Dissipation of Regulatory Rents: How Milk Marketing Orders Made Milk Producers Worse Off

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Abstract

This paper illustrates how regulatory rents are dissipated through entry by exploring the case of U.S. milk marketing orders. Producers incur costs to share in rents created by marketing orders. Previous analyses measure the income transfer and some social costs generated by the regulation, but ignore participation costs. The participation costs are modeled and quantified, and are shown to significantly reduce producer benefits and increase social costs of the regulation. Net producer losses from marketing orders follow because the cost of lower milk prices due to entry is paid in part by producers who remain outside the marketing orders. (*JEL* K23, Q18)

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> But, while the tendency of monopoly rents to be transferred into costs is no longer a novel insight, its implications both for the measurement of the aggregate social costs of monopoly and for a variety of other important issues relating to public regulation (including tax policy) continue for the most part to be ignored. [Richard A. Posner (1975), p. 808]

Gordon Tullock's seminal 1967 paper argued forcefully that the Harberger triangles understate the social costs of monopoly. He showed that competition for monopoly rents can convert those rents into social costs. Anne O. Krueger (1974) made a related point, illustrating how competition for import licenses would dissipate rents from import quotas. Posner described how the social costs associated with such rent dissipation might be estimated, presenting estimates for imperfectly competitive and regulated industries, and providing (limited) evidence that Tullock was correct.

Surprisingly little work has subsequently measured the Tullock-Posner rent dissipation for any industry, in part perhaps because costs associated with rent-seeking are often hard to measure with publicly available data. This paper models and measures rent dissipation within an important regulatory setting, milk marketing orders in the United States. This government program transfers income from consumers to dairy farms that produce beverage quality milk. We show that the resulting rents attracted entry into production of beverage quality milk, resulting in excess quality—beverage quality milk produced for the manufacturing milk market. A key result is that the additional costs of meeting beverage quality milk standards dissipate the regulatory rents, raising the social cost of the regulation. Previous work that ignores rent dissipation greatly overstates producer benefits and understates the social costs of milk marketing orders.

Thus this paper provides a detailed illustration of the well-known inefficiencies that may result from regulation (e.g., George J. Stigler (1971) and Sam Peltzman (1976) on political economic forces behind regulation, Hernando De Soto (1989) and Daron Acemoglu and Thierry Verdier (2000) on regulation and corruption, and Abhijit V. Banerjee (1997) on rents accruing to regulators). Gene M. Grossman and Elhanan Helpman (1996) concluded that protectionist regulation was most likely to be found in "sunset" industries, since rent-dissipating entry into such industries was least likely to occur. This article illustrates the difficulties of preserving regulatory rents even in such "declining" industries. Despite net exit of firms from dairy farming, milk marketing orders induce entry into the regulated market from the pool of producers outside the regulated market.

A few authors have attempted to measure the costs created by rent-seeking activities in the case of monopolies. Keith Cowling and Dennis C. Mueller (1978) used advertising expenditure and after-tax monopoly profits as an estimate of the resources expended by firms to secure monopoly rents. For a large number of public, U.S. firms, Cowling and Mueller found that rent dissipation is approximately of the same magnitude as the Harberger triangles, doubling the social cost of monopoly from 6.5 percent to 13 percent of the value of the firms' production. Robert T. Masson and Joseph Shaanan (1984) adopted Cowling and Mueller's approach, but presented a range of cost estimates by assigning varying proportions of advertising expenditure and profits as costs of securing market power. Masson and Shaanan found that rent dissipation is a significant element of the social cost of monopoly even when a small portion (25 percent) of advertising expenditure and profits are wasteful. Karl Aiginger and Michael Pfaffermayr (1997) estimated dissipation of rents accruing from market power as the difference between actual costs and those of the most efficient firm in an industry. Studying European paper and cement industries, Aiginger and Pfaffermayr found that rent dissipation is a much larger share of the social cost of market power than are the Harberger triangles.

Even fewer studies have measured the Tullock-Posner costs in the context of regulation. A notable exception is Randall R. Rucker and Wally N. Thurman (1990), who modeled and estimated the welfare effects of U.S. peanut policy, including the dissipation of rents created by participation rules. Rucker and Thurman showed that rents from U.S. peanut regulation were partially dissipated due to program rules that caused a misallocation of output among alternative markets.

Dozens of studies have addressed the economic effects of milk marketing regulation in the United States (see, among others, Reuben A. Kessel (1967); John E. Kwoka, Jr. (1977); Paul W. MacAvoy (1977); Richard A. Ippolito and Robert T. Masson (1978); William D. Dobson and Larry Salathe (1979); Daniel A. Sumner and Christopher A. Wolf (1996); and Thomas L. Cox and Jean-Paul Chavas (2001)). The literature helped to establish what has come to be the conventional wisdom on the economics of a key element of U.S. farm policy: milk marketing orders transfer income from milk consumers to milk producers (dairy farms), resulting in a net loss to society. Previous work has explored many conceptual and empirical issues and has become more technical and elaborate over the years. Nonetheless, the welfare analysis in the literature has ignored the fact that those who stand to benefit from regulation devote resources to securing those benefits, thereby reducing the net benefit to farmers and adding to the social cost of the regulation. A key contribution of this article is to examine a crucial set of participation requirements neglected by the previous literature, and to clearly show the conceptual and empirical implications of these rules for the welfare analysis of milk marketing regulation.

We develop a model of milk markets that makes explicit the process by which policy rents are transformed into costs. Results from our welfare analysis stand in contrast to the stylized facts supported by the previous literature. We show that producer benefits from milk marketing regulation are smaller than previously estimated, and that, under likely conditions, this key element of U.S. farm policy has made milk producers as a group worse off, not better off. Simply put, a program that proponents claimed benefits dairy farmers as a whole my have actually reduced producer welfare. This result reverses the conventional wisdom on this important government program.

In its examination of U.S. dairy policy, this article illustrates a fundamental concept of regulatory economics: rents created through government policy tend to be competed away by producers and consumers (Tullock; Posner; Browning; Krueger). In this case, productive resources are misallocated to produce too much quality. Milk marketing orders apply only to milk that meets the higher quality standards required for beverage milk. Farmers that meet the higher standards qualify for the rents provided by the program, even if they sell their milk to the manufacturing market where lower standards apply. The result is that a substantial and growing share of beverage-quality milk is sold to the manufacturing market, and thus is of excess quality for its intended use. Policy-created rents are transformed into costs (the cost of meeting the higher standards), reducing the net benefit to producers from milk marketing orders and increasing the social cost. The impacts are large. In 1948 (the earliest year for which available), 59 percent of milk produced in the United States met beverage quality standards (grade A) and 78 percent of that was actually used for beverage products. By 2000 98 percent of U.S. milk was grade A, but only 34 percent of that was actually used for beverage products. Producers no longer meet the more costly standards simply so that their product can be used for beverage milk; those costs are incurred to allow the milk to qualify for higher prices created by marketing order price regulations.

In this article we show, in accordance with the general insights of Tullock, Posner and others, that a major part of the waste of the U.S. milk marketing order program has been that the U.S. milk producers have incurred extra costs in competing for the rents created by a cartel-style regulatory program. A significant cost of milk regulation in the United States is that the milk supply has been too clean.

I. A Typical Model of Milk Marketing Orders

Milk marketing orders are a central element of the government programs that resulted from the Depression-era farm legislation. These farm programs have evolved, yet they continue to transfer income from taxpayers and consumers to farm resource owners with varying degrees of efficiency. In addition to milk marketing orders, a range of other policy instruments apply to farm commodities. Trade barriers raise domestic prices for sugar, beef, and dairy products, among others; a complex set of government payment programs apply for dairy and crops such as grains and oilseeds and cotton; price support and government purchase programs apply for dairy products and sugar; and a recently-inaugurated quota buyout scheme applies for tobacco (USDA-ERS, USDA-FSA). These programs have imposed various welfare costs of differing magnitudes but none has had the kind of rent dissipation found here for milk marketing orders.

Under the Agricultural Agreement Act of 1937, the U.S. Department of Agriculture (USDA) intervenes in the dairy markets of a given region at the request of at least two-thirds of the farms selling Grade A milk in that region. The intervention is in the form of a marketing order that sets minimum prices that processors must pay for raw milk depending on its end-use. The marketing orders set a high price for milk used for beverage products, and a lower price for milk used for manufacturing (i.e., cheese, butter, powder, etc.) products. Revenue from each milk class is pooled and participating producers receive a market-wide average, or pooled, price.[1]

In conjunction with the regulated milk marketing system, two sets of sanitary standards exist in the United States. One standard is set for milk that can be sold to the beverage market, known as Grade A milk, and a lower standard is set for milk sold to the manufacturing market, known as Grade B milk. In order to participate in marketing order regulation, a producer must produce Grade A milk, but need not sell to the beverage market.[2] The sale of Grade B milk is not regulated by milk marketing orders.

A standard analysis of U.S. milk marketing order regulation is depicted in Figure 1. This model is the basis for the literature on milk marketing orders (see, e.g., Kessel; Ippolito and Masson; Dahlgran; Cox and Chavas; Sumner and Wolf (1996)).[3] Standard features included in Figure 1 are that demand for fluid milk, $Q_F(P_F)$, is inelastic and demand for manufacturing milk is relatively elastic. In the figure, we assume demand for manufacturing milk is perfectly elastic, so that the price of manufacturing milk facing the marketing order, P_M, is independent of allocation of milk to this use. The marginal cost of producing Grade A milk is denoted in the figure as MC_A.[4]

Under the standard analysis, the fluid market is not differentiated from the manufacturing market in the absence of regulation, and a single price, P_M, prevails for milk in all uses. The total quantity of Grade A milk produced is Q'_{A0}, the quantity sold to the fluid market is Q_{F0}, and the difference is sold to the manufacturing market. Marketing order regulation discriminates against fluid milk consumers, raising the price on the fluid market to P_F, reducing the quantity sold on the fluid market to Q_{F1}. The marketing order sets the price of Grade A milk in manufacturing equal to the price of (unregulated) Grade B milk, P_M. The blend price paid to Grade A producers, found along the curved line labeled P_{blend}, is decreasing in the total quantity of milk sold, and is asymptotic to P_M. The blend price is the incentive price for milk producers, resulting in total quantity of Grade A milk, Q'_{A1}, and blend price, P'_{A1}. By reducing fluid consumption and increasing total milk production, the marketing order increases the quantity of Grade A milk sold to the manufacturing market.

Under the welfare geometry typically applied to marketing orders, the loss in consumer surplus for fluid milk consumers is equal to area $a + b + c + d$, the gain in producer surplus for participating (i.e., Grade A) producers is equal to area $b + d + e$. Area c is the standard Harberger welfare triangle measuring lost consumer income not transferred to producers. Revenue pooling also induces excess milk production, the cost of which is measured by area f. Thus, the deadweight cost of milk marketing orders is area $c + f$.

Not included in this picture is the market for Grade B milk. Ippolito and Masson extended the model to explicitly model the market for Grade B milk, and also allowed for a downward-sloping demand for Grade A milk in manufacturing. They showed that, with downward sloping demand for Grade A milk in manufacturing, the additional Grade A milk sold on the manufacturing market lowers the price of manufacturing milk, making producers of Grade B milk worse off, and consumers of manufacturing milk better off. Ippolito and Masson and other authors ignored the incentive to switch from Grade B to Grade A, making milk grade exogenous.

This standard analysis misses a key lesson of the economics of monopoly and regulation. Posner states the lesson succinctly for the case of monopoly: "The existence of an opportunity to obtain monopoly profits will attract resources into efforts to obtain monopolies, and the opportunity costs of those resources are social costs of monopoly too" (p. 807). The extension of this argument to regulation is straightforward. In the context of milk marketing orders, the rents created by the policy to benefit producers of Grade A milk (area $b + d + e$) are transformed into costs by the efforts of milk producers to obtain those rents. Once the regulation is in place, the existence of the policy-created rents induces competition that dissipates the rents. The competition comes from new entrants into Grade A milk production, and in particular from Grade B producers who convert to Grade A to share in the benefits of marketing order regulation. Additional Grade A milk production is sold to the manufacturing market, yet meets the Grade A (i.e., fluid grade) standards at a cost to the producer. The implication is that area $b + d + e$ in Figure 1 is not the gain in producer surplus, as the previous literature has argued, but that some portion of that area is an additional social cost of milk marketing orders.

The phenomena we discuss here are associated with large changes in the U.S. dairy industry. Figure 3 illustrates the evolution of milk production by grade and usage from 1948 to 2000. While the amount of Grade A (i.e., beverage quality) milk grew rapidly, the amount of milk used for beverage purposes grew only slowly. Over the past 50 years, the amount of Grade A milk used for manufactured dairy products rose from 14,564 million pounds in 1948 to 107,132 million pounds in 2000. As a share of total milk production, milk produced with excess quality for its actual (and expected) usage rose from 13 percent in 1948 to 64 percent in 2000. Joseph V. Balagtas and Daniel A. Sumner (2005) estimate the effect of marketing order regulation on the Grade A share of milk, controlling for other factors that might influence the decision by farms to produce Grade A or Grade B milk. These other factors include changes in dairy farm structure and changes in quality standards. Using cross-section time-series data of 47 states over 48 years, their econometric model exploits geographic and temporal variation in the implementation of milk regulation to identify the policy effect. Balagtas and Sumner find that marketing order policy is a key determinant of the premium paid for Grade A milk, and is indeed a significant driver of the variation in the Grade A share across states and over time. Thus there is compelling evidence that the regulation has caused excess Grade A milk production.

In the following section, we develop a model that makes explicit the transformation of milk policy rents into social costs, and consider the implications for the welfare analysis.

II. A Model of Milk Marketing Orders with Endogenous Participation

A. Equilibrium Prices and Quantities

Consider a more general model of milk markets without a marketing order in place:

(1) Fluid demand $Q_F = Q_F(P_F)$

(2) Manufacturing demand $Q_M = Q_M(P_M)$

(3) Total milk supply $Q_T = Q_T(P_M)$

(4) Market Clearing $Q_T = Q_M + Q_F$.

Equation (1) is the local demand for fluid milk, equation (2) the portion of the national demand for manufacturing milk facing local producers, and equation (3) is the local supply of all milk (Grade A and Grade B). Equation (4) imposes the market-clearing condition that total quantity of milk supplied equals the total quantity demanded by the two markets.

Under milk sanitation rules, of the total quantity of milk, only Q_F must meet Grade A sanitation standards. Yet benefits from participation in the marketing order program induce producers to substitute Grade A milk for Grade B milk on the manufacturing market. Because of stricter Grade A standards, Grade A milk is more costly to produce than Grade B milk. The equilibrium quantities of Grade A milk (Q_A) and Grade B milk (Q_B), where $Q_T \equiv Q_A + Q_B$, are determined endogenously, based on the additional cost of meeting Grade A standards, and on the premium paid for Grade A milk. Here, we consider the long-run, in which all inputs are variable, and model the additional cost of Grade A standards as an additional variable cost over the Grade B cost of production:

(5) $C_A(q) = C_B(q) + kq,$

where $C_A(q)$ is cost of producing q units of Grade A milk, $C_B(q)$ is the cost of producing the same quantity of Grade B milk, and k is the additional marginal cost of meeting Grade A standards. For simplicity, we assume k is constant for the industry.[5] Later we relax this assumption of constant k, allowing the additional cost of meeting Grade A standards to increase with the quantity of Grade A milk. The basic results are unchanged, except that in the case of increasing costs, persistent policy rents accrue to inframarginal firms.

In the absence of a marketing order, a premium is paid for milk sold on the fluid market, reflecting the additional costs of meeting Grade A standards:

(6) $P_F = P_M + k.$

This relationship is enforced by arbitrage—producers choosing milk grade. In the absence of the marketing order, only Grade A milk sold on the fluid market gets the fluid price, and thus only milk sold on the fluid market is Grade A: $Q_A = Q_F$.

Marketing order regulation sets a premium for milk sold on the fluid market,

(7) $P_F = P_M + D,$

where $D > k$. The price of Grade A milk used in manufacturing is set equal to the unregulated price of Grade B milk:

(8) $P_M = P_B.$

As noted above, the price paid to Grade A producers is a weighted average of the regulated fluid and manufacturing prices:

(9) $P_A = uP_F + (1 - u)P_M,$

where u is defined as the fluid market utilization rate of Grade A milk, $u \equiv Q_F/Q_A$. Substituting equations (7) and (8) into (9), the Grade A blend price can be written as

(10) $P_A = P_B + uD.$

Thus, in contrast to the market with no marketing order, in which a premium is paid for milk sold on the fluid market, marketing order regulation creates a premium for Grade A milk in all uses. In an internal equilibrium (i.e., with some milk sold to the manufacturing market), the premium for Grade A milk reflects the cost of meeting Grade A standards:

(11) $P_A = P_B + k.$

Substituting equation (10) into equation (11), the equilibrium condition can be stated equivalently as

(12) $uD = k.$

Noting that $u \equiv Q_F/Q_A$, equation (12) can be rearranged to show that the equilibrium quantity of Grade A milk under marketing order rules is:

(13) $Q_A = (D/k)Q_F.$

Since $D > k$, the quantity of Grade A milk exceeds the quantity of fluid milk demanded, and some Grade A milk is sold on the manufacturing market.

Figure 2 illustrates our analysis of milk marketing order regulation with endogenous participation. For the purpose of comparison, the demand curves and Grade A marginal cost are identical to those depicted in Figure 1. We super-impose the marginal cost of producing Grade B milk, MC_B, in Figure 2 following the cost structure assumed in equation (5). In the absence of marketing order regulation, the equilibrium relationship between prices of fluid and manufacturing milk, equation (6), results in a quantity of fluid milk demanded Q_{F0}. This is also the quantity of Grade A milk produced, $Q_{A0} = Q_{F0}$, since only milk sold on the fluid market gets the premium. The total quantity of milk (Grade A and Grade B) produced is Q_T, of which $Q_T - Q_{A0}$ is Grade B milk.

In our analysis, as in the standard analysis, the high price set by the marketing order for fluid milk, P_{F1}, reduces fluid milk consumption to Q_{F1}, and the equilibrium price for Grade A milk is found along the blend price line. In contrast to the standard analysis, we find the equilibrium price and quantity of Grade A milk based on the equilibrium price relationship, equation (11), which takes into account the additional cost of meeting Grade A standards. The resulting quantity of Grade A milk is Q_{A1}. The total quantity (Grade A and Grade B) of milk produced remains Q_T, but now only $Q_T - Q_{A1}$ is Grade B milk, less than in the standard model. Also, now $Q_{A1} - Q_{F1}$ is Grade A milk used for manufacturing.

B. The change in producer surplus, with constant costs of meeting Grade A standards

Our welfare analysis departs from the standard analysis also in the calculation of the change in producer surplus. Producer surplus in the absence of marketing order regulation is total revenue less total cost:

$$(14) \qquad PS_0 \equiv P_M Q_T + kQ_{F0} - \left(\int_0^{Q_T} MC_B(Q)\,dQ + kQ_{F0}\right)$$

$$= P_M Q_T - \int_0^{Q_T} MC_B(Q)\,dQ\,.$$

Thus, in the unregulated market, the additional revenue generated by the premium for fluid market milk, kQ_{F0}, just compensates producers for the additional cost of meeting Grade A standards on that milk.

Producer surplus under marketing order regulation is

$$(15) \quad PS_1 \equiv P_M Q_T + kQ_{A1} - \left(\int_0^{Q_T} MC_B(Q)dQ + kQ_{A1}\right).$$

$$= P_M Q_T - \int_0^{Q_T} MC_B(Q)dQ\ .$$

Under marketing order regulation, the additional revenue generated from Grade A milk—that is, fluid-quality milk that may or may not be used in manufacturing—just compensates producers for the additional cost of meeting Grade A standards on that milk.

The change in producer surplus from introducing marketing orders into the unregulated market is:

$$(16) \quad \Delta PS = PS_1 - PS_0 = 0.$$

With constant k, the additional cost of producing Grade A milk for manufacturing exactly offsets the rents created by price discrimination. That is, producers as a group are no better off under milk marketing order regulation than they are in an unregulated market! Milk producers who sell milk to the manufacturing market, and who otherwise would have produced Grade B milk, incur the additional cost of Grade A standards in order to share in the benefits of regulation. The additional costs dissipate the rents created by price discrimination, and reduce producers' net benefits from regulation.

Figure 2 illustrates the key welfare effects. The marketing order increases Grade A milk revenue, as indicated by the shaded rectangle labeled "Additional Grade A Revenue."[6] However, marketing order regulation induces producers to shift quantity Q_{A1}

- Q_{A0} from Grade B to Grade A, at a per unit cost of *k*. In Figure 2, this additional cost is indicated by the shaded parallelogram labeled "Additional Grade A Costs." With constant *k*, the additional cost of meeting Grade A standards exactly offsets the additional Grade A revenue created by milk marketing orders. Thus, policy rents are transformed into social costs.

Previous authors have discussed the additional cost of meeting Grade A standards (Ippolito and Masson, Alden C. Manchester (1983)). However, the welfare analyses applied to marketing orders have invariably excluded the additional cost of producing Grade A milk that is used for manufacturing. As a result, the previous literature on milk marketing orders has overstated the net benefits to producers and understated the social cost.

C. *Change in producer surplus, with constant costs of meeting Grade A standards, and downward sloping demand for manufacturing milk*

When demand for manufacturing milk is downward-sloping, the marketing order results in a lower price of manufacturing milk, $P_{M1} < P_{M0}$, and a reduction in total quantity of milk, $Q_{T1} < Q_{T0}$.[7] In this case, and with constant marginal costs of meeting Grade A standards, it becomes clear that marketing order regulation makes milk producers as a group unambiguously worse off!

Producer surplus without the marketing order is

$$(17) \qquad PS_0 = P_{M0}Q_{T0} - \int_0^{Q_{T0}} MC_B(Q)dQ,$$

which is identical to equation (14) except for the "0" subscript on the total quantity of milk, indicating the unregulated equilibrium quantity. As was true in the small-region case (with P_M fixed), the additional revenue generated by the higher price for fluid market milk, kQ_{F0}, just compensates producers for the additional cost of meeting Grade A standards on that milk.

Producer surplus under the marketing order is now

$$(18) \qquad PS_1 = P_{M1}Q_{T1} - \int_0^{Q_{T1}} MC_B(Q)dQ\,,$$

which is identical to equation (15) except for the "1" subscript on the total quantity of milk, indicating the regulated equilibrium quantity. Again, the additional revenue generated from the premium for Grade A milk just compensates producers for the additional cost of meeting Grade A standards on that milk.

The change in producer surplus from introducing marketing orders into the unregulated market is:

$$(19) \qquad \Delta PS = \int_{P_{M1}}^{P_{M0}} Q_T(P_M)dP_M \leq 0.$$

Since the marketing order results in a lower price for manufacturing milk, $P_{M1} < P_{M0}$, ΔPS is unambiguously negative.

With constant marginal additional cost of meeting Grade A standards, the additional costs of meeting Grade A standards completely dissipate the rents from price discrimination leaving Grade A producers as a group no better off. At the same time, with downward sloping demand for manufacturing milk, the marketing order increases the quantity of milk sold on the manufacturing market, lowering the price of all milk, and making the remaining Grade B producers worse off. Thus, milk producers as a group are made worse off by the marketing order

D. Change in producer surplus, with increasing costs of meeting Grade A standards

The additional marginal cost of meeting Grade A standards may be an increasing function of the quantity of Grade A milk; as more Grade A milk is produced, producers with higher costs of meeting Grade A standards enter Grade A production. Let the additional cost of meeting Grade A standards for the industry be an increasing function of the quantity of Grade A milk:

(20) $C_A(q) = C_B(q) + k(q),\ k' > 0.$

We write the producer surplus equations for the large-region case.

Producer surplus without the marketing order is

(21) $$PS_0 = P_{M0}Q_{T0} + k(Q_{A0})Q_{A0} - \left(\int_0^{Q_{T0}} MC_B(Q)dQ + \int_0^{Q_{A0}} k(Q)dQ \right),$$

where $Q_{A0} = Q_{F0}$. On the margin, the premium for fluid milk, $k(Q_{A0})$, is equal to the additional cost of meeting Grade A standards. However, with $k' > 0$, the premium for fluid milk exceeds the average additional cost of meeting Grade A standards. Thus, in contrast to the case in which k is constant, here, the additional revenue from the premium for fluid milk, $k(Q_{A0})Q_{A0}$, exceeds the additional cost of meeting Grade A standards $\int_0^{Q_{A0}} k(Q)dQ$.

Producer surplus under marketing order regulation is

(22) $$PS_1 = P_M Q_{T1} + k(Q_{A1})Q_{A1} - \left(\int_0^{Q_{T1}} MC_B(Q)dQ + \int_0^{Q_{A1}} k(Q)dQ \right).$$

Again, since $k' > 0$, $k(Q_{A1})Q_{A1} - \int_0^{Q_{A1}} k(Q)dQ > 0$.

The change in producer surplus due to marketing order regulation is a generalization of equation (19):

$$(23)\qquad \Delta PS = [P_{M1}Q_{T1} - P_{M0}Q_{T0}] + \int_{Q_{T1}}^{Q_{T0}} MC_B(Q)dQ$$

$$+ \int_{Q_{A1}}^{Q_{A0}} k(Q)dQ + k(Q_{A1})Q_{A1} - k(Q_{A0})Q_{A0}$$

$$= \int_{P_{M1}}^{P_{M0}} Q_T(P_M)dP_M + [\int_{Q_{A1}}^{Q_{A0}} k(Q)dQ + k(Q_{A1})Q_{A1} - k(Q_{A0})Q_{A0}],$$

where $\int_{P_{M1}}^{P_{M0}} Q_T(P_M)dP_M \leq 0$, (the equality holds for a small region facing perfectly elastic demand for manufacturing milk); $\int_{Q_{A1}}^{Q_{A0}} k(Q)dQ < 0$ is the additional cost of meeting Grade A standards for additional Grade A milk, all of which is sold to the manufacturing market; and $k(Q_{A1})Q_{A1} - k(Q_{A0})Q_{A0} > 0$ measures the additional revenue created by price discrimination and transferred to Grade A producers. For $k' > 0$, $\int_{Q_{A1}}^{Q_{A0}} k(Q)dQ$ + $k(Q_{A1})Q_{A1} - k(Q_{A0})Q_{A0} > 0$. In words, when the marginal cost of meeting Grade A standards is an increasing function of the quantity of Grade A milk, the additional Grade A revenue created by the marketing order exceeds the additional cost of meeting Grade A standards. The sign of the net effect of marketing orders on producer surplus is ambiguous in this case, and depends on the shape of $k(Q_A)$ and on the slope of the demand for manufacturing milk. In this case, policy rents are partially, but not completely, dissipated by the cost of meeting Grade A standards for milk sold to the manufacturing market.

III. Measures of the Additional Cost of Meeting Grade A Standards

The existing literature on milk marketing orders ignores the additional cost of meeting Grade A standards. As a result, the literature overstates producer gains from milk marketing order regulation, and understates the net social cost. There are no ideal data on the economic costs of meeting Grade A standards over the life of marketing orders. In this section, we make use of existing data and develop two alternative approaches to measuring the additional cost of meeting Grade A standards. First we describe the additional costs.

A. Defining the additional cost of meeting Grade A standards

The federal government and state governments play an important role in setting milk sanitation standards in the United States. The U.S. Public Health Service (PHS) promotes a model of sanitary regulation of Grade A, or fluid grade, milk for voluntary adoption by each state. The Grade A Pasteurized Milk Ordinance (PMO), first published by the PHS in 1927 and most recently revised in 1999, sets the minimum health and sanitation requirements of fluid grade milk in the United States. While the states have maintained ultimate responsibility for setting and enforcing health and sanitation standards, all have adopted the PMO as the set of uniform, minimum health and sanitation requirements of fluid grade milk (U.S. Department of Health and Human Services). Similarly, although Grade B standards are ultimately set and enforced at the state level, the USDA has prescribed standards for Grade B milk since 1963 (USDA, AMS).

To prevent the marketing of contaminated milk, Grade A and Grade B farms are inspected regularly for compliance with farm sanitation requirements. Farm requirements encompass specifications on the health and care of the dairy herd, the cleanliness of the milking procedure, the design and cleanliness of milking facilities and equipment, and the availability and hygiene of the water supply. Grade A farm requirements have always been more stringent than Grade B farm requirements. In addition, milk from all Grade A farms and Grade B farms is regularly tested for compliance with bacteriological, chemical, and temperature standards. The Grade A standards for these characteristics also have been more stringent than those for Grade B milk.

Standards for both milk grades have become stricter over time, and Grade B standards have converged toward Grade A standards. However, Grade A standards continue to be more stringent. Cost-of-production studies and interviews with dairy scientists and milk sanitation regulators have indicated that the different sanitary requirements for Grade A and Grade B milk and farms translate into additional production costs for Grade A milk relative to Grade B milk (Jermome W. Hammond and Boyd M. Buxton (1970); Gary G. Frank et al. (1977); Ralph M. Chite (1991)).

Interviewing regulators in 1991, Chite found that the greatest obstacles for conversion to Grade A at that time were water systems of inadequate quality, the use of non-electric cooling practices, and a lack of financial resources that would allow the investments necessary to upgrade facilities.

Frank et al. analyzed cost of production data from a 1974-75 survey of Wisconsin dairy farms, and found that, on average, Grade A farms incur higher average costs. Using cost accounting methods, these authors compared production costs on a sample of Wisconsin dairy farms milking approximately the same size herds (40 head). They found that cash expenses were slightly higher on Grade B farms in 1975 (but lower in 1974), largely because of higher feed expenses on Grade B farms. However, Grade A producers had higher capital costs per cwt of milk sold and also incurred higher costs of unpaid labor directly related to additional time spent cleaning to meet stricter Grade A standards.

They found that Grade A average costs ranged from $0.23 to $0.47 per cwt (1974 current dollars) higher than Grade B average costs. For perspective, the U.S. average Grade B milk price in 1974 was $7.13/cwt. (This estimate does not include the cost of more frequent inspections required by Grade A standards.)

While the findings on the additional cost of meeting Grade A standards are suggestive, they are also limited and are not comprehensive. Therefore, we must use proxy information. The next two sections develop alternative indicators of the costs of meeting Grade A standards for each year between 1948 and 1996.

B. Cost-based estimates of the average additional social cost of meeting Grade A standards

One measure of the cost of excess milk quality can be developed based on the cost-of-production studies discussed above. The work by Frank, Peterson, and Hughes provides the most recent estimate of the additional cost of producing Grade A milk. Their conservative estimate of the average additional cost of meeting the stricter Grade A sanitation standards is $0.23 per cwt. (100 pounds of milk) in 1974, or $0.65 per cwt. in 1999 dollars.[8] However, the additional cost of compliance with Grade A standards is likely to have decreased over time because of changes in the industry. The average herd size of U.S. dairy farms has grown over time, so to the extent that the additional costs of meeting Grade A standards are fixed costs independent of herd size, the additional costs per cwt. of output will have fallen accordingly. The additional cost of producing Grade A milk also may have fallen over time with changes in human capital. As farm management has improved through learning and through entry of new managers, the cost of meeting Grade A standards likely has fallen. Further, as Grade B standards have risen closer to Grade A standards, the additional of cost of meeting Grade A standards has fallen.

In addition to variation in the time dimension, industry costs and the size distribution of dairy farms also vary regionally (Harry M. Kaiser and Mitch J. Morehart (2000); Sara D. Short (2000); Daniel A. Sumner and Christopher A. Wolf (2002)), so an estimate of production costs based on a sample of Wisconsin producers generally is not representative of the costs of producing milk in, for example, California or New York. Average herd size is a closely related to milk production costs and varies among regions (Kaiser and Morehart). To the extent that more stringent Grade A standards impose additional fixed costs independent of herd size, herd size is negatively correlated with the average additional cost of producing Grade A milk. Thus, the average additional cost of meeting Grade A standards is lower in those regions with larger herds.

Unfortunately, the data that would capture regional and temporal variation in Grade B costs do not exist. Lacking sufficient data for econometric estimates, we apply a simple method using the data available to approximate the variation in the additional cost of meeting stricter sanitary standards over time, positing a functional form based on herd size:

(24) $\text{Additional cost per cwt} = 21.7(\text{herd size})^{-1}$.

Equation (24) is calibrated to pass through the observation from Wisconsin, 1974 from Frank, Peterson, and Hughes. It is decreasing in herd size, allowing for both cross-sectional and temporal variation in the additional cost of meeting Grade A standards, and thus is consistent with the stylized facts: states characterized by larger herd sizes have lower costs, and as dairy farms across the country have tended towards larger herds, the additional cost of meeting Grade A standards has shrunk. Based on equation (24), this measure of the additional cost of excess Grade A milk is

$$(25)\qquad \int_{Q_{A0}}^{Q_{A1}^{*}} k(q)dq = 21.7(herdsize)^{-1}\left(Q_{A1}^{*} - Q_{A0}\right)$$

C. Price-based estimates of the average additional cost of meeting Grade A standards

An alternative estimate of the additional cost of producing Grade A milk can be gleaned from the model developed in the previous section. Based on equation (11), the additional, per unit cost of meeting Grade A standards is, at the margin, equal to the observed difference between the prices for Grade A and Grade B milk, $P_A - P_B$. If the additional cost of meeting Grade A standards is constant for the industry ($k'(Q_A) = 0$), then $P_A - P_B$ is also the average additional cost of meeting Grade A standards. In the case of increasing costs of meeting Grade A standards ($k'(Q_A) > 0$), the average additional cost of meeting Grade A standards is less than ($P_A - P_B$).

By assuming a functional form for $k(Q_A)$, we develop estimates of the additional cost of excess milk quality. Lacking any prior conviction on the shape and location of $k(Q_A)$, we adopt a simple, transparent function form. We approximate $k(Q_A)$ with a quadratic, increasing function that passes through the origin:[9]

$$(26)\qquad k(q) = \alpha q^2$$

where, based on equation (11), $\alpha = (P^*_A - P^*_B)/Q^{*2}_A)$ for an interior equilibrium, and the asterisk (*) denotes data. An estimate of the cost of excess Grade A milk is

$$(27)\qquad \int_{Q_{A0}}^{Q_{A1}^*} k(q)dq = \int_{Q_{A0}}^{Q_{A1}^*} \frac{P_{A1}^* - P_{B1}^*}{\left(Q_{A1}^*\right)^2} q^2 dq = \left(\frac{1}{3}\right)\left(\frac{P_{A1}^* - P_{B1}^*}{\left(Q_{A1}^*\right)^2}\right) q^3 \Bigg|_{Q_{A0}}^{Q_{A1}^*}$$

For markets with a Grade A share of 100 percent, the interior equilibrium condition, equation (11), does not necessarily hold, in which case equation (27) overstates the cost of excess milk quality. We assume that for markets with 100 percent Grade A milk, the additional cost at the margin is equal to one-half the Grade A premium. Thus, for states with a Grade A share of 100 percent, an estimate of the cost of excess quality is

$$(28)\qquad \int_{Q_{A0}}^{Q_{A1}^*} k(q)dq = \int_{Q_{A0}}^{Q_{A1}^*} \frac{\frac{1}{2}\left(P_{A1}^* - P_{B1}^*\right)}{\left(Q_{A1}^*\right)^2} q^2 dq = \left(\frac{1}{6}\right)\left(\frac{P_{A1}^* - P_{B1}^*}{\left(Q_{A1}^*\right)^2}\right) q^3 \Bigg|_{Q_{A0}}^{Q_{A1}^*}$$

Both of our two approaches are plausible but each relies on an assumption to replace a lack of data. We have no strong reason to prefer one measure over the other. Therefore, as a third measure of cost we calculate the simple average of the two cost measures from equation (25) and from equations (27) and (28).

IV. Data and Estimates of the Annual Cost of Excess Milk Quality

We use equations (25), (27), and (28) together with annual data on Grade A production, fluid milk consumption, average prices received for Grade A and Grade B milk, and average dairy herd size, to develop two alternative estimates of the additional cost of meeting Grade A standards. We calculate the quantity of Grade A milk that would exist in the absence of milk marketing orders, Q_{A0}, as the quantity of fluid milk that would have been consumed in the absence of price discrimination plus 10 percent. We calculate the quantity of fluid milk that would have been consumed in the absence of price discrimination based on data on the fluid milk differential, *D*, together with a fluid milk demand elasticity of -0.5, which is the central tendency of estimates found in the agricultural economics literature (for example, Dale M. Heien and Cathy Roheim Wessels (1998); Kuo S. Huang (1993)). The surplus of 10 percent is included based on arguments by some economists that this additional production of Grade A milk would be produced to arbitrage price fluctuations resulting from seasonal fluctuations of milk production, and the perishability of fluid milk (Roland W. Bartlett (1965); William D. Dobson and Larry Salathe (1979); Manchester).

As was documented in the previous section, compliance with Grade A standards has required capital investments to upgrade dairy facilities. Such investments ranged from relatively minor modifications of existing structures to the construction of new facilities, and included adoption of new technology such as a refrigerated milk tank or new plumbing. For farms facing such hurdles to the Grade A market, milk grade choice is an investment decision. As such, expected streams of future prices are relevant to milk grade choice. As a proxy for the producers' expectations of milk prices and quantities, we use five-year moving average prices and quantities.

Recall Figure 3, which shows the quantity of Grade A milk used in manufacturing in the United States for years 1948-2000. Grade A milk production grew during that time period, driven by growth of Grade A milk sold to the manufacturing market. Although the Grade A share of U.S. milk production always has been less than 100 percent, the Grade A share for some states has been 100 percent since at least the start of our data set (1948), and other states have since grown to 100 percent Grade A.

Figure 4 presents our estimates of the annual cost of excess milk quality based on our two measures of the average additional cost of meeting Grade A standards. The price-based estimate is calculated by applying equation (27) to the portion of surplus milk produced in states with a Grade A share of 100 percent, applying equation (28) to the portion of surplus Grade A milk produced in states with 100 percent Grade A, then summing the two. Using our price-based measure, the annual cost of excess milk quality peaks at $782 million in 1968, and averages $557 million over the period. The price-based cost grows initially, as the quantity of surplus Grade A milk grows, but then declines as an increasing share of Grade A milk is produced in states with a Grade A share of 100 percent. Using our cost-based measure, the annual cost of excess milk quality grew from $90 million in 1948 to $234 million in 1986, with an average annual cost during the period of $147 million. Although the per unit additional cost of meeting Grade A standards fell over time with the growth in herd sizes, the total cost of excess milk quality using our cost-based measure did not fall as sharply because the quantity of surplus Grade A milk grew over time.

A. The cost of excess milk quality as an additional social cost of milk marketing orders

As detailed in the introduction, many economists have quantified different aspects of the social costs of milk marketing orders (for example, Ippolito and Masson; Dahlgran; Sumner and Wolf (1996); and Cox and Chavas, among many others). None of these authors has included in their estimates the welfare cost of excess quality, which is in addition to the Harberger welfare measures—fluid consumer losses, Grade A producer gains, manufacturing producer losses, and manufacturing consumer gains. Table 1 puts the cost of excess quality in the context of the welfare effects found by prior studies. This important literature has left out an important part of the story.

The top two rows of Table 1 summarize the major results of two important prior studies. Using a model similar to that depicted in Figure 1, Ippolito and Masson estimated that the benefit to Grade A producers from milk marketing orders was $211 million in 1974, or $595 million in 1999 dollars—a figure that is explicitly "gross of any regulation-induced expenditures" (p.54). Ippolito and Masson found that the annual social cost of milk regulation was approximately $60 million in 1974, or $170 million in 1999 dollars. These estimates include the cost of distortions in milk markets, as well as administration costs of the program. In a more recent study of milk marketing orders, Cox and Chavas, making no distinction between Grade A and Grade B milk, found that milk marketing orders raised producer surplus by $293 million in 1995, or $311 million in 1999 dollars. Cox and Chavas found a deadweight cost of marketing orders of $127 million, or $135 million in 1999 dollars.

We have shown that, by ignoring the cost of excess milk quality in ex post analysis of the welfare effects of milk marketing orders, both of these studies overstated the annual benefit to producers and understated the annual deadweight cost. Every study of milk marketing orders in the literature suffers from the same bias in the welfare measurements.

Table 1 shows that the gain to milk producers net of the cost of milk quality is significantly smaller than previously estimated. Using the price-based estimate of the cost of excess milk quality, producers were actually made worse off by marketing orders, just as the model developed above indicated was possible. Using the price-based measure, we find that marketing orders reduced producer surplus by $114 million in 1974, and $93 million in 1995. Using the cost-based measures of the cost of excess quality, marketing orders increased producer surplus, but by far less than the previous literature indicates. Using the average of our measures, by neglecting the cost of qualifying for the marketing orders, the literature overestimated producer benefits by approximately 263 percent in 1974 and by approximately 508 percent in 1995.

The estimates of the annual deadweight cost of milk marketing orders found in the previous literature are far too small. Using the price-based estimate of the cost of excess milk quality, the previously estimated deadweight cost of milk marketing orders is 81 percent too small in 1974, and 75 percent too small in 1995. Our other measures of the cost of excess quality also suggest that the literature underestimates the true social cost of milk marketing orders.

Our estimates are appropriate as calculated. Nevertheless, some care is required for applying the cost of excess quality to forward-looking welfare analysis. For example, Cox and Chavas simulated the effects of deregulation relative to the status quo of marketing order regulation. For the thought experiment analyzed by Cox and Chavas—how would markets respond to deregulation—ignoring milk grade would be appropriate only if deregulation would not cause a shift towards production of Grade B milk. Their analysis misses the consequences of such a shift. However, if any of the fixed costs of compliance with Grade A standards are recoverable, or if the additional variable costs are not zero, then we would expect a shift towards Grade B in response to deregulation. Other studies explicitly conduct ex post analyses for which the omission of the cost of excess quality is important.

So far we have presented welfare effects for three sample years. Adjusting the annual costs of excess milk quality for the time value of money (we use a four percent discount rate), and adding up the adjusted annual costs over the years, we can get a measure of how much waste has been generated by the excess milk quality induced by marketing orders. Using the price-based estimate of the additional cost of meeting Grade A standards, and adjusting annual costs by a four percent annual discount rate, we calculate that the capitalized cost of excess milk quality from 1948 to 1996 is $92 billion. Alternatively, using the cost-based estimate, the capitalized cost of excess milk quality from 1948 to 1996 is $19 billion. Our average cost measure yields a capitalized cost of $66 billion.

Thus, the conventional wisdom on the economic effects of milk marketing orders—supported by a large economic literature on the subject—omitted tens of billions of dollars in social costs attributable to marketing order regulation. Properly accounting for compliance costs, milk marketing order regulation has been much less beneficial to producers as a group, and may have made producers as a group worse off. Milk marketing orders have been hugely more wasteful than was previously believed.

V. Reconciling producer losses with the continued producer support of marketing orders

We have demonstrated that milk marketing orders have had, at best, a theoretically ambiguous effect on producers, and, under reasonable assumption, have made producers worse off. Some discussion is in order to reconcile the ambiguous effects of marketing orders on producer welfare with the fact that marketing order regulations exist only by producer choice. The Agricultural Adjustment Act of 1935 established authority for milk marketing orders to operate where a two-thirds majority of Grade A producers voted in favor of the regulation in referendum. Thus, if marketing orders made producers worse off, as our research suggests was possible, why would producers have chosen to be regulated by them? Possible answers to this question relate to aspects of marketing orders and the process of milk grade choice that the analysis above does not consider.

The producer welfare measure used above is based on economic surplus for all milk producers, Grade A and Grade B. Aggregating producers in this way is appropriate since the stated policy objective to raise producer income and wealth makes no distinction between milk grades. However, the stated objective of benefiting all producers is directly inconsistent with limiting the vote to Grade A producers, and the costs and benefits to producers are not distributed evenly across Grade A and Grade B producers. In fact, Grade B producers receive none of the benefits of marketing orders; rents created by price discrimination on the fluid milk market are distributed only among Grade A producers. At the same time, Grade B producers bear a significant portion of the cost of lower manufacturing milk prices. In other words, Grade A producers receive all of the producer benefits and bear only a portion of the costs of milk marketing orders. Thus, from the perspective of Grade A producers—that is, producers with a vote—marketing orders can be beneficial, even when producers as a group lose.

A related issue is the provision that allows a dairy cooperative to “bloc vote”, that is, cooperatives cast votes on behalf of their producer-members, in referenda to approve marketing orders (Kenneth W. Bailey p.117). Cooperatives, whose producers traditionally served the fluid market, have been disproportionately represented by Grade

A producers. In this case, bloc voting could allow Grade A producer-members to impose a marketing order, despite the costs to Grade B producer-members and non-member Grade B producers.

Another explanation is that the corner solution case ($Q_B = 0$) applies to many regions over many years. In these cases, rents from price discrimination are not entirely dissipated by the cost of meeting Grade A standards, and producers are made better off. Nonetheless, the costs of meeting Grade A standards reduce producer benefits and add to the social cost of the regulation.

Also, rent dissipation takes time. The switch to Grade A has occurred gradually over time, so that early entrants into the regulated, Grade A market benefited before entry reduced the rents (Peter Berck and Jeffrey M. Perloff (1985)). Furthermore, because producers are heterogeneous in the cost of meeting Grade A standards, low-cost producers receive a policy rent even though the marginal farm does not. Finally, until now, the waste associated with excessive milk quality has been ignored or misunderstood, and the welfare consequences of rent dissipation ignored and it possible that producers and their cooperatives were provided faulty analysis by their economic advisors.

VI. Conclusion

A stated goal of milk marketing orders is to improve income and wealth of milk producers (Paul W. MacAvoy, p.113). The mechanism to achieve that goal is price discrimination against fluid milk consumers, implemented by revenue pooling that allocates the rents to all producers of fluid quality, or Grade A, milk. However, rents attract entry. Specifically, dairy producers who specialized in producing manufacturing milk have been induced by marketing orders to produce excess quality, selling Grade A milk to the market that requires less quality. The additional cost of meeting Grade A standards is paid by producers in order to participate in the marketing orders, and therefore dissipates the rents created by marketing order regulation. As a result, and as the analytical and empirical results presented here show, marketing order regulation has had theoretically ambiguous—and, under reasonable conditions, negative—effects on producer welfare.

Our research on an important instrument of U.S. dairy policy has quantified the importance of regulatory rent dissipation. Milk marketing orders are like a government sponsored and protected cartel. Entry costs into the cartel have been paid in terms of the efforts to produce excess milk quality. Despite the intense scrutiny that milk marketing regulation has received from economists, this study is the first to carefully quantify the costs associated with the insights of Tullock, Browning, Krueger, and Posner.

Table 1. Estimated Annual Cost of Excess Quality Compared to Published Welfare Effects of Milk Marketing Orders

	Ippolito and Masson	Cox and Chavas[e]
Year analyzed	1974	1995
	$ million[a]	
Gain to producers ignoring the cost of excess quality	595	311
Deadweight cost ignoring the cost of excess quality	169[b]	135
Cost of excess quality		
Price-based measure[c]	709	405
Cost-based measure[d]	153	206
Average measure	431	306
Net gain to producers		
Price-based measure[c]	-114	-93
Cost-based measure[d]	442	105
Average measure	164	6
Total Deadweight Cost		
Price-based measure	878	540
Cost-based measure	322	341
Average measure	600	441

Sources: The top two rows, those ignoring the costs of excess quality, are from Ippolito and Masson, Dahlgran, and Cox and Chavas. All remaining rows are authors' calculations.

a. Real 1999 dollars, adjusted by the GDP Implicit Price Deflator.

b. Includes administration costs.

c. Using price-based measure of the average additional per unit cost of meeting Grade A standards, equations (27) and (28).

d. Using the cost-based measure of the average additional per unit cost of meeting Grade A standards, equation (25).

e. As discussed in the text, the estimates from Cox and Chavas may be appropriate for forward-looking analysis, but only if deregulation would not result in a shift towards Grade B milk that would allow producers to save the additional cost of meeting Grade A standards for manufacturing milk.

Figure 1. The standard model of milk marketing orders.

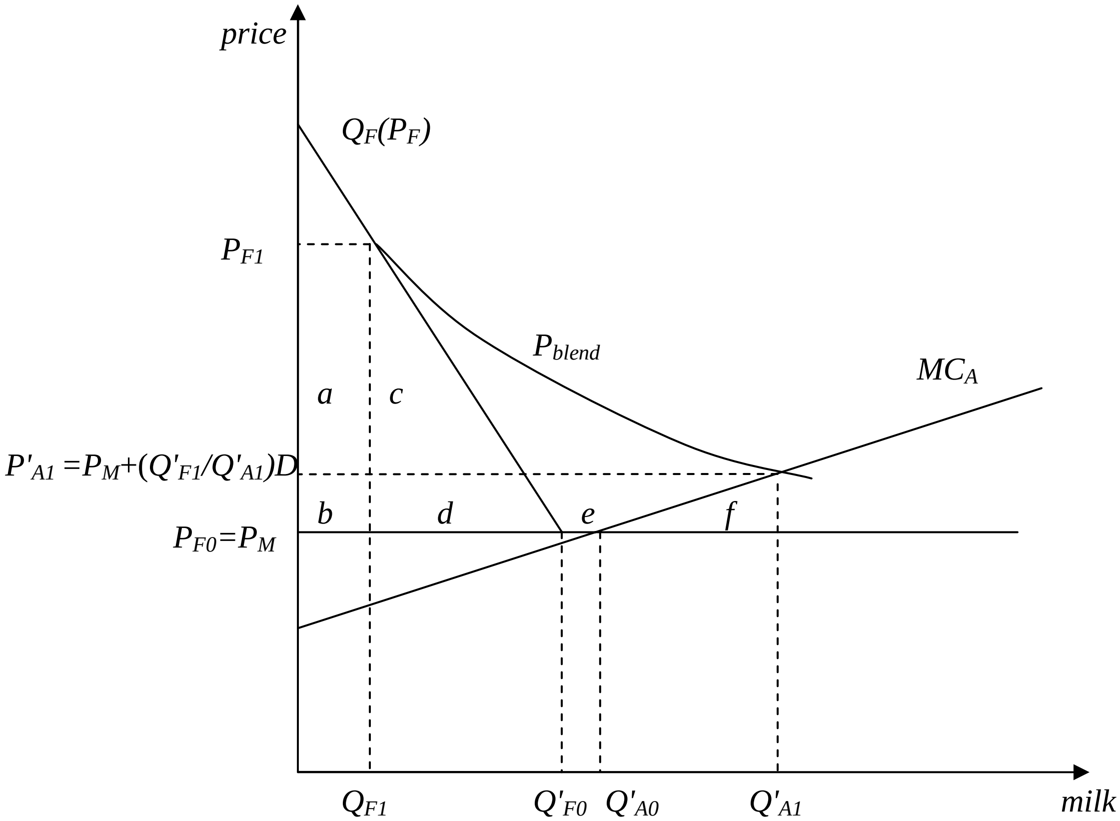


Figure 2.Dissipation of milk marketing order rents.

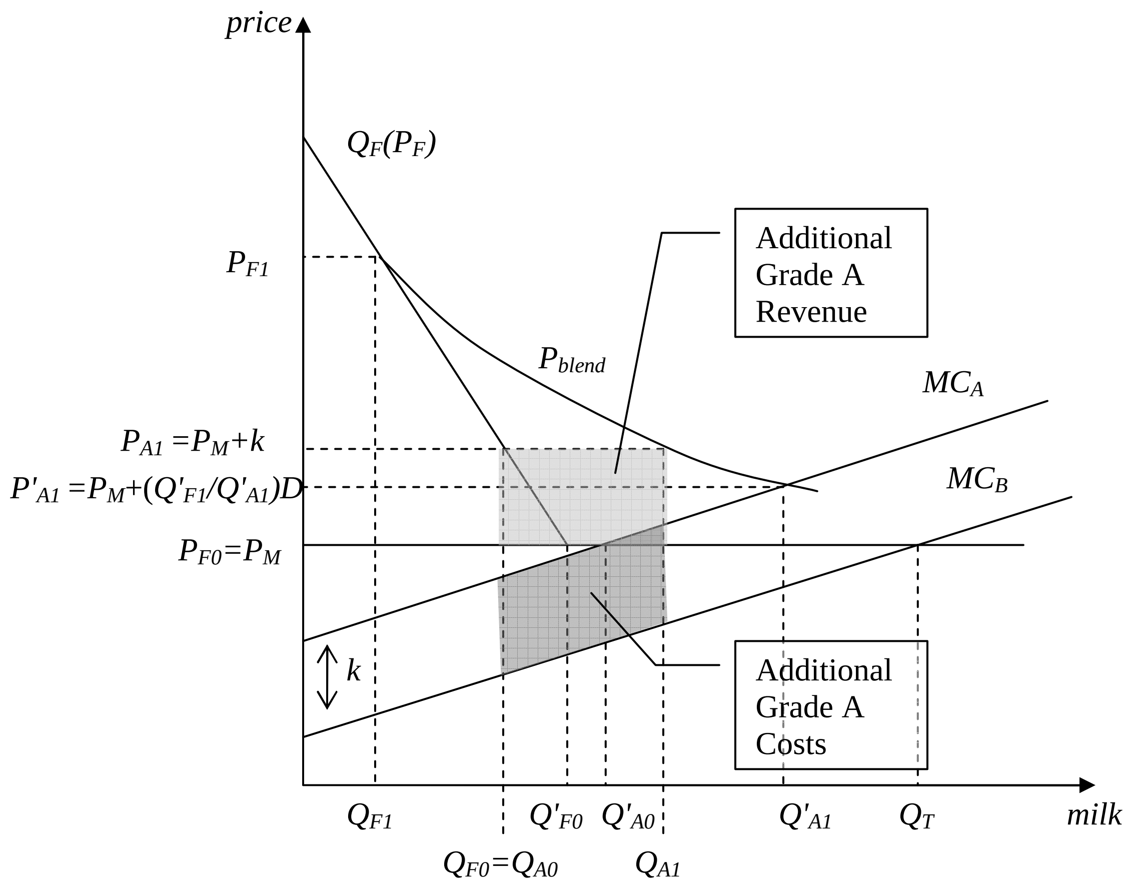
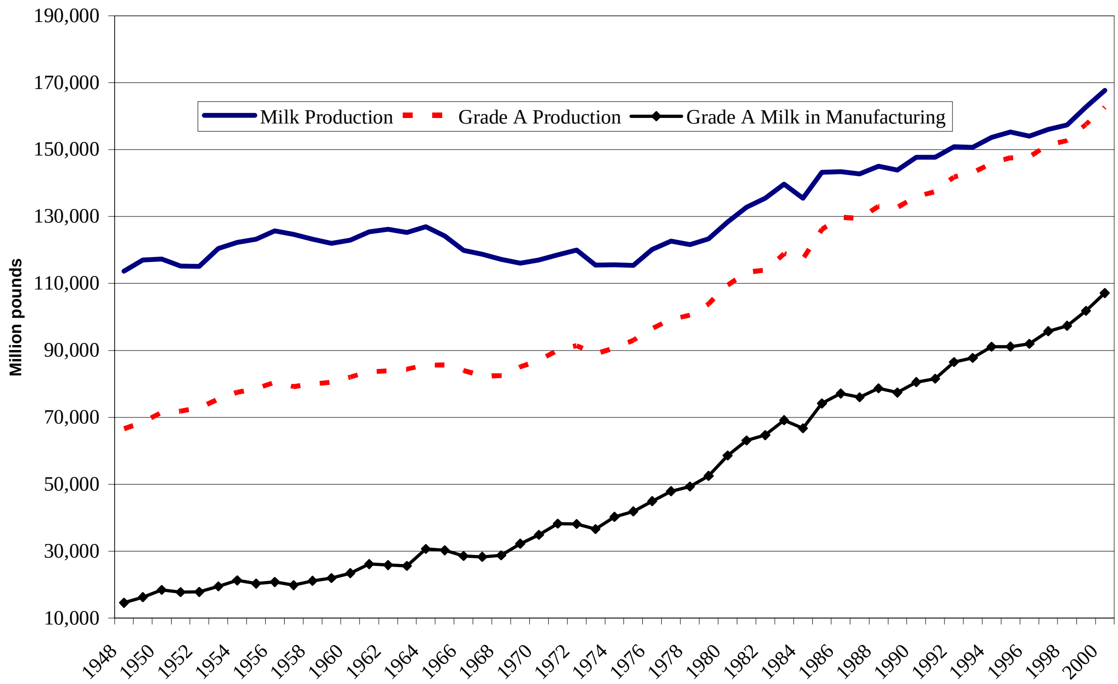
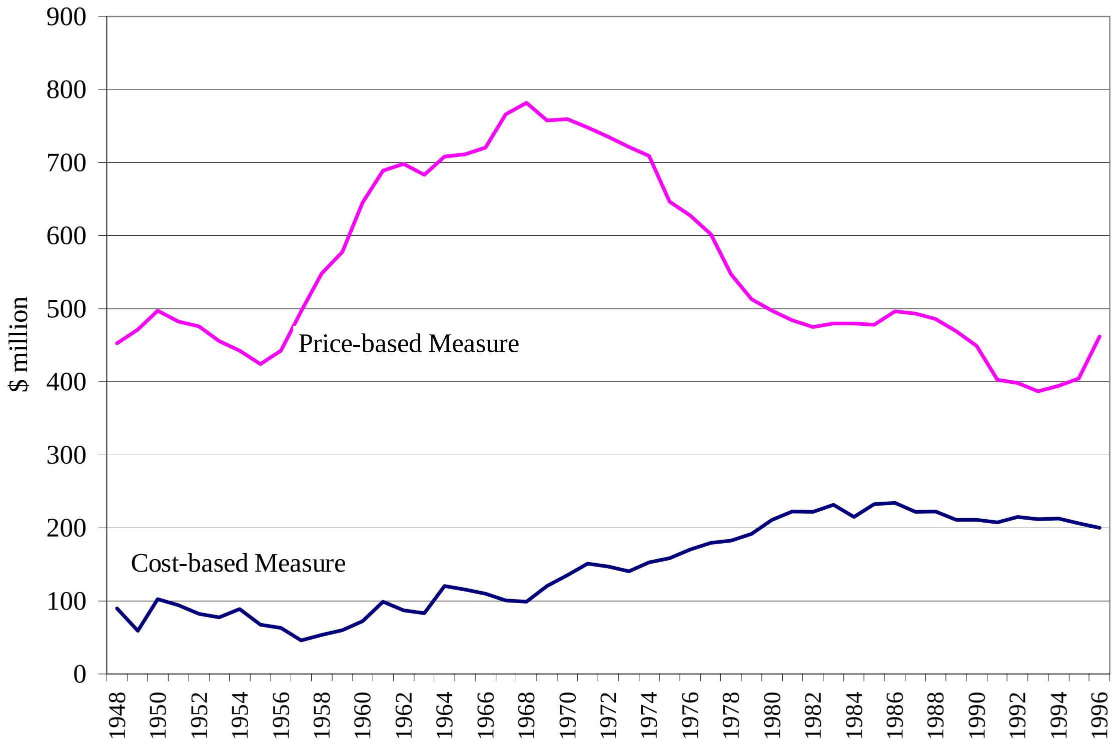


Figure 3. Total Milk Production, Grade A Milk Production, and Grade A Milk Used in Manufacturing, United States 1948-2000.



Source: USDA-NASS (a), and USDA-NASS (b).

Figure 4. Annual Costs of Excess Milk Quality ($million), United States 1948-1996.



Source: Author's calculations.

Note: Price-based measure is computed using equations (27) and (28). Cost-based measure is computed using equation (25). All prices reported in 1999 dollars.

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Notes

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[1] Marketing orders initially set prices for two end-use classes of milk, beverage products and manufacturing products. Later, marketing orders set different prices for milk used in different manufacturing products, as well. Today, marketing orders distinguish between four end-use classes: beverage products (still the highest price); soft and frozen products; cheese; and butter and powder. Although the details of milk pricing rules have evolved over time, the key elements of price discrimination and revenue pooling remain.

[2] An initial justification for a higher minimum price for milk sold on the fluid market was the additional cost of meeting Grade A standards (Manchester; Wilson and Sumner).

[3] Parish preceded Kessel and developed a model applied to Australian dairy policy.

[4] Most of the literature ignores the distinction of milk grade.

[5] An assumption of constant k is equivalent to Posner's assumption that the supply of inputs into securing a monopoly is perfectly elastic. We discuss below the case in which Grade A standards impose some additional fixed costs.

[6] Our measure of the change in Grade A revenue caused by the marketing order differs from the standard analysis. Because we take into account the cost of meeting Grade A standards, we find equilibrium prices for Grade A milk that are higher than those in the standard analysis, and equilibrium quantities of Grade A milk that are smaller than those in the standard analysis.

[7] We consider the interior equilibrium, in which some Grade B milk is produced under marketing order regulation. In the corner solution, in which all milk is converted to

Grade A, the blend price becomes the incentive price, and total quantity of milk increases.

[8] Prices are adjusted by GDP Implicit Price Deflator and are reported in real 1999 dollars.

[9] Our focus is on the cost of meeting Grade A standards for additional Grade A milk production induced by the marketing order (Q_{A1} - Q_{A0} in Figure 2). The assumption that $k(0) = 0$ is used only to locate the function for the quantity of Grade A milk in excess of the quantity of Grade A milk that would have been produced in the absence of milk marketing orders. We do not need to specify the shape and location of $k(Q_A)$ for units that would have been Grade A in the absence of milk marketing orders.