent and disruptive regional problems.

2. The empirical context

We now consider the empirical evidence as it bears on these issues. The benefits of fixed exchange rates, as suggested by the literature discussed above, are functions of the trade links between participating economies, their foreign investment links, and their ability to import or export an anti-inflationary commitment. Table 1 shows the openness of the economies of Europe and North America. It suggests that the costs of exchange rate uncertainty on trade are likely to be lower in the latter because trade as a share of income is relatively low for North America in general, and for the U.S. in particular. Table 2 shows similarly that intra-bloc trade is less important in North America than in Europe, suggesting that within-bloc exchange-rate stability or currency unification would be less beneficial. 2/

However, these generalizations disguise variation among the members of both blocs. Measured as a share of either total trade or GDP, trade with the United States is much more important to Canada and Mexico than is trade with its North American partners to the United States. About three-quarters of both Canadian and Mexican merchandise exports go to the U.S., whereas only 18 and 7 percent of U.S. exports are destined for Canada and Mexico, respectively. This suggests that, insofar as exchange rate uncertainty disrupts trade, currency links would be much more beneficial to Canada and Mexico than to the U.S.

1/ Subsequent work has suggested that their estimates should be scaled down: see in particular von Hagen (1992) and Bayoumi and Masson (1992).

2/ Both of these effects reflect the size of the U.S. economy in the North American region, due to which much of its trade takes place between U.S. regions and hence is not recorded in the international trade statistics.

Table 1. Indices of Openness for Different Groups of Economies

	EC	Canada and United States	Canada, United States, and Mexico
Exports/GNP (Merchandise exports FOB)			
1985	0.213	0.071	0.074
1986	0.203	0.071	0.073
1987	0.190	0.071	0.074
1988	0.216	0.082	0.083
1989	0.209	0.085	0.086
Average	0.206	0.076	0.078
Imports/GNP (Merchandise imports FOB)			
1985	0.210	0.096	0.097
1986	0.192	0.102	0.103
1987	0.184	0.101	0.102
1988	0.212	0.104	0.104
1989	0.209	0.104	0.104
Average	0.201	0.101	0.102
Total trade/GNP (Merchandise FOB)			
1985	0.423	0.167	0.170
1986	0.394	0.174	0.176
1987	0.373	0.172	0.176
1988	0.427	0.185	0.187
1989	0.418	0.188	0.190
Average	0.407	0.177	0.180

Source: International Financial Statistics (various issues).

Table 2. Intra-Regional and Inter-Regional Trade in Two Blocs

	Billions of Dollars			Fraction of Total		
	1980	1986	1989	1980	1986	1989
European Community						
Total trade	1,517.7	1,577.9	2,299.5	1	1	1
Of which: Intra-regional trade	768.6	896.7	1,355.0	0.506	0.568	0.589
Trade with rest of world	749.2	681.2	954.5	0.494	0.432	0.415
Trade with East Asia	74.8	99.9	170.7	0.049	0.063	0.074
Trade with North America	132.6	150.9	205.0	0.087	0.096	0.089
North America						
Total trade	639.8	805.5	1,145.1	1	1	1
Of which: Intra-regional trade	207.0	279.5	415.7	0.323	0.347	0.363
Trade with rest of world	432.8	526.0	729.4	0.676	0.653	0.637
Trade from East Asia	116.3	218.3	317.8	0.182	0.271	0.277
Trade from EC	117.5	149.1	206.1	0.186	0.185	0.180

Source: Frankel (1992).

The Mexican and Canadian economies also show significant levels of sectoral diversification. According to Kenen's criterion, the larger-than-average shares of agriculture in Mexico and of construction and energy/mining in Canadian production, shown in Table 3, indicate that sector-specific supply and demand shocks to this economy should have relatively modest macroeconomic repercussions. 1/ Although the differences are small, they suggest that Canada and Mexico, due to their greater sectoral diversification, may sacrifice less than the typical European country by foreswearing the exchange rate as an instrument of adjustment. A qualification to this view is that sectors that are heavily represented may themselves be characterized by unusually large shocks. Another caveat is that particular sectors are concentrated in specific regions within these countries, magnifying the problems created by sectoral shocks. Both points recur in our discussion of the results reported in Section III.

The benefits of fixed exchange rates are also an increasing function of the impact of exchange rate uncertainty on investment. McLeod and Welch (1991a) have suggested that this link has been particularly important for Mexico in that real exchange rate overvaluation has repeatedly provoked investment collapses. Figure 1 displays the investment rate and the real exchange rate for Mexico, and drives home this point. 2/ But if foreign rather than domestic investment is thought to be especially sensitive to exchange rate uncertainty, this consideration is likely to operate more powerfully in Europe, where intra-bloc investment is relatively important (see Table 4).

What of the benefits of the anti-inflationary credibility derived from an exchange rate peg? Canada does not evince problems of price stability of the type which afflicted many members of the EMS in the 1980s. Thus, the importance of this argument in the North American context hinges on the value to Mexico, if any, of importing the Fed's commitment to price stability. That value depends, in turn, on whether the Mexican central bank in fact possesses the independence to pursue policies of price stability on its own. Cuikerman (1992) quantifies the legal independence of central banks. According to his index, the Bank of Mexico is considerably less independent than the Federal Reserve Board or the Bank of Canada, consistent

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1/ A curious feature of these data is the relatively small size of the energy sector in Mexico, despite the general perception of the importance of oil production in the economy. One explanation is that, in a dual economy with a relatively small modern industrial sector, the energy sector may actually be considerably more important in the economy than indicated by the raw data. In addition, the definition of the energy sector includes industries, such as electricity and water, which are relatively small in Mexico. Since our results are consistent with the oil industry being a leading sector in Mexico, we will continue to characterize it as an oil producing economy.

2/ The real exchange rate shown is the CPI-based rate against the U.S., with constituent series drawn from IFS.

Figure 1.

Mexico: Real Exchange Rate and Investment Share of GNP, 1961-90

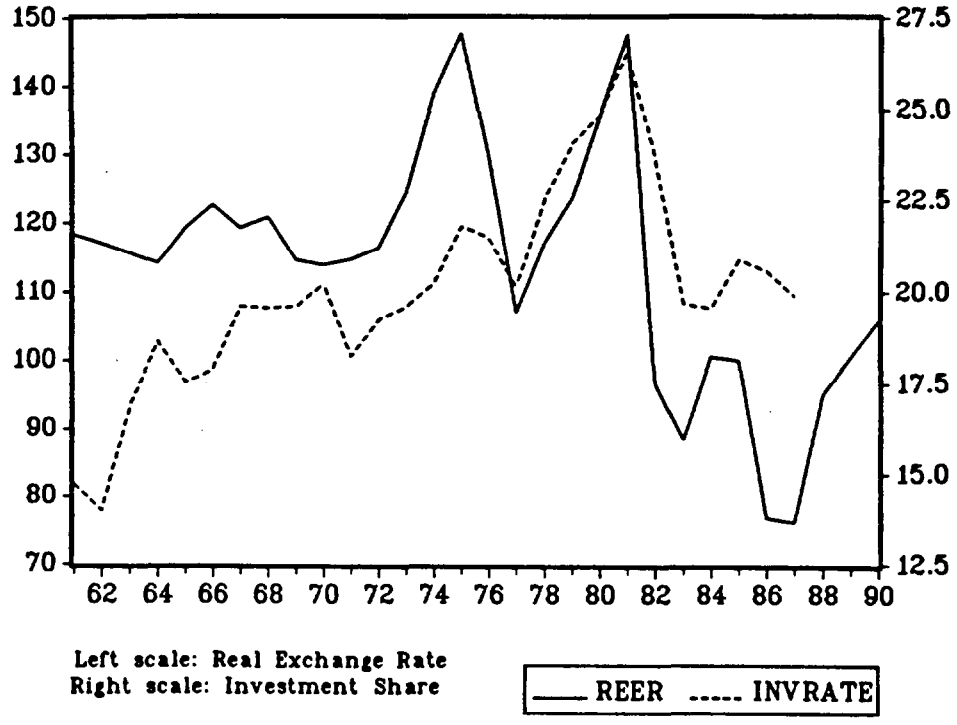

Table 3. Shares of Production by Category: Selected Countries 1/

(In percent)

	Agriculture 2/	Construction	Energy and Mining 3/	Manufacturing	Services
Canada	4.0	7.6	9.0	23.4	56.0
United States	2.3	5.5	5.8	22.2	64.2
Mexico	8.0	3.9	4.4	27.1	56.6
Japan	3.1	8.1	4.2	31.4	53.3
France	4.7	6.6	3.8	27.8	57.0
Germany	2.1	6.1	4.2	38.3	49.4
Italy	5.0	6.7	5.7	27.2	55.5
United Kingdom	2.1	6.7	7.8	27.6	55.9
Belgium	2.5	5.8	4.1	25.4	62.2
Denmark	6.6	8.3	3.0	24.6	57.5
Greece	17.3	7.4	5.1	21.1	49.1
Netherlands	5.2	6.3	9.1	23.4	56.0
Portugal	8.6	6.4	3.6	33.8	47.5
Spain	6.1	7.5	3.4	31.2	51.8

Source: OECD National Accounts and Mexican national data.

1/ GDP at current prices. All data are for 1986, except Mexican data which are for 1988.

2/ Including hunting, fishing, and forestry.

3/ Mining and quarrying (including petroleum and natural gas production), plus electricity generation and gas and water distribution.

Table 4. Intra-Regional and Inter-Regional Investment in Two Blocs

	1984	1985	1986	1987	1988
North America					
Direct investment positions in billions of U.S. dollars					
Outward					
Within North America	70.71	74.19	82.24	95.82	104.58
Outside North America	174.238	191.773	217.183	264.571	284.539
Total	244.948	265.962	299.473	360.391	389.119
Intra as percent of total	29.0	27.9	27.5	26.6	26.9
Inward					
Within North America	70.71	74.19	82.24	95.82	104.58
Outside North America	177.23	195.455	233.312	288.451	329.861
Total	247.94	269.645	315.552	384.271	434.441
Intra as percent of total	28.5	27.5	26.0	25.0	24.0
European-Community 1/					
Within the EC					
Direct investment positions in millions of ECU					
Declared by investing country	-4,265	-6,987	-12,469	-12,646	-19,076
Declared by country receiving investment	4,358	5,666	10,354	11,722	22,976
Outside the EC					
Direct investment excluding intra-community					
Outward	-17,395	-15,349	-22,164	-30,780	-30,711
Inward	6,177	5,637	6,840	12,578	14,278
Direct investment as percent of total EC direct investment					
Declared by investing country	19.69	31.28	36	29.12	38.31
Declared by country receiving investment	61.37	50.12	60.22	48.24	61.67

Sources: U.S. Dept. of Commerce, Survey of Current Business, August issues; and Balance of Payment Statistics, International Monetary Fund.

1/ European Community Direct Investment, 1948-88, Eurostat.

with arguments that it will acquire credibility through an exchange rate peg. At the same time, the Bank of Mexico appears considerably more independent than the central banks of several of the European countries (France, Italy, Belgium, and Spain) said to have benefitted in the 1980s from having imported the Bundesbank's credibility. This suggests that the added benefits of imported credibility accruing from an exchange rate peg may be more modest in North America than in Europe.

This discussion has been couched in terms of fixed exchange rates rather than monetary union, since a common currency is implausible so long as new political institutions comparable to those under construction by the EC are not established in North America as well. 1/ Currency unification in Europe is part of a larger political bargain in which new institutions such as the European central bank will be embedded. Given the North American political context, the relevant question is not currency unification but the potential benefits of fixed exchange rates.

III. The Costs

We turn now to estimating the costs that could be incurred if a fixed exchange rate regime were adopted within North America. As discussed earlier, to the extent that underlying disturbances are symmetrically distributed across regions, the costs of a fixed exchange rate are small; if, however, regional disturbances are relatively idiosyncratic then the costs will be large. Accordingly, we identify and then analyze disturbances across the regions of North America. In order to provide a benchmark, the results for North America are then compared with those for the EC, a region which is actively considering the adoption of a common currency.

1. Methodology

Our methodological point of departure is the familiar aggregate demand and aggregate supply diagram reproduced in Figure 2. The aggregate demand curve (labelled AD) is downward sloping in price-output space, reflecting that lower prices raise real money balances and therefore product demand. The short-run aggregate supply curve (SRAS) is upward sloping, reflecting the assumption that capacity utilization can be varied in the short run to capitalize on the profit opportunities afforded by changes in aggregate demand. The long-run aggregate supply curve (LRAS) is vertical, since capacity utilization eventually returns to its normal level, preventing demand shocks from permanently affecting the level of production.

The effect of a positive demand shock is shown in the left half of the lower panel. As the aggregate demand curve shifts from AD to AD', the short-run equilibrium moves from its initial point E to the intersection of SRAS with AD'. Both output and prices rise. As the aggregate supply curve becomes increasingly vertical over time, the economy moves gradually from the short-run equilibrium D' to the long-run equilibrium D". As the economy

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1/ This point has been forcefully argued by Laidler (1992).

traverses the new aggregate demand curve, output falls back to its initial level, while the price level continues to rise. The response to a permanent positive demand shock is a short-term rise in production followed by a gradual return to the initial level of output, and a permanent rise in prices.

The effects of a positive supply disturbance (a favorable technology shock that permanently raises potential output, for instance) is shown in the right-hand bottom panel. The short- and long-run aggregate supply curves shift to the right by the same amount, displacing the short-term equilibrium from E to S'. Output rises but prices fall. As the supply curve becomes increasingly vertical over time, the economy moves from S' to S", leading to further increases in output and additional declines in prices. Whereas demand shocks affect output only temporarily, supply shocks affect it permanently. And whereas positive demand shocks raise prices, positive supply shocks reduce them.

We estimate this framework using a procedure proposed by Blanchard and Quah (1989) for distinguishing temporary from permanent shocks to a pair of time-series variables, as extended to the present case by Bayoumi (1992a). Consider a system where the true model can be represented by an infinite moving average representation of a (vector) of variables, X_t, and an equal number of shocks, ϵ_t. Formally, using the lag operator L, this can be written as:

$$\begin{aligned} X_t &= A_0\epsilon_t + A_1\epsilon_{t-1} + A_2\epsilon_{t-2} + A_3\epsilon_{t-3} \ldots . \\ &= \sum_{i=0}^{\infty} L^i A_i \epsilon_t \end{aligned} \tag{1}$$

where the matrices A_i represent the impulse response functions of the shocks to the elements of X.

Specifically, let X_t be made up of change in output and the change in prices, and let ϵ_t be demand and supply shocks. Then the model becomes

$$\begin{bmatrix} \Delta y_t \\ \Delta p_t \end{bmatrix} = \sum_{i=0}^{\infty} L^i \begin{bmatrix} a_{11i} & a_{12i} \\ a_{21i} & a_{22i} \end{bmatrix} \begin{bmatrix} \epsilon_{dt} \\ \epsilon_{st} \end{bmatrix} \tag{2}$$

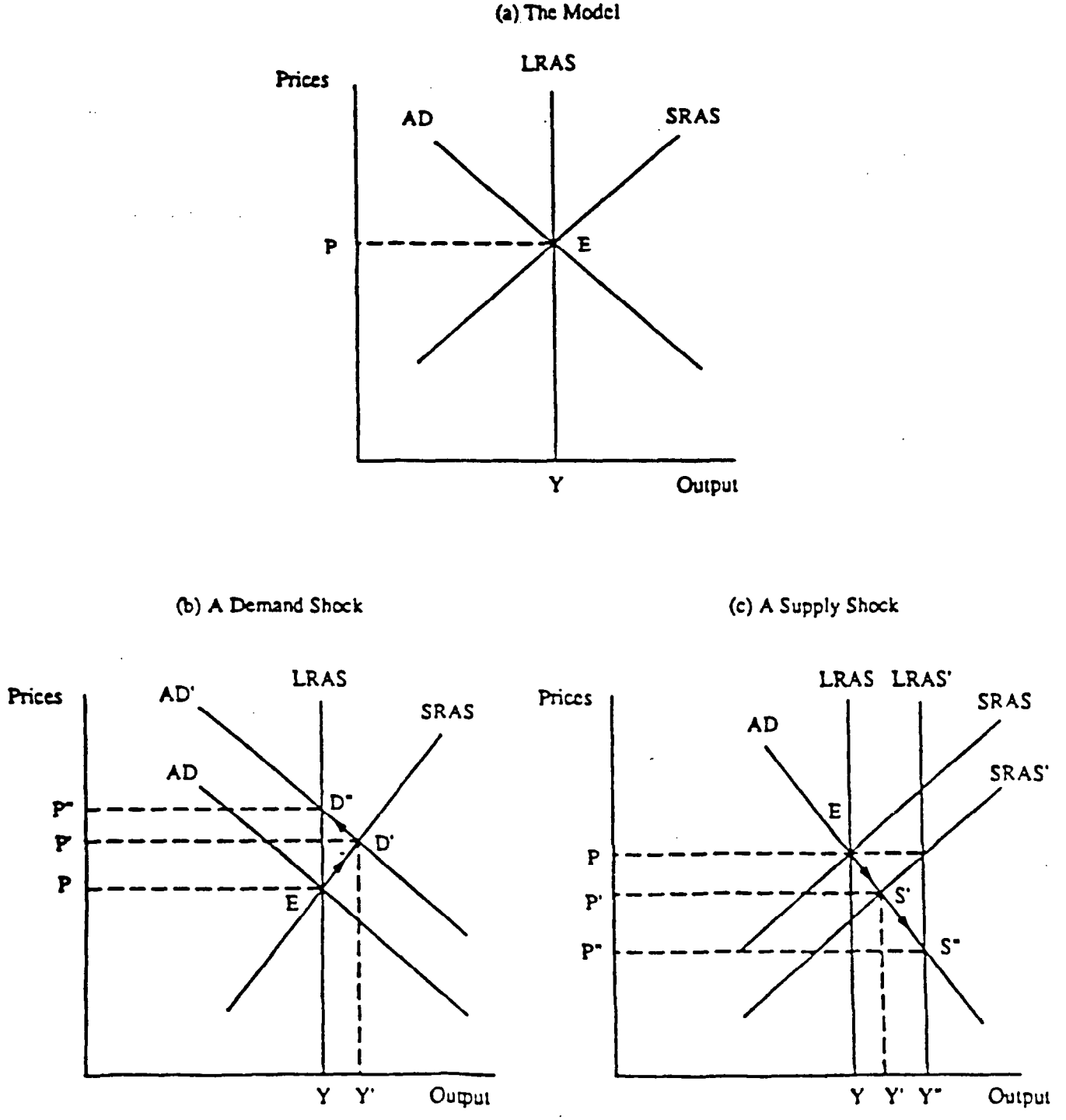
where y_t and p_t represent the logarithm of output and prices, ϵ_{dt} and ϵ_{st} are independent supply and demand shocks, and a_{11i} represents element a_{11} in matrix A_i.

The framework implies that while supply shocks have permanent effects on the level of output, demand shocks only have temporary effects. (Both have permanent effects upon the level of prices.) Since output is written in first difference form, this implies that the cumulative effect of demand shocks on the change in output (Δy_t) must be zero. The model implies the restriction,

$$\sum_{i=0}^{\infty} a_{11i} = 0.$$

Figure 2.

The Aggregate Demand and Supply Model



The model defined by equations (3.2) and (3.3) can be estimated using a vector autoregression. Each element of X_t can be regressed on lagged values of all the elements of X. Using B to represent these estimated coefficients, the estimating equation becomes,

$$\begin{aligned} X_t &= B_1 X_{t-1} + B_2 X_{t-2} + \ldots + B_n X_{t-n} + e_t \\ &= (I - B(L))^{-1} e_t \\ &= (I + B(L) + B(L)^2 + \ldots) e_t \\ &= e_t + D_1 e_{t-1} + D_2 e_{t-2} + D_3 e_{t-3} + \ldots \end{aligned}$$

where e_t represents the residuals from the equations in the vector autoregression. In the case being considered, e_t is comprised of the residuals of a regression of lagged values of Δy_t and Δp_t on current values of each in turn; these residuals are labeled e_{yt} and e_{pt}, respectively.

To convert equation (3.4) into the model defined by equations (3.2) and (3.3), the residuals from the VAR, e_t, must be transformed into demand and supply shocks, ϵ_t. Writing $e_t = C\epsilon_t$, it is clear that, in the two-by-two case considered, four restrictions are required to define the four elements of the matrix C. Two of these restrictions are simple normalizations, which define the variance of the shocks ϵ_{dt} and ϵ_{st}. A third restriction comes from assuming that demand and supply shocks are orthogonal. 1/

The final restriction, which allows the matrix C to be uniquely defined, is that demand shocks have only temporary effects on output. 2/ As noted above, this implies equation (3.3). In terms of the VAR it implies,

$$\sum_{i=0}^{\infty} \begin{bmatrix} d_{11i} & d_{12i} \\ d_{21i} & d_{22i} \end{bmatrix} \begin{bmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{bmatrix} = \begin{bmatrix} 0 & . \\ . & . \end{bmatrix}$$

1/ The conventional normalization is that the two variances are set equal to unity, which together with the assumption of orthogonality implies $C'C = \Sigma$, where Σ is the variance covariance matrix of e_y and e_p. However, when we wish to calculate the variance of the shocks themselves, we report results using the normalization $C'C = \Gamma$, where Γ is the correlation matrix of e_y and e_p (see Bayoumi, 1991, for a discussion of this decomposition). These two normalizations gave almost identical paths for the shocks, except for a scaling factor, and hence are used interchangeably.

2/ This is where our analysis, based on Blanchard and Quah (1989), differs from other VAR models. The usual decomposition assumes that the variables in the VAR can be ordered such that all the effects which could be attributed to (say) either a_t or b_t are attributed to whichever comes first in the ordering. This is achieved by a Choleski decomposition (Sims, 1980).

This restriction allows the matrix C to be uniquely defined and the demand and supply shocks to identified. 1/

Interpreting shocks with a permanent impact on output as supply disturbances and shocks with only a temporary impact on output as demand disturbances is controversial. Doing so requires adopting the battery of restrictions incorporated into the aggregate-supply-aggregate-demand model of Figure 2. One can think of frameworks other than the standard aggregate-supply-aggregate-demand model in which that association might break down. Moreover, it is conceivable that temporary supply shocks (for example, an oil price increase that is reversed subsequently) or permanent demand shocks (for, example, a permanent increase in government spending which affects real interest rates and related variables) dominate our data. But here a critical feature of our methodology comes into play. While restriction (3.5) affects the response of output to the two shocks, it says nothing about their impact on prices. The aggregate-supply-aggregate-demand model implies that demand shocks should raise prices while supply shocks should lower them. Since these responses are not imposed, they are useful for testing our interpretation of permanent output disturbances in terms of supply and temporary ones in terms of demand.

We find that the restriction is universally satisfied for industrial regions, such as the eastern seaboard of the United States. On the other hand, the price restriction is generally not satisfied for regions which are heavily dependent on raw material production, such as the south western region of the United States or the western half of Canada. One interpretation of this divergence in results, which is consistent with the underlying aggregate-supply-aggregate-demand model, is in the case of raw material producing regions positive supply shocks are associated with increases in the relative price of raw materials. This change in the terms of trade implies a positive aggregate demand shock, which is inextricably linked with the underlying aggregate supply disturbance. Hence, in the case of raw material producers, the identified supply shocks may also include associated aggregate demand shocks whose effect cannot be differentiated empirically, and which produce the perverse behavior in prices. 2/ The implication for these regions is that while the aggregate supply disturbances are measured accurately, the aggregate demand disturbances are not. Note, however, that the mismeasurement affects a very particular type of aggregate demand disturbances, while the other disturbances, such as those associated with macroeconomic policy, will be measured correctly.

1/ Note from equation (3.4) that the long run impact of the shocks on output and prices is equal to $(I-B(1))^{-1}$. The restriction that the long-run effect of demand shocks on output is zero implies a simple linear restriction on the coefficients of this matrix.

2/ Bayoumi and Eichengreen (1992) find a similar effect in data for the Gold Standard, when agriculture was a much more important part of national production.

2. Data

We assembled data on prices and output for U.S. states, Canadian provinces and the Mexican nation. 1/ For Mexico, data covering the period 1963-89 on real and nominal GDP are drawn from World Bank and IMF publications. Individual state products are available from the Bureau of Economic Analysis (BEA) of the U.S. for the period 1963-86 (described in Renshaw, Trott and Friedenberg (1988)). They measure gross output produced by each state and hence represents the state-level equivalent of the GDP series for Mexico.

Although the BEA aggregates the 50 state product series into eight divisional products (for New England, Mid-East, Great Lakes, Plains, South East, South West, Rocky Mountains and Far West), the aggregation is not ideal for the questions at hand. The BEA distinguishes three Western divisions: the Rocky Mountains (Colorado, Idaho, Montana, Utah and Wyoming), the South West (Arizona, New Mexico, Oklahoma, and Texas), and the Far West (California, Nevada, Oregon, and Washington). This aggregation does not permit us to consider the possible correlation of supply and demand disturbances to Oregon and Washington with disturbances to Canada, since Oregon and Washington are dwarfed by California in the Far West region as defined by the BEA. Similarly, we might wish to analyze the correlation of disturbances to Idaho, Montana and Wyoming with disturbances to Canada, but they are dominated in the data for the Rocky Mountain states by Colorado, whose links with Canada are weaker. Hence we combined data for Oregon and Washington with the Rocky Mountain states other than Colorado and defined a new region (the North West). We added Colorado and Nevada to the BEA's South West, leaving California as the Far West.

In Canada, provincial data on total domestic spending rather than GDP were collected; we discuss the biases this may introduce below. 2/ These data are available for the period 1971-90. Statistics Canada distinguishes three regions: the Atlantic Provinces (Newfoundland, Prince Edward Island, and New Brunswick), Central Canada (Quebec and Ontario), and Western Canada (Manitoba, Saskatchewan, Alberta, British Columbia, the Yukon and the Northwest Territories). Since the Atlantic region is extremely small (accounting for less than 10 percent of Canadian domestic demand), we follow Mundell in combining the Atlantic Provinces and Central Canada to form Eastern Canada.

The outcome is a division of the North American economy into 11 reasonably sized regions which reflect the major regional differences in economic structure. The size of the regions is shown in Table 5. The U.S. Mid-East, Great Lakes and South East regions are almost twice as large as the South West and California. These regional economies in turn are twice

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1/ We are unaware of the existence of Mexican regional data. In any case, as discussed below, Mexico itself represents a very small part of the North American economy.

2/ Nominal data on provincial product are available, but no deflators exist.

Table 5. Relative to GDP in 1986

(Converted at market exchange rates)

	U.S. Dollars (millions)	Percent of Total
Eastern Canada	253	5.6
Western Canada	108	2.4
New England	246	5.4
Mid-East	818	18.0
Great Lakes	701	15.4
Plains	293	6.4
South East	873	19.2
South West	509	11.2
California	534	11.8
North West	119	2.6
Mexico	86	1.9

Note: Canadian data refer to total domestic demand, not domestic product as for U.S. regions and Mexico. Source: see text.

Table 6. Standard Deviations of Growth and Inflation

(Measured as logarithms)

	Growth	Inflation
Eastern Canada	0.024	0.026
Western Canada	0.043	0.030
New England	0.030	0.021
Mid-East	0.025	0.021
Great Lakes	0.041	0.024
Plains	0.027	0.023
South East	0.027	0.024
South West	0.021	0.033
California	0.024	0.021
North West	0.030	0.022
Mexico	0.039	0.186

Note: Canadian data refer to total domestic demand, not domestic product as for U.S. regions and Mexico. Source: See text.

the size of Eastern Canada, New England and the Plains, which are themselves twice the size of the Western Canada, the North West and Mexican economies. 1/

Before analyzing these data, we consider them in unprocessed form. Table 6 displays the standard deviations of growth and inflation, measured as the first difference of the logarithm of real output and of the price deflator. One might expect the Mexican data to display higher volatility than the other regions. Table 6 confirms this for inflation but shows that it is true to a lesser extent for output growth: the standard deviation of output growth for Mexico is exceeded by that for Western Canada, an energy and raw-material producing region, and by the U.S. Great Lakes region, which was singled out by Blanchard and Katz (1992) as being characterized by unusual output volatility due to its specialization in the production of durable goods.

Table 7 shows the inter-regional correlations of the output growth rates, Table 8 those of inflation. 2/ Consider first the output correlations for the U.S. 3/ Many of these are in the neighborhood of 0.7. It is not surprising that the interregional correlations are so high given the integration of the national economy; another perspective is that a correlation of 0.7 leaves considerable room for regional divergences, as emphasized by Blanchard and Katz (1992). EC data for the period 1960-88 analyzed in Section III.D below show that analogous correlations between Germany on the one hand and Denmark, Belgium, the Netherlands and France on the other are all over 0.5. Thus, the correlation of output growth across U.S. regions is not much higher than across the original EC member states.

The "core" of the U.S. economy (the regions with uniformly high correlations between them) is the Mid-East, the Great Lakes, the South East and New England. California and the Plains also display reasonably high correlations with the core, while the South West and North West exhibit relatively low correlations with the Mid-East, New England and (in the case of the South West) California. By U.S. standards, Eastern and Western Canada display a low correlation with one another. Indeed, output in

---

1/ This heterogeneity is similar to that found in the European Community, which we consider below.

2/ In discussing these data it is useful to recall that the statistic $(1/2)\ln([1+r]/([1-r])$ is distributed approximately normally with variance $1/(T-3)$, where r is the correlation and T is the number of time periods. We can thus calculate whether the correlations are significantly different from zero at standard confidence levels. For the U.S. and Mexico, for which we have matching data for 1964-86, the 95 percent confidence level corresponds to 0.42, the 99 percent confidence level to 0.55. When the shorter Canadian time series are used, the corresponding levels are 0.55 and 0.63. See Kendall and Stuart (1967), pp. 292-293.

3/ Previously, we considered correlations across U.S. regions in growth and inflation in Bayoumi and Eichengreen (1993a). The tables here differ not just because of different definitions of regions but also because, in our previous paper, we reported only correlations with the Mid-East.

Table 7. Correlation of Growth: North American Regions (1964-86)

	Eastern Canada	Western Canada	New England	Mid-East	Great Lakes	Plains	South East	South West	Calif.	North West
Eastern Canada										
Western Canada	0.44									
New England	0.34	-0.22								
Mid-East	0.42	-0.20	0.94							
Great Lakes	0.54	0.08	0.82	0.89						
Plains	0.54	0.23	0.72	0.77	0.90					
South East	0.42	0.14	0.82	0.87	0.94	0.88				
South West	0.25	0.47	0.37	0.42	0.63	0.72	0.71			
California	0.56	0.07	0.74	0.69	0.79	0.70	0.75	0.55		
North West	0.53	0.48	0.45	0.44	0.71	0.70	0.70	0.71	0.82	
Mexico	0.10	0.77	-0.22	-0.10	0.20	0.20	0.20	0.62	-0.01	0.28

Notes: For Canada the data refer to total domestic demand, and cover the period 1972-86. 5 percent significance levels are 0.42 (0.51 for the Canadian data). 1 percent levels are 0.50 (for Canada 0.59).
Source: See text.

Table 8. Correlation of Inflation: North American Regions (1964-86)

	Eastern Canada	Western Canada	New England	Mid-East	Great Lakes	Plains	South East	South West	Calif.	North West
Eastern Canada										
Western Canada	0.99									
New England	0.86	0.90								
Mid-East	0.87	0.89	0.99							
Great Lakes	0.85	0.89	0.99	0.99						
Plains	0.67	0.70	0.82	0.77	0.84					
South East	0.91	0.92	0.95	0.95	0.96	0.87				
South West	0.81	0.83	0.92	0.91	0.91	0.85	0.96			
California	0.88	0.90	0.98	0.97	0.98	0.87	0.97	0.95		
North West	0.81	0.84	0.92	0.89	0.92	0.95	0.96	0.93	0.95	
Mexico	-0.50	-0.56	-0.10	0.01	-0.06	-0.21	-0.08	-0.19	-0.11	-0.15

Notes and Source: See Table 7.

Western Canada is more highly correlated with output in the U.S. North West and South West than with that of Eastern Canada (as conjectured by Mundell). Output in Eastern Canada moves more closely with output in several eastern regions of the U.S., although there is little correlation between growth in Eastern Canada and New England. Mexican growth is significantly correlated with growth in the U.S. South West (not surprisingly in light of direct foreign investment links and the importance of energy production to both economies). The high correlation between Mexican output and that of Western Canada suggests that it is mainly the energy factor that it as work. A striking feature of Table 7 is the absence of any correlation between growth in Mexico and California.

Table 8, which considers inflation, confirms the existence of high correlations within both the U.S. and Canada and, more strikingly, between Canadian and U.S. regions despite the maintenance of a flexible exchange rate between them. Fluctuations in Mexican inflation are negatively correlated with the other rates, reflecting the high levels of inflation in the late 1980s.

Another perspective on the behavior of prices is offered by Table 9, which converts the Canadian and Mexican deflators into dollars and reports the standard deviations of regional real exchange rates, measured in terms of relative dollar output deflators. Clearly, none of the other real rates displays anything approaching the volatility of that between Mexico and the various U.S. and Canadian regions. Note, however, that the real rates between the two halves of Canada on the one hand and the U.S. South West on the other are as volatile as those between the Canadian regions and Mexico. Several of the real rates between U.S. regions, notably those linking the South West to other parts of the country, are considerably more volatile than the real exchange rate between the two halves of Canada.

Thus, the unprocessed data tell a straightforward story. Output fluctuations are poorly correlated between the two halves of Canada, between the North West and South West and the rest of the U.S., and between Mexico and the other regions. These also tend to be the relationships exhibiting the greatest real exchange rate volatility, although the two halves of Canada and the U.S. North West are exceptions to this generalization. There is evidence of positive output comovements across the four outlying regions (Western Canada, the U.S. North West and South West, and Mexico), although the real exchange rates between them remain volatile.

3. Results

We next use our variant of the Blanchard-Quah procedure to link growth and inflation movements to underlying supply and demand disturbances. In each case our regressions were estimated on the entire time series available for the region considered. In 8 of the 11 cases, the implicit over-identifying restriction, that permanent increases in output should be accompanied by permanent reductions in prices while temporary increases in output should be accompanied by permanently higher prices, was satisfied. The three exceptions were Western Canada, the U.S. North West and the U.S.

Table 9. Real Exchange Rates Between North American Regions

	Eastern Canada	Western Canada	Mid-East	New England	Great Lakes	Plains	South East	North West	South West	Calif.
Eastern Canada										
Western Canada	0.012									
Mid-East	0.095	0.095								
New England	0.085	0.085	0.013							
Great Lakes	0.084	0.084	0.015	0.003						
Plains	0.085	0.084	0.021	0.014	0.015					
South East	0.104	0.102	0.019	0.025	0.027	0.025				
North West	0.103	0.101	0.018	0.023	0.024	0.021	0.006			
South West	0.166	0.161	0.076	0.084	0.086	0.006	0.057	0.061		
California	0.099	0.099	0.008	0.016	0.019	0.021	0.011	0.010	0.057	
Mexico	0.168	0.160	0.213	0.202	0.199	0.196	0.210	0.209	0.220	0.211

Notes: Data cover the period 1971-86. All real exchange rates are normalized to one in 1982.

Source: See text.

South West, which displayed perverse price responses to permanent shocks, as shown in Figure 3. These three regions are all heavy producers of raw materials, which, as discussed earlier, may well explain their perverse behavior. 1/ Comparable plots for the impact of demand disturbances on prices are shown in Figure 4.

Another way of assessing the validity of our procedure is to analyze the path of the underlying demand and supply disturbances, and to attempt to associate them with historical events. U.S. results are discussed in Bayoumi and Eichengreen (1993a); briefly, the results conform to expectations, with negative supply shocks corresponding to the two oil shocks, and a large negative demand shock in 1982 at the time of the Reagan/Volker deflation. 2/ Figure 5 shows the supply and demand disturbances to the Mexican economy. 3/ We discuss these at length, because they provide a new perspective on the supply- and demand-side effects of Mexican policy initiatives as well as providing an additional check on our procedure.

The ten years starting in the mid-1960s are marked by relatively little turbulence, reminding us that high inflation and stabilization-induced interruptions to Mexican growth are relatively recent phenomena. 4/ The source of the negative demand shock in 1971 is not obvious. One candidate is fiscal austerity: the public sector primary deficit declined from 1.5 to 0.5 percent of GDP between 1970 and 1971. 5/

The 1976 devaluation (often alleged to have been contractionary) and the stabilization measures that followed in 1977 (such as a cut in the public sector deficit) show up as negative impulses to both aggregate demand and aggregate supply. Subsequently there is evidence of increasing demand

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1/ Mexico, also a heavy producer of raw materials, did not display this anomalous response. What is striking about Mexico is the exceptionally large response of prices to supply shocks. A large change in prices relative to output in response to supply shocks is indicative of a relatively steep short-run aggregate supply curve, consistent with Mexico having a relatively flexible economy. However, Figures 3 and 4 show that the responses of both prices and output to supply shocks are large relative to those displayed by other economies. It could be that negative supply shocks in Mexico provoked an endogenous response of money supply and hence high inflation, which we pick up as a large response of prices. In other words, in the U.S. and Canada, reduced supply raises prices despite that money supply is held more or less constant; whereas in Mexico, reduced supply also provokes increased money creation, which magnifies the price response.

2/ The results for the aggregate Canadian data, reported in Sterne and Bayoumi (1992), also correspond to expectations.

3/ A comparable figure for the United States appears in Bayoumi and Eichengreen (1992).

4/ Dornbusch (1988) and Diaz and Tercerco (1988) also emphasize this point.

5/ Diaz and Tercero (1988), p. 364.

pressure, coincident with the large-scale foreign borrowing that dominated the late 1970s and early 1980s. It is notable that this inflow of foreign capital does not appear to have been accompanied by significant increases in the economy's supply capacity.

The 1982 devaluation shows up in the data not so much as a negative shift in aggregate demand (since fiscal retrenchment was absent) as a negative shift in aggregate supply. Fiscal correction followed only in 1983, which we pick up as a negative shock to aggregate demand. Aggregate demand impulses are consistently smaller in the first half of the de la Madrid presidency (1983-85) than in the second half of the Lopez Portillo sexennio that preceded it, reflecting the "fierce budget cutting" that characterized de la Madrid's term in office. 1/ There is a large positive supply shock in 1984, for which real appreciation of the peso is the most frequently cited explanation. 2/ Two discrete devaluations took place in 1985, and we see a large negative innovation to aggregate supply. In 1986 Mexico suffered the largest terms-of-trade deterioration in its modern history, due to the collapse of oil prices and the fall in its oil revenues by nearly two thirds. This is apparent in a large negative shift in aggregate demand. The single largest innovation to aggregate demand in the sample period is that between 1986 and 1987, plausibly reflecting capital inflows into the Mexican stock market in the first nine months of the year. Finally, the post-1987 stabilization program shows up as a pronounced negative innovation to aggregate demand. The late-1980s also display a series of positive supply shocks, plausibly associated with the supply-side reforms and trade liberalization that accompanied the stabilization.

This discussion of the Mexican demand and supply disturbances implies a potential difference between the results for the U.S. and Canada on the one hand and Mexico on the other. In the U.S. and Canada supply disturbances appear to reflect exogenous factors such as oil price shocks, while demand disturbances reflect both exogenous factors and the effects of macro-economic policy (as predicted by the AD/AS framework). Consequently, supply disturbances are probably the better guide to the symmetry or asymmetry of underlying disturbances following a change in exchange rate regime. In the case of Mexico, in contrast, supply disturbances appear to be correlated with, among other factors, changes in the real exchange rate. This means that the supply disturbances may not invariant to the exchange rate regime. It is also possible, however, that the correlation between supply disturbances and the exchange rate reflects the response to changes in supply potential in an economy with little financial room to manoeuver. Under this interpretation the causality runs from supply disturbances to the real exchange rate, rather than the other way round, and the supply disturbances remain a good measure of underlying conditions.

1/ The quote is from Dornbusch (1988). The PSBR was cut from 17.6 percent of GDP in 1982 to 8.5 percent in 1983 and to less than 4 percent in 1985. See Ortiz (1991), p. 285.

2/ See for example Diaz and Tercero (1988) and McLeod and Welch (1991).

Figure 3.

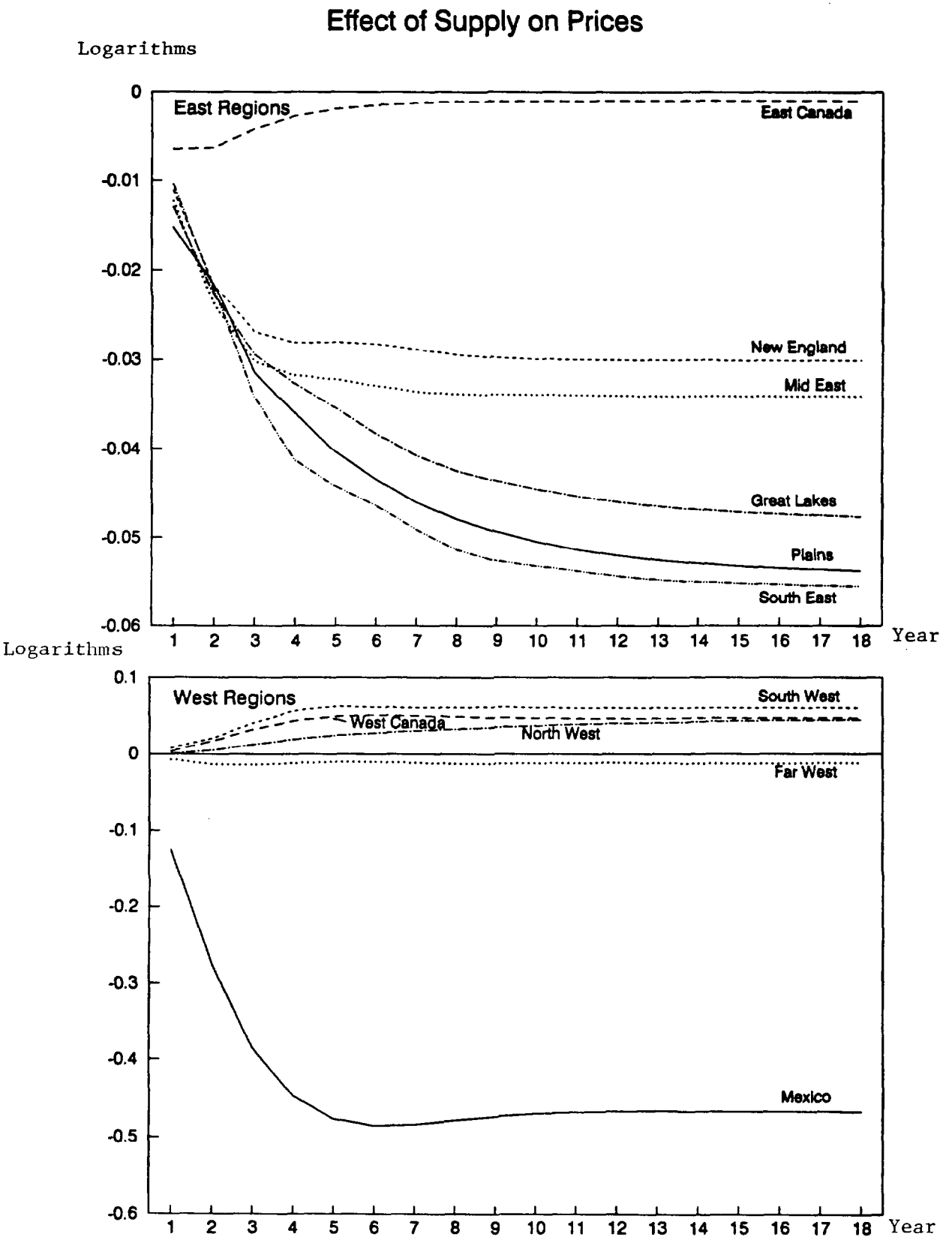
Effect of Supply on Prices
Logarithms
East Regions
East Canada
New England
Mid East
Great Lakes
Plains
South East
0
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Year
Logarithms
West Regions
South West
West Canada
North West
Far West
Mexico
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Year

Figure 4.

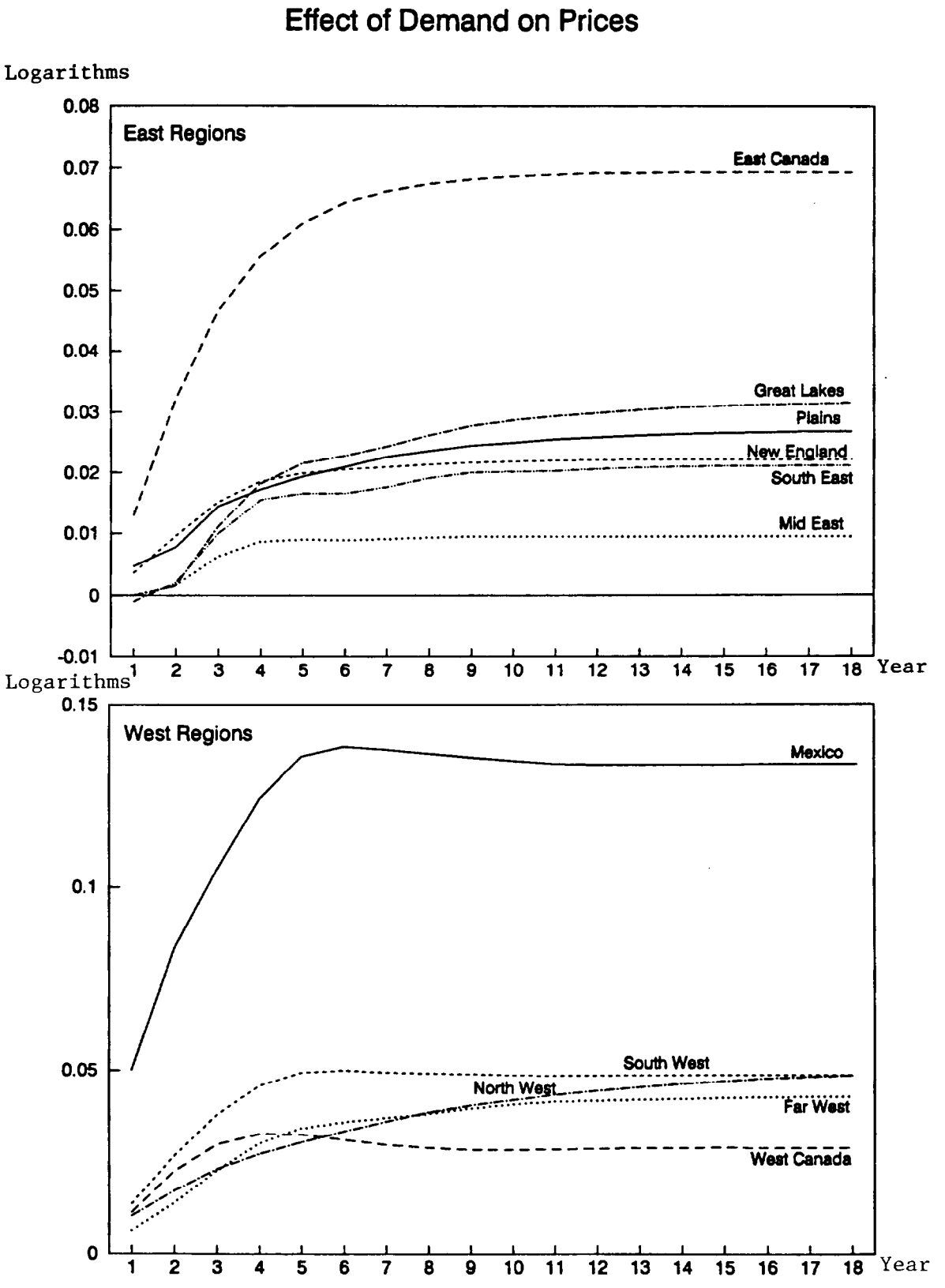
Effect of Demand on Prices
Logarithms
East Regions
East Canada
Great Lakes
Plains
New England
South East
Mid East
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
-0.01
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Year
Logarithms
West Regions
Mexico
South West
North West
Far West
West Canada
0.15
0.1
0.05
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Year

Figure 5.

Mexico: Supply and Demand Disturbances, 1966-89

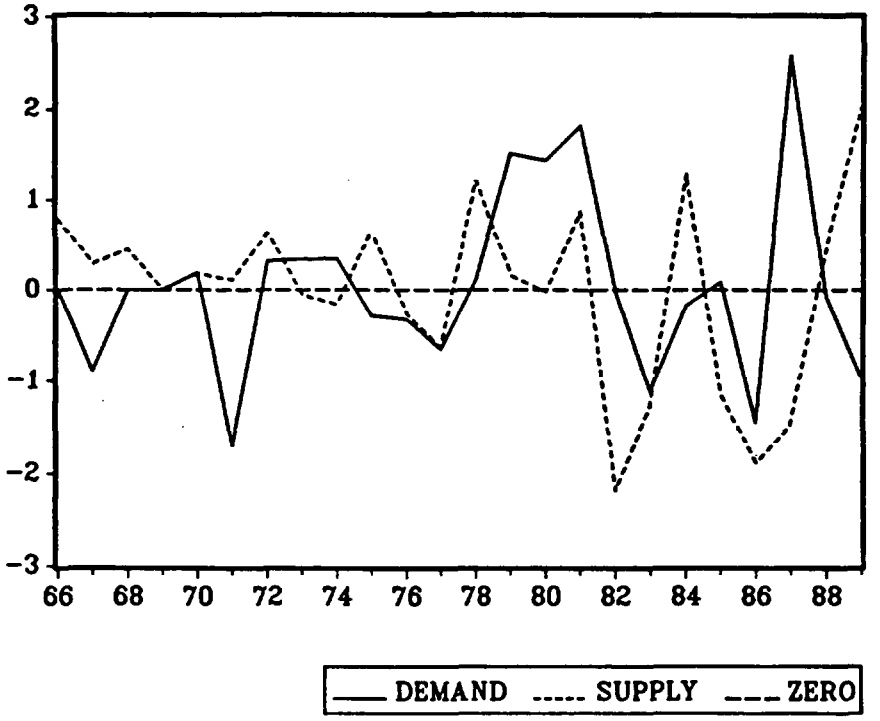

Table 10 reports the standard deviations of the estimated supply and demand disturbances for all of the regions. Their relative magnitudes can also be seen in Figures 6-7, where the impulse responses of output are depicted. (Since all the data are in logarithms, a change of 0.01 on the vertical axis represents a one percent deviation; the horizontal axis represents years.) Both supply and demand disturbances are largest in Mexico, the latter presumably reflecting shifts in government policy, the former a function of, among other things, shocks to the international petroleum market. Consistent with this explanation for Mexico's large output responses to supply shocks, the other regions displaying the largest output responses to supply shocks are Western Canada and the U.S. North West, also energy producing regions. 1/ These regions exhibit sizeable supply shocks despite that the variance in their growth rates is not always particularly large. That the western regions show smaller output responses to demand shocks is also consistent with their more heavily raw-material-based economies, which imply relatively inelastic short-run supply curves. None of the U.S. or Canadian regions displays demand disturbances approaching the size of Mexico's, although the Great Lakes, the leading producer of consumer durables, and New England, which in our sample period experienced shifts in demand away from textiles and toward electronics and defense industries, display unusual demand-side volatility.

Tables 11 and 12 report the interregional correlations of the supply and demand disturbances. On the supply side, New England, the Mid-East and the Great Lakes display high correlations with one another. Supply shocks to California and the South East are more diverse, but they are also significantly correlated with those to the three previously mentioned U.S. regions. Supply shocks to the North West and South West are not significantly correlated with those to any of the eastern regions, although they are correlated with one another (and those to the North West are weakly correlated with those to California). The Plains "are in the middle," being significantly correlated with the Great Lakes but not the rest of the U.S. core.

A striking finding is the absence of a significant correlation between supply shocks to the two halves of Canada. Nor are supply shocks to Eastern Canada significantly correlated with those to any U.S. region (or to Mexico). Supply shocks to Western Canada are significantly correlated with those to the U.S. North West and South West, suggesting the existence of a

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1/ Recall that our definition of the North West includes Wyoming and Montana.

Table 10. Standard Deviations of Demand and Supply Disturbances

	Demand	Supply
Eastern Canada	0.016	0.019
Western Canada	0.012	0.037
New England	0.025	0.014
Mid-East	0.019	0.012
Great Lakes	0.033	0.013
Plains	0.022	0.016
South East	0.018	0.011
South West	0.017	0.019
California	0.016	0.013
North West	0.013	0.025
Mexico	0.151	0.053

Source: See text.

Figure 6.

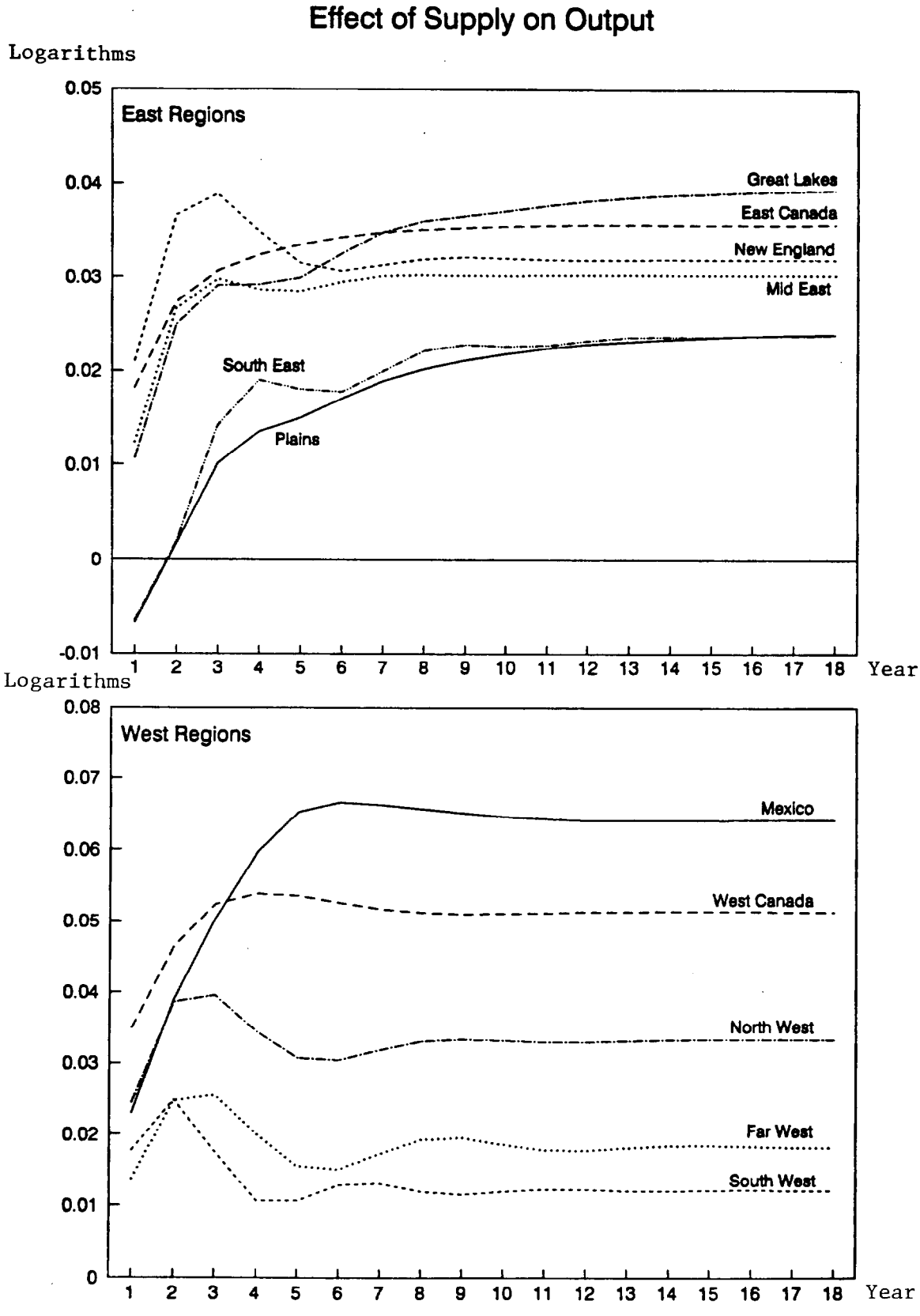
Effect of Supply on Output
Logarithms
East Regions
Great Lakes
East Canada
New England
Mid East
South East
Plains
0.05
0.04
0.03
0.02
0.01
0
-0.01
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Year
Logarithms
West Regions
Mexico
West Canada
North West
Far West
South West
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Year

Figure 7.

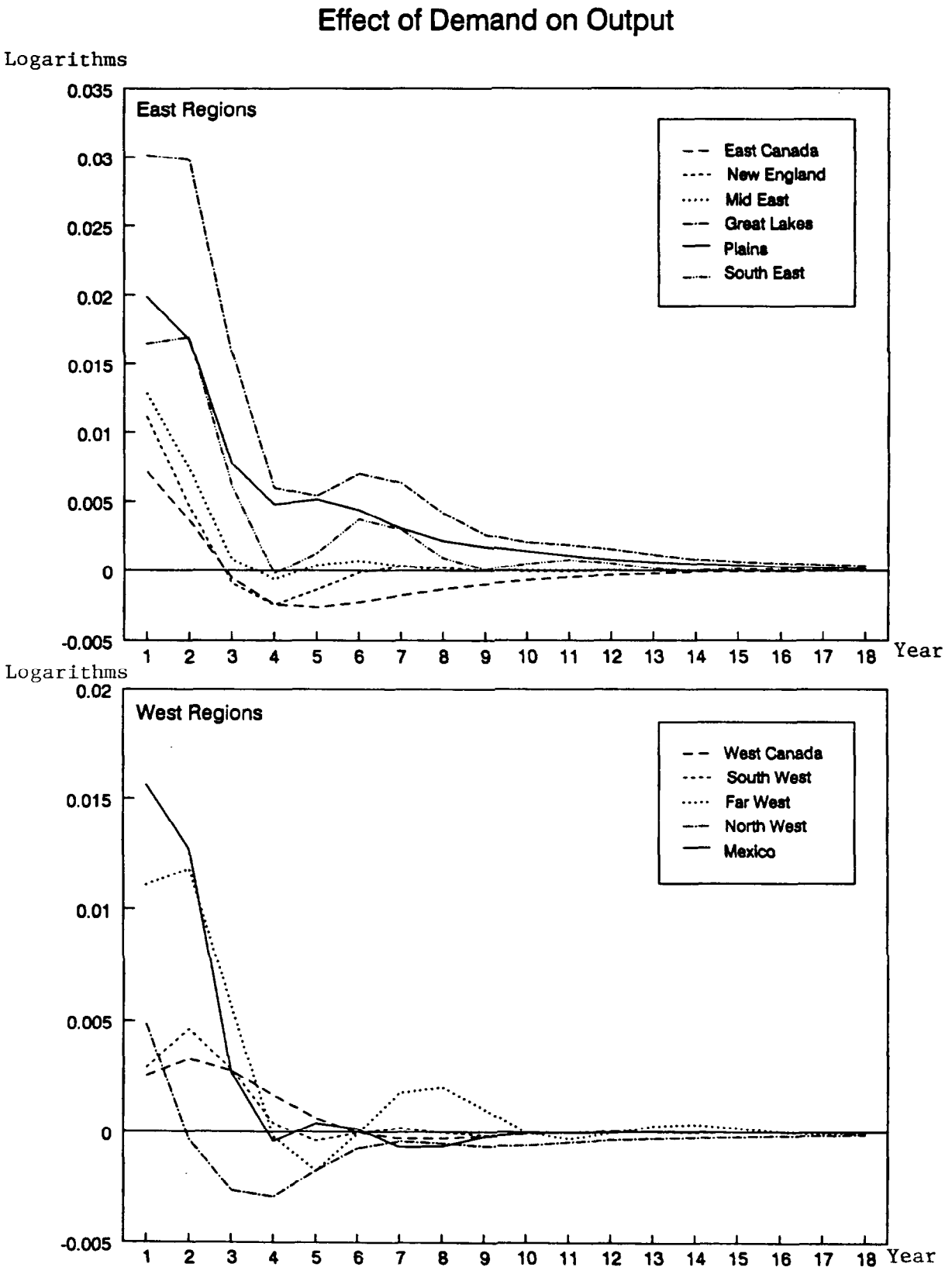
Effect of Demand on Output
Logarithms
East Regions
East Canada
New England
Mid East
Great Lakes
Plains
South East
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
-0.005
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Year
Logarithms
West Regions
West Canada
South West
Far West
North West
Mexico
0.02
0.015
0.01
0.005
0
-0.005
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Year

Table 11. Correlation of Underlying Supply Disturbances: North American Regions (1966-86)

	East Canada	West Canada	New England	Mid-East	Great Lakes	Plains	South East	South West	Calif.	Northwest
Eastern Canada										
Western Canada	0.30									
New England	0.11	0.01								
Mid-East	0.15	-0.26	0.88							
Great Lakes	0.06	-0.07	0.77	0.81						
Plains	0.37	-0.10	0.34	0.30	0.46					
South East	-0.03	-0.52	0.44	0.67	0.66	0.49				
South West	-0.05	0.54	0.11	-0.14	-0.08	-0.52	-0.56			
California	0.23	0.14	0.68	0.61	0.67	0.47	0.43	0.07		
North West	0.05	0.52	0.29	0.03	0.27	0.14	-0.29	0.55	0.59	
Mexico	0.14	0.57	-0.09	-0.35	-0.43	-0.50	-0.64	0.77	-0.17	0.33

Notes: The significance levels are 0.43 and 0.51 (5 percent and 1 percent, respectively). For the Canadian data they are 0.55 and 0.65. Source: See text.

Table 12. Correlation of Underlying Demand Disturbances: North American Regions (1966-86)

	East Canada	West Canada	New England	Mid-East	Great Lakes	Plains	South East	South West	Calif.	Northwest
Eastern Canada										
Western Canada	0.67									
New England	0.46	0.07								
Mid-East	0.31	0.10	0.79							
Great Lakes	0.11	-0.15	0.66	0.60						
Plains	0.33	0.06	0.63	0.51	0.79					
South East	0.00	-0.18	0.51	0.50	0.70	0.69				
South West	0.64	0.56	0.31	0.11	0.19	0.31	-0.10			
California	0.40	0.24	0.64	0.35	0.62	0.46	0.31	0.45		
North West	0.44	0.33	0.34	0.30	0.41	0.10	0.13	0.23	0.51	
Mexico	0.54	0.36	0.33	0.30	-0.04	0.13	0.15	0.27	0.17	0.15

Notes: See Table 11. Source: See text.

unified western economic region, with the striking and important exception of California. 1/

The data for Mexico suggest that its supply disturbances are uncorrelated or negatively correlated with those to most other regions. The notable exceptions are the U.S. South West (again, presumably reflecting direct foreign investment and energy production on both sides of the border) and Western Canada (reflecting the second of these factors).

The demand disturbances tell a complementary story. One of the highest correlations is between the two halves of Canada, consistent with the importance of national economic policy. The highest correlations are often for neighboring U.S. regions. Demand shocks to the Plains are correlated with demand shocks to the eastern U.S. regions. Yet correlations between U.S. regions are not uniformly higher than correlations between them on the one hand and Canada and Mexico on the other, as one would anticipate if demand disturbances were exclusively a function of national policy. Other factors are clearly also at work.

Mexico's demand disturbances are uncorrelated with those to the U.S. South West and Western Canada, an intuitive contrast with the results for aggregate supply. One curious result is the significant positive correlation between Mexico and Eastern Canada. Demand disturbances derived using GDP data for all of Canada starting in 1960 show a much lower correlation with Mexico (0.30), despite that they are dominated by the eastern provinces; hence we suspect that the correlation reported in Table 12 is an anomaly reflecting the shortness of the Canadian regional data set.

If we use these results to divide North America into currency areas, and we place more weight on supply disturbances than on demand disturbances (on the grounds that these reflect the impact of shocks to technology and world market conditions), there is some support for Mundell's hypothesis of an east-west split, with Western Canada joining the U.S. North West and the U.S. South West. California fits more neatly with the eastern regions of

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1/ One might worry that the absence of a correlation between Eastern Canada and the U.S. reflects the limitations of the Canadian regional data (which measure total domestic demand rather than GDP). Since real and nominal GDP data are available at the national level starting in 1960 (from the OECD National Income Accounts), we therefore ran our decomposition on these national data and on total domestic demand for all of Canada (east and west combined). The correlation of the two sets of estimated supply disturbances was 0.83; since Eastern Canada accounts for over two-thirds of the national total, this provides some reassurance that the underlying disturbances identified from the data on total demand are similar to those using GDP. In addition, we examined the correlation of the supply shocks derived using national data with supply shocks to U.S. regions; like the data for Eastern Canada, they displayed essentially no correlation.

the U.S., while Eastern Canada apparently belongs on its own. Turning to Mexico, its logical partners in a currency area are the U.S. South West, the U.S. North West and Western Canada.

4. European comparisons

The relevant question is not whether the borders of existing currency areas in North America should be redrawn in this way, but whether they might be combined into a single exchange-rate or monetary union. European comparisons are useful for framing the answer. European policymakers appear convinced that the EC is a viable currency area. We can therefore ask whether the incidence of shocks in North America renders it a less viable currency area than Western Europe.

Tables 13 and 14, derived by applying the same procedure to real GDP and GDP deflator data for European countries drawn from the OECD National Income Accounts, summarize the correlation across EC members of supply and demand disturbances. 1/ We concentrate on the correlations displayed by the supply disturbances, since, as argued above, these are more likely to be stable over time. None of the correlations of EC member supply disturbances with those to Germany (the country at the center of the prospective European Monetary Union) is as high as two-thirds. Thus, while the correlation between supply disturbances to Mexico, the U.S. and Canada is lower on average than the correlation of many supply disturbances within the U.S., the correlation of supply disturbances to different EC member countries is low as well. If Western Europe is a viable currency union, this suggests, then North America may be one as well.

On the other hand, the correlation of supply disturbances is much higher within the leading industrial countries of the European continent (Germany, France, Belgium, the Netherlands, and Denmark) than between these countries and the Southern European economies. If the correlation of supply shocks is taken as the sole criterion, then this EC "core" looks more like a viable currency area than North America as a whole. One interpretation of this EC "core-periphery" distinction is in terms of the relative importance of agriculture and industry. In the countries of the European "periphery" where agriculture remains relatively important, supply shocks are poorly correlated with those to Europe's industrial "core." 2/ This factor might also contribute to the low observed correlation between supply shocks to Western Canada and Eastern Canada on the one hand and to Mexico and the industrial regions of the U.S. on the other. 3/

1/ Note that the over-identifying restriction that positive supply shocks should be associated with falling prices was satisfied in all cases.

2/ Admittedly, this does not help us to understand the low correlation of supply shocks to the European "core" and to the U.K. We offer an alternative explanation for this observation in the next paragraph.

3/ It also might explain why shocks to Western Canada are so poorly correlated with those to the industrial regions, and why supply shocks to California are not as correlated with those to the eastern regions as are the latter with one another.

Table 13. Correlation Of Supply Shocks Across European Countries

	Germany	France	Belgium	Nether-lands	Denmark	United Kingdom	Italy	Spain	Ireland	Portugal	Greece
Germany	1.00										
France	0.54	1.00									
Belgium	0.61	0.45	1.00								
Netherlands	0.59	0.42	0.63	1.00							
Denmark	0.59	0.47	0.42	0.56	1.00						
United Kingdom	0.05	0.10	0.05	0.08	-0.05	1.00					
Italy	0.23	0.33	-0.01	0.33	0.09	0.38	1.00				
Spain	0.31	0.20	0.18	0.19	0.20	0.04	0.25	1.00			
Ireland	-0.06	0.14	0.04	-0.02	0.23	0.17	-0.16	0.05	1.00		
Portugal	0.21	0.32	0.37	0.14	-0.10	0.32	0.21	0.51	-0.10	1.00	
Greece	0.14	0.36	0.23	0.11	0.12	-0.13	0.40	0.19	-0.02	0.03	1.00

Notes: The significance levels are 0.43 and 0.51 (5 percent and 1 percent, respectively). Source: See text.

Table 14. Correlation of Demand Shocks Across European Countries

	Germany	France	Belgium	Nether-lands	Denmark	United Kingdom	Italy	Spain	Ireland	Portugal	Greece
Germany	1.00										
France	0.35	1.00									
Belgium	0.33	0.54	1.00								
Netherlands	0.17	0.35	0.54	1.00							
Denmark	0.39	0.35	0.33	0.18	1.00						
United Kingdom	0.16	-0.22	0.34	0.38	0.04	1.00					
Italy	0.17	0.57	0.40	0.19	0.06	-0.27	1.00				
Spain	-0.07	0.51	0.23	0.10	0.19	-0.25	0.43	1.00			
Ireland	-0.08	0.13	0.15	-0.31	0.17	-0.28	0.27	0.20	1.00		
Portugal	0.21	0.56	0.44	0.02	0.35	-0.13	0.59	0.37	0.07	1.00	
Greece	0.19	0.18	0.10	0.19	-0.05	0.24	0.04	0.06	-0.18	0.29	1.00

Notes: See Table 13. Source: See text.

With the exception of Ireland, none of the EC-member correlations with Germany is negative, in sharp contrast to that between Mexico and the industrial regions of the United States. And the correlation between supply shocks to Mexico and to the industrial regions of the U.S. is decidedly more negative than the correlation of supply shocks to Ireland and the leading industrial countries of the EC. The negative correlation of Mexican supply shocks with those to the industrial regions of the U.S. and Canada plausibly reflects Mexico's status as an energy producer, as argued above. A difference between the EC and North America relevant to the case for monetary union, then, is the absence of an EC member that relies as heavily as Mexico on oil production as a leading economic sector.

That supply shocks to the U.K., the most important oil producer in the Community, display an unusually low correlation with supply shocks to other EC members is consistent with this emphasis on the energy-producing sector. Norway, a likely future member of the Community, relies on energy production to an even greater extent. In Bayoumi and Eichengreen (1992b), we report analogous correlations between Germany and Norway: the correlation of their supply disturbances is -0.3, consistent with our interpretation of negative correlations in terms of the importance of energy production.

IV. Conclusion

This paper has considered monetary and exchange rate arrangements for NAFTA through the dual lenses offered by the theory of optimum currency areas and the experience of European monetary unification. In principle, the European Commission's argument that reaping the full benefits of economic integration requires firmly fixed exchange rates and ultimately a single currency for Europe applies with equal force to North America. The dependence of Canadian and Mexican exporters on the U.S. market underscores the point. Also relevant is the argument that pegging the Mexican peso to the U.S. dollar may help to buttress the anti-inflationary commitment of the Bank of Mexico. The greater independence of the Federal Reserve Board (compared to the Bank of Mexico) suggests that the latter should acquire additional anti-inflationary credibility by pegging the peso to the dollar.

But the benefits of permanently fixing the exchange rate must be weighed against the costs of relinquishing it as an instrument of adjustment. We have therefore analyzed the incidence of supply and demand disturbances to different North American regions and EC member countries to gain insight into these comparative costs. Our analysis suggests that the costs of truly fixed exchange rates (or monetary union) are likely to be higher for North America than for the EC's continental core (Germany, France, Belgium, the Netherlands, and Denmark). Supply shocks are more correlated across these European countries than across parts of North America. This is so even for Eastern Canada and the U.S. East, which are often thought to comprise a plausible currency area. Only if the entire European Community comprises a viable currency area can the same be said of Canada and the United States. Even then, the negative correlation of supply shocks to Mexico with those to the industrial regions of the United States,

and the exceptionally large magnitude of Mexico's supply shocks, suggest that Mexico would incur higher costs than Southern Europe from a rigid currency link. This, we have suggested, reflects the importance of petroleum production in the Mexican economy.

Of course, energy production is also important to the U.S. South West and to Western Canada. The correlation between their supply shocks and those to the rest of their respective currency areas is strikingly low. Here is where other elements of optimum currency area theory come into play. Labor mobility between the South West and the rest of the U.S. and between Western and Eastern Canada is high and accompanied by relatively little social and political strain. In contrast, the prospect of relieving pockets of high unemployment through migration across the Mexican-U.S. border would be likely to create considerable political opposition. Similarly, the U.S. and Canada both possess highly-articulated systems of fiscal federalism which work to minimize the dislocations caused by region-specific shocks. While fiscal federalism is under active discussion in the EC, the creation of such institutions at the North American level has not been broached in NAFTA negotiations. 1/ For all these reasons, we conclude that North America is less of an optimum currency area than the European Community. 2/

How will North American economic integration affect our cost-benefit calculus? As free trade expands the NAFTA partners' openness to one another, the argument that exchange rate stability encourages trade and investment will carry growing weight. But one should not exaggerate the rate at which trade and investment rates will grow. Hufbauer and Schott (1992) estimate that the NAFTA agreement could raise the Mexican export-to-GNP ratio from 14 percent in 1988 to no more than 16 percent in 1995. Cox and Harris (1992) suggest that the impact on Canadian openness will be even smaller.

1/ On the prospects for fiscal federalism at the EC level, see Italianer and Vanheukelen (1992).

2/ What options remain for exchange rate arrangements for NAFTA? Some sort of target zone with an escape clause, like the 2 1/2 percent bands around which the European Monetary System has been organized, could have certain features that might be desirable for both Canada and Mexico. It could combine the stabilizing effect on the volume of intra-bloc trade and investment of a stable rate with periodic realignments taken in response to country-specific shocks. A target zone would not have all the risk-reducing benefits of a single currency, but neither would it entail all the costs of relinquishing the exchange rate once and for all. Such a recommendation has been advanced by McLeod and Welch (1991a,b). They also emphasize the importance of energy-price shocks to the Mexican economy in arguing for the need for exchange rate flexibility. The example of the EMS does not imply that the width of the EMS bands is necessarily appropriate to Canada or Mexico. Even the EMS has recognized that different national circumstances warrant different band widths, allowing the currencies of certain high-inflation, high-debt EMS members to fluctuate by as much as 6 percent around their central parities.

Continued economic integration may increase the attractiveness of fixed exchange rates between the NAFTA partners by enhancing the effectiveness of alternative channels of adjustment. Exposed to inter-American competition, labor organizations in the three countries may accept greater wage flexibility. With nominal wages free to adjust, the need for exchange rate changes will no longer be so pressing. On the other hand, McLeod and Welch (1991b) argue that NAFTA will make Mexican exports "more price responsive and create more opportunities for switching from imports to domestic products. Thus, devaluation could become a more effective policy just as Mexico abandons its use."

Another question is how NAFTA will affect regional specialization in different parts of North America and hence the co-movement across regions of shocks. With economic integration will come greater regional specialization. 1/ Western Canada will specialize even more heavily in land-and resource-based products such as wheat, lumber and paper. Eastern Canada's specialization in manufactures such as chemicals and metal products will be reinforced. 2/ The Plain states will increase their specialization in field crops such as corn, wheat and soybeans, Mexico in fruit and vegetables. 3/ The petroleum sector should become even more important to Mexico as a result of North American free trade. 4/ For all these reasons, the correlation of disturbances across the regions of North America could fall after NAFTA.

A final issue is regional differentiation within Mexico. Krugman and Hanson (1991) argue that the FTA will cause Mexican manufacturing to concentrate near the country's northern border, insofar as firms have the incentive to locate production close to the U.S. market. The Mexican economy will become specialized regionally, with industry concentrated in the north, services in the environs of the capital, agriculture in the interior, and energy-related activities along the coasts. The exchange rate, like other macroeconomic instruments that operate at the national level, will be less efficacious, since different parts of Mexico will be experiencing different economic problems. More than any other factor, this may strengthen the case for a fixed exchange rate and, ultimately, a common currency for NAFTA.

1/ This tendency is explored in a European and North American context in Bayoumi and Eichengreen (1992a) and Krugman (1993).

2/ Many of these inferences are drawn from a study of the stock market effects of NAFTA negotiations reported by Thompson (1991).

3/ By implication, agriculture in other parts of the U.S., such as California and Florida, will contract. See Hufbauer and Schott (1992), p. 64 et seq.

4/ Hufbauer and Schott (1992), p. 65.

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