

**Policy Risk:
An Empirical Analysis of a Market
for a Government-Created Asset**

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Paper prepared for the 1998 American Agricultural Economics Association Meeting.
Salt Lake City, Utah, August 2-5, 1998

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Abstract

This paper investigates the California dairy quota. The quota rate of return has been relatively high. The variability of returns is high relative to government bonds but not relative to the S&P500. Most of the returns are from monthly dividends, but most of the variability is from the capital gains.

Introduction

California dairy policy is a complex mesh of State and Federal regulations. This paper investigates only one component of this policy--the California dairy quota. This research is valuable because the State and Federal governments and industry groups all have expressed strong interest in a better understanding of the effects of the quota program.

The California dairy quota program has some features that allow this research to contribute more generally to understanding the capitalization of agricultural policy benefits and the impact of risks associated with agricultural policy (Barichello, Lerner and Stanbury, Sumner and Alston). Particular program features help make flow returns to quota ownership and the capitalized value of the quota more transparent than they are in many other agricultural quota programs. In addition, we have assembled a more complete data set on quota than is available for most other policy-created assets.

Capitalization of program benefits reflects expectations about government policy. Therefore, the value of policy-created assets reflects farmers' assessments of the level and variability of future returns to policy. We use the term "policy risk" to reflect certain characteristics of the policy-created quota asset. This paper focuses on the behavior of the market for California dairy quota as a policy-created asset market. In particular, we examine contributions to the flow returns to quota, the variability of these returns and the risk characteristics of quota. The concept "policy risk" has two distinct but related components. "Portfolio risk" refers to the effect of perceived policy variation on the contribution of the policy-created asset to the variability of the returns of the relevant portfolio. This definition is consistent with the use of the term "risk" in portfolio analysis

and capital asset pricing. "Default risk" refers to the perceived probability of substantial negative policy change—the default of an established government policy. Thus, in this sense, risk is similar to how the term is used in discussion of environmental risks or in discussion of the risk of default. Eliminating the program and termination of policy benefits is the extreme case of default risk, and the probability of program termination reflects default risk. This paper focuses on portfolio risk and examines the behavior of the quota as an asset.

The Basic Operation of the Quota Program

Before discussing characteristics of the asset market, it is important to appreciate how the flow returns to quota are generated. The dairy quota program began in 1969. As a step towards pooling milk revenues, quota was allocated to producers in proportion to their fluid milk sells.

Aggregate milk production is $M = \sum_i M_i$, where M_i is the production of producer i . Let total output equal total use, $M = C = \sum_j C_j$, where C_j is the milk used in one of the five milk classes ($j=1, 2, 3, 4a, 4b$). Pool revenue $(R)^1$, given class prices (P_j) , can be calculated as follows:

$$R = P_1 * C_1 + P_2 * C_2 + P_3 * C_3 + P_{4a} * C_{4a} + P_{4b} * (M - C_1 - C_2 - C_3 - C_{4a}).$$

The quota program has no direct role in setting milk prices by end-use or in allocating milk among classes. The quota program applies to the dispersal of pool revenue. 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 milk production and class prices. Prior to 1994, monthly returns for quota were calculated as the difference between the weighted average of the prices of higher-priced end-use classes of milk and

the weighted average of the prices of lower-priced end-use classes of milk. For a typical month, the return to quota ownership was $D = P_q - P_n$, where D is the differential, P_q is the quota milk price, and P_n is the overbase (non-quota) milk price.

The cut-off point that determined the share of the intermediate classes in P_q or P_n depended on the quantity of quota relative to the quantity of milk. Also, the weights varied monthly depending on milk sales. Aggregate milk prices P_q and P_n each varied widely because the underlying class prices varied. In summary, D varied because of variation in (1) milk sales by class, (2) amount of quota, and (3) class prices.

Since 1994, the payment per unit of quota has been fixed and invariant with respect to milk market conditions. Under this system, the first step in dispersing pool revenue is to allocate daily \$0.195 per pound of solids-not-fat (snf) for each pound of quota owned. No assignment is made for fat. This dispersal is also defined as \$1.70 (8.7 lbs. snf/cwt. milk * \$0.195/lbs. snf) per cwt. quota in terms of fluid milk. For aggregate quota quantity Q , (in snf terms), the total revenue assigned to quota is $\$0.195 * Q$, and the quota revenue for an individual is $\$0.195 * Q_i$, where Q_i varies from zero (for about 20% of producers) up to total milk output (for a few percent of producers in any month). The rest of the milk pool revenue (R_n)

$$R_n = R - \$0.195 * Q$$

is dispersed according to milk production. The price paid for milk is $P_n = R_n / M$. The quota milk price (P_q) is defined as the sum of the \$0.195 and the overbase price, i.e.

$P_q = \$0.195 + P_n$. Total revenue for producer i (TR_i) is simply

$$TR_i = M_i * P_n + Q_i * 0.195.$$

Quota, subject to the program regulations, is an asset that entitles the owner to a quota dividend. Since 1994, the dividend, or return, to quota ownership has been simply \$0.195 per pound of snf per day. Prior to 1994, the per unit return to quota was the difference of the two random prices P_q and P_n . As Sumner and Wolf (1996) show, quota ownership does not affect marginal production decisions because the marginal revenue is a function solely of the overbase and not the quota price.

Characteristics and regulations of the asset market are also important. Quota can be bought and sold, but the program limits ownership to farmers who maintain a valid market milk permit and produce market milk in the State of California from at least five cows (State of California). Once purchased, no quota can be sold for two years, except for cases of hardship, and a producer who sells quota cannot buy back quota for two years. New quota has been allocated intermittently following a formula, which has been adjusted occasionally. New quota is allocated to incumbent quota owners and new producers. Total new quota created has generally been tied to the quantity of Class 1 usage (Ekboir, Sumner, and Wolf). In 1978, the State broke from this basic policy by giving out quota without consideration of Class 1 sales (Boynton). The last dispersal of quota was 1992. New quota and quota purchased from cases of hardship may not be sold for five years.

Note, these stipulations do not require a farmer to produce each month as much as or more milk than the quantity of quota owned. The provisions of the quota program do not state a minimum quantity of milk that a producer must supply. The State of California, by law, cannot limit the amount of milk that a farmer can produce (State of California Food and Agricultural Codes, Section 62721).

Returns to Quota Ownership

Monthly benefits to owning a pound of California dairy quota is comprised of three components:

$$B_t = [Q_{ti} * (P_{qti} - P_{nti}) * D_t + \Delta(V_t) * Q_{ti} + \Delta(Q_{ti}) * V_t] / V_{t-1}$$

As discussed above the daily revenue flow is based on the differential, the difference between the quota price (P_{qti}) and the overbase (P_{nti}) per pound of snf multiplied by the number of days in the month (D_t). For an annual return, the monthly flow is summed to obtain the annual flow.

Capital gains (or losses) may also be calculated for each period. The monthly capital gain is $\Delta(V_t) = (V_t - V_{t-1})$ where V_t is the average price paid for quota purchased during month t . The annual capital gain is the quota price for December of the year t less the $t-1$ year's December quota price.

The calculation of the contribution to returns of new quota to quota ownership begins by taking the new quota (v_t) distributed in January and dividing that quantity (lbs. snf) by the total quota in the State (τ_t). This quantity, $(\Delta(Q_{ti}) = (v_t/\tau_t))$, is valued using the January price of that year. For the monthly return, each month is allocated one-twelfth of the new quota value; $\Delta(Q_{ti}) * V_t = [(v_t * V_t)/\tau_t]/12$. The return to quota is the sum of these components. The rate of return or benefit is the return divided by the $t-1$ month's price for the monthly returns or divided by the December price of the $t-1$ year for the annual returns.

The Data

We have assembled monthly observations on the average price of quota, the quota milk price and the overbase milk price (all in dollars per pound of snf) for the full period

since the program's inception in July 1969. We also have information on new quota allocations. From these data other values are constructed, the next section describes these computations. Additional data used for the analysis below include the rate of return of the S&P500 and the yield of the 10-Year U. S. Treasury Securities.

Risk and Returns to Quota Ownership

We focus now on returns to quota ownership and portfolio risk of investing in the quota. Portfolio risk is associated with variability of returns and the relationship of that variability with the variability of a broader portfolio, how the quota fits into the larger farm portfolio. This analysis is conducted through a variety of hypothesis tests concerning the risk nature of the asset.

We begin by examining the monthly returns to quota and the variability of these returns. Table 1 provides the mean, standard deviation and coefficient of variation for each of the components of quota returns and the total returns. This table also provides these statistics for the rate of return calculated on monthly data and, for comparison, the overbase milk price.

Several findings in Table 1 merit comment. First, in contrast to investments in many equities, most of the return to quota ownership has come from the monthly flow of income in the form of the differential. More than 90 percent of the returns are from the differential—only about 5 percent are from capital gains. Note, the distribution of new quota has provided only a tiny contribution to the benefit of owning quota on average. Second, the capital gain is the dominant contributor to the monthly variation in returns. The coefficient of variation in monthly returns (3.97) is dominated by wild swings in capital gains which is reflected in wild swing in the price of quota (often by 20 to 30

percent in a single month). Notice, also, that the coefficient of variation of the differential is slightly larger than the coefficient of the overbase milk price which implies that the price of quota milk contributed variability and that the two milk prices do not move together.

Monthly data may be of limited interest in the context of capital gains, and this is particularly true for milk quota because of the restrictions on liquidity and the restrictions that limit speculative investments in quota. Table 2 provides statistics on annual returns. The mean returns information tells the same story as Table 1. Also, coefficients of variation for the differential and new quota are similar to those based on monthly data. Now, however, the coefficient of variation of capital gains is only one fifth of its previous value and the coefficient of variation² of total quota returns is now below 1.0.

The final three rows of Table 2 provide information on the annual average return to investing in milk quota relative to the S&P500 and a 10-year Treasury bill over the same 26-year period. Both the mean rate of return and the standard deviation are higher for the investment in quota, but the coefficient of variation of returns is lower than for an investment in the S&P500 stock index. At more than 23 percent, the rate of return to owning quota is remarkable. Further, since most of the return comes from the monthly flow, an investor who plans to simply hold quota for the long term is less concerned with variation in annual quota price, so the overall coefficient of variation may be less relevant compared to the S&P500 where more than 80 percent of returns are derived from capital gains alone.

The riskiness of an investment can only be assessed in the context of the rest of an investor's portfolio. A standard approach to this issue in dealing with financial assets is

to examine the relationship of returns to the S&P500. Table 3 provides the covariance and correlation coefficients of the rate of return for quota and S&P500. The relationship has been negative over the 26 years of data with a correlation coefficient of -0.30. the correlation with the Treasury bill returns is -0.06. (For comparison we also present the correlation between the Treasury bill returns and the S&P500.) The variance of a portfolio made up of equal parts of quota and S&P500 stocks is equal to

$$\text{var}(\text{portfolio}) = \text{var}(\text{quota}) * 0.25 + \text{var}(\text{S\&P500}) * 0.25 + 2 * \text{cov}(\text{quota}, \text{S\&P500}) * 0.25.$$

Using this variance, the standard deviation of this mixed portfolio is 10.17 percent. The mean return is 19.04 percent, so the coefficient of variation is 0.53--well below that of either the S&P500 or the quota alone.

A common approach to measuring the contribution of a investment to the riskiness of the overall portfolio is to calculate the "beta" defined as the covariance of return between an item with the base portfolio divided by the variance of the base portfolio. The beta is also just the slope coefficient of the simple regression of the item of interest on the base portfolio returns. Four betas are presented in column 3 of Table 3. In the context of the S&P500, the case of common stock betas are usually positive and in the range of 0.7 to 1.5. All our betas are negative reflecting the potential for diversification.

Now let us consider how an investment in quota or other assets relate to the investment in dairy farming itself. For most dairy farmers, the investment in the dairy farms (cows, land, equipment, machinery, human capital, etc.) is a very large portion of the full portfolio. Returns to this investment are in the form of farm profits, and our

interest now is of the variation in the rate of return to dairy farm investments in California from 1971 through 1996.

Data on the rate of return to dairy farm investments is not available for California; we, therefore, do not calculate betas with this as the base portfolio. However, as a proxy of the variation in dairy farm profits (as opposed to investment in quota) overtime we turn to the variation in the price of overbase milk. Especially in California, random variation in milk output per cow is small, and variable costs, mostly labor and feed are relatively more under the control of the farm. Feed costs and the milk price are positively correlated (especially in annual data), but we argue that variation over time in the price of milk drives variation in profits.

Table 4 presents covariances and correlation coefficients between the price of milk (as proxy for dairy farm profits) and the S&P500 and returns to quota. The correlation with the monthly flow return to quota (the differential) is negative as expected, but the correlation is small. The correlation between the price of milk and the capital gains in quota is also negative. This correlation may be surprising. One hypothesis is that when dairy farm profits are low, more farmers are likely to sell quota (as a relatively liquid asset) and fewer farmers have ready capital (or credit) for quota purchase. Therefore, low milk prices would be associated with a decline in quota price; thus, we would expect a positive correlation in Table 4. What we see, however, is a negative correlation. The other possible effect is that, when milk price is high, monthly return to quota is low and may be expected to remain low. This effect seems to dominate the relationship.

Finally, Table 4 shows that returns to quota (the sum of the three components) is negatively correlated with milk price and returns to investing in the S&P500 is positively correlated with milk price. Quota returns co-vary negatively with the stock market while dairy farm profits co-vary positively with the stock market index.

Conclusion

This paper investigated the portfolio characteristics of California dairy quota. The rate of return to quota has been relatively high (at least on a before tax basis). The variability of returns is also high relative to government bonds but not relative to a diversified portfolio of stocks. Unlike stocks, most of the return to quota is from the monthly differential (like a dividend). However, as with stocks, most of the variability in returns is from the capital gains.

We also examine how returns to quota ownership co-vary with other investment options and with dairy farm profits. These results show (with negative covariance) that investment in quota lowers risk in the overall portfolio, whether quota is added to stocks or to investment in dairy farming. This last finding highlights the difference between this California dairy quota relative to production or marketing quotas (Lerner and Stanbury).

In this paper we have set aside the issue of default risk. However, by showing that the investment in quota has had a relatively high rate of return and that this return is negatively correlated with investment in either stocks and dairy farm profits our analysis re-enforces the importance of the default component of policy risk.

Table 1. Analysis of Monthly Data (January 1971 to December 1996)

	Mean	Standard Deviation	Coefficient of Variation ¹
Monthly Differential ^{2,3}	5.28	1.96	0.37
Capital Gains ⁴	0.30	22.51	75.53
New Quota Return ⁵	0.17	0.34	2.01
Quota Return ⁶	5.73	22.74	3.97
Quota Rate of Return	2.06%	7.19%	3.49
Overbase Milk Price ²	0.67	0.20	0.30

¹ The coefficient of variation is the ratio of the standard deviation to the mean.

² The overbase milk price and the differential are in terms of dollars per pound of solids-not-fat.

³ The differential is the difference between the quota milk price and the overbase milk price in dollars per pound of snf times the number of days in the month

⁴ Quota return is the sum of the three components: monthly differential, capital gains, and new quota return.

⁵ The new quota value is the value of quota disbursed in January of some years. This variable is the total new pounds of snf quota given out multiplied by the January quota price divided by the total pounds of snf quota already in the system.

⁶ The quota rate of return is composed of a monthly dividend, monthly capital gains, and new quota disbursals for the year divided by 12.

Table 2. Analysis of Annual Data (1971 to 1996)

	Mean	Standard Deviation	Coefficient of Variation
Overbase Milk Price ¹	0.67	0.19	0.29
Annual Differential ^{1,2}	63.15	16.30	0.26
Capital Gains ²	3.58	53.55	14.97
New Quota Return	2.00	3.69	1.84
Quota Return ³	68.73	57.38	0.84
Quota Rate of Return	23.22%	19.47%	0.84
S&P500 Rate of Return ⁴	14.86%	14.22%	0.96
10-Year Treasury Bill ⁵	8.61%	2.16%	0.25

¹ The overbase milk price and the differential are in dollars per pound of solids not fat, and both are summed over the year.

² The differential and capital gains are the sum of the respective 12 monthly returns.

³ The total quota return is composed of the sum of the differential, annual capital gains (from the December of the previous year to the present year's December), and new quota disbursements valued at the quota price in January of the present year.

⁴ The S&P500 rate of return was constructed from the *Economic Report of the President 1998*. This series is the change in the annual Standard & Poor's Composite Index (1941-43=10) plus the dividend price ratio (Table B-95).

⁵ The 10-Year Treasury bill is the yield taken from the *Economic Report to the President 1998* (U.S. Treasury Securities, Constant Maturities, Table B-73).

Table 3. Covariance, Correlation Coefficient, and Beta¹ for Annual Rates of Returns

	Correlation Coefficient	Covariance	Beta
Quota and S&P500	-0.30	-0.0084	-0.41
Quota and U. S. Treasury Bill	-0.06	-0.00026	-0.55
S&P500 and U. S. Treasury Bill	-0.13	-0.00038	-0.02
U. S. Treasury Bill and S&P500	-0.13	-0.00038	-0.82

¹ The beta is the ratio of the covariance of x and y and the variance of y, i.e.

$\text{Cov}(x,y)/\text{var}(y)$. In this table, x is the first variable, and y is the second variable in each pair.

Table 4. Covariances and Correlation Coefficients

	Monthly	Annual	Monthly	Annual
	Covariance		Correlation Coeff.	
Overbase Milk Price and Differential	-0.09	-0.33	-0.22	-0.11
Overbase Milk Price and Capital Gains	-0.33	-2.78	-0.07	-0.27
Overbase Milk Price and New Quota Value	-0.007	-0.09	-0.10	-0.12
Overbase Milk Price and Quota Return	-0.42	-3.21	-0.09	-0.29
Overbase Milk Price and Quota Rate of Return	-0.002	-0.02	-0.12	-0.40
Overbase Milk Price and S&P500 Rate of Return	N/A ¹	0.009	N/A	0.32

¹ N/A indicates the data is not available.

Endnotes

¹Because minimum prices are based on multiple components, the pool revenue is based on eleven prices and end-use demands (snf and fat for each class and the fluid carrier for Class 1). However, for clarity of explanation, we approximate this with a single price per class.

²An interesting finding in Table 2 is that the coefficient of variation for the differential is now slightly smaller than for the overbase milk price. The low monthly covariance of overbase and quota milk prices, due to lags in price formulas, is reduced with annual data.

Reference

- Alston, Julian M. "Economics of Commodity Supply Constraints." Eds. Tilman Becker, Richard Gray, and Andrew Schmitz. *Improving Agricultural Trade Performance under the GATT*. Wissenschaftsverlag Vauk, Kiel KG Germany. 1992.
- Barichello, Richard R. "Capitalizing Government Program Benefits: Evidence of the Risk Associated with Holding Farm Quotas." Eds. John M. Antle and Daniel A. Sumner. *The Economics of Agriculture, Volume 2, Papers in Honor of D. Gale Johnson*. The University of Chicago Press Chicago, IL. 1996.
- Boynton, Robert D. "Milk Marketing in California: A Description of the Structure of the California Dairy Industry and the Government Programs Under Which It Operates." Ed. Craig S. Alexander, Dairy Institute of California. Sixth Edition, May 1996.
- Economic Report of the President: February 1998*, United States Government Printing Office, Washington, D. C. 1998.
- Ekboir, Javier, Daniel A. Sumner, and Christopher A. Wolf. "A Study of California's Milk Pool Quota System." Working Paper, University of California, Davis. October 1996.
- Lerner, George and W. T. Stanbury. "Measuring the Cost of Redistributing Income by Means of Direct Regulation." *Canadian Journal of Economics*. 18(1985): 190-207.
- State of California Department of Food and Agriculture Milk Pooling Branch. "Pooling Plan for Market Milk as Amended." Effective September 1, 1994.
- State of California Food and Agricultural Codes. 1997.
- Sumner, Daniel A. "Stability and the Tobacco Program." Ed. Daniel A. Sumner. *Agricultural Stability and Farm Programs: Concepts, Evidence, and Implications*. Westview Press, Inc. Boulder, CO. 1988.
- Sumner, Daniel A. and Christopher A. Wolf. "Quotas without Supply Control: Effects of Dairy Quota Policy in California." *American Journal of Agricultural Economics*. 78(1996): 354-366.