THE REAL OPTION VALUE OF FREE TRADE AGREEMENTS*

Gonzalo Cortázar**

ABSTRACT

The purpose of this paper is to analyze the effects of exchange rate risk in the value of bilateral and multilateral trade agreements. In order to value a bilateral trade agreement we initially consider a firm that must sell all its output in the local market. Then, we assume that the country in which the firm is located joins a bilateral trade agreement allowing the firm to redirect its output to another market whenever the level of exchange rates makes this optimal. The value of the bilateral trade agreement for the firm is then computed as the difference in firm value under both scenarios. Similarly, we value a multilateral trade agreement by computing the value of a firm that has the option to redirect its output to any among N countries.

Our results indicate that volatility of exchange rates may be valuable and thus their stabilization may harm some firms. In particular it provides support to those who oppose eliminating all volatility by means of defining a single currency within these trade agreements. Our main contribution is to incorporate modern financial economics into the analysis of free trade agreements and to highlight the option value of having costs and revenues expressed in different currencies.

SÍNTESIS

El propósito de este trabajo es el de analizar los efectos del riesgo cambiario en el valor de los acuerdos comerciales bilaterales y multilaterales. A fin de valorar un acuerdo inicialmente consideramos que una firma debe vender toda su producción en el mercado local. Entonces, asumimos que el país en que está ubicado se incorpora a un acuerdo comercial bilateral que permite a la firma reorientar su producción a otro mercado cuando el nivel de tipos de cambio lo hace óptimo. El valor del acuerdo comercial bilateral para la firma se calcula, entonces, como la diferencia en valor de la firma en cada escenario. Asimismo, valoramos un acuerdo comercial multilateral calculando el valor de una firma que tiene la opción de reorientar su producción a cualquiera de N países.

Nuestros resultados indican que la volatilidad cambiaria puede resultar valiosa y por tanto, su estabilización puede dañar a algunas firmas. En especial, proporcionar apoyo a aquellos que se oponen a la eliminación de toda volatilidad mediante la definición de una sola moneda dentro de estos acuerdos comerciales. Nuestro principal aporte es el de incorporar la teoría de finanzas moderna al análisis de los acuerdos de libre comercio y de destacar el valor de opción de contar con costos e ingresos expresados en monedas diferentes.

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1. INTRODUCTION

In recent years several international free trade agreements have become commonplace in the world economy. The U.S. has countered the E.E.C. integration efforts with free trade arrangements with Canada and probably Mexico. Scores of similar accords are at different levels of implementation around the world.[1] These agreements represent only the latest development in a sustained process of world market integration. The opening of markets to non-domestic firms is related to the spectacular development of multinational corporations (MNC), whose economic activities cross the borders of several nations. These MCNs,[2] which view foreign markets as an alternative to domestic growth, have reached a prominent role in the world economy [Batra and Hadar (1979)].

The theory of Multinational Corporations (MNCs) developed in the past decades is an effort to understand why they emerge and how they make their basic economic decisions. Among other issues, it tries to explain the cross sectional patterns of foreign direct investments and the determinants of entry choice by the firm. The two basic ways of serving a given foreign market are to export output from a domestic plant or to switch to international production, i.e., Foreign Direct Investment (FDI)[3].

Traditional International Trade Theory has long emphasized the value of trade agreements between countries with diverse characteristics. In particular, it states that countries with the most dissimilar endowment will trade the most. In this paper we highlight another source of value for a MNC: the *number* of potential

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[1] Mexico and Chile signed a free trade agreement in 1991. Mercosur, a common market among several Latin American countries is currently under negotiation. Similar treaties exist in Central America and other regions.

[2] Alternative names are Multinational Enterprises (MNE) and Transnational Corporations (TNC).

[3] Other entry alternatives exist, including licensing, franchising, management contracts, turnkey contracts, etc.

markets. One of the effects of free trade agreements is to effectively increase the number of potential output destinations for each firm.

The purpose of this paper is to try to quantify the increase in firm value coming from the additional number of potential markets made available by the subscription of a free trade agreement. We follow a modern finance theory approach to value firms with and without trade agreements. The basic intuition is that the option that a firm has to redirect its output among different alternative markets is valuable and should increase with the number of markets and with the uncertainty of its payoffs. Our model follows the real options literature in the tradition of Brennan and Schwart (1985), McDonald and Siegel (1986), Majd and Pindyck (1987) or Cortázar and Schwartz (1993), among others.

We start by describing the controversy on the effect of exchange rate uncertainty on investments and trade. Then we analyze a bilateral trade agreement that allows a firm that is currently selling all its output in the local market to alternatively export it to a foreign country. Uncertainty of payoffs is introduced in this model through the stochastic specification for the exchange rate between both countries. It is obvious that the addition of a foreign market is very valuable for a firm that has excess capacity and is searching for new markets where to sell its products. However, in this paper we are interested only in quantifying the additional value of a capacity constrained firm that retains the ability of redirecting its output to any market within a given trade agreement. To quantify this excess value we first compute the value of the firm that is selling all its output in the local market and then compare it with the value of a firm that can sell its output in any of two markets.

We then analyze a multilateral trade agreement and quantify the additional value of a firm that can sell its output in any of N markets. To compute the increase in value due only to the option feature we assume the output unit price, expressed in the same currency, is the same in all markets, but exchange rates fluctuate randomly. Finally, we draw our conclusions.

The main result of this paper is that exchange rate risk is valuable for firms that can redirect their output among different markets, a value that increases with the number of potential markets and with volatility of exchange rates. This result has empirical implications for monetary unions like the European Monetary Union (EMU) in that the elimination of exchange rate uncertainty among its members could decrease the value of some firms that may choose to move their production facilities outside the EMU boundaries to profit from the option feature just described.

2. THE EXCHANGE RATE UNCERTAINTY ISSUE

Volatility of exchange rates among major currencies have increased greatly since the collapse of the Bretton Woods system in the early 70's. No consensus exists on whether the volatility increase is due to the floating mechanism for exchange rates that has been in effect since then, or due to other independent factors. Whatever the reason, reduction in the volatility of exchange rates has been a stated objective of economic agents. For example, some countries, most noticeably members of the European Economic Community, have coordinated their monetary policies to stabilize exchange rates between them.

A second way of dealing with volatility has been the development of active markets for currency futures and options. Considerable controversy still exists on the degree of efficiency of these markets and the magnitude of risk premiums. Many studies consider the forward markets to be an unbiased estimator of the future spot price, which leads to the conclusion that, on average, there is no risk premium associated with it [Cornell (1977)]. Others have found some bias,[4] including possibly a time-varying risk premium across currencies, either positive or negative, but still with zero mean [Fama (1984)].

One of the first analyses of the effects of exchange rate uncertainty on foreign direct investment (FDI) behavior of multinational corporations is found in Batra and Hadar (1979). Under assumptions of firm utility maximization and risk aversion, the authors claim that uncertainty in exchange rates will reduce the export level of MNCs relative to domestic selling. Dixit (1989) is the first to incorporate continuous-time stochastic exchange rates in a model of optimal FDI by a multinational firm. Specifically, he analyzes optimal entry and exit decisions of a risk-neutral firm that has a timing option, which allows for costless delay of an irreversible investment. In his model the alternatives for the MNC are to invest in the market (FDI) or to pull out completely. Dixit's results only add to the widespread belief on the virtues of price stabilization. Among recent examples are Balassa (1990) describing how a low real exchange rate uncertainty can create a positive business climate, Ingersoll and Ross (1988) indicating the perverse effect of interest rate uncertainty on the long-term investment behavior of a firm, and Dornbusch (1987) and Van Wijnberger (1985) reaching the same conclusion with respect to uncertainty over tariff structures.[5]

In spite of mounting theoretical support, empirical evidence of the benefits of exchange rate stabilization has been more elusive. The implementation of the European Monetary System (E.M.S.) has provided an excellent empirical setting to analyze this issue. This monetary system was set in 1979 with the stated purpose of stabilizing exchange rates among its members in order to boost output and trade. A number of econometric studies have been performed using

[4] See review by Hodrick (1987).

[5] See Pindyck (1991) for a review.

European data, basically agreeing on the effectiveness of the E.M.S. in reducing the volatility of exchange rates, but presenting conflicting results about the effect of this uncertainty reduction on trade levels.[6] De Grauwe and Verfaille (1988) even report a reduction in total output growth of member countries under less volatile exchange rates, which they consider puzzling. In our work we will provide a theoretical model that is consistent with the above empirical facts.

3. THE REAL OPTION VALUE OF BILATERAL TRADE AGREEMENTS

To determine the additional economic value for a firm to enter a bilateral trade agreement we start by computing its value when it sells all its output q in the local market (country A) at a unit price P_A with a unit cost w_A. If the interest rate is r_A and the production levels and unit prices and costs are constant, the value of the firm V_A^A can be computed as the net present value of its cash flows:

$$V_A^A = \frac{q(P_A - w_A)}{r_A} \tag{1}$$

Now assume that country A and country B subscribe a bilateral free trade agreement whereby the firm can now choose where to send its output between both countries. Let X_B be the value of the currency of country B expressed in the currency of country A. For the moment we assume all prices, including the exchange rates, are deterministic. If interest rate parity holds, and r_A is greater than or equal to r_B, then X_B will grow at a $(r_A - r_B)$ rate. Using the well known Gordon equation for discounting a growing perpetuity, it can easily be seen that the value of the firm located in country A, that is selling all its output in country B, is:

$$V_A^B = q\left[\frac{X_B P_B}{r_A-(r_A-r_B)} - \frac{w_A}{r_A}\right] \tag{2}$$

Obviously, if V_A^B is greater than V_A^A the firm will decide to export all its production, and the value of the bilateral trade from the firm's perspective amounts to the difference between these two values.

The above model is very naive in that all prices are considered deterministic. We now introduce uncertainty into our model by considering that the exchange

[6] Empirical studies by Cushman (1983, 1986), Abrahms (1980), Thursby and Thursby (1985), and Kenen and Rodrik (1986) conclude that reductions in volatility increase exports. On the other hand, studies by Hooper and Kohlhagen (1978) and Gotur (1985) find a decrease in exports under similar conditions.

rate fluctuates randomly. Let us assume that the exchange rate X_B follows a Wiener stochastic process according to:

$$\frac{dX_B}{X_B} = \mu dt + \sigma dz \tag{3}$$

where μ is the instantaneous trend; σ is the known instantaneous standard deviation; t represents time; and dz is an increment to a standard Gauss-Wiener process.

There has been considerable controversy on the adequate stochastic process specification for exchange rates. On a theoretical ground, purchasing power parity would suggest that real exchange rates should exhibit a mean reverting behavior. In addition, there is some evidence that exchange rate variations do not follow a log normal distribution, exhibiting fatter tails [Boothe and Glassman (1987)], changing variance or lack of smoothness [Stulz (1990)]. This could be the reason for the systematic biases that have been found when applying the Black-Scholes formula to options on currencies, instead of on stocks.

Efforts to improve the currency option pricing formula by changing some of the distributional assumptions have not been very successful [Shastri and Wethyavivorn (1987); See Stulz (1990) for a review], and as Meese and Rogoff (1988) point out, the random walk model for exchange rates cannot be rejected using standard statistical tests. Given the status of empirical research on exchange rates, we find it adequate for our purposes to specify a standard Brownian motion for this process. It is important to note that we do not have to specify if exchange rates follow a random walk or a mean reverting process with purchasing power parity holding in the long run. For our purposes it suffices that μ is bounded (even if unknown) and σ known and nonstochastic.[7]

Once we have defined the stochastic process for the exchange rate we must assume there is a futures currency market which allows for hedging exchange rate risk. We then form a riskless portfolio by investing a specific proportion in the firm and shorting futures in foreign currency. Imposing the no arbitrage condition on the return of this riskless portfolio, it can be shown [Cortázar (1992)] that the value of the firm must satisfy the following differential equation:

$$\max_q \left[\frac{1}{2} V_{X_B X_B} X_B^2 \sigma^2 + q(X_B P - w_A) + (r_A - r_B) X_B V_{X_B} - r_A V \right] = 0 \tag{4}$$

$$\frac{1}{2} W_{X_B X_B} X_B^2 \sigma^2 + q(P_A - W_A) + (r_A - r_B) X_B W_{X_B} - r_A W = 0 \tag{5}$$

[7] Recall that the hedging argument used for option pricing implies that the drift of the exchange rate does not affect results.

subject to the following conditions:

$$W(0) = 0 \tag{6}$$

$$\lim_{X_B \to \infty} \frac{V(X_B)}{X_B} < \infty \tag{7}$$

$$W(X_B^*) = V(X_B^*) \tag{8}$$

$$W_{X_B}(X_B^*) = V_{X_B}(X_B^*) \tag{9}$$

In which V is the value of a firm that is optimally exporting its output; W is the value of a firm that is optimally selling locally its output; V_{X_B} is the partial derivative, X_B^* is the cut-off exchange rate above which it is optimal to export instead of selling locally. It can be shown by solving this model[8] that the value of the exporting firm V, with exchange rate uncertainty is:

$$V(X_B) = c_4 X_B^{\alpha_2} + \frac{qX_B P_B}{r_B} - \frac{qw_A}{r_A} \qquad for\ X > X*$$

$$c_4 = q\,\frac{\dfrac{PX_B^*(d_1 - 1)}{r_B} - \dfrac{P_A d_1}{r_A}}{(d_2 - d_1)X_B^{*\alpha_2}}$$

$$d_1 = \alpha_1 + \alpha_2$$

$$d_2 = \alpha_1 - \alpha_2 \tag{10}$$

$$\alpha_1 = \frac{1}{2} - \frac{(r_A - r_B)}{\sigma^2}$$

$$\alpha_2 = \sqrt{\left[\alpha_1^2 + \frac{2r_A}{\sigma^2}\right]}$$

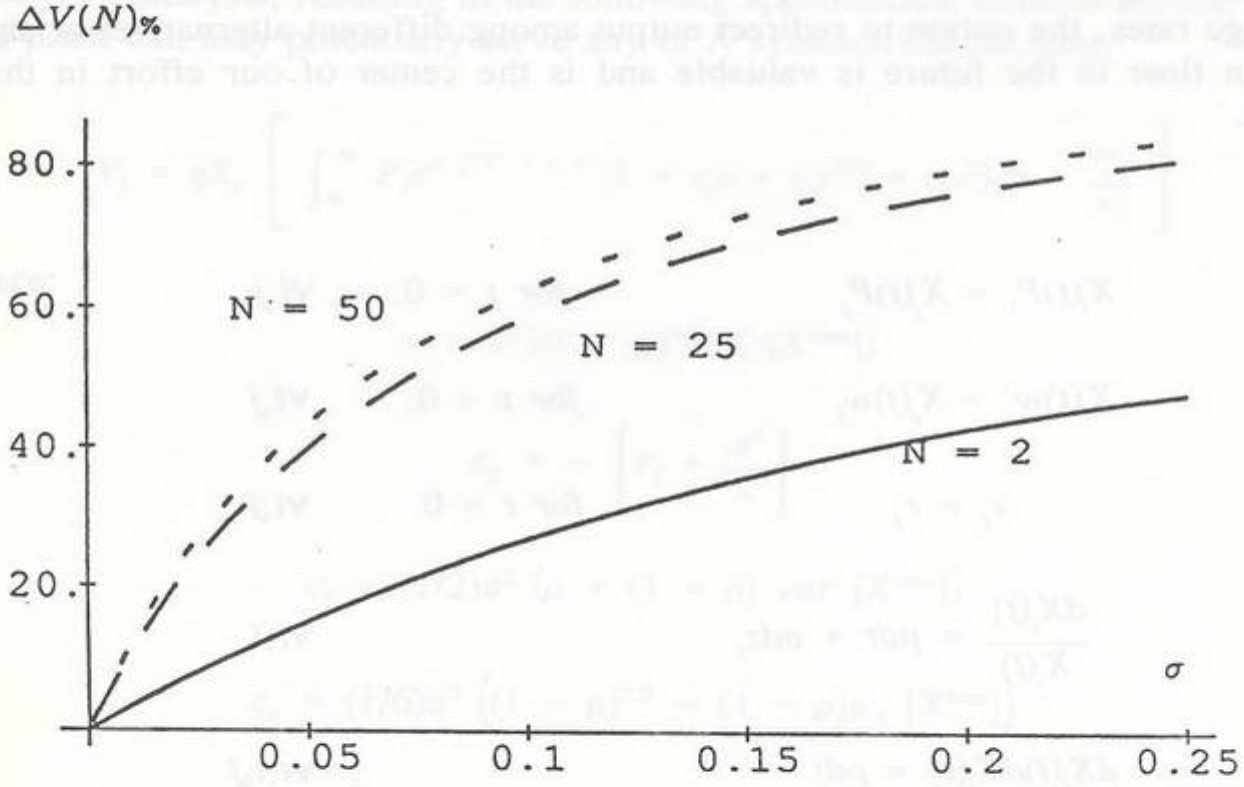
$$X_B^* = \frac{w_A}{P_B}$$

[8] See Cortázar (1992).

Comparing the expression for the value of the exporting firm with and without uncertainty (V and V_A^B) it becomes clear that the option value of allowing the firm to switch destination for its output, whenever the exchange rate level makes this optimal, amounts to $c_4 X_B^{\phi_4}$. Moreover, this option amounts to the additional value of the bilateral trade agreement whenever at the moment of its subscription the firm is indifferent between selling locally or exporting, which would be the case if r_A and P_A are equal to r_B and $X_B P_B$, respectively.

FIGURE 1

Firm Value With and Without the Option to Redirect Output Provided by a Bilateral Free Trade Agreement



This option value is positive and could amount to a sizable fraction of the total firm value, depending on the parameter levels. Moreover, the relative importance of this option increases with volatility of exchange rates as can be seen in Figure 1. Notice, however that this is a comparative static analysis in which we have fixed the level of the exchange rate, X. Should there be a high risk premium[9]

[9] The literature seems to suggest that risk premiums associated with exchange rates are low, at the most.

associated with holding currency, the increase in volatility could lower X, turning the net effect undetermined.

4. THE REAL OPTION VALUE OF MULTILATERAL TRADE AGREEMENTS

Multilateral trade agreements can effectively increase the number of potential markets a firm can supply. In this section we want to extend our previous analysis of a bilateral trade agreement that allowed a firm to redirect its output to any of two markets by considering now that the firm can choose among any of N countries that have subscribed a multilateral trade agreement.

To concentrate on quantifying only the option value available we consider all N countries identical in terms of output price, unit costs (expressed in the same currency), interest rates and the parameters of their exchange rate stochastic processes. Thus at the time of the valuation the firm is indifferent among all N countries as destination for its output. However, due to the randomness of future exchange rates, the option to redirect output among different alternatives at any point in time in the future is valuable and is the center of our effort in this section.

Then,

$$X_i(t)P_i = X_j(t)P_j \qquad \text{for } t = 0, \qquad \forall i,j$$

$$X_i(t)w_i = X_j(t)w_j \qquad \text{for } t = 0, \qquad \forall i,j$$

$$r_i = r_j \qquad \text{for } t = 0 \qquad \forall i,j$$

$$\frac{dX_i(t)}{X_i(t)} = \mu dt + \sigma dz_i \qquad \forall t,i$$

$$dX_i(t)dX_j(t) = \rho dt \qquad \forall t,i,j$$

where i, j are any of the N markets; $X_i(t)$ is the random price of one unit of currency of country i at time t, expressed in the investor's currency[10]; P_i and w_i represent the constant price and cost of one unit of output, expressed in the currency of country i; r_i is the risk-free rate of country i; μ and σ are the

[10] For example: let the investor be from Japan. If country i is the U.S., then X_i expresses the yen per dollar exchange rate.

instantaneous drift and standard deviation; dz_i is an increment to the standard Gauss-Wiener process for country i; and ρ is the correlation between exchange rate processes for any two markets, i and j.

In order to compute the value of the firm under a multilateral trade agreement we can note that the firm has now the option to send its output to any of N markets. Obviously, at each point in time the firm will choose the one that provides the maximum payoff. We can relate our problem with that of a financial claim that has a *quality option* embedded whereby the short position has the choice of delivering any one of an acceptable set of assets. This problem was analyzed by Boyle (1989) who proposes a procedure for determining the value of this option through some numeric approximation. Boyle solves the problem for a non-divided paying asset. In our case, it is clear that the interest rate of the currency is analogous to a dividend and in addition there is not one option but an infinite number of infinitesimal options available to the firm, the final destination of the output at each instant in time. Cortázar (1992) describes both extensions to Boyle's analysis, resulting in the following approximate solution for the value of a plant that may potentially serve any of N symmetrical markets:

$$V_1 = qX_1 \left[\int_0^{\infty} P_1 e^{c_1\sqrt{\tau} + c_2\tau} (1 + c_3\tau + c_4\tau^{3/2} + c_5\tau^2) d\tau - \frac{w_1}{r_1} \right] \tag{11}$$

where:

$$c_1 = \sigma \left((1 - \rho)^{1/2} \; E \; [X^{\max}] \right) \tag{12}$$

$$c_2 = - \left[r_i + \frac{\sigma^2}{2} \right] \tag{13}$$

$$c_3 = (1/2)\sigma^2 \left(\rho + (1 - \rho) \; var \; [X^{\max}] \right) \tag{14}$$

$$c_4 = (1/6)\sigma^3 \left((1 - \rho)^{3/2} + (1 - \rho)\mu_3 \; [X^{\max}] \right) \tag{15}$$

$$c_5 = (1/24)\sigma^4 \left(3\rho^2 + 6 \; \rho(1 - \rho) \; var \; [X^{\max}] + (1 - \rho^2)\mu_4 [X^{\max}] \right) \tag{16}$$

and X^{max} is the highest order statistic for a multivariate uncorrelated normal distribution; μ_s is the s^{th} moment; E[] and *var*[] are the expectation and variance operators. Owen and Steck (1962) tabulates these moments, for several N values.

Thus, the value of a plant that may serve N symmetric markets may be obtained by computing Eq. (11) through numerical methods.

In order to highlight the relative importance of having N possible markets we compute $\Delta V(N)_{\%}$ as the percentage of total value due to the increased number of markets:

$$\Delta V(N)_{\%} = \frac{(V(N) - V(1))}{V(N)} \times 100 \qquad (17)$$

in which V(N) is the value of the firm that has N available markets.

FIGURE 2

Percentage Increase of the Firm Value Dye to the Option to Redirect Output Provided by a Multilateral Free Trade Agreement, as a Function of the Volatility of Exchange Rates and the Number of Markets

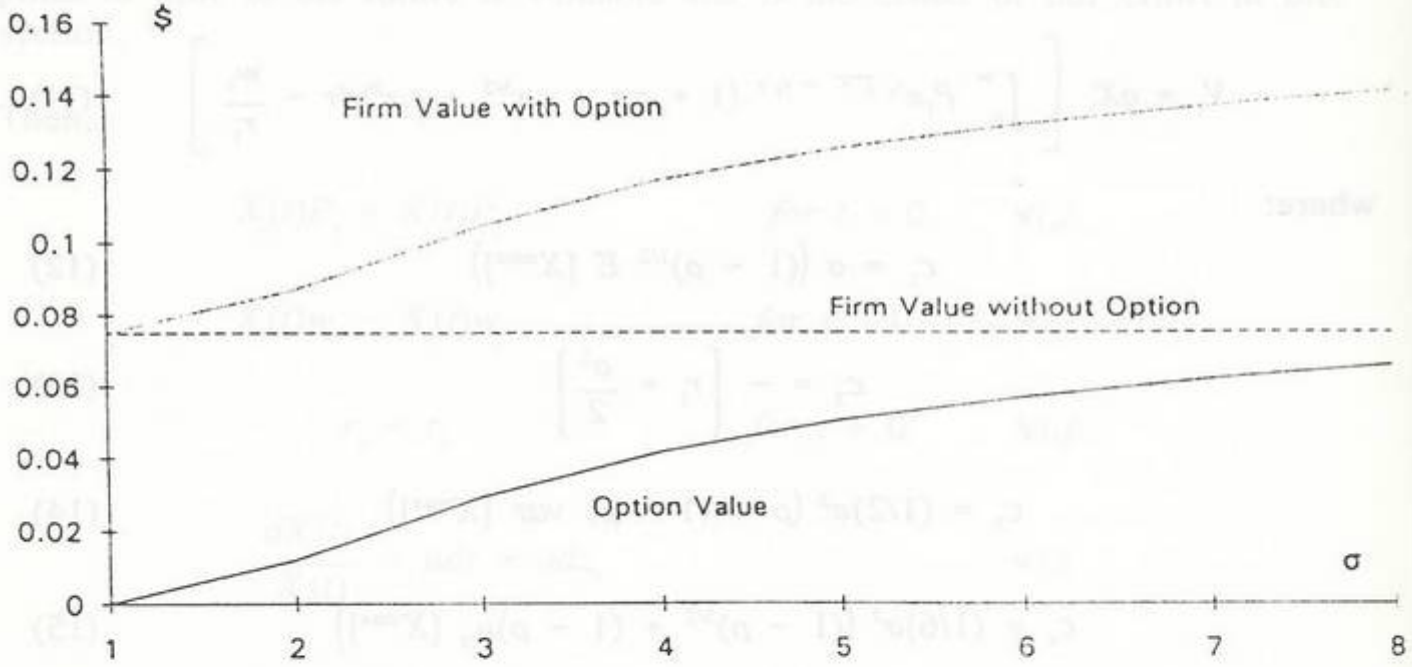


Figure 2 plots $\Delta V(N)_{\%}$ versus the standard deviation of exchange rates σ, for N equal to 2, 25 and 50. It can be seen that $\Delta V(N)_{\%}$ increases with N and σ, which is reasonable because the option to redirect output should be more valuable in those cases. It is worth noting that, at least for the parameter values used, a substantial percentage of total plant value is explained by the option term.

5. CONCLUSIONS

The purpose of this paper was to analyze the effect of exchange rate risk in the value of bilateral and multilateral trade agreements. The development of active future markets on all major currencies has allowed investors to hedge this risk, providing support for a no-arbitrage partial equilibrium model, for pricing purposes. Given current exchange rate levels, fixed output prices, fixed unit costs, and known parameters for the stochastic processes of exchange rates, we are able to value real asset investments under different settings.

In order to value a bilateral trade agreement, we initially consider the value of a firm that is selling all its output in the local market. No option to redirect output is available to the firm. Then, we assume that the country in which the firm is located joins a bilateral trade agreement allowing the firm to redirect its output to another market whenever the level of exchange rates makes this optimal. The value of the bilateral trade agreement for the firm can then be computed as the difference in firm value under both scenarios.

Next we value a multilateral trade agreement by considering that the firm has the option at each instant of time to redirect its output to the country that provides the highest payoff. We modify a quality option pricing procedure to include dividend paying assets and infinitesimal options and provide a numeric solution to approximate the value of the firm.

The general conclusion of this paper runs against common perception that stability of exchange rate *must* be good economic policy. It must be noted that, in spite of the traditional theoretical support on the benefits of exchange rate stabilization, empirical evidence has been very elusive. The implementation of the European Monetary System (E.M.S.) has been effective in reducing the volatility of exchange rates, but there are conflicting results about the effect of this uncertainty reduction on trade levels.

This paper is consistent with the argument that the reduction of exchange rate volatility may harm some firms. In particular, it provides support to those who oppose eliminating all volatility by means of defining a single currency within these trade agreements. Our main contribution is to incorporate modern financial economics into the analysis of the free trade agreements and to highlight the option value of having costs and revenues expressed in different currencies. Volatility of exchange rates is found to be valuable, as long as risk premiums are low. Even though our assumptions could be questioned for some real world settings, the model provides a tool for quantifying this option value and analyzing its sensitivity to different parameters.

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