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Working Paper

The Impact of Product Recalls on the Wealth of Sellers

Working Paper, No. 33

Provided in Cooperation with:
George J. Stigler Center for the Study of the Economy and the State, The University of Chicago Booth School of Business

CENTER FOR THE STUDY OF THE ECONOMY AND THE STATE

WORKING PAPER SERIES

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Working Paper No. 033

March, 1984

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THE IMPACT OF PRODUCT RECALLS ON THE WEALTH OF SELLERS

Gregg Jarrell and Sam Peltzman*

I. INTRODUCTION

This paper has a simple goal: to estimate the losses borne by owners of a firm that recalls a defective product from the market. While we stick close to the "facts," we hope they will shed some light on an important issue in the regulation of consumer protection. This is the extent to which information about product quality is sufficient to deter production of faulty products. In many areas, including the two which are the focus of our analysis--drugs and autos--there is extensive regulation of product quality prior to marketing of the product. One normative justification of such pre-market regulation would be that mere disclosure of any defects after a good is marketed does not impose sufficient costs on the marketer to deter optimally the production of defective products. Such sub-optimal deterrence could occur if, for example, consumers were insufficiently sophisticated in assimilating information about defects or the tort liability system insufficiently compensated them for resulting damages.

While we do not address these normative issues directly, we hope that our results will be useful in assessing the magnitude of the potential normative "problem." Accordingly, we will compare our estimates of losses to owners with independent estimates of some elements of the cost associated with the product defects. In particular, we are able to estimate at least the rough magnitude of elements of the direct costs to firms of recalling defective

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*We thank James Frieden, Michael Ryngaert, Thaddeus Niemira and Monica Noether for their assistance.

products. These would include the costs of destroying contaminated batches of drugs, the costs of repairing defective cars, etc. An obvious question--and a test of capital-market efficiency--would be whether the capital market internalizes these costs. If it fails to do so, any presumption of suboptimal deterrence would be strengthened. In many cases, these direct costs will be a major component of the "social" costs of the defect. For example, the repair costs for a potentially defective auto part could even exceed the relevant social costs if the probability that the part will fail is very low. But some cases involve potentially large indirect costs for consumers--e.g., health damages from a dangerous drug. In these cases, optimal deterrence would require a penalty greater than the direct costs we are able to estimate.

The main focus of the paper is on the changes in shareholder wealth which accompany recalls of automobiles and drugs (prescription, over-the-counter and medical devices). We chose these particular products, because each yields a good-sized sample of recalls and because we could obtain associated data on some elements of the direct costs of most of these recalls. The samples also differ in an interesting dimension: drug recalls occur much less frequently (per firm) than auto recalls. Important examples of the latter occur every few weeks or months, while the former occur once or twice in a decade.

Our primary finding is that the capital market in fact penalizes producers of both recalled drugs and autos far more than the direct costs. Indeed, the capital market penalty seems so great that it may even exceed a plausible independent estimate of the relevant social costs. We do not press this point, because we have only the most fragmentary data on the relevant indirect costs and because we want to avoid the implicit issue of capital-market efficiency. But to the empirical question "how much deterrence does the capital market provide against the sale of faulty products?", the answer implied by our data must be "considerable."

We also find that competitors of drug and auto firms with recalled products are not helped by their rival's travail. In fact, in both cases they bear substantial losses.

II. HOW "SHOULD" THE STOCK MARKET REACT TO NEWS OF A PRODUCT RECALL?

The stock market does not react to every event which entails a cost to shareholders, only to those which are not entirely expected. So if product recalls occurred with the same regularity as, say, wage payments we would no more expect stock prices to fall when a recall occurs than on payday, even though both events impose real costs on stockholders. The market can be expected to respond to news of recalls only if the news resolves some uncertainty. And, since recalls are not entirely unexpected, the response will understate the costs of the recall to stockholders. To see this, let any uncertainty be resolved within a "month," and suppose that only one of two things can happen to a firm next month: either a product is recalled at some cost (K) to shareholders or there is no recall. So, the firm's month-end stock price (S_1^i) will be either:

(1) $S_1^{NR} = V$ if no recall occurs, or

(2) $S_1^R = V-K$ if a recall occurs,

where

V = present value of the firm's profits including all expected recall costs except those occurring next month, and where we assume independence of succcessive monthly events.

The firm's stock price at the beginning of the month is the present value of future profits, or

(3) $S_o = p(V-K) + (1-p)V = V-pK,$

where

p = probability that a recall occurs next month.

Thus, if a recall occurs next month, the stock price will change by (2)-(3) above, or

$$(4) \quad S_1^R - S_o = -(1-p)K \ ,$$

i.e., by the <u>unexpected</u> component (1-p) of the recall cost. Only if the recall is entirely unexpected (p = 0) will (4) = K. In months where recalls do <u>not</u> occur, stockholders get a capital gain of (1)-(3), or

$$(5) \quad S_1^{NR} - S_1^o = pK \ .$$

So, to get at the market's estimate of K, we would need to subtract (5) from (4)--i.e., to compute the <u>difference</u> between the return in months with and without recalls.

In practice, (4) and (4)-(5) will be about equal if p is small. This is the case with drugs where our data indicate that most uncertainty is resolved within a month and where no company in our sample has been involved in more than two distinct recalls in a period of about 100 months. For this sample, then, we use conventional "event study" methodology, more fully described below, in which we, in effect, estimate just (4). But auto recalls are far less of a surprise than drug recalls, so we attempt to estimate (4)-(5) for that sample.

III. DRUG RECALLS

A. <u>SELECTION OF DRUG RECALL SAMPLE</u>

When a drug product is found to be defective, the manufacturer is required to remove that product from the market. This recall can be initiated either by the manufacturer or the Food & Drug Administration (FDA), and it can involve anything from a few bottles of contaminated or mislabeled product to the permanent removal of a product from the marketplace. The FDA classifies recalls by health hazard: Class I recalls involve product defects that may have seriously adverse health consequences including death; Class II recalls involve temporary or medically reversible health hazards while Class III cases are unlikely to entail adverse health consequences.

Our sample focuses on recalls that involve a serious health hazard and/or a relatively large amount of product. We selected the sample from weekly reports of FDA Recalls and Court Actions in the Food Drug and Cosmetic Reporter, an industry newsletter commonly called the "Pink Sheets." Recalls were included in our sample if the Pink Sheets report gives an estimate either of the direct costs of the recall or, more commonly, of the number of units recalled. In addition, we include those recalls where direct cost estimates are provided in the Wall Street Journal. Our sample period runs from 1974 through 1982.

Our sample consists of most of the largest and more hazardous recalls in this period. For example, Class I recalls account for over half of our sample, while they account for less than 2% of the over 3,000 FDA citations reported between 1973 and 1978.[1] Many of our cases received considerable publicity. Over half of our 32 cases were covered by the Wall Street Journal. Five of these cases were serious enough so that the recalled products were withdrawn indefinitely from the market. Table 1 which is elaborated below, summarizes this sample. It shows the names of the manufacturers of the recalled drugs in our sample, the event dates and estimates of the stock market response and direct costs of the recalls incurred by these

[1]Lawrence H. Block, "An Evaluation of Drug Product Citations in the FDA Weekly Reports Between 1970 and 1978," Contemporary Pharmacy Practice Vol. 3, No. 3, (Summer, 1980), pp. 171-79.

Table 1

Sample of Drug Recalls with Firm Names, Event Dates
Stock Returns, Estimated Dollar Loss, and WSJ Dummy

Case #	Firm Name	Event Date	No WSJ[1] Dummy	Direct Cost as Percent of Market Value	Recall Firm's CER % -4 to +5	Estimated Direct Dollar Cost (000's)
1.	Abbott	4/28/76	1	0.00%	-1.91%	$ 5
2.1	Am. Hospital	11/26/74	1	0.03	-4.26	172
2.2	Am. Hospital	1/13/75	0	0.05	-7.10	430
3.	Block	6/11/79	0	2.33	-7.76	2330
4.	Bolar	12/24/80	0	2.34	-10.63	1600
5.	Lilly (V-Cillin)	12/5/77	1	0.05	-1.42	1150
6.	Lilly (Oraflex)	8/3/82	0*	0.66	-10.46	30400
7.	Johnson (Tylenol)	10/1/82	0*	1.35	-15.88	100000
8.1	Mallinckrodt	11/14/74	1	0.00	3.55	10
8.2	Mallinckrodt	12/10/74	0	0.57	-8.43	1300
9.	Merck	8/8/80	1	0.01	-2.76	353
10.1	Milton Roy	7/15/76	1	0.05	3.64	12
10.2	Milton Roy	8/25/76	0	0.05	-1.98	12
11.	Morton Norwich	11/23/79	0	0.06	-2.75	250
12.	Johnson (Ortho)	10/13/75	0	0.13	2.65	6500
13.	Parke Davis	8/13/76	0	0.04	-0.63	1000
14.	Proctor-G. (Rely)	9/18/80	0*	2.46	-5.29	150000
15.	Richardson	10/1/78	0	1.68	-8.18	11500
16.	Richardson	9/26/80	1	1.78	-2.35	9530
17.	Robins	4/28/76	1	0.77	-0.33	2100
18.	Searle Labs	11/17/76	1	0.09	-6.56	600
19.	Searle Labs	6/9/81	1	0.07	-1.00	1000
20.	SmithKline	4/26/79	0	0.13	-8.93	3700
21.	Squibb	1/16/75	0	0.24	-9.40	3500
22.	Squibb	11/28/77	1	0.05	-12.11	560
23.1	Sterling	1/14/76	1	0.55	-18.20	6000
23.2	Sterling	2/18/76	0	0.55	-18.84	6000
23.3	Sterling	4/14/76	1	0.03	-2.15	270
24.	Sterling	4/5/78	1	0.02	-6.77	200
25.	American Home Prod.	3/4/82	0	0.05	-0.69	3044
26.1	Robins	5/29/74	0*	0.47	-18.12	2550
26.2	Robins	6/28/74	0*	0.47	-11.16	2550

* = Recalled products were withdrawn from the market.
1. 1 = Recall not reported in WSJ.

manufacturers as a result of the recalls. We exclude cases without stock returns data for the manufacturer. This requires that the manufacturer be a publically-traded firm having stock returns data for a 100 trading day period centered on the day that the recall becomes public information.

B. CHOOSING EVENT DATES

For each recall, we sought to identify the earliest date at which news of a recall might have become public. This could precede the date on which a recall actually began or was ordered by the FDA. For example, the first hint that a recall may eventually occur might be press reports (we use the Wall Street Journal) implicating a drug (e.g., Tylenol) in a health problem (poisoning). In such a case, the date of the press report is our "event date." In general, we use the date of the earliest press story on the troubled product, when there is a WSJ story. For most cases, this is the same date that the recall begins. For recalls not covered by WSJ stories, the event date is the earliest date on which the FDA notified a manufacturer to recall a product. This date is taken from the Pink Sheet story that reports the citation. If these initial FDA communications appear to be strictly private correspondences, then we use the publication date (usually a week or so later) of the Pink Sheet reporting the recall as the event date for these non-WSJ cases.

Sometimes news about essentially the same product defect is spread out over time. For example, two defective batches of a product are found several weeks apart (cases 2.1 and 2.2) or a product defect is found a month before the firm decides that a recall is necessary (26.1 and 26.2). We treated these related events as separate events (and split direct costs evenly among them) if more than three weeks elapsed between the events. These are identified by case numbers with decimals in the Table. (We treat related events less than three weeks apart, like the rest, as a single event beginning on the earliest date of adverse news).

C. DIRECT COSTS OF RECALLS

For most cases, we estimate the "direct cost" of a drug recall by assuming that all of the violative units become worthless upon recall. Specifically, where the Pink Sheet citation reports the number of units of the violative batch that are in distribution channels, we multiply this figure by the wholesale price of the product as reported in the appropriate yearly issue of the American Druggist's Blue Book and the Drug Topics Red Book to estimate "direct costs".

For some of the more publicized recalls, information on the direct cost was available from news stories, because the companies took an extraordinary charge to their income. (Case numbers 6, 7, 14, 26 have their direct losses taken from the WSJ.) For instance, the WSJ reported on 10/29/82 that it would cost Johnson & Johnson about $50 million to recall and destroy 22 million units of Extra-Strength Tylenol capsules. In addition, it was reported tht new tamper-proof packaging, additional television advertising, and related efforts to rebuild consumer confidence would cost another $50 million. Therefore, our estimated direct cost to Johnson & Johnson of the Tylenol recall is $100 million.

We make no allowance for tax benefits due to recall costs. Where we use reported extraordinary charges, we use the pre-tax figure, and we ignore any tax savings from inventory losses. Accordingly, our direct cost estimates may be over-generous.

For each recall Table 1 gives the estimated direct cost in dollars (last column) as well as a percent of the market value (just before recall) of the respective manufacturer's common stock. In both dollar and percentage terms, the recall of Proctor & Gamble's Rely Tampon (14) entails the largest estimated direct cost ($150 million, 2.5 percent of market value) in our sample, while the Class I recall of Abbott Labs' Plasmatein (1) is the least costly ($5,000, .0005 percent).

D. CAPITAL MARKET RETURNS

The full costs to manufacturers of recalled drugs is measured by net-of-market (or excess) stock returns in the period surrounding public announcement of the recall. These excess returns are obtained from the Scholes excess return file at the University of Chicago's Center for Research in Security Prices (CRSP).[1] We cumulate excess returns for each manufacturer over several "event windows" of different intervals to allow for pre-event leakage or post-event revision. The most narrow event window is six days, from $t = -2$ to $t = 3$, where $t = 0$ is the formal event date of the recall. The widest event window is from $t = -49$ to $t = 50$.[2]

Table 2 presents mean cumulative excess returns (CER) for various event windows. These are negative for every window from 1 week to 5 months around the event date. But the two week window (CER(-4, 5)) yields a loss roughly

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[1]For cases 3, 4, 8.1, 8.2, stock returns are unavailable from this source. So we constructed excess return series for these cases by subtracting the return to the New York Stock Exchange Index from returns to these firms' stocks.

[2]Some of the wider event windows result in overlap of the related events denoted by decimal case numbers in Table 1. In these cases, we (1) arbitrarily split the time between events in half and attributed the excess return for any day to the event closest in time, and (2) set the remaining excess returns to zero. For example cases 26.1 and 26.2 occur 22 trading days apart. Excess returns for the first 11 days after 5/29/74 are attributed to 26.1 and all subsequent excess returns are set = 0 for that case. Excess returns for the 11 days ending 6/28/74 are attributed to 26.2 and all preceding excess returns are set = 0 for that case. In this way, we avoid double counting of the same excess return.

Table 2

Means and Dispersion Measures for CER to Drug Recall Firms (Various Intervals), Relative Dollar Loss, and CER to Drug Portfolios

Variable Name[1]	Mean (%)	S.E. Mean[2] (%)	t-stat. Mean	Minimum (%)	Maximum (%)
CER (-49, 50)	-6.742	3.113	-2.17	-35.94	28.40
CER (-29, 30)	-5.479	2.411	-2.27	-30.84	15.85
CER (-14, 15)	-7.147	1.969	-3.63	-22.46	5.06
CER (-9, 10)	-6.563	1.392	-4.71	-24.10	9.05
CER (-4, 5)	-6.132	0.985	-6.23	-18.84	3.64
CER (-2, 3)	-2.832	0.696	-4.07	-15.39	3.26
BDRUG (-4, 5)	-1.170	0.335	-3.49	-8.53	5.86
Relative Loss %	0.534	0.135	3.95	0.00	2.46

1. a) CER (-X, Y) is the cumulative excess return (from Scholes Excess Returns Tape, University of Chicago CRSP) from X trading days before to Y trading days after the recall event.
   b) BDRUG (-4, 5) is the cumulative excess return to an equal-weighted portfolio of all NYSE or ASE drug manufacturers having a SIC of 2834, 2840, or 2841 (about fifty firms). The cumulative excess return to this drug portfolio is computed from $t = -4$ to $t = 5$ for each date on which there was a drug recall that is included in our sample. The drug firm subject to the recall is excluded from the drug portfolio when computing BDRUG for each particular recall event.
   c) Relative Loss % is the estimated direct loss expressed as a percent of the market value of the equity of the recall firm. The market value is computed 40 trading days before the recall event date.

2. The standard error σ of the mean CER (-X, Y) is computed using the formula:

$$\sigma(-X, Y) = [\sum_{i=1}^{N} \sigma_i^2]^{1/2}/N$$

where σ_i^2 is the variance of the i^{th} recall firm's excess stock return and $N = 32$ recalls. σ_i^2 is estimated for each firm by using daily excess returns from $t = -49$ to $t = -5$ and $t = 5$ to $t = 50$. Let S_i^2 be the variance of the above-defined time series of daily excess returns. Then σ_i^2 is computed by multiplying S_i^2 by T, where T is the number of trading days in the particular event window. (T is 10 for CER (-4, 5), 20 for CER (-9, 10), and so on.) These standard errors are virtually identical to the standard errors of the sample-mean CERs.

within a percentage point of that for any wider window. This means that essentially all of the market response to the event is compressed into the two surrounding weeks. In addition, there are no systematic "mistakes"--i.e., there is no systematic recovery of some of these losses in the 50 days after the event date (or else the CER (-49, 50) would be smaller than CER (-4, 5)). Finally, note that fully nine-tenths of the sample suffers a loss in the two weeks surrounding a recall (see Table 3). It is clear that recalls constitute adverse news for stockholders and that most of the uncertainty about them is resolved in the two weeks surrounding public disclosure of the recall.

It is also clear that the capital losses are substantial by any standard. In particular, they are much larger than our generous estimate of direct costs. The mean CER (-4, 5) is -6.13%, which is fully twelve times the mean relative direct cost of 0.53% (and over 50 times the median). We never fully succeed in explaining this enormous gap.

The last line of Table 2 contains another mystery. This shows the CER (-4, 5) for an equally-weighted portfolio of drug stocks. We conjectured that competitors might benefit from the adversity visited on the seller of the recalled product. Instead, the spillover seems negative. All drug stocks suffer a (significant) mean loss of just over 1 percent in the two weeks surrounding a recall. This cannot be explained by any tendency for recalls to be bunched (in which case one recall would beget expectations of others).[3]

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[3]We have 26 unrelated events in the 9 years 1974-82, or about 3 per year. If recalls were being generated by a Poisson process with a mean of (26/9) per year, the standard deviation would be 1.7. This differs insignificantly from the sample standard deviation of 1.45, so the distribution of recalls seems essentially random.

The disproportionate size of capital market losses relative to estimated direct costs led us to see if the capital market losses are systematically related to the degree of publicity surrounding the recall or to whether there was a complete product withdrawal. These may be proxies for costs which we cannot estimate. For example, a complete withdrawal may engender losses to specific assets (e.g. research and development, past advertising) which are not written off. Table 3 presents the mean CERs over three sub-samples of recalls. The mean CER (-4, 5) for the 14 recalls that were not covered by the WSJ and that did not involve withdrawal is -3.76%, while the mean CER for the 13 no-withdrawal recalls covered by the WSJ is -6.36%. The mean CER for the five recalls that resulted in product withdrawals is -12.18%. (All five withdrawals were covered by the WSJ.) These mean CERs imply that a WSJ story engenders an additional CER of -2.6%, and that the product withdrawal distinction adds another -5.8%. So both extra publicity and a withdrawal are costly. But the remaining cases still entail an enormous discrepancy between the capital loss and direct costs.

Table 4 reorganizes the data in Table 3 into specific subperiods. It shows that stocks typically decline both in the week before and the week after our event date. If our event date is, as we intend, the earliest date of public information, then Table 4 implies that there is some prior leakage of non-public information. In no other subperiod from $t = -50$ to $t = +50$ is there as large a change as in either of the two weeks around the recall date, and only in these two weeks does the frequency of negative CERs exceed significantly what would be expected from a random process.

Table 3

Mean CER to Drug Recall Firms for Various Event Intervals
by Classes With and Without WSJ Stories and Product Withdrawals

CER Interval	Mean CER to Recall Firm % All	No WSJ No Wdraw	WSJ No Wdraw	WSJ Wdraw	Percent of All CERs Negative	t-ratio*
-2 to 3	-2.83	-1.16	-3.62	-5.45	84.4	5.36
-4 to 5	-6.13	-3.76	-6.36	-12.18	90.6	7.87
-9 to 10	-6.56	-3.73	-7.58	-11.86	84.4	5.36
-14 to 15	-7.15	-3.11	-8.80	-14.15	71.9	2.76
-29 to 30	-5.48	0.97	-8.06	-16.82	71.9	2.76
-49 to 50	-6.74	-1.19	-8.41	-17.95	62.5	1.46
Number of Observations	32	14	13	5	32	32

* T-ratio is the percent of All negative minus 50% divided by the standard error (S) from a binomial distribution: i.e. $S = (P \cdot Q/N)^{1/2}$, where P is the percent negative, Q is the percent positive, and N is the number of cases (32).

Table 4

Mean CER to Drug Recall Firms for Successive Intervals Around Event Date by Classes With and Without WSJ Stories and Product Withdrawals

CER Interval	Mean CER to Recall Firm %				Percent of All Negative	t-ratio*
	All	No WSJ No Wdraw	WSJ No Wdraw	WSJ Wdraw		
-50 to -35	-1.94	-4.69	-0.13	1.07	50.0	0.00
-34 to -20	1.78	2.65	1.72	-0.50	34.4	-1.86
-19 to -5	-1.16	-0.22	-1.86	-1.97	53.1	0.35
-4 to 0	-2.36	-0.85	-3.23	-4.29	71.9	2.76
1 to 5	-3.78	-2.91	-3.13	-7.89	81.3	4.54
6 to 19	0.05	1.92	-1.51	-1.13	59.4	1.08
20 to 34	1.02	2.17	1.36	-3.08	34.4	-1.86
35 to 50	-0.36	0.73	-1.62	-0.15	43.8	-0.71
Number of Observations	32	14	13	5	32	32

* See Table 3 for explanation.

E. CROSS-SECTIONAL CER REGRESSIONS-

We investigate the relationship between capital market losses and direct costs more formally in Table 5. Here we regress CERs on the relative dollar loss together with dummy variables for publicity (= 1 if there was no WSJ story) and withdrawal and the CER(-4, 5) to the portfolio of other drug firms. This latter is not really an exogenous variable, given the previously documented spillover effect of recalls. But we include it to account crudely for the industry-specific component of the total loss (as well as "other" industry-specific news). Table 5 confirms the tendency for both publicity and product withdrawal to be costly, though some of the standard errors are large enough to caution against pushing these conclusions too hard. The main new result is the negative relationship between the CERs and the relative direct cost variable. This is consistent with our prior expectation, but the coefficient implies that an extra dollar of direct cost adds $2 to $4 to the stockholders' loss. This imples that even our generous estimates of direct losses are systematically low, but correlated positively with the "true" cost of a recall.

The first line of Table 6 sheds further light on the relationship between the stock market loss and direct costs. It reveals that the latter are higher for publicized recalls and for withdrawals. The relevant coefficients are statistically weak, but they are large relative to the mean direct cost. This implies that part of the extra costs of publicity and product withdrawals shown in Table 3 are due to the tendency for these recalls to have larger direct costs.

The larger message of Tables 5 and 6 confirms that of the crude data in Table 3. It is that stockholder losses from recalls go beyond costs which can be attributed to the specific product. Note, from Table 6, that the CER to

Table 5

Stock Returns to Drug Recall Firms Regressed on Relative Dollar Loss, Drug Portfolio Returns, and Dummy Variables for No WSJ Story and for Product Withdrawal

Dependent Variable	Constant	Independent Variables: Direct Cost as % of Market Value	No WSJ Dummy	With-drawal Dummy	CER (-4, 5) Drug Port-folio	Summary Statistics: Adj. R^2 F-value	Mean of Dep. Var./No. of Obs.
CER (-14, 15)	-0.052 (-1.96)	-0.039 (-1.95)	0.040 (1.34)	-0.045 (-1.13)	0.735 (1.64)	0.248 3.56	-0.071 32
CER (-9, 10)	-0.036 (-1.50)	-0.035 (-1.94)	0.022 (0.81)	-0.040 (-1.11)	1.091 (2.68)	0.251 3.59	-0.066 32
CER (-4, 5)	-0.040 (-2.09)	-0.020 (-1.38)	0.016 (0.76)	-0.058 (-2.01)	0.693 (2.14)	0.250 3.58	-0.061 32

Table 6

Regression of Relative Direct Cost and Drug Portfolio CER on WSJ and Product Withdrawal Dummy Variables

Dependent Variable	Constant	Independent Variables: Relative Direct Cost (%)	No WSJ Dummy	With-drawal Dummy	Summary Statistics: Adj. R^2 F-value	Mean Dep. Var. No. Obs.
Relative Direct Cost in %	0.631 (3.13)	- -	-0.383 (-1.37)	0.450 (1.18)	0.094 2.61	0.534 32
CER (-4, 5) of Drug Portfolio	-0.025 (-2.54)	0.014 (1.80)	0.008 (0.69)	0.006 (0.35)	0.025 1.27	-0.013 32

competitors is much more weakly related to the case-specific variables than is the recall firm's CER. This imples that any recall, regardless of "size", engenders a roughly similar industry wide asset loss. Further, even after allowing for the understatement of direct costs implied by the coefficients in Table 5, we do not come close to rationalizing the 6% average loss of a recall. That is, the regressions imply that an unpublicized recall which does not result in a withdrawal and has trivial direct costs still entails a loss of over 3 percent (based on CER(-4, 5)).

Of course, our case-specific variables may be leaving out important product-specific costs. For example, they exclude any estimate of expenses for product liability suits. But we have to doubt that these can amount to much for a case involving a small defective batch of an otherwise safe product. We suspect that the major impact of product liability costs is showing up in the large coefficient of direct costs and the extra losses due to product withdrawals. Every withdrawal in our sample has engendered well-publicized product liability suits.

For one of these cases, we have a full profile of product liability costs. Even though samples of one yield notoriously noisy estimates, it seems worth exploiting these data to get a sense of the likely magnitude of this specific cost. The case involves the Dalkon Shield, an intrauterine birth control device which was implicated in deaths of some users. The two events in our sample (26.1 and 26.2) emanating from this product withdrawal generated CER (-4, 5) values of -18 and -11 percnt, or a total loss of around $150 million to the manufacturer, A. H. Robins. Robins took a pretax charge in 1974 of $5.1 million for the costs directly related to withdrawing the product and destroying inventory, and these are shown in Table 1. The company also agreed with the SEC to break out all expenses (extra legal fees and uninsured liability payments) related to litigation over this product in its financial statements. It has done this in every annual report from 1976 to date. The total of the pre-tax charges reported for 1976-82 is $29 million. If the stream of these expenses is discounted at 10 percent per year back to 1974, when the recall occurred, we obtain a 1974 present value of $17 million. A simple regression of the log of the annual elements of this expense stream against time implies a mean increase in these expenses of 21 percent (SE = 11 percent) per year. We then assumed that expenses would continue to be incurred for another five years and would equal the predicted values from this regression in each year from 1983 through 1987. These assumptions imply an additional $21 million of liability costs in 1974 present value, bringing the total to $38 million.

This exercise tells us that, in (partial) hindsight, a reasonably complete independent estimate of the full costs of the recall to Robins is on the order of under 1/3 the stock market loss. (Since Robins has had an average tax rate of over 40 percent in recent years, even this is too high.) So, if the product liability component of this cost is anything like the consumer cost of the product defect, the stock market loss appears to exceed the "social loss." While we hesitate to push these fragmentary data this far,[4] they imply that the stock market losses exceed substantially those costs to firms which can plausibly be attributed to the recall of a specific drug.

Another way of putting this is that the stock market is imposing a substantial "goodwill" loss on a firm when a recall occurs that cannot be

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[4]A fuller treatment would require us to see if announcement of the liability costs affected the returns to Robins' stock. For example, if the initial reaction overestimated these costs, subsequent announcements of the actual costs would engender positive excess returns.

attributed to costs specific to the recalled product. The stock market appears to expect that news of a recall will reduce consumers' demand for other products sold by the firm and thereby impose additional losses on the firm. We get corroborating evidence for this conjecture when we add the market value of the firm to the regressions in Table 5. A single product typically accounts for a smaller fraction of a firm's profits the larger the firm, so the percentage loss due to recall of a single product should be smaller for larger firms if there is no spillover to other products. But the coefficient of the firm's market value is never as much as a tenth of its standard error, and this result implies that losses do spillover to the firm's other products. Indeed, we showed earlier that the losses may spillover to other firms in the same industry.

This exceptionally conservative (expected) response of consumers to news of a recall is something of a mystery, because there seems to be no easily apprehendible rational basis for expecting one product failure to beget others. As nearly as we can tell from our recall data, product failures occur randomly. However, whatever their source, it seems clear that the costs to drug firms of a recall are so large that they must exert a powerful deterrent effect on the production of defective products.

IV. AUTO RECALLS

Since the late 1960s, the National Highway Traffic Safety Administration of the Department of Transportation (DOT) has been empowered to order manufacturers to recall and repair autos with defects which compromise safety. Here we use a sample of 116 "major recalls" that occurred in 1967-81 to analyze the stock market's response to the news of this form of product defect. Our analysis here will have to be sensitive to a problem we raised in Section II: Recall announcements occur too frequently to be treated as entirely surprising to the stock market, so the market's response to the news of a recall can understate the full costs it imposes on producers of recalled cars. However, the problem is easier to state than solve, so we defer dealing with it until later in the section.

A. RECALL SAMPLE

Each recall is initiated by an order from DOT specifying which particular group of cars are to be recalled and what is to be done to fix the car. The distribution of the number of cars per recall is highly skewed. Some involve a few hundred cars or even less, and a few involve millions of cars. We wanted to avoid dealing with a lot of obviously trivial cases while retaining enough variety to analyze the effects of recall size. Accordingly, our sample is drawn from all recall announcements reported in the WSJ involving the domestic "Big 3" (GM, Ford and Chrysler) for 1967-1981[5] which exceeded the following minimum size criteria: 50,000 cars for GM, 20,000 for Ford and 10,000 for Chrysler. These cutoffs are crudely consistent with the relative market shares (and stock market values) of these firms, and they result in roughly equal representation of each firm in our sample. The sample is described more precisely in Table 7. It is clear that, even after excising the small recalls, there is a very broad range of recalls in our sample, and that our sample remains highly skewed to the right; every relevant coefficient of variation comfortably exceeds one. GM has the biggest recalls, Chrysler the smallest, but these ranks are reversed when recalls are measured relative to market value.

[5]We have no stock market data for foreign producers and American Motors has too few recalls to permit reliable comparisons with the others.

Table 7
Major Recalls, 1967-81 Descriptive Statistics

Sample	# of Recalls	Cars per Recall (000's) Mean	S.D.	MIN.	MAX.	Cars per $Million of Market Value Mean	S.D.
1. ALL RECALLS	116	717.8	1552.8	14	12000	158.8	342.7
A. GM	41	1244.7	2352.0	50	12000	70.5	141.0
B. FORD	44	567.2	859.8	50	2700	128.0	179.0
C. CHRYSLER	31	234.6	391.1	14	1300	320.0	582.0
2. ALL 1967-74 RECALLS	53	612.7	1320.8	14	6700	72.0	132.0
3. ALL 1975-81 RECALLS	63	806.1	1729.6	19.6	12000	231.9	437.4

B. STOCK MARKET RESPONSE TO RECALL ANNOUNCEMENTS

For each of the 116 recalls in our sample we computed CERs for various periods around the event date--the date of the WSJ story about the recall. We used the same source (the Scholes excess return file from CRSP) and procedure as for drug recalls. The basic results are in Panel 1 of Table 8. We find significantly negative average CERs for every event window, and the average gets larger absolutely as the windows widens. We did not go beyond the two week window, CER(-5, 5), because recalls are so numerous that much wider windows would have created serious overlap problems.[6] That window yields a mean CER of -1.60 percent. About 1/2 this total is realized in the 3 days surrounding the event, another 1/3 in the subsequent 4 days (CER (2,5)) with the 1/5 or so remainder leaking out prior to the day before the event. Also, there is a significantly above average frequency of negative recalls for every window, though these do not begin to approach the near-unanimity in the corresponding data for drugs.

Panels A, B and C of Table 8 break out results by company. These reveal that every firm suffers a negative average CER and an above-average frequency of negative CERs for every event window. That unanimity tends to support a conclusion that recalls are costly, even though many of the individual statistics in panels A-C are not significant. The rather wide standard errors on some of these makes us cautious about pushing comparisons among firms too hard, but it appears that GM loses about 1/2 as much per recall as either of its competitors (based on CER(-5,5)). The extent to which this is plausibly due to its smaller recalls (per dollar of market value) is discussed later.

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[6] As it is, 4 of our 116 cases overlap. We left the overlaps in our sample, but no result would change very much if the overlapping cases are deleted or if we had made, the same adjustments as for drug recall overlaps.

Table 8
Mean CER for Auto Stocks. Various Intervals
Around Day of Recall. 1967-81

Sample (# of Recalls)	Event (-5,5)	Window (-3,3)	(-1,1)	(-5,1)	(2,5)
1. Total (116)					
- Mean	-1.60%	-.96%	-.81%	-1.07%	-.53%
- t	3.40	2.56	3.30	2.85	1.87
- % Negative	61.2*	62.1*	64.7*	62.1*	60.3*
A. General Motors (41)					
- Mean	-.97	-.80	-.88	-.48	-.49
- t	1.64	1.70	2.86	1.02	1.38
- % Negative	56.1	58.5	65.9*	56.1	56.1
B. Ford (44)					
- Mean	-2.03	-1.58	-.63	-1.51	-.52
- t	3.50	3.42	2.08	3.26	1.49
- % Negative	63.6	68.2*	61.4	63.6	54.5
C. Chrysler (31)					
- Mean	-1.83	-.28	-.98	-1.24	-.59
- t	1.37	.26	1.40	1.16	0.73
- % Negative	64.5	58.1	67.7*	67.7*	74.2*

See text for description of sample, and see note to Table 2 for method of computing t.

* = t > 2.0. (See note to Table 3).

1. Does the CER Understate the Cost of a Recall?

Our discussion in Section II implies that the CER for recall periods is an estimate of $-(1 - p) \times K$, where K = the cost of a recall to a company and p = probability of a recall. So one way to estimate K would be to estimate p directly and divide the CER by $(1 - p)$. To see where such a procedure would lead, note that every company in our sample experienced an average of 2 to 3 major recalls per year in the 1967-81 period, or about 1 in every 10 two-week periods. If uncertainty is typically resolved in the two weeks surrounding a recall, a plausible estimate of p would be around .1, and, using this estimate, we could estimate an average loss due to a recall of around 1.8 percent of market value rather than the 1.6 percent in Table 8.

However, that procedure is based on an implicit assumption that needs to be examined with special care in the case of the auto industry in the 1967-81 period. This is that the other unexpected events impacting auto stocks in the two weeks surrounding a recall were not adverse or favorable on average. To elaborate: *ex ante* every CER is zero in expected value. If the *only* surprise is that a recall did or did not occur, the *ex post* CER is then $-(1 - p)K$ or pK as in equations (4) and (5). If other surprises occur during recall periods, but are not systematically adverse or favorable, then the -1.6 percent mean CER in these periods is an *unbiased estimate* of $-(1 - p)K$ and it therefore underestimates K. We can correct the underestimate as suggested above, or we could estimate pK directly from CERs in non-recall periods. Those CERs would be an unbiased estimate of pK if, again, other surprises in these non-recall periods are neither good nor bad on average.

We know, however, that this last supposition is false for the 1967-81 period. These were hardly the best of times for domestic auto producers. The adverse effects of growing foreign competition, pollution regulation, etc.

dominated their stock market performance, and the average CER in non-recall periods was negative. This raises two problems: (1) the CER for non-recall periods is obviously not an unbiased estimate of pK, the capital <u>gain</u> due to the absence of a recall, (2) the CER for recall periods overstates $-(1 - p)K$ <u>if</u> other surprises in these periods were also adverse on average. It helps to state both of these precisely by revising (4) and (5) to include "other" surprises as follows:

$$(4)' \qquad \left(S_1^R - S_o\right)_t = -(1 - p_t)K_t + X_t \ ,$$

$$(5)' \qquad \left(S_1^{NR} - S_o\right)_t = p_t K_t + Y_t \ ,$$

where

X_t = the gain or loss due to non-recall events, in recall period t, and

Y_t = gain or loss from non-recall events in non-recall period t. The t-subscript indicates that actual returns in any particular period--the $\left(S_1^i - S_o\right)$ variables--are generated by a process whose elements can vary from period to period. Our calculated CERs are <u>ex post</u> realizations of this process for some particular time interval. They include the realizations of X_t or Y_t, and these can be positive or negative on average. We know that the mean value of Y_t for 1967-81 is negative, because the mean value of $\left(S_1^{NR} - S_o\right)_t$ is negative for this period (see below). We also know from Table 8 that the mean value of $\left(S_1^R - S_o\right)_t$ is negative, but this is insufficient to tell us that the mean of X_t is negative. Therefore, either procedure suggested above for estimating the mean of K has potential pitfalls. If we estimate $\overline{p}_t$ directly and divide the mean return in recall periods by $(1 - \overline{p}_t)$, we get an estimate of: $-\overline{K}_t + \overline{X}_t/(1 - \overline{p}_t)$, which is unbiased only if $\overline{X}_t = 0$. If, on the other hand, we subtract the mean of (5)' from the mean of (4)', we obtain

$$-\overline{K}_t + (\overline{X}_t - \overline{Y}_t) ,$$

which is unbiased only if $\overline{X}_t = \overline{Y}_t$. If $\overline{X}_t$ = its <u>ex ante</u> value of zero, then this estimate understates $-\overline{K}$, since $\overline{Y}_t < 0$. In addition, this latter estimate is likely to be noisier than any simple transformation of (4)', because of the variance added by the Y_t series.

Since our readers deserve more than a lecture in elementary statistics, Table 9 presents various estimates of (4)' - (5)' for the (-5, 5) event window. These are labeled "Adjusted Mean CER", and the adjustment is as follows: For each year we compute the mean CER(-5, 5) for every non-recall period[7] for each of the three firms. Then we subtract this year-and-company specific non-recall mean CER from the CER(-5, 5) for each recall experienced by the company in the same year. This adjusted mean CER is an unbiased estimate of $\overline{K}$ on the assumption that both recall and non-recall periods within a year share a common company-specific impact of non-recall news. For ease of comparison, we repeat the unadjusted CER(-5, 5) from Table 8, and we provide the added detail of a sub-period breakdown.

None of the results in Table 8 are much affected by our adjustment of the CERs. The adjusted-mean CER (-5, 5) in Panel 1 is a bit smaller than the unadjusted mean, but it remains significantly negative. The main innovation in Table 9 is in the sub-period data of Panels 2 and 3, not in how the CERs are calculated. These reveal a sharp difference in the impact of recalls between periods. The average recall costs less than 1 percent of market value before 1975 (for every firm) regardless of how the CER is measured and it costs more than 2 percent after 1975. This difference is mainly attributable to Ford and Chrysler whose average recall-period CERs in this post-1975 period

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[7]More precisely, we compute 11 x mean daily ER for non-recall periods.

Table 9
Mean CERs for Auto Recalls. Adjusted For Non-Recall News.
1967-81

Sample and (Number of Recalls)	Adjusted Mean CER(-5, 5) Mean	t	Unadjusted Mean CER (-5, 5) Mean	t
1. All. 1967-81 (116)	-1.38%	2.83	-1.60%	3.40
A. General Motors (41)	-.60	0.91	-.97	1.64
B. Ford (44)	-2.05	3.51	-2.03	3.50
C. Chrysler (31)	-1.46	1.06	-1.83	1.37
2. All 1967-74 (53)	-0.60	0.77	-0.55	0.73
A. GM (18)	-0.56	0.57	-0.57	0.63
B. Ford (17)	-0.44	0.63	-0.44	0.60
C. Chrysler (18)	-0.81	0.40	-0.64	0.33
3. All 1975-81 (63)	-2.04	3.35	-2.48	4.19
A. GM (23)	-0.64	0.71	-1.28	1.45
B. Ford (27)	-3.07	3.88	-3.02	3.79
C. Chrysler (13)	-2.37	1.29	-3.48	1.99

See text for description of Adjusted Mean CER(-5,5). Unadjusted mean CER(-5, 5) is computed as in Table 8.

range from around -2 1/2 to -3 1/2 percent. This post-1975 period is not only more costly per recall, but there are more of them compared to the previous period (63 v. 53). This combination is especially costly for Ford, which bore the brunt of the increased recall activity (27 v. 17 before 1975).

The substantial difference between the stock market response to pre and post 1975 recalls turns out to be more apparent than real. As we show subsequently (see Table 11) it is due mainly to the decline in the real value of auto stocks: equally costly recalls translate into a higher percentage loss of market value the lower the market value. In addition, recalls increased in size after 1975 (see Table 7).

2. <u>How does the Cost of a Recall Vary with the Number of Cars?</u>

Every recall announcement contains information on the number of cars involved, and we should expect news of big recalls to be more costly than news of smaller recalls. But we found it as difficult to verify this for autos as for drugs. As with drugs, we wanted to allow for a "goodwill" effect of recalls, which we assume is proportional to the firm's market value. So we want an estimate of

$$\text{\$ RECALL LOSS} = A \cdot (\text{MKT. VALUE}) + B(\text{CARS})$$

across recalls. Here A = "goodwill" cost and B = cost per car. Since $LOSS = %LOSS × MKT. VALUE, we estimated

$$\text{\% RECALL LOSS} = A + B(\text{CARS/VALUE})$$

using - CER (-5,5) as an estimate of %LOSS. A sample of the uniformly disappointing results is in Table 10. The regression estimate of B is rarely more than a standard error from zero and it is negative at least as often as it is positive. Nothing much is gained by allowing for inflation (i.e., assuming that B is proportional to the GNP deflator; see lines 1(a) - 3(a)) or changing the event window to (-1,1) in order to reduce noise. As with drugs, the A term (not explicitly shown in the table) accounts for essentially all of the recall cost.

One reason for this is that costs per car vary across recalls, so that our regression model is too crude. There is no handy way to estimate independently the dollar cost per car or per recall, as we could with drugs. But, from fragmentary press accounts; we know that the firms' estimates of their explicit costs per car repaired range from something like $10 to $1000, so the measurement error entailed by assuming that B is constant is considerable. There is the additional complication that car owners frequently do not respond to recall notices, and the response rate varies considerably across recalls.[8] We tried some crude adjustments for differences in repair costs and response rates for a sample of recalls, but this failed to sharpen the results in Table 10.[9]

We can get some insight into the likely importance of measurement error by comparing the data on cars/market value in Table 7 with subsequent results. For example, we have already noted that GM has the lowest stock market loss per recall and the lowest cars/value. Note also that both cars/value and the mean stock market loss is much larger in 1975-81 than in 1967-74. All of this is consistent with a positive relationship between the market loss and recall size which we suspect is being hidden by measurement error in the disaggregated data summarized in Table 10. But we also have to note that Chrysler has a much higher cars/value than Ford, but no higher mean stock market loss.

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[8] The law gives the owner the right, but no obligation, to have his car fixed at zero direct cost. Actual response rates vary over a range from about 1/3 to nearly 100 percent.

[9] Each recall order is published in DOT's annual Safety Related Recall Campaigns for Motor Vehicles and Motor Vehicle Equipment Including Tires. Sometimes the order requires repair only if inspection reveals a defect, and other times repair or replacement is mandatory. We allowed B to depend on a dummy = +1 if repair was required. The publication also gives response rates for some recalls, and we allowed B to vary with these. But neither variable worked. Nor did a variety of other adjustments which we tried—e.g. modeling the goodwill loss as a constant dollar, rather than constant percentage, amount.

Table 10
Regression Estimates of the Marginal Cost of a Recalled Auto. By Firm and Period

Sample (# of Recalls)	Cost/Car	t
1. All. 1967-81 (116)	-$2.62	0.2
(a) Price Deflated (1972 = 1.00)	-$1.21	0.1
(b) Based on CER(-1,1)	8.73	1.3
2. All 1967-74 (53)	-4.98	0.1
(a) Price Deflated	-9.09	0.2
(b) Based on CER(-1,1)	19.26	0.7
3. All 1975-81 (63)	-10.09	0.7
(a) Price Deflated	-6.63	0.8
(b) Based on CER(-1,1)	5.83	0.9
A. GM (41)	33.95	0.8
B. Ford (44)	-0.94	0.0
C. Chrysler (31)	-8.80	0.4

Note: Each Cost/Car is the estimate of B in a regression of the general form:

$$-CER(-t,\ t) = A + B\left(\frac{CARS}{VALUE}\right),$$

Where CARS = # of cars recalled, and VALUE = market value of the firm. Negative values of B imply that the marginal cost of a car is negative! t = ratio of B to its standard error.

For lines 1(a), 2(a), 3(a), $\frac{CARS}{VALUE}$ is multiplied by the GNP deflator (1972 = 1.0) to account for the effects of inflation on recall costs. CER (-5, 5) is the dependent variable in all regressions, except 1(b), 2(b) and 3(b) which use CER(-1, 1).

Another approach to separating crudely the "goodwill" from direct cost elements of the stock market loss is to see whether it is plausible to assume no goodwill loss at all. For drug recalls, we found that such an assumption would appear utterly implausible because the stock market losses are very much larger than the direct costs. As a first step in such a comparison for autos we have converted the percentage losses (using the unadjusted CER(-5,5)) to (constant 1981) dollar losses per recall and per car. The first column of Table 11 shows that each recall cost around $140 million in market value on average, with GM bearing the highest mean dollar cost and Chrysler the lowest. It also shows that the difference between the pre and post 1975 dollar losses (see lines 2 and 3) is much smaller than the difference in the corresponding percentage losses in Table 9. So, with the caution implied by the large standard errors, we can attribute much of that percentage difference to the combined effects of inflation and the poor stock market performance of auto stocks in the late 1970s. Were it not for those twin events, the costs of recalls could well have been lost in the noise of stock prices.

Table 11 also expresses these dollar losses on a per car basis. While we report a mean loss/car, we have little confidence that the high dollar amounts are meaningful. These means are dominated by a few extremely small recalls that generate extremely large losses/car. Accordingly, we show two other measures less affected by these extreme values--the median and the mean dollar loss/mean number of cars in a recall (labeled mean/mean).[10] This last datum, is equivalent to aggregate losses in a sample divided by aggregate cars, so it comes closest to summarizing the experience of these firms over long periods. What is perhaps most interesting about this figure is its stability over time and between companies: in any large sample of recalls, the loss/car seems to be around $200.

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[10]To illustrate the problem entailed by very small recalls, remember that losses and cars are essentially uncorrelated. So, suppose losses in a 1 car recall and a 100 car recall are each $100. The mean loss/car = 1/2(100/1 + 100/100) = $50.50, but the total loss from both recalls is only 200/101 = $1.98 per car. This last figure is our mean/mean for this sample.

Table 11
Estimated Dollar Losses Per Recall and Per Car.
1967-81. Constant 1981 Dollars

Sample (# of Recalls)	Loss/Recall (Million $) Mean	t	Loss/Car ($) Mean	t	Median	Mean/Mean
1. All 1967-81 (116)	141.1	2.2	813.3	1.5	185.7	196.6
A. GM (41)	235.5	1.4	477.5	0.6	46.6	189.2
B. Ford (44)	128.6	3.7	694.2	2.3	198.2	226.7
C. Chrysler (31)	34.0	1.0	1426.4	0.9	95.7	144.9
2. All 1967-74 (53)	110.1	0.9	1092.9	1.0	64.7	179.7
3. All 1975-81 (63)	167.2	2.7	578.1	2.0	189.0	207.4

Note: Loss/Recall is estimated by multiplying CER (-5, 5) for each recall period by the market value of the firm in that period. Mean Loss/Car is the mean of [(Loss/Recall)/Cars involved in the recall]. The last column (Mean/Mean) is obtained by dividing the mean of Loss/recall, as shown in the first column, by the mean of cars/recall from Table 7. Each loss/recall is deflated by the GNP deflator set to a base of 1981 = 1.0.

This last result suggests that--with sufficiently large samples to iron out the random fluctuations--recall costs are proportional to cars recalled. But it appears implausible that the $200 figure is entirely attributable to the direct costs of a recall. Since such costs are a deductible expense, it would imply pre-tax costs of nearly $400 per car, and this would in the high end of the range of per car costs which have appeared in press reports about specific recalls.[11] We know of only one publically available piece of data which permits an estimate of the per car cost in a large sample of recalls: GM disclosed that it spent $33 million on recalls in 1982 (Detroit Free Press, May 22, 1983). This amounts to about $35 per GM car recalled that year. If this is anywhere close to being typical, then the bulk of the stock market loss represents indirect costs: lost sales and goodwill, liability suits, etc.[12,13] In this sense, there is a rough similarity between auto and drug

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[11] For example, a recent Detroit Free Press series on recalls states that a 1983 recall of 240,000 GM cars "is thought to be the most expensive per-car recall ever." GM's estimate of its total direct cost for the recall is $30 million, or $125 per car. Detroit Free Press May 24, 1983.

[12] In this connection, we note recent evidence that new car sales of recalled models appear to decline when the recall is announced. See S. M. Crafton, G. E. Hoffer and R. J. Reilly "Testing the Impact of Recalls on the Demand for Automobiles" Economy Inquiry v. XIX, Oct. 1981, 694-703 and R. J. Reilly and G. E. Hoffer "Will Retarding the Information Flow on Automobile Recalls Affect Consumer Demand?" Economic Inquiry v. XXI July, 1983, 444-447. The latter article estimates that sales of a domestic recalled "line" decline about 5 percent in the month of a recall announcement in the 1977-81 period, but there is no indication that the decline lasts more than a month.

A single month sales decline of this magnitude could not account for very much of the typical stock market loss. There are about 60 domestic "lines" with average monthly sales of around 10,000 cars. Reilly and Hoffer exclude lines with fewer than 8,000 cars per month. If the average line in the sample has 20,000 monthly sales, a 5 percent decline represents 1,000 cars or roughly $10 million sales. The lost pre-tax profits on these sales would amount to under $2 million, based on the industry's margin of sales over material and labor costs.

[13] We also found no serial correlation in recalls. For example the correlation of the number of recalls in successive three-month periods is .03 for Chrysler, .08 for Ford and GM and .17 for the aggregate of all three firms. None of these are significant; auto recalls, like drug recalls, appear to occur randomly.

recalls. But there seems to be a closer connection between the size of the indirect and direct costs for auto recalls than for drug recalls.

3. <u>How are Competitors Affected by Auto Recalls?</u>

The surprising result that competitors lose rather than gain during a drug recall holds for auto recalls as well. And, as with drugs, the surprise is deepened by the large magnitudes involved. The data are summarized in Tables 12 and 13. Table 12 shows mean CERs to equal weighted "portfolios" of the two competitors during recall periods (e.g. a Chrysler-Ford portfolio during GM recalls). The main result is that competitors lose about 1 percent on average during a two-week recall period, or about 2/3 as much as the recall company loses. All of this is attributable to 1975-81 recalls, where the competitors' loss (-2.40%) virtually matches the recall company's loss! This difference between sub-periods is less intelligible than the similar sort of difference we found for recall companys CERs (see Table 9). In that case, we saw that the apparently weak negative CERs for 1967-74 were plausibly masking negative real dollar impacts roughly comparable to those in the later period. In Table 12 we find similarly weak, but positive CERs for competitors in 1967-74. These would be consistent with non-trivial real dollar gains to competitors, a result which would excite no surprise. But the post '74 data clearly describe a much different world. Table 13 organizes the data by company. Reading across any of rows in panels A-C gives the response of a particular competitor to recalls of its rivals. For example, we find from panel A that GM lost on average a) 2.13% during Ford recalls, b) .83% during Chrysler recalls, c) 1.59% during all Ford and Chrysler recalls, etc. Panel D shows the average response of both rivals to a particular company's recalls. So, e.g., panel D.1. says that Ford and Chrysler lost 1.03% on average during all GM recalls in 1967-81. With due respect given to the large standard errors, this detail reveals some interesting patterns: a) GM loses more

Table 12.
Mean CERs of Competitors During Recall Periods.
Various Event Windows. 1967-1981

Sample (# of Recalls)	Event Window -5,5	-3,3	-1,1	-5,1	2,5
1. All 1967-81 (116)					
- Mean	-1.01%	-.92%	-.35%	-.49%	-.52%
- t	2.46	2.76	1.55	1.43	1.94
- % Negative	59.5*	56.0	57.8	62.1*	52.6
2. 1967-74 (53)					
- Mean	.64	.17	.18	.57	.08
- t	1.09	0.42	0.62	1.07	0.22
- % Negative	41.5	37.7	45.3	45.3	45.3
3. 1975-81 (63)					
- Mean	-2.40	-1.84	-.79	-1.37	-1.03
- t	4.65	3.81	2.41	3.30	2.70
- % Negative	74.6*	71.4*	68.3*	76.2*	58.7

Note: Each entry shows the Mean CER(-x,y) for an equal-weighted portfolio of competitors during recall periods. So, e.g., for a GM recall; our "portfolio" is Chrysler and Ford, and our CER(-x,y) for that recall is just the average of the Chrysler and Ford CERs. Tso ratio of the Mean CER to the sample standard error is shown below the mean.

"% Negative" is the percentage of negative CERs to the portfolio of competitors.

* = t > 2.0.

Table 13
Mean CER (-5,5) of Competitors During Recall Periods.
By Company and Sub-Period. 1967-81.

Competitor Company	Recall Company GM	Recall Company Ford	Recall Company Chrysler	All Recalls of Other Cos. In '67-'81	'67-'74	'75-'81
A. GM						
- Mean		-2.13%	-.83%	-1.59%	-.09%	-2.92%
- t		4.02	1.04	3.49	0.13	5.34
- % Negative		75.0*	54.8	66.7*	45.7	85.0*
- N		44	31	75	35	40
B. Ford						
- Mean	-1.11		.36	-.48	.86	-1.81
- t	1.34		0.47	0.83	1.11	2.24
- % Negative	53.7		54.8	54.2	50.0	58.3
- N	41		31	72	36	36
C. Chrysler						
- Mean	-.94	-.94		-.94	1.16	-2.41
- t	0.83	0.95		1.27	1.12	2.44
- % Negative	53.7	54.6		54.1	37.1	66.0*
- N	41	44		85	35	50
D. All Competitors				(See Table 12 for Aggregation across all Recalls.)		
1. 1967-1981						
- Mean	-1.03	-1.54	-.23			
- t	1.24	2.64	383.2			
- % Negative	56.1	63.6	58.1			
2. 1967-1974						
- Mean	1.00	.42	.50			
- t	0.87	0.45	0.50			
- % Negative	38.9	41.2	44.4			
- N	18	17	18			
3. 1975-81						
- Mean	-2.61	-2.77	-1.25			
- t	2.39	4.22	1.47			
- % Negative	69.6*	77.8*	76.9*			
- N	23	27	13			

Note: Each entry under "Recall Company" is based on the CER(-5,5) of competitors of that company during tht company's recall periods. For example data in Panel A. refer to GM's CER(-5,5) during Ford and/or Chrysler recalls. The -2.13% under Ford means that GM's Mean CER(-5,5) was -2.13% during the 44 Ford recall periods, etc. The last 3 columns give data for a specific competitor (e.g. GM in panel A) aggregated across all recalls of other companies (Ford and Chrysler in panel A.) for specific time periods.

Panel D. shows the aggregated response of competitors to particular company recalls, again for specified time periods. For example, the -1.03% entry under GM in panel D.1. is the mean CER(-5,5) of GM's competitors (Chrysler and Ford) during the 41 GM recalls in 1967-81.

See note to Table 12 for definition of "Mean", "t", and "% Negative". N = number of recalls in the cell. For panel D., t and % negative are based on CER(-5,5) of equal weighted portfolio of competitors (see note to Table 12).

during its rivals' recalls (1.59%) than it does during its own recalls (0.97%); the reverse is true for both Chrysler and Ford. The GM response to rivals recalls in 1975-81 (-2.92%) is particularly noteworthy: it loses even more than they do. b) The most damaging recalls for competitors are GM and Ford recalls, particularly in 1975-81. (-2.61% and -2.77% respectively). GM's rivals lose more than GM does in this period. c) By contrast, the relatively small Chrysler recalls cost rivals about half as much as GM and Ford recalls (see D.3) and only about 1/3 what they cost Chrysler itself in this 1975-81 period. So Chrysler recalls seems to be treated mainly as idiosyncracies without strong implications for industry wealth.

Since excess returns to auto stocks were negative on average over our sample period, and especially so in 1975-81, the reader may wonder if the negative industry effects which we attribute to recalls have a more general source. This seems implausible. From Table 9 panel 3 we find that the mean company CER in non-recall periods for 1975-81 was about - 1/2 percent, or under 1/4 the mean CER for competitors during recall periods.[14] So other news would have to be consistently <u>especially</u> bad during recall periods for a general "bad news" explanation to make sense. This stretches credulity, and we can easily reject a hypothesis of no diffference between the mean CER in non-recall periods and the mean CER to competitors in recall periods.

The more intriguing question raised by Table 12 is whether there is any company-specific component at all in the loss due to recalls, given that the mean company-specific and competitor CERs are so similar. Table 13 gives us a hint: there is no general tendency for companies to respond identically to their own recalls and those of competitors. A more formal answer is given by

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[14]Note that the - 1/2 percent <u>includes</u> the negative returns to competitors during recall periods, so it is <u>too large</u> an estimate of the impact of non-recall news.

regressing a recall company's CER(-5,5) on that of the portfolio of its competitors during recall periods. The regression coefficient here gives the company's average share in any industry-wide effects of recalls, and the intercept gives the average company-specific component. We computed the regression for each of the three companies, and obtained a mean intercept of -1.12 percent (t = 2.98).[15] So there is a significant company-specific component to recall losses over and above a company's share in the industry-wide loss.

V. SUMMARY

There are striking similarities in the effects of drug and auto recalls on the wealth of shareholders. Both are extremely costly, surely more costly than the direct costs of recalling the defective product and, plausibly, more costly than all of the costs attributable to the specific product defect. In both types of recalls a more general loss of "goodwill" seems to be a large component of the total loss. This result is not unique to this study. One of us has found similarly large "goodwill" losses for FTC false-advertising cases.[16] Just what lies behind these goodwill losses remains something of a mystery which we leave for future research. Our attempts, mainly with drugs, to find answers in costs of product liability suits and in time dependence of recalls succeeded only in deepening the mystery.

Another similarity between drugs and auto recalls--and the source of another mystery--lies in the response of competitors. Their owners lose

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[15] The average regression coefficient is .69(t = 7.46). This implies that the typical company-share in an industry-wide recall loss of 1 percent is under 1 percent. The proximate reason for this is that Chrysler has more volatile returns than the others, so when Chrysler loses 1 percent the others lose less.

[16] Peltzman, "The Effects of FTC Advertising Regulation," <u>J. of Law and Econ.</u>, v. 24, December, 1981, pp. 403-447.

substantially when a rival product is recalled. Any favorable effects on the demand for substitutes from a recall are swamped by a more general negative effect on the industry. This is another piece of evidence that something much more is involved in a recall than failure of a specific product.

It is difficult to compare the magnitudes of the losses in drug and auto recalls, because both the frequency of recalls and the number of firms involved differ. Per recall, the percentage loss is much greater for drug recalls (6% v. 1 1/2 %). But auto recalls occur over twice as frequently, and involve only 3 companies v. 19 for drugs (in our samples.) So per-company per-year, auto recalls are considerably more costly. The average loss to rivals is roughly the same (1 percent) for auto and drug recalls, but with about 50 rivals in the case of drugs v. 2 for autos, it is clearly the drug recalls which have the more substantial cross-firm effects.

We began by promising to shed light on the degree to which the capital market might sub-optimally deter production of faulty products. We believe we have done so. It is clear that, in the simple sense of the market's not internalizing even the direct costs, suboptimal deterrence is no problem. It is also clear that to make a suboptimal deterrence story credible requires very generous estimates of the indirect social costs. The only source of such large costs we have found is in the cross-company effects. This might suggest that there is a larger scope for industry cooperation in product design and inspection than economists have heretofore imagined.

Finally, we hope that our results have begun defining an agenda for future research. They suggest that recall costs are like an iceberg whose easily visible part hides most of what is important. The challenge for future research is to discover just what form--e.g. reduced sales, increased quality costs, lost "political capital"--these large, currently amorphous costs take.