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Capitalization of Farm Policy Benefits and the Rate of Return to Policy-Created Assets: Evidence from California Dairy Quota

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The rate of return to ownership of California dairy quota is about 27% per year—well above that of typical financial assets, but in line with other measured returns to agricultural quotas. Ownership of dairy quota does not contribute positively to total variation of typical portfolios, including those of dairy farm assets, and so contributes little or no portfolio risk. A plausible alternative hypothesis for the high rate of return is that quota owners see significant risk of policy change that would reduce future quota values. That is, they face default risk in quota ownership.

The capitalization of farm program benefits and the effects of policy on the rate of return to investments in farm assets have long been important to agricultural policy analysis. The issues arise in the context of the influence of policy on prices of farmland, other physical assets, and policy-created assets such as farm program quota. Basic economic principles tell us that the benefits of government programs will affect returns to and prices of resources connected to a program. The incidence of flow benefits depends, in part, on the elasticities of supply of these resources, with the prices of inelastic resources affected most. The capital prices of assets do not depend directly on past returns, but on expectations about future returns. Of course, in many practical cases, the history of past returns is a crucial source of information used to form expectations.

Johnson assessed the literature on returns to farm quota, stating, "Roughly speaking, the discount rate used to value future earnings from [farm-program created] quotas is approximately 25%. Thus, individuals who have recently

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purchased a quota do receive a net return from owning the quota, but the net return can be reasonably said to be return to risk" (p. 202). Johnson's assessment was based on studies across a number of countries and commodity programs that inferred rates of return from indirect evidence. (See, e.g., Arcus, Barichello 1981, Seagraves, Sumner and Alston, Warley, among others in the earlier literature.)

In this article, we exploit particular characteristics of the California dairy quota program and an unusually rich data set to study the capitalization of program benefits and risks associated with farm policy. The design of the California dairy quota program helps make flow returns to quota ownership and the capitalized value of the policy benefits more transparent compared with most other agricultural programs. This transparency allowed us to assemble a more complete data set on the flow of policy benefits and capital values than has been available for other government programs. In addition, the long policy history and the existence of monthly flow return and asset price data are unusual for such markets. We were, therefore, able to measure the contribution of quota ownership to variability of total returns in alternative portfolios. We also used information on dairy farm costs and returns, and created proxies for variations of return to investments in dairy production assets.

Defining Policy Risk

Economists have used the term "policy risk" in two senses to discuss the rate at which expected revenue streams attributed to farm policy are capitalized into asset values. The first sense, which we will call "portfolio risk," is the standard notion from the investment/finance literature. The portfolio risk associated with an investment, and hence the risk premium demanded, is measured by the contribution of that investment to the future variability of returns of the investor's whole portfolio of assets. This is the risk that is typically measured by the "beta" associated with a stock or bond in asset-pricing models. The second sense, which we will call "default risk," is related to the likelihood of a negative shock in the future that reduces the expected value of an investment. This is analogous to the way "risk" is used in the risk assessment literature and in informal discussions, for example, when someone says that rock climbing is a "risky" hobby. In the context of policy analysis, default risk is related to the likelihood that a policy change that lowers the value of policy-related assets will occur in the future.

Obviously, each form of risk can be important to asset prices and in some assets and market situations, both may be important. More of either form of risk will reduce asset prices and increase the historical measured rate of return. First, let us consider portfolio risk. It is often observed that the benefits of farm programs (such as returns to production quotas or marketing quotas) are typically tied to production of a specific commodity. In that case, the benefits attributable to the government program co-vary positively with returns to farming. Further, given that farmers and other investors in farm assets typically have a large share of their portfolio in farm-related assets, variability of returns to farm policy are not fully diversified. Therefore, the rates of return demanded for investments in such policy-created assets are relatively high, in part because these investments add to the risk of the portfolio held by policy beneficiaries. Second, consider default risk. Farmers often anticipate that there is a significant likelihood that the historical returns associated with farm programs will fall in the future. Therefore, the expected value of the future revenue stream is less than that reflected by historical returns to investments in policy-created assets. This means that the measured historical rate of return on investments in these policy-created assets will be high relative to investments for which the chance of default is lower or negligible.

Using our unique data, we found that the historical rate of return to investments in California dairy quota has been about 27% per year—quite similar to that for other farm-policy-created quotas. However, we show clearly that this is not a result of portfolio risk. We established for this important case, that the relatively high historical rate of return to a farm-policy-created asset does not derive from rules that limit the ability of quota to be held by those with fully diversified portfolios. Of course, this does not mean that policy risk overall plays an unimportant role. Indeed, we expect that the reason historical rates of return to farm-policy-created assets have been "high" is that farmers see a nontrivial probability of a significant and (from their point of view) negative change in the underlying policy. That is, quota owners build substantial default risk into their estimate of the expected future return.

Measurement of Returns to Agricultural Quota

Previous researchers have attempted to compare the rates of return to investments in farm quotas to the rates of return earned by investments in other assets. The modern literature began with an innovative study by Seagraves, who calculated the rate of return for flue-cured tobacco allotment in North Carolina from estimated flow returns to quota ownership and variations in land prices. Based on data from the 1950s to 1960s, Seagraves estimated a high and declining rate of return over time and argued this decline was the result of subsiding producer concerns about the future of tobacco production and the quota program (see also Shuffett and Hoskins). Sumner and Alston noted that in 1982, the price of flue-cured tobacco quotas was three to five times the lease rate of the time, suggesting a rate of return of 0.20–0.33.

Several estimates deal with dairy marketing quota. Moschini and Meilke calculated the rates of return for the dairy quota in Ontario from 1980 to 1986 to be in the range of 0.10–0.34, depending on the specific type of quota and year. Barichello (1996) and Chen and Meilke found rates of return for Ontario dairy quota in the range of 0.26–0.36. Colman et al. found in the United Kingdom that the average ratio of the lease rate to dairy quota price was 0.18, from 1986 to 1998, with a small increase at the end of the period. (See also Arcus on the value of milk quota in British Columbia and Hubbard on the returns to milk quota in the United Kingdom.)

In general, the measured rates of return for quotas have been higher than the rates of return to investments in typical equity market indexes such as the S&P500. However, the cited studies have relied on relatively limited data on either the asset values or the flow returns to the quota asset to make these calculations.

In a well-known article, Lermer and Stanbury used the capital asset-pricing model (CAPM), to argue that the risk associated with Canadian agricultural marketing quotas was separable into diversifiable and nondiversifiable risk. Lermer and Stanbury claimed that most Canadian farmers who produced under one of the marketing quota programs had a high proportion of their wealth attached to producing the commodity under quota. Furthermore, the asset value of the quota was tied directly to the anticipated profitability in the industry. Finally, restrictions limited the transfer of quotas to nonproducers, who would be likely to have more diversified portfolios relative to the farmer-quota owners. The limited amount of diversification of producers who also owned quota meant that producers incorporated an additional risk premium from the risk that was not diversified through a broad portfolio. Lermer and Stanbury noted that their model implied that this limited ability to diversify "will be reflected in [the producer's] unwillingness to bargain up the price for quota rights" (p. 194). Lermer and Stanbury attributed the relatively high rates of returns to quota ownership to an inability to diversify quota risk. However, they did not test their hypotheses empirically and probably underestimated the diversification potential for Canadian quota owners. To our knowledge, no one has tested their hypothesis until the present paper.

Sumner, Alston, Barichello (1996) each represented policy risk primarily in terms of a probability factor representing the likelihood of program elimination (or other reduction of policy benefits) that lowers the asset price by reducing the expected present value of the future returns to the quota. Barichello (1996) stated, "This risk is manifested in a possible fall in the expected value of the asset rather than an increase in the variance of its future returns, the risk normally incorporated via a risk premium in the discount rate" (p. 294). However, Alston noted that in the case of the risk-averse producer, a risk premium exists in addition to the effect on the probability of program elimination on the expected value of future program benefits. Sumner observed in the case of the tobacco production quota, the restriction "that buyers of quota must be active tobacco producers also means that returns on investment in quota will be highly correlated with the returns to the farming activity" (p. 130).

Overall, the literature has found that the measured rate of return to owning farm-policy-created quota is relatively high. Some authors have explained that the measured rate of return reflects both the expected value of the future stream of benefits associated with the quota and the contribution of the quota to the risk of the quota owner's full portfolio. This article is the first to measure explicitly the degree to which portfolio risk accounts for the high historical rate of return to quota.

The Basic Operation of the California Dairy Quota Program

The dairy quota program in California began in July 1969. Quota was initially allocated to producers in proportion to their sales of milk for beverage consumption. However, milk revenue for the industry is not affected by the existence or distribution of quota. As in the U.S. federal milk marketing order system, additional dairy revenue in California is generated through price discrimination by end-use and then pooled before being dispersed to producers. The California quota program has no role in setting milk prices by end-use (price discrimination) or in allocating milk among uses. The quota program affects only the dispersal of pool revenue among producers.

Quota ownership varies across farms, and the revenue of an individual farm depends on the amount of quota that the farm owns, as well as a farm's milk production and the minimum class prices.

Prior to 1994, monthly returns to quota were calculated as the difference between the weighted average of the prices of the higher-priced end-use classes of milk, P_q, and the weighted average of the prices of the lower-priced end-use classes of milk, P_n. For a typical month, the flow return to quota ownership was the difference between the quota milk price, P_q, and the overbase (nonquota) milk price, P_n (Sumner and Wolf 1996). Milk prices P_q and P_n each varied widely because of variation in the underlying class prices and shares used to create the weighted averages. Thus, the per-unit flow of returns to quota varied over time because of differences in: (*a*) milk sales by end use; (*b*) amount of aggregate quota relative to total milk sales; and (*c*) end-use class prices. Since 1994 the payment per unit of quota has been fixed.

Under the current system, the first step in dispersing pool revenue is simply to allocate daily \$0.195 per pound of solids-not-fat (snf) for each pound of quota owned. For the aggregate quota quantity, Q (in snf terms), the total daily revenue assigned to quota is \$0.195Q. Quota revenue for an individual quota owner is \$0.195Q_i, where Q_i varies from zero (for about 20% of producers) up to a farm's total milk output (for a few producers in any month). The rest of the pool revenue, R_n, is dispersed to individual producers according to milk production. The nonquota pool price per unit of snf is therefore $P_n = R_n/M$, where M is total milk output in the program. The quota milk price, P_q, is defined in snf terms as $P_q = \$0.195 + P_n$ and total revenue for producer i is simply $R_i = M_i P_n + 0.195 Q_i$.

California regulates the quota asset market and transactions are reported on a monthly basis. Quota is an essentially homogenous asset that is transferable statewide, unlike for example, farm real estate. Quota is traded directly between individuals using quota-market brokers who facilitate the market. During the period of investigation, there were always more than 2,000 quota owners and several hundred additional dairy producers who were eligible to own quota. Between several dozen and more than one hundred transactions were completed each year. Some quota owners sold their entire quota in a given transaction, while others sold only a portion. In many months, there were more recorded buyers than sellers, indicating that some sales lots of quota were divided among buyers each of whom purchased a portion of the total available from that seller. At a given time, additional potential sellers had quota available for sale at a higher price than that prevailing in the market and additional potential buyers were available if prevailing prices would have been lower. Farmers interested in acquiring quota always could find potential sellers with whom to bargain and those interested in selling always could find potential buyers. The market for quota was, thus, relatively liquid, with no evidence of any significant market power on the part of either buyers or sellers.

Two sets of quota-market regulations are important to discuss here. First, quota returns may only be earned by farmers who maintain valid market milk permits and produce market milk in California from at least five cows. The restriction makes it more likely that quota owners have relatively specialized portfolios tied to dairy-related assets. We test the importance of this restriction on the returns to quota.

Second, minimum holding periods limit short-term speculative trading through several specific rules: (*a*) after a purchase of quota, a producer may sell no quota for two years, except for the cases of hardship; (*b*) a producer who sells quota may not buy quota for two years; and (*c*) newly allocated quota and quota purchased from hardship cases may not be sold for five years. New quota was allocated to current owners and new producers intermittently, but no new quota has been allocated since 1992 (*California Food and Agricultural Codes*).

Limitations on short-term buying and selling of quota and on who may transact in the market likely reduces the number of transactions each month and may have increased month-to-month volatility somewhat. However, there is no evidence that loosening the rules to allow more short-term speculation in the market would have changed the market price fundamentals significantly.

Measurement of the Returns to Quota Ownership Using Available Data

The return in period t to owning a pound of California dairy quota (in pounds of snf per day) for a month (*Quota Return*) is comprised of three components: (*a*) $\textit{Flow Return}_t = [(P_{\mathrm{qt}} - P_{\mathrm{nt}})D_t]/8.7$, represents the monthly revenue flow from quota in pounds of snf equivalent, where the prices are per hundredweight of milk and must be divided by 8.7 to convert to pounds of snf. The total is multiplied by the number of days in the month (D_t) to convert daily revenue to monthly revenue; (*b*) $\textit{Capital Price Gain}_t = V_t - V_{t-1}$, represents the difference between the average price paid for quota between month t and month $t-1$; and (*c*) $\textit{New Quota Return}_t = (N_t V_t)/12Z_t$, represents the monthly value contribution of any annual disbursements of new quota. This is simply the number of units of new quota distributed to existing producers, N_t, times the unit price of quota, divided by the total quota already owned, Z_t and divided by 12 to turn annual value into a month flow equivalent.[1] Summing the components yields the total monthly return to quota: $\textit{Quota return}_t = \textit{Flow Return}_t + \textit{Capital Price Gain}_t + \textit{New Quota Return}_t$.

Based on administrative records kept by the California Department of Food and Agriculture, Milk Pooling Branch, we assembled monthly observations on each variable since the inception of the program in July 1969. However, the first few months after the quota program began saw a rapid jump in the value of quota and extreme variability in the quota price. These months were clearly not representative of the next twenty-nine years. Therefore, our sample period for empirical analysis begins in January 1970.

The California Department of Food and Agriculture has long surveyed hundreds of dairy farms each month and reported detailed cost survey data every two months. The survey includes information on many individual cost-of-production items as well as summary measures (table 1). These data were the only source of such cost information available on a regular basis for the full period of investigation.

The cost information was combined with data on the market price of milk received by California dairy farmers in order to compute a proxy measure of average flow returns per unit sold. We divided by the cost variable to get a percentage returns variable. We used this percentage relative margin as a rate of returns

Table 1. Summary statistics and definitions for returns, prices, and costs: 1970–98

Variable Names and Definitions	Dollars per Pound of Solids-Not-Fat: Mean	Dollars per Pound of Solids-Not-Fat: Standard Deviation
Flow Return to Quota: The difference between the *Quota Milk Price* and the *Overbase Milk Price* in dollars per hundredweight of milk times the number of days in the month, all divided by 8.7. The difference was fixed at $0.195 per day after December 1993.	5.38	1.74
Capital Price Gain to Quota: The average monthly *Quota Price* less *Quota Price* of previous month.	0.52	21.70
New Quota Return: The total new pounds of quota given out in January of selected years, multiplied by the January quota price of that year, divided by the total pounds of snf quota already in the system. The return is distributed at the rate of one-twelfth per month.	0.19	0.33
Total Quota Return: The sum of the *Flow Return, Capital Price Gain,* and *New Quota Return.*	6.09	21.91
Overbase Milk Price: Monthly pool price for milk in California determined as a weighted average of the various minimum class prices, which vary monthly based on market conditions.	1.15	0.30
Unit Cost of Milk Production: The weighted average cost of production for market milk in California including feed, hired labor, and miscellaneous costs (herd replacement costs, taxes, insurance, operating costs, depreciation, and marketing costs less miscellaneous income).	1.07	0.25
Per-Unit Milk Return: The *Overbase Milk Price* less the *Unit Cost of Milk Production.*	0.082	0.11
	Percent	
Flow Rate of Return to Quota: The monthly *Flow Return* divided by *Quota Price.*	1.7	0.62
Total Quota Rate of Return: The monthly *Total Quota Return* divided by *Quota Price.*	2.2	7.2
Market Index Rate of Return: The monthly rate of return of the NYSE/AMEX/Nasdaq Value-Weighted Market Index from returns of the trades of the month.	1.1	4.6
Relative Margin of Milk Production: The *Per Unit Milk Return* divided by the *Unit Cost.*	7.6	9.5

Sources: For milk price and quota data: *California Dairy Information Bulletin.* For costs: California Department of Food and Agriculture, Milk Pooling Branch cost surveys. For market rates of return: Center for Research on Securities Prices, University of Chicago.

indicator. Additional data used for the empirical analysis included the monthly rate of return to investments of a market index of equities in the United States. This variable represents returns to a diversified nondairy portfolio and is a standard measure used in the finance literature.

Applying a Capital Asset-Pricing Model to Quota-Market Data

We next turn to measuring the role of variability to returns to quota in determining the market price of quota and the role of portfolio risk in the high rate of return to investments in quota. Therefore, we must specify a model for pricing quota as a capital asset. Researchers in the finance literature have spent considerable effort investigating the pricing of investments in a portfolio context. In the simplest commonly used approach, the degree to which an investment adds to the risk of the full portfolio, typically denoted as the *beta*, is measured as the covariance between the rate of return to a specific investment and that of the overall market portfolio divided by the variance of the rate of return to the market portfolio. (Classic contributions are Sharpe, Lintner, Black, Fama and Miller, Ross.) Using this definition, $beta_j$ is the coefficient of the simple regression of the rate of return of the investment j on the rate of return of the market portfolio.

Virtues of this framework are its simplicity, robustness, and long-track record. As a descriptor of asset prices, the model assumes competition and the potential for portfolio diversification. As discussed above, California dairy quota is available for trade each month among hundreds of potential buyers and sellers. Furthermore, whereas holding-time rules limit short-run speculation, owners typically hold quota well beyond the required two-year (and even the five-year) holding period. Therefore, these basic conditions for application of the model seem to be approximately satisfied.

Any model has limitations. However, after reviewing several different asset-pricing models (the consumption beta, Arrow–Debreu securities, and the pure arbitrage version of the Arrow–Debreu securities models, as well as CAPM), Varian concludes, "...in most asset pricing, the value of an asset ends up depending on how it co-varies with other assets. What is surprising is how generally this insight emerges in models that are seemingly very different" (p. 370). Therefore, we used the simple CAPM framework to determine the impact of portfolio risk on the value of the California dairy quota.

Returns and Risk of Investments in Dairy Quota

Table 1 provides the mean and standard deviation for each component of quota returns and for the total returns to quota, all on a monthly basis. Although not included in table 1, we also examined the data on an annual basis and as adjusted for changes in the overall price level. Several facts stand out in the first four rows of table 1. First, in contrast to investments in stock market indexes, almost 90% of *Total Quota Return* came from the monthly *Flow Return to Quota*—less than 10% of the quota return was from *Capital Price Gain*. In a typical stock index most return is from capital gain not dividends. (*New Quota Return*, which is analogous to a stock-split, provided only a very small share of the benefit of owning quota.) Second, capital price gains were the dominant contributor to the monthly variation in returns. The coefficient of variation for the monthly *Total Quota Return*, approximately 3.6, was dominated by positive and negative changes in the monthly price of quota. There were no statistical differences with respect to the characteristics listed above when the data were summarized on an annual basis, except, of course, the means were approximately 12 times larger.

On an annual basis there was, naturally, less variability in quota prices and returns (coefficients of variation are smaller), but the patterns across variables remained unchanged. When data were adjusted for growth in the GDP price deflator, returns were smaller but the basic patterns remained. We used nominal data because we were mainly interested in comparing returns and their relationships, and part of the interest in diversification may have been related to covariance induced by differing correlation of returns with the overall price level.

Table 1 also shows summary statistics on the *Overbase Milk Price*, *Unit Cost of Production*, and *Per Unit Milk Return* (defined as the *Overbase Milk Price* less *Unit Costs). Per Unit Milk Return* had a higher coefficient of variation than its components. This indicates the important point that there is less than perfect correlation between the *Unit Cost* and *Overbase Milk Price*. These summary statistics change little for the annual summary of the data.

Finally, table 1 summarizes the information in the form of nominal rates of return and allows comparison of nominal rates of return to quota to rates of return to other assets. Measured over 348 months, the *Flow Rate of Return* (the *Flow Return* divided by the *Quota Price)* was 1.7% per month and the *Total Quota Rate of Return* was 2.2% per month. The annual rate of return was 27% for total return to quota ownership. Note that, over this twenty-nine-year period, the historical rate of return to investments in quota was double the historical rate of return to investments in a diversified portfolio of stocks as shown by the *Market Index Rate of Return*—2.2% per month compared to 1.1% per month. This finding confirms that the historical rate of return to investments in California dairy quota is similar to that of other policy-created farm quotas and well above the rate of return to an index of stocks. Variability of rates of return was less on annual data and mean rates of return were of course, smaller when adjusted for inflation, but basic relationships did not change.

We next turn to measuring how California dairy quota performed in the context of a portfolio of a diversified stock index. Column 1 of table 2 provides the betas from the regressions of the *Flow Rate of Return* and the *Total Quota Rate of Return* on the *Market Index*. Analogous betas are commonly found in the finance literature for individual stocks and other investments. Using a market portfolio as the base portfolio, common stock betas are positive and usually range from 0.7 to 1.5 (Gallinger and Poe). In our case, the beta for *Flow Rate of Return* is *negative,* but not significantly different from zero.[2] The beta for the *Total Quota Rate of Return* is 0.099 and not significantly different from zero.[3]

These results show that investments in California dairy quota would have contributed nothing to risk when held in a fully diversified portfolio of equities. Investments in California dairy quota would contribute less risk to the market portfolio than an investment in a typical common stock and, in that sense, would be expected to offer a lower rate of return for the same expected value of future benefits.

Table 2. Covariance relationships between the rates of return to investments in Quota and investments in an index of equities and dairy production assets

	Estimated Betas[a]	
	Market Index[b]	Relative Margin[c]
Flow Rate of Return to Quota[d]	−0.0024	−0.040
	(0.0030)	(0.0045)
Total Quota Rate of Return	0.099	−0.049
	(0.084)	(0.040)

[a]The values in parentheses are the standard errors of the corresponding betas.
[b]Entries in this column represent regression coefficients with *Market Index* (monthly rate of return of the NYSE/AMEX/NASDAQ Value-Weighted Market Index) as the independent variable and *Flow Rate of Return* or *Quota Rate of Return* as the dependent variables.
[c]Entries in this column represent regression coefficients with *Relative Margin* [(*Overbase Milk* $Price_t$-*Unit* $Cost_t$)/*Unit* $Cost_t$] as the independent variable and *Flow Rate of Return* or *Quota Rate of Return* as the dependent variables.
[d]Using the Breusch–Godfrey test, we rejected the null hypothesis of no autocorrelation for the two regressions with *Flow Rate of Return* as the dependent variable. We used the Cochran–Orcutt method for the regressions of *Flow Rate of Return* to correct for the third-order autocorrelation.

The betas associated with a diversified portfolio of common stock are likely to be less relevant when quota ownership is limited to California dairy producers. Therefore, we considered the investment in dairy quota in the context of investments more typically held by dairy producers. No monthly data exist on the rate of return to portfolios held by California dairy producers over the past thirty years. Hence, we cannot simply calculate the beta for the returns to quota with respect to the returns to the portfolio held by California dairy farmers. However, we did have information useful in creating a proxy for the rate of return to a dairy farm portfolio that was sufficient to answer the questions posed here.

U.S. Department of Agriculture (USDA) data indicate that, in 1996, California dairy producers had only 11% of their wealth invested outside of the farm, indicating a limited degree of portfolio diversification. Statistical data and interviews with representative producers and other experts suggest that investments in assets associated with farm production (cows, land, equipment, machinery, etc.) represent the bulk of the portfolio owned by dairy producers (USDA). Furthermore, dairy farms in California tend to be quite specialized and almost all dairy farm revenue in California comes from milk sales (USDA, Sumner and Wolf 2002). In this context, the total value of dairy quota (about one billion dollars) is about 5% of the magnitude of the approximate value of California dairy farms. As a polar case, we considered how investments in quota perform in the context of a portfolio of investments in the dairy farm production assets. The nature of these data precluded estimating a formal CAPM beta, but as noted by Varian, a beta-type of measure can be derived from a number of pricing models where the market index may be represented by another relevant portfolio.

To implement this approach, we needed a proxy for monthly returns to investments in dairy production assets in California. As shown in table 1 and discussed above, we were able to find well-documented data on the cost of production for milk in California for the past three decades to match data on milk prices and returns to quota. We, therefore, used variations in *Relative Margin* (*Per Unit Milk Return* divided by the *Unit Cost*) as a statistical instrument for the variations over time in the rates of return to dairy farming in California. Variations in *Relative Margin* reflect variation over time in milk prices, costs of production, and yield per cow. These are obviously important components of variations in farm net returns; therefore, we expected *Relative Margin* to co-vary positively with the unobservable rate of return to investments in dairy farm assets. As long as *Relative Margin* co-varies positively with the dairy farm returns, we could use this proxy to estimate consistently the beta-type measure of the contribution of quota to risk in a portfolio dominated by dairy production assets. In particular, the beta-type estimate in our regression will obviously have the same sign as the true beta. Thus, the sign of the relationship between *Quota Rate of Return* and *Relative Margin*, measured by regression parameter, reflects the sign of a beta between rate of return to quota and rate of return to dairy production assets.

Table 2 presents the estimated beta-type measure between both *Flow Return* and *Total Quota Returns* and *Relative Margin*. Both estimated coefficients are negative. The estimated beta from the regression *Flow Return* on *Relative Margin* is large relative to its standard error and statistically different from zero at a 0.01 level of significance. The *Flow Return* estimate is important because most dairy farmers make few quota transactions. Monthly returns from owning quota smoothes their net revenue flow from milk sales. This income smoothing impact may contribute positively to the value of quota and lower the rate of return. The coefficient from the regression of *Total Quota Rate of Return* on *Relative Margin* is also negative but not large relative to its estimated standard error.[4]

As explained above, the quota program changed in 1994 and the daily return to quota were fixed in nominal terms for the last four years of our twenty-nine-year sample period. The result was a positive but statistically insignificant beta in the post-1993 period compared with a negative beta in the earlier period. Given the negative co-variation between returns to quota and returns to the stock market index or dairy farm investment in 1970–93, reducing variability of quota returns post-1993 increased the contribution of quota returns to riskiness of these portfolios. Consistent with the finance literature, table 2 presents the average betas for the full period. However, examining the two sub-periods reinforces the main point of the analysis. Portfolio risk contributed by quota cannot account for the relatively high rates of return earned by owners of California dairy quota.[5]

Summary and Implications

The measured rates of return to farm-policy-created quotas are typically found to be high relative to the rate of return to other investments. One hypothesis for the high historical rates of return is that policy rules typically require that quota be held by farm producers, which adds a portfolio risk premium to the rate of return. Similar quota ownership rules also apply to California dairy quota. The argument is that, with the lack of diversification typical of farm producers, owning quota adds to the risk of the asset portfolio owned by farmers; therefore, quota earns a high rate of return to compensate for the additional portfolio risk.

Under production or marketing quotas, but not under California dairy quota, returns to quota ownership are tied closely and positively to returns to farming (Lermer and Stanbury, Sumner, Barichello 1996, Organisation for Economic Co-operation and Development). In those cases, quota may be worth less to farmers than to outsiders because quota may add to the risk of the overall enterprise. The magnitude of this effect is the relevant question.

We found that over a twenty-nine-year period, the rate of return to California dairy quota has also been high (2.2% on a monthly basis and about 27% per annum) compared with other investments and similar to the rates of return observed for other agricultural quotas. The quota return was double that of a diversified portfolio of stocks, although the variability of the quota return was relatively small. We also found that returns to quota had a zero or negative covariance with returns to other investments, and generally lowered the risk in the overall portfolio when added to either a market index of equities or a portfolio of dairy production assets.

Because of its covariance properties, an investment in California dairy quota lowered the variability of total returns and reduced overall portfolio risk for California dairy farmers. The implications of this result are that the producers would pay extra for quota because of this negative covariance property. Therefore, restrictions that only dairy farmers may own quota do little (or nothing) to reduce the price of quota because California dairy quota is likely to be more valuable to dairy farm owners than to those outside the business. Quota acts as a hedge in a portfolio comprised of dairy production assets, and in that sense the restriction on ownership by nonfarmers does not reduce the price of quota. That means that the portfolio risk characteristics should *reduce*, not increase the measured rate of return to quota.

Portfolio risk cannot account for the high measured rate of return to California dairy quota ownership. Moreover, since the California quota rate of return is similar to that for other farm-policy-created quotas, this evidence suggests that portfolio risk is a weak explanation for the high measured rate of return for farm quota assets. Therefore, other hypotheses, such as policy default risk, must be considered, and evaluated empirically (Wilson and Sumner).

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Endnotes

[1]In July 1978, the California Department of Food and Agriculture disbursed new quota as a result of *ad hoc* legislation. To set the value of this disbursal, we multiplied the amount of quota disbursed by the July 1978 quota price, divided by the total quota in the system at July 1978. We allocated one-sixth of this total to each month from July 1978 to December 1978.

[2]Scott and Brown argued that if the market portfolio and the error co-vary and the error is autocorrelated, then the estimate of beta is biased and unstable. For all the regressions, we checked for the covariance of the market portfolio and the error and autocorrelation. Our estimate of the covariances was zero for all of the models. For the *Flow Rate of Return* regressions, we discovered using the Breusch–Godfrey test that the error is autocorrelated. We corrected for the third-order autocorrelation using the Cochran–Orcutt procedure. The corrected results are reported in table 2.

[3]We also estimated this model using annual data. The basic results do not change. The flow return beta remains negative and approximately the same size as its standard error. The total returns beta is negative with annual data, but the t-statistic is still approximately 1.0 and far below the critical value for a significant relationship.

[4]We also estimated this model using annual data. The basic results did not change but the coefficients were larger and so were the standard errors. However, the betas remained negative and were significantly different from zero for the flow returns relationship. The model results were also unaffected by using inflation adjusted data or using the absolute difference between overbase milk price and unit costs rather than relative margin.

[5]The flow rate of return to quota was approximately the same in the two periods, but because the capital price gains were negative in the later years, the total quota rate of return was lower for the four-year post-1993 period.

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