Why hedging, as practiced for storable commodities, is not an option for dairy farmers: a critical discussion

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Abstract. It is common practice in the literature to apply the same hedging practices (i.e., full hedging and minimum variance hedging) to storable and non-storable commodities. But is this approach also suitable for fluid milk? Dairy farmers have very different hedging objectives than grain farmers. The former want to lock in profitable forward prices for fluid milk, while the latter are looking for profitable storage margins for grain. In this paper, we will discuss not only why standard hedging practices are inappropriate when the goal is to lock in a forward price for fluid milk but also which hedging practice should be used instead.

Keywords. Hedging, storage hedge, forward price hedge, fluid milk.

Introduction

After the Second World War, there was a controversial debate as to whether or not futures markets should be introduced for non-storable commodities (Bakken, 1970). Ultimately, however, the proponents of the introduction prevailed, and futures markets for non-storable commodities were introduced. The last futures market for a non-storable commodity to be introduced in the United States was the market for fluid milk in 1996.

Like other futures markets, the fluid milk futures market has attracted some interest in the literature. In particular, several hedging studies (e.g., Cropp, 1996; Maynard et al., 2005; Altman, et al., 2008; Newton and Thraen, 2013; Mirza et al., 2020) have been conducted for fluid milk over the past three decades. What the fluid milk hedging studies had in common with the earlier literature was that they all assumed, without further analysis, that the same hedging practices (i.e., full hedging and minimum variance hedging) that work for storable commodities can also be applied to non-storable commodities.

But can this generalization simply be made? Can hedging practices developed for storable commodities really be applied to fluid milk? Dairy farmers hedge for a completely different purpose than grain farmers: while dairy farmers want to lock in profitable forward prices for milk yet to be produced, grain farmers want to lock in profitable storage margins for grain to be stored after harvest.

In this paper, we will explain why the previous generalization is not possible. First, we will discuss the reasons why standard hedging practices are not the right tool if the goal is to lock in a profitable forward price for fluid milk. We will then illustrate what hedging practice should have been used instead to lock in a forward price for fluid milk.

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Our work is important because it challenges the widely held view in the literature that standard hedging practices (i.e., full hedging and minimum variance hedging) are applicable to all hedging objectives. This view is incorrect. When the objective is to lock in a forward price, a different hedging practice is required, namely forward price hedging, as we will call this practice.

Although this paper focuses on dairy farmers and fluid milk, the results of this paper should also be applicable to other non-storable commodity markets, such as live cattle, feeder cattle, or lean hog markets.

The remainder of the paper is organized as follows. First, we will revisit the hedging of storable commodities. The former will then serve as a benchmark for the more detailed discussion of fluid milk hedging. Finally, we will draw a conclusion.

A brief recap of storable commodity hedging

As mentioned above, there are two standard hedging practices for storable commodities in the literature: full hedging and minimum variance hedging. Although the two practices do not serve the same purpose, they both revolve around the basis and its trading, where the basis is defined as the difference between the spot price and the futures price of a storable commodity (basis = spot price – futures price). There are two advantages to hedging the spot price risk on a futures market and trading the basis instead. First, if the spot price and the futures price converge at the delivery point of the futures contract when the contract expires, the current basis is the price the market is currently willing to pay to store the storable commodity until the futures contract expires. Second, because the basis tracks the cost of storage, it also exhibits strong seasonal patterns that a storer of a storable commodity can use to his advantage (Gray and Rutledge, 1971).

Full hedging

Full hedging, also known as basis trading (Working, 1953a,b), is a trading strategy in which a farmer evaluates whether or not it makes sense to store a storable commodity (e.g., grain) based on the current basis (usually the basis at harvest time) and the expected basis at contract expiration (the expected basis is not exactly known in advance, but it should not exceed the cost of transportation to or from the next delivery point of the futures contract; otherwise arbitrageurs could make a risk-free profit). If the difference between the current basis and the expected basis at contract expiration is greater than the farmer's storage costs (expected basis – current basis > storage costs), the farmer will store his grain and take a short position in the futures market. The latter serves two purposes: First, the short hedge protects the farmer against possible future spot price fluctuations. Second, the short hedge locks in the current basis at which the grain is purchased. Finally, to close out the storage transaction, the farmer sells the stored grain on the spot market and closes out his short position on the futures market by buying a long futures contract. The latter determines the basis at which the grain is ultimately sold. The profit from the storage transaction is then the final basis minus the initial basis and the storage costs (storage profit = final basis – initial basis – storage costs) (Hieronymus, 1977).

The former can also be illustrated using the example of a grain farmer considering whether it makes sense to store grain after harvest (see below). For the sake of simplicity, let us assume that our farmer not only delivers the same quality as specified in the futures contract but also at the delivery location specified in the futures contract (i.e., we assume par delivery).

	Spot market		Futures market		
	Buy	Sell	Long	Short	Basis
Initial basis (harvest)	500			530	-30
Final basis (fall)		578	580		-2
					+28

Note: Numbers in cents per bushel.

One option that is always available to a grain farmer is to sell the grain at harvest. In our case, our grain farmer could receive a price of 500 cents per bushel by selling his grain at harvest. The other option is to store the grain and sell it later. However, the latter only makes sense if the storage transaction generates enough revenue to cover the cost of storage. To evaluate the latter, our farmer must compare the current basis, which in our case is -30 cents per bushel (500 – 530 = -30), with the expected basis at the expiration of the contract. Since we have assumed par delivery (i.e., same quality and delivery location), the expected basis at contract expiration should average zero[2]. Thus, if the storage cost that our farmer would incur if he were to store his grain until contract expiration is less than 30 cents per bushel, he would have a strong incentive to store his grain. If he chooses to store, our farmer would have to sell a short futures contract to hedge the spot price risk and lock in the current basis of -30 cents per bushel. The storage margin our farmer can ultimately realize depends on the basis at which he can sell the grain. Assuming our farmer can sell his grain at a basis of -2 cents per bushel (578 - 580 = -2), the final storage margin he can realize is +28 cents per bushel (-(-30) + (-2) = +28).

[2] In fact, perfect convergence to a zero basis at contract expiration is rarely observed. When markets are oversupplied and storage space is scarce, the basis tends to be less than zero. On the other hand, when markets are undersupplied and there is a high risk that the futures contract will be delivered with a lower quality, the basis tends to be higher than zero (Hieronymus, 1977).

Minimum variance hedging

The other approach that also deals with the basis and its trading is minimum variance hedging (Johnson, 1960; Stein, 1961). However, unlike full hedging, minimum variance hedging is concerned with determining a hedge ratio, i.e., the percentage of a storable commodity that must be hedged on the futures market in order to minimize the variance of the basis profits from hedging (i.e., the revenues from storage). The standard method of calculating the hedge ratio is to regress the differenced spot price of the storable commodity on the corresponding differenced futures price of the commodity (Ederington, 1979). The slope parameter then determines the hedge ratio, and the intercept parameter determines the average storage revenue of the corresponding hedge.

The inappropriateness of standard hedging practices

The randomness of the forward basis

While full hedging and minimum variance hedging are specifically tailored to storable commodities and basis trading, there are two key points that call into question the applicability of these two approaches to fluid milk. The first point is that in milk production, we are not dealing with a post-production situation but with a pre-production situation (dairy farmers want to lock in prices for fluid milk before milk production takes place in order to have planning certainty). The last point is important because in the pre-production situation, we are not dealing with the basis but with the forward basis, where the forward basis is defined as the difference between a forward price and a futures price (forward basis = forward price – futures price). The distinction between the two bases is important because, unlike the basis, the forward basis does not track the current price of storage but rather the expected cost of transportation between the delivery point of the futures contract[3] and the delivery point of the forward contract to which the forward basis belongs. This last point is important because it shows that the forward basis is not an actual price but a price forecast that is random in nature. However, a non-random basis is a prerequisite for basis trading (the other prerequisite is that the basis moves in favor of the hedger); if the basis were random, basis trading would be nothing more than a gamble.[4]

Forward basis: not the relevant variable

The more important question, however, is whether the forward basis is the relevant variable on which dairy farmers should/would base their hedging decisions. Obviously, expected transportation costs are not the variable that dairy farmers are interested in; dairy farmers do not arbitrage fluid milk between locations. Rather, dairy farmers have production decisions to

[3] Although futures contracts for non-storable commodities exclude the possibility of physical delivery at contract expiration but require cash settlement, the settlement price can still be assigned to one (or more) location(s). Thus, at least in theory, there is a delivery location for every non-storable commodity futures contract.

[4] The randomness of the forward basis is also important for hedge ratio regressions because a random basis implies a random hedge ratio. Hedge ratios calculated for fluid milk are therefore only a snapshot in time and cannot be generalized.

make and are therefore primarily interested in the selling price of fluid milk and whether that price at least covers their production costs. Consequently, from a dairy farmer's perspective, the forward basis does not provide the technical or economic conditions that would make it suitable for basis trading (i.e., full/minimum variance hedging).

Fluid milk hedging

The assumption that fluid milk futures markets serve the purpose of basis trading can obviously be rejected; the conditions for basis trading are not met. In fact, we already know the purpose that fluid milk futures markets should serve: fluid milk futures markets should allow dairy farmers to lock in profitable forward prices for milk yet to be produced. The critical question, however, is how such hedging, which allows dairy farmers to lock in a forward price for fluid milk, actually works.

Crush margin hedging

To get an idea of how forward price hedging works, we need only look at crush margin hedging (Peck, 1978). As the name suggests, crush margin hedging originated in the soybean crushing industry. Soybean crushers typically prefer to lock in profitable crush margins prior to crushing. To do this, they simultaneously take a long position on the soybean futures market and a short position on the soybean meal/oil futures market when a profitable crush margin is being reached.[5] The latter locks in the crush margin (note that in contrast to basis trading, the first step in crush margin hedging does not involve a spot market transaction). The futures positions are not closed out until the soybeans are purchased, or the soybean meal/oil is sold. The realized crush margin is then equal to what can actually be obtained on the spot market for the soybean meal/oil, less the cost of the soybeans needed to produce the meal/oil and the net profits from the futures market transactions.

Forward price hedging

In principle, forward price hedging follows the same logic as crush margin hedging. The only difference is that the focus is on a single futures market because the intention is to lock in a forward price rather than a margin. The first step in a forward price hedge is to take a short position on the futures market once a futures price is reached that the hedger considers profitable. The short position serves two purposes: first, it protects the hedger against future spot price fluctuations. Second, it locks in the current futures price. The futures price can be thought of as a reference price from which the actual realized price is later derived. Note that, as with crush margin hedging, there is no spot market transaction in the first step of a forward price hedge. Later, when the production takes place and the commodity is sold, the short position on the futures market is closed out by buying a long futures contract. The actual

[5] Since crushing soybeans yields approximately 11 pounds of oil and 44 pounds of meal per bushel of soybeans, in practice it takes 10 soybean contracts, 11 soybean meal contracts and 9 soybean oil contracts to hedge the spot price risk.

realized price is then equal to the local spot price at the time of production plus the net profit from the futures market transaction (realized price = local spot price + net profit from futures market transaction). Another way to calculate the realized price is to add up the initial futures price and the local basis at the time of production (realized price = initial futures price + local basis at the time of production).

Forward price hedging can also be illustrated by an example of a dairy farmer seeking to lock in a profitable forward price for fluid milk to be produced later (see below).

	Spot market		Futures market		
	Buy	Sell	Long	Short	Price/Basis
Locked in price				16	16
Local basis		13.5	14		-0.5
					+15.5

Note: Numbers in dollars per hundredweight.

Similar to grain markets, dairy farmers have two options for marketing their fluid milk. The first option is to wait for production and sell the fluid milk at the prevailing spot price (in our case, 13.5 dollars per hundredweight). However, this option is risky because there is no guarantee that the spot price at the time of production will cover the farmer's production costs. The other option is for our dairy farmer to follow the futures market and, when a futures price is reached that promises profitable production, take a short position in the futures market to lock in that futures price, in our case, 16 dollars per hundredweight. The short futures position is not closed out until the fluid milk is actually produced and sold on the spot market, in our case, for 13.5 dollars per hundredweight. The actual realized price then depends on the local basis at the time of production. In our case, with a local basis of -0.5 dollars per hundredweight (13.5 – 14 = -0.5), our dairy farmer would realize a price of 15.5 dollars per hundredweight (16 + (-0.5) = 15.5) for his fluid milk. Admittedly, the second option is not without risk, albeit a lesser one (thanks to the forward price hedge, the spot price risk is exchanged for the less risky basis risk at the time of production). However, the primary objective of forward price hedging is not to minimize all risk, but to lock in a profitable forward price, in this case for fluid milk, prior to production. And this goal is obviously being achieved: the realized fluid milk price differs from the original locked-in futures price only by the amount of the local basis at the time of production.

Table 1 compares the results of this paper once again in tabular form.

Table 1: Comparison of grain and fluid milk hedging

	Grain hedging (post-harvest)	Fluid milk hedging
Commodity characteristics		
Commodity:	Storable	Non-storable
Production:	At the beginning of the hedge	At the end of the hedge
Basis characteristics		
Basis type:	Basis (= spot price – futures price)	Forward basis (= forward price – futures price)
Basis interpretation:	Current price of storage	Expected price of transportation
Basis pattern:	Strong seasonal patterns	Random
Hedging		
Hedging objective:	Lock in of a profitable storage margin	Lock in of a profitable forward price
Hedging practice:	Standard hedging practices (i.e., basis trade)	Forward price hedge

Note: For grain hedges, the par delivery assumption may apply.

As discussed above, not only does fluid milk hedging involve a commodity with different product and market characteristics, but more importantly, the forward basis for fluid milk has completely different characteristics that make it unsuitable for basis trading. In fact, it was never the intention of dairy farmers to trade the forward basis. Dairy farmers want to lock in a profitable forward price for fluid milk before the actual production takes place, and the only way to lock in a forward price is to use a forward price hedge, as shown above. Standard hedging practices, on the other hand, are not an option for dairy farmers; they serve a different hedging purpose. This is an important finding as it contradicts the assumptions of previous literature (e.g., Maynard et al., 2005; Newton and Thraen, 2013).

Although this paper has focused on dairy farmers and fluid milk, the results of this paper should also be applicable to other non-storable commodity markets, such as live cattle, feeder cattle, and lean hog markets. As in the fluid milk market, the primary interest of cattle farmers and hog producers in the live cattle, feeder cattle, and lean hog markets is to lock in a profitable forward price in advance of production. In fact, the results of this paper should even be applicable to grain markets when the goal is to lock in a forward price for grain to be delivered at harvest.

Conclusion

In this paper, we have critically discussed whether standard hedging practices (i.e., full hedging and minimum variance hedging) developed for storable commodities can be readily applied to the hedging of fluid milk. We have shown that there are two key issues that call into question the applicability of standard hedging practices to fluid milk. The first point is that if standard hedging practices were applied to fluid milk, one would be dealing not with the basis but with the forward basis. The distinction between the two bases is important because the forward basis is the expected transportation cost between the delivery location of the milk futures contract and the local milk delivery location at the time of production. However, price expectations are inherently random, which is a problem because basis trading requires a non-random basis. The other and more important point is that expected transportation costs are not the variable that dairy farmers are interested in when making production decisions.

The hedging practice that dairy farmers really need to lock in fluid milk prices in advance of production to have planning certainty is forward price hedging, as we have further shown in this paper. Forward price hedging follows the logic of crush margin hedging, except that forward price hedging focuses on a single futures market because the intent is to lock in a forward price, not a margin. The first step in a forward price hedge is to take a short position on the futures market when a futures price is reached that promises profitable milk production. Note that in contrast to standard hedging practices, the first step in forward price hedging does not involve a spot market transaction. When the milk is actually produced and sold, the short position is closed out. The actual realized price is then equal to the locked-in futures price plus the local basis at the time of production.

Forward price hedging is the third hedging practice, along with standard hedging practices and crush margin hedging. Understanding the difference between these three practices is important because they serve different hedging purposes. While standard hedging practices and crush margin hedging are used to lock in a basis and a margin, forward price hedging is used to lock in a forward price.

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