Mass Layoffs and Industrial Production: An Analysis of Monthly Data in the Manufacturing Sectors

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Abstract

We examine short-term relation between mass layoffs and industrial production in the manufacturing sectors. We employ Granger causality test on seasonally-adjusted monthly series. Our results for the overall manufacturing sector indicate causality from industrial production to the number of mass layoffs, but not vice versa. The signs of the lag coefficients show that mass layoffs occur in just one month following a decrease in industrial production. A breakdown of the sample shows bidirectional causality for the majority of the individual manufacturing sectors. The negative signs of the lag coefficients indicate that, for the majority of the manufacturing sectors, production decreases after an increase in mass layoffs and mass layoffs increase after a decrease in production.

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I. Introduction

Employee layoff has been an integral part of corporate strategy to address firm performance and economic slowdown.[1] While Hillier et al. (2007) and others examine firm performance around layoffs, they provide little information on the dynamic relation between these two. Annual data used in their studies do not show how soon layoffs occur following weak performance and whether the performance changes immediately following a layoff. To examine these issues, we focus on layoffs and performance on a monthly basis. Since monthly data are available at the industry level, we employ Granger causality test on mass layoffs and industrial production index in the manufacturing industries.[2]

There has been little systematic analysis of layoffs and performance by industry in the finance literature. Few studies examine contagion effect of layoffs in the industry. Madura et al. (1995) show positive and significant effects of a bank layoff on other banks. Goins and Gruca (2008) find that negative stock price reactions to layoff announcement will result in simultaneous negative reactions for non-announcing firms in the oil and gas industry suggesting an intra-industry effect. Other studies look at the reasons for layoffs in selected industries. Yoo and Mody

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[1] In October 2008, for example, major U.S. corporations such as American Express, Yahoo Inc., Merck & Co. announced plans to lay off thousands of employees in response to economic downturn.

[2] Mass layoff is defined as an event when fifty or more initial claims for unemployment insurance benefits are filed against an employer during a five-week period.

(2000) find that digitalization and productivity increases reduce employment in the telephone industry. Quesada and Gazo (2006) report that consolidation and reorganization are the primary reasons layoffs occur in the wood products and furniture industries.

Our results show evidence of Granger causality from monthly industrial production to the number of monthly mass layoffs for the overall manufacturing sector. The negative signs of the lag regression coefficients indicate that a decline in production one month prior results in an increase in the number layoffs in the current month. Our data fail to provide any evidence of causality from layoffs to production for the overall manufacturing sector.

Our results for the majority of the seventeen individual manufacturing sectors indicate bidirectional causality between monthly mass layoffs and monthly industrial production. The signs of the lag regression coefficients show that, for the majority of the sectors, an increase in mass layoffs decreases production and a decrease in production increases mass layoffs within a month.

The paper is organized as follows. Section II provides background information and develops the hypotheses. The data and sample selections are described in Section III. Section IV presents the empirical results. Concluding remarks are given in Section V.

II.Background

Previous studies argue that layoffs have both costs and benefits. Bailey and Sherman (1988) claim that layoffs boost firm's profits, and Bhagat et. al. (1990) argue that layoffs result in substantial cost savings. Costs associated with layoffs result from low morale and productivity of surviving employees, high turnovers of surviving employees, outplacement services, and rehiring of new employees [e.g., Bailey and Sherman (1988) and Mccune et al. (1988)]. Cascio

(1993) points out that although firms expect layoffs to increase productivity, in practice layoffs can create survivor's syndrome of loss or morale, distrust of management, and ultimately decline productivity.

To gain financial market's perspective on the costs and benefits of layoffs, a number of prior empirical studies examine stock price reactions to layoffs. The findings show that layoffs in general elicit negative reactions indicating that financial markets view layoffs as a signal of real financial problems which seem to outweigh the cost-cutting benefits of layoffs [Worrell et al. (1991), Hallock (1998), and Hillier et al. (2007)]. These reactions can, however, depend on the reasons for layoffs and other layoff characteristics. For example, Chalos and Chen (2002) observe positive stock price reactions to layoffs associated with revenue refocusing and weak negative stock price reactions to layoffs associated with plant closings. Palmon et al. (1997) find that stockholder reaction is positive when cost reduction motive is cited and negative when adverse market condition is cited. Elayan et al. (1998) observe stronger stock price reactions for layoffs that are large, permanent, and unanticipated.

In addition to stock return analysis, a number of studies provide a direct examination of firm performance before and after layoffs. The findings show declining performance prior to layoffs suggesting that layoffs seem to occur in response to poor performance. Espahbodi et al. (2000) find that operating performance of firms that lay off employees declined from three years before to the year of layoffs. Hillier et al. (2007) find a decline in changes in return on assets over three years prior to layoffs, and Elayan et. al. (1998) observe a decline in return on equity from two years before a layoff.

The findings on firm's performance following layoffs are inconclusive. While Elayan et al. (1998) find higher return on equity over two years following layoffs, Hillier et al. (2007) find slight evidence of an increase in return on assets over three years following layoffs. Just like stock price reactions, Chalos and Chen (2002), show that firm's performance improvement can depend on the reasons for layoffs. They find that return on assets increases when layoffs are associated with revenue refocusing.

Following the findings in prior studies, we expect significant causality from industrial production to mass layoffs. With regards to the directions of the change, we expect that a decrease in product will result in an increase the number of layoffs. How quickly and which manufacturing sectors respond to a change in production and lay off employees are empirical issues examined in this paper.

Since we examine production (output) and not net earnings, the cost-cutting impact of mass layoffs may not be directly reflected in our results. One possible way mass layoffs can increase industrial production is that layoffs can create an atmosphere of efficiency improvement within the organization which results in higher production. A mass layoff can also decrease production when it lowers employee morale and make employees less productive. We expect a weak causality from mass layoffs to industrial production.

III.Data and Sample

We obtain mass layoff data from *Haver Analytics database* which collects data for this series from the U.S. Bureau of Labor Statistics (BLS). The BLS reports only on mass layoffs - layoffs impacting at least 50 employees of a single establishment. Our version of Havers Analytics contains monthly data on mass layoffs from April 1995 to June 2008 (159 months).

Data for industrial production index also comes from *Haver Analytics database* which compiles data from the Industrial and Production Capacity Utilization reports of Board of

Governors of the Federal Reserve System. We collect monthly industrial production data for the same period as the mass layoff data, from April 1995 to June 2008.

Table 1 reports seasonally-adjusted mean, median, and standard deviation per month for the number of mass layoffs and industrial production index series (base year 2000 = 100). The mean values show that manufacturing sectors had roughly 465 mass layoffs during the sample period with the highest number of mass layoff occurring in the transportation equipment sector and the lowest number in the petroleum and coal sector. The mean industrial production index value during the sample period for all manufacturing sectors is 99.67 with the highest value in apparel and leather sector and the lowest value in the furniture sector.

Figure 1 provides the mean number of mass layoffs and the mean industrial index value during the sample period. For comparative purposes, we scale the number of mass layoffs by setting December 2000 value equal to 100. Figure 1 shows that, from April 1995 to June 2008, industrial production increase steadily except during the 2001 recession year. The number of mass layoffs during the sample period shows a downward trend except during the 2001 recession year when the number of layoffs increased and peaked around the month of September 2001. These long-term data indicate that industrial production increased while the number of mass layoffs decreased from April 1995 to June 2008. In the next section, we provide empirical findings on the short-term relations between mass layoffs and industrial production in the manufacturing sectors.

IV. Empirical Findings

Unit Root Test

This paper examines the dynamic relationship between mass layoffs and industrial production in manufacturing industries. We use the causality procedure of Granger (1969) on the monthly series of number of mass layoffs and industrial production from April 1995 to June 2008 in various manufacturing groups. The Granger causality procedure requires that the series are stationary. We employ the following Augmented Dickey-Fuller (ADF) procedure to test for stationarity.

$$\Delta Y_t = \alpha_1 + \alpha_2 Y_{t-1} + \sum_{k=1}^{K} \delta_k \, \Delta Y_{t-1} + \varepsilon_t \qquad (1)$$

where ΔY_t is the first difference operator, α_k and δ_k are constant unknown parameters, and ε_t is zero mean white noise error term. The *K*-lagged difference terms are chosen so that the error term ε_t becomes white noise. The null hypothesis that Y_t contains a unit root i.e., Y_t is non-stationary amounts to testing α_2 = 0. The series is considered stationary if α_2 is negative and significantly different from zero. The distribution for the ADF statistics is given in Fuller (1976).

The results of the ADF tests are given in Table 2.[3] The results indicate that, in the level form, the number of mass layoffs in the overall manufacturing sector is a stationary series while industrial production index is a non-stationary series. In the first difference, industrial production index becomes stationary. For the individual sectors, all the mass layoff and

[3] We start with a maximum lag length of 6 months and reduce it to the appropriate lag length *K* using Akaike's Information Criterion (AIC).

industrial production series are non-stationary, but in the first differences they become stationary series. The ADF statistics are negative and significantly different from zero for these series. For the Granger causality tests in the next section, we use the first difference of series for both monthly industrial production index and mass layoffs.

Granger Causality Test

The Granger causality models are given by the following autoregressive representations. To test causality from mass layoffs to industrial production (L → P), we use the following model:

$$\Delta P_t = \alpha + \sum_{k=1}^{K} \alpha_k \, \Delta P_{t-k} + \sum_{j=1}^{J} \delta_j \, \Delta L_{t-j} + \varepsilon_t. \qquad (2)$$

To test causality from industrial production to mass layoffs (P → L), we use the following model:

$$\Delta L_t = \alpha + \sum_{k=1}^{K} \alpha_k \, \Delta L_{t-k} + \sum_{j=1}^{J} \delta_j \, \Delta P_{t-j} + \varepsilon_t. \qquad (3)$$

where, *K* is the lag length for the dependent variable and *J* is the lag length for the independent variable. α_k is the coefficient for the lagged dependent variable and δ_j is the coefficient for the lagged independent variable. Causality from one variable to the other is tested by an F-statistic. In the case of L → P, the F value will indicate whether the residual variance of the Granger equation with the mass layoff series omitted is significantly greater than the residual variance of the full equation. If so, the lags of mass layoffs add to the explanatory power of the equation, that is, mass layoff Granger causes industrial production. Granger causality for P → L is examined in a similar way.

The results for the Granger causality tests are reported in Table 3. We ran Granger causality test for two sets of maximum lags. Optimal number of lags is chosen by minimizing Akaike's Information Criterion (AIC) for maximum lag of 6 months [$\sqrt[3]{159} \approx 6$] and 13 months [$(12*(T/100)^{0.25}$ Schwert (1989)]. Use of the maximum lag lengths is discussed in Mamum and Nath (2005, footnote 7). Lags reported below are in the order of dependent and independent variables (for example, in L → P, mass layoff (L) is independent and industrial production index (P) is dependent variable). We report F values and signs of the coefficients for lagged independent variables that are significant.

For the overall manufacturing industry, the results show that mass layoffs do not Granger cause industrial production. Also, none of the lagged coefficients of mass layoffs are significant in the regression model. These results suggest that overall manufacturing production does not improve following a mass layoff. For the causality test P → L, the results indicate that industrial production Granger cause mass layoffs. The coefficient in month -1 is significant and negative suggesting that a decline in industrial production in the previous month results in higher mass layoffs in the current month.

The results for individual manufacturing sectors show that mass layoffs Granger cause production, L → P, in 10 out of 17 sectors. In all cases when the F values are significant, the signs of the lagged coefficients for mass layoffs show that an increase in mass layoffs leads to a decrease in industrial production. Sectors such as food, beverage, and tobacco, textile, apparel, metals, machinery, computer and electronics, experience decrease in monthly production following a mass layoff. A possible explanation is that layoffs in these sectors impacted morale of the surviving employees which decreased productivity. Another explanation could be that these sectors lay off employees in anticipation of decline in production in the upcoming months. Some of the sectors that do not experience any change in production following mass layoffs are paper, printing, petroleum and coal, nonmetallic minerals, transportation equipment, and furniture. Although, the F value for the electrical and appliances sector is not significant, the negative signs of the coefficients indicate monthly production changing in opposite director following a layoff. Overall, our evidence suggests that industrial production has a negative association with mass layoffs in prior months.

The findings on L → P for the individual manufacturing sectors show that in 10 out of 17 cases, monthly changes in industrial production Granger causes mass layoffs. Some of the manufacturing sectors with significant F values are textile, wood products, metals, and machinery. For the sectors with significant Granger causality, the negative signs of the lagged coefficients are negative and for one month before indicating that these manufacturing sectors react very quickly a decline in production. These results are consistent with prior empirical results in Espahbodi et al. (2000, Hillier et al. (2007), Elayan et. al. (1998) that firm performance declines before layoffs. Sectors such as apparel and leather, petroleum and coal, and transportation and equipment do not appear to lay off employees in a short-term in response to production activities.

V.Conclusions

Although prior studies examine the association between layoffs and firm performance, the short-term relation between these two is not known. Also, their association is not fully investigated in light of individual industries. To this end, we examine the association between production and mass layoffs monthly series in seventeen manufacturing sectors. We employ Granger causality test on seasonally-adjusted industrial production index and number of mass layoff data from April 1995 to June 2008.

A plot of our data shows that during long-term sample period, industrial production trended upward while the number of mass layoffs trended downward indicating a negative association between these two. Our causality test results for overall data show that industrial production Granger causes mass layoffs and that mass layoffs seem to occur within a month following a decrease in production. We find no evidence of causality from mass layoffs to production for the overall data.

For the individual manufacturing sectors, we observe bidirectional causality for ten of the seventeen sectors. The signs of the lagged coefficients in $L \rightarrow P$ indicate that production decreased following an increase in mass layoffs in the majority of the sectors. A possible explanation is that layoffs in these sectors impacted employee morale and hence decreased productivity. Another explanation could be that these sectors lay off employees in anticipation of week production in the upcoming months. The signs of the lagged coefficients in $P \rightarrow L$ indicate that the number of mass layoffs increases if production decreases the previous month. It appears that some of the manufacturing sectors such as paper, chemicals, plastics and rubber react very fast to a change in production.

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Table 1. Descriptive statistics.

Industry	Variable	Obs	Mean	Median	SD
Manufacturing LOFEEGM IPMFN	# of mass layoffs	159	465.52	430.48	136.09
	industrial production	159	99.67	101.10	10.78
Food, Beverage, & Tobacco LOFEE1M IPE1T2 LOFEE2M	# of mass layoffs	159	70.97	72.42	16.07
	industrial production	159	102.17	101.20	4.10
Textile & Product Mills LOFEE3M IPE3T4 LOFEE4M	# of mass layoffs	159	23.56	21.63	9.54
	industrial production	159	101.42	100.50	12.02
Apparel & Leather LOFEE5M IPE5T6 LOFEE6M	# of mass layoffs	159	37.53	38.48	23.31
	industrial production	159	124.37	114.50	40.91
Wood Products LOFEF1M IPF1	# of mass layoffs	159	25.33	24.75	9.21
	industrial production	159	100.71	100.30	6.31
Paper LOFEF2M IPF2	# of mass layoffs	159	9.47	9.12	1.72
	industrial production	159	101.30	100.30	4.62
Printing LOFEF3M IPF3	# of mass layoffs	159	8.09	7.90	3.71
	industrial production	159	104.35	102.5	6.19
Petroleum & Coal LOFEF4M IPF4	# of mass layoffs	159	1.31	1.27	1.45
	industrial production	159	99.90	97.60	7.09
Chemicals LOFEF5M IPF5	# of mass layoffs	159	6.69	6.20	3.45
	industrial production	159	98.82	96.00	9.94
Plastics and Rubber LOFEF6M IPF6	# of mass layoffs	159	23.19	21.89	9.59
	industrial production	159	98.32	100.60	5.77
Nonmetallic Minerals LOFEF7M IPF7	# of mass layoffs	159	15.05	15.06	5.33
	industrial production	159	101.86	102.00	5.60
Primary Metals LOFEG1M IPG1	# of mass layoffs	159	21.37	18.40	11.88
	industrial production	159	108.52	109.80	6.24
Fabricated Metals LOFEG2M IPG2	# of mass layoffs	159	27.32	24.20	12.52
	industrial production	159	103.69	103.30	5.46
Machinery LOFEG3M IPG3	# of mass layoffs	159	28.27	24.04	14.69
	industrial production	159	108.92	110.20	6.58
Computer and Electronics LOFEG4M IPG4	# of mass layoffs	159	31.20	22.86	23.55
	industrial production	159	103.14	101.80	50.58
Electrical and Appliances LOFEG5M IPG5	# of mass layoffs	159	15.95	14.40	7.70
	industrial production	159	106.23	104.80	7.11
Transportation Equipment LOFEG6M IPG61T3+IPG64T9	# of mass layoffs	159	76.27	71.88	27.10
	industrial production	159	99.57	100.30	7.84
Furniture LOFEG7M IPG7	# of mass layoffs	159	14.79	13.68	6.55
	industrial production	159	97.50	99.60	7.12

Table 2. Results of Augmented Dickey-Fuller unit root test. Optimal number of lags is chosen using Akaike's Information Criterion (AIC).

Industry	Variable	Level Data ADFt	A	First Difference ADFt	A
Manufacturing	# of mass layoffs	-2.59[a]	3	-11.02[c]	2
LOFEEGM IPMFN	industrial production	-2.17	4	-3.68[c]	3
Food, Beverage, & Tobacco	# of mass layoffs	-0.97	9	-6.33[c]	8
LOFEE1M IPE1T2 LOFEE2M	industrial production	-0.32	9	-8.56[c]	2
Textile & Product Mills	# of mass layoffs	-2.73	4	-9.57[c]	3
LOFEE3M IPE3T4 LOFEE4M	industrial production	0.82	4	-5.62[c]	3
Apparel & Leather	# of mass layoffs	-1.31	6	-7.81[c]	5
LOFEE5M IPE5T6 LOFEE6M	industrial production	-0.84	4	-3.62[c]	3
Wood Products	# of mass layoffs	-2.76	4	-12.62[c]	2
LOFEF1M IPF1	industrial production	-2.12	4	-5.34[c]	3
Paper	# of mass layoffs	-2.23	4	-10.23[c]	3
LOFEF2M IPF2	industrial production	-1.23	2	-10.74[c]	1
Printing	# of mass layoffs	-2.34	5	-9.27[c]	4
LOFEF3M IPF3	industrial production	-0.47	4	-4.46[c]	3
Petroleum & Coal	# of mass layoffs	-3.85	4	-10.61[c]	3
LOFEF4M IPF4	industrial production	-1.15	2	-10.63[c]	1
Chemicals	# of mass layoffs	-2.82	4	-10.41[c]	4
LOFEF5M IPF5	industrial production	-0.75	1	-9.53[c]	1
Plastics and Rubber	# of mass layoffs	-2.42	6	-7.91[c]	5
LOFEF6M IPF6	industrial production	-2.69	4	-5.03[c]	3
Nonmetallic Minerals	# of mass layoffs	-2.59	5	-9.75[c]	4
LOFEF7M IPF7	industrial production	-2.65	3	-6.95[c]	2
Primary Metals	# of mass layoffs	-2.23	4	-9.59[c]	3
LOFEG1M IPG1	industrial production	-2.18	4	-6.03[c]	3
Fabricated Metals	# of mass layoffs	-2.57	3	-10.23[c]	2
LOFEG2M IPG2	industrial production	-2.90	5	-2.73[c]	9
Machinery	# of mass layoffs	-2.08	3	-10.07[c]	2
LOFEG3M IPG3	industrial production	-2.32	8	-3.41[c]	7
Computer and Electronics	# of mass layoffs	-2.15	9	-4.34[c]	8
LOFEG4M IPG4	industrial production	0.87	5	-3.07[c]	4
Electrical and Appliances	# of mass layoffs	-1.84	5	-7.81[c]	4
LOFEG5M IPG5	industrial production	-1.58	5	-3.94[c]	4
Transportation Equipment	# of mass layoffs	-2.39	6	-7.33[c]	5
LOFEG6M IPG61T3+IPG64T9	industrial production	-1.50	2	-9.67[c]	1
Furniture	# of mass layoffs	-2.94	3	-10.95[c]	2
LOFEG7M IPG7	industrial production	-2.43	3	-5.68[c]	2

Table 3. Results of Granger causality test between *number of mass layoffs (L) and industrial production (P)* in several manufacturing industries. Optimal number of lags is chosen by minimizing Akaike's Information Criterion (AIC) for maximum lag of 6 months [$\sqrt[3]{159} \approx 6$] and 13 months [$(12*(T/100)^{0.25}$ Schwert (1989)]. Lags reported below are in the order of dependent and independent variables (for example, in L → P, L is independent and P is dependent variable). F-value and signs of the coefficients for lagged independent variables that are significant are reported. Monthly series from April 1995 to June 2008 are used.

Industry	Causality	Maximum Lags = 6			Maximum Lags = 13		
		Lags	F-value	Coeff	Lags	F-value	Coeff
Manufacturing	L → P	3,6	1.73	none	7,8	1.37	none
	P → L	6,1	10.09[c]	-1	2,1	7.55[c]	-1
Food, Beverage, & Tobacco	L → P	1,4	5.67[c]	-1	2,4	4.82[c]	-1,-2
	P → L	6,5	1.75	-1	8,5	1.09	-1
Textile & Product Mills	L → P	6,2	3.15[b]	-1,-2	10,5	1.95 [a]	-1,-2,-3
	P → L	5,1	3.75[b]	-1	5,7	1.69	+6
Apparel & Leather	L → P	6,1	5.51[b]	-1	6,9	2.28[b]	-1,-3,-6,-7,-8
	P → L	5,1	0.37	none	5,1	0.37	none
Wood Products	L → P	3,2	2.33[a]	-1	3,1	3.54[a]	-1
	P → L	3,5	4.53[c]	-1,-2	3,6	4.40[c]	-1,-2
Paper	L → P	1,3	1.57	none	1,4	2.23[a]	-3,-4
	P → L	3.2	6.99[c]	-1	3,2	6.99[c]	-1
Printing	L → P	6,1	0.00	none	6,1	0.00	none
	P → L	4,1	4.62[c]	-1	4,9	2.59[c]	-1,-2,+3,-6,+8
Petroleum & Coal	L → P	1,1	0.19	none	1,1`	0.19	none
	P → L	4,1	0.33	none	13,1	0.14	none
Chemicals	L → P	1,3	2.72[b]	-2,-3	1,3	2.72[b]	-2,-3
	P → L	6,1	9.40[c]	-1	9,1	10.23[c]	-1
Plastics and Rubber	L → P	3,2	3.43[b]	-1	3,2	3.43[b]	-1
	P → L	5,1	7.44[c]	-1	5,1	7.44[c]	-1
Nonmetallic Minerals	L → P	2,1	0.53	none	2,1	0.53	none
	P → L	6,1	0.49	none	6,9	1.04	-4
Primary Metals	L → P	1,1	5.55[c]	-1	1,1	5.55[c]	-1
	P → L	3,1	8.17[c]	-1	3,1	8.17[c]	-1
Fabricated Metals	L → P	4,6	2.57[b]	-1,-2,-3	8.12	2.43[c]	-2,-11,+12
	P → L	2,5	1.74	-2,+5	2,5	1.74	-2,+5
Machinery	L → P	5,4	3.23[b]	-1,-2,-3	7,8	2.85[c]	-1,-2,-3,-4,-7,-8
	P → L	2,2	7.44[c]	-1	2,2	7.43[c]	-1
Computer and Electronics	L → P	4,6	3.25[c]	-2,-3,-5	10,11	2.54[c]	-2,-3,+6,-11
	P → L	5,1	0.70	none	8,7	1.24	+7
Electrical and Appliances	L → P	6,4	1.44	-2,-3,-4	6,11	1.56	-11
	P → L	4,1	4.48[b]	-1	4,9	4.48[b]	-1
Transportation Equipment	L → P	1,1	1.60	none	1,1	1.60	none
	P → L	5,1	0.06	none	5,1	0.06	none
Furniture	L → P	2,1	0.22	none	2,1	0.22	none
	P → L	2,1	7.19[c]	-1	2,9	2.62[c]	-1,+3,+8

[a, b, and c] denote statistical significance at the 10%, 5%, and 1% level, respectively.

Figure 1. Industrial Production and Mass Layoffs