Chapter 5 to follow through on Demsetz's (1967) and Umbeck's (1977) embryonic contributions on rights formation. In Chapter 5 I attempt to show that the property rights model is useful in predicting when new rights will be created and when existing rights will be placed in the public domain. I also argue that such changes pervade economic activity.[9]

[9]Another distinction of my study, although this need not be unique to the property rights approach, is that I take no account of problems of risk aversion; all my attempts to explain behavior proceed under the assumption of risk neutrality. As is shown in Chapter 3, there is much to be gained and little to be lost by assuming people to be risk-neutral.

2

The public domain: rationing by waiting and price controls

This chapter consists primarily of an elaborate example – the 1970s price controls on gasoline – that illustrates the usefulness and power of the property rights framework. Chapter 1 contains a property rights proposition central to this book: Unless property rights are perfectly delineated, which, given positive transaction costs, they never are, some valued properties will always be in the public domain. In this chapter the nature of maximization as affected by properties in the public domain is examined and the actual resolutions of several public domain issues are analyzed. Because an analysis of rationing by waiting offers a convenient introduction to the subject of property rights, I will initially concentrate, though briefly, on such an analysis; I will subsequently present the more detailed analysis of maximization under price controls, which brings out major features of the substance and the mechanics of property rights.

RATIONING BY WAITING

The rationing by waiting model used here, which is stripped of many real-world features, is most elementary. Using this model makes it easy to concentrate on the public domain issue and ignore peripheral problems. I will use the results of this basic analysis in the subsequent analysis of the 1973–75 price controls on gasoline.

When the government provides commodities at a zero pecuniary price and makes them available on a first-come first-served basis, commodities are allocated strictly by the order in which individuals join the queue, and ultimately by the amount of time individuals spend waiting in line. Even though orderly queues are often encountered, they should not be taken for granted, as the following example illustrates. Suppose it is publicly announced that a package containing $1 million is to be given to the first in line at a particular place. It might seem that the first person to hear the announcement would rush to the site and wait for the package to arrive.

If, however, no policing of the line is to be provided, the ultimate owner of the $1 million is likely to be someone with an armored truck and a machine gun. In the absence of policing, the first person to hear such an announcement will probably not bother to join the queue unless she or he is able to compete effectively with owners of machine guns.

The specific nature of restrictions (in the preceding example, first-come first-served and no policing) delineates the margins of competition – in this case firepower rather than time. The queue will be orderly only if the appropriate restrictions are placed upon it. Such restrictions seem to be applied often, and orderly rationing by waiting is a common occurrence. I will assume that the queue is policed enough to be orderly.

The mechanics developed in price theory texts can readily be used to determine the properties of the first-come first-served allocation. On the supply side, the government supplies a fixed quantity of a good. On the demand side, the only change from the textbook mechanics I make in my analysis is to exchange commodities for time rather than for money. Given the fixed supply, forces of demand determine the equilibrium price per unit of the good being distributed in terms of the amount of time spent by individuals in the queue. Almost anything that can be said about money in the standard case can be applied to time when allocation is by waiting.[1]

One evident and important difference between rationing by dollars and rationing by time, however, is that allotment of dollars across individuals differs from the corresponding allotment of time. If there is a good whose waiting time per unit is five minutes, if waiting is the only method of acquiring the good, and if the good cannot be traded, then a person will stand in line to obtain additional units of the good until the value of five minutes of his time reaches the value of one extra unit of the good. For example, when the value of the individual's time is $12 per hour (or $1 for five minutes), he will continue to rejoin the line to obtain another unit of the good as long as his marginal valuation of the good exceeds $1. If the price of the good becomes $1 instead of five minutes, the analysis proceeds along standard lines. Given that the good cannot be traded, the individuals who ultimately get the good in the original case, however, are those who value it most in time rather than in money.

Changes in the rules governing distribution of the good can be accommodated easily by this model of rationing by waiting. For instance, there is no reason to assume that the given commodity will be doled out in fixed batches. There are other possible rules governing its distribution: Individuals may be allowed as much of it as they desire; access to the line may be limited to once per period or allowed any number of times; and

[1]Barzel (1974, pp. 73–95).

once the commodity is obtained, trading it may be permitted. Each rule constitutes a distinct way of allocating rights to the good.

This basic analysis of rationing by waiting yields one key result: A commodity announced to be free is effectively placed in the public domain and is of no value until ownership is established. Establishing ownership requires that an individual fulfill certain criteria – in the example here, the criterion is to spend five minutes in a queue. Acquisition of the commodity consumes real resources over and above the resources used in production. In the example, ownership of one already produced unit is established by spending five minutes in a queue. Whatever the method by which rights are acquired – and such methods differ from case to case – it is generally true that resources must be spent to gain possession of commodities in the public domain, and that individual maximization applies here no less than to conventional exchange.

PRICE CONTROL ANALYSIS

How are property rights allocated to a commodity that is sold at prices below the market equilibrium level? In the model of rationing by waiting, queuing is the means by which ownership is established. Rationing by waiting can be viewed as a special case of price control.

Real-world price controls differ from rationing by waiting in two important ways. First, whereas in the price control analysis all that is required is that the controlled price be lower than the equilibrium price, in the rationing by waiting model I assume that the (money) price is zero.[2] Second, whereas in the rationing by waiting model I assume that competition can occur only through queuing, in the price control analysis that assumption is not always valid.

In the rationing by waiting model, individuals acquire rights to the rationed commodity by spending the appropriate amount of time in the queue. Under price controls, rights allocation is more complex, and the determination of how rights to an asset are actually allocated is essential in the analysis of the controls.[3] In the remainder of this chapter I analyze the early-1970s price controls on gasoline. Before beginning this analysis, however, it is worthwhile to look at a generic price control model.

In the generic model, it is assumed that competition initially emerges as queuing. Consider Figure 2.1, where D is the demand curve, S is the supply curve, the equilibrium price and quantity are represented by P^* and Q^*, and the control price is represented by P_C. Assuming that the control price is perfectly enforced, a discrepancy between quantity de-

[2]I focus on price ceilings – below equilibrium price controls – and ignore price floors – above equilibrium price controls.

[3]See Cheung (1974, pp. 53–71).

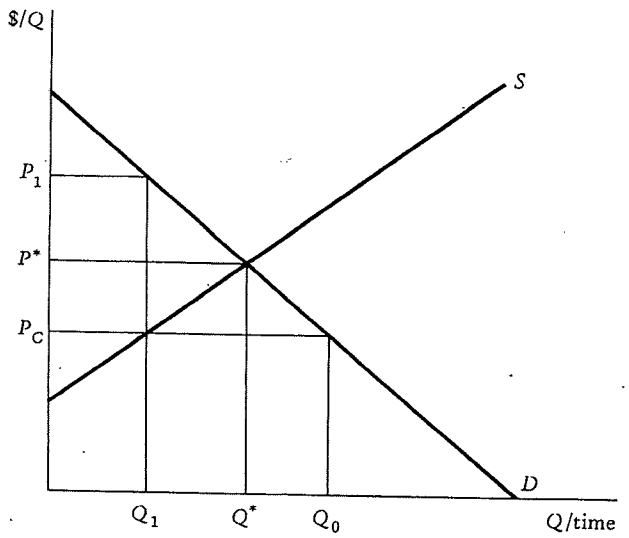

Figure 2.1

manded, Q_0, and quantity supplied, Q_1, known as "shortage," will arise. Sellers will only supply Q_1; Q_1, then, is the quantity available to consumers, a quantity for which they will be willing to pay P_1. Because consumers can pay P_C only in money, they will spend the difference $(P_1 - P_C)$ by waiting in line. For example, if $Q = 100$, $P_C = \$1$, $P_1 = \$2$, and the opportunity cost for consumers is \$10 per hour, then buyers in the aggregate will spend a total of \$100 in money and ten hours in time to purchase ten units.[4] Because queuing is the only margin of competition, this is the new equilibrium under the price control. As the discussion proceeds, various simplifying assumptions underlying the generic model will be dropped one at a time. It is essential, however, first to describe the control itself and its background.

The price controls

The Economic Stabilization Act of 1970 gave the president of the United States the authority to impose controls on prices. On August 15, 1971, President Richard Nixon imposed a ninety-day economywide freeze of prices at their May 1971 level. This freeze was known as Phase

[4]The area $(P_1 - P_C) \times Q_1$ in Figure 2.1 represents the dollar value of the time expenditure.

I of the price controls.[5] Phase II, which began on November 14, 1971, contained a less stringent set of price regulations, which did allow many firms to raise prices above Phase I levels when input costs increased. Gasoline prices, however, as well as the prices of heating oil, crude oil, and residual fuel, were effectively controlled at the Phase I level. Phase III, introduced on January 11, 1973, initially involved a voluntary form of the Phase II controls. On June 14, 1973, the Nixon administration imposed another economywide price freeze as part of Phase III. This freeze lasted until August 12, 1973, at which time Phase IV, the final phase, began. However, for the petroleum industry, including gasoline retailers, the Phase III freeze continued until September 6, 1973. Phase IV was essentially a period of gradual price deregulation, although petroleum products, including retail gasoline, were still subject to price controls.

For many commodities, the price controls caused such inconveniences as fewer sales made on credit, a smaller variety of goods available, and less frequent free delivery. As a rule, shortages did not arise. In the case of gasoline, the discrepancy between the controlled price and the market-clearing price that would have prevailed without the controls was not small enough to mask some of the effects of the price controls.[6] In the wake of the Arab–Israeli war that erupted on October 6, 1973, the Organization of Arab Petroleum Exporting Countries (OAPEC) restricted exports and raised the price of crude petroleum.[7] Prior to the war, the world price of crude oil had been around \$3 a barrel. On October 16, OAPEC raised the price to nearly \$5 per barrel, and on December 23 the price was raised to \$11.561 per barrel.[8] This drastic price increase – more than threefold in nominal dollars – coupled with price controls led to shortages and queuing in the United States by December 1973. Some aspects of these shortages may conveniently be analyzed using the property rights model.

[5]Much of the information on the Nixon administration price controls comes from Kalt (1981) and Rockoff (1984). In the case of retail gasoline, prices were not explicitly controlled; instead, the margins, or markups, were controlled at various stages. Only the price of crude petroleum was controlled. (This information was provided by Bruce Peterson of the American Petroleum Institute and Del Fogelquist of the Western Oil and Gas Association.) The Cost of Living Council and the Internal Revenue Service were the primary agencies involved with policy and enforcement of the controls.

[6]The meaning of "small enough" is clarified in the last paragraph of this chapter.

[7]OAPEC is an influential subgroup within the Organization of Petroleum Exporting Countries (OPEC).

[8]The average per barrel regulated price of crude oil in the United States was \$3.89 for 1973 and \$6.87 for 1974. See *Statistical Abstract of the United States 1986*, p. 698.

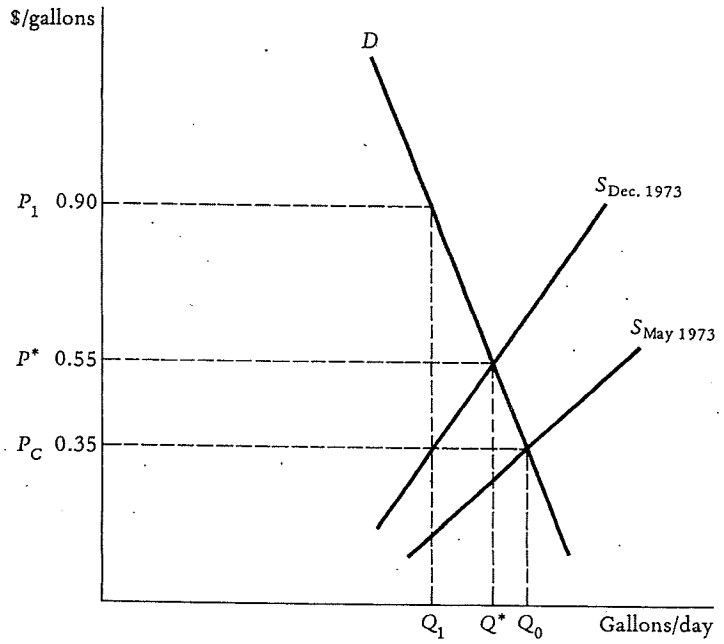

Figure 2.2

The gasoline transaction

Gasoline may appear to be a simple commodity. In the course of this chapter, however, it should become clear that gasoline transactions have numerous valued attributes. Because during the period of price controls market participants were able to alter the levels of attributes not controlled by the government, the actual allocation of property rights differed from that nominally specified by the controls. The examination of this price control episode brings out the strength of the property rights framework in suggesting areas for economic inquiry and in developing refutable implications.

Figure 2.2 depicts the change in circumstances in the gasoline market induced by the 1973 Arab–Israeli war. In May 1971 the price of regular gasoline was about 35 cents per gallon (P_C). The crude-oil price hike that resulted from the war caused a shift up and to the left in the supply of gasoline, from something like $S_{\text{May 1973}}$ to $S_{\text{Dec. 1973}}$, as depicted in Figure 2.2.[9]

[9]Control of the wholesale price of gasoline complicates, but does not change, the essence of the analysis.

In the absence of price controls, the market-clearing price would have been around 55 cents per gallon, P^*, after this decline in supply.[10] What effect did price controls have on the behavior of market participants? Prior to Cheung's work, the price control literature asserted that a shortage of $(Q_0 - Q_1)$ would arise or that the typical consumer would acquire a fraction of the amount of gasoline desired.[11] However, the contention that the shortage would be borne proportionately, randomly, or arbitrarily ignores the postulate of wealth maximization; and in the process the concept of equilibrium was and is often ignored.

Wealth maximization implies that individuals will carry on an activity until, for the marginal unit, net gains are zero. The question that must be asked even when a price is controlled is: Can the buyer or the seller take additional steps to get or to provide another unit at a cost below the added gain? If the answer is yes, an equilibrium has not yet been reached. The notion of a "market-clearing" equilibrium requires that all individuals make whatever moves they wish to make given the existing property rights arrangement. Textbook analyses of a binding price ceiling that conclude that a shortage will exist ignore the possibility of adjustments and thus implicitly deny that individuals maximize if adjustments are available. The way in which margins of adjustment were exploited under gasoline price controls will be examined in the next few sections.

Preliminary considerations of property rights under controls

The Nixon administration could have exercised several options instead of, or in addition to, simply imposing price controls. As the shortage became severe, it could, for instance, have estimated Q_1 (Figure 2.1 or Figure 2.2) and issued coupons for that number of gallons. Had coupons been issued, rights to the purchase of gasoline would have been allocated; and because property rights would have been secure, people would not have needed to spend resources to acquire these rights. In fact, coupons were not issued, so the question at issue is: What property rights system prevailed under price controls?

Earlier, using Figure 2.1, I made the general statement that when the maximum price for a commodity is set at P_C, the quantity of it that will be available in the marketplace is Q_1. Underlying this statement are two important assumptions about property rights, one explicit and one implicit. The explicit assumption is that under price controls the sellers' right to set prices is restricted; here, sellers of gasoline were legally prohibited from selling it at any price above 35 cents per gallon. The implicit

[10]As controls were relinquished, the uncontrolled price of gasoline finally leveled off at around 55 cents per gallon in the summer of 1974.

[11]See Cheung (1974) for a review of this literature.

assumption is that sellers retain the right to provide whatever quantity they wish. Given the sellers' marginal cost curve and the control price of 35 cents per gallon, the maximizing quantity they would have offered was Q_1, as indicated in Figure 2.2. Consumers wished to purchase Q_0 at the control price, but this quantity had no operational relevance: No forces were present to yield this quantity. Q_1 was ultimately the quantity that was allocated among the consumers. P_1 is the maximum price that consumers would pay to purchase the (entire) quantity Q_1, which in Figure 2.2 is 90 cents per gallon of gasoline. Q_1, the quantity offered at P_C, was the quantity that consumers wanted to purchase at the higher price P_1. In reality, rationing by waiting turned out to be the equilibrating force, given that the maximum price sellers had the right to charge was lower than the one buyers were willing to pay.

Rationing of gasoline by waiting

Why did waiting lines for gasoline materialize in the fall of 1973? Shortages per se are not a cause for waiting, and the regulators had never formally adopted queuing as the method of allocating gasoline. It became clear, however, that queuing, although subject to various exceptions and added controls, was the only method of distribution that was going to be allowed.

Under controls, the actual pecuniary price per gallon of gasoline was positive − 35 cents. Although rationing by waiting was analyzed on the assumption that the pecuniary price is zero, as long as the controlled price of gasoline is held below the market-clearing price, the queuing analysis essentially applies. Gasoline, then, was placed in part in the public domain, and the queue served to establish rights over that unowned component. Gasoline sellers owned the property rights to 35 cents per gallon of gasoline, and buyers could acquire rights to the difference between P_1 and P_C (which in Figure 2.2 is 55 cents per gallon) by getting in the queue. If the wage rate of the marginal waiter had been $6 per hour (or 10 cents per minute), the market-clearing queue length would have been five and a half minutes per gallon.[12]

Given that buyers acquired gasoline by a combination of money and

[12]An important complication arises with regard to the mechanics of the queue. It makes a difference, for example, if gasoline is rationed by the gallon or by the tank. In most cases, gas was rationed by the (capacity of the) tank. A person who drove a car with a small tank could get less gasoline than someone whose car had a large tank. Since waiting time was independent of the size of the gas tank, savings associated with purchase size became more prominent, and consequently the expected frequency of people's running out of gas was higher. Independent of shortages, a person could save resources (time) by filling the tank less often, and people occasionally did run out of gas by postponing purchase too long. The expectation is that with price controls, people will run out of gas more often.

time, the conventional demand curve is somewhat misspecified. As usually formulated, it shows how much money people will pay for varying amounts of gasoline when no waiting is required, but not how much they will pay in terms of a combination of money and time. It is easy to construct a modified demand curve in which the price is stated in minutes per gallon, given that 35 cents per gallon must also be paid. Such a demand curve displays marginal valuation in terms of time per unit over and above 35 cents per unit. Compared with the conventional formulation, this type of demand curve varies across individuals, depending on the opportunity cost of their time. Of two individuals who have identical demand for gasoline but who differ in their opportunity cost of time, the one with the low opportunity cost of time will always be able to outbid the other once queuing becomes part of the price of gasoline. In what follows, demand is assumed to account for the two components of price. I will now return to the main problem.

The preceding discussion of the rights of sellers and of buyers brings out the fact that the rights to the value of the gasoline were divided by price controls. The sellers had the right to the value of the gasoline up to the control price, and the buyers could acquire the right to the difference between the control price and their marginal valuation by joining a queue. By paying the control price plus the time price, the buyers could obtain the property rights to a gallon of gasoline. Except for the fact that buyers had to pay a pair of prices, the market for gasoline may be viewed as having functioned normally. Indeed, there are many markets in which both money and time prices are paid by the buyer. A person who insists on eating lunch at noon in the cafeteria is charged a money price by the cashier and faces a time price as well: waiting time. In this case, pecuniary prices for commodities are fixed by the market. In the case of gasoline, the money price was fixed by government.

What are the regulators regulating?

The preceding analysis contains many implicit assumptions that tag the waiting price onto the control price. In the next few sections some of these assumptions are altered in order to increase the correspondence between the waiting model and the actual situation.

The approximate average price of gasoline in the United States in May 1971 was 35 cents per gallon, and in the analysis a single control price of 35 cents per gallon was used. Yet the gasoline price controls were based on actual gasoline prices, which were subject to considerable variation. Prices were lower at gas stations nearer to production centers, reflecting lower transportation costs. Prices were higher for premium than for regular gasoline. Prices were lower at gas stations that used low prices as

promotional devices than at gas stations that used other means of promotion. Prices were lower at self-service stations. A self-service station selling regular gasoline at 34 cents per gallon in the summer of 1973 would have had to sell regular at a maximum price of 34 cents during price controls, and a full-service station selling regular at 38 cents during this period would have had its maximum price fixed at 38 cents.[13] A price control constitutes the assignment of property rights; assuming that the regulators could easily ascertain the actual base price and could easily enforce it, delineation was clear in one important respect: Each seller clearly knew what price he could legally charge. In other essential respects, however, delineation was less clear.

What exactly is it that one purchases in a gas station? "Gasoline" is not a sufficient answer. Like all transacted commodities, gasoline has a large number of valuable attributes. For example, when is it available? Is the gas station open nine hours per day or twenty-four hours per day? Is the octane rating 88 or 98? Is the gas station self-service or full-service? It is essential to have specific information about regulation of the attributes of gasoline before its effects can be adequately examined. Ambiguity surrounded the control of such attributes under price controls.

Much of the ambiguity in the scope of controls results directly from the great number and variability of attributes of gasoline. The attributes of gasoline transactions can be classified into those of the gasoline itself and those of the services provided with the gasoline. Gasoline is commonly graded as regular or as premium, depending on the octane rating; here I assume that under the controls premium gasoline had to have a minimum octane rating of 90.[14] Thus "premium gasoline" describes a range of products 90 octane and above, not a strictly defined single product. There are other variations among premium gasolines. For example, Exxon's premium gasoline had performance additives different from Shell's, and the premium gasoline sold in the Rocky Mountains was probably refined differently from that sold at sea-level locations. Price controls essentially ignored most of the variations in gasoline quality. Because it is prohibitively costly to define rights to all the valuable attributes of a commodity, it is not surprising that the control specifications were not fully detailed. Correspondingly, it is expected that regulations also consistently fail to address certain attributes specifically. Indeed, the real-world price con-

[13]Actually, it is difficult to figure out the precise price used by the regulators.

[14]Premium and regular grades are generally determined by industry standards through the American Petroleum Institute (API) and the American Society for Testing and Methods (ASTM). Bruce Peterson of the API reports that the standards are voluntary, although there are some state regulations, with varying degrees of enforcement. No single octane rating is specified to distinguish regular from premium; for purposes of the analysis I assume that premium gasoline must be at least 90 octane and regular can be any octane lower than that.

trols specified just the grade of gasoline and largely ignored other attributes, including attributes of the second type (kind of service provided).

When attributes subject to variability are incompletely specified, the affected parties, correspondingly, are allowed different amounts of leeway, each according to her or his particular circumstances. Consider the following illustration. Two stations, A and B, were selling premium gasoline in the summer of 1973. Station A sold 90-octane premium for 39 cents per gallon, and station B sold 92-octane premium for 43 cents. The lowest octane level at which a gasoline was still considered premium was 90; B could lower its octane from 92 to 90 while staying within the controller's definition of premium.[15] When price controls were imposed, A was allowed to sell premium for no more than 39 cents and B could sell premium for no more than 43 cents. As a result of the price controls, part of the rights to the value of the gasoline was placed in the public domain. In my initial analysis, in which gasoline was implicitly considered as a homogeneous commodity, it was seen that price controls effectively allowed the seller to retain the right to 35 cents per gallon and allowed buyers to capture the remaining value (which had been put in the public domain) by joining a queue. This conclusion must be reexamined in light of the opportunity to adjust the quality of the gasoline.

The regulation did not restrict sellers to the precise quality of gasoline they were selling during the spring of 1973. With product quality as a variable and with a regulation that did not specify all of the relevant quality attributes, property rights had become extremely murky by late 1973. Both station A and station B were required to maintain the octane level of their premium gasolines at no less than 90. Station A was restricted to a maximum price of 39 cents a gallon and to a minimum octaine level of 90; station B was restricted to the set minimum octane level but to a maximum price of 43 cents a gallon. Station B, then, could lower its octane to below pre-control levels and still sell the gasoline as premium for 43 cents. If gas stations had to pay refiners 2 cents per gallon for each unit increase in octane level, station B was able to save 4 cents per gallon of premium gasoline. As long as consumers were willing to pay more than 43 cents per gallon for premium gasoline (i.e., $P_1 > 0.43$), they were willing to pay the higher money price for B's gasoline, provided that the time price they had to pay was correspondingly less than for A's gasoline. Since the time price reflected acquiring rights from the public domain and was not transferred to anybody, there was no countervailing loss from the reduction in waiting time when buying B's gasoline. Station B, by being able to adjust gasoline quality without violating the regulation, could capture some of the value of the gasoline that seemed to end

[15]I am assuming that the retailer was in charge of gasoline quality, which because of price controls at the wholesale level, may not have been so.

up in the public domain as a result of price controls. The government's specification of rights played into the hands of station B.

Two tests of the preceding analysis follow. First, gasoline quality, in terms of octane levels, should have declined as sellers attempted to capture the value that was placed in the public domain. Second, the quantity of antiknock additives (substitutes for octane sold separately from gasoline) should have increased subsequent to the imposition of price controls.

I will now turn to an analysis of gas station services and the attendant impact of price controls. The type and level of services attached to the purchase of gasoline vary considerably from station to station. Full-service stations pump the gas, wash windshields, and provide clean restrooms; self-service stations provide little besides the gasoline itself. As it applied to gasoline, the price control regulation specified nothing about the level of services to be provided along with the gasoline. A simple illustration using two stations, which differ only in the level of services they provide, will serve to isolate the effects of this lack of specification. Station 1 sells regular gasoline for 33 cents per gallon and provides few extra services.[16] Station 2 sells the same regular gasoline for 36 cents, but provides 3 cents' worth of services per gallon in the form of pumping the gas, cleaning the windshield, and checking under thte hood. Once price controls are imposed, Station 1 can charge no more than 33 cents per gallon; Station 2 can charge no more than 36 cents. Station 2, like station B in the previous example, has an additional margin of adjustment not available to station 1. Station 2 can reduce its service level to zero, saving 3 cents per gallon in costs, and still sell gasoline for 36 cents, enabling it to avoid losing some of its wealth to the public domain. Consumers will buy all that station 2 can sell at 36 cents a gallon without service so long as the cost of waiting at station 1 exceeds 3 cents per gallon.

The available supply of gasoline declined during the era of price controls, and the number of stations selling it also got smaller. Those stations that had the greatest number of margins at which to adjust were able to tolerate the price control situation longer than those with fewer margins of adjustment. Because consumers would pay the same full price for the same product no matter where they made the purchase, they were indifferent between paying a higher money price and waiting less at the first kind of station and doing the reverse at the second kind. Thus, self-service or no-service stations, the ones having fewer margins at which to adjust to price controls, were expected to be among the first to go out of business. Stations selling premium at the lowest possible octane level were expected

[16]Convenient locations and smoothly functioning pumps are examples of services even low-service gas stations still provided. In general, if under competition a station was selling gasoline at a price higher than what it had paid for it (including transportation), some service must have been provided.

to be similarly affected. These implications are testable, although the data for the latter implication may be more difficult to collect than those for the former implication.

Gas station owners were able to alter still other margins of their product without violating the letter of the regulation. One of these margins was station hours. Station owners could choose their hours of operation, thereby lowering costs without violating the regulation. Selling gasoline in the middle of the night is more costly than during business hours because workers must be paid a higher wage to work at night and because security is more problematic. Perhaps because complex pricing schemes are costly to operate, twenty-four–hour stations charge the same price at all hours. The average cost of twenty-four–hour stations is higher than that of stations open only in daytime hours, and therefore the single price charged by the former must be higher than that charged by the latter. Price controls required stations to retain the old price but did not require them to keep the old hours. Most stations that had been open twenty-four hours a day quickly shortened their hours of service. Such stations were thus able to charge prices higher than those charged by others while incurring the same costs.[17]

Thus far I have considered only the margins of adjustment open to sellers. There also were margins at which buyers alone or buyers and sellers together could adjust in order to minimize dissipation. Resources spent in the queue were not received by others, and the existence of queues indicated that potential gains from sidestepping queues existed. One common way to circumvent price controls, and thus to lower the losses therefrom, was to tie the sale of gasoline to the sale of another product, not subject to price controls. Owners were able to use lubrication and other gas station services to mask the true price of gasoline to the regulators. A customer whose waiting cost for a full tank of gasoline was $5 was willing to pay up to $5 above the competitive price of lubrication when it was bundled up with a full tank of gas and no waiting. The seller who provided such bundles was able to capture some of the value that had formerly been dissipated by waiting. At no previous time in history had automobiles been so well lubricated.

THE MINIMIZATION OF DISSIPATION

It is useful here to return to the analysis of adjustment by sellers regarding customer service in order to bring out an important point developed by Cheung. In his analysis of price controls Cheung recognizes that the initial attenuation of the property rights structure would put some potential

[17]Eventually, most stations reduced their hours to the minimum (and most convenient to them) required to dispense their gasoline allocation.

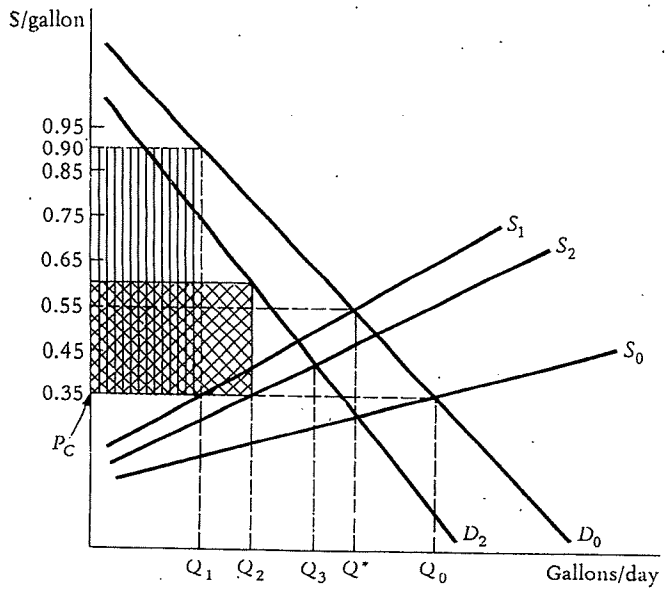

Figure 2.3

income in the public domain, thus leading to income dissipation to the extent that resources were spent to capture the non-exclusive income. An equally important point made by Cheung is that the maximization hypothesis implies that all such dissipation will be a constrained minimum. Dissipation is simply the process of adjusting to new constraints – here the constraint is price controls. By adjusting their levels of service downward as the constraint of price controls became binding, sellers were able to capture value that would otherwise have been left in the public domain. This action is a component of the minimization of dissipation.

Consider the following example, depicted in Figure 2.3. S_0 and D_0 represent the market conditions for full-service regular gasoline before the supply decrease and before the implementation of price controls, and P_C, 35 cents per gallon, represents the market price. That price ultimately became the control price. When the supply shifted, S_1 representing the new supply, price controls became binding. Had sellers continued to offer full service, they would have supplied a quantity Q_1 for which consumers were willing to pay 90 cents per gallon. The difference between that price and the control price, 55 cents per gallon, would have been dissipated in the form of time spent in the queue. The total value of the queuing dissipation is shown by the shaded rectangle. This 55 cents per gallon was lost in the sense that the customer's time expenditure was received by no

one. As indicated, the (maximizing) seller could capture some of this dissipated income by reducing gasoline quality and gasoline services.

Because gasoline continued to be sold by the gallon, the coordinates of Figure 2.3 have the right units for the changed product, but the supply and demand curves for the new quality must be redrawn. S_2 is the new supply of gasoline, which required fewer resources because of the elimination of services. Consumers' valuation of the no-service gasoline was less than that of full-service gasoline; the new demand is shown by D_2. The services eliminated, however, were valued by consumers more than they cost to produce; this is why they were provided to begin with. Therefore, the intersection between S_2 and D_2 (at quantity Q_3), the no-service curves, must then be to the left of the intersection between D_0 and S_1 at quantity Q^*. This is a reflection of a cost of regulation that the adjustments could not eliminate. The dissipation per gallon was reduced (to near 25 cents in the example), and the number of gallons of gasoline (Q_2) was larger than in the absence of the adjustment (Q_1). The total dissipation, after service reduction, is shown by the hatched area and (combined with the appropriate "welfare triangles") is less than the dissipation without the service reduction.[18]

Before October 1973, the adjustment in gasoline quality was sufficient to yield an equilibrium price as low as 35 cents per gallon, and thus no waiting lines emerged. After October 1973, the price control constraint in the gasoline market was so severe that even when all the available adjustments had been taken advantage of, the equilibrium price exceeded 35 cents a gallon. Consequently, shortages ensued and queues were required to ration the available quantity.

CONCLUSION

Analysis of rationing by waiting and of price controls brings out the fact that because of the complexity of transactions, market participants have many margins besides quantity and price to which they can adjust. Maximization implies that such margins will be exploited, and the pattern of that exploitation is predictable: People will use the lowest-cost methods available to them under the constraints to reclaim the value that the regulations place in the public domain. As a result of such actions, dissipation from the regulations is minimized. In the case of the 1970s gasoline price controls, the adjustments took form as the lowest permitted gasoline octane levels, the shortest possible hours of operation for service stations, and the very frequent lubrication of automobiles.

[18]The service reduction also reduced the magnitude of the shortage induced by price controls. Before the service reduction, the shortage is $(Q_0 - Q_1)$. After the service reduction, the shortage falls.