Dynamic Gains from North American Free Trade in an Equilibrium Model of the Current Account

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ABSTRACT

The benefits of economic integration in North America are explored by quantifying the gains that the two small open economies of the region can obtain from free trade in financial assets as a vehicle to smooth consumption. Numerical simulations of a stochastic intertemporal equilibrium model are used to estimate the effects of free financial asset trading on economic activity and welfare. The results suggest that in Mexico, where business cycles have been larger and access to world markets has been more limited, free asset trading would produce more benefits that in Canada, where the risk of business cycles is smaller.

I. INTRODUCTION

The North American Free Trade Agreement (NAFTA) announced August 12, 1992 between Canada, Mexico, and the United States seeks to create the largest free-trade zone in the world,[2] to achieve, for the first time, economic integration between two industrialized countries and one developing country, and to serve as the cornerstone of the free-trade zone comprising all of the Western Hemisphere envisaged in the Enterprise for the Americas Initiative. Given the far-reaching trade reform proposed in early negotiations of the NAFTA, and the strategic importance of the agreement, economists have rushed to undertake the task of assessing its effects on a variety of important economic issues—particularly macroeconomic performance, welfare, sectoral and regional trade patterns, and industrial organization (see for instance Baer (1991), Dornbusch (1990), Fritsch (1991), Globerman (1991), Hufbauer and Schott (1991), International Monetary Fund (1991a), and Reynolds et. al. (1991)).[3]

The purpose of this paper is to contribute to this research by producing quantitative estimates of the macroeconomic effects of trade liberalization for the small open economies of North America using a dynamic, stochastic equilibrium model. The analysis

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because of the difficulties in producing quantitative estimates of the effects of policies with these models. Recent developments in real business cycle theory have provided researchers with the tools that are necessary to produce such quantitative estimates, and the first attempts at performing policy analysis using dynamic stochastic, general equilibrium models have already been made (Cooley and Hansen (1989), Greenwood and Huffman (1991), Mendoza (1991b)). Nevertheless, work in this area is at a preliminary stage and much needs to be done before this approach reaches the same degree of flexibility that state-of-the-art econometric models have as policy-making tools.

Dynamic equilibrium macroeconomic models may also work well as a complement to the CGE models used in the trade literature. Most CGE models are deterministic and cannot account for the gains from trade resulting from changes in the long-run behavior of investment and the current account because they abstract from modelling optimal intertemporal behavior. By contrast, intertemporal macroeconomic models incorporate uncertainty and focus mainly on consumption-smoothing and growth-related gains from trade,[7] while abstracting from modelling the rich multi-sector and multi-agent structure typically found in CGE models (see Wigle (1988) for an analysis of the Canada-U.S. Free Trade Agreement and Hazledine (1990) for an examination of the role of industrial organization in CGE models).

While the estimates of the benefits of free trade presented in this paper are not affected by the Lucas Critique, since the dynamic game between private agents and policy-makers is modelled explicitly, the many simplifications adopted in the analysis imply that its results cannot be viewed as general or final, but rather as complementary to estimates obtained with traditional models. The model proposed here is an extension of equilibrium models of the current account widely studied in the early 1980s, as in Obstfeld (1981), Svensson and Razin (1983) and Greenwood (1983). These models emphasize the role of international trade as a consumption-smoothing mechanism, but the majority of them abstract from modelling investment and focus only on exchange economies. While this is a useful simplification for theoretical work, empirical research has shown that investment behavior should not be ignored (see for example Hercowitz (1986) and Mendoza (1992)). Hence, this paper considers the possibility of investment in domestic capital as an alternative use for the agents' savings, as in Backus, Kehoe and Kydland (1990) and Stockman and Tesar (1990), but in the more limited framework studied by Mendoza (1991a) that does not assume the existence of complete insurance markets.

The quantitative analysis applied to the case of Mexico in this paper is the first attempt to explore the implications of real business cycle theory for a developing country. Extending real business cycle theory to the case of developing countries requires that new elements be incorporated to account for the distortions and imperfections that affect markets in these countries. The model studied in this paper considers the barriers to international capital mobility and the imperfect nature of capital markets in developing countries, but it abstracts from introducing other important distortions.

The paper is organized as follows: Section II reviews the stylized facts of business cycles and the status of current exchange restrictions in Canada and Mexico. Section III discusses the structure of the model. Section IV presents the results of simulations that illustrate the model's ability to mimic the stylized facts. Section V reports estimates of the effects of liberalizing trade in financial assets on economic activity and welfare. The last section presents some concluding remarks.

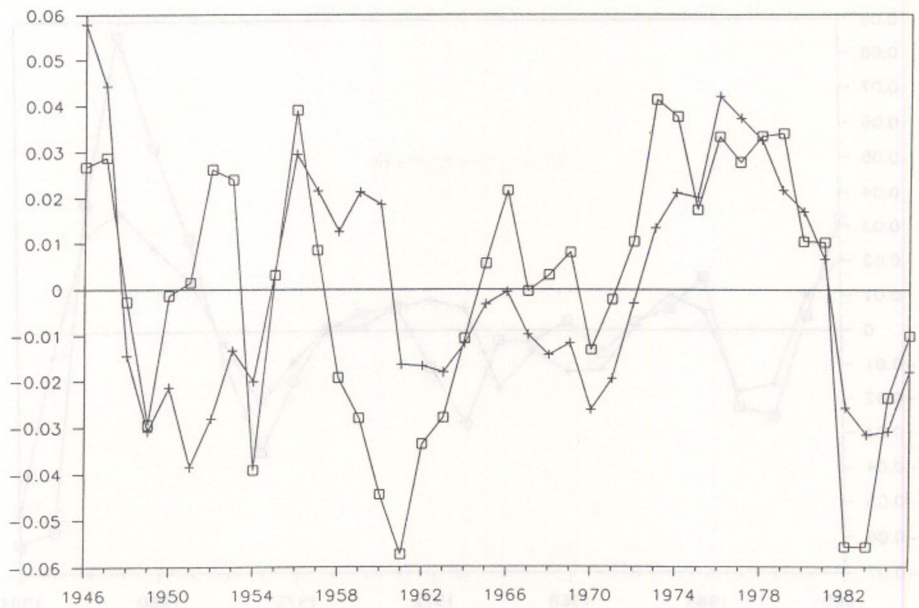

Figure 1. Canada: GDP and Consumption (deviations from trend)
Note: □ GDP + Consumption

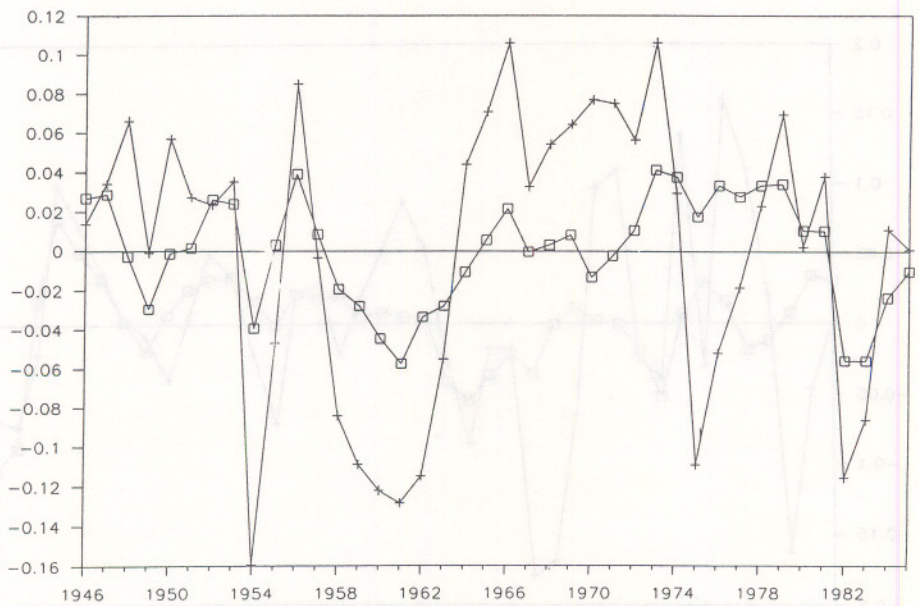

Figure 2. Canada: GDP and Savings (deviations from trend)
Note: □ GDP + Savings

Table 1 and Figures 1–4 show that the data for Canada and Mexico do not contradict the basic implications of consumption smoothing.[8] In terms of standard deviations relative to the standard deviation of GDP, Table 1 shows that consumption is the least variable of all macroaggregates, while savings, investment, and the balance of trade are more variable than output. Regarding the coefficients of correlation with GDP, consumption, savings and investment are procyclical, while the trade balance and real net foreign interest payments are countercyclical or almost uncorrelated with GDP. All macroeconomic aggregates for both countries also exhibit some degree of positive persistence.

Despite the difference in the size of economic fluctuations between Canada and Mexico—GDP is almost 3/4 of a percentage point more variable in Mexico than in Canada—the *qualitative* properties of business cycles in the two countries are not very different. Canada and Mexico exhibit a similar ranking of the coefficients of relative variability, co-movement with GDP, and first-order autocorrelation of all macroeconomic aggregates. Moreover, even some *quantitative* regularities appear to be common to the business cycles in the two countries, particularly with regard to the variability of savings, investment and consumption relative to the variability of GDP.

Despite these similarities, the specific characteristics of Mexico, as a developing country where international capital mobility and the access to world capital markets under competitive conditions have been restricted with varying intensity during the postwar period, should be reflected in the country's stylized facts. The large fluctuations of the balance of trade, the strong negative co-movement between the trade balance and GDP, and the lower variability of net foreign interest payments in Mexico compared with Canada may reflect in part some of these particular characteristics. For instance, the consumption-smoothing principle predicts that, assuming investment remains constant, net foreign assets should fluctuate more in an economy where GDP is more variable because holdings of foreign assets are adjusted more to prevent consumption from being affected by output changes. Nevertheless, real net foreign interest payments, which are used here to approximate the behavior of net holdings of foreign assets, are more variable in Canada than in Mexico. One possible interpretation of this fact would be that capital controls or capital market imperfections have prevented the optimal adjustment of foreign assets in the Mexican economy. By contrast, Canada during the postwar era has been characterized by the absence of capital controls and a high degree of integration of her financial markets with those of the United States.

The empirical regularities documented in this section illustrate that macroeconomic aggregates in Canada and Mexico tend to behave in a manner consistent with the predictions of a consumption-smoothing model of savings, investment, and current-account behavior. Thus, in principle it can be argued that the liberalization of trade in foreign financial assets for these two countries should bring about an improvement in welfare as individuals would have unrestricted access to world markets, thereby improving their ability to smooth consumption. The gains from this type of trade liberalization should be larger for Mexico, where business cycles are larger and trade in foreign assets has been more constrained. The rest of the paper will attempt to shed some light on these issues.

B. Exchange Restrictions

Given the theoretical results that have established the equivalence between quantity constraints on capital flows and different forms of price distortions and exchange-rate regimes (see Adams and Greenwood (1985), Frenkel, Razin, and Sadka (1991), and

Preferences: Preferences are given by:

$$\mathrm{E}\left[\sum_{t=0}^{\infty}\left\{u(C_t - G(L_t))\exp\left(-\sum_{\tau=0}^{t-1} v(C_\tau - G(L_\tau))\right)\right\}\right]. \tag{1}$$

with

$$u(C_t - G(L_t)) = \frac{\left[C_t - \frac{L_t^{\omega}}{\omega}\right]^{(1-\gamma)} - 1}{1-\gamma}, \quad \omega > 1,\ \gamma > 1, \tag{2}$$

and

$$v(C_t - G(L_t)) = \beta \ln\left(1 + C_t - \frac{L_t^{\omega}}{\omega}\right), \qquad \beta > 0. \tag{3}$$

Where C_t denotes private consumption and L_t are labor services.

As discussed in Mendoza (1991b), the endogenous-impatience utility function (1) is the stochastic analog of the utility function that Obstfeld (1981) used to produce a well-defined *deterministic* stationary equilibrium for the holdings of foreign assets. This steady state is attained when the accumulation of assets moves the impatience rate to reach the level of the world's real interest rate. In this paper, the endogenous rate of time preference produces a well-defined *stochastic* stationary equilibrium. The functional forms in (2) and (3) simplify the analysis by separating the labor supply choice from optimal savings dynamics, thereby allowing the model to explore the interaction between foreign assets and domestic capital as means of savings at the expense of eliminating the wealth effect on labor.[9]

Technology: The production technology is:

$$G(K_t, L_t, e_t, K_{t+1}) = \exp(e_t)\, QK_t^{\alpha}L_t^{1-\alpha} - \left(\frac{\phi}{2}\right)(K_{t+1} - K_t)^2,$$
$$0 < \alpha < 1, \qquad \phi > 0, \tag{4}$$

Where e_t is a random shock to output that may originate in productivity changes or terms-of-trade shocks, $QK_t^{\alpha}L_t^{1-\alpha}$ is a Cobb-Douglas production function, K_t is domestic capital, and $(\phi/2)(K_{t+1} - K_t)^2$ is the capital-adjustment cost as a function of net investment.[10] The capital evolution equation is:

$$K_{t+1} = (1-\delta)K_t + I_t, \qquad 0 \le \delta \le 1, \tag{5}$$

where δ is a constant rate of depreciation and I_t is gross investment.

Financial Structure: Financial markets adopt three forms depending on the restrictions affecting foreign asset trading and on the characteristics of world capital markets. First, in the absence of capital controls, and assuming perfectly competitive financial markets, agents enjoy unrestricted access to a market where they borrow or lend as much as they subject to

$$C_t = \exp(e_t)QK_t^\alpha \hat{L}_t^{(1-\alpha)} - \left(\frac{\phi}{2}\right)(K_{t+1} - K_t)^2 - K_{t+1} + K_t(1-\delta) + (1+r^*)A_t - A_{t+1},$$

$$\hat{L}_t = \operatorname{argmax}_{L_t}\left\{\exp(e_t)K_t^\alpha L_t^{(1-\alpha)} - \frac{L_t^\omega}{\omega}\right\},$$

$A_t \geq \Delta$, $K_t \geq 0$, and $C_t \geq 0$.

The probabilistic setting is simplified as follows. In every period the shocks take one of two values:

$$e_t \in E = \{e^1, e^2\}. \tag{11}$$

One-step conditional transition probabilities are denoted as π_{sr} and satisfy the conditions that $0 \leq \pi_{sr} \leq 1$ and $\pi_{s1} + \pi_{s2} = 1$ for $s,r = 1,2$. To minimize the number of free parameters in the model, the transition probabilities and the shocks are assumed to be symmetric: $\pi_{11} = \pi_{22} = \pi$ and $e^1 = -e^2 = e$, so that the asymptotic standard deviation, σ_e, and the first-order autocorrelation coefficient, ρ_e, of the disturbances are given by $\sigma_e = e$ and $\rho_e = 2\pi - 1$.

The first-order conditions describing optimal intertemporal plans in this free-trade economy have the usual interpretation, although with the caveat that changes in current consumption affect the rate of time preference at which future consumption is discounted.[14] From the perspective of any period t, optimal savings are set so as to equate the stochastic marginal rate of substitution between C_t and C_{t+1} with the gross real rate of return on foreign assets $1 + r^*$. Optimal investment is set so as to equalize the expected values of the returns on capital and foreign assets, taking risk factors into account by weighing each possible occurrence of the marginal product of capital by the marginal utility of consumption obtained in each state of nature. Thus, as a rough approximation, investment is governed by an optimal portfolio allocation decision that equates the returns on alternative assets, and savings are determined by the desire to smooth consumption given its fixed intertemporal relative price. Any need for savings not covered by investment in domestic capital, once investment is set optimally, will be covered by borrowing or lending in world capital markets.

Equilibrium in the Economies with Restricted Trade: The equilibrium of the economies with imperfect capital mobility and complete credit rationing is characterized in a similar manner as in the free-trade model, except that whenever restrictions on foreign asset trading are binding A_{t+1} is not a choice variable and equation (7), or equation (8), replaces (6). In the case of complete credit rationing, the restriction on foreign asset accumulation is always binding and the optimization problem is identical to the one that describes a closed economy—with a constant equal to the trade-balance target implied by $\hat{A}$ added into the resource constraint.

The presence of a binding constraint on A_{t+1} implies that investment is no longer governed by the optimal portfolio allocation rule discussed above. Since the economy is now "closed" in a dynamic sense, agents must undertake any optimal adjustment in savings exclusively by investing or disinvesting in domestic capital. Optimal savings are determined by a condition that equates the expected intertemporal marginal rate of substitution in consumption with the expected marginal productivity of capital.

model matches that observed in the data (4.3 percent). Next, values for the parameters that characterize preferences, technology, and the random disturbances must be selected. In general, the values of the parameters γ (coefficient of relative risk aversion), ω (1 plus the inverse of the intertemporal elasticity of substitution in labor supply), α (capital's share in output), δ (depreciation rate), β (the consumption elasticity of the rate of time preference), Q (an efficiency parameter), and r^* (the world's real interest rate), are selected using long-run averages of actual data, the restrictions imposed by the deterministic steady-state equilibrium of the model, and also by approximating some of the estimates obtained in the relevant empirical literature. The values of the parameters are as follows:

$$\text{Canada: } \alpha = 0.32,\ Q = 1.0,\ \delta = 0.1,\ r^* = 0.04,\ \omega = 1.455,\ \sigma = 1.6,\ \beta = 0.11,\ \phi = 0.023,\ \rho_e = 0.41, \text{ and } \sigma_e = 1.285 \text{ percent.} \tag{12}$$

$$\text{Mexico: } \alpha = 0.64,\ Q = 0.507,\ \delta = 0.1,\ r^* = 0.04,\ \omega = 1.113,\ \gamma = 2.3,\ \beta = 0.56,\ \phi = 0.029,\ \rho_e = 0.17, \text{ and } \sigma_e = 2.00 \text{ percent.} \tag{13}$$

The value of α is set as 1 minus the ratio of labor income to national income at factor prices. The efficiency parameter Q is a scale variable that does not affect equilibrium co-variances in the model, but it is used for consistency to correct for relative economy size given the Cobb-Douglas technology and the fact that income per capita in Mexico, adjusted for purchasing power, is one quarter of that in Canada. δ is the usual 10 percent depreciation rate of real business cycle models. r^* at 4 percent is the real interest rate for the U.S. economy in Kydland and Prescott (1982) and Prescott (1986). ω for both countries is in the range of estimates discussed in Mendoza (1991a). γ is set following Prescott's (1986) observation that γ is not much higher than 1, taking into account that agents in developing countries are likely to be more risk averse (see Ostry and Reinhart (1991)). β is determined by the steady-state equilibrium condition, considering that the postwar average ratio $-r^*A/Y$ is 1.9 percent for Canada and 2.5 percent for Mexico. ϕ, ρ_e, and σ_e are calibration parameters set to mimic σ_I, ρ_y, and σ_y respectively as observed in Canada and Mexico for the postwar period.

Table 2 presents the properties of business cycles in the model economies. The first column of each panel reports standard deviations relative to the percentage standard deviation of GDP, the second column lists coefficients of first-order serial autocorrelation, and the last column shows coefficients of correlation with GDP. These statistical moments can be compared with the corresponding moments from actual data reported in Table 1 to assess the model's ability to explain the stylized facts. A detailed discussion of this issue for the case of Canada is included in Mendoza (1991a). In general, the free trade model seems capable of explaining many of the key empirical regularities that characterize business cycles in Canada— including the controversial correlation between savings and investment— with the notable exceptions of the GDP correlation of consumption and savings, and the first-order autocorrelations of investment and the balance of trade. Apparently, as shown in Mendoza (1992), the assumption that the effective intertemporal relative price of consumption remains fixed at $1 + r^*$ is too strong, and a more realistic structure that would decompose consumption in tradable and nontradable goods would contribute to resolve these anomalies.

The model calibrated to the Mexican economy is less successful, but still capable of because it is likely to yield larger gains from trade than a comparison between free trade and a regime with some degree of capital mobility. The experiment in the case of Mexico has a straightforward interpretation as an attempt to quantify the changes that liberalizing trade would imply. For Canada, since capital controls have not been present in recent history in this country and her financial markets are close to fully integrated with U.S. financial markets, the experiment is better conceived as a measurement of the opportunity costs of restricting trade.

The comparison of simulations of the model under the two policy regimes for each country has two dimensions. The first focuses on the effects of liberalizing trade on economic activity, with the purpose of identifying differences in the cyclical behavior of key macroeconomic aggregates. The second deals with the welfare effects of free trade.

Welfare effects in this context are measured in terms of percentage changes in a level of consumption that remains fixed over time, but that yields the same lifetime utility as optimal consumption plans under free and restricted trade respectively. These stationary consumption paths are determined as follows:[17] There is a maximum lifetime utility attainable from each initial state of nature (K,A,e) under each trade regime, denoted $V^r(K,A,e)$ and $V^u(K,A,e)$ for restricted and unrestricted trade respectively, and hence there are time-invariant consumption streams $C^r(K,A,e)$ and $C^u(K,A,e)$ that represent the same level of lifetime utility as each V^r and each V^u. The percentage difference between C^r and C^u for each state of nature (K,A,e) is a measure of the welfare gain resulting from liberalizing trade when the economy is at that point in the state space. Welfare gains can then be looked at as "expected welfare gains," which are averages computed with the model's limiting probability distribution of the state variables, or as state-specific welfare gains from which maximum and minimum welfare gains can be determined. These welfare gains can be interpreted as "compensating variations" that measure how much additional permanent consumption agents need to be as well off under restricted trade as under free trade.

Table 3 lists the properties of business cycles that the model predicts for Canada and Mexico under trade regimes different from those assumed to produce the benchmark

TABLE 3. Canada and Mexico: Properties of Business Cycles Under Alternative Trade Regimes

	Strict Capital Controls						*Full Free Trade*		
	Canada			*Mexico*			*Mexico*		
Variables	μ[1]	σ[2]	ρy[3]	μ[1]	σ[2]	ρy[3]	μ[1]	σ[2]	ρy[3]
(1) GDP	1.00	1.00	1.000	1.00	1.00	1.000	1.00	1.00	1.000
(2) C	1.00	0.85	0.976	1.00	0.97	0.965	1.00	0.91	0.918
(3) S	1.00	1.64	0.939	1.00	1.11	0.969	1.00	1.23	0.949
(4) I	1.00	1.77	0.939	1.00	1.17	0.969	1.00	3.62	0.415
(5) L	1.00	0.70	1.000	1.00	0.89	1.000	1.00	0.90	1.000
(6) TB							1.02	0.54	−0.084
(7) −A	—	—	—	—	—	—	1.02	4.65	0.165
memo items:	SD(GDP) = 2.82			SD(GDP) = 4.09			SD(GDP) = 3.56		
	CORR(S,I) = 1.000			CORR(S,I) = 1.000			CORR(S,I) = 0.482		

Notes: [1]Mean relative to the mean in the corresponding benchmark model.
[2]Standard deviation relative to the percentage standard deviation of output SD(GDP).
[3]Coefficient of correlation with GDP.

TABLE 4. Canada and Mexico: Welfare Gains of Free Trade in Financial Markets

			Long-Run Gains	
	Short-Run Gains		*Probability weights*	
Country	*Maximum*	*Minimum*	*Free Trade*	*Capital Controls*
Canada	35.00	0.006	0.019	0.008
Mexico	257.00	0.009	0.502	0.026
Relative gains	7.34	1.500	26.421	3.250
Convergence experiments:				
Mexico, $\alpha = 0.32$	110.18	0.038	2.717	0.094
Mexico, $\gamma = 1.6$	33.03	0.007	0.015	0.014

Notes: Welfare gains measured as percentage increments in a level consumption that remains fixed over time and produces the same expected lifetime utility as the corresponding trade regimes. For Canada, the measures of welfare gains correspond to the absolute value of welfare losses obtained by considering a transition from the current state of free trade in financial assets to a regime of capital controls. For Mexico, measures of welfare gains consider a transition from a hypothetical regime of strict capital controls to a regime of free trade in financial assets. The simulations assume that for regimes of capital controls the average trade balance is the same as for free trade regimes.

Minimum welfare gains are very small for both countries because they occur when the initial state of the economy implies a level of foreign asset holdings close to the one set by capital controls. Nevertheless, Mexico's minimum welfare gain is 1½ times larger than Canada's.

The second panel of Table 4 reports long-run welfare gains that do not take as given the initial state of the economy, but rather assign some probability to the possibility of introducing the change in trade regimes when the economy is in a particular state (K_t, A_t, e_t), treating the welfare gain as an expected value. Since the model with and without free trade has been simulated for both Canada and Mexico, there are two sets of probability weights that can be used to compute the expected welfare gains for each country. Using free trade probabilities, the long-run gains from liberalizing trade for Mexico are equivalent to an increase of ½ percent in a fixed path of consumption forever, 26 times more than the long-run gains for Canada. Using the probabilities from the regime of capital controls, which by construction disregard those states of nature in which the gains from trade are larger (i.e. those initial states (K_t, A_t, e_t) where A_t is different from $\hat{A}$), Mexico's expected gains from trade measure only 0.026 percent, but are still more than 3 times larger than for Canada.[20]

Despite the fact that Mexico seems to benefit significantly more from free trade than Canada, the long-run welfare gains are generally small for both countries. However, it is very likely that actual gains from trade liberalization are significantly underestimated by the model. The only role played by international trade in this model is to serve as a mechanism to smooth consumption given fluctuations in domestic output. The size of the welfare gains is determined by how much agents wish to smooth consumption and by how well the vehicles for savings available (capital and foreign assets) serve this purpose. Given the actual size of business cycles in Canada and Mexico, and the degree of risk aversion that the model assumes for each country, the ability of agents to smooth consumption is not drastically affected by prohibiting them from entering world financial markets. This argument has been well documented for the case of industrial countries in the work of Lucas (1987), Cole and Obstfeld (1991), Backus, Kehoe, and Kydland (1990), and Mendoza (1991b). The results in this section show that the argument may also hold for a developing country where GDP fluctuates more, agents are more risk averse,

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NOTES

1. This paper was written for the session "Trade and Capital Market Implications of North American Economic Integration" organized by the North American Economics and Finance Association at the annual meetings of the ASSA in New Orleans, January 1992.

2. As of 1990, the combined population of Canada, Mexico and the United States exceeded 364 million and their combined GDP was about $6,200 billion.

3. However, researchers in this area are wary because previous experiences in measuring the effects of trade liberalization have failed to produce the impressive gains from free trade that theory would predict (see for example Coughlin (1990) for the Canada-U.S. Free Trade Agreement and Cecchini et. al. (1988) and Baldwin (1989) for the Europe 1992 project of economic integration).

4. For some details on financial services see *The Washington Times*, July 16, 1992, p.E2, for a general overview of NAFTA see *The Wall Street Journal*, August 13, 1992, p.A1: *The New York Times*, August 13, 1992, p.A1: and *The Financial Times*, August 13, 1992, p.1.

5. For a review of the existing restrictions see part B of Section II.

6. For applications to issues related to trade liberalization see Greenwood and Kimbrough (1985), Kimbrough (1987), and Frenkel and Razin (1987).

7. For a discussion on growth-related gains from trade see Baldwin (1989).

8. The fact that the stylized facts do not contradict the basic prediction of the consumption smoothing model is not proof that the model is supported by the data. The stylized facts are reported simply to provide some empirical motivation and a basis for the numerical simulations to be presented later.

9. Greenwood and Huffman (1991), and Mendoza (1991a) also used this structure of the consumption-labor choice. Without the wealth effect on labor, productivity and hours worked are perfectly procyclical; while this is counterfactual, in most real business cycle models with a wealth effect the substitution effect still dominates and hours are still highly procyclical (see Christiano and Eichembaum (1992)).

10. Costs of adjusting the capital stock are necessary to distinguish physical from financial assets and to prevent excessive investment variability in neoclassical open- economy models, where agents try to balance the marginal productivity of domestic capital with the real rate of return on savings in world markets (see Mendoza (1991a) for details).

11. Although random shocks to the interest rate introduced additional income and substitution effects, Mendoza (1991a) showed that shocks to r^* with a standard deviation of up to 5 percent of the mean have minimal effects on the behavior of macroeconomic aggregates in the free trade model.

12. Mendoza (1991b) shows that capital controls, as a quantity constraint, can be replaced with taxes on foreign income and produce exactly the same outcome.

13. Note that with the particular labor-consumption choice implied by (2)–(3), the marginal rate of substitution between C and L depends on the latter only, and hence labor supply is set by equating the marginal disutility and the marginal product of labor. The outcome of this maximization problem can be separated from the rest of the dynamic program to simplify the analysis, and the result enters in the Bellman equation as $\bar{L}$.

14. A more thorough analysis of similar first-order conditions is undertaken in Mendoza (1991a).

15. Running OLS regressions using model-generated data and assuming 5 percent interest-rate disturbances shows that the elasticity of investment increases by a factor of 3, from 0.8 to 2.4, as capital controls are lifted.

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