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A Futures Market for International Trade

Udo Broll[1♣]
Bernhard Eckwert[2]

The paper studies the question how futures markets for international trade, which do not exist in the real world, would perform in a general equilibrium trade context. We find that futures markets, where terms of trade risks can be insured directly, generate zero equilibrium risk premia. Futures markets for international trade enable market participants to deal effectively, and free of cost, with instabilities in relative prices for international trade.

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1. Introduction

During the last decade the financial sector has been the most rapidly evolving part of the global economy. The changes in the financial sector have significantly improved international diversification of exchange rate risks. Yet, the basic risks affecting international trade derive from terms of trade fluctuations rather than from nominal exchange rate instability (Obstfeld and Rogoff, 1996). Terms of trade uncertainty may be caused by asymmetric stochastic shocks to the price levels in different countries which, due to rigidities, are not instantly absorbed by movements of the nominal exchange rate. Other sources of terms of trade uncertainty are uncertain spot exchange rates or uncertain transaction and marketing costs in foreign markets.

Changes in terms of trade influence the division of gains from trade between countries, i.e., terms of trade effects will always help one country and harm the other (see, for example, Jones, 1965, Marjit and Acharyya, 2003, Feenstra, 2004). The terms of trade are not only

[1] Department of Business Management and Economics, Dresden University of Technology, Germany.
♣ We would like to thank our referee for helpful comments and suggestions. Corresponding author: Dresden University of Technology, D-01062 Dresden, Germany, fax: +49 351 463-37736, e-mail: udo.broll@tu-dresden.de
[2] Department of Economics, University of Bielefeld, Germany.

affected by exchange rate movements but also by changes in domestic and foreign goods prices (see Ruffin, 1974, van Wincoop, 1999). Thus, financial instruments with payoffs that depend on the exchange rate between currencies provide only partial insurance against the risks which derive from fluctuating terms of trade (Goss, 2000, Wong, 2003, Drees and Eckwert, 2003, Broll and Eckwert, 2006). Despite the dynamic development of the global financial sector in recent times, markets where international terms of trade risks can be insured directly are still non-existent.

This paper develops a general equilibrium framework to analyze risk management policies in open economies. By hedging against terms of trade risk exposure, these economies can increase their gains from trade. We carry out a thought experiment and analyze how a future market for international trade would perform. On this market agents can trade contracts for contingent delivery of goods at a future date. A contract's payoff depends on the random intertemporal terms of trade. We ask whether it would be desirable if such a market were organized and how the equilibrium allocation of risk would be affected.[3]

As a main result we find that, unlike markets for other financial assets, a future market for international trade exhibits a zero equilibrium risk premium. In equilibrium, the terms of trade risk is efficiently allocated. A future market for international trade benefits all agents by allowing costless diversification of individual portfolios.

The paper is organized as follows. In section 2, a model of international trade under terms of trade uncertainty is introduced. We define a risk sharing mechanism through the specification of futures markets for international tradeable goods. The main result is proved in section 3. Concluding remarks are given in section 4.

2. The Trade Model

We begin by describing our assumptions about international trade under terms of trade uncertainty and the existence of a futures market for international tradeable commodities. Consider a two country world economy of pure exchange which extends over two periods. In each period there exists one perishable homogeneous consumption good which can be traded between the countries. Production is already given in both periods.[4]

The consumption sector in each country can be described by a representative consumer. Let $u(c_0, c_1)$ be the utility function of the consumption sector in the home country (country 1). Similarly $U(C_0, C_1)$ denotes the utility function of the foreign country (country 2).

[3] For a similar question, i.e., how to hedge or insure against risks that affect standards of living if an array of risk markets could be established, see Shiller, 1993.

[4] For a study of the interaction between production, investment, international trade and price/exchange rate uncertainties, see Kawai and Zilcha, 1986, Broll, Chow and Wong, 2001, Drees and Eckwert 2003.

Consumption in period i at home and abroad are denoted by c_i and C_i. The utility functions are strictly increasing and strictly concave.

Denote by x and X, respectively, the quantity of exports of country 1 and country 2 in period 0. In period 1, imports of country 1 are $\tilde{p}x$ and imports of country 2 are $\tilde{p}X$. The random intertemporal terms of trade are denoted by $\tilde{p} := p + \tilde{\varepsilon}$, where $\tilde{\varepsilon}$ is an exogenous terms of trade shock, with $E(\tilde{\varepsilon}) = 0$. The systematic component of the intertemporal terms of trade is p and will be determined endogenously in equilibrium.

The consumers in both countries have access to a future market for international trade. On the future market, which is open at date 0, contracts for contingent delivery of commodities are traded. A futures contract pays off p units of the commodity at date 1, if the terms of trade turn out to be p. Both the payoff p and the price of a futures contract, denoted θ, fall due in period 1.

The consumers in both countries maximize expected utility, defined over current and future consumption. If $\bar{x}_0$ and $\bar{x}_1$ are the initial endowments in period 0 and 1, and the variable h denotes the sale (or purchase, if negative) on the future market, the risk averse consumer in country 1 chooses international trade x and futures contracts h such that:

$$\max_{x,h} E[u(c_0, \tilde{c}_1)], \tag{1}$$

subject to

$$c_0 = \bar{x}_0 - x,$$
$$\tilde{c}_1 = \bar{x}_1 + \tilde{p}x + h(\theta - \tilde{p})$$

The first order conditions for problem (1) are:

$$E[u_1(c_0, \tilde{c}_1)] - E[u_2(c_0, \tilde{c}_1)\tilde{p}] = 0, \tag{2}$$

$$E[u_2(c_0, \tilde{c}_1)(\theta - \tilde{p})] = 0, \tag{3}$$

where u_i denotes marginal utility of consumption in the present and future period.
Combining equations (2) and (3) yields:

$$E[u_1(c_0, \tilde{c}_1)] = \theta E[u_2(c_0, \tilde{c}_1)]. \tag{4}$$

Similarly, and in obvious notation, the consumer in country 2 solves,

$$\max_{X,H} E[U(C_0, \tilde{C}_1)] \tag{5}$$

subject to

$$C_0 = \overline{X}_0 - X,$$
$$\widetilde{C}_1 = \overline{X}_1 + \widetilde{p}X + H(\theta - \widetilde{p}),$$

leading to the first order conditions:

$$E[U_2(C_0, \widetilde{C}_1)(\theta - \widetilde{p})] = 0, \tag{6}$$

$$E[U_1(C_0, \widetilde{C}_1)] = \theta E[U_2(C_0, \widetilde{C}_1)]. \tag{7}$$

The international economy is in equilibrium if the commodity and the future markets clear.

Definition The vector $(\theta^*, p^*, h^*, H^*, x^*, X^*)$ is an equilibrium if

(i) Given $\theta = \theta^*$ and $\widetilde{p} = p^* + \widetilde{\varepsilon}$, consumer's optimum in (1) and (5) is obtained at (x^*, h^*) and (X^*, H^*).

(ii) All markets clear, i.e.,

$$x^* + X^* = 0, \tag{8}$$

$$h^* + H^* = 0. \tag{9}$$

We shall study now the equilibrium risk premium in the futures market for international trade.

3. The Main Result

In models of partial equilibrium it is often assumed that futures markets are biased, i.e., exhibit a non-zero risk premium. Depending on whether the future market is upward or downward biased, typically different implications for the economy-wide risk allocation can be obtained.[5]

The following proposition claims that in *equilibrium* futures markets for international trade are unbiased.

Proposition 1. In equilibrium futures markets for international trade are unbiased, i.e., $\theta^* = E(\widetilde{p}) = p^*$. The risk sharing market ensures that in equilibrium all terms of trade risk exposures are allocated efficiently.

Proof Let (x^*, p^*) be the solution to the following system

$$u_1(\overline{x}_0 - x, \overline{x}_1 + px) = pu_2(\overline{x}_0 - x, \overline{x}_1 + px), \tag{10}$$

$$U_1(\overline{X}_0 - x, \overline{X}_1 + px) = pU_2(\overline{X}_0 - x, \overline{X}_1 + px), \tag{11}$$

[5] See, for example, Kawai and Zilcha, 1986, Lence, 1995, Sercu and Uppal, 1995, Wong 2003.

and define $\theta^* = p^*, X^* = -x^*, h^* = x^*$, and $H^* = X^*$. Since

$$\tilde{c}_1^* = \bar{x}_1 + \tilde{p}x^* + h^*(\theta^* - \tilde{p}) = \bar{x}_1 + p^* x^*$$

and

$$\tilde{C}_1^* = \bar{X}_1 + \tilde{p}X^* + H^*(\theta^* - \tilde{p}) = \bar{X}_1 + p^* X^*,$$

are non-random, equation (3) and (6) are satisfied.

Also, equations (4) and (7) are satisfied by virtue of (10) and (11). Thus, given the forward rate θ^* and random terms of trade $\tilde{p} = p^* + \tilde{\varepsilon}$,, the consumers' optimal choices are (x^*, h^*, X^*, H^*). Since, by definition of x^*, h^*, X^*, H^*, the equilibrium conditions (8) and (9) are satisfied, the vector $(\theta^*, p^*, h^*, H^*, x^*, X^*)$ constitutes an equilibrium.

It remains to show that there cannot exist another equilibrium with $\theta \neq p$. By way of contradiction assume that $(\theta^\dagger, p^\dagger, h^\dagger, H^\dagger, x^\dagger, X^\dagger)$ is an equilibrium with $\theta^\dagger \neq p^\dagger$. Consumption in country 1 is given by

$$c_0^\dagger = \bar{x}_0 - x^\dagger$$

$$\tilde{c}_1^\dagger = \bar{x}_1 + (p^\dagger + \tilde{\varepsilon})x^\dagger + h^\dagger(\theta^\dagger - p^\dagger - \varepsilon^\dagger) \tag{12}$$

Consumption in country 2 is

$$C_0^\dagger = \overline{X}_0 - X^\dagger$$

$$\tilde{C}_1^\dagger = \bar{X}_1 + (p^\dagger + \tilde{\varepsilon})X^\dagger + H^\dagger(\theta^\dagger - p^\dagger - \varepsilon^\dagger) \tag{13}$$

Equation (3) can be rewritten as

$$E[u_2(c_0^\dagger, \tilde{c}_1^\dagger)](\theta^\dagger - p^\dagger) - \operatorname{cov}(u_2(c_0^\dagger, \tilde{c}_1^\dagger), \tilde{\varepsilon}) = 0. \tag{14}$$

Let us first consider the case where $\theta^\dagger - p^\dagger > 0$. Under this constellation $\operatorname{cov}(u_2(.), \tilde{\varepsilon})$ must be positive by virtue of (14). Equation (12) and the fact that the covariance is positive together imply $h^\dagger > x^\dagger$. Similar reasoning for country 2 yields $H^\dagger > X^\dagger$. Combining the last two inequalities with the commodity market equilibrium condition, $x^\dagger = -X^\dagger$, yields $h^\dagger + H^\dagger > x^\dagger + X^\dagger = 0$. Similarly, if $\theta^\dagger < p^\dagger$, we obtain $h^\dagger + H^\dagger < 0$ by the same reasoning as above. Thus the future market for international trade exhibits either excess demand or excess supply contradicting our assumption that $(\theta^\dagger, p^\dagger, h^\dagger, H^\dagger, x^\dagger, X^\dagger)$ is an equilibrium.

According to the Proposition 1 a futures market for international trade cannot be biased. As an immediate implication, by providing hedging opportunities free of cost, such a risk sharing market ensures that in equilibrium all terms of trade risks are allocated efficiently.

Our finding that the risk premium on the futures market for international trade cannot be different from zero may appear puzzling at first sight. Conventional wisdom holds that typically financial markets generate non-zero risk premia, so that agents get rewarded for their risk bearing. Yet, this intuition does not apply to the futures market of international trade. On this market no outside stock of contracts is supplied which makes it different from other markets for financial assets. In equilibrium, therefore, the speculative positions of the agents on this market must either be zero or cancel out in the aggregate. Yet, since in a symmetrically informed economy all agents speculate in the same direction, it is impossible that non-zero speculative positions of some agents are offset by those of others. Thus, in equilibrium speculation must be absent, i.e., all agents choose a full hedge which requires the risk premium to be equal to zero.

This kind of reasoning assumes that the trading partners are symmetrically informed. In the presence of informational asymmetries the equilibrium risk premium on the futures market for international trade may differ from zero and the risk allocation may be inefficient. To see this, consider the case where the consumer in country 1 has more reliable information about the intertemporal terms of trade than the consumer in country 2. Being rational, the better informed agent tries to exploit his informational advantage at the expense of his trading partner. In an effort to avoid being exploited the consumer in country 2 will trade only reluctantly, or possibly not at all, on the futures market. In equilibrium, therefore, the terms of trade risks may not be fully hedged and the risk allocation may be inefficient.

4. Concluding Remarks

This paper develops a general equilibrium framework to analyze risk management policies in open economies. Hedging with futures and other derivatives is an important tool for insurance in international trade. In reality, various derivative markets for commodities, interests and currencies are available. However, these markets provide only partial insurance against the risks which derive from fluctuating international terms of trade. This paper studies the question whether it would be desirable if such risk sharing markets were organized, and how they would perform in equilibrium. We demonstrate by hedging against terms of trade risk exposure, open economies increase their gains from trade.

Our study suggests that in equilibrium, the risk premium in the futures market for international trade is zero. Thus, by trading on this market agents can get protection against the terms of trade risk at zero cost. In equilibrium, therefore, the terms of trade risk is fully diversified in individual portfolios; and it is also allocated efficiently on the market level. In view of this result the organization of futures markets for international trade constitutes an important tool which enables market participants to deal effectively with instabilities in prices for international commodity exchange.

Our two period approach can easily be extended to a model with arbitrary, but finite, time horizon. A simple backward induction argument shows that in such a generalized framework, again, the futures market for foreign trade will be unbiased. It is also worth mentioning that our analysis assumes away all informational asymmetries among agents. If expectations about the stochastic terms of trade in the future period 1 depend on private information, then part of this information will be revealed by the equilibrium price of futures contracts. The impact of endogenous information flows on the operation of a futures market for international trade is beyond the scope of this paper.

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