

Measuring the Benefits from Futures Markets: Conceptual Issues

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Abstract

This paper illustrates that the usual consumer surplus approach to evaluation of the benefits of a futures market fails because of certain unobserved benefits. In particular, when futures markets provide benefits in the form of a reduced variability of future spot prices, the usual consumer surplus approach will systematically understate the benefits of futures markets.

Key words: futures markets; price variability; consumer surplus

JEL classification: D6; G0

1. Introduction

Over the past decade or so, there has been an impressive expansion in the number of commodity and financial futures markets throughout the world, and in the variety of such markets. It is widely believed that, in a world of incomplete markets, the introduction of new financial markets will improve social welfare. For example, futures markets provide benefits to participating traders and through them, to consumers, by reducing transaction costs, by providing a more efficient flow of information among traders, and by shifting risks among them. Of course, any new markets can be beneficial to the overall economy as well, although external effects might negate these benefits [see Hart (1975), Newbery and Stiglitz (1984), Geanakoplos and Polemarchakis (1986), Elul (1995), and Duffie and Rahi (1995)].

A specific benefit of futures markets is that they can act to reduce risks for market participants. They do this in part by providing a mechanism for shifting risks from more risk averse to less risk averse traders. They also do this by improving the flow of information among market participants. In addition, under certain conditions at least, futures markets can reduce the perceived variability of future spot prices.

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For the most general case, there is little agreement on the effect the futures markets have on the underlying spot market; see Mayhew (2000) for a comprehensive survey.

From a public policy point of view, these potential benefits of futures markets must be weighed against the potential costs in evaluating regulatory proposals concerning such markets. The appropriate way to measure the benefits of futures markets is through a consumer surplus approach. However, there are basic conceptual problems with applying consumer surplus to the evaluation of the benefits of a futures market in a world with an incomplete set of markets. As will be shown here, the assumption of rational behaviour by consumers in the face of uncertainty about future spot prices of commodities leads to the conclusion that the usual consumer surplus approach to evaluation of the benefits of a futures market fails because of certain unobserved benefits. In particular, when futures markets provide benefits in the form of a reduced variability of future spot prices, the usual consumer surplus approach will systematically understate the benefits of futures markets.

In what follows, we examine only the conceptual problems associated with consumer surplus in measuring the benefits of a futures market associated with a reduction in the variability of future spot prices for a commodity. However, it is obvious that the same problems arise in more inclusive studies of the benefits of futures markets.

2. The Analytical Framework

For simplicity of notation, we use a two-period, two-commodity framework to derive our measure of the value of a futures market. An extension of the result to the n -period, m -commodity case is straightforward. We consider a pure exchange economy, in which a typical consumer is provided with known endowments of the two goods, x and y , in each of the two periods. At time $t = 1$, prices p_1 and q_1 for the goods x and y , are known with certainty, but prices in the second period are random variables. At time $t = 2$, second period prices of the goods are known before the consumer makes his consumption choices. It is assumed that the market rate of interest r is known with certainty.

Let x_t and y_t denote the consumption levels of goods x and y in period t , $t = 1, 2$, respectively. In each period, prices of the two goods are p_t and q_t , respectively, whereas the consumer has endowments of the two goods, ω_{xt} and ω_{yt} , respectively. Thus, the present value of income for the consumer is

$$V = p_1\omega_{x1} + q_1\omega_{y1} + (1+r)^{-1}(p_2\omega_{x2} + q_2\omega_{y2}). \quad (1)$$

Let β denote the personal time discount rate. Suppose that the consumer has an additive, separable inter-temporal utility function. His expected utility is then

$$EU = u_1(x_1, y_1) + \beta \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} u_2(x_2, y_2) f(p_2, q_2) dp_2 dq_2, \quad (2)$$

where $u_t(.,.)$ is the utility function and $f(.,.)$ is the joint density function of the second period prices. Based upon the information available, the consumer will choose optimal consumption levels in the two periods to maximize his expected utility. Because of price information updating, the problem is to be analyzed by the usual dynamic programming approach; that is, a backward induction procedure is adopted.

At time $t=2$, when the choices x_1 and y_1 have already been made and prices p_2 and q_2 are known, the amount of money available to be spent is

$$V_2 = [V - (p_1x_1 + q_1y_1)](1+r). \quad (3)$$

We assume away the default problem, so that it is simply assumed that $V_2 > 0$. The consumer's problem is to maximize $u_2(x_2, y_2)$ subject to the constraint that $p_2x_2 + q_2y_2 = V_2$. This results in the demand functions $x_2 = x_2(p_2, q_2; V_2)$ and $y_2 = y_2(p_2, q_2; V_2)$.

Returning to the first period problem, the consumer chooses x_1 and y_1 to maximize

$$EU = u_1(x_1, y_1) + \beta \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} u_2[x_2(p_2, q_2; V_2), y_2(p_2, q_2; V_2)] f(p_2, q_2) dp_2 dq_2. \quad (4)$$

The first order conditions are as follows:

$$\frac{\partial EU}{\partial x_1} = \frac{\partial u_1}{\partial x_1} - p_1(1+r)\beta \frac{\partial EU_2}{\partial V_2} = 0, \quad (4a)$$

$$\frac{\partial EU}{\partial y_1} = \frac{\partial u_1}{\partial y_1} - q_1(1+r)\beta \frac{\partial EU_2}{\partial V_2} = 0. \quad (4b)$$

Now, assume that there exists a shift parameter α appearing in the probability density function $f(.,.)$ such that an increase in α results in a decrease in the variability of p_2 . For example, an increase in α decreases the variance of a normally distributed p_2 . A futures market is assumed to be represented by an increase in α .

3. The Effect of a Futures Market

We wish to measure the consumer surplus that results from an increase in α . Since we are concerned with a compensated demand curve, changes resulting from an increase in α must be such that $d(EU) = 0$, where

$$d(EU) = \left[\frac{\partial EU}{\partial x_1} \frac{dx_1}{d\alpha} + \frac{\partial EU}{\partial y_1} \frac{dy_1}{d\alpha} + \frac{\partial EU}{\partial p_1} \frac{dp_1}{d\alpha} + \frac{\partial EU}{\partial q_1} \frac{dq_1}{d\alpha} + \frac{\partial EU}{\partial \alpha} \right] d\alpha + \frac{\partial EU}{\partial V} dV. \quad (5)$$

Note that, in an equilibrium framework, both p_1 and q_1 are determined endogenously (although individuals take them as given when making their decisions). Consequently, both are functions of α . By the first order conditions,

$$\frac{\partial EU}{\partial x_1} = \frac{\partial EU}{\partial y_1} = 0, \quad (6)$$

whereas $dq_1/d\alpha = 0$ by the usual partial equilibrium assumption. Equation (5) implies

$$\frac{\partial EU}{\partial V} dV = - \left[\frac{\partial EU}{\partial p_1} \frac{dp_1}{d\alpha} + \frac{\partial EU}{\partial \alpha} \right] d\alpha. \quad (7)$$

Moreover,

$$\frac{\partial EU}{\partial p_1} = -x_1 \beta (1+r) \frac{\partial Eu_2}{\partial V_2} \quad (8)$$

and

$$\frac{\partial EU}{\partial V} = \beta (1+r) \frac{\partial Eu_2}{\partial V_2}. \quad (9)$$

We derive the following equation:

$$-dV = \left\{ -x_1 \frac{dp_1}{d\alpha} + \left[\beta (1+r) \frac{\partial Eu_2}{\partial V_2} \right]^{-1} \frac{\partial EU}{\partial \alpha} \right\} d\alpha. \quad (10)$$

Assume that introducing a futures market changes the value of α from $\alpha = 0$ to $\alpha = \alpha^*$, and that associated with that change in α is a change in p_1 from $p_1(0)$ to $p_1(\alpha^*)$. The measure of consumer surplus due to the introduction of the futures market is then given by

$$W = - \int_{p_1(0)}^{p_1(\alpha^*)} x_1(p_1, q_1) dp_1 + \frac{1}{\beta(1+r)} \int_0^{\alpha^*} \left[\frac{\partial Eu_2}{\partial V_2} \right]^{-1} \frac{\partial EU}{\partial \alpha} d\alpha, \quad (11)$$

with

$$\frac{\partial EU}{\partial \alpha} = \beta \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} u_2[x_2(p_2, q_2; V_2), y_2(p_2, q_2; V_2)] \frac{\partial f(p_2, q_2; \alpha)}{\partial \alpha} dp_2 dq_2. \quad (12)$$

By the usual partial equilibrium assumption, we have $f(p_2, q_2; \alpha) = f_p(p_2|q_2; \alpha)$

$f_q(q_2)$ where $f_p(\cdot|\cdot)$ denotes the conditional density of p_2 given q_2 and $f_q(\cdot)$ is the marginal density of q_2 . Furthermore, $u_2(\cdot, \cdot)$ is monotonically decreasing in p_2 and q_2 . By the Quirk-Saposnik (1962) result concerning the first-degree stochastic dominance, it follows that if the conditional distribution function $f_p(p_2|q_2; \alpha)$ is an increasing function of α , then $\partial EU / \partial \alpha > 0$. More generally, assume that $u_2(\cdot, \cdot)$ is monotonically decreasing and concave in p_2 and q_2 . By the Hadar-Russell (1969) result, if an increase in α leads to a distribution $f_p(p_2|q_2; \alpha)$ that is stochastically dominated in the second degree, then $\partial EU / \partial \alpha > 0$. In particular, if $f_p(p_2|q_2; \alpha)$ is normal and if there is a mean-preserving decrease in the variance resulting from an increase in α , then $\partial EU / \partial \alpha > 0$.

Thus, under any of the above conditions, if a futures market leads to stabilization of future spot prices, then $\partial EU / \partial \alpha > 0$. As a result, the second integral of equation (11) is positive, but not observable. The integral measures the benefits to a consumer from a decrease in the variability of p_2 even if this has no effect on p_1 .

Also, note that the consumer surplus measure depends only on the first period demand for x ; the backward oriented dynamic programming routine incorporates all second period benefits into the first period measure. Equation (10) points out a difficulty in measuring the contribution to the consumer surplus by a futures market. To accurately measure the benefits of a futures market, information on consumers' inter-temporal preferences must be gathered. Lacking this information, the benefits of futures markets tend to be underestimated when the futures market stabilizes spot prices.

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